ENVIRONMENTAL RESTORATION PROGRAM

FINAL
ERP SITE NO. 2 REMEDIAL INVESTIGATION REPORT

157th AIR OPERATIONS GROUP
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION
MISSOURI AIR NATIONAL GUARD
ST. LOUIS, MISSOURI

Prepared For:

ANG/CEVR
Andrews Air Force Base, Maryland

October 2004

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CONTRACT NO. DAHA92-01-D0007
Delivery Order No. 0007
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Prepared For:
ANG/CEVR
Andrews Air Force Base, Maryland

Prepared By:
MWH Americas, Inc.

October 2004

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LIST OF ACRONYMS

° F	degrees Fahrenheit
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
ANG	Air National Guard
AOC	Area of Concern
AOG	Air Operations Group
ARAR	applicable or relevant and appropriate requirement
ARNG	Army National Guard
AST	aboveground storage tank
bgs	below ground surface
Brotcke	Brotcke Well & Pump, Inc.
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CALM	Cleanup Levels for Missouri
CCV	continuing calibration verification
CE	Civil Engineer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C_{IDI}	contact/inhalation values
C_{LEACH}	soil leaching to groundwater concentration values
CLP	Contract Laboratory Program
COC	chain-of-custody
DOD	Department of Defense
EPA	Environmental Protection Agency
FS	Feasibility Study
HSA	hollow-stem auger
ID	inner-diameter
IDW	investigation-derived waste
ERP	Environmental Restoration Program
Keystone	Keystone Laboratories, Inc.
LCS	laboratory control standard
MDNR	Missouri Department of Natural Resources
mg/kg	milligrams per kilogram
MOANG	Missouri Air National Guard
msl	mean sea level
MS/MSD	matrix spike/matrix spike duplicate
MWH	MWH Americas, Inc.
NFG	National Functional Guidelines
OD	outside diameter
OpTech	Operational Technologies Corporation
PA	Preliminary Assessment
PCB	polychlorinated biphenyl
PID	photoionization detector

LIST OF ACRONYMS (CONTINUED)

ppmv	parts per million by volume
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RPD	relative percent difference
RI	Remedial Investigation
SI	Site Inspection
SOW	Statement of Work
SSP	Site Safety Plan
Station	Jefferson Barracks ANG Station
SVOC	semivolatile organic compound
TEH	total extractable hydrocarbons
TPH	total petroleum hydrocarbons
U.S.	United States
UST	underground storage tank
VOC	volatile organic compound

EXECUTIVE SUMMARY

MWH Americas, Inc. (MWH) has been contracted under the Environmental Restoration Program (ERP) to complete a Remedial Investigation (RI) for the Missouri Air National Guard's (MOANG's) 157th Air Operations Group (AOG) at the Jefferson Barracks Air National Guard (ANG) Station (Station) in St. Louis, Missouri. This work is being performed under Contract No. DAHA-92-01-D0007, Delivery Order No. 0007.

The purpose of the RI is to determine the nature and extent of chemical constituents in soil and groundwater at ERP Site No. 2; and to evaluate the threat to public health, welfare, and the environment.

A Preliminary Assessment started in 1993 by Operational Technologies Corporation (OpTech) identified four sites at the Station as Areas of Concern (AOCs), and recommended AOC-A through AOC-D (now referred to as ERP Sites No. 1 through 4) for further investigation. The four AOCs were further investigated by OpTech during the Site Inspection (SI) phase of their investigation, the purpose of which was to determine if chemical constituents were present at each AOC.

The SI phase, conducted in December 1994, consisted of a geophysical survey at AOC-A and AOC-D, a soil vapor survey at the four AOCs used to develop the optimum locations of borings, and soil borings at the four AOCs to confirm and to attempt to delineate chemical constituents in soil. Piezometer installation was planned as part of the SI activities to determine groundwater flow direction in the vicinity of the AOCs, but as groundwater was not encountered above the bedrock in the majority of borings, piezometers were not installed.

AOC-A, AOC-C, and AOC-D (ERP Sites No. 1, 3, and 4) received a No Further Response Action Planned designation from the Missouri Department of Natural Resources (MDNR) and are not addressed further in this RI Report.

The PA determined AOC-B (ERP Site No. 2) to be a relatively small area storage area adjacent to the south side of Building 51. Building 51 was constructed in the late 1960s and utilized for vehicle maintenance. The used oil generated by these activities was

disposed east of Building 42 and south of Building 51 during the 1960s and 1970s. A 3,000-gallon aboveground storage tank (AST) was used to store used motor oil in the southwestern portion of ERP Site No. 2. The AST replaced 55-gallon drums that had previously been used for storage of the used oil. Other materials such as hydraulic fluid, new motor oil, and cleaning compounds were stored in 55-gallon drums on gravel within ERP Site No. 2. The gravel was periodically replaced because of staining from spilled materials. The AST was subsequently removed.

During the SI, soil vapor survey points were advanced at ERP Site No. 2, to screen for chemical constituents associated with possible spillage from used oil and solvent storage. Total petroleum hydrocarbons (TPH) were detected in three soil vapor samples; and toluene, ethylbenzene, and xylene were detected in one soil vapor sample. Four soil borings were advanced at ERP Site No. 2, and three soil samples were collected from each boring for laboratory analysis for volatile organic compounds, semivolatile organic compounds (SVOCs), TPH, and metals. SVOCs were detected in two soil samples, and TPH was detected in four soil samples. Six metals were detected in the soil samples, namely arsenic, beryllium, copper, lead, nickel, and zinc. TPH, benzo(a)pyrene, and beryllium were the only chemical constituents detected in soil above the current MDNR soil cleanup action levels.

In September 2003, MWH finalized the *ERP Site No. 2 Remedial Investigation Work Plan* describing procedures of the additional investigation sampling and analysis activities at this site. The technical approach was to use data gathered during previous investigations to streamline and focus the RI field data collection activities. The purpose of the RI investigative activities was to verify the soil and groundwater conditions noted during the SI; to provide the additional information necessary to delineate the areal extent, depth, and concentration of chemicals present in soil and groundwater; and to determine the apparent direction of groundwater flow beneath ERP Site No. 2. The proposed RI activities included the advancement of eight soil probeholes to collect near-surface soil samples; the drilling of boreholes to facilitate installation of four groundwater monitoring wells; and two separate rounds of groundwater monitoring at the newly-installed wells. The RI fieldwork was conducted during October and December 2003.

The Station is located along the western bank of the Mississippi River, approximately 10 miles south of the city of St. Louis, in St. Louis County, Missouri. The Station occupies approximately 135 acres and is bordered by the Mississippi River to the east. The shallow subsurface is comprised predominantly of clay, silty clay, and sand, with some gravel lenses. During the 2003 RI field activities, the apparent horizontal groundwater flow direction at ERP Site No. 2 was determined to be generally toward the east, in the direction of the Mississippi River, as was previously estimated. Horizontal hydraulic gradients calculated for the 2003 field activities were approximately 0.13 foot/foot across ERP Site No. 2.

2003 RI activities at ERP Site No. 2 detected soil contamination of SVOCs, total TPH, and arsenic in excess of MDNR soil cleanup action levels. SVOC exceedances were limited to the shallow soil intervals of SB-2 and SB-8 (east of the former location of the AST). The TPH exceedance was limited to the 6-10 foot below ground surface interval of boring SB-3 (off the southwest corner of the large concrete pad). Arsenic exceedances were detected in seven of the eight deep soil intervals (seven of the total sixteen samples) collected during the 2003 RI. It should be noted that high levels of arsenic are common in soils near the Station. These are likely normal background soil levels per the geochemical survey of Missouri agricultural soils undertaken in the 1970s (Tidball, 1984), as illustrated by a comparison of ERP Site No. 2 arsenic levels (ranging from 7.1 to 12.4 milligrams per kilogram [mg/kg]) to the geochemical survey arsenic levels nearest the Station (ranging from 7.0 to 70 mg/kg).

Based on the soil sampling completed to date at ERP Site No. 2, it appears natural attenuation has reduced the concentrations of many constituents in soil in the time since the SI fieldwork was completed.

The 2003 groundwater sampling activities indicated no chemicals of concern above MDNR Cleanup Levels for Missouri (CALM) standards. Although constituents are present in soil at ERP Site No. 2, they are not leaching to groundwater.

However, to address the SVOC and TPH constituents remaining in the soil at concentrations above the MDNR CALM standards, the soil will be overexcavated and

disposed at an off-site location. As part of the overexcavation activities, some additional delineation will be required at the areas near soil borings SB-2, SB-3, and SB-8. The proposed soil delineation and soil removal activities will be addressed in a Removal Action Work Plan, to be submitted and approved by MDNR.

1.0 INTRODUCTION

1.1 PROJECT PURPOSE AND SCOPE

MWH Americas, Inc. (MWH) received a contract delivery order (Contract No. DAHA-92-01-D0007, Delivery Order No. 0007) from the Air National Guard (ANG), under the provisions of the Environmental Restoration Program (ERP), to complete a Remedial Investigation (RI) and corresponding Decision Document for the 157th Air Operations Group (AOG) at the Jefferson Barracks ANG Station (Station) in St. Louis, Missouri (Figure 1). This RI Report summarizes soil and groundwater investigative activities at the final outstanding ERP site at the Station, namely ERP Site No. 2 (Figure 2), formerly designated as Area of Concern B (AOC-B).

The purpose of the RI is to determine the nature and extent of chemical constituents in soil and groundwater at ERP Site No. 2; and to evaluate the threat to public health, welfare, and the environment. The RI Report is intended to provide sufficient background of ERP Sit No. 2, including history, physical setting, and nature and extent of the chemical constituents, in order to evaluate the next step in the process toward closing ERP Site No. 2.

The RI Report has been prepared on behalf of the ANG by MWH and generally follows the format and content guidelines associated with applicable State of Missouri regulations, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, the National Oil and Hazardous Substances Pollution Contingency Plan, and the procedures set forth in the Guidance for Conducting Non-Time Critical Removal Actions Under CERCLA (Environmental Protection Agency [EPA]/540/R/92/057), the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA/540/G-89/004), and the basic Statement of Work (SOW).

1.2 INSTALLATION RESTORATION PROGRAM DESCRIPTION

The Department of Defense (DOD) developed the ERP to identify and evaluate sites on DOD property where contamination may be present due to past releases of hazardous

chemicals or hazardous waste storage, handling, or disposal practices. The purpose of the ERP is to confirm the presence or absence of suspected chemical constituents; and to mitigate hazards to health, welfare, or the environment that may result from the presence and migration of these chemicals. Additionally, the ERP process is designed to aid in remediation of contaminated sites. The steps in the ERP process are summarized below:

- Preliminary Assessment (PA) - A PA is performed to identify the locations of suspected areas of contamination at a site. Normally, this involves interviews with personnel familiar with operations at the site, historical record searches, and visual site inspections. A PA identifies AOCs that need further investigation, and possibly remediation.

- Site Investigation - After identification of AOCs from the PA, a Site Investigation is typically conducted to confirm or deny the existence of environmental contamination at the site. Activities involved in the Site Investigation include sampling various media for chemicals of concern and identifying the possibility for chemical migration. The Site Investigation identifies those areas from the PA that need further attention. Additional investigative activities can then be conducted at the site, leading to eventual cleanup of the impacted areas.

- RI - During an RI, additional data is collected, to define the extent of chemical constituents identified during the Site Investigation and to assess potential risks to human health and the environment. The RI determines the magnitude and extent of the constituents. The magnitude and extent of chemical constituents must be determined before proper remediation of the sites can be accomplished.

- Feasibility Study (FS) - An FS is conducted subsequent to the RI to evaluate possible remedial alternatives for the site. Based on the extent of chemical constituents determined during the RI, the FS evaluates a variety of factors (cost, ease of implementation, availability of technology, degree of remediation, etc.) to determine the most appropriate remedial alternative. Analysis of remedial alternatives is essential to proper

Plot Date: 3/5/04

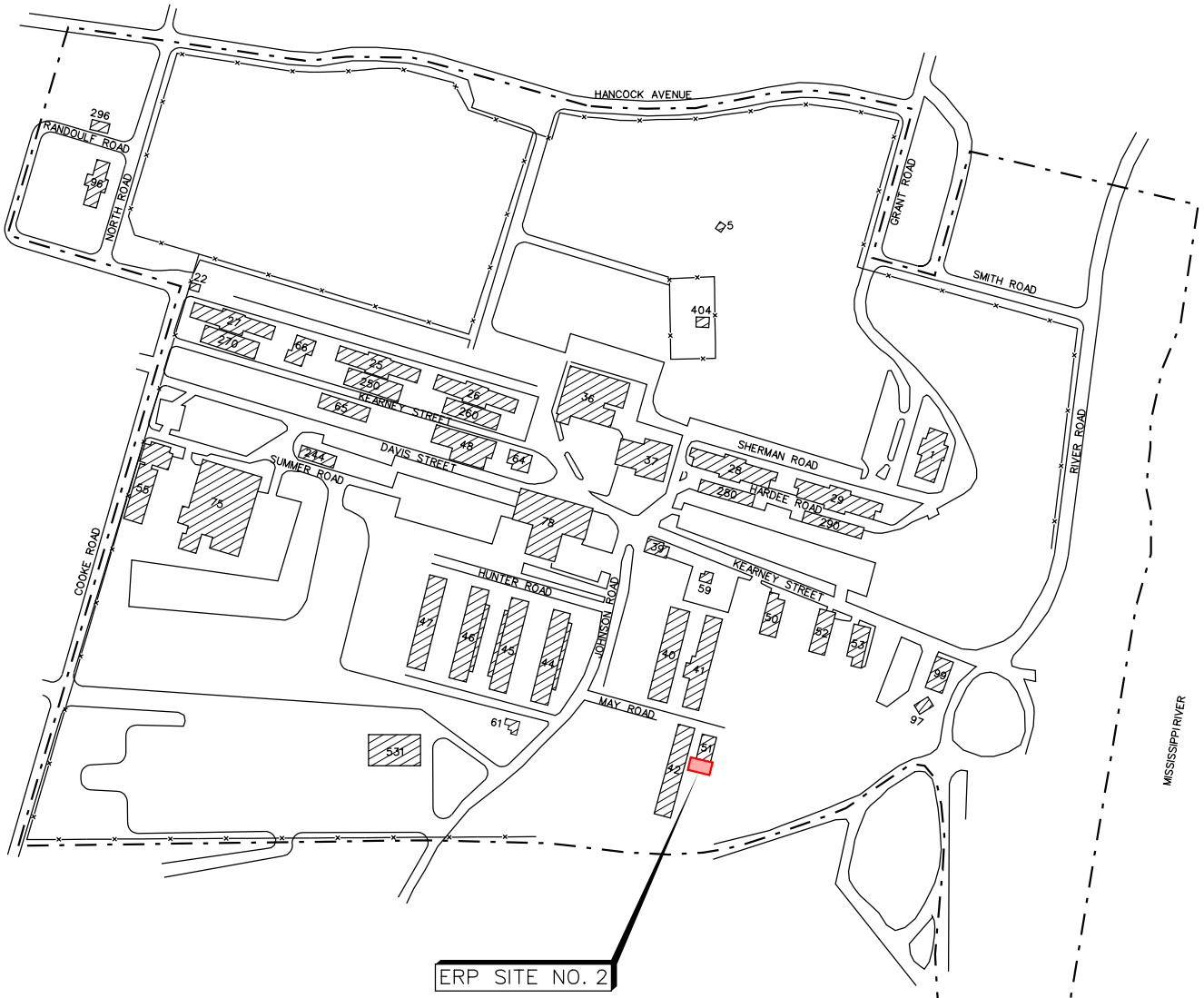
MAP SOURCE:

USGS TOPOGRAPHIC QUADRANGLES
OAKVILLE, MISSOURI–ILLINOIS
WEBSTER GROVES, MISSOURI–ILLINOIS

0 1000 2000
SCALE IN FEET

P:\CAD\GUARD\MW\ST.LOUIS\R WORK PLAN\BDR

MWH DES MOINES IOWA	157TH AIR OPERATIONS GROUP JEFFERSON BARRACKS ST. LOUIS, MISSOURI	157TH AIR OPERATIONS GROUP LOCATION	FIGURE 1



LEGEND:

- BUILDING
- FENCE
- PROPERTY BOUNDARY

N

0 500

APPROXIMATE SCALE IN FEET

SOURCE: IRP PA/SI REPORT FOR JEFFERSON BARRACKS ANG STATION, BY OPTECH CORP., MARCH 1997.

MWH Des Moines Iowa	157TH AIR OPERATIONS GROUP JEFFERSON BARRACKS ST. LOUIS, MISSOURI	ERP SITE NO. 2 LOCATION	FIGURE 2

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cleanup of the site. The appropriate alternative (both technological and economical) must be selected to ensure proper remediation. Additional investigative studies, such as treatability studies, may be necessary to complete this phase.

- Remedial Design (RD) - The purpose of the RD is to produce design drawings and specifications for the selected alternative. The selected alternative is presented in the recommendations of the FS. A properly designed remediation system will allow effective site remediation.

- Remedial Action (RA) - The RA consists of the implementation of the RD. Implementation of the RD must be conducted thoroughly and in accordance with the RA Work Plan in order to ensure proper site remediation.

The above steps make remediation of the identified site, the ultimate goal of the ERP process, a reality.

1.3 GENERAL INVESTIGATIVE APPROACH

On-site RI activities at ERP Site No. 2, the Building 51 storage area, included the advancement of eight soil probeholes using Geoprobe® technology to collect near-surface soil samples; hollow-stem auger technology to drill borings to facilitate installation of four groundwater monitoring wells; and two separate rounds of groundwater monitoring at the newly-installed wells. The field activities, methods, and procedures followed those proposed in the *Final ERP Site No. 2 Remedial Investigation Work Plan* of September 2003.

1.4 REPORT ORGANIZATION

This RI Report has been prepared on behalf of the ANG by MWH and generally follows the organizational guidelines contained in the SOW and the United States (U.S.) EPA guidance documents. The RI Report has been organized into the following sections:

- Section 1 is an introduction and includes the purpose and scope of the RI Report.

- Section 2 presents information on the Station background and history, including previous investigations conducted at ERP Site No. 2.

- Section 3 summarizes the physical characteristics and setting of the Station including climate, topography, geology, hydrogeology, and surface water.

- Section 4 is a summary of the field activities and procedures conducted at ERP Site No. 2 by MWH in October and December 2003.

- Section 5 discusses the nature and extent of soil and groundwater chemical constituents at ERP Site No. 2.

- Section 6 summarizes the applicable or relevant and appropriate requirements (ARARs) to ERP Site No. 2.

- Section 7 presents the summary and conclusions of the RI Report.

- Section 8 includes the references used in the RI Report.

2.0 STATION BACKGROUND INFORMATION

This section provides background information for the Station and ERP Site No. 2, including location, adjacent land use, Station history, and previous and recent investigations conducted at ERP Site No. 2. The contents of this section are taken primarily from the March 1997 ERP PA/SI Report (Operational Technologies Corporation, 1997) prepared by Operational Technologies Corporation (OpTech) of San Antonio, Texas, and other documents discussed below.

2.1 LOCATION

The Station is situated in eastern Missouri, which includes the confluence of two of the nation's largest rivers, the Missouri and the Mississippi. As shown in Figure 1, the Station is located along the western bank of the Mississippi River, approximately 10 miles south of the city of St. Louis, in St. Louis County, Missouri. The Station occupies approximately 135 acres and is bordered by the Mississippi River to the east. The main entrance to the Station is currently through the north gate.

2.1.1 Adjacent Land Use

Land use in the vicinity of the Station is generally mixed residential and commercial. The Station is bounded by a county park to the north, a national veterans cemetery to the south, and an apartment complex to the west.

2.2 STATION HISTORY

Currently stationed at the Station are several ANG units including Headquarters 157th AOG, 218th Engineering Installation Squadron, 121st Air Control Squadron, and a Civil Engineering detachment. Also located at the Station are several Army National Guard (ARNG) units, components of the U.S. Army Reserve, National Guard Bureau Human Resources (eastern division), Defense Fuels Supply, and the U.S. Coast Guard. A full-time work force of approximately 140 people supports the Station's total unit training assembly population of over 2,000 soldiers.

On July 10, 1826, troops of the U.S. First Infantry Regiment encamped at the site later known as Jefferson Barracks. The military reservation of Jefferson Barracks was established on the edge of a vast expanse of wilderness known as the Louisiana Purchase. At the beginning, Jefferson Barracks was the largest military reservation in the country, covering over 1,700 acres and stretching 2 miles along the west bank of the Mississippi River. Jefferson Barracks was the first basic training camp of the U.S. Army and home of the First U.S. Cavalry. Throughout its history, Jefferson Barracks served as a U.S. Ordnance Depot, U.S. Army Engineers Depot, the largest U.S. Army General Hospital, U.S. Naval Munitions Storage Depot, Introduction and Separation Center, National Guard Mobilization Headquarters, Army Air Corps School, and as a training base. During the 1800s, Jefferson Barracks utilized mainly stone or wooden buildings. An extensive rebuilding program took place between 1890 and 1905, replacing the original stone and wooden buildings with red brick structures, which are still in use today. During World War I, Jefferson Barracks was designated as a clearing house for recruits. With the advent of World War II, there was a large increase in the population of Jefferson Barracks. Numerous temporary facilities and temporary wooden buildings were constructed to accommodate the increase in population.

On June 30, 1946, Jefferson Barracks was deemed unfavorable for use as a training site for a large modern army, and was declared surplus and erased from the muster roles as an active post. Elements of the Missouri National Guard then moved onto the base. On June 8, 1950, a tract of land containing 135 acres was transferred to the State of Missouri for use in training and maintaining reserve (National Guard) components of the armed forces. Hence, the former 1,700 acres of military reservation was reduced to 135 acres. In 1952, Missouri Guard units at Jefferson Barracks included the ANG's 157th Tactical Control Group, 181st Tactical Control Squadron, two Ground Electronic Engineering Installation Agency Squadrons, and ARNG Organizational Maintenance companies which provided vehicle maintenance to ARNG units in the St. Louis area. By 1970, most ARNG units in the St. Louis area had moved to Jefferson Barracks, and the majority of the maintenance activities at Jefferson Barracks were related to vehicle maintenance support or ARNG combat units.

In order for the Air Force to provide funds for the construction and maintenance of facilities used by the ANG at Jefferson Barracks, it required that the property be leased back to the Federal Government for a long term (at least 20 years). This lease was signed in 1970 and is effective until the year 2023. Since the lease was signed, the ANG has upgraded many of the 1890-1905 era buildings (red brick) to modern-day standards while maintaining their historical architectural features. The temporary wooden buildings from the World War II era have been demolished with the exception of one building. It has been upgraded and is currently in use as a carpenter shop for the ANG Civil Engineers. Some buildings under ARNG control have been improved, but most have not been maintained due to lack of funds. ANG units assigned to Jefferson Barracks provide radar support to both active and reserve organizations. ARNG units provide combat engineers, military police, and transportation and vehicle maintenance support. The size of the full-time work force, Air Force and Army technicians, active duty personnel, and Missouri State employees gives the Station the appearance of an active duty base.

2.3 PREVIOUS INVESTIGATIONS

The Air National Guard Readiness Center/Installation Restoration Branch authorized OpTech to conduct a PA/SI at the Station. The PA of the 157th AOG was initiated by ANG Readiness Center and OpTech personnel in November 1993. The PA consisted of interviews with personnel who were stationed at Jefferson Barracks at the time of the interview or who were retired or currently assigned to other military installations, all of whom were determined to be knowledgeable of the current and past waste disposal practices conducted at the Station. The PA also included a review of Station records and field observations.

The PA process revealed four AOCs at the Station, based on their historical use of hazardous materials and hazardous wastes; one of those AOCs was designated AOC-B, a storage area south of Building 51, now known as ERP Site No. 2 (Figure 2). The four AOCs (AOC-A through AOC-D) were further investigated by OpTech during the SI phase of their investigation, the purpose of which was to determine if contamination was present at each AOC, and, if so, if the presence of concentrations warranted further investigation as an ERP site.

The SI phase was conducted from December 5 through 15, 1994. It consisted of: a geophysical survey at AOC-A and AOC-D to provide information on possible buried sources of chemical constituents, and to verify no subsurface structures or hazards to drilling were present based on historical information obtained during the PA; a soil vapor survey at the four AOCs to delineate the extent of impacting benzene, toluene, ethylbenzene, and total xylenes (BTEX) or total petroleum hydrocarbon (TPH), the results of which were used to develop the optimum locations of borings; and soil borings at the four AOCs to confirm and to attempt to delineate chemical constituents in soil. A total of 14 soil borings were drilled at the AOCs to obtain soil samples for field screening, subsurface geological characterization, and laboratory analytical analyses. A total of 37 soil samples and three surface sediment samples were submitted for AOC-specific analytical analyses that included testing for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), TPH, and total metals. The soil samples were field-screened using a photoionization detector (PID) and a field gas chromatograph, then subsequently analyzed for the laboratory parameters related to the potential chemicals of concern identified in the PA. The historical analyte detections in soil from the 1994 SI are included as Appendix A.

Piezometer installation was planned as part of the SI activities to determine groundwater flow direction in the vicinity of the AOCs, but as groundwater was not encountered above the bedrock in the majority of borings during drilling, and at the direction of the ANG Readiness Center, piezometers were not installed.

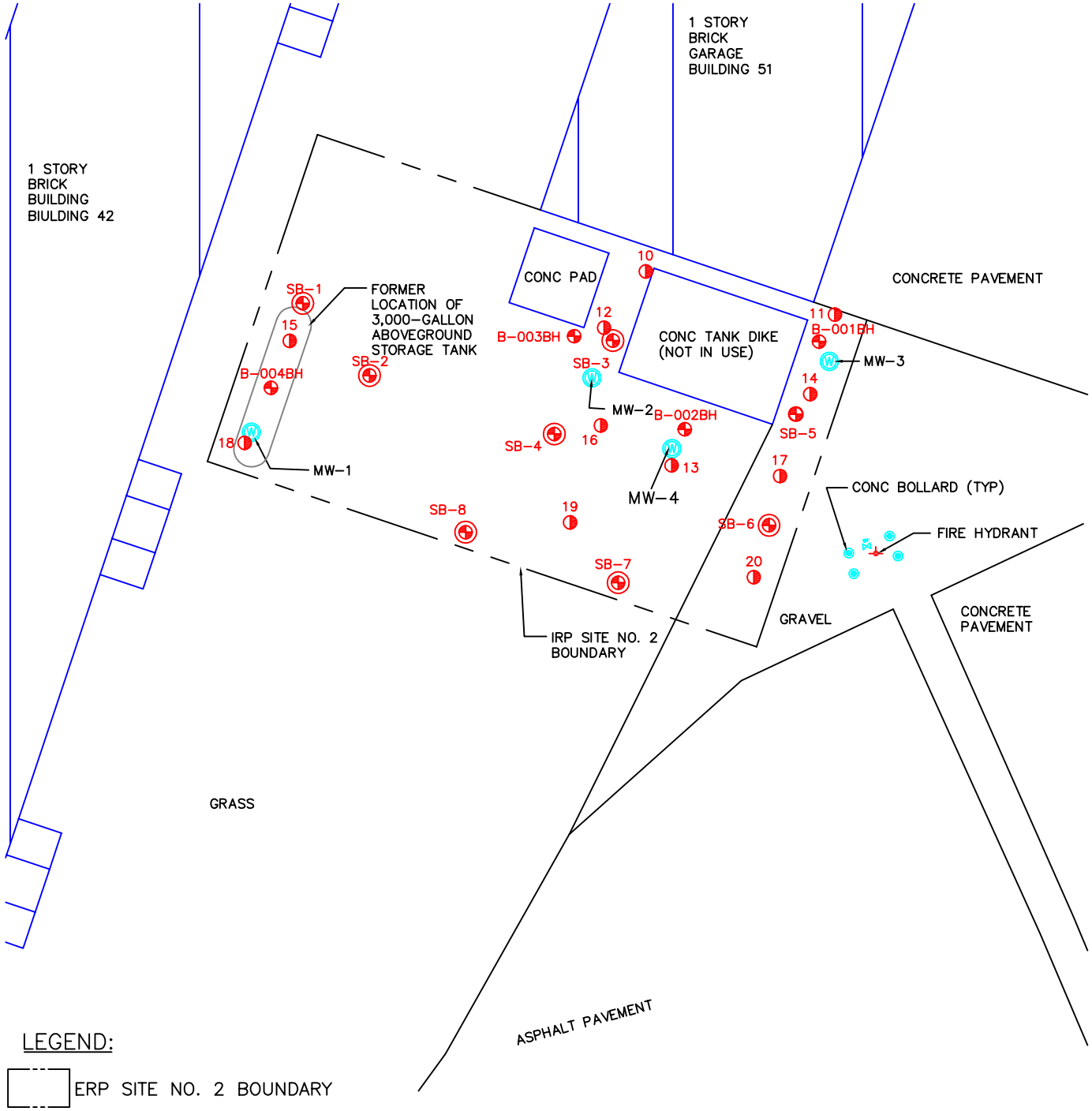
AOC-A, AOC-C, and AOC-D, designated by OpTech during the PA/SI, received a No Further Response Action Planned designation from the Missouri Department of Natural Resources (MDNR) in a letter dated May 28, 2003, and are thus not addressed further in this RI Report.

2.4 ERP SITE NO. 2 DESCRIPTION

Based on the PA conducted in 1993 and 1994, Building 51 was constructed in the late 1960s and was used for vehicle maintenance on a full-time basis until 1975. Building 51 had two maintenance bays where a combined total of two to four vehicles were serviced

weekly. The used oil generated by the vehicle maintenance activities at Building 51 was disposed east of Building 42 and south of Building 51 during the 1960s and 1970s. The PA determined the AOC at Building 51 to be the roughly 40- by 60-foot area adjacent to the building on the south side, surfaced by grass, gravel, and a small concrete pad. This area is currently used to store grounds maintenance vehicles and equipment, and other miscellaneous nonhazardous materials. A HAZ-STOR building is located in this area, adjacent to the southwest corner of Building 51; and a 15- by 18-foot concrete pad, constructed in 1991, is situated adjacent to the southeast corner of Building 51 (Figure 3). A 3,000-gallon aboveground storage tank (AST) was used to store waste motor oil in the southwestern portion of the storage area; the AST was removed, and no physical evidence of its previous location remains at the site. The AST replaced 55-gallon drums that had previously been used for storage of the used oil. It is estimated the AST was present from the early 1970s until the late 1980s and was used to store waste motor oil from all ARNG maintenance facilities. Other materials such as hydraulic fluid, new motor oil, and cleaning compounds were stored in 55-gallon drums on gravel within the storage area. The gravel was periodically replaced because of staining from spilled materials. No records documenting the disposition of the replaced gravel were found during the PA work completed by OpTech.

During the SI, eleven soil vapor survey points (labeled 10 through 20; Figure 3) were advanced at ERP Site No. 2, to screen for chemical constituents associated with possible spillage from used oil and solvent storage. Four soil borings (labeled B-001BH through B-004BH; Figure 3) were advanced at ERP Site No. 2, and three soil samples were collected from each boring for laboratory analysis. Each soil sample was analyzed for VOCs, SVOCs, TPH, and metals. TPH, benzo(a)pyrene, and beryllium were detected in soil above the current MDNR soil cleanup action levels.



Plot Date: 3/24/04

P:\CAD\GUARD\AIR\STLOUIS\RI WORK PLAN\FIG03

MWH DES MOINES IOWA	157TH AIR OPERATIONS GROUP JEFFERSON BARRACKS ST. LOUIS, MISSOURI	ERP SITE NO. 2 LAYOUT	FIGURE 3

3.0 ENVIRONMENTAL SETTING

The environmental setting of the Station is presented through discussions of physiography, climate, geology, soils, hydrogeology, and surface water. These discussions incorporate both regional and local perspectives. Information and results from this and other previous investigations have been used, where applicable, to describe the geologic setting and hydrogeologic characteristics of the Station and ERP Site No. 2.

3.1 CLIMATE

The climate of Missouri is essentially continental. There are frequent changes in weather, both from day to day and from season to season. Missouri is in the path of cold air moving down out of Canada, warm, moist air coming up from the Gulf of Mexico, and dry air from the west. While winters are cold and summers hot, prolonged periods of very cold or very hot weather are unusual.

In the summer, temperatures in eastern Missouri rise to 90 degrees Fahrenheit (° F) or higher on an average of 55 to 60 days each year. In the winter, there is an average of about 70 days with temperatures below 32° F. The annual average temperature in the St. Louis area is 55.3° F.

The majority of precipitation occurs during the fall, winter, and early spring months. Measurable precipitation occurs on an average of about 100 days each year; about half of those will be days with thunderstorms. Precipitation in the St. Louis area averages approximately 38 inches a year. Snowfall is the most common in December, January, and February, with a yearly average of approximately 17 inches. Major flooding occasionally occurs along the Missouri and Mississippi Rivers, normally from March through July. Tornadoes are also a danger in the area, mainly occurring from March through June.

3.2 TOPOGRAPHY

3.2.1 Regional Topography

The topography of St. Louis County varies widely in character, ranging from the flat, almost featureless floodplains of the Missouri and Mississippi Rivers, to the rugged,

intensely dissected uplands of the west county area. The area lies within the Dissected Till Plains physiographic province, a gently undulating region, with altitudes ranging from 500 to 700 feet above sea level.

3.2.2 Site Topography

The elevation of the Station ranges from approximately 390 (the general elevation of the Mississippi River at the Station) to 500 feet above mean sea level (msl). Construction of buildings, roads, and parking areas has altered the original topography of the Station where native soils have been cut and graded to provide flat construction surfaces.

The ERP Site addressed in this RI Report is a relatively level area. ERP Site No. 2 has a gentle slope from west to east. The elevation of ERP Site No. 2 ranges from approximately 452 to 456 feet above msl.

3.3 GEOLOGY

3.3.1 Soils

Soils at the Station consist primarily of the Urban Land-Harvester complex, which are deep, moderately drained silt loams. This complex consists of Urban Land and the intermingled areas of moderately well-drained Harvester soils on rolling and hilly uplands. Prior to urban development, these areas contained circular and elongated limestone sinks known as karst topography. Some sinks have been filled or altered during development and are no longer easily recognized. The karst areas are about 50 to 55 percent located in Urban Land and Harvester soils, and are so intermingled or in such intricate patterns that to separate them in mapping is not practical. The Urban Land part of this complex is covered by streets, parking lots, and other structures that so obscure or alter the soil that identification of the series is not feasible (United States Department of Agriculture Soil Conservation Service, 1979). Typically, the surface layer of the Harvester soil is mixed very dark grayish brown to brown silt loam about 2 inches thick. The next layer, to a depth of about 20 inches, consists of brown and pale brown silt loam and silty clay loam fill material. Below the reworked fill material to a depth of 60 inches is older, unworked, brown silt loam. In places, cuts and fills are several feet deep, and the cuts expose residual chert or limestone bedrock. In a few places, the surface layer is

silty clay loam. In some areas, slopes around the sinks are more than 20 percent. The Urban land soil is essentially impervious to water. Permeability is moderately slow in the Harvester soils, natural fertility is medium, and organic matter content is very low. The surface layer of the Harvester soils is friable. Surface runoff is rapid to very rapid.

The Harvester soils in the complex are in yards, open spaces around buildings, parks, and gardens, and in undeveloped random tracts that are primarily in and around sinks. Most of the sinks in the unit are deep and have steep sides. They are generally not suitable for building sites because soils on the sides of the sinks are generally not stable; also, the sink can become plugged, resulting in a saturated soil condition in the bottom of the sink during some parts of the year.

3.3.2 Regional Geology

Three major structural features have been noted in the vicinity of the Station: the St. Louis Fault, Dupo Anticline, and the Cheltenham Syncline. The St. Louis Fault trends northeast and the rock layers dip one to two degrees toward the northeast. The Dupo Anticline trends northwest from Illinois into Missouri. The Cheltenham Syncline is located directly west of the Dupo Anticline. Rock formations that crop out consist primarily of limestone and cherty limestone, although several shale units are present. Exposed formations that range in age from Ordovician to Mississippian are distributed throughout St. Louis County, Missouri. The geology of the region is characterized by up to 150 feet of unconsolidated material, which is underlain by bedrock. The unconsolidated material includes lacustrine and glacial till deposits, which consist primarily of silt and clay. The St. Louis and Salem Formations are subject to the development of karst (sinkhole) topography.

Eastern Missouri lies near the western margin of the Illinois Basin; bedrock was deposited in the Illinois Basin during the Mississippian Period, 360 million years ago, and lasted approximately 30 million years. The stratigraphic sequence preserved in the basin ranges from Cambrian to Upper Pennsylvanian in age. Regional bedrock is made up of the Meramecian Group, which consists of (in ascending order) the Warsaw, Salem, St. Louis, and St. Genevieve Formations. The St. Louis Formation is the uppermost

bedrock unit at Jefferson Barracks. In east-central Missouri, the total maximum thickness of the Meramecian Group ranges from 300 to 450 feet. The lithology of the Meramecian Group consists primarily of shale, shaley limestone, dolostone, and limestone. The St. Louis and St. Genevieve Formations are primarily massive, fine-grained limestones containing occasional thin shale beds and chert. Shale and shaley limestone occur primarily in the lower half of the Group, in the Warsaw and Salem Formations. The Salem Formation is the most argillaceous (contains clay material) of the group and grades into a shaley limestone at its base.

3.3.3 Site Geology

Soil lithologic information obtained by MWH from wells drilled and boreholes advanced during the October and December 2003 RI activities indicate the shallow subsurface is comprised predominantly of clay, silty clay, and sand, with some gravel lenses.

3.4 HYDROGEOLOGY

3.4.1 Regional Hydrogeology

In addition to surface-water sources, a large amount of water is available from bedrock and alluvial aquifers that underlie the region. Though some groundwater is too mineralized to use, much of it is fresh and of good quality. Throughout much of St. Louis County, potable groundwater supplies are available from Mississippian limestones, but water yields are highly variable and unpredictable. However, these bedrock and alluvial aquifers account for only one to two percent of the total pumpage, respectively (United States Geological Survey and Missouri Geological Survey and Water Resources, 1974).

Large amounts of fresh water are stored in the bedrock and alluvium underlying the area. The bedrock aquifers are primarily dolomite and limestone with one notable exception, the St. Peter Sandstone. Groundwater occurs along fractures, bedding planes, in solution openings in the limestone and dolomite, and in voids between the grains in sandstone. The principal bedrock aquifers are the St. Peter, the Roubidoux, the Gasconade, and the Potosi. Shallow bedrock aquifers that are hydraulically connected with the rivers also receive recharge from natural infiltration of the rivers during sustained high-river stage

and flooding. Most private water wells are only drilled deep enough to encounter the St. Louis Limestone, Salem Formation, or Warsaw Formation, which are minor aquifers (MDNR, October 1996).

Areas having the greatest potential for development of groundwater are in the Mississippi and Missouri River floodplains. Water from the alluvial deposits generally is a very hard calcium-magnesium-bicarbonate type with iron and manganese content commonly being high. Saline water has moved upward from the underlying bedrock into the alluvial aquifers at Valley Park and Times Beach in the Meramec River valley and in the Mississippi River valley near St. Peters. Alluvial aquifers in the area are recharged by infiltration of stream water during sustained high-river stage flooding, by direct precipitation, and by underflow from underlying and adjacent bedrock.

An undetermined amount of discharge from deeper aquifers into shallow aquifers is taking place in the St. Louis area. In areas such as Valley Park, where deep wells have been improperly cased or where casings have deteriorated, mineralized water from deeper aquifers has moved up into shallower horizons and, where head differences permit, some waters move from shallower aquifers into deeper ones through wells (United States Geological Survey and Missouri Geological Survey and Water Resources, 1974). The unconsolidated deposits in the vicinity of the Station are not considered to be an aquifer due to the low water-bearing capacity of the deposits. Well yields from these deposits are described as "essentially not water yielding" (PEER Consultants, P.C., 1993). Logs of wells drilled in the general area show total depth completions ranging from approximately 200 to 325 feet below ground surface (bgs), with yields from 0.5 to 4 gallons per minute. According to the MDNR, there are no active public water supply wells within a 4-mile radius of the Station.

A zone of karst terrain occurs in a discontinuous belt surrounding the Station on the northeast, west, and southwest. Karst terrain is characterized by the development of caves and sinkholes, and groundwater flow in karst terrain occurs principally in solution-enlarged joints and fractures. Consequently, the direction of groundwater flow in bedrock in the vicinity of the Station is difficult to ascertain.

3.4.2 Site Hydrogeology

Due to the lack of geologic data from geotechnical or RI activities conducted at the Station in the past, it was not possible to accurately estimate site-specific groundwater conditions. Although no groundwater was encountered during excavations for removal of underground storage tanks (USTs) at the SS-1 site west of Building 40, groundwater was encountered in some of the borings drilled during the 1994 SI fieldwork (OpTech, 1997). It was previously estimated that local shallow groundwater flow direction is generally toward the Mississippi River.

The measured depths to groundwater at ERP Site No. 2 were approximately 17 to 23 feet bgs during October 2003, and 14.5 to 23 feet bgs in December 2003 (Table 1).

During the 2003 RI field investigation activities, the apparent horizontal groundwater flow direction at ERP Site No. 2 was generally toward the east, in the direction of the Mississippi River, as was previously estimated for the SI. Shallow groundwater contour maps, for October and December 2003, are included as Figures 4 and 5, respectively. Horizontal hydraulic gradients calculated for the 2003 field activities were approximately 0.13 foot/foot across ERP Site No. 2.

3.5 SURFACE WATER

The City of St. Louis, near the confluence of the Missouri and Mississippi Rivers, has abundant access to surface-water supplies. According to the MDNR, the City of St. Louis draws 100 percent of surface water from the Missouri River (Missouri Department of Natural Resources, October 1996). Flooding can occur in the area during all months, but is most common in March through July.

Federal Emergency Management Agency floodplain maps were reviewed by OpTech personnel to determine the extent of the 100-year floodplain in the vicinity of the Station. The majority of the Station is not situated within the 100-year floodplain, but is located in Zone C, or "areas of minimal flooding." Only a small portion of the Station, along the riverbank, is impacted by the 100-year floodplain. All natural drainage from the Station flows directly to the Mississippi River.

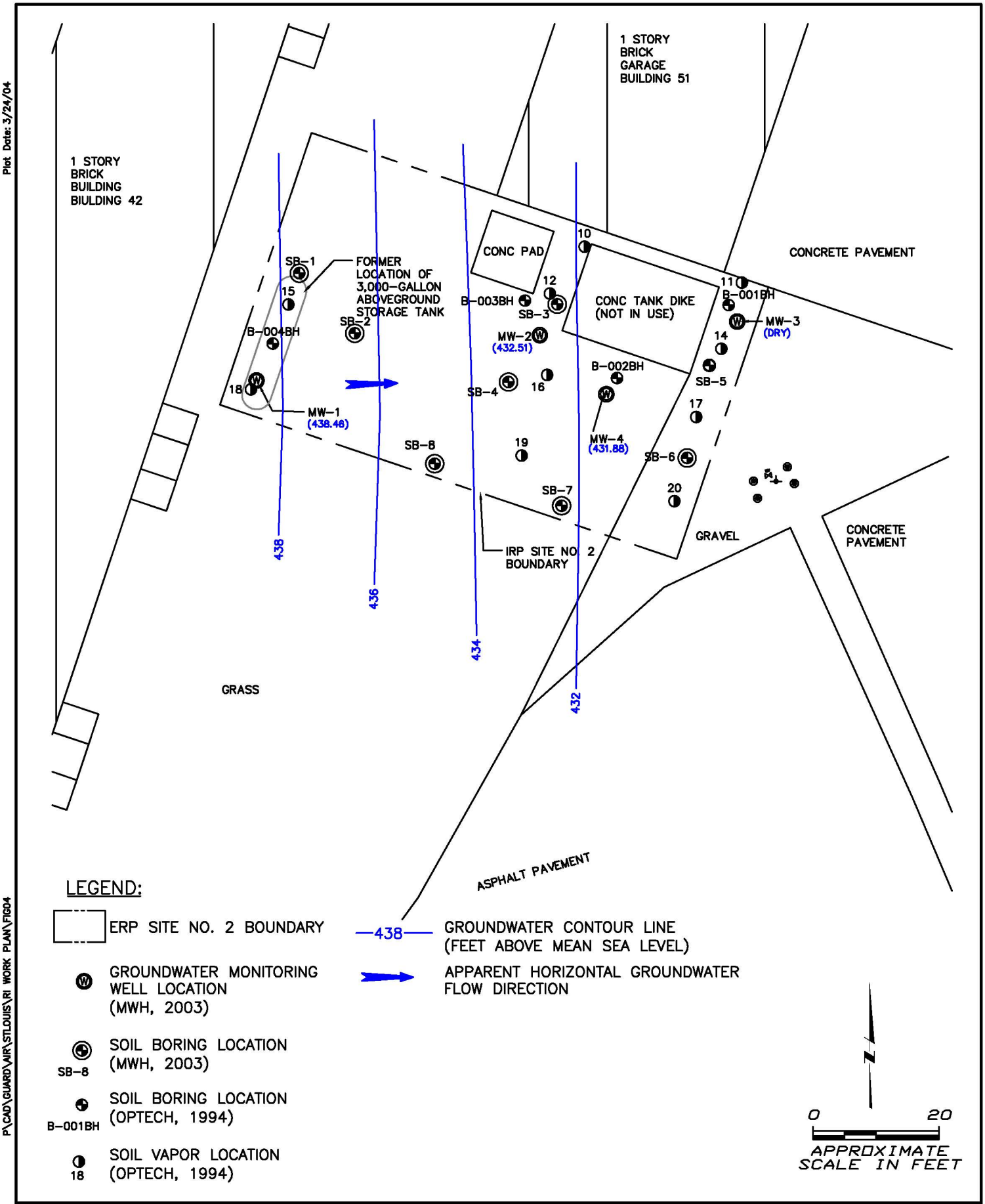
TABLE 1

WATER LEVEL MEASUREMENTS, OCTOBER AND DECEMBER 2003
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION

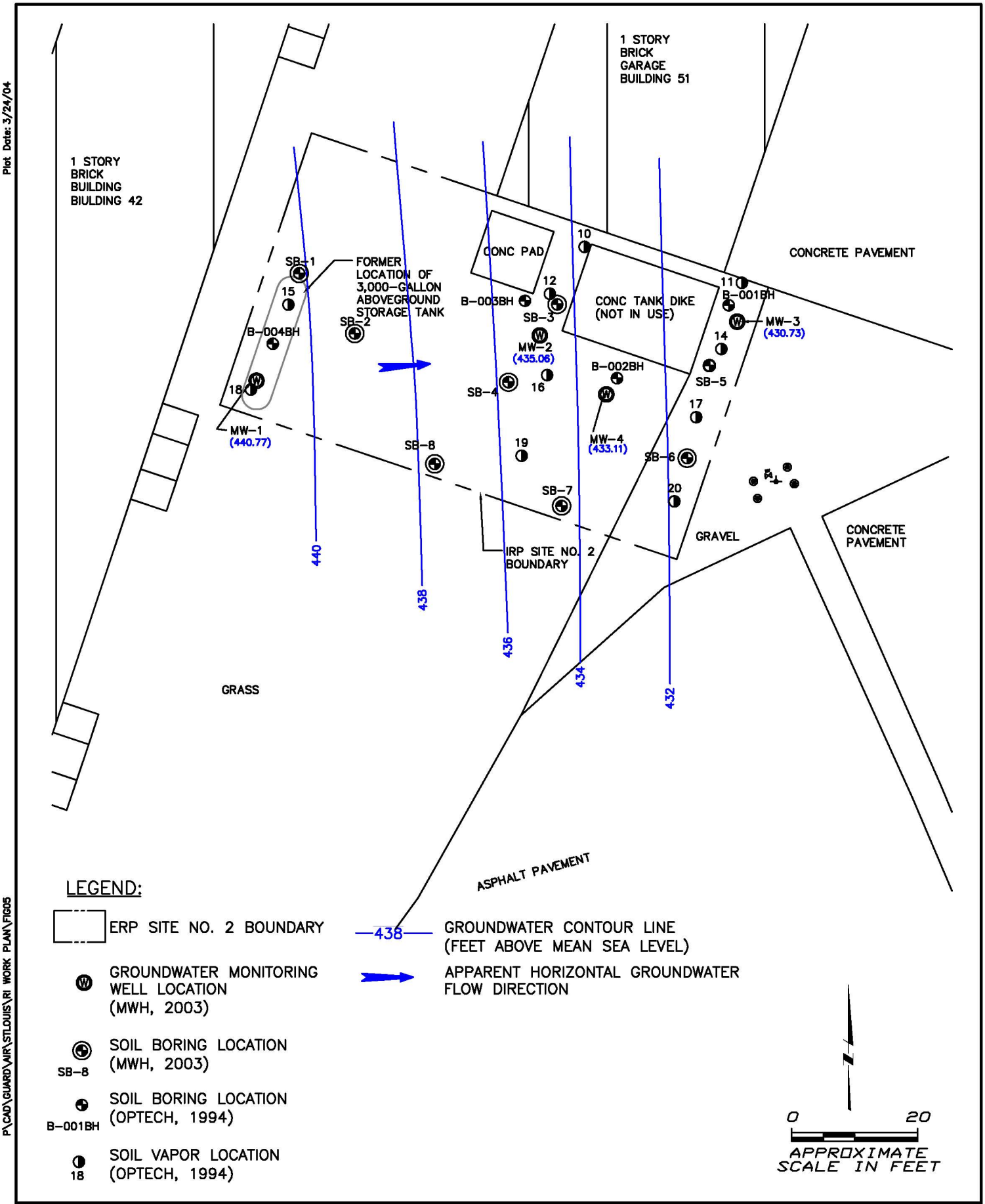
			10/9/2003 and 10/10/2003			12/4/2003 and 12/5/2003		
Location / Well Identification	**Well Completion**	**Elevation of TOC (feet msl)**	**Depth to Water (feet) from TOC**	**Groundwater Elevation (feet msl)**	**Total Depth of Well (feet msl)**	**Depth to Water (feet) from TOC**	**Groundwater Elevation (feet msl)**	**Total Depth of Well (feet msl)**
IRP Site No. 2								
MW-1	Flushmount	455.28	16.82	438.46	25.1	14.51	440.77	25.1
MW-2	Flushmount	455.06	22.55	432.51	24.9	20.00	435.06	25.0
MW-3	Flushmount	453.45	---	---	25.1	22.72	430.73	24.9
MW-4	Flushmount	454.52	22.64	431.88	25.0	21.41	433.11	25.0

Notes:
TOC = Top of casing.
msl = Above mean sea level.
--- = Essentially no groundwater in well.

A drainage ditch lies between the southern boundary of the Station and the Jefferson Barracks National Cemetery, carrying surface drainage to the Missouri River to the east. The drainage ditch is located approximately 120 feet south of ERP Site No. 2.



MWH DES MOINES IOWA	157TH AIR OPERATIONS GROUP JEFFERSON BARRACKS ST. LOUIS, MISSOURI	ERP SITE NO. 2 GROUNDWATER CONTOUR MAP OCTOBER 2003	FIGURE 4



Plot Date: 3/24/04

P:\CAD\GUARD\AIR\STLOUIS\RI WORK PLAN\FIG05

MWH DES MOINES IOWA	157TH AIR OPERATIONS GROUP JEFFERSON BARRACKS ST. LOUIS, MISSOURI	ERP SITE NO. 2 GROUNDWATER CONTOUR MAP DECEMBER 2003	FIGURE 5

4.0 2003 REMEDIAL INVESTIGATION PROGRAM AT ERP SITE NO. 2

This section summarizes monitoring well installation and sampling activities performed at the Station during the RI, as proposed in the *Final ERP Site No. 2 Remedial Investigation Work Plan* (MWH, 2003). These activities were selected based on results of the PA/SI and subsequent meetings and discussions.

4.1 TECHNICAL APPROACH AND SCOPE OF WORK

The technical approach for conducting the RI at ERP Site 2 No. 2 was to use data gathered during previous investigations to streamline and focus data collection activities during the 2003 field activities. The purpose of the RI investigative activities was to verify the soil and groundwater conditions noted during the SI, and to provide the additional information necessary to delineate the areal extent, depth, and concentration of chemicals present in soil and groundwater at ERP Site No. 2.

The following activities were completed as part of the 2003 RI program:

- Eight Geoprobe® boreholes were advanced, including soil sampling, logging, and PID readings, in order to further define the extent of soil impact.
- Four groundwater monitoring wells were installed in the immediate vicinity of the highest soil impacts noted during the SI.
- Soil was logged and PID readings measured during well installation.
- Groundwater samples were collected over two rounds at the four newly installed monitoring wells to verify current groundwater conditions.
- Water level measurements were taken in the four new wells in order to determine the apparent direction of groundwater flow beneath the site (Table 1).

Locations of boreholes advanced and monitoring wells installed as part of the 2003 activities are illustrated in Figure 3.

4.1.1 Soil Boring and Monitoring Well Depths

The eight soil borings at ERP Site No. 2 were advanced to 10 feet bgs during the 2003 RI field activities. This maximum depth was selected as it permitted shallow soil stratigraphy to be assessed. Additionally, the greatest concentrations of chemical constituents detected during the 1994 SI ended at approximately 10 feet bgs, and concentrations below that depth were less than MDNR soil cleanup action levels.

The four groundwater monitoring wells installed at ERP Site No. 2 during the 2003 RI activities were constructed so that the screen would intersect wet zones noted during previous investigations, to a depth of 25 to 26 feet bgs. This depth permitted the groundwater to be sampled and shallow soil stratigraphy to be assessed, in order to verify current groundwater conditions and determine the apparent direction of groundwater flow beneath the Site.

4.1.2 Sample Collection and Analysis

Borings were continuously cored to 10 feet, and soil samples were collected from the sleeves in 2-foot intervals for in-field vapor screening (i.e., PID readings). Two soil samples were submitted for laboratory analysis from each borehole, from the intervals exhibiting the greatest apparent impact, based on field observations. Where no impact was observed, the soil samples were collected from the uppermost and lowermost soil intervals recovered during probing.

Drill holes were drilled 25 feet (26 feet for MW-3), and soil samples were collected from the continuous-core sampler in 2-foot intervals for in-field vapor screening (i.e., PID readings). No soil samples were submitted for laboratory analysis from the drill holes, per the *RI Work Plan*.

Groundwater samples were to be collected from the four newly installed monitoring wells over two rounds. Groundwater samples were collected from wells MW-1 and MW-2 no less than 24 hours following completion of well development. Wells MW-3 and MW-4 recharge slowly and thus did not have sufficient water for sampling during the first round. Groundwater samples were collected from all four monitoring wells during the second round.

4.2 INVESTIGATION PROCEDURES

4.2.1 Borehole and Drilling Procedures

4.2.1.1 Site Safety and Permits. A site-specific Site Safety Plan (SSP) was prepared for MWH personnel designated for field activities. Site safety during the 2003 field activities was conducted in accordance with pertinent Occupational Safety and Health Administration requirements to ensure the health and safety of field workers. A copy of the site-specific SSP was presented in Appendix A of the *Final ERP Site No. 2 Remedial Investigation Work Plan* (MWH, 2003).

The Station Civil Engineer (CE) coordinated the location and marking of utilities in the vicinity of the proposed borings and new monitoring wells. The Station Environmental Officer obtained the required dig permits from the Station CE prior to commencement of field activities.

4.2.1.2 Soil Borings. Soil borings advanced at ERP Site No. 2 were completed by Brotcke Well & Pump, Inc. (Brotcke) of Fenton, Missouri using a small track-mounted Geoprobe® hydraulic direct-push system. During probing, soil was collected in disposable acetate-lined sleeves at intervals of 4 feet. The borings were abandoned in accordance with the Missouri Well Construction Rules. The borings were backfilled with chipped bentonite to within 2 to 3 inches of the surface to provide a proper seal, immediately following soil sampling activities. The remaining opening was covered with native soil to match the surface where the probehole was placed.

4.2.1.3 Drill Holes. Drilling for monitoring wells installed at ERP Site No. 2 was completed by Brotcke using a truck-mounted 8-inch outside diameter (OD) hollow-stem auger (HSA) drilling system. A 4-foot split-barrel continuous-core sampler was advanced to collect soil throughout the depth of each drill hole. Each drill hole was completed as a groundwater monitoring well.

4.2.1.4 Equipment Decontamination. Decontamination procedures, as outlined in the *RI Work Plan*, were implemented. Before use, the nondedicated drilling, boring, groundwater, and soil sampling equipment was decontaminated. Large equipment was

steam cleaned. Small downhole equipment was washed with a nonphosphate detergent and rinsed with deionized water prior to use at subsequent sample locations.

4.2.2 Soil Sampling Activities

4.2.2.1 Boring Logs. Boring logs were prepared during advancement of each boring and drill hole. The recovered soil was used to construct lithologic logs that include texture, color, moisture content, and consistency. The boring logs are included as Appendix B.

4.2.2.2 Laboratory Sample Collection. Two grab soil samples were collected directly from the acetate-lined sleeve during each borehole advancement and placed in clean, labeled, laboratory-supplied containers. The soil was packed in a manner as to minimize the amount of void space within the container. The sample collection activities were documented in the project field book. The sample was accompanied by completed chain-of-custody (COC) documentation.

4.2.2.3 Soil Sample Field Screening. As each lift of soil was removed and exposed for logging during the borehole and drilling advancement, a portion of the soil from each sampling interval was placed in a small, labeled, plastic bag. After sealing the bag and allowing the soil sample to stabilize at ambient temperature, headspace readings were measured using a PID. The PID readings are indicated on the soil boring logs in Appendix B. Field screening was conducted to help determine the vertical extent of any volatile chemical constituents that may be present, and to aid in the selection of the samples for laboratory analysis.

4.2.3 Groundwater Investigation

4.2.3.1 Monitoring Well Construction. The four drill holes were completed as groundwater monitoring wells (MW-1 through MW-4) as specified in the *RI Work Plan*. The wells were constructed so that the screen intercepted the wet zones encountered during previous investigations and to a total depth of 25 to 26 feet bgs. Upon completion of drilling activities at each well location, monitoring well materials were installed through the drilling augers. Each well was constructed of flush-threaded 2-inch

inner-diameter (ID) Schedule 40 polyvinyl chloride (PVC) well screen, 10 feet in length, and 2-inch ID Schedule 40 PVC riser pipe. The well screens were factory slotted, with a slot width of 0.010 inches. The bottom of the screens were plugged with a threaded cap. Appropriately sized filter pack sand was placed in the annular space surrounding the well screens by slowly pouring as the augers were withdrawn from the drill hole. The filter pack extended to approximately 3 feet above the top of the screens. Bentonite chips were placed to a depth of approximately 4 feet above the filter pack and hydrated. Neat cement was mixed and slurried into the drill hole to within 1 foot of the ground surface.

The four wells were completed flush with the surrounding grade. The area around the well casings was dug out to accommodate a reinforced, flushmount, metal well box set into a concrete pad. The metal well boxes were supplied with bolt-down metal covers. A tight-fitting PVC cap was installed on the end of the riser pipe of each well. The monitoring well construction diagrams are included in Appendix B. The wells were properly certified with the State of Missouri, and the Monitoring Well Certification Records are included as Appendix C.

4.2.3.2 Monitoring Well Survey. Surveying was completed for each newly installed monitoring well. The locations of the four new wells were determined relative to other facility features. The elevations of the tops of the well casings were surveyed to within 0.01 foot relative to an on-site benchmark.

4.2.3.3 Monitoring Well Development. The four new wells were developed no sooner than 24 hours following construction. Each well was developed using a new disposable bailer. The minimum amount of water purged from each well during development was three times the amount of any water used during well construction plus three times the standing water volume in the well, except for those wells that purged dry. Purging continued until the silt and sand at the bottom of the well was removed, or the well was purged dry three times. During the development process, pH, temperature, and conductivity of the water were periodically measured and recorded.

4.2.3.4 Monitoring Well Groundwater Sample Collection. Two of the newly installed groundwater monitoring wells were sampled during the first round of the 2003

field activities. Wells MW-1 and MW-2 recovered sufficiently following development for sampling, whereas wells MW-3 and MW-4 did not. All four wells were sampled during the second round of the 2003 field activities.

The two wells that recovered sufficiently were sampled no sooner than 24 hours following well development, for the first round of groundwater sampling, using low-flow techniques with a QED® bladder pump and new dedicated tubing. At the time of sampling, the cap on the well casings was removed and the wells were allowed to equilibrate. The water level was measured using an electronic water level probe to the nearest 0.01 foot. To reduce sample turbidity, the total depth of each well was measured following collection of the groundwater samples. All water level measurements were measured from a permanent reference point marked on the top each monitoring well casing.

The monitoring wells were purged prior to sampling, using the QED® bladder pump, in an effort to remove stagnant water and ensure a representative groundwater sample was collected. Field parameters (pH, temperature, and conductivity) were measured using a Horiba flow-through cell during purging and prior to sample collection. Each well was purged until the measured parameters had stabilized. The parameters were considered stable if there was less than a 10 percent change in conductivity and pH, and less than a one degree Celsius change in temperature. Final parameters were recorded before sampling, and are included as Table 2.

Groundwater samples were collected using the QED® bladder pump immediately following the purging of that well. The groundwater was collected directly into clean, labeled, laboratory-supplied containers. Care was exercised while obtaining samples to be analyzed for VOCs and TPH, to ensure no headspace existed in the sample containers. All sample collection activities were documented in the project field book. All samples were accompanied by completed COC documentation.

TABLE 2

FIELD PARAMETERS
2003 REMEDIAL INVESTIGATION PROGRAM
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION

Monitoring Well ID:		MW-1		MW-2		MW-3 [a]	MW-4 [a]
Date Collected:		10/10/2003	12/4/2003	10/10/2003	12/5/2003	12/4/2003	12/5/2003
Parameter	Units						
Temperature	°C	17.7	14.6	17.4	14.9	15.3	14.0
pH	S.U.	5.84	6.07	6.20	6.43	6.75	6.50
Conductivity	µS/cm	0.228	0.242	0.427	0.454	0.557	0.527

Notes:
[a] There was insufficient groundwater during the first round of field work to permit sampling.
°C = Degrees Celsius.
µS/cm = Microsiemens per centimeter.
S.U. = Standard units.

A second round of water level measurements and groundwater sampling, following the procedures outlined above, was conducted. The second round of groundwater sampling was completed nine weeks after completion of the first round.

4.2.4 Quality Assurance and Quality Control

The quality assurance/quality control (QA/QC) procedures for the 2003 field activities were followed as specified in the *RI Work Plan*. Field and laboratory QA/QC checks were performed, to evaluate the performance of the field sampling procedures and laboratory analytical procedures.

Field QA/QC checks included the collection and analysis of field duplicates and trip blanks for the purpose of evaluating quality assurance in field sampling methods. Field duplicate soil samples were collected from two probeholes. Field duplicate groundwater samples were collected from monitoring well MW-1 during each round of groundwater sampling. Precision was evaluated in field duplicates by calculating the relative percent difference (RPD) of chemical concentrations detected in the primary sample and its duplicate. The RPD reflects the combined precision of field and laboratory procedures for the associated samples. An RPD goal of 35 percent was chosen for this project.

Analysis of trip blanks provides a means of assessing potential cross-contamination of groundwater samples during field sampling, handling, and/or transport. Each cooler used to ship groundwater samples collected for VOC analyses was accompanied by a trip blank that was also analyzed for VOCs.

4.2.5 Investigation-Derived Waste

Personal protective and other disposal equipment was placed in polyethylene trash bags and disposed with the Station municipal solid waste. Soil cuttings produced during advancement of the borings or during drilling activities that did not appear to be impacted were thin-spread in a nearby low area, as approved by the Station Environmental Officer. Impacted soil cuttings were containerized in a drum. All decontamination, development, and purge waters were containerized in a drum. The drums were labeled and staged south of ERP Site No. 2, as approved by the Station Environmental Officer, until laboratory analysis is reviewed and a final disposal option is determined.

4.2.6 Land Surveying

The locations of each of the four newly installed monitoring wells were determined relative to other Station features. The elevations of the tops of the well casings were surveyed to within 0.01 foot relative to an on-site benchmark.

4.3 SAMPLE ANALYSES, HANDLING, AND DOCUMENTATION

Once a desired soil or groundwater sample was retrieved and logged by field personnel, the sample was prepared for shipment to the laboratory. Sample analysis methods are summarized in Table 3. Handling procedures used during the 2003 field activities are presented below.

4.3.1 Soil Sample Analyses

Two soil samples from each borehole at ERP Site No. 2 were submitted for laboratory analysis. The soil samples were submitted to Keystone Laboratories, Inc. (Keystone) of Newton, Iowa, for analysis of VOCs, SVOCs, polychlorinated biphenyls (PCBs), TPH, and the eight Resource Conservation and Recovery Act (RCRA) metals.

4.3.2 Groundwater Sample Analyses

Groundwater samples collected from monitoring wells during the first and second rounds of the 2003 field activities at ERP Site No. 2 were analyzed for VOCs, SVOCs, PCBs, TPH, and the eight RCRA total metals. During the second round of groundwater sampling, well MW-3 produced only enough water to analyze for VOCs, SVOCs, and TPH. The groundwater samples were submitted to Keystone for analysis.

4.3.3 Sample Containers

A summary of sample types, number of samples, and respective reference methods were presented as Table 1 of the *Final ERP Site No. 2 Remedial Investigation Work Plan* (MWH, 2003). All sample containers were provided by the laboratory.

TABLE 3

ANALYTICAL METHODS FOR SOIL AND GROUNDWATER SAMPLES
2003 REMEDIAL INVESTIGATION PROGRAM
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION

Chemical Constituent	Method Number	Reference
Soil		
Volatile Organic Compounds	EPA Method 8260B	SW-846
Semivolatile Organic Compounds	EPA Method 8270C	SW-846
Total Petroleum Hydrocarbons	EPA Method 8015	SW-846
Total Extractable Hydrocarbons	EPA Method 8015	SW-846
Polychlorinated Biphenyls	EPA Method 8082	SW-846
Metals, Total	EPA Method 6010/7000	SW-846
Groundwater		
Volatile Organic Compounds	EPA Method 8260B	SW-846
Semivolatile Organic Compounds	EPA Method 8270C	SW-846
Total Petroleum Hydrocarbons	EPA Method 8015	SW-846
Total Extractable Hydrocarbons	EPA Method 8015	SW-846
Polychlorinated Biphenyls	EPA Method 8082	SW-846
Metals, Total	EPA Method 6010/7000	SW-846

Notes:
EPA = Environmental Protection Agency.

4.3.4 Sample Preservation and Holding Times

Most of the parameters that were measured or evaluated are not chemically stable under some conditions. In these cases, sample preservation was required. Methods of sample preservation are relatively simple and are generally intended to: 1) retard biological action, 2) retard hydrolysis, and 3) reduce sorption effects. Prepreserved bottles were provided by the laboratory. In addition, all sample holding times were met.

4.3.5 Sample Handling

Immediately following collection, samples were placed in coolers with ice. In preparation for transport, samples were packed in coolers in such a way as to prevent breakage of samples. Ice was packed with the samples in order to maintain sample temperature during transport.

Samples were shipped to Keystone, and the coolers and accompanying COC documentation were transferred from MWH to the receiving laboratory employee.

4.3.6 Chain-of-Custody Documentation

COC procedures provide an accurate written record tracing the possession of individual samples from the time of field collection through laboratory analysis. The COC record was used to document the samples taken and the analyses requested. Information recorded on the COC by field personnel included the following:

- Project name
- Sampling location
- Sample designation
- Date and time of collection
- Sample matrix
- Sample analyses required
- Signature of sampler
- Signature of individuals involved in the custody transfer.

Copies of the signed COC documents for the 2003 field activities are included as Appendix D.

5.0 NATURE AND EXTENT OF CHEMICAL CONSTITUENTS

This section summarizes the chemical constituents in soil and groundwater at ERP Site No. 2, and compares the analytical results to current MDNR soil cleanup action levels. The historical analyte detections in soil from the 1994 SI are included as Appendix A. The soil boring logs and monitoring well construction diagrams (with PID readings) are included as Appendix B, COC documentation is included as Appendix D, and laboratory analytical reports are included as Appendix E, for the 2003 field investigative activities.

5.1 SOIL INVESTIGATIONS

5.1.1 1993-1994 PA/SI Results

This investigation began with a soil vapor survey, which was performed at 11 points across ERP Site No. 2 (labeled 10 through 20; Figure 3). The soil vapor samples were collected to screen for chemical constituents associated with possible spillage from used oil and solvent storage, and to develop the optimum locations of borings. The soil gas was collected from a depth of 5 feet bgs and immediately analyzed on site for BTEX and TPH in a mobile laboratory. TPH was detected in three soil vapor samples (1,371 parts per million by volume [ppmv] at soil vapor location 12; 33 ppmv at soil vapor location 17; and 13 ppmv at soil vapor location 18); and toluene, ethylbenzene, and xylene were detected in one soil vapor sample (8.7, 4.0, and 22.5 micrograms per liter (µg/L), respectively, at soil vapor location 12).

Four soil borings (labeled B-001BH through B-004BH; Figure 3) were advanced at ERP Site No. 2, and three soil samples were collected from each boring for laboratory analysis. Each soil sample was analyzed for VOCs, SVOCs, TPH, and metals. VOCs were not detected in any soil sample from the Site. SVOCs were detected in two soil samples (B-003BH in the 1- to 2.5-foot bgs interval, and B-004BH in the 0.5- to 2-foot bgs interval) in concentrations ranging from 240 to 2,500 micrograms per kilogram (µg/kg). TPH was detected in a total of four soil samples (B-001BH in the 3.5- to 5- and 30- to 31.5-foot bgs intervals, B-003BH in the 5- to 6.5-foot bgs interval, and B-004BH in the 0.5- to 2-foot bgs interval) in concentrations ranging from 0.89 (reported as gasoline) to 440 (reported as #2 fuel oil) milligrams per kilogram (mg/kg). Antimony,

mercury, selenium, silver, and thallium were not detected in concentrations above method reporting limits in the soil samples collected at ERP Site No. 2. Six metals were detected in the soil samples: arsenic concentrations ranged from 2.0 to 10.6 mg/kg; beryllium ranged from 8.6 to 39.6 mg/kg; copper ranged from 14.7 to 54.3 mg/kg; lead ranged from 7.1 to 133 mg/kg, nickel ranged from 10.7 to 38.9 mg/kg, and zinc ranged from 38.6 to 710 mg/kg.

TPH, benzo(a)pyrene, and beryllium were detected in soil above the current MDNR soil cleanup action levels. TPH was detected above the soil cleanup action level of 200 mg/kg in one soil sample (B-001BH in the 3.5- to 5-foot bgs interval). Benzo(a)pyrene was detected above the MDNR Cleanup Levels for Missouri (CALM) standard of 200 µg/kg in two shallow soil samples (B-003BH in the 1- to 2.5-foot bgs interval, and B-004BH in the 0.5- to 2-foot bgs interval). Beryllium was detected above the CALM standard of 0.05 mg/kg in ten of the twelve soil samples.

5.1.2 2003 Fieldwork Results

Eight soil borings were advanced at ERP Site No. 2 to further delineate the vertical and areal extent of soil impact. To check for the chemicals of concern established from the PA/SI work (TPH, BTEX, SVOCs, and metals) and other constituents that may be associated with used oil, the soil samples from each boring were analyzed for VOCs, SVOCs, PCBs, TPH, and the eight RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver).

The eight soil borings (SB-1 through SB-8) were placed in the locations at ERP Site No. 2 shown in Figure 3, and advanced to a depth of 10 feet bgs. Two soil samples from each boring were selected for laboratory analysis. The soil intervals exhibiting the greatest apparent impact were to be selected for analysis, but such impact was noted in only one borehole; soil from boring SB-3 exhibited apparent impact (as a petroleum-like odor, green staining, and elevated PID readings) in the 6- to 10-foot bgs interval (6-10'). The remaining soil samples were collected from the uppermost and lowermost intervals, where enough soil was recovered during probing to fulfill the sampling requirements.

A total of eight VOCs were detected in soil from ERP Site No. 2, with one or more of the VOCs found in twelve of the fourteen soil samples. However, no VOCs were detected above MDNR CALM standards.

SVOCs were detected in four soil samples. Three or more SVOCs were detected in borings SB-2 (0-4'), SB-4 (0-8'), SB-5 (0-4'), and SB-8 (0-4'). The shallow soil samples from borings SB-2 and SB-8 were the only ones to have SVOC detections greater than MDNR CALM standards; both of these samples had exceedances of benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene. PCBs were not detected in any soil sample from ERP Site No. 2 during the 2003 RI fieldwork.

Total TPH (the sum of TPH and total extractable hydrocarbons [TEH]) was detected in nine of the fourteen soil samples. Of these, the only exceedance of the soil cleanup action level for total TPH was in both soil samples collected from boring SB-3 (6-8' and 8-10').

Mercury and selenium were not detected in any of the soil boring samples. The remaining six of the eight RCRA metals were detected in most samples, at very low levels, with the exception of arsenic. Arsenic was detected above the MDNR CALM standard in seven of the eight deep samples collected from each borehole.

A summary of the soil constituent detections is provided in Table 4, and the soil cleanup action level exceedances for the 2003 RI fieldwork are illustrated in Figure 6.

No soil samples were collected from the four holes drilled for the installation of monitoring wells at ERP Site No. 2, but the soil was logged and PID readings were collected for the full length of the drill holes. No apparent impact was observed in the soil removed from the four drill holes.

5.1.3 Extent of Chemical Constituents in Soil

Based on the soil sampling completed to date at ERP Site No. 2, it appears natural attenuation has reduced the concentrations of chemical constituents in soil in the time since the SI fieldwork was completed. As of the RI in 2003, chemical constituents in soil

TABLE 4

CHEMICAL CONSTITUENT DETECTIONS IN SOIL
2003 REMEDIAL INVESTIGATION PROGRAM
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION

	Sample Identification:	SB-1		SB-2		SB-3		SB-4	
	Sample Date:	10/8/2003		10/8/2003		10/8/2003		10/9/2003	
	Sample Depth (feet):	0-8	8-10	0-4	8-10	6-8	8-10	0-8	8-10
Constituent (mg/kg)	**Soil Cleanup Action Level [a]**								
Volatile Organic Compounds									
Acetone	2,700 mg/kg	**0.111**	<0.050	<0.050	**0.077**	**0.316**	<0.076	**0.147**	<0.050
Benzene	1 mg/kg [b]	<0.001	<0.001	<0.001	<0.001	<0.005	<0.002	<0.001	<0.001
2-Butanone (MEK)	7,400 mg/kg	<0.005	<0.005	<0.005	<0.005	**0.061**	<0.008	**0.021**	<0.005
Carbon Disulfide	630 mg/kg	<0.005	<0.005	<0.005	<0.005	**0.099**	<0.008	**0.016**	**0.005**
Ethylbenzene	10 mg/kg [b]	<0.001	<0.001	<0.001	<0.001	**0.008**	**0.002**	<0.001	<0.001
Tetrachloroethene	40 mg/kg	<0.001	<0.001	<0.001	<0.001	<0.005	<0.002	<0.001	<0.001
Toluene	5 mg/kg [b]	**0.002**	<0.001	<0.001	**0.003**	**0.010**	**0.005**	**0.002**	<0.001
Xylenes, Total	10 mg/kg [b]	<0.002	<0.002	<0.002	**0.004**	**0.020**	**0.014**	<0.002	<0.002
Semivolatile Organic Compounds									
Acenaphthene	1,700 mg/kg	<0.33	<0.33	**0.58** (J)	<0.33 (J)	<1.65	<0.33	<0.33	<0.33
Anthracene	8,500 mg/kg	<0.33	<0.33	**0.75** (J)	<0.33	<1.65	<0.33	<0.33	<0.33
Benzo(a)anthracene	1 mg/kg	<0.33	<0.33	**2.23** (J)	<0.33	*<1.65*	<0.33	<0.33	<0.33
Benzo(a)pyrene	0.2 mg/kg	*<0.33*	*<0.33*	**0.72** (J)	*<0.33*	*<1.65*	*<0.33*	*<0.33*	*<0.33*
Benzo(b)fluoranthene	0.9 mg/kg	<0.33	<0.33	**2.42** (J)	<0.33	*<1.65*	<0.33	<0.33	<0.33
Benzo(g,h,i)perylene	Not Established	<0.33	<0.33	**0.47** (J)	<0.33	<1.65	<0.33	<0.33	<0.33
Benzo(k)fluoranthene	8 mg/kg	<0.33	<0.33	**0.86** (J)	<0.33	<1.65	<0.33	<0.33	<0.33
Chrysene	36 mg/kg	<0.33	<0.33	**2.31** (J)	<0.33	<1.65	<0.33	<0.33	<0.33
Dibenzofuran	110 mg/kg	<0.33	<0.33	**0.35** (J)	<0.33 (J)	<1.65	<0.33	<0.33	<0.33
Fluoranthene	1,600 mg/kg	<0.33	<0.33	**4.49** (J)	<0.33	<1.65	<0.33	**0.43**	<0.33
Fluorene	1,100 mg/kg	<0.33	<0.33	**0.44** (J)	<0.33 (J)	<1.65	<0.33	<0.33	<0.33
Indeno(1,2,3-cd)pyrene	3 mg/kg	<0.33	<0.33	**0.5** (J)	<0.33	<1.65	<0.33	<0.33	<0.33
2-Methylnaphthalene	Not Established	<0.33	<0.33	<0.33 (J)	<0.33	<1.65	<0.33	<0.33	<0.33
Naphthalene	120 mg/kg	<0.33	<0.33	<0.33 (J)	<0.33	<1.65	<0.33	<0.33	<0.33
Phenanthrene	Not Established	<0.33	<0.33	**3.56** (J)	<0.33	<1.65	<0.33	**0.34**	<0.33
Pyrene	2,100 mg/kg	<0.33	<0.33 (J)	**3.66** (J)	<0.33	<1.65	<0.33	**0.35**	<0.33
Polychlorinated Biphenyls	Varies	No Detections		No Detections		No Detections		No Detections	
Total Extractable Hydrocarbons									
as Gasoline	Not Established	<5	**7**	<5	<5	**339** (J)	**39** (J)	<5	<5
as #2 Diesel Fuel	Not Established	<5	<5	**42** (J)	<5	<5	<5	**13**	<5
as Waste Oil	Not Established	<5	<5	<5	<5	**63**	**19**	<5	**9**
TPH as Gasoline	Not Established	<5	<5	<5	<5	**1,880**	**177**	<5	<5
Total TPH [c]	200 mg/kg [b]	No Detections	**7**	**42** (J)	No Detections	**2,282** (J)	**235** (J)	**13**	**9**
Total Metals									
Arsenic	11 mg/kg	**8.6**	**11.0**	**9.4**	**10.3**	**7.4**	**12.2**	**7.9**	**11.5**
Barium	14,000 mg/kg	**437**	**179**	**200**	**214**	**157**	**176**	**158**	**189**
Cadmium	110 mg/kg	<0.6	<0.6	<0.6	<0.6	**1.3**	<0.6	**0.6**	**0.6**
Chromium	2,100 mg/kg	**15.9**	**18.0**	**15.2**	**10.3**	**13.4**	**9.3**	**14.3**	**9.7**
Lead	260 mg/kg	**72.1**	**13.2**	**11.6**	**17.1**	**40.7**	**16.3**	**90.7**	**11.2**
Mercury	0.6 mg/kg	<0.28	<0.31	<0.24	<0.35	<0.37	<0.26	<0.26	<0.28
Selenium	300 mg/kg	<1.1	<1.2	<1.2	<1.2	<1.3	<1.3	<1.2	<1.2
Silver	140 mg/kg	<0.6	**0.8**	**0.9**	**0.8**	**0.9**	**0.8**	**0.7**	**0.9**

Notes:

[a] Soil Cleanup Action Levels from the Soil Target Concentrations for Ingestion/Dermal Contact/Inhalation Pathway Scenario A, Missouri Department of Natural Resources (MDNR) Cleanup Levels for Missouri (CALM) Document, September 2001, except where noted.

[b] D for scored Table 4.

[c] Total total petroleum hydrocarbons (TPH) is the sum of all detected TPH and all detected total extractable hydrocarbons, per the MDNR.

ERP = Environmental Restoration Program.

mg/kg = Milligrams per kilogram.

Shaded = Chemical constituent equals or exceeds the MDNR Soil Cleanup Action Level.

Bold = Chemical constituent equals or exceeds the laboratory reporting limit.

Italicized = Laboratory reporting limit equals or exceeds the MDNR Soil Cleanup Action Level.

Data validated to Level II; (J) = estimated.

TABLE 4 (CONTINUED)

CHEMICAL CONSTITUENT DETECTIONS IN SOIL
2003 REMEDIAL INVESTIGATION PROGRAM
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION

	Sample Identification:	SB-5		SB-6		SB-7		SB-8	
	Sample Date:	10/9/2003		10/8/2003		10/8/2003		10/8/2003	
	Sample Depth (feet):	0-4	8-10	0-4	7-10	0-4	8-10	0-4	8-10
Constituent (mg/kg)	**Soil Cleanup Action Level [a]**								
Volatile Organic Compounds									
Acetone	2,700 mg/kg	**0.107**	<0.071	**0.115**	<0.072	<0.075	<0.069	**0.079**	<0.071
Benzene	1 mg/kg [b]	<0.001	<0.001	**0.002**	<0.001	<0.001	<0.001	<0.001	<0.001
2-Butanone (MEK)	7,400 mg/kg	**0.018**	**0.007**	**0.016**	<0.007	<0.007	<0.007	**0.014**	<0.007
Carbon Disulfide	630 mg/kg	<0.006	**0.007**	<0.007	<0.007	<0.007	**0.008**	<0.006	<0.007
Ethylbenzene	10 mg/kg [b]	<0.001	<0.001	**0.001**	<0.001	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	40 mg/kg	**0.043**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	5 mg/kg [b]	<0.001	<0.001	**0.004**	<0.001	**0.001**	<0.001	<0.001	<0.001
Xylenes, Total	10 mg/kg [b]	<0.003	<0.003	**0.003**	<0.003	<0.003	<0.003	<0.003	<0.003
Semivolatile Organic Compounds									
Acenaphthene	1,700 mg/kg	<0.33	<0.33	<0.33 (J)	<0.33 (J)	<0.33 (J)	<0.33 (J)	**2.57** (J)	<0.33 (J)
Anthracene	8,500 mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	**2.95**	<0.33
Benzo(a)anthracene	1 mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	**4.73**	<0.33
Benzo(a)pyrene	0.2 mg/kg	*<0.33*	*<0.33*	*<0.33*	*<0.33*	*<0.33*	*<0.33*	**2.03**	*<0.33*
Benzo(b)fluoranthene	0.9 mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	**4.27**	<0.33
Benzo(g,h,i)perylene	Not Established	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	**0.68**	<0.33
Benzo(k)fluoranthene	8 mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	**1.62**	<0.33
Chrysene	36 mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	**4.60**	<0.33
Dibenzofuran	110 mg/kg	<0.33	<0.33	<0.33 (J)	<0.33 (J)	<0.33 (J)	<0.33 (J)	**1.89** (J)	<0.33 (J)
Fluoranthene	1,600 mg/kg	**0.70**	<0.33	<0.33	<0.33	<0.33	<0.33	**13.1**	<0.33
Fluorene	1,100 mg/kg	<0.33	<0.33	<0.33 (J)	<0.33 (J)	<0.33 (J)	<0.33 (J)	**2.14** (J)	<0.33 (J)
Indeno(1,2,3-cd)pyrene	3 mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	**0.72**	<0.33
2-Methylnaphthalene	Not Established	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	**0.59**	<0.33
Naphthalene	120 mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	**1.37**	<0.33
Phenanthrene	Not Established	**0.63**	<0.33	<0.33	<0.33	<0.33	<0.33	**15.0**	<0.33
Pyrene	2,100 mg/kg	**0.53**	<0.33	<0.33	<0.33	<0.33	<0.33	**15.7**	<0.33
Polychlorinated Biphenyls	Varies	No Detections		No Detections		No Detections		No Detections	
Total Extractable Hydrocarbons									
as Gasoline	Not Established	<5	<5	<5	<5	<5	<5	<5	<5
as #2 Diesel Fuel	Not Established	<5	<5	<5	<5	<5	<5	**22** (J)	<5
as Waste Oil	Not Established	**12**	<5	<5	<5	**29**	<5	<5	<5
TPH as Gasoline	Not Established	<5	<5	<5	<5	<5	<5	<5	<5
Total TPH [c]	200 mg/kg [b]	**12**	No Detections	No Detections	No Detections	**29**	No Detections	**22** (J)	No Detections
Total Metals									
Arsenic	11 mg/kg	**7.1**	**11.2**	**8.1**	**11.7**	**7.6**	**12.0**	**7.5**	**12.4**
Barium	14,000 mg/kg	**168**	**173**	**158**	**185**	**126**	**204** (J)	**132**	**191**
Cadmium	110 mg/kg	<0.6	<0.7	**0.7**	**0.6**	<0.6	<0.6	<0.6	<0.6
Chromium	2,100 mg/kg	**13.4**	**10.3**	**11.4**	**9.4**	**16.3**	**11.9**	**11.9**	**11.2**
Lead	260 mg/kg	**26.0**	**11.4**	**69.0**	**9.7**	**72.0**	**14.8**	**34.2**	**12.4**
Mercury	0.6 mg/kg	<0.34	<0.23	<0.34	<0.32	<0.32	<0.29	<0.33	<0.33
Selenium	300 mg/kg	<1.2	<1.3	<1.2	<1.1	<1.2	<1.3	<1.3	<1.2
Silver	140 mg/kg	**0.9**	**0.8**	**1.0**	**0.8**	**0.6**	**0.8**	**0.7**	**0.9**

Notes:

[a] Soil Cleanup Action Levels from the Soil Target Concentrations for Ingestion/Dermal Contact/Inhalation Pathway Scenario A, Missouri Department of Natural Resources (MDNR) Cleanup Levels for Missouri (CALM) Document, September 2001, except where noted.

[b] D for scored Table 4.

[c] Total total petroleum hydrocarbons (TPH) is the sum of all detected TPH and all detected total extractable hydrocarbons, per the MDNR.

ERP = Environmental Restoration Program.

mg/kg = Milligrams per kilogram.

Shaded = Chemical constituent equals or exceeds the MDNR Soil Cleanup Action Level.

Bold = Chemical constituent equals or exceeds the laboratory reporting limit.

Italicized = Laboratory reporting limit equals or exceeds the MDNR Soil Cleanup Action Level.

Data validated to Level II; (J) = estimated.

above MDNR soil cleanup action levels are generally limited to total TPH in the 6- to 10-foot bgs interval of boring SB-3 (off the southwest corner of the large concrete pad), and SVOCs in the shallow intervals of SB-2 and SB-8 (east of the former AST).

Beryllium was detected above the MDNR CALM standard of 0.05 mg/kg in ten of the twelve soil samples collected during the 1994 SI activities. Arsenic was detected above the CALM standard of 11 mg/kg in seven of the eight deep soil samples (seven of the total sixteen samples) collected during the 2003 RI.

It is likely that natural levels of arsenic are high in soils underlying the Station. A geochemical survey of Missouri agricultural soils was undertaken in the 1970s, which involved the collection of ten soil samples from each of Missouri's 114 counties for analyses of total concentrations of 43 elements. This survey provides a reference for background concentrations of metals in Missouri agricultural soils. The samples analyzed for this survey were collected from the surface soil horizon (plow zone, 0 to 15 centimeters in depth; Tidball, 1984). In the table directly below, data obtained in this geochemical survey of Missouri agricultural soils, from samples collected nearest the Station, are compared to the concentration ranges of soil samples collected during the 2003 RI, and to the MDNR CALM standard.

GEOCHEMICAL SURVEY OF MISSOURI ARSENIC SOIL BACKGROUND CONCENTRATIONS COMPARED TO ERP SITE NO. 2 DETECTIONS AND THE MDNR CALM STANDARD

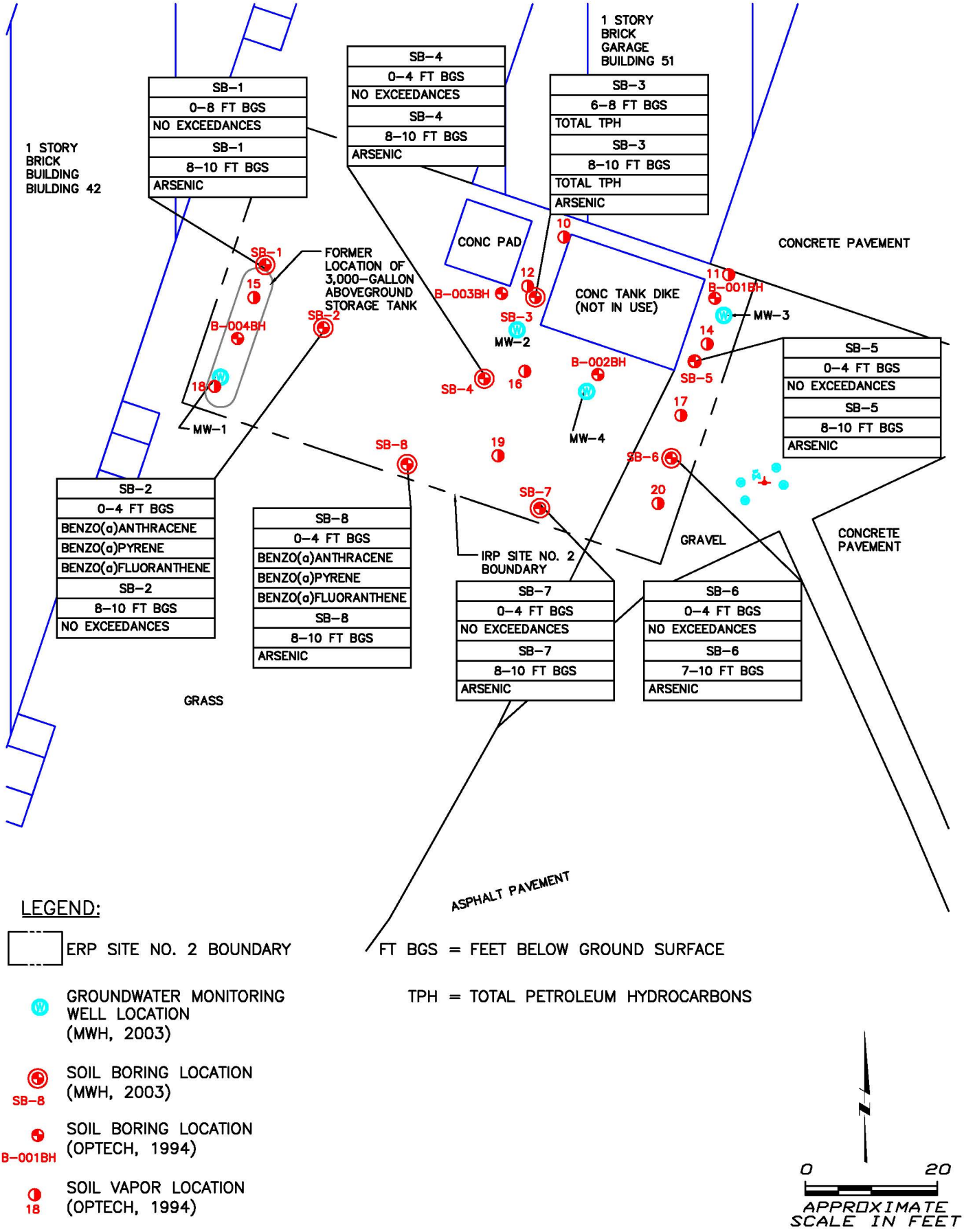
Analyte	Geochemical Survey of Missouri [a]	Sample Range [b] 2003 RI	MDNR CALM Value [c]
Arsenic	7.0 to 70 mg/kg	7.1 to 12.4 mg/kg	11 mg/kg

Notes:

[a] Element concentration range detected in soil samples collected within St. Louis and Jefferson Counties, Missouri nearest the Station. Data interpreted from Tidball, Ronald R., 1984. "Geochemical Survey of Missouri, Geography of Soil Geochemistry of Missouri Agricultural Soils." Geological Survey Professional Paper 954-H, I. United States Government Printing Office, Washington.

[b] Range of the 16 samples collected during the 2003 RI.

[c] Soil Cleanup Action Level from the Soil Target Concentrations for Ingestion/Dermal Contact/Inhalation Pathway Scenario A, MDNR CALM Document, September 2001.



MWH DES MOINES IOWA	157TH AIR OPERATIONS GROUP JEFFERSON BARRACKS ST. LOUIS, MISSOURI	ERP SITE NO. 2 SOIL SAMPLING LOCALITIES AND CLEANUP LEVEL EXCEEDANCES OCTOBER 2003	FIGURE 6

5.2 GROUNDWATER INVESTIGATION

5.2.1 2003 Fieldwork Results

Well locations were chosen based on prior sampling results and reported locations of former storage, in order to verify current groundwater conditions at ERP Site No. 2. As with the soil samples, groundwater samples from each well where enough water was available were analyzed for VOCs, SVOCs, PCBs, TPH, and the eight RCRA metals.

One VOC, tetrachloroethylene, was detected in the groundwater collected from monitoring well MW-3 during the second round of sampling in December 2003 (there was no groundwater in MW-3 during the first round), below the groundwater CALM standard. No other VOCs were detected in any of the groundwater samples.

No SVOCs, PCBs, or total TPH were detected in any of the groundwater samples collected from the monitoring wells in either round of sampling.

Barium was detected in the groundwater collected from monitoring wells MW-1, MW-2, and MW-4, below the MDNR CALM standard of 2,000 µg/L. MW-3 did not have enough water present during either round to analyze for metals. Lead was detected in the groundwater from the first round of sampling at MW-2, below the groundwater CALM standard of 15 µg/L. No other metals were detected in the groundwater sampled at ERP Site No. 2.

A summary of the soil constituent detections is provided in Table 5, and the groundwater analytical results for the 2003 RI fieldwork are illustrated in Figure 7.

5.2.2 Extent of Chemical Constituents in Groundwater

The RI groundwater sampling activities conducted over two rounds in 2003 indicated no chemical constituents above MDNR CALM standards. No previous groundwater sampling had been conducted at ERP Site No. 2.

TABLE 5

CHEMICAL CONSTITUENT DETECTIONS IN GROUNDWATER
2003 REMEDIAL INVESTIGATION PROGRAM
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION

Sample Identification:		MW-1		MW-2		MW-3 [b]	MW-4 [b]
Sample Date:		10/10/2003	12/04/2003	10/10/2003	12/04/2003	12/04/2003	12/04/2003
Constituent (µg/L)	**Groundwater Cleanup Action Level [a]**						
Volatile Organic Compounds	Varies	No Detections	No Detections	No Detections	No Detections		No Detections
Tetrachloroethylene	5 µg/L					**1.9**	
Semivolatile Organic Compounds	Varies	No Detections	No Detections	No Detections	No Detections	No Detections	No Detections
Polychlorinated Biphenyls	Varies	No Detections	No Detections	No Detections	No Detections	Not Analyzed [d]	No Detections
Total Extractable Hydrocarbons							
as Gasoline	Not Established	<100	<100	<100	<100	<100	<100
as #2 Diesel Fuel	Not Established	<100	<100	<100	<100	<100	<100
as Waste Oil	Not Established	<100	<100	<100	<100	<100	<100
TPH as Gasoline	Not Established	<10	<10	<10	<10	<10	<10
Total TPH [c]	10,000 µg/L	No Detections	No Detections	No Detections	No Detections	No Detections	No Detections
Total Metals							
Arsenic	50 µg/L	<5	<5	<5	<5	Not Analyzed [d]	<5
Barium	2,000 µg/L	**46**	**45**	**64**	**37**	Not Analyzed [d]	**64**
Cadmium	5 µg/L	<1	<1	<1	<1	Not Analyzed [d]	<1
Chromium	100 µg/L	<5	<5	<5	<5	Not Analyzed [d]	<5
Lead	15 µg/L	<5	<5	**6**	<5	Not Analyzed [d]	<5
Mercury	2 µg/L	<0.50	<0.50	<0.50	<0.50	Not Analyzed [d]	<0.50
Selenium	50 µg/L	<5	<5	<5	<5	Not Analyzed [d]	<5
Silver	100 µg/L	<10	<10	<10	<10	Not Analyzed [d]	<10

Notes:

[a] September 2001.

[b] There was insufficient groundwater during the first round of field work to permit sampling.

[c] Total total petroleum hydrocarbons (TPH) is the sum of all detected TPH and all detected total extractable hydrocarbons, per the MDNR.

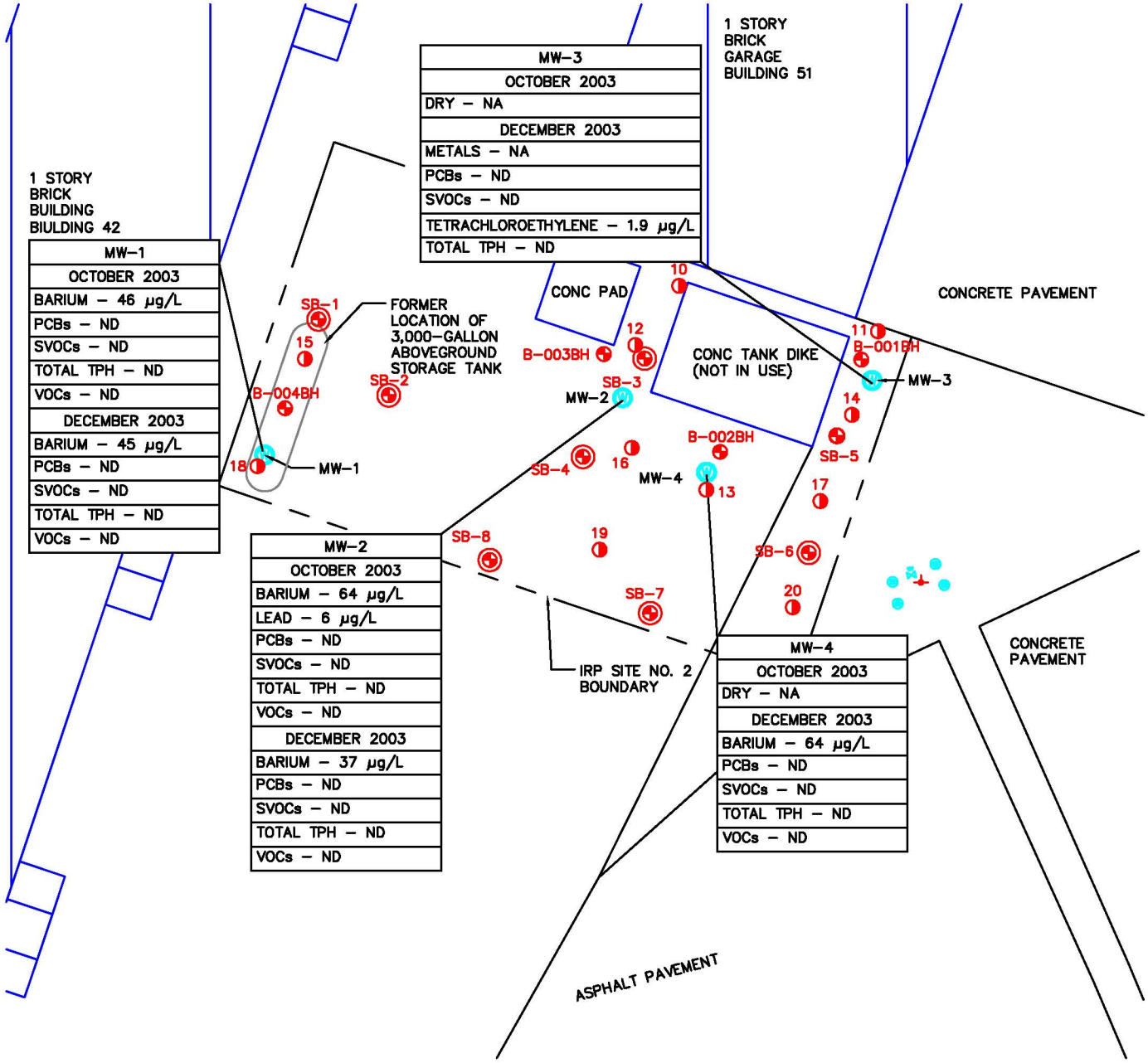
[d] There was insufficient groundwater during the second round of field work to allow for analysis of all constituents.

ERP = Environmental Restoration Program.

µg/L = Micrograms per liter.

Bold = Chemical constituent equals or exceeds the laboratory reporting limit.

Data validated to Level II; no qualifiers required for data on this table.



LEGEND:

ERP SITE NO. 2 BOUNDARY

GROUNDWATER MONITORING WELL LOCATION (MWH, 2003)

SB-8 SOIL BORING LOCATION (MWH, 2003)

B-001BH SOIL BORING LOCATION (OPTECH, 1994)

18 SOIL VAPOR LOCATION (OPTECH, 1994)

PCBs = POLYCHLORINATED BIPHENYLS
TPH = TOTAL PETROLEUM HYDROCARBONS
SVOCs = SEMIVOLATILE ORGANIC COMPOUNDS
VOCs = VOLATILE ORGANIC COMPOUNDS

ND = NO DETECTIONS
NA = NOT ANALYZED
µg/L = MICROGRAMS PER KILOGRAM

0 20
APPROXIMATE SCALE IN FEET

MWH DES MOINES IOWA

157TH AIR OPERATIONS GROUP
JEFFERSON BARRACKS
ST. LOUIS, MISSOURI

ERP SITE NO. 2
GROUNDWATER SAMPLING LOCALITIES
AND ANALYTICAL RESULTS
OCTOBER AND DECEMBER 2003

FIGURE 7

Plot Date: 3/24/04

P:\CAD\GUARD\AIR\STLOUIS\RI WORK PLAN\FIG07

5.3 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Field QA/QC checks included the collection and analysis of field duplicates and trip blanks for the purpose of evaluating quality assurance in field sampling methods. Laboratory QA/QC checks included calibration of instruments, analyses of method blanks, matrix spike/matrix spike duplicate (MS/MSD) samples, laboratory control standards (LCSs), and routine analysis of surrogate compounds. Results of the field and laboratory QA/QC evaluations for the October and December 2003 sampling events are presented below.

5.3.1 Field Duplicates

Precision was evaluated in field duplicates by calculating the RPD of chemical concentrations detected in the primary sample and its duplicate. The RPD reflects the combined precision of field and laboratory procedures for the associated samples. An appropriate RPD goal is 35 percent.

Field duplicate samples were collected from borehole samples SB-4 (0-8') and SB-6 (0-4'). The detected analytes for these soil samples are summarized in Table 6. The primary and field duplicate soil samples from borehole SB-4 contained reportable concentrations of four VOCs, three SVOCs, total TPH, and six metals in common. The primary and field duplicate soil samples from borehole SB-6 contained reportable concentrations of six VOCs and five metals in common. Of the twenty-five RPD calculations completed for the two field duplicate samples, sixteen were within the appropriate RPD goal. Duplicate soil samples outside of the RPD goal were likely primarily due to the heterogeneity of the soil samples, which results from both the natural condition of soils and the packing of sample jars.

Field duplicate samples were collected from monitoring well MW-1 during both the first and second rounds of groundwater sampling, as this well produced sufficient water for the large number of sample containers that had to be filled. The detected analytes for these groundwater samples are summarized in Table 6. The primary and field duplicate groundwater samples from the first and second round sampling of well MW-1 both

TABLE 6

QUALITY ASSURANCE/QUALITY CONTROL RESULTS
2003 REMEDIAL INVESTIGATION PROGRAM
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION

Medium:		Soil						Medium:	Groundwater					
Sample Identification:		SB-4	Dup-2		SB-6	Dup-1		Sample Identification:	MW-1	Dup-1		MW-1	Dup-1	
Sample Date:		10/10/2007			10/9/2007			Date Analyzed:	10/10/2003			12/04/2003		
Sample Depth (feet):		0-8			0-4									
Detected Constituents	**Soil Units**			**RPD**			**RPD**	**Groundwater Units**			**RPD**			**RPD**
Volatile Organic Compounds														
Acetone	mg/kg	0.147	0.102	**36.1**	0.115	0.071	**47.3**	µg/L	<10.0	<10.0	--	<10.0	<10.0	--
Benzene	mg/kg	<0.001	<0.001	--	0.002	0.002	0.0	µg/L	<1.0	<1.0	--	<1.0	<1.0	--
2-Butanone (MEK)	mg/kg	0.021	0.015	33.3	0.016	0.016	0.0	µg/L	<5.0	<5.0	--	<5.0	<5.0	--
Carbon Disulfide	mg/kg	0.016	0.016	0.0	<0.007	0.010	--	µg/L	<1.0	<1.0	--	<1.0	<1.0	--
Ethylbenzene	mg/kg	<0.001	<0.001	--	0.001	0.002	**66.7**	µg/L	<1.0	<1.0	--	<1.0	<1.0	--
Toluene	mg/kg	0.002	0.002	0.0	0.004	0.005	22.2	µg/L	<1.0	<1.0	--	<1.0	<1.0	--
Xylenes, Total	mg/kg	<0.002	<0.002	--	0.003	0.004	28.6	µg/L	<2.0	<2.0	--	<2.0	<2.0	--
Semivolatile Organic Compounds														
Benzo(a)anthracene	mg/kg	<0.33	0.60	--	<0.33	<0.33	--	µg/L	<10	<10	--	<10	<10	--
Chrysene	mg/kg	<0.33	0.63	--	<0.33	<0.33	--	µg/L	<10	<10	--	<10	<10	--
Fluoranthene	mg/kg	0.43	1.76	**121.5**	<0.33	<0.33	--	µg/L	<10	<10	--	<10	<10	--
Phenanthrene	mg/kg	0.34	1.70	**133.3**	<0.33	<0.33	--	µg/L	<10	<10	--	<10	<10	--
Pyrene	mg/kg	0.35	1.37	**118.6**	<0.33	<0.33	--	µg/L	<10	<10	--	<10	<10	--
Total Extractable Hydrocarbons														
as Gasoline	mg/kg	<5	11	--	<5	<5	--	µg/L	<1.0	<1.0	--	<1.0	<1.0	--
as #2 Diesel Fuel	mg/kg	13	<5	--	<5	<5	--	µg/L	<1.0	<1.0	--	<1.0	<1.0	--
as Waste Oil	mg/kg	<5	20	--	<5	<5	--	µg/L	<1.0	<1.0	--	<1.0	<1.0	--
TPH as Gasoline	mg/kg	<5	<5	--	<5	<5	--	µg/L	<1.0	<1.0	--	<1.0	<1.0	--
Total TPH [a]	mg/kg	13	31	**81.8**	No Detections	No Detections	--	µg/L	No Detections	No Detections	--	No Detections	No Detections	--
Total Metals														
Arsenic	mg/kg	7.9	8.7	9.6	8.1	7.5	7.7	mg/L	<0.005	<0.005	--	<0.005	<0.005	--
Barium	mg/kg	158	151	4.5	158	171	7.9	mg/L	0.046	0.046	0.0	0.045	0.046	2.2
Cadmium	mg/kg	0.6	0.6	0.0	0.7	<0.6	--	mg/L	<0.001	<0.001	--	<0.001	<0.001	--
Chromium	mg/kg	14.3	18.9	27.7	11.4	11.4	0.0	mg/L	<0.005	<0.005	--	<0.005	<0.005	--
Lead	mg/kg	90.7	119	27.0	69.0	10.4	**147.6**	mg/L	<0.005	<0.005	--	<0.005	<0.005	--
Silver	mg/kg	0.7	0.7	0.0	1.0	0.7	**35.3**	mg/L	<0.010	<0.010	--	<0.010	<0.010	--

Notes:

[a] Total total petroleum hydrocarbons (TPH) is the sum of all detected TPH and all detected total extractable hydrocarbons, per the MDNR.

ERP = Environmental Restoration Program.
RPD = Relative percent difference.
mg/kg = Milligrams per kilogram.
µg/L = Micrograms per liter.
mg/L = Milligrams per liter.
Bold = Value outside RPD Goal.
Appropriate RPD Goal = 35 percent.
Data validated to Level II; no qualifiers required for data on this table.

contained reportable concentrations of barium in common. This analyte had an RPD of zero for the first round of groundwater sampling and an RPD of 2.2 for the second round, well below the appropriate RPD goal of 35.

5.3.2 Trip Blanks

Analysis of trip blanks provides a means of assessing potential cross-contamination of groundwater samples during field sampling, handling, and/or transport. Each cooler used to ship groundwater samples collected for VOC analyses was accompanied by a trip blank, also analyzed for VOCs. A total of two trip blanks were submitted for analysis. No detectable concentrations of VOCs were reported in the trip blanks that accompanied the samples.

5.3.3 Data Validation

Laboratory analytical results were evaluated in accordance with the U.S. EPA Contract Laboratory Program (CLP) National Functional Guidelines (NFG) for Organic Data Review (October 1999), U.S. EPA CLP NFG for Inorganic Data Review (July 2002), and the analytical methods. The analytical data were reviewed and qualified based on the results of the data evaluation parameters and/or the QC sample results provided by the laboratory.

The following summarizes the review of the analytical data that did not meet the QC criteria:

- The continuing calibration verification (CCV) associated with the VOC analysis of all samples in the laboratory work order number 13J0432 indicated a low biased recovery of 68.4 percent (QC limit: 70 to 130 percent) for naphthalene. Samples in this work order were qualified "J" as estimated for naphthalene.

- For the analysis of TEH (sum of TEH as gasoline, #2 diesel fuel, and used oil) results for samples SB-2 (0-4'), SB-8 (0-4'), SB-3 (6-8'), and SB-3 (8-10') are considered estimated (according to the laboratory) because the sample chromatogram does not resemble the fuel standard used for

quantitation. These samples within work order number 13J0432 were qualified "J" as estimated.

- Several surrogates associated with the SVOC analysis of samples in work order number 13J0432 were outside of acceptance criteria:

  - The surrogate 2-fluorobiphenyl associated with the analysis of sample SB-1 (8-10') had a recovery outside the acceptance criteria with a high bias. Since the SVOC results in this sample were nondetect, no qualification was necessary.

  - For the analysis of sample SB-2-0-4, the surrogates 2-fluorophenol, 2,4,6-tribromophenol, and phenol-d6 had low biased recoveries, and surrogate 2-fluorobiphenyl had a high biased recovery. Since four of the six surrogates were outside of their respective QC criteria, the compounds were qualified "J" as estimated.

  - The surrogates 2-fluorophenol, 2,4,6-tribromophenol, and phenol-d6 associated with the analysis of samples SB-2 (8-10'), SB-8 (0-4'), SB-7 (8-10'), SB-6 (7-10'), and Dup-1 indicated low biased recoveries. The associated compounds in these samples were qualified "J" as estimated.

  - The surrogates 2-fluorophenol and phenol-d6 associated with the analysis of sample SB-8 (8-10') indicated low biased recoveries. The associated compounds in this samples were qualified "J" as estimated.

  - The surrogates 2,4,6-tribromophenol and phenol-d6 associated with the analysis of samples SB-7 (0-4') and SB-6 (0-4') indicated low biased recoveries. The associated compounds in these samples were qualified "J" as estimated.

- The MS/MSD associated with the SVOC analysis of sample SB-1 (8-10') (work order number 13J0432) indicated low biased recoveries for phenol, n-nitroso-di-n-propylamine, 3&4-methylphenol, diethylphthalate, dimethylphthalate, 2,6-dinitrotoluene, and pyrene. Since these indicated low biased recoveries, these compounds were qualified "J" as estimated in this sample only.

- The MS associated with the metals analysis of barium in sample SB-7 (8-10') (work order number 13J0432) indicated a low biased recovery. This analyte was qualified "J" as estimated in this sample only.

- The CCV associated with the SVOC analysis of the samples in laboratory work order number 13J0548 indicated low biased recovery of 78.3 percent for 4-nitroaniline and a high biased recovery of 210 percent for pentachlorophenol (QC limit: 80 to 120 percent). Each sample in this work order was qualified "J" as estimated for 4-nitroaniline due to the low bias. No qualification was necessary for pentachlorophenol due to the high biased recovery and the sample results being nondetect.

- The CCV associated with the SVOC analysis of the samples in laboratory work order number 13L0340 indicated high biased recoveries for 2,4-dinitrophenol (145 percent), 4,6-dinitro-2-methylphenol (127 percent), indeno(1,2,3cd)pyrene (134 percent), dibenz(a,h)anthracene (124 percent) and benzo(g,h,i)perylene (134 percent). Since these are high biased and the sample results were nondetect, no qualification is necessary.

- The surrogate, terphenyl-d4, associated with sample MW-1 in work order 13J0548, indicated a high biased recovery. Since the SVOC results in this sample were nondetect, no qualification was necessary.

- The LCS associated with the samples in laboratory work order number 13L0340 indicated low biased recoveries for diethylphthalate and di-n-butylphthalate. Samples in this work order were qualified "J" as estimated for these compounds.

- The MS/MSD associated with the SVOC analysis of sample MW-1 in work order number 13J0548 indicated high biased spike recoveries for pentachlorophenol. Since this compound was nondetect, no qualification is necessary.

- The MS/MSD associated with the SVOC analysis of sample MW-1 in work order number 13L0340 indicated low biased spike recoveries for diethylphthalate, anthracene, and di-n-butyl phthalate. These compounds were qualified "J" as estimated in this sample only.

- The surrogate decachlorobiphenyl associated with the PCB analyses of samples DUP-1 and MW-2 in work order number 13J0548 indicated low biased recoveries. These samples were qualified "J" as estimated.

- The LCS associated with the mercury analysis of samples in work order number 13J0548 indicated a high biased recovery. Since this reflects a high bias and the sample results were non-detect, no qualification was necessary.

Based on the results of this data validation, the data are considered valid and complete as qualified.

6.0 REVIEW OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The Superfund Amendments and Reauthorization Act of 1986 requires all remedial actions comply with ARARs of other environmental and public health statutes. Applicable requirements are those requirements or standards that specifically address a substance, action, or other circumstance found at a site. A relevant and appropriate requirement means a requirement or standard that while not addressing the specific circumstances at a given site, does address similar situations found at other sites.

Identification of ARARs is accomplished by determining if the ARARs are promulgated (that they are legally enforceable and of general applicability), more stringent, and applicable or relevant and appropriate (there must be a connection between the statute, regulation or provision, and the site characteristics/remedies).

ARARs can be divided up into three groups: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. A site's location is a fundamental determinant of its impact on human health and the environment. Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conductance of activities solely because they are in specific locations.

A review of the chemical-, location-, and action-specific ARARs identified for ERP Site No. 2, as presented in the *RI Work Plan*, are summarized in the following sections. As part of the evaluation for ARARs, selection of soil and groundwater evaluation criteria were established.

6.1 CHEMICAL-SPECIFIC ARARS

Chemical-specific ARARs include state and federal requirements regulating chemical constituent levels in various media. The chemical-specific ARARs are important in developing remedial objectives that comply with regulatory requirements or guidance (as appropriate). Chemicals detected or suspected during the PA/SI work were used as the basis for identification of potential chemical-specific ARARs. The ARARs to be used for soil and groundwater are provided below.

6.1.1 Soil

The Missouri UST Soil Remedial Goals are used as ARARs at ERP Site No. 2 due to the location of a historical storage tank in the Site's immediate vicinity. The site-specific soil cleanup levels for BTEX and total TPH have been determined by completing a matrix where the Site features are scored. This matrix, Table 4 of the UST Closure Guidance Document (MDNR, March 1996), in included as Appendix F with the current Station features scored.

The non-UST Soil Remedial Goals utilize Table B1 from the CALM policy document as a reference (MDNR, 2001). Because the current land use is not restricted to industrial, Scenario A is used as the initial evaluation criteria. The evaluation criteria for Scenario A indicate soil concentrations must meet the lesser of the ingestion/dermal contact/inhalation values (C_{IDI}) or the soil leaching to groundwater concentration values (C_{LEACH}) listed in Table B1 of the CALM policy document.

6.1.2 Groundwater

The cleanup action levels for groundwater are defined by the potential use of groundwater. Due to the lack of shallow groundwater above bedrock beneath the Station, it is unlikely the shallow groundwater could be used as a drinking water source. Thus the Missouri UST Non-Potable Groundwater Remedial Goals will be used as ARARs at ERP Site No. 2, which provide groundwater cleanup levels for BTEX and TPH (Table 5, MDNR, March 1996). The non-UST Groundwater Remedial Goals will also utilize Table B1 from the CALM policy document; the values associated with the Groundwater Target Concentrations in Table B1 will be used.

6.1.3 Site Cleanup Goals Screening Process

The soil and groundwater laboratory analytical data from ERP Site No. 2 activities have been compared to the evaluation criteria established in Sections 6.2.1 and 6.2.2, respectively.

6.2 LOCATION-SPECIFIC ARARS

No location-specific ARARs are considered to be potentially applicable to the RI activities conducted at the Station in 2003. However, location-specific ARARs may be evaluated further should there be a need for FS activities, depending on the selected remedial alternatives.

6.3 ACTION-SPECIFIC ARARS

Action-specific ARARs are regulatory requirements defining acceptable treatment and disposal procedures for the particular actions presented in the alternatives. Table 7 lists the potential action-specific ARARs for consideration during the investigation and remedial activities.

TABLE 7

ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION

Action Subject to Requirements	Requirement	Reason Why Requirement is Potentially Applicable	Regulatory Citation
Removal and disposal of soil.	Dispose of excavated soil in accordance with applicable Land Disposal Restrictions	This rule is a potential Applicable or Relevant and Appropriate Requirement (ARAR) because removal of impacted soil will be evaluated.	40 Code of Federal Regulations (CFR) Part 268, as incorporated by reference in 10 Code of State Regulations (CSR) 25-5.262.
Groundwater contamination.	Meet the Missouri Effluent Regulations, Groundwater (1996).	The impacts to groundwater documented in previous investigations will need to be addressed with this potential ARAR.	10 CSR 20.7.031(5)(D).
Protection of surface and groundwater quality and resources.	This requirement sets criteria for the protection of surface and groundwater quality and resources.	This rule is a potential ARAR because monitoring wells will be installed at the Site.	10 CSR 23-4.050 and 10 CSR 20-7.031.
Treatment of contaminated soils.	This requirement sets land application disposal restriction applicable to generators of hazardous waste.	This rule becomes a potential ARAR if it is necessary to dispose of excavated soil.	40 CFR Part 268, as incorporated by reference in 10 CSR 25-5.262.
Disposal of wastes at an approved solid waste disposal facility.	This requirement applies to disposal of regulated quantities of hazardous waste, polychlorinated biphenyls (PCBs), or bulk liquids.	This rule becomes a potential ARAR if hazardous waste, PCBs, or bulk liquids need to be disposed.	10 CSR 80-3.010 (3).
Disposal of PCB-contaminated materials.	This requirement applies to disposal of PCB-contaminated materials.	This rule becomes a potential ARAR if material or soil from releases of PCBs have been observed at the Station and subsequent disposal is required.	10 CSR 25-13.010.
Requirements of characterization of hazardous wastes.	Any materials generated during field activities shall be properly characterized.	This rule becomes a potential ARAR because waste materials may require disposal.	40 CFR Part 260 and 261.

TABLE 7
(CONTINUED)

ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION

Action Subject to Requirements	Requirement	Reason Why Requirement is Potentially Applicable	Regulatory Citation
Land disposal restrictions for hazardous waste.	Hazardous and mixed waste generated during field activities shall be disposed of according to the Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions.	This rule becomes a potential ARAR if hazardous or mixed waste is generated at the Station.	40 CFR 268.7 and 268.32, and 10 CSR 25-7.268.
Methods for identifying hazardous waste.	Test procedures and requirements for identification of materials as hazardous and regulated waste under RCRA shall be followed.	This rule becomes a potential ARAR if waste materials are generated.	10 CSR 25-4.261.
Standard health and safety requirements.	Field activities shall be conducted in accordance with the cited requirements of appropriate Air National Guard requirements and will be documented.	This rule becomes a potential ARAR because field activities will be conducted at the Site.	29 CFR Part 1904, 29 CFR
Health and safety training requirements.	The cited health and safety training requirements shall be adhered to.	This rule becomes a potential ARAR because field activities will be conducted at the Site.	29 CFR 1910: 1910.100 Subpart Z, Toxic and Hazardous Substances.
Groundwater monitoring well construction and abandonment.	Missouri Well Construction Code sets standards for monitoring well installation permit requirements, and for the renewal and placement of permit number.	This rule becomes a potential ARAR when groundwater monitoring wells are constructed or abandoned.	10 CSR 23-1.010–1.060 and 10 CSR 23-1.090, 10 CSR 23-1.105, 10 CSR 23-1.140.
Groundwater monitoring well construction and abandonment.	Missouri Well Construction Code sets standards for the general protection of groundwater during monitoring well construction and abandonment.	This rule becomes a potential ARAR if groundwater monitoring wells are constructed or abandoned at the Site.	10 CSR 23-3020–3.080 and 10 CSR 23-3.110.

TABLE 7
(CONTINUED)

ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION

Action Subject to Requirements	Requirement	Reason Why Requirement is Potentially Applicable	Regulatory Citation
Installation of monitoring well(s) or piezometers.	Monitoring Well Construction Code (Chapter 4 of the Missouri Well Construction Rules) sets standards for monitoring well and piezometer construction.	All sections of the Monitoring Well Construction Code are potential ARARs for this project.	Missouri Well Construction Rules 10 CSR 23-4.010-10 CSR 23-4.080.
Installation of monitoring well(s).	This requirement provides criteria for the locations where monitoring wells should be placed.	This rule becomes a potential ARAR because monitoring well(s) is to be installed at this Site which is located in a floodplain. Special criteria will be determined for specific site.	10 CSR 23-4.030 (1) (C).
Installation of monitoring well(s).	Minimum standards for properly constructed monitoring wells are described by this requirement.	This rule becomes a potential ARAR due to the possible presence of volatile organic compounds (VOCs) and petroleum products in Site groundwater. This rule requires special consideration in the selection of riser pipe, casing materials, and polymer additives for bentonite slurry-grout.	10 CSR 23-4.060 (1) (A) and (11) (A).
Installation of monitoring well(s).	Minimum standards for properly constructed monitoring wells are described by this requirement.	This rule becomes a potential ARAR if piezometers are installed at this Site in the future.	10 CSR 23-4.060 (1) (D) (1), (2), and (3).
Installation of monitoring well(s).	Minimum standards for properly constructed monitoring wells are described by this requirement.	This rule becomes a potential ARAR if monitoring wells and piezometers are installed at this Site which is located in a floodplain. Elevation of riser assembly is required.	10 CSR 23-4.060 (7).

TABLE 7
(CONTINUED)

ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
JEFFERSON BARRACKS AIR NATIONAL GUARD STATION

Action Subject to Requirements	Requirement	Reason Why Requirement is Potentially Applicable	Regulatory Citation
Installation of monitoring well(s).	Minimum standards for properly constructed monitoring wells are described by this requirement.	This rule becomes a potential ARAR if monitoring wells are installed at this Site which is located in a floodplain. Additional well protection is necessary.	10 CSR 23-4.060 (12) (A) (3).
Installation of monitoring well(s).	Minimum standards for properly constructed monitoring wells are described by this requirement.	This rule becomes a potential ARAR due to the possible presence of VOCs and petroleum products in Site groundwater, because of compatibility concerns between groundwater and grout used to plug the monitoring well.	10 CSR 23-4.080 (4).
Abandonment (plugging) of monitoring well(s).	Minimum standards for properly constructed monitoring wells are described by this requirement.	This rule becomes a potential ARAR if monitoring wells or piezometers are abandoned at this Site in the future.	10 CSR 23-4.080 (6).

7.0 SUMMARY AND CONCLUSIONS

7.1 BACKGROUND

MWH has been contracted under the ERP to complete an RI for MOANG's 157th AOG at the Station in St. Louis, Missouri. The purpose of the RI is to determine the nature and extent of chemical constituents in soil and groundwater at ERP Site No. 2. The investigation at the Site detected constituents in soil and groundwater samples, with concentrations of SVOCs, TPH, and arsenic exceeding MDNR soil cleanup action levels in soil.

A previous investigation at ERP Site No. 2 (the 1994 SI) detected VOCs, SVOCs, TPH as gasoline and diesel, and beryllium in soil above MDNR soil cleanup action levels. No groundwater samples were collected during that investigation. The source of the soil constituents is most likely associated with former AST and drum storage at the site.

In September 2003, MWH finalized an *RI Work Plan*, which described the rationale and procedures for investigation sampling and analysis activities. The investigative fieldwork was conducted during October and December 2003.

During the 2003 fieldwork at ERP Site No. 2, a total of eight soil borings were advanced and four monitoring wells were installed. Soil screening and sampling, groundwater sampling of the new monitoring wells, and water level measurements were completed during the 2003 fieldwork.

7.2 HYDROGEOLOGY

The Station is located along the western bank of the Mississippi River. The average ground elevation of ERP Site No. 2 is approximately 455 feet msl. The shallow subsurface is comprised predominantly of clay, silty clay, and sand, with some gravel lenses.

The unconsolidated deposits in the vicinity of the Station are not considered to be an aquifer due to the low water-bearing capacity of the deposits, and they are not used as a drinking water source in the area. A zone of karst terrain occurs in a discontinuous belt

surrounding the Station on the northeast, west, and southwest. Consequently, the direction of groundwater flow in bedrock in the vicinity of the Station is difficult to ascertain.

Due to the lack of resulting geologic data from any geotechnical or RI activities conducted at the Station in the past several years, it was not possible to accurately estimate site-specific groundwater conditions. Although no groundwater was encountered during excavations for removal of USTs at the SS-1 site west of Building 40, groundwater was encountered in several of the borings drilled during the 1994 SI activities. During the 2003 RI field investigation activities, the apparent horizontal groundwater flow direction at ERP Site No. 2 was determined to be generally toward the east, in the direction of the Mississippi River, as was previously estimated for the SI. Horizontal hydraulic gradients calculated for the 2003 field activities were approximately 0.13 foot/foot across ERP Site No. 2.

7.3 NATURE AND EXTENT OF CHEMICAL CONSTITUENTS

7.3.1 Soil Investigations

Based on the soil sampling completed to date at ERP Site No. 2, it appears natural attenuation has reduced the concentrations of chemical constituents in soil over time. As of the 2003 RI activities, chemical constituents in soil above MDNR cleanup action levels are generally limited to total TPH in the 6- to 10-foot bgs interval of boring SB-3 (near the southwest corner of the large concrete pad), and SVOCs in the shallow intervals of SB-2 and SB-8 (east of the former AST).

Beryllium was detected above the MDNR CALM standard in ten of the twelve soil samples collected during the 1994 SI activities. Arsenic was detected above the CALM standard in seven of the eight deep soil samples (seven of the total sixteen samples) collected during the 2003 RI. High levels of arsenic are common in soils near the Station, per the geochemical survey of Missouri agricultural soils undertaken in the 1970s, and are likely normal background levels.

7.3.2 Groundwater Investigations

The RI groundwater sampling activities conducted over two rounds in 2003 indicated no

chemical constituents above MDNR CALM standards. No previous groundwater sampling had been conducted at ERP Site No. 2.

7.4 CONCLUSIONS

Based on the investigative work conducted at ERP Site No. 2, the sources of chemical constituents are most likely associated with the former AST and drum storage. The former AST in the southwest corner of the Site and the drums and stained gravel were removed, and chemicals are no longer stored in this area.

Because approximately the northern one-third of ERP Site No. 2 is covered by concrete pads and a semipermanent connex storage building, and the remainder of the Site is covered with grass, migration of soil through other means (i.e., direct contact exposure, surface water runoff, wind blown dust, etc.) would be essentially eliminated in this area.

The chemicals of concern detected in soil at ERP Site No. 2 have had the potential to migrate to groundwater. However, no constituents were detected above groundwater cleanup levels during either round of groundwater sampling, providing the conclusion that leaching from soil to groundwater is not occurring.

Based upon results of the previous and recent investigations conducted at ERP Site No. 2, the following has been concluded:

- During the SI, soil vapor survey points advanced at ERP Site No. 2 detected TPH in three soil vapor samples; and toluene, ethylbenzene, and xylene were detected in one soil vapor sample.

- TPH, benzo(a)pyrene, and beryllium were the only chemical constituents detected in soil above the current MDNR soil cleanup action levels during the 1994 SI fieldwork.

- SVOC detections in soils above MDNR CALM standards during the 2003 RI were limited to the shallow soil intervals of borings SB-2 and SB-8, located east of the former AST).

- Total TPH detections above the MDNR soil cleanup action level during the 2003 RI were limited to the 6- to 10-foot bgs interval of soil boring SB-3, located adjacent to the southwest corner of the large concrete pad.

- Arsenic in soil exceeding the MDNR CALM standard was detected in seven of the eight deep soil intervals (seven of the total sixteen samples) collected during the 2003 RI. That is, this constituent is detected in exceedance of the standard in deep soils, far from human contact. Additionally, high levels of arsenic are common in soils near the Station, and thus these detections are likely normal background soil levels.

- Based on the soil sampling completed to date at ERP Site No. 2, it appears that natural attenuation has reduced the concentrations of many chemical constituents in soil in the time since the SI fieldwork was completed.

- Groundwater in unconsolidated sediments in the vicinity of the Station is not used as a source of drinking water.

- The 2003 groundwater sampling activities indicated no chemicals of concern above MDNR CALM standards.

Chemical constituents in groundwater at ERP Site No. 2 have been adequately delineated, and no further assessment of groundwater is necessary.

7.5 RECOMMENDATIONS

Additional soil characterization and removal is recommended. Steps to close out ERP Site No. 2 are as follows:

- Submit Work Plan to MDNR for additional site characterization activities.

- Conduct additional shallow soil sampling in the immediate vicinity of soil boring SB-3, where TPH was detected above MDNR CALM standards in the 6-8 and 8-10 feet bgs intervals during the 2003 RI.

- Conduct additional shallow soil sampling in the vicinity of soil borings SB-2 and SB-8, where SVOCs were detected above MDNR CALM standards in the 0-4 feet bgs interval during the 2003 RI.

- Overexcavate soil around the areas of SVOC and TPH exceedances.

- Collect additional soil samples in the sidewalls and floor of the excavation(s) to confirm the surrounding soil is clean.

- Backfill the excavation(s) with clean soil, and repair the excavated area to match the surrounding surface.

- Document the soil removal and clean closure activities.

- Following additional soil sampling, overexcavation, confirmation, backfill, and documentation activities, ERP Site No. 2 will be requested for No Further Action.

8.0 REFERENCES

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