U.S. Army Corps of Engineers
Fort Worth District

Final Longitudinal Stream Sampling Study
Field Sampling Plan

Bosque and Leon River Watersheds Study

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of Engineers
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MWH
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ACRONYMS

bgs	below ground surface
BRA	Brazos River Authority
°C	degrees Celsius
cfs	cubic feet per second
CQC	contractor quality control
CSM	conceptual site model
DOT	Department of Transportation
DQCR	Daily Quality Control Report
DQOs	data quality objectives
FSP	field sampling plan
GPS	global positioning system
IDW	investigation-derived waste
MS/MSD	matrix spike/matrix spike duplicate
MWH	MWH Americas, Inc.
NTU	nepholemetric turbidity unit
NWIRP	Naval Weapons Industrial Reserve Plant
ppb	parts per billion
PPE	personal protective equipment
psi	pounds per square inch
PVC	polyvinyl chloride
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RPD	relative percent difference
SAP	sampling and analysis plan
SOP	standard operating procedure
SSHP	site safety and health plan
TIEHH	The Institute of Environmental and Human Health at Texas Tech University

ACRONYMS (continued)

USACE	U.S. Army Corps of Engineers Fort Worth District
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency

1.0 INTRODUCTION

This Longitudinal Stream Sampling Study Field Sampling Plan (FSP) is a component of the *Sampling and Analysis Plan - Bosque and Leon River Watersheds Study* (SAP; MWH Americas, Inc. 2002a). The SAP includes a quality assurance project plan (QAPP), a site safety and health plan (SSHP), and task-specific FSPs. The task-specific FSPs are prepared as addenda to the overall SAP to describe the project requirements for the field investigations associated with the Bosque and Leon River Watersheds Study.

This FSP was prepared for the U.S. Army Corps of Engineers Fort Worth District (USACE) by its environmental contractor, MWH Americas, Inc. (MWH), through authorization provided in contract DACW57-97-D-004, Task Order DY01, Modification No. 003. This FSP has been prepared in accordance with the USACE Statement of Work dated May 7, 2002, and the *Requirements for the Preparation of Sampling and Analysis Plans* (EM 200-1-3; USACE, 2001).

1.1 PROJECT DESCRIPTION AND BACKGROUND

The purpose of the USACE Bosque and Leon River Watersheds Study is to assess the impact of perchlorate releases associated with the former Naval Weapons Industrial Reserve Plant at McGregor, Texas (NWIRP McGregor). Specifically, the USACE study is assessing the impact of perchlorate releases on Lake Belton and Lake Waco water quality, and the potential human and environmental exposure to perchlorate in the Lake Belton and Lake Waco study area. NWIRP McGregor is located approximately 20 miles southwest of Waco, Texas, as shown on Figure 1-1.

A conceptual site model (CSM) was prepared to provide a preliminary conceptual understanding of potential human and environmental exposures to perchlorate in the Lake Belton and Lake Waco study area (MWH, 2002b). The CSM identified data gaps in the current understanding of perchlorate migration and exposure within the study area, and identified additional investigation activities aimed at filling such data gaps. A Longitudinal Stream Sampling Study is one of the field investigation activities proposed to fill certain data gaps identified in the CSM.

Please refer to the SAP for a historical summary of NWIRP McGregor, a description of the integrated multi-disciplinary project team, a description of the USACE perchlorate study area, the environmental setting, and a brief summary of previous environmental investigations in the study area. Details regarding the historical use, and investigation history at former NWIRP McGregor also are included in the *Final Conceptual Site Model Bosque and Leon River Watersheds Study* (MWH, 2002b).

1.2 FIELD SAMPLING PLAN SCOPE AND OBJECTIVES

This FSP describes the field activities to be performed and defines the procedures and methods to be used to collect field measurements and samples during the Longitudinal Stream Sampling Study. The elements of the Longitudinal Stream Sampling Study include:

- Longitudinal surface water flow measurements within Harris Creek, Station Creek, Cowhouse Creek, and the South Bosque River.

- Longitudinal surface water sampling on Harris Creek, Station Creek, Cowhouse Creek, and the South Bosque River.

- Rainfall measurements within the study area watersheds.

- Installing monitoring wells in close proximity to the stream sampling locations in order to collect groundwater elevation (water level) measurements. Please note that although groundwater samples will not be collected as part of the Longitudinal Stream Sampling Study field program, this FSP includes groundwater sampling procedures in the event the project team determines groundwater sampling is necessary to supplement the data obtained from other Bosque and Leon River Watersheds Study field programs.

1.3 DOCUMENT ORGANIZATION

The remainder of this FSP consists of:

- Section 2.0 Field Program. Includes the Longitudinal Stream Sampling Study rationale and data quality objectives (DQOs), sampling equipment and procedures, and all other operations associated with the field sampling program.

- Section 3.0 Health and Safety Program. References the site-specific SSHP component of the SAP. It includes all personal protective equipment (PPE) and safety precautions applicable to the field activities described in this FSP.

- Section 4.0 Quality Control. Includes the quality control that is specific to this field program including field quality assurance/quality control (QA/QC) samples and data validation requirements.

2.0 FIELD PROGRAM

This section describes the field program rationale and DQOs; field documentation procedures; and sampling locations, rationale, equipment, and procedures for the Longitudinal Stream Sampling Study.

2.1 QUALITY ASSURANCE PROJECT PLAN

All data for this project will be collected in accordance with the QAPP, which along with the SSHP and this FSP, is a component of the SAP (MWH, 2002a). The QAPP presents the QA/QC protocols that will be used to meet the DQOs of this field program. The QAPP will be referenced throughout this document to support the sampling techniques and data collection procedures presented herein. The types of data to be collected during this field program and their intended uses are presented in Table 2-1.

2.2 DATA QUALITY OBJECTIVES

DQOs have been developed for each field task in this field program using the seven-step process as outlined in the *Guidance for the Data Quality Objectives Process, EPA QA/G-4* (USEPA, 1994a) and additional guidance as provided in *Data Quality Objectives for Hazardous Waste Site Investigations, EPA QA/G-4HW* (USEPA, 2000). The steps in this process are:

- State the Problem
- Identify the Decision
- Identify the Inputs to the Decision
- Define the Boundaries of the Study
- Develop Decision Rules
- Specify Tolerable Limits on Decision Errors
- Optimize the Design for Obtaining Data.

The DQOs developed for the Longitudinal Stream Sampling Study field tasks (including surface water flow/groundwater elevation measurements, surface water sampling, and rainfall measurements) are presented in Table 2-2.

2.3 STANDARD OPERATING PROCEDURES

When appropriate, the field procedures will be conducted in accordance with the Brazos River Authority (BRA) and MWH standard operating procedures (SOPs) presented in Appendix A. The applicable BRA SOPs include:

- P&ED-FF-1001 Flowmeter Initialization

- P&ED-FF-1002 Programing Flowmeter Equipment
- P&ED-FF-1004 Sample Retrieval
- P&ED-FF-1005 Downloading Automated Sampling Sites
- P&ED-FF-1006 General Maintenance

The applicable MWH SOPs include:

- SOP-01 Drilling
- SOP-02 Well Design
- SOP-03 Well Development
- SOP-05 Groundwater Sampling
- SOP-14 Field Documentation
- SOP-15 Field Logbook

Caution: Please note that the methods and procedures presented in this FSP were developed specifically for the project DQOs and, therefore, will supersede those presented in the SOPs if conflicts exist. Field sampling personnel shall be required to become familiar with the SOPs prior to initiating fieldwork. The field team leader shall correct any conflicts to the SOPs to avoid confusion and insure that the field sampling personnel adhere to the project DQOs.

2.4 FIELD DOCUMENTATION

All information pertinent to the field activities described herein will be entered directly into a field logbook and on project-specific field forms. The field logbook will be maintained throughout all field activities and will consist of a weatherproof, bound, survey-type book, with non-removable, numbered pages.

All data generated during the investigation and any deviations from this work plan will be recorded in detail in the field logbook. At a minimum, the date, weather conditions, personnel on site, type of activities being performed, samples collected, and any unusual conditions encountered during the investigation will be recorded in the logbook. Corrections to erroneous data will be made by crossing a single line through the entry and entering the correct information. Unused portions of the logbook pages will be crossed out, signed, and dated at the end of each work day. Language used will be objective, factual, and free of personal opinions. Hypotheses for observed phenomena may be recorded; however, they must be clearly indicated as such and only relate to the subject observation. The field forms that are applicable to this project include daily quality control reports, Tailgate Safety Meeting Forms, and Chain-of-Custody Records. Field forms will become part of the project record. Sample field forms are provided in Appendix B of this work plan.

In addition to written records, photographs also will be taken as necessary to supplement written descriptions of field activities entered in the field logbook and on field forms.

Photographs will be included in project reports when appropriate, and will be stored with the permanent project files.

2.5 SURFACE WATER MONITORING

2.5.1 Introduction

Fifteen automated monitoring stations will be installed along streams that discharge to Lake Waco and Lake Belton. Each monitoring station will be programmable to collect surface water samples and to measure and record stream flow and rainfall data. Details regarding the surface water monitoring locations and rationale, equipment and procedures, and sample frequency are presented below.

2.5.2 Locations and Rationale

The monitoring network will include installation of 15 automated monitoring stations along Harris Creek, Station Creek, Cowhouse Creek and the South Bosque River as shown on Figures 2-1 through 2-11. The monitoring station locations were selected by the project team during the planning meetings conducted to finalize the CSM. The overall rationale for the selected monitoring locations along Harris Creek, Station Creek, and South Bosque River is to provide data that can be used to evaluate the perchlorate concentrations and associated flow rates entering Lake Waco and Lake Belton. The rationale for the monitoring location on the Cowhouse Creek is to evaluate if Ft. Hood is a potential source of perchlorate.

The global positioning system (GPS) coordinates for several of the proposed monitoring station locations are included in Table 2-3. The field team will document the actual GPS coordinates of the monitoring stations when they are installed.

2.5.3 Equipment and Procedures

Automated Stream Monitoring Stations. The field crew will install the following equipment at each monitoring station:

- Isco 4230 Flow Meter (equipped with a bubbler and a rain gauge).
- Isco 6712 Auto Sampler.
- PVC pipe to run sample tubing and bubbler to the center of the stream.
- 12-volt battery and solar panel to recharge the battery.
- An additional data logger to store groundwater-elevation data from nearby monitoring well (monitoring well information is presented in Section 2.6).
- A protective portable steel enclosure to house the flow meter, auto sampler, battery, and data logger.

The flow meter will be programmed, operated, and maintained according to the BRA SOPs provided in Appendix A. The applicable SOPs include P&ED-FF-1001 Flowmeter Initialization, P&ED-FF-1002 Programing Flowmeter Equipment, and P&ED-FF-1006 General Maintenance. BRA will arrange for and compensate an Isco, Inc. company representative to be on site to assist the field crew with the installation and programming of the stream monitoring stations. A project-specific SOP for the operation and programming of the Isco 6712 Auto Sampler will be developed by BRA with the assistance of the Isco, Inc. representative.

Stream Channel Survey. The stream channel will be surveyed at each monitoring location in order to determine the appropriate stream characteristics for programming the monitoring stations. The survey will include:

- Establishing a benchmark.
- Measuring elevations across the floor of the stream channel (perpendicular to flow) to calculate the cross sectional area.
- Measuring elevations along the floor of the stream channel (parallel to flow) to calculate the slope.
- Measuring the elevation of the bubbler.

The field crew will conduct the survey using an automatic level instrument and measuring rod. At a minimum, the stream elevation measurements (slope and cross section) will be taken at 1-foot increments or at obvious terrain breaks. The data points from the survey will be entered into the flow meter, which automatically calculates the cross sectional area, slope, and converts the gauge height (as measured by the bubbler) to a flow rate.

Surface Water Flow and Rainfall Measurements. Each auto sampler will be programmed to collect stream flow and rainfall measurements at the frequencies outlined in Section 2.5.4. The stream flow and rainfall measurements will be recorded to the internal data storage memory in the Isco 4230 Flow Meter. The measurements to be recorded include stream stage (level) in feet above the measuring point, stream flow in cubic feet per second (cfs), and rainfall in inches per storm event.

Surface Water Sampling. Each auto sampler will be programmed to collect sequential grab surface water samples at the frequencies outlined in Section 2.5.4. The samples will be collected into bottles that will be stored within the auto sampler until manually retrieved by the field crew. Sample containers and preservation requirements for the surface water samples are presented in Table 2-4.

The field crew will visit the sampling stations every 14 days to collect samples, reload the auto sampler, download data from the data loggers, check the operation of the metering station and equipment, and perform any needed maintenance activities. Because the hold time for perchlorate is 28 days, this should allow sufficient time to collect the samples and submit them to the lab without having to pay for rush analyses. The following field

observations and measurements also will be collected during each visit to each sampling station.

Field Observations:

- Cloud cover
- Wind velocity
- Secchi Disk transparency
- Water color
- Aquatic vegetation in percent cover
- Instantaneous flow rate.

Field Measurements collected through the use of a Hydrolab (multi-parameter instrument):

- Temperature
- Dissolved oxygen
- Specific conductance
- pH
- Salinity
- Dissolved oxygen percent saturation.

The applicable SOPs for retrieving the surface water samples include P&ED-FF-1004 Sample Retrieval, P&ED-FF-1005 Downloading Automated Sampling Sites, and P&ED-FF-1006 General Maintenance, which are included in Appendix A.

Quality Assurance/Quality Control Sample Collection. The quality assurance/quality control (QA/QC) samples that will be collected during the Longitudinal Stream Sampling Study field program include blind duplicate samples and matrix spike/matrix spike duplicate (MD/MSD) samples. A discussion of the QA/QC sample types and frequencies is presented in Section 4.2. The procedures for collecting the required QA/QC samples are discussed below.

A blind duplicate is submitted with a fictional sample identification so that the laboratory is unaware the sample is a duplicate. Blind duplicate samples are used to assess the consistency and precision of the laboratory. The blind duplicate samples will be obtained by programming the automatic samplers to fill an additional sample jar with every 10^{th} environmental sample that is collected (10 percent frequency).

Matrix spike/matrix spike duplicate samples are duplicate samples submitted to the laboratory to measure the efficiency of the analytical method in recovering target analytes from an environmental matrix, as well as the laboratory precision and accuracy. The MS/MSD samples will be obtained by programming the automatic samplers to fill two additional sample jars (one for the MS and one for the MSD) with every 20^{th}

environmental sample that is collected (5 percent frequency). The QA/QC samples will be handled according to the procedures described in Section 2.11.

2.5.4 Sample Frequency, Designation, and Analysis

Sample Frequency. The sampling stations located on the South Bosque River, Harris Creek, and Station Creek will be programmed to collect stream flow and rainfall measurements continuously. Initially, the surface water samples will be collected at the following frequency to obtain baseline data:

- Once daily for the first seven days.
- Once weekly for the next three weeks
- Once every two weeks for the remainder of the project (i.e., 12 months).

The monitoring stations will be programmed to return to daily surface water sampling when a significant storm event has occurred (a discussion of what constitutes a significant storm event is presented below). The sampling frequency may be modified as the baseline data and post-storm event data are received and evaluated. For example, the post-storm event sampling frequency may need to be increased or decreased to meet the DQOs.

The sampling station located on Cowhouse Creek will be programmed to collect surface water samples on a monthly basis during the project. Continuous stream flow and rain gauge monitoring also will be performed at the Cowhouse Creek monitoring station; however, the sampling frequency at Cowhouse Creek will not be altered by storm events. Table 2-5 lists the surface water samples that are anticipated to be collected during this field investigation.

At all sampling locations, blind duplicate samples will be collected at a frequency to represent 10 percent of the environmental samples collected and MS/MSD samples will be collected at a frequency to represent 5 percent of the environmental samples collected.

Significant Storm Event Criteria. Factors that contribute to defining a significant storm event for the purposes of evaluating surface water and groundwater interactions include rainfall (total and duration), change in stream flow, and change in groundwater level. These factors are complicated by the fact that rainfall and changes in steam flow and groundwater level can occur both on a local and regional scale. As a result, it is difficult to define what constitutes a significant storm event without assessing data trends that will be obtained during this field program.

As discussed above, BRA will arrange for and compensate an Isco, Inc. company representative to be on site during the installation and initial programming of the stream monitoring stations. Initial programming of the monitoring stations to collect data following a storm event will be based on the recommendations of the Isco, Inc. representative and local knowledge of the field team. The field team will clearly

document the assumptions and criteria that are used to establish when a significant storm event has occurred and the resulting changes in monitoring frequency (e.g., returning to daily sampling). Each quarterly update will include refinements to the criteria that define a significant storm event and how the monitoring frequencies are affected by those criteria (refer to Section 4.5 for a discussion of the project reporting requirements).

Sample Designation. Each surface water sample will be designated with an alphanumeric character string set apart by hyphens. The designation will begin with the stream name abbreviation and monitoring station number (e.g., "SBR1" for South Bosque River monitoring station 1, "HC1" for Harris Creek monitoring station 1, etc.), followed by "SW" to indicate a surface water sample, and finally by the date and military time the sample was collected. For example, the surface water sample collected from Station Creek monitoring station 1 at 16:15 on November 18, 2002 would be designated "SC1-SW-11-18-02-1615.

Blind duplicate samples will be designated with a fictitious number beginning with 1001 so the laboratory is unaware the sample is a duplicate. For example, the blind duplicate sample collected with environmental sample "SC1-SW-11-18-02-1615" would be designated "SW-1001". The field crew will keep careful records of the designations given to the blind duplicate samples and their corresponding environmental sample so that the analytical results can be correlated when they are received. Each MS/MSD sample will have the same designation as its associated environmental sample except that "MS" or "MSD" will follow the sample designation (e.g., "SC1-SW-11-18-02-1615 MS" and "SC1-SW-11-18-02-1615 MSD").

Sample Analysis. All surface water samples will be analyzed for perchlorate by USEPA Method 314.0. The USACE Engineer Research and Development Center Environmental Laboratory at the Environmental Chemistry Branch in Omaha, Nebraska will perform all sample analyses. The USACE laboratory will conform to the analytical method requirements, analytical quality control requirements, instrument calibration frequency, and the laboratory quality control requirements presented in the QAPP. A discussion of sample labeling, chain-of-custody, handling and shipping is presented in Section 2.11.

2.6 MONITORING WELL INSTALLATION

2.6.1 Introduction

This Longitudinal Stream Sampling Study field program will include installing shallow groundwater monitoring wells near surface water monitoring stations so that the interactions between surface water and groundwater levels (elevations) can be assessed. Details regarding the monitoring well locations and rationale, well installation equipment and procedures, and water level measurement procedures and frequencies are presented below.

Please note that groundwater samples will not be collected as part of the Longitudinal Stream Sampling Study field program. However, groundwater sampling procedures are included in this FSP for future reference in the event the project team determines groundwater sampling is necessary to supplement the data obtained from other Bosque and Leon River Watersheds Study field programs.

2.6.2 Locations and Rationale

One shallow groundwater monitoring well will be installed near each surface water monitoring station, with the exception of the Cowhouse Creek monitoring station (i.e., a monitoring well will not be installed at the Cowhouse Creek monitoring station). The wells will be located such that groundwater elevation measurements can be collected (in the shallow water-table aquifer) in conjunction with the measurements collected at the nearby surface water monitoring stations. The resulting data will be used to assess groundwater and surface water interactions and how groundwater levels are impacted by storm events.

The actual location of the wells will be determined based on field reconnaissances conducted when the surface water monitoring stations are installed. The wells will be located close enough to the monitoring stations to meet the DQOs. However, the actual location of the wells will depend on site conditions that may include underground or overhead utilities and whether a drill rig can access the location. Please note that if a existing U.S. Navy well is located close enough to a surface water monitoring station to meet the DQOs, the Navy will be contacted to obtain permission to use that well to collect groundwater elevation data in lieu of installing a new well.

2.6.3 Equipment and Procedures

As described in Section 2.3 of the CSM, the geology of the Bosque and Leon River watersheds consists of a thin veneer of soil (averaging 2 feet in thickness) underlain by limestone and marl. Depth to water in the unconfined aquifer is typically less than 10 meters (Cannata, 1988; Collins, 1989). Therefore, it is anticipated that the monitoring wells will be drilled and installed using drilling equipment that is capable of drilling through bedrock (e.g., air rotary, dual-tube percussion drilling). The selected drilling method will be suitable for installing monitoring wells that may eventually be sampled for water quality (e.g., drilling methods that require circulating fluids other than air or water are not recommended). MWH SOP-1 Drilling (located in Appendix A) presents descriptions and suitability of the applicable drilling methods. It is anticipated that the wells will be approximately 30 to 40 feet deep to allow the well screen to be placed across the shallow water table as described in Section 2.7.

2.6.4 Soil Sampling Equipment and Procedures

The soil and rock cuttings generated during the drilling process will be examined in the field as the monitoring well borings are advanced in order to log the borehole stratigraphy and to identify water-bearing zones. No soil samples will be retained for chemical analysis during this field program.

The drill cuttings collected for stratigraphic logging will be described according to the Unified Soil Classification System (USCS) as depicted in Figure 2-12. The USCS soil classification is based on grain size, degree of grading, stiffness, plasticity, and density. In addition, the soil description will also include Munsell color (wet), soil particle angularity, rock type, moisture content, and visible signs of contamination. All stratigraphic data will be recorded on the Monitoring Well Boring Log Form included in Appendix B.

2.6.5 Handling of Drill Cuttings

Drill cuttings that accumulate at the ground surface while drilling the monitoring well borings will be transferred to Department of Transportation (DOT) approved 55-gallon drums. Because the final disposal options for the drill cuttings may vary depending on the results of the disposal-profiling samples (discussed below in Section 2.13), the cuttings from one boring will not be mixed with the cuttings from another boring. A complete discussion of the investigation-derived waste (IDW) program is presented in Section 2.13.

Each 55-gallon drum will be clearly labeled with its contents, date of generation, and the name and telephone number of the contact person. The 55-gallon drums containing the drill cuttings will be temporarily stored near the well prior to final disposition.

2.7 MONITORING WELL DESIGN, CONSTRUCTION, AND COMPLETION

Details regarding the design, construction, and completion of the monitoring wells that will be installed during the Longitudinal Stream Sampling Study are presented below. Additional information is included in MWH SOP-2 Groundwater Monitoring Well Design and Installation (located in Appendix A) and USACE EM 1110-1-4000, "Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites", 1 November 1998. If a conflict arises among the FSP, SOP-2, and USACE EM 1110-1-4000; the USACE EM 1110-1-4000 shall be used.

2.7.1 Design

The monitoring wells will be constructed of threaded 2-inch diameter Schedule 40 polyvinyl chloride (PVC) riser connected to flush threaded sections of Schedule 40 PVC screen, with a PVC end cap. The screened sections will consist of 0.010-inch slot screen, and a 16/30-mesh sand pack will be used to accommodate screen slot size and subsurface formation. Each monitoring well will be constructed with at least 15 feet of well screen installed across the shallow water table to accommodate seasonal water-table fluctuations. The screen in each monitoring well will be placed from the bottom of the borehole (which will extend at least 10 feet below where groundwater is first encountered) and the screen will extend at least 5 feet above the top of the water table. A diagram of the proposed monitoring well completion details is shown on Figure 2-13.

2.7.2 Construction

To ensure the stability of the borehole during well construction, the monitoring wells will be installed through the drill string. After the riser casing and capped screen have been positioned to the desired depth in the borehole, a sand pack consisting of clean, non-carbonate, 16/30-mesh silica sand will be placed in the annulus between the screen and borehole wall. The sand will be slowly poured down the annulus between the screen and the drill pipe, and allowed to settle out of drill pipe as it is slowly retracted from the borehole. The depth of the sandpack in the annular space will be monitored continuously using a weighted probe. As the drill pipe is pulled upward and the sand settles out through the bottom of the pipe, additional sand will be added so that sand always remains in the bottom end of the drill string. This will prevent the borehole from collapsing around the screen before the sand pack is in place. Sand will be added until it is 2 feet above the top of the screen after the drill string is removed.

After the required sand pack thickness has been achieved, the sand will be allowed to settle for approximately 15 minutes, after which the depth of the sand pack will be verified. If additional sand is required, it will be added to the borehole as described above. The sand will be once again allowed to settle and the thickness of the sand pack will be verified. This process will continue until settlement of the sand pack is no longer observed.

After the sand pack is in place, a minimum 5-foot thick seal of bentonite pellets or bentonite slurry will placed on top of the sand pack through the drill string as it is slowly withdrawn. The thickness of the bentonite seal will be monitored with a weighted probe. If bentonite pellets or granular bentonite is used, the bentonite will be hydrated with source water for a minimum of 45 minutes prior to resuming completion activities. Following hydration of the bentonite seal, the thickness of the seal will be verified with a weighted probe.

After the bentonite seal has been adequately hydrated, the remaining annular space will be grouted with neat Portland cement, again through the drill string. No accelerator, such as calcium chloride will be added to the cement grout. The cement grout will be placed to a depth that allows for a protective surface completion to be installed as described below.

2.7.3 Completion

Each monitoring well will be completed above ground and will be protected with a locking steel casing (refer to Figure 2-13). The protective steel casing will be approximately five feet in length and will extend to a height of approximately 2.5-feet above the ground surface. The protective casing will have a vented lid that can be secured with a lock. A mortar collar will be placed within the protective casing annulus from the ground surface to six inches above the ground surface. A 0.25-inch diameter hole (drainage port) will be drilled in the protective casing centered, approximately 0.125-inch above the mortar collar. The mortar mix will be composed of one part cement to two parts sand. Minimal water will be used to hydrate the mix. The protective casing will then be set in a minimum four-foot-square, four-inch-thick concrete pad that slopes away from the steel casing toward the ground surface. The inner PVC well casing of each well will be capped with a lockable, protective, expandable well cap.

Four bollards will be placed around each well for protection from vehicle traffic. Each bollard will consist of a three-inch diameter, capped steel post extending three feet above and below the ground surface and will be embedded in concrete-filled postholes. The bollards shall be located outside of the concrete pad. Posts placed inside a concrete pad may cause the pad to crack, either by normal stress relief or if severely struck, such as by a vehicle.

2.8 MONITORING WELL DEVELOPMENT EQUIPMENT AND PROCEDURES

The monitoring wells will be developed to remove fines from the gravel pack and to assure good communication between the aquifer and the well. The procedures for developing the monitoring wells are presented below. Additional information is included in MWH SOP-3 Groundwater Monitoring Well Development (located in Appendix A).

The monitoring wells will be developed no sooner than 24 hours after grouting and well construction is completed. Each well will be developed by surging with a vented surge block, or equivalent device, followed by bailing or pumping to remove sediments drawn into the well by the surging procedure.

An electric water-level meter will be used to measure the depth to groundwater and the total depth of the monitoring well prior to and immediately after well development. During well development, pH, specific conductivity, and temperature of the purge water

will be periodically monitored with a field portable meter (e.g., Hydrolab). The selected water-quality meter shall be calibrated daily according to the manufacturers' instructions. All calibration information and water quality measurements will be recorded on a Monitoring Well Development Form (refer to Appendix B). At a minimum, water quality measurements will be taken at the beginning of well development and after evacuating each borehole volume. Well development will continue at each well for a maximum of 4 hours or until three consecutive water quality measurements meet the following criteria:

- Specific conductivity $\pm$ 10 percent
- Temperature $\pm$ 1° C
- Turbidity $\leq$ 20 nepholemetric turbidity units (NTUs)
- Within $\pm$ 0.2 pH units.

All monitoring well development water will be placed in DOT-approved 55-gallon drums. Because the final disposal options for the development water may vary depending on the results of the disposal-profiling samples (discussed below in Section 2.13), the development water from one well will not be mixed with the development water from another well. Each 55-gallon drum will be clearly labeled with its contents, date of generation, and the name and telephone number of the contact person. The 55-gallon drums containing the development water will temporarily stored near the well prior to disposal. A complete discussion of the IDW program is presented in Section 2.13.

2.9 WATER-LEVEL MEASUREMENTS EQUIPMENT AND PROCEDURES

Following well development, each monitoring well will be equipped with a pressure transducer/data logger to measure water levels. The data logger at each well will be programmed according to the manufacturer's instructions to record water levels at the same frequency that the nearby surface water monitoring stations record stream flow (refer to Section 2.5.4). In the event groundwater samples are collected (refer to Section 2.10), the pressure transducer shall be removed prior to collecting the groundwater samples.

The pressure transducers will be installed in the screened interval below the lowest anticipated water table elevation. Ideally, the pressure transducer will be located approximately 2 feet off the bottom of the well. However, because transducers are available in different pressure ranges, the pressure transducer should never be lowered to a depth that produces a greater pressure than the operating range of the transducer. Operating ranges in feet of water for different pressure transducers can be determined by multiplying the pounds per square inch (psi) of the transducer by 2.3. For example, a 10-psi transducer can operate from water table to a maximum depth of 23 feet; a 50-psi transducer can operate down to 115 feet below the water table. The transducer cable will be secured at the well head to prevent the transducer from slipping, which would result in

inaccurate measurements. After the transducer is secured, the cable will be marked so that it can be determined if the transducer inadvertently moved between inspections.

The data logger converts the pressure value sent by the transducer into feet of water above the transducer, and records the values in its memory. The data can then be downloaded from the logger to a PC computer using an RS-232 port. Each transducer has specific parameters that must be input to the data logger to make the appropriate conversions from pressure units to feet of water.

2.10 GROUNDWATER SAMPLING EQUIPMENT AND PROCEDURES

As discussed above, groundwater samples will not be collected during the Longitudinal Stream Sampling Study field program. The following groundwater sampling procedures are presented in the event the project team determines groundwater sampling is necessary to supplement the data obtained from other Bosque and Leon River Watersheds Study field programs. Additional information is included in MWH SOP-5 Water Sampling and Field Measurements (located in Appendix A).

2.10.1 Water Level Measurements

Prior to sampling, the depth to water and total depth of the well will be measured to the nearest hundredth of a foot and recorded on the Groundwater Sampling Log (refer to Appendix B). Water levels and well depths will be measured using an electric water level meter. All measurements will be referenced to the surveyed measuring point, which will be the north side of the top of the PVC casing. The probe and calibrated tape of the water level meter will be thoroughly decontaminated prior to use in each well following the procedures outlined in Section 2.12

2.10.2 Well Purging

To ensure that groundwater samples are representative of aquifer water quality, a minimum of three casing volumes (if practical) of groundwater will be purged from each well prior to sampling. The casing volume will be determined by multiplying the height of water in the well (in feet) by the volume per linear foot of 2-inch diameter casing (i.e., 0.16 gallons per foot). If there is insufficient groundwater recharge to allow three casing volumes to be purged from the well, it will be fully evacuated and sampled as soon as sufficient volume is available for sampling (typically within 24 hours and with 80 percent recovery of pre-purging water level).

Because perchlorate is the only constituent of concern, the monitoring wells will be purged with a peristaltic pump or a bailer. The pump will be attached to new polyethylene tubing that will be discarded after each well is sampled. If a bailer is used, it will consist of a new, disposable polyethylene type. New nylon rope will be used to raise and lower the bailer. The bailer and rope will be discarded after the well is sampled.

Use of disposable equipment will eliminate the necessity to decontaminate the equipment between uses and the associated handling and disposal of decontamination fluids. If the groundwater samples will be analyzed for organics, use of a peristaltic pump is inappropriate, and a bailer or alternate sampling procedure shall be used (e.g., bladder pump).

While evacuating each well, pH, specific conductivity, temperature, dissolved oxygen, and redox potential of the purge water will be periodically monitored with a field portable meter (e.g., Hydrolab). The selected water-quality meter shall be calibrated daily according to the manufacturer's instructions. All calibration information and water quality measurements as well as any other observations (e.g., odor, color, or sheen) will be recorded on a Groundwater Sampling Log (refer to Appendix B). At a minimum, water quality measurements will be taken at the beginning of well evacuation and after each casing volume is removed. Well evacuation will continue until a minimum of three casing volumes have been removed and three consecutive water quality measurements meet the following criteria:

- Specific conductivity $\pm$ 10 percent
- Temperature $\pm$ 1° C
- Turbidity $\pm$ 10 NTUs
- Dissolved oxygen ± 10 percent
- Within $\pm$ 0.2 pH units

2.10.3 Groundwater Sample Collection

A complete set of sample containers will be prepared prior to sampling each well. Sample containers will be obtained certified clean from the laboratory. Table 2-4 contains a summary of the required sample containers and preservatives. Containers will be labeled according to the procedures outlined in Section 2.11. Sample containers shall be handled with care to prevent the containers from being inadvertently contaminated (e.g., containers will not be placed directly on the ground; or stored near gas cans, compressors, or generators).

All groundwater samples will be collected directly from the discharge tubing attached to the peristaltic pump or the discharge port on the bailer. Sample containers will be filled to the neck of a 50mL glass or plastic bottle and sealed with a Teflon-lined cap.

Immediately after sample collection, the sample containers will be placed in an ice-packed cooler and maintained at 4 $\pm$2 degrees Celsius (°C). Sample labeling, chain-of-custody, and shipping procedures are described in Section 2.11.

2.10.4 Sample Frequency, Designation, and Analysis

Sample Frequency. If the project team determines that groundwater samples are required, the sampling frequency will be determined at that time.

Sample Designation. Each groundwater sample will be designated with an alphanumeric character string set apart by hyphens. The designation will begin with the monitoring well abbreviation, followed by "GW" to indicate a groundwater sample, and finally by the date the sample was collected. For example, the groundwater sample collected from monitoring well MW-SC1 on November 18, 2002 would be designated "MW-SC1-GW-11-18-02." Groundwater samples collected from existing U.S. Navy wells will be designated according to the same procedure (i.e., U.S. Navy well abbreviation followed by "GW" and the date).

Blind duplicate groundwater samples will be designated with a fictitious number beginning with 1001 so the laboratory is unaware the sample is a duplicate. For example, the blind duplicate sample collected with environmental sample "MW-SC1-GW-11-18-02" would be designated "GW-1001". The field crew will keep careful records of the designations given to the blind duplicate samples and their corresponding environmental sample so that the analytical results can be correlated when they are received. Each MS/MSD sample will have the same designation as its associated environmental sample except that "MS" or "MSD" will follow the sample designation (e.g., "MW-SC1-GW-11-18-02 MS" and ""MW-SC1-GW-11-18-02 MSD"). Equipment blanks are samples of analyte free (deionized) water that are rinsed over decontaminated sampling equipment, collected, and submitted for analysis. These samples are used to assess cross-contamination from the sampling equipment, in addition to incidental contamination, the sample container, and/or preservatives. The field crew will keep careful records of the designations given to the equipment blank samples and their corresponding sampling location so that the analytical results can be correlated when they are received. Each equipment blank sample will have the same designation as its associated sampling location except that "EB" will follow the sample designation (e.g., "MW-SC1-GW-11-18-02 EB").

Sample Analysis. All groundwater samples will be analyzed for perchlorate by USEPA Method 314.0. The USACE Engineer Research and Development Center Environmental Laboratory at the Environmental Chemistry Branch in Omaha, Nebraska laboratory will perform all sample analyses. The USACE laboratory will conform to the analytical method requirements, analytical quality control requirements, instrument calibration frequency, and the laboratory quality control requirements presented in the QAPP. A discussion of sample labeling, chain-of-custody, handling and shipping is presented in Section 2.11.

2.11 SAMPLE LABELING, CHAIN-OF-CUSTODY, HANDLING, AND SHIPPING

The following procedures for sample labeling, chain-of-custody, handling and shipping are intended for the samples scheduled for collection during the Longitudinal Stream Sampling Study (refer to Table 2-5). However, these procedures are applicable to any environmental sample collected during the Bosque and Leon River Watersheds Study (e.g., groundwater, sediment, etc.).

2.11.1 Sample Labeling

A label will be placed on each sample container submitted for analysis and will include the following information:

- Project name and location
- Sample designation
- Date and time of sample collection
- Preservative (if applicable)
- Sampler's initials
- Requested analyses.

2.11.2 Chain-of-Custody

A chain-of-custody form will be completed and will accompany each sample cooler submitted to the laboratory. This form includes project identification, project location, sample designation, and analysis type. In addition, there are spaces for entry of the sample collection date and time, signatures of the persons relinquishing and receiving samples, and the conditions of the samples upon receipt by the laboratory. An example chain-of-custody form is included in Appendix B.

2.11.3 Sample Handling and Shipping

After sample collection, each sample container will be placed in a cooler that contains sufficient ice to maintain the samples at a temperature of 4 ±2 °C. Plastic "blue" ice shall not be used to chill the samples. Each sample will be wrapped separately in bubble-wrap or other protective material. Ice will be double-bagged in zip-lock bags such that the water will not fill the cooler as the ice melts. The chain-of-custody record will be placed inside a plastic bag, sealed, and placed inside the cooler. The cooler will be taped shut with strapping tape and custody seals shall be affixed to the outside of the cooler. All samples will be shipped to the laboratory within 24 hours of sample collection via Federal Express priority service (or equivalent) to ensure that the samples arrive at the laboratory in time to meet both analytical holding times and the project schedule.

2.12 EQUIPMENT DECONTAMINATION PROCEDURES

To prevent cross-contamination, all reusable water sampling, water-level measurement, and downhole drilling equipment will be thoroughly decontaminated between uses. All downhole drilling equipment shall be thoroughly steam cleaned prior to drilling each boring. All steam cleaning operations will be conducted over a temporary decontamination pad constructed adjacent to each well location. The temporary decontamination pad will consist of a plastic liner with bermed edges that will prevent the decontamination fluids from contacting the ground surface.

Because disposable groundwater sampling equipment generally will be used, it is anticipated that only the electric water-level indicator will require decontamination between sampling monitoring well locations. In addition, the pressure transducers used to record the water levels in the wells will be decontaminated at the end of the project or prior to use in another well (if applicable). Decontamination of non-dedicated equipment will include:

- Wash with laboratory-grade detergent (Alconox)
- Rinse with tap water
- Triple rinse with distilled water
- Air dry.

All decontamination fluids will be contained either in the temporary decontamination pads or in 5-gallon buckets. The decontamination fluids will be transferred to DOT-approved 55 gallon drums for temporary storage pending characterization and disposal. The decontamination fluids will be stored in the same 55-gallon drum(s) used to contain the development water generated from the same well. For example, the decontamination fluids generated while decontaminating the drilling equipment used to install MW-SC1 will be stored in the same 55-gallon drum(s) used to contain the development water generated from monitoring well MW-SC1. All decontamination fluids will be handled, characterized, and disposed of as described in Section 2.13.

2.13 INVESTIGATION DERIVED WASTE HANDLING

2.13.1 Introduction

The types of IDW expected to be generated during field activities include personal protective equipment (PPE), disposable field equipment, the material used to construct the temporary decontamination pads, decontamination fluids, drill cuttings, and monitoring well development and sampling purge water. All field activities are expected to be conducted in Level D PPE (see Section 1.4 of the SSHP); therefore, the only PPE that will be discarded will be disposable work gloves. The PPE and disposable sampling equipment (e.g., paper towels, empty 5-gallon buckets, disposalble bailers, etc.) will be discarded as non-hazardous municipal waste.

All drill cuttings, temporary decontamination pad materials, decontamination fluids, and monitoring well development and sampling purge water will be contained in DOT-approved 55-gallon drums for temporary storage near the monitoring wells pending characterization and disposal. Each drum containing IDW will be clearly labeled to indicate its contents, date generated, and the name and telephone number of the contact person for this project. Each 55-gallon drum will be dedicated to a specific type (i.e., soil, development water, decontamination fluids, or decontamination pad materials) and source of IDW (e.g., monitoring well MW-SC1). For example, soil cuttings from one well will not be mixed with the soil cuttings from another well in the same 55-gallon drum. Likewise, the development and groundwater sampling purge water from one well will not be mixed with the liquid IDW generated at another well. The decontamination fluids generated at each well will be stored in separate drums to prevent dilution of the development water, which will be sampled to characterize the IDW for disposal (discussed below).

2.13.2 IDW Disposal Profiling Sample Locations and Rationale

Disposal-profiling samples will be collected and analyzed for perchlorate to determine the appropriate disposal options for the drill cuttings, temporary decontamination pad materials, decontamination fluids, and monitoring well development and sampling purge water IDW. Because the likely source of contamination for each type of IDW is the groundwater, and because all IDW types from a particular well are likely to be equally contaminated (or non-contaminated), one disposal-profiling sample will be collected from the monitoring well development water to represent all IDW generated at each well. For example, the disposal-profiling sample collected from the development water generated at monitoring well MW-SC1 will be used to determine the appropriate disposal options for all IDW generated at monitoring well MW-SC1, including the drill cuttings and temporary decontamination pad materials.

The disposal-profiling samples will be designated to match the well were the wastes were generated. For example, the disposal-profiling sample collected from the development water generated at monitoring well MW-SC1 will be designated "MW-SC1-IDW". The sample designations for all samples to be collected during the Longitudinal Stream Sampling Study are listed on Table 2-5. Please note that QA/QC samples will not be collected in conjunction with the IDW disposal-profiling samples because the results will not be used for site characterization. The procedures for collecting the IDW disposal-profiling samples are presented below.

2.13.3 Disposal-Profiling Sampling Equipment and Procedures

One disposal-profiling sample will be collected from each set of drums containing the development water from one monitoring well and analyzed for perchlorate. If more than one drum containing the development water IDW was generated at a particular well, the sample will be a composite of aliquots collected from each drum. The sample will be

collected with a clean glass, stainless steel, or Nalgene flask and poured directly into the appropriate sample containers. If a composite sample is required, two flasks will be used. One flask will be used to collect the sample aliquots, which will be transferred to the second flask for homogenization prior to filling the appropriate sample containers. All IDW disposal-profiling samples will be handled and shipped according to the procedures discussed in Section 2.11.

2.13.4 IDW Characterization and Disposal Criteria

In order to determine the appropriate disposal options for the IDW, it will be necessary to determine if the wastes are hazardous or nonhazardous as defined by RCRA. A waste is classified as hazardous if it is listed in 40 CFR 261, Subpart D (i.e., it is a *listed* hazardous waste) or it exhibits any of the four criteria of hazardous waste as identified in 40 CFR 261, Subpart C (i.e., it is a *characteristic* hazardous waste exhibiting the characteristic of ignitability, corrosivity, reactivity, or toxicity).

Based on the information presented in the CSM, the following assumptions apply to characterizing the IDW generated during the Longitudinal Stream Sampling Study:

- The perchlorate in the study area is not from a source listed in 40 CFR 261, Subpart D (i.e., it is not a *listed* hazardous waste).

- The anticipated concentrations of perchlorate in the study area (and therefore in the IDW) are likely to be in the low part-per-billion range. As a result, it is unlikely that the IDW will exhibit the characteristic of ignitability, corrosivity, or reactivity.

- There are no established toxicity criteria for perchlorate in 40 CFR Part 261.24.

Therefore, the IDW will not be considered hazardous waste regardless if perchlorate is detected in the disposal-profiling samples because it is not from a listed source, it will not exhibit the characteristic of ignitability, corrosivity, or reactivity, and because RCRA has not established toxicity criteria for perchlorate.

If there are detectable concentrations of perchlorate in a disposal-profiling sample, the IDW represented by that sample will be disposed of a RCRA Subtitle D or Subtitle C landfill as non-hazardous waste containing perchlorate. If perchlorate is not detected in a disposal-profiling sample, the landowner where the IDW was generated will be consulted as to whether the IDW can be disposed of near the well site. If permission is granted by the landowner, the non-contaminated soil IDW will be spread on the ground surface near the monitoring well where it was generated. Non-contaminated water IDW will be poured into a publicly owned treatment works drainage system. In this instance, the materials used to construct the temporary decontamination pad will be discarded as non-hazardous municipal waste. If the landowner does not grant permission to dispose of the non-contaminated soil IDW near the monitoring well where it was generated, then that

IDW will be disposed of a RCRA Subtitle D or Subtitle C landfill as non-hazardous waste. Figure 2-14 present a decision –tree diagram for disposing of the IDW.

2.14 TOPOGRAPHIC SURVEY

As discussed in Section 2.5, the automated stream monitoring stations will be located using GPS according to the pre-selected coordinates listed in Table 2-3. The stream channel will be surveyed at each monitoring location to obtain data necessary for programming the flow meters (refer to Section 2.5.3.2). Once the stream sampling stations are installed and programmed, no additional surveying is required.

After the monitoring wells are completed, a licensed surveyor will determine the map coordinates and elevation of each well. The reference point for each well will be the top of the north side of the inner PVC well casing. The horizontal control for each measurement will be within $\pm$0.1 foot and will be reported in North American Datum 1983 coordinates. The vertical control for each measurement will be within $\pm$0.01 foot using the National Geodetic Vertical Datum of 1929.

2.15 CONTRACTOR QUALITY CONTROL

The three-phase Contractor Quality Control (CQC) program described in Section 6.0 of the SAP will be implemented for each definable feature of work. The definable features of work for the Longitudinal Stream Sampling Study include:

- Installing and programming the stream sampling stations
- Collecting surface water samples
- Installing and developing monitoring wells
- Installing and programming pressure transducers and data loggers in monitoring wells
- Laboratory analyses
- Data management (including data reduction, validation, and reporting).

The CQC program will be implemented prior to initiating each definable feature of work and will remain in effect throughout its duration.

TABLE 2-1

SUMMARY OF DATA TYPES AND USES FOR THE LONGITUDINAL STREAM SAMPLING STUDY FIELD INVESTIGATION

Field Program	Summary of Proposed Activities	Data	Data Type	Data Uses
Field Observations	Observations by an on-site professional during all field activities.	Date Weather conditions On-site personnel Field activity type Samples collected/Details Unusual conditions encountered	Field Field Field Field Field Field	Project documentation
Automated Stream Monitoring Station Installation	Survey stream channel at each monitoring location during installation of the automated flow meters and samplers.	Establish benchmark Channel cross-section elevations Channel slope elevations.	Definitive Definitive Definitive	Programming flow meter
Stream Flow Measurements	Collect measurements of stream stage (level) and flow at each automated monitoring station location (refer to Figures 2-1 through 2-11).	Stream stage in feet Stream flow in cfs	Definitive Definitive	Assess surface and groundwater interactions, relationship between stream flow and perchlorate concentrations, and how storm events impact stream flow and perchlorate concentrations.
Rainfall Measurements	Collect rainfall measurements at each automated monitoring station location (refer to Figures 2-1 through 2-11).	Total rainfall	Definitive	Assess how storm events impact stream flow and perchlorate concentrations, and how storm event impact surface water and groundwater interactions.
Surface Water Sampling	Collect surface water samples at network of automated stream monitoring stations.	Perchlorate	Definitive	Assess perchlorate concentrations in surface water, evaluate impacts to Lake Belton and Lake Waco water quality, assess risks to human health and the environment.
Utility Clearances	Conduct utilities search and stake the utility locations prior to drilling and installing groundwater monitoring wells.	Utility locations Field survey	Field Field	-Stake utilities -Ensure safety of field personal -Prevent disruption of utilities.
Monitoring Well Installation	Drill and install one groundwater monitoring well near each automated stream monitoring station location.[a]	USCS Visual identification of saturated zone.	Field Field	Generate stratigraphic logs and identify uppermost (i.e., shallow unconfined) water-bearing zone in order to set the well screen across the water table.
Monitoring Well Development	Develop each well to remove fine-grained sediments and to assure good communication between the aquifer and the well.	pH Specific Conductivity Turbidity Temperature	Field Field Field Field	Remove fine-grained sediments from the well to assure good communication between the aquifer and the well.
Monitor Groundwater Elevations in Wells	Install pressure transducer and data logger at each well to monitor changes in water table elevation.	Elevation of water table	Definitive	Assess groundwater and surface water interactions, and how water table elevation is affected by storm events.
Monitoring Well Survey	Survey horizontal and vertical location of each monitoring well.	North American Datum (NAD) 1983; National Geodetic Vertical Datum (NGVD) of 1929.	Definitive	Surveyed well locations will be used for reporting purposes and to generate potentiometric surface maps.
Investigation Derived Waste (IDW) Sampling	Collect samples of monitoring well development water IDW.	Perchlorate	Definitive	Characterize IDW for disposal purposes. (Note: Results of monitoring well development water IDW disposal-profiling samples will be used to characterize the drill cuttings, decontamination pad materials and decontamination fluid IDW for disposal).

a A monitoring well will not be installed at the Cowhouse Creek Monitoring Station Location
cfs Cubic feet per second
IDW Investigation-derived waste

TABLE 2-2

DATA QUALITY OBJECTIVES FOR THE LOGITUDINAL STREAM SAMPLING STUDY FIELD INVESTIGATION
(Page 1 of 4)

USEPA DATA QUALITY OBJECTIVE STEP	FIELD ACTIVITY Surface Water Flow/Groundwater Elevation Measurements	FIELD ACTIVITY Surface Water Sampling	FIELD ACTIVITY Rainfall Measurements
STEP 1: **State the Problem**			
Problem Statements	1) Surface water and groundwater interactions need to be evaluated. 2) Surface water and groundwater responses and interactions during storm events need to be evaluated. 3) A correlation between stream flows and perchlorate concentrations is impossible due to the absence of co-located data for stream flow and perchlorate concentrations. 4) The duration of existing recorded measurements of rainfall, stream stage (or level), velocity, and flow rate is insufficient to quantify flows on the streams.	1) Changes in perchlorate concentrations as surface water migrates from former NWIRP McGregor to Lake Belton and Lake Waco need to be evaluated. 2) Variations in perchlorate concentrations in surface water during storm events needs to be evaluated. 3) A correlation between perchlorate concentrations and stream flows is impossible due to the absence of co-located data for surface flow and perchlorate concentrations.	1) The duration of existing recorded measurements of rainfall, stream stage (or level), and flow rate is insufficient to quantify flows on the streams.
Planning Team Members	Brian Condike – USACE Project Manager David Ebersold – MWH Project Manager Kyle Headley – BRA Project Manger Dr. Todd Anderson – TIEHH	Planning team as indicated previously.	Planning team as indicated previously.
Primary Decision Makers	Brian Condike – USACE Project Manager David Ebersold – MWH Project Manager Kyle Headley – BRA Project Manger	Primary decision makers as indicated previously.	Primary decision makers as indicated previously.
Relevant Deadlines	Surface water and groundwater data needs to be obtained concurrently over duration of at least 12 months.	Surface water quality data needs to be obtained over a duration of at least 12 months and during storm events.	Rainfall measurements need to be collected continuously during duration of project (i.e., 12 months).
STEP 2: **Identify the Decision**			
Principle Study Questions	1) How do surface water and groundwater interact and how do perchlorate concentrations change as surface water migrates from former NWIRP McGregor to Lake Belton and Lake Waco? 2) How do surface water and groundwater respond and interact during storm events and how do perchlorate concentrations vary in surface water during storm events? 3) What is the correlation between perchlorate concentrations and stream flow in Harris Creek, Station Creek, Cowhouse Creek and the South Bosque River? 4) How does rainfall affect steam flow and groundwater elevations?	1) How do perchlorate concentrations change as surface water migrates from former NWIRP McGregor to Lake Belton and Lake Waco? 2) How do perchlorate concentrations vary in surface water during storm events? 3) Is there a correlation between stream flow and perchlorate concentrations in Harris Creek, Station Creek, Cowhouse Creek, and South Bosque River?	1) How does rainfall affect steam flow and groundwater elevations?

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TABLE 2-2

DATA QUALITY OBJECTIVES FOR THE LOGITUDINAL STREAM SAMPLING STUDY FIELD INVESTIGATION
(Page 2 of 4)

USEPA DATA QUALITY OBJECTIVE STEP	FIELD ACTIVITY Surface Water Flow/Groundwater Elevation Measurements	FIELD ACTIVITY Surface Water Sampling	FIELD ACTIVITY Rainfall Measurements
STEP 2 **Identify the Decision (continued)**			
Alternate Actions	Assess surface water and groundwater interactions. Determine if continued monitoring is necessary.	Perchlorate present - Assess how perchlorate concentrations change as surface water migrates from former NWIRP McGregor to Lake Belton and Lake Waco. Perchlorate not present – Determine if continued monitoring is necessary.	Assess how rainfall affects stream flow and groundwater elevations. Determine if continued monitoring is necessary.
STEP 3: **Identify the Inputs to the Decision**			
Environmental Measurements	The monitoring network will include installation of 15 self-contained, automated monitoring stations along the Harris Creek, Station Creek, Cowhouse Creek and the South Bosque River. Stream stage (level) and flow rate measurements will be collected at each monitoring station. The automated monitoring stations described in Section 2.5 are capable of recording the measurement data. In addition, shallow groundwater monitoring wells will be installed near each stream station (with the exception of the Cowhouse Creek location) to allow for groundwater monitoring (groundwater elevation). Groundwater elevation measurements will be collected using a pressure transducer that record data to a data logger.	The monitoring network will include installation of 15 self-contained, automated monitoring stations along the Harris Creek, Station Creek, Cowhouse Creek and the South Bosque River. Environmental measurements in the streams will include perchlorate concentrations in surface water and general water quality measurements. The automated monitoring stations described in Section 2.5 are capable of collecting water samples for chemical analyses.	Automated rainfall measurements will be recorded at each stream monitoring location.
Basis for Action Level	Changes in surface water and groundwater levels may be used to determine when a significant storm event has occurred. Monitoring frequency is contingent on storm events as described in Section 2.5.	Because the purpose of this field investigation is to collect data that will be used to evaluate impacts and risks from perchlorate, the action level for perchlorate is any valid detectable concentration.	Rainfall data may be used to determine when a significant storm event has occurred. Monitoring frequency is contingent on storm events as described in Section 2.5.
STEP 4: **Define Study Boundaries**			
Population of Interest	Stream stage (level), stream flow, and groundwater level.	Perchlorate concentrations and general water quality measurements.	Rainfall totals.
Spatial Boundaries	The spatial boundary of the study area defined by the Bosque and Leon River Watersheds Study. A description of the study area is included in Section 2.0 of the SAP. The boundary of the study area is shown on Figure 2-1 of this FSP.	The spatial boundary of the study area defined by the Bosque and Leon River Watersheds Study. A description of the study area is included in Section 2.0 of the SAP. The boundary of the study area is shown on Figure 2-1 of this FSP.	The spatial boundary of the study area defined by the Bosque and Leon River Watersheds Study. A description of the study area is included in Section 2.0 of the SAP. The boundary of the study area is shown on Figure 2-1 of this FSP.

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TABLE 2-2

DATA QUALITY OBJECTIVES FOR THE LOGITUDINAL STREAM SAMPLING STUDY FIELD INVESTIGATION
(Page 3 of 4)

USEPA DATA QUALITY OBJECTIVE STEP	FIELD ACTIVITY Surface Water Flow/Groundwater Elevation Measurements	FIELD ACTIVITY Surface Water Sampling	FIELD ACTIVITY Rainfall Measurements
STEP 4 Define Study Boundaries (continued)			
Temporal Boundaries	Once the sampling stations are installed, the automated sampling stations will be programmed to collect surface water flow and groundwater elevation data continuously as described in Section 2.5 for a period of 12 months.	Once the sampling stations are installed, the automated sampling stations will be programmed to collect water samples at predetermined frequencies and when conditions change (i.e., during storm events) as described in Section 2.5 for a period of 12 months. Because the holding time for perchlorate is 28 days, the maximum duration between retrieval of samples from the automated samplers will be 14 days. This will allow adequate time for the laboratory to process and analyze the samples without incurring costs for rush analyses.	Automated rainfall data will be collected continuously for a period of 12 months.
Scale of Decision Making	Quarterly technical memorandums will be prepared that present the data and discuss the results and make recommendations for modifying the monitoring requirements, if necessary.	Quarterly technical memorandums will be prepared that present the data and discuss the results and make recommendations for modifying the monitoring requirements, if necessary.	Quarterly technical memorandums will be prepared that present the data and discuss the results and make recommendations for modifying the monitoring requirements, if necessary.
Practical Constraints on Data Collection	Practical constraints include operator error when programming the automated monitoring stations and malfunction of the samplers. Operator error will be minimized by complying with the SOPs and equipment user manuals. Equipment malfunction will be controlled to the extent possible by inspecting the samplers when collecting the water quality samples (refer to Section 2.5).	Practical constraints include operator error when programming the automated samplers and malfunction of the samplers. Operator error will be minimized by complying with the SOPs and equipment user manuals. Equipment malfunction will be controlled to the extent possible by inspecting the samplers when collecting the water quality samples (refer to Section 2.5).	Practical constraints include operator error when programming the samplers and malfunction of the samplers. Operator error will be minimized by complying with the SOPs and equipment user manuals. Equipment malfunction will be controlled to the extent possible by inspecting the samplers when collecting the water quality samples (refer to Section 2.5).
STEP 5: Development of Decision Rules			
Statistical Parameter of Interest	Instantaneous measurements of stream stage (level), stream flow, and groundwater level.	Total perchlorate concentrations.	Total rainfall measurements.
Scale of Decision Making	Data will be considered representative of the monitoring location. Extrapolation of the data may be possible between sampling stations or when assessed in conjunction with other field investigations (e.g., groundwater dye tracer studies).	Data will be considered representative of the monitoring location. Extrapolation of the data may be possible between sampling stations or when assessed in conjunction with other field investigations (e.g., Lake Waco and Lake Belton sampling).	Data will be considered representative of the study area.

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TABLE 2-2

DATA QUALITY OBJECTIVES FOR THE LOGITUDINAL STREAM SAMPLING STUDY FIELD INVESTIGATION
(Page 4 of 4)

USEPA DATA QUALITY OBJECTIVE STEP	FIELD ACTIVITY Surface Water Flow/Groundwater Elevation Measurements	FIELD ACTIVITY Surface Water Sampling	FIELD ACTIVITY Rainfall Measurements
STEP 5 Development of Decision Rules (continued)			
Action Level	As described above, changes in surface water and groundwater levels may be used to determine when a significant storm event has occurred, which influences the monitoring frequency. Actual action levels will be established in consultation with the Isco company representative who will be on site during installation and programming of the stream monitoring stations.	The action level for perchlorate is any valid detectable concentration. The applicable analytical method for perchlorate is USEPA Method 314.0, which has a method detection limit of 0.9 µg/l and a method reporting limit of 4 µg/l.	As described above, rainfall data may be used to determine when a significant storm event has occurred, which influences monitoring frequencies. Actual action levels will be established in consultation with the Isco company representative who will be on site during installation and programming of the stream monitoring stations.
Alternative Actions	See previously defined alternate action in Step 2.	See previously defined alternate action in Step 2.	See previously defined alternate action in Step 2.
Decision Rules	Data will be assessed to resolve the decision statements presented above.	Data will be assessed to resolve the decision statements presented above.	Data will be assessed to resolve the decision statements presented above.
STEP 6 Specify Tolerable Limits on Decision Errors			
Null Hypothesis	Surface water and groundwater interacts.	Surface water contains detectable concentrations of perchlorate.	Rainfall affects stream flow.
Alternate Hypothesis	Surface water and groundwater does not interact.	Surface water does not contain detectable concentrations of perchlorate.	Rainfall has little or no impact on stream flow.
Gray Region	Relationship between surface water and groundwater is not clear from data.	Detected perchlorate concentration is between the MDL and the MRL.	Relationship between rainfall and stream flow is not clear from data.
Tolerable Probability of Making an Incorrect Decision	Data trends will be assessed in quarterly reports.	Perchlorate concentrations in samples collected according to this FSP and analyzed and verified according to the QAPP will be considered valid. Results that are in the gray region will be considered detections (i.e., perchlorate is present) unless otherwise qualified.	Data trends will be assessed in quarterly reports.
STEP 7: Optimize the Design for Obtaining Data	Automated samplers will be used to collect surface water flow and groundwater elevation measurements. The data collection design is described in this field sampling plan.	Automated samplers will be used to collect surface water samples. The data collection design is described in this field sampling plan.	Automated samplers will be used to record rainfall data. The data collection design is described in this field sampling plan.

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TABLE 2-3

AUTOMATED STREAM MONITORING STATIONS
LOCATION SUMMARY

Monitoring Station ID	Stream Name	Latitude Degrees	Latitude Minutes	Longitude Degrees	Longitude Minutes	Property Owner/Comments
SC1	Station Creek	31	22.885	97	29.548	Texas A&M University
SC2	Station Creek	31	22.824	97	29.484	Texas A&M University
SC3	Station Creek	31	22.039	97	29.789	Texas Department of Transportation
SC4	Station Creek	31	21.146	97	28.719	Texas Department of Transportation
SC5	Station Creek	31	19.448	97	29.273	Residential Owner - Possibly Dan Gates Sr., Michael D. Gates or B.R. Leggett Sr. - Addresses may be 4935, 4937County Rd. 314 or Route 1 based on mail boxes.
SC6	Station Creek	31	18.833	97	28.358	State of Texas - Mother Neff Park
SBR1	South Bosque River	31	24.492	97	22.142	1057 Indian Trail - Possible Owner
SBR2	South Bosque River	31	25.34	97	18.875	TBD
SBR3	South Bosque River	31	27.665	97	17.756	TBD - may be county right-of-way or private landowner
SBR4	South Bosque River	TBD	TBD	TBD	TBD	TBD
SBR5	South Bosque River	31	29.095	97	16.278	Texas Department of Transportation
SBR6	South Bosque River	TBD	TBD	TBD	TBD	USACE
HC1	Harris Creek	31	26.743	97	24.516	TBD - may be City of McGregor street right-of-way or private landowner
HC2	Harris Creek	31	28.878	97	21.607	TBD - Owner lives across the street.
CHC1	Cowhouse Creek	TBD	TBD	TBD	TBD	TBD

TBD - To be determined.

TABLE 2-4

SAMPLE CONTAINERS AND PRESERVATION REQUIREMENTS

Analysis	Container Type	Container Size (Number)	Closure	Preservative	Holding Time
Water Samples[(a)]					
Perchlorate USEPA Method 314.0	Glass or plastic	50- milliliter minimum (one per sample)	Teflon-lined cap	None	28 days from sample collection to analysis.

a Surface water samples, groundwater samples (if collected), and monitoring well development water investigation-derived waste samples.

TABLE 2-5

SUMMARY OF SAMPLES TO BE COLLECTED DURING THE LONGITUDINAL STREAM SAMPLING STUDY FIELD PROGRAM

Sample Designation [a]	Sample Location/Rationale[b]	Sample Type	Analytes [c]	Method[d]
STATION CREEK				
SC1-SW-date-time	Surface water sample collected at automated monitoring station SC1 located on Station Creek. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
SC2-SW-date-time	Surface water sample collected at automated monitoring station SC2 located on Station Creek. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
SC3-SW-date-time	Surface water sample collected at automated monitoring station SC3 located on Station Creek. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
SC4-SW-date-time	Surface water sample collected at automated monitoring station SC4 located on Station Creek. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
SC5-SW-date-time	Surface water sample collected at automated monitoring station SC5 located on Station Creek. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
SC6-SW-date-time	Surface water sample collected at automated monitoring station SC6 located on Station Creek. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
Quality assurance/quality control (QA/QC) samples will be collected at each stream monitoring station[e]				

(a) Sample Designation:
SC– Station Creek SBR – South Bosque River HC – Harris Creek CHC – Cowhouse Creek SW – Surface Water IDW – Investigation-Derived Waste

(b) At each monitoring station, samples will be collected at the following frequency: once daily for the first seven days, once weekly for the next three weeks, and once every two weeks for the remainder of the project. Sample frequency will return to daily after each significant storm event (refer to Section 2.5.4).

(c) All samples will be sent to: The USACE Engineer Research and Development Center Environmental Laboratory at the Environmental Chemistry Branch in Omaha, Nebraska

(d) Samples will be collected every 14 days in order to meet the 28-day turnaround time for the analytical method.

(e) QA/QC samples: Each automated sampler will be programmed to collect a blind duplicate sample with every 10^{th} sample collected and matrix spike/matrixspike duplicate samples with every 20^{th} sample collected (refer to Section 2.5).

TABLE 2-5

SUMMARY OF SAMPLES TO BE COLLECTED DURING THE LONGITUDINAL STREAM SAMPLING STUDY FIELD PROGRAM

Sample Designation [a]	Sample Location/Rationale[b]	Sample Type	Analytes [c]	Method[d]
SOUTH BOSQUE RIVER				
SBR1-SW-date-time	Surface water sample collected at automated monitoring station SBR1 located on the South Bosque River. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
SBR2-SW-date-time	Surface water sample collected at automated monitoring station SBR2 located on the South Bosque River. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
SBR3-SW-date-time	Surface water sample collected at automated monitoring station SBR3 located on the South Bosque River. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
SBR4-SW-date-time	Surface water sample collected at automated monitoring station SBR4 located on the South Bosque River. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
SBR5-SW-date-time	Surface water sample collected at automated monitoring station SBR5 located on the South Bosque River. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
SBR6-SW-date-time	Surface water sample collected at automated monitoring station SBR6 located on the South Bosque River. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
Quality assurance/quality control (QA/QC) samples will be collected at each stream monitoring station[e]				

(a) Sample Designation:
SC– Station Creek SBR – South Bosque River HC – Harris Creek CHC – Cowhouse Creek SW – Surface Water IDW – Investigation-Derived Waste

(b) At each monitoring station, samples will be collected at the following frequency: once daily for the first seven days, once weekly for the next three weeks, and once every two weeks for the remainder of the project. Sample frequency will return to daily after each significant storm event (refer to Section 2.5.4).

(c) All samples will be sent to: The USACE Engineer Research and Development Center Environmental Laboratory at the Environmental Chemistry Branch in Omaha, Nebraska

(d) Samples will be collected every 14 days in order to meet the 28-day turnaround time for the analytical method.

(e) QA/QC samples: Each automated sampler will be programmed to collect a blind duplicate sample with every 10th sample collected and matrix spike/matrixspike duplicate samples with every 20th sample collected (refer to Section 2.5).

TABLE 2-5

SUMMARY OF SAMPLES TO BE COLLECTED DURING THE LONGITUDINAL STREAM SAMPLING STUDY FIELD PROGRAM

Sample Designation [a]	Sample Location/Rationale[b]	Sample Type	Analytes [c]	Method[d]
HARRIS CREEK				
HC1-SW-date-time	Surface water sample collected at automated monitoring station HC1 located on Harris Creek. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
HC2-SW-date-time	Surface water sample collected at automated monitoring station HC2 located on Harris Creek. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
Quality assurance/quality control (QA/QC) samples will be collected at each stream monitoring station[e]				
COWHOUSE CREEK				
CHC1-SW-date-time	Surface water sample collected at automated monitoring station CHC1 located on Cowhouse Creek. Assess perchlorate concentrations.	Environmental	Perchlorate	USEPA Method 314.0
Quality assurance/quality control (QA/QC) samples will be collected at each stream monitoring station[e]				
INVESTIGATION DERIVED WASTE				
MW-SC1-IDW	Sample collected from monitoring well MW-SC1 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0

(a) Sample Designation:
SC– Station Creek SBR – South Bosque River HC – Harris Creek CHC – Cowhouse Creek SW – Surface Water IDW – Investigation-Derived Waste

(b) At each monitoring station, samples will be collected at the following frequency: once daily for the first seven days, once weekly for the next three weeks, and once every two weeks for the remainder of the project. Sample frequency will return to daily after each significant storm event (refer to Section 2.5.4).

(c) All samples will be sent to: The USACE Engineer Research and Development Center Environmental Laboratory at the Environmental Chemistry Branch in Omaha, Nebraska

(d) Samples will be collected every 14 days in order to meet the 28-day turnaround time for the analytical method.

(e) QA/QC samples: Each automated sampler will be programmed to collect a blind duplicate sample with every 10th sample collected and matrix spike/matrixspike duplicate samples with every 20th sample collected (refer to Section 2.5).

TABLE 2-5

SUMMARY OF SAMPLES TO BE COLLECTED DURING THE LONGITUDINAL STREAM SAMPLING STUDY FIELD PROGRAM
(Page 4 of 5)

Sample Designation [a]	Sample Location/Rationale[b]	Sample Type	Analytes [c]	Method[d]
INVESTIGATION DERIVED WASTE (continued)				
MW-SC2-IDW	Sample collected from monitoring well MW-SC2 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0
MW-SC3-IDW	Sample collected from monitoring well MW-SC3 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0
MW-SC4-IDW	Sample collected from monitoring well MW-SC4 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0
MW-SC5-IDW	Sample collected from monitoring well MW-SC5 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0
MW-SC6-IDW	Sample collected from monitoring well MW-SC6 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0
MW-SBR1-IDW	Sample collected from monitoring well MW-SBR1 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0
MW-SBR2-IDW	Sample collected from monitoring well MW-SBR2 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0
MW-SBR3-IDW	Sample collected from monitoring well MW-SBR3 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0
MW-SBR4-IDW	Sample collected from monitoring well MW-SBR4 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0

(a) Sample Designation:
SC– Station Creek SBR – South Bosque River HC – Harris Creek CHC – Cowhouse Creek SW – Surface Water IDW – Investigation-Derived Waste

(b) At each monitoring station, samples will be collected at the following frequency: once daily for the first seven days, once weekly for the next three weeks, and once every two weeks for the remainder of the project. Sample frequency will return to daily after each significant storm event (refer to Section 2.5.4).

(c) All samples will be sent to: The USACE Engineer Research and Development Center Environmental Laboratory at the Environmental Chemistry Branch in Omaha, Nebraska

(d) Samples will be collected every 14 days in order to meet the 28-day turnaround time for the analytical method.

(e) QA/QC samples: Each automated sampler will be programmed to collect a blind duplicate sample with every 10^{th} sample collected and matrix spike/matrixspike duplicate samples with every 20^{th} sample collected (refer to Section 2.5).

TABLE 2-5

SUMMARY OF SAMPLES TO BE COLLECTED DURING THE LONGITUDINAL STREAM SAMPLING STUDY FIELD PROGRAM
(Page 5 of 5)

Sample Designation [a]	Sample Location/Rationale[b]	Sample Type	Analytes [c]	Method[d]
INVESTIGATION DERIVED WASTE (continued)				
MW-SBR5-IDW	Sample collected from monitoring well MW-SBR5 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0
MW-SBR6-IDW	Sample collected from monitoring well MW-SBR6 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0
MW-HC1-IDW	Sample collected from monitoring well MW-HC1 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0
MW-HC2-IDW	Sample collected from monitoring well MW-HC2 development water. Characterize all IDW generated at this well for disposal.	Disposal-profiling	Perchlorate	USEPA Method 314.0

(a) Sample Designation:
SC– Station Creek SBR – South Bosque River HC – Harris Creek CHC – Cowhouse Creek SW – Surface Water IDW – Investigation-Derived Waste

(b) At each monitoring station, samples will be collected at the following frequency: once daily for the first seven days, once weekly for the next three weeks, and once every two weeks for the remainder of the project. Sample frequency will return to daily after each significant storm event (refer to Section 2.5.4).

(c) All samples will be sent to: The USACE Engineer Research and Development Center Environmental Laboratory at the Environmental Chemistry Branch in Omaha, Nebraska

(d) Samples will be collected every 14 days in order to meet the 28-day turnaround time for the analytical method.

(e) QA/QC samples: Each automated sampler will be programmed to collect a blind duplicate sample with every 10^{th} sample collected and matrix spike/matrixspike duplicate samples with every 20^{th} sample collected (refer to Section 2.5).

3.0 HEALTH AND SAFETY PROGRAM

All personnel involved with the field activities described in this FSP shall follow the Site *Safety and Health Plan – Bosque and Leon River Watersheds Study* (SSHP; MWH, 2002a). The SSHP was prepared specifically for the field investigations that will support the USACE Bosque and Leon River Watersheds Study, and includes the health and safety procedures and protocols for the Longitudinal Stream Sampling Study. The Activity Hazard Analysis that is specific to the Longitudinal Stream Sampling Study summarized in Table 1-1a of the SSHP.

4.0 QUALITY CONTROL

This section is a summary of quality control procedures that will be followed during the Longitudinal Stream Sampling Study field program, including daily quality control reports, field and laboratory quality control samples, data validation, and final reporting requirements. The overall quality program for all field investigations that will be implemented to support the USACE Bosque and Leon River Watersheds Study is presented in the *Quality Assurance Project Plan – Bosque and Leon River Watersheds Study* (QAPP; MWH, 2002a)

4.1 DAILY QUALITY CONTROL REPORTS

Daily Quality Control Reports (DQCRs) will be prepared for every day field work is performed. DQCRs are field reports that summarize daily activities and help project personnel track quality control activities. These reports will include location(s) of work, weather conditions and temperatures, work performed, results of any inspections/tests performed, the individuals performing the inspections/tests, equipment calibration procedures, problems identified and associated corrective actions taken, any instructions received from the USACE Project Manager, and any general comments. A DQCR form is included in Appendix B.

4.2 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Quality assurance/quality control samples will be collected and submitted for laboratory analysis during sampling activities to ensure the quality of the data generated. The QA/QC sample types and frequencies are listed below. QA/QC sample locations, collection procedures, and designations are presented in Section 2.5.3.5.

QC Sample Type	Frequency
Blind Duplicate	Ten percent of the total number of surface water samples will be collected as a duplicate set: one submitted to the laboratory labeled as the environmental sample and the other submitted "blind" to assess laboratory consistency and precision.
Matrix Spike/Matrix Spike Duplicate	Five percent of the total number of groundwater samples will be collected as a triplicate set: one submitted to the laboratory labeled as the environmental sample, one as the MS, and one as the MSD. The MS/MSD results will be used to measure the efficiency of the analytical method in recovering target analytes from an environmental sample matrix and the laboratory precision and accuracy.
Equipment Blank	Ten percent of the total number of samples, of any media, in which non-dedicated sampling equipment was used, will be tested to assess cross-contamination from the sampling equipment by collecting an equipment blank sample.

4.3 LABORATORY QUALITY CONTROL

The surface water and IDW samples will be analyzed for perchlorate using USEPA Method 314.0 as outlined in Section 2.0 of this work plan. All analytical procedures performed during this project will conform to the most recently promulgated version of *Method 314.0 - Determination of Perchlorate in Drinking Water Using Ion Chromatography* (USEPA, 1999). Additional information regarding the analytical method requirements is included in Section 7.0 of of the QAPP.

The analytical quality control requirements (laboratory method detection limits; practical quantitation limits; summary of internal quality control procedures; control limits for matrix spikes, matrix spike duplicates, and surrogate spikes; control limits for laboratory control samples; and calibration procedures) are presented in Appendix A of the QAPP**.** Data management, including the format of the data packages and data archive, will follow the guidance set forth in Section 9.0 of the QAPP.

4.4 DATA VALIDATION AND VERIFICATION

All data received from the laboratory will be reviewed by the MWH Project Chemist to ensure that the data meets the project data quality objectives (refer to Section 9.5 of the QAPP, Reconciliation with Data Quality Objectives). Specifically, the Project Chemist will review the holding times, MS/MSD recoveries, relative percent differences (RPDs), and blank analyses. In addition, Level IV data validation on 10 percent of the analyzed

data for the surface water samples also will be performed in accordance with *USEPA Contact Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review* (USEPA, 1994b), the Department of Defense *"Quality Systems Manual for Environmental Laboratories"* (Version 1.0, October 2000), and the USACE EM 200-1-3, Appendix I "*Shell for Analytical Chemistry Requirements"* (February 2001). All data will be presented with explanations of nonconforming data. Resampling or reanalysis may be requested in the case of unsatisfactory performance on the part of the laboratory.

4.5 REPORTING REQUIREMENTS

Project activities will be documented in the quarterly updates regarding the data that were collected during the field sampling activities. A technical memorandum will be prepared each quarter that discusses the results and makes recommendations for refining the sampling/measurement criteria. The text will also include a discussion of field methods and procedures that deviated from those proposed in this document (if any). All laboratory analytical data will be presented with a data validation narrative that will summarize the quality and usefulness of the data.

5.0 REFERENCES

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