FINAL
UNIFORM FEDERAL POLICY - QUALITY ASSURANCE PROJECT PLAN SUPPLEMENTAL INVESTIGATION AT SITES SS017: LOT 69, DP022: BUILDING 222, AND SS025: T-9 STORAGE AREA FORMER GRIFFISS AIR FORCE BASE ROME, NEW YORK

February 2017

Prepared For:

Air Force Civil Engineer Center
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Contract/Task Order No: FA8903-16-F-0012

Prepared By:

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INTRODUCTION

Bhate Environmental Associates, Inc. (Bhate), under contract with the Air Force Civil Engineer Center (AFCEC), is performing long term management (LTM), site remediation, and site investigations at the former Griffiss Air Force Base (AFB), Rome, New York.

The former Griffiss AFB covered approximately 3,552 contiguous acres in the lowlands of the Mohawk River Valley in Rome, Oneida County, New York. Topography within the valley is relatively flat, with elevations on the former Griffiss AFB ranging 435 to 595 feet above mean sea level. Three Mile Creek, Six Mile Creek (both of which drain into the New York State Barge Canal, located to the south of the base), and several state-designated wetlands are located on the former Griffiss AFB, which is bordered by the Mohawk River on the west. Due to its high average precipitation and predominantly silty sands, the former Griffiss AFB is considered a groundwater recharge zone.

This Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) has been prepared in conjunction with the tasks described in the Former Griffiss AFB 2016 Project Management Plan (PMP) (Bhate, November 2016) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Sites. The scope of work to be completed under this UFP-QAPP for site closure (SC) is summarized below.

GRIFFISS PERFORMANCE-BASED REMEDIATION SCOPE OF WORK

Group	Site	Work Element	Monitoring Matrix	Site Objective
CERCLA Site –Lot 69 Former Hazardous Waste Storage Area	SS017	Collect data to support unrestricted closure using a SI, if necessary.	Soil	SC
CERCLA Site - Building 222	DP022	Collect data to support unrestricted closure using a SI, if necessary.	Soil	SC
CERCLA Site - T-9 Storage Area	SS025	Collect data to support unrestricted closure using a supplemental investigation (SI), if necessary.	Soil	SC

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ACRONYMS AND ABBREVIATIONS

§	Section
A2LA	American Association of Laboratory Accreditation
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AFRL	Air Force Research Laboratory
AI	Action Item
AMSL	Above mean sea level
AOC	Area of Concern
ASTM	ASTM International (formerly American Society for Testing and Materials)
BEC	BRAC Environmental Coordinator
bgs	Below ground surface
Bhate	Bhate Environmental Associates, Inc.
BRAC	Base Realignment and Closure
BS	Bachelor of Science
°C	Degree Celsius
CA	Corrective Action
CAS	Chemical Abstract Service
CCB	Continuing calibration blank
CCV	Continuing calibration verification
CD	Compact disc
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHMM	Certified Hazardous Materials Manager
CIH	Certified Industrial Hygienist
CL	Control Limit
CLP	Contact Laboratory Program
CNTS	Cherokee Nation Technology Support
CO	Contracting Officer
COC	Chemical of concern
COPC	Chemicals of potential concern
COR	Contracting Officer's Representative
CPEA	Certified Professional Environmental Auditor
CPR	Cardiopulmonary Resuscitation
CSM	Conceptual Site Model
CSP	Certified Safety Professional
CVAA	Cold-vapor atomic absorption
%D	Percent difference/drift
DDT	Dichlorodiphenyltrichloroethane
DL	Detection limit
DoD	Department of Defense
DOE	Department of Energy
DPT	Direct Push Technology
DQCR	Data Quality Control Report
DQI	Data Quality Indicator
DQO	Data Quality Objective
ECD	Electron Capture Detector
EDD	Electronic data deliverable
EDGE	Economic Development Growth Enterprises Corporation
E & E	Ecology and Environment, Inc.
EICP	Extracted Ion Current Potential
ELAP	Environmental Laboratory Accreditation Program
e-mail	Electronic mail
ERPIMS	Environmental Resources Program Information Management System
ESD	Explanation of Significant Difference
FD	Field duplicate
FFA	Federal Facilities Agreement
FID	Flame Ionization Detector
FOM	Field Operations Manager
ft	Feet or foot

GC/MS	Gas Chromatograph/Mass Spectrometer
GIS	Geographic Information System
GLDC	Griffiss Local Development Corporation
HASP	Health and Safety Plan
HAZWOPER	Hazardous waste operations and emergency response
HQ	Hazard Quotient
HSM	Health and Safety Manager
ICAL	Initial calibration
ICP	Inductively Coupled Plasma
ICV	Initial calibration verification
IMS	Integrated Master Schedule
IRA	Interim Remedial Action
IRP	Installation Restoration Program
JBSA	Joint Base San Antonio
LAW	LAW Engineering and Environmental Services, Inc.
LCL	Lower confidence limit
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
LIMS	Laboratory Information Management System
LOD	Limit of detection
LOQ	Limit of quantitation
LTM	Long-term management
LUC	Land Use Controls
µg/kg	Micrograms per kilogram
mg/kg	Milligrams per kilogram
MDL	Method detection limit
mL	Milliter
MPC	Measurement performance criteria
MS/MSD	Matrix spike/matrix spike duplicate
NA	Not applicable or not available
NIST	National Institute of Standards and Technology
NPL	National Priorities List
NYCRR	New York Codes, Rules, and Regulations
NYS	New York State
NYSBC	New York State Barge Canal
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
Ocuto	Ocuto Blacktop and Paving Environmental Services
O&M	Operation and maintenance
OSHA	Occupational Safety and Health Administration
oz	Ounce
PAH	Polycyclic aromatic hydrocarbons
PARCCSS	Precision, accuracy, representativeness, comparability, completeness, and sensitivity
Parsons	Parsons Government Services
PBR	Performance-Based Remediation
PCB	Polychlorinated biphenyl
PDF	Portable document format
PDS	Post-digestion spike
PE	(Registered) Professional Engineer
PEER	PEER Consultants, P.C.
PG	(Registered) Professional Geologist
PID	Photoionization detector
PM	Project Manager
PMP	Project Management Plan
POC	Point of Contact
PPE	Personal protective equipment
PQO	Project quality objective
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
QSM	Quality Site Manager

r2	Coefficient of determination
%R	Percent recovery
RCRA	Resource Conservation and Recovery Act
REM	Registered Environmental Manager
RI	Remedial Investigation
RL	Reporting limit
ROD	Record of Decision
RPD	Relative percent difference
RRS	Rome Research Site
RRT	Relative retention time
RSD	Relative standard deviation
RSL	Regional Screening Level
RT	Retention time
SAC	Strategic Air Command
SC	Site Closure
SCO	Soil Cleanup Objective
SDG	Sample delivery group
SI	Supplemental Investigation
SIM	Selected Ion Monitoring
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
SVOC	Semi-volatile organic compound
SW	Solid Waste
TA	TestAmerica Laboratories, Inc.
TAGM	Technical and Administrative Guidance Memorandum
TAL	Target Analyte List
TBD	To be determined
TCE	Trichloroethene
UCL	Upper confidence limit
UFP	Uniform Federal Policy
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound

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WORKSHEETS 1 AND 2 - TITLE AND APPROVAL PAGE

Project Name and Site Location:	Environmental Remediation at Base Realignment and Closure (BRAC) Eastern Region, Griffiss Air Force Base (AFB), Rome, New York
Contract Number:	FA8903-16-F-0012
Document Title:	*Uniform Federal Policy-Quality Assurance Project Plan* [UFP-QAPP], *Supplemental Investigation at Sites SS017: Lot 69, DP022: Building 222, and SS025: T-9 Storage Area, Former Griffiss Air Force Base, Rome, New York*
Lead Organization:	Air Force Civil Engineer Center (AFCEC) 2261 Hughes Avenue, Suite 155 Joint Base San Antonio (JBSA) Lackland, TX 78236-9853
Lead Regulatory Organization:	United States Environmental Protection Agency (USEPA) Region 2, New York State Department of Health (NYSDOH), and New York State Department of Environmental Conservation (NYSDEC)
Contractor's Contact Information:	Bhate Environmental Associates, Inc. (Bhate) 1608 13th Avenue South, Suite 300 Birmingham, AL 35205 Email: knemmers@bhate.com
Identify Regulatory Program:	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
List organizational partners (stakeholders) and connection with lead organization:	USEPA, regulator; NYSDEC, regulator; NYSDOH, regulator; AFCEC, representative party; Bhate, prime contractor; Parsons Government Services (Parsons), Field Support Contractor; and Property Owners/Occupants (including the Griffiss Local Development Corporation [GLDC], Mohawk Valley Economic Development Growth Enterprises Corporation [EDGE], and Oneida County Department of Aviation)
List dates and titles of documents written for previous site work, if applicable:	Law Engineering and Environmental Services, Inc. (LAW), *Draft-Final Primary Report, Volume 21, Remedial Investigation, Griffiss Air Force Base, New York*, December 1996
Preparation Date:	February 2017

Approvals

This UFP-QAPP has been reviewed and approved by the following persons.

Investigative Organization's Project Manager:

Kimberly A. Nemmers

Organization: Bhate Environmental Associates, Inc.

Investigative Organization's Project Quality Assurance/Quality Control (QA/QC) Manager:

Corey Green

Organization: Bhate Environmental Associates, Inc.

Technical Manager:

J. Mark Stapleton

Organization: Bhate Environmental Associates, Inc.

Installation Point of Contact (POC)/Griffiss BRAC Environmental Coordinator (BEC)/ Contracting Officer's Representative (COR):

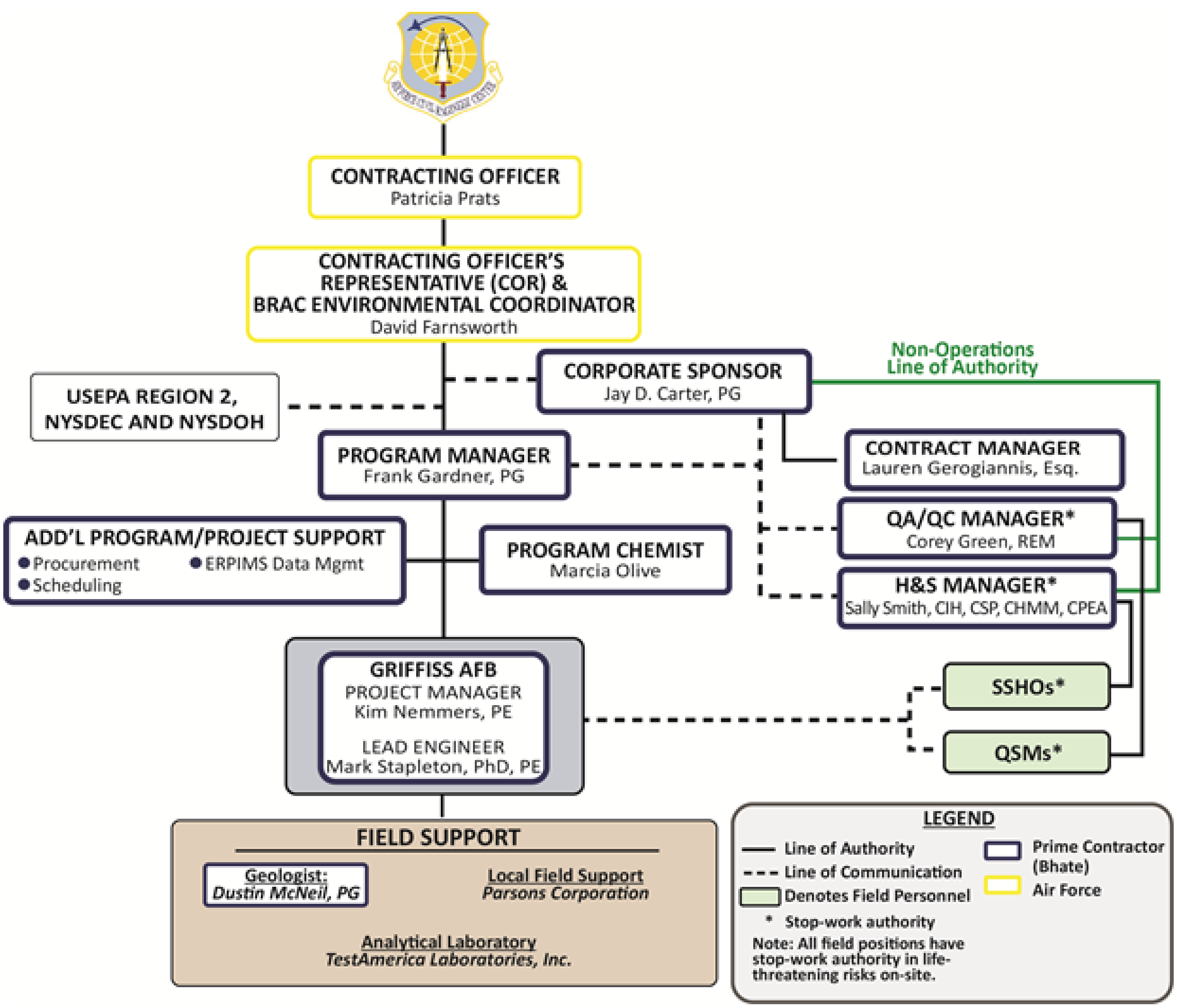
David Farnsworth

Organization: Griffiss AFB

WORKSHEETS 3 AND 5 – PROJECT ORGANIZATION AND DOCUMENT DISTRIBUTION

This worksheet identifies reporting relationships between all organizations involved in the project, including the lead organization and all contractor and subcontractor organizations. **Figure 1** presents the Griffiss AFB Performance-Based Remediation (PBR) Organization Chart. Bhate is the prime contractor for all work completed under this UFP-QAPP. Personnel contact information is provided on Worksheet 6.

Figure 1. Organization Chart



The following lists the entities who will receive copies of the approved UFP-QAPP, subsequent UFP-QAPP revisions, addenda, and amendments.

Document Title:	*Uniform Federal Policy-Quality Assurance Project Plan, Supplemental Investigation at Sites SS017: Lot 69, DP022: Building 222 and SS025: T-9 Storage Area, Former Griffiss Air Force Base, Rome, New York*
Contract Number:	FA8903-16-F-0012

Recipient	**Organization**	**Electronic Copy**	**Hard Copy**	**Notes**
David Farnsworth	Griffiss POC/BEC/ COR AFCEC	1 electronic copy Working Copy, Draft, Draft Final, and Final	1 for each version or update	
Sean Eldredge	AFCEC Support	1 electronic copy Working Copy, Draft, Draft Final, and Final	1 for each version or update	
Robert Morse	USEPA Remedial Project Manager (PM)	1 electronic copy of Draft, Draft Final and Final	1 for each version or update	
Heather Bishop	NYSDEC Environmental Engineer	1 compact disc (CD) of Draft Final and Final	1 Hard copy of Draft Final, unless otherwise requested	
Kristin Kulow	NYSDOH	1 electronic copy Working Copy, Draft, Draft Final, and Final	1 for each version or update	
PBR Contractor	Bhate Internal SharePoint	Uploaded	None	All documents to be uploaded onto Bhate SharePoint

WORKSHEETS 4, 7, AND 8 – PERSONNEL QUALIFICATIONS AND SIGN-OFF SHEET

Table 1. Personnel Qualifications and Sign-off

Project Personnel	Project Title and Role	Education and Experience	Specialized Training and Certifications	Signature
AFCEC				
David Farnsworth	Griffiss BEC and COR	Bachelor of Science (BS), Civil Engineering, 10 years' Air Force Facilities Engineering/Management and 24 years' Air Force Environmental Engineering/Management		FARNSWORTH.DAVID.SCOTT.1011912580 Digitally signed by FARNSWORTH.DAVID.SCOTT.1011912580 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USAF, cn=FARNSWORTH.DAVID.SCOTT.1011912580
Prime Contractor				
Frank Gardner	BRAC Eastern Region PBR Program Manager - Responsible for management of PBR Contract including monthly reporting, scheduling, invoicing, and achievement of proposed performance objectives on or ahead of schedule	BS, Geology (1981), Eastern Michigan University 24 years' Federal Project Management experience and 28 years' experience performing environmental site investigations and remedial actions at sites nationwide.	Professional Geologist (PG)	
Kim Nemmers	Griffiss AFB PBR PM - Responsible for management of PBR implementation at Griffiss AFB, including achievement of proposed performance objectives on or ahead of schedule	BS, Civil Engineering (1998), Purdue University Master of Science, Environmental Engineering (2002), Illinois Institute of Technology 13 years' PM experience 16 years' environmental remediation and field operations management	Professional Engineer (PE)	

Project Personnel	Project Title and Role	Education and Experience	Specialized Training and Certifications	Signature
Marcia Olive	Project Chemist	BS, Chemistry (1995), University of Colorado, Colorado Springs 18 years' experience on Department of Defense (DoD) (AFCEC, U.S. Army Corps of Engineers [USACE], Navy), Department of Energy (DOE), and Superfund projects as a Project Chemist.		[signature]
Corey Green	Project QA/QC Manager	BS, Chemistry (1991), University of South Carolina Masters of Science, Environmental Systems Engineering (1993), Clemson University 19 years' experience in report and plan preparation for environmental investigations, compliance, and remediation 15 years' experience performing QC reviews of project deliverables	Registered Environmental Manager (REM) Asbestos Inspector	Corey K Green

Project Personnel	Project Title and Role	Education and Experience	Specialized Training and Certifications	Signature
Sally Smith	Health and Safety Manager (HSM)	Masters of Health Science, Industrial Hygiene and Environmental Health Engineering (2001), Johns Hopkins University Masters of Public Health, Occupational Epidemiology (1976), University of Illinois BS, Biochemistry (1974), University of Illinois 32 years' health and safety experience. 22 years' Resource Conservation and Recovery Act (RCRA) and Superfund experience for federal environmental remediation and construction projects.	Certified Industrial Hygienist (CIH) Certified Safety Professional (CSP) Certified Hazardous Materials Manager (CHMM) Certified Professional Environmental Auditor (CPEA) Construction Safety and Health Supervisor	Sally S Smith
Dustin McNeil	Field Operations Manager (FOM)/Site QA/QC and Site Safety and Health Officer (SSHO)	BS, Natural Resource Management (2000), Colorado State University 16 years' experience in performing and providing oversight of field investigations for DoD and DOE environmental and geotechnical projects.	PG	Dustin McNeil
Subcontractors Supporting Laboratory Services				
Jessica DeHerrera	TestAmerica Laboratories, Inc., Denver, CO, Project Manager	BS Environmental Science – Metropolitan State University, Denver, CO - 2012 4 years' environmental laboratory experience		Jessica DeHerrera

Note: Approvals can be received via electronic mail or similar such that actual signature of this UFP-QAPP is not required.

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Manpower Requirements

The Bhate team will be supported by Parsons Government Services (Parsons) and will mobilize operational personnel from their Syracuse, New York office. Project management, scheduling, and technical support will be based in Bhate's Lakewood, Colorado, office. Personnel resumes are available through Parsons human resources department for Parsons personnel and through Bhate's human resources department for Bhate personnel.

Project Management and Field Supervision

The Bhate project management approach is to work closely with the client to accomplish project objectives and ensure continuous client satisfaction with the project. Therefore, the Bhate Eastern BRAC PBR PM will have overall responsibility for project schedule, costs, and resources. A FOM will be assigned with responsibility for accomplishing the fieldwork. The FOM will report directly to the Griffiss AFB PBR PM and supervise day-to-day activities in the field. The Griffiss AFB PBR PM and FOM will jointly develop schedules and budgets throughout the project. Resource requirements will be addressed with full support of Parsons/Bhate staff prior to mobilization and on a regular basis during the course of work.

Project controls personnel will be assigned to assist with daily cost tracking and equipment/materials procurement. The project controls personnel will work closely with the PM and FOM with regard to project costs and planning.

Personnel - Duties and Responsibilities

Overall Responsibilities

Bhate will accomplish the following:

- Initiate and maintain a thorough and proactive safety program throughout the entire project. **Appendix A** contains the Griffiss AFB Program Health and Safety Plan (HASP).
- If a conflict, error, or discrepancy is found in contract documents, obtain a written interpretation or clarification from the AFCEC Contracting Officer (CO) before proceeding with the task(s) in question with the AFCEC COR copied on such correspondence.
- Notify the AFCEC CO and COR in writing or by electronic mail (e-mail) of any potential change to site conditions.
- Assign a PM for the life of the project (with prior written notice provided to AFCEC before any necessary changes in Parsons/Bhate supervision are executed).
- Maintain at the site copies, as appropriate, of the UFP-QAPP, HASP, specifications, addenda, written amendments, change orders, work directive changes, field test records, field orders, and written interpretations and clarifications.
- Manage all resources to meet the project schedule in a cost-effective manner.
- Effectively communicate project-related information with the AFCEC COR and installation POC.

Responsibilities of the Project Management Team

The Bhate PM will have day-to-day responsibility for technical, schedule, and budget issues. The FOM and other support personnel (as needed) will support the PM in the field. Due to the size of the project, the FOM will also serve as the SSHO and will assume on-site QC responsibilities. Individual responsibilities are described further in the following sections.

Project Manager

The Griffiss AFB PBR PM (Kimberly Nemmers, PE) is in charge of the overall project and has full authority for project coordination and direction. The PM will also communicate directly with the COR. The PM will:

- Interpret and plan the overall work effort.
- Review and approve submittals (including Daily Quality Control Reports [DQCRs]).
- Define resource needs and secure staff and equipment commitments.
- Monitor subcontractor performance, schedules, budgets, and invoices.
- Develop, review, and meet work schedule and budget objectives.
- Ensure technical adequacy of field, laboratory, and data management activities.
- Attend meetings with AFCEC, Griffiss AFB personnel, USEPA Region 2, NYSDOH, and NYSDEC, as required.
- Document the need for required contract modifications.

To carry out these functions, the PM will have the authority to:

- Determine staff and subcontractor priorities.
- Allocate additional personnel, as needed.
- Establish work budgets and schedules with milestones.
- Approve subcontractor work and invoices.
- Review and approve invoices.

Field Operations Manager

The FOM duties will be performed by Dustin McNeill, PG (Bhate). The FOM is responsible for the performance of all field activities in accordance with this UFP-QAPP and other project plans and specifications, including preparation of DQCRs. The FOM will also act as the SSHO and the Quality Site Manager (QSM). The FOM will:

- Implement day-to-day activities required by the HASP (**Appendix A**) and this UFP-QAPP.
- Coordinate field activities at the site, as directed by the PM.
- Oversee sampling activities and ensure all pre-investigation requirements are completed.
- Manage day-to-day administrative and procurement activities at the site.
- Monitor work progress and schedule, and advise the PM of variances.

- Ensure compliance of all site work tasks with governing State and Federal regulations pertinent to the work. Has stop work authority.
- Assist in preparation of work progress schedules and project reports.
- Compile daily logs for submittal to the PM.
- Attend work progress meetings.
- Report any proposed significant project changes to the PM in a timely manner to allow review and approval prior to incorporating the changed condition.

Health and Safety Manager

The HSM (Sally Smith, CIH, CSP, CHMM, CPEA) will be responsible for the development, implementation, oversight, and enforcement of the HASP. The HSM will:

- Sign and date the Program HASP, prior to submittal.
- Be available for emergencies.
- Provide onsite consultation to the FOM/SSHO as needed to ensure the Program HASP is fully implemented.
- Coordinate any modifications to the Program HASP with the FOM/SSHO and the COR.
- Provide continued support for upgrading/downgrading the level of personal protection.
- Be responsible for evaluating data and recommending changes to engineering controls, work practices, and personal protective equipment (PPE).
- Review accident reports and results of daily inspections. Has stop work authority.

Site Safety and Health Officer

The FOM will also act as the SSHO and is responsible for implementing the Program HASP to satisfy federal, State, and local regulations and ensuring that the plan is consistent with site conditions. The SSHO will be responsible for the enforcement of the Program HASP during those times that the HSM is absent from the site. The SSHO may take actions independent of the project group to stop the project, if required, to address safety concerns. The SSHO is responsible for conformance of all site work with requirements and procedures identified in the Program HASP. To oversee the day-to-day implementation of the Program HASP, the SSHO will:

- Approve PPE and safety procedures specified in the Program HASP.
- Oversee the maintenance and use of field equipment.
- Designate appropriate personal protection levels, including upgrades.
- Provide guidance to the project staff to maintain compliance of all site work with Federal and State regulations.
- Be "first at the scene" for emergencies and be responsible for notifying the HSM and the Griffiss AFB contact. The SSHO is also responsible for preparing an *Incident Report Form* related to any emergency.

Project Chemist

The Project Chemist (Marcia Olive) will be responsible for the QA/QC of analytical data generated during project activities in accordance with SW-846 and other requirements as specified by AFCEC. In addition, the Project Chemist will provide necessary oversight and guidance for the subcontracted laboratory through various QA/QC activities, including data review/validation and systems and performance auditing. The Project Chemist will:

- Coordinate with the FOM on field sampling and shipment.
- Verify the receipt of samples with the subcontracted laboratories.
- Coordinate with the subcontracted laboratories on laboratory QA/QC matters.
- Resolve all QC problems with the subcontracted laboratories and report them to the PM.
- Review all chemical analytical data for compliance with QC requirements and technical accuracy.
- Ensure all the analytical data packages are validated against project requirements.

Subcontractors

The selection of qualified subcontractors will be in accordance with Bhate procurement procedures. Subcontractors will be supervised by the FOM to verify the operator qualifications and use of properly operating equipment. The FOM will also direct the activities of the subcontractors, including work stoppage and/or taking appropriate emergency actions. The PM is responsible for overall subcontractor performance.

An individual with each respective subcontractor will serve to manage each task. They will have the responsibility for planning, supervising, conducting, and delivering work for the assigned tasks.

The following is a description of the routine training and certification requirements for implementation of the work.

Routine Training and Certification Requirements

This section outlines the training and certification required to complete the activities in the UFP-QAPP. The following sections describe the requirements for contractor and subcontractor personnel working onsite. Refer to Table 1 - Personnel Qualifications and Sign-off for Worksheets 4, 7, and 8 – Personnel Qualifications and Sign-off Sheet (on pages 5-7 of this UFP-QAPP).

Field Work Training

Field team members will be adequately trained in field methods and sampling procedures outlined in this plan and the Standard Operating Procedures (SOPs) (**Appendix B**). Specifically, field team members will have training in the following activities:

- Mobilization and Demobilization
- Soil sampling and sample handling, packaging, and shipping

- Waste characterization, removal and handling (as required)

The Griffiss AFB Program HASP (see **Appendix A** of this UFP-QAPP) and its Activity Hazard Analyses (see Attachment 1 of the HASP) specify required safety and field training related to the bullets listed above.

Training will be provided by the FOM, who is required to have a minimum of 3 years of direct field experience with sampling, sample handling, packaging and shipping, field equipment operation, and handling of hazardous and non-hazardous waste. Subcontractor personnel may require additional training to operate heavy equipment. This training is not provided by the FOM and will be the responsibility of the subcontractor.

Health and Safety Training

Bhate and subcontractor personnel who work at hazardous waste project sites are required to meet the Occupational Safety and Health Administration (OSHA) training requirements defined in Title 29 Code of Federal Regulation (CFR) Section (§) 1910.120 (e). These requirements are:

- 40 hours of formal off-site instruction;
- A minimum of 3 days of actual on-site field experience under the supervision of a trained and experience field supervisor; and
- 8 hours of annual refresher training.

Field personnel who directly supervise employees engaged in hazardous waste operations also receive at least 8 additional hours of specialized supervisor training. The supervisor training covers the Program HASP requirements, training requirements, PPE requirements, spill containment program, and health-hazard monitoring procedures and techniques. At least one member of every field team will maintain current certification in the American Red Cross "Multimedia First Aid" and "CPR Modular" or equivalent. Table 2 outlines special personnel training requirements.

Table 2. Special Personnel Training Requirements

Project Function	Specialized Training – Title or Description of Course	Personnel Titles/ Organizational Affiliation	Location of Training Records/ Certificates
FOM	40-Hour Hazardous Waste Operations and Emergency Response (HAZWOPER) Training	FOM/Bhate	Bhate, Lakewood Colorado
	8-Hour HAZWOPER Refresher	FOM/Bhate	Bhate, Lakewood Colorado
	8-Hour OSHA Supervisor Training	FOM/Bhate	Bhate, Lakewood Colorado
	First Aid/Cardiopulmonary Resuscitation (CPR)	FOM/Bhate	Bhate, Lakewood Colorado

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WORKSHEET 6 – COMMUNICATION PATHWAYS

Communication Drivers	Responsible Entity	Name	Contact Information	Procedure (Timing, Pathways, Documentation, etc.)
Contract Execution	Griffiss BEC	David Farnsworth	david.farnsworth@us.af.mil 518-563-2871	E-mail/communication with installation and Bhate PM
Manage all contract phases	Bhate PBR Program Manager	Frank Gardner	fgardner@bhate.com 303-386-6454	All project information will be copied to the AFCEC PM. Bhate Program Manager will notify AFCEC PM of field related problems by phone or e-mail by close of business the day of the event if possible and no later than noon Central Daylight/Standard Time the following day.
Regulatory agency interface	Installation BEC/Griffiss AFB PBR PM	David Farnsworth/ Kim Nemmers	david.farnsworth@us.af.mil 518-563-2871 knemmers@bhate.com 303-550-9239	Partnering meetings will be held regularly. Additional coordination and communication with regulatory agencies will be completed by the Bhate PM or by the Bhate PBR Program Manager with COR approval. All regulatory interactions will be documented.
Field progress reports	FOM/Bhate PM	Dustin McNeil/ Kim Nemmers	dmcneil@bhate.com 720-463-3904 knemmers@bhate.com 303-550-9239	DQCRs will be provided to the PM by the FOM for review and issuance to the BEC.
Field corrective actions	FOM/QA/QC Manager	Dustin McNeil/ Corey Green	dmcneil@bhate.com 720-463-3904 cgreen@bhate.com 205-918-4002	Corrective actions will be issued in writing by the FOM to the Project QA/QC Manager for review and approval.
Stop work due to safety issues	FOM/HSM	Dustin McNeil/ Sally Smith	dmcneil@bhate.com 720-463-3904 ssmith@bhate.com 205-918-4032	The FOM can issue a stop work order for actions that present immediate and imminent danger. The HSM will be consulted after the Stop Work verbally and then with a follow-up documented report per the Program HASP (**Appendix A**).

Communication Drivers	Responsible Entity	Name	Contact Information	Procedure (Timing, Pathways, Documentation, etc.)
QAPP changes prior to field work	Technical Director and/or QA/QC Manager	Mark Stapleton and/or Corey Green	mstapleton@bhate.com 205-999-7657 cgreen@bhate.com 205-918-4002	Change pages for the QAPP will be issued to USEPA Region 2, NYSDEC, and the BEC via e-mail and followed by hard copy, as needed.
QAPP changes during project execution	Technical Director and/or QA/QC Manager	Mark Stapleton and/or Corey Green	mstapleton@bhate.com 205-999-7657 cgreen@bhate.com 205-918-4002	Change pages for the QAPP will be issued to USEPA Region 2, NYSDEC, and the BEC via electronic mail (e-mail) and followed by hard copy, as needed.
Laboratory QC Variances	Project Chemist	Marcia Olive	molive@bhate.com 720-463-3905	The laboratory will be required to repeat the determination of the limit of detection (LOD) if there are significant changes to the method or instrumentation prior to analysis of the first sample. The limit of quantitation (LOQ) will be verified quarterly; if the method is modified or major changes are made to the instrumentation, the LOQ will be verified and reported.
Analytical corrective action	Project Chemist	Marcia Olive	molive@bhate.com 720-463-3905	Determines the need for corrective action for analytical issues; reviews data and technical deliverables as needed; provides feedback to Bhate PM on technical deliverables within 10 days of receipt.
Data Verification Issues	Project Chemist	Marcia Olive	molive@bhate.com 720-463-3905	Confirms that scientifically sound data is used in making project decisions via a three step data review (Worksheets 34 and 37).
Data Validation Issues	Project Chemist	Marcia Olive	molive@bhate.com 720-463-3905	Evaluate whether the collected data comply with project requirements by comparing the data collected with criteria established based on data quality objectives (DQOs). Coordination with contracted laboratory.

Communication Drivers	Responsible Entity	Name	Contact Information	Procedure (Timing, Pathways, Documentation, etc.)
Data Review Corrective Action	Project Chemist	Marcia Olive	molive@bhate.com 720-463-3905	If corrective action is deemed necessary, the review of supporting raw data to verify accuracy may be involved.
Health and Safety issues	HSM	Sally Smith	ssmith@bhate.com 205-918-4032	The onsite SSHO/FOM will verbally report any issue to the HSM and notify the AFCEC COR and CO in accordance with the requirements of the performance work statement to ensure the project team is aware of any issues that may arise. A Bhate incident form must be completed within 24 hours by the SSHO/FOM and submitted to the HSM for review and approval. Within 5 days of the incident, the HSM will complete the Bhate incident investigation form.

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WORKSHEET 9 – PROJECT SCOPING SESSION PARTICIPANTS SHEET

Date: 19 September 2016

Location: Former Griffiss AFB teleconference

Purpose: Discuss sampling plan expectations for Sites SS017 (Lot 69), DP022 (Building 222), and SS025 (T-9)

Participants:

Name	Organization	Title/Role
Kristin Kulow	NYSDOH	Project Manager
Sean Eldredge	AFCEC/Cherokee Nation Technology Solutions (CNTS)	Contract/Technical Support
Franz Schmidt	CNTS	AFCEC Technical Support
Frank Garnder	Bhate	Program Manager
Kim Nemmers	Bhate	Project Manager
Marcia Olive	Bhate	Project Chemist

Notes/Comments: Ms. Nemmers briefly outlined that Bhate had a contract for the next 5 years for the above mentioned sites. She explained that Bhate had agreed to obtain certain end states. The sites that were the focus of this discussion (Sites SS017 (Lot 69), DP022 (Building 222, and SS025 (T-9)) are planned for SC. These three sites had the groundwater use restriction removed and were soils-only sites.

Ms. Nemmers asked Ms. Kulow if she had any questions from the slide pack. Ms. Kulow indicated that she did not, but she mostly focused her review of the slides on the three sites for today's discussion.

Ms. Nemmers presented Site SS025, specifically discussing that no confirmation samples were collected after the interim removal action. Ms. Olive then asked about the fact that the site had been backfilled, pointing out that we are essentially sampling backfill. Ms. Kulow then said that soil cleanup objectives (SCOs) would apply regardless of the fact that the soil was historic fill. However, she agreed to obtain further information on how the DER-10 Technical Guidance for Site Investigation and Remediation would apply to a site like Site SS025 (**Action Item [AI]-01**).

Ms. Nemmers asked if we could use historical data to select chemicals of concern (COCs) for analysis. Ms. Kulow thought that historic site knowledge could be used to select the proposed analysis but wanted to confirm (**AI-02**). She then explained that there is a difference between unrestricted and residential cleanup and asked, which is the goal for these sites. Ms. Nemmers stated that she needed to discuss this further with Mr. Farnsworth (**AI-03**), who is the BEC and COR for the project. Ms. Kulow then stated that sampling to bedrock is required in 2 foot intervals. In addition a sample from 0 to 2-inches below the vegetation or impervious surface is required, followed by a 0 to 2 feet interval, 2 to -4 feet interval and so on. Later in the discussion, Ms. Nemmers asked if sampling below groundwater was required since groundwater use restrictions had been removed from these sites. Ms. Kulow did not think that sampling below the water table would be required by wanted to confirm (**AI-04**).

The discussion then focused on Site DP022 (Building 222) due to the challenges with sampling under the existing building. Ms. Olive explained that a risk assessment had eliminated all COCs, with the exception of lead. For this reason, confirmation samples only evaluated metals. The only metal that exceeded the SCOs was aluminum. Ms. Kulow indicated that analytical results from the soils beneath the building, specifically where the battery acid disposal pit was located, were necessary to remove the land use controls. Ms. Nemmers asked if sufficient soil samples can be collected to support a risk-based closure using a risk assessment. Ms. Kulow said that New York State doesn't review risk assessments. She suggested that the site could be redefined as the pit to clarify boundaries and limit the assessment. Ms. Nemmers asked that if aluminum, or similar COCs, continue to exceed the SCOs, then could these COCs be eliminated based upon being naturally occurring. Ms. Kulow said that COCs can be eliminated as a concern if they can be demonstrated as naturally occurring. Ms. Nemmers asked what was needed to demonstrate that a COC was naturally occurring. Ms. Kulow said that background sampling from a non-industrial area would be needed. Ms. Nemmers asked Mr. Eldredge and Mr. Schmidt for assistance in finding similar background study information for the former Griffiss AFB (**AI-05**). Bhate also agreed to work with AFCEC to determine if hand auguring or similar could be completed within the building (**AI-06**).

Mr. Gardner asked about sampling at Site SS017 (Lot 69). Ms. Nemmers said she felt that questions regarding that site had been addressed through the group's discussion. She then explained that only one boring location previously had exceedances. However, the use of the site today may cause the analytical results to be different as the site is used for bus storage and repairs.

The meeting concluded with a review of action items as follows:

- **AI-01:** Ms. Kulow to obtain further information on how the DER-10 Technical Guidance for Site Investigation and Remediation would apply to a site like Site SS025 that is mostly historical fill to groundwater table. Ms. Kulow did not feel the fill brought in during the 1990's fit the definition of historical fill:

  "Historic fill material" means non-indigenous or non-native material, historically deposited or disposed in the general area of, or on, a site to create useable land by filling water bodies, wetlands or topographic depressions, which is in no way connected with the subsequent operations at the location of the emplacement, and which was contaminated prior to emplacement."

- **AI-02:** Ms. Kulow to confirm that historical data is sufficient to select COCs for analysis
- Ms. Kulow confirmed via email **AI-03:** Ms. Nemmers to further discuss appropriate screening levels based upon site closure for residential or unrestricted (including agricultural use) use with AFCEC.

Screening criteria will be based on NYSDEC Unrestricted SCOs and USEPA RSLs for Residential Soils as listed in WS 15.

- **AI-04:** Ms. Kulow to confirm that no soil sampling is required below the water table based upon removal of the groundwater use restriction previously.
  This action is ongoing.
- **AI-05:** Bhate and AFCEC to find the background study previously completed for the former Griffiss AFB.
  This action is ongoing.
- **AI-06:** Bhate and AFCEC to determine if hand auguring could be completed within the building at Site DP022 (Building 222).
  This action is ongoing.

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WORKSHEET 10 – CONCEPTUAL SITE MODEL

This worksheet describes the Conceptual Site Model (CSM). The CSM integrates existing information and working assumptions about the physical site conditions; the nature, occurrence, and distribution of chemicals; fate and transport processes; and potential exposures to human and ecological receptors. The CSM is based on the current understanding of site history and conditions.

10.1 Site Location-for the Former Griffiss AFB

The former Griffiss AFB is located in the City of Rome in Oneida County, New York (**Figure 2**). The former Base lies within the Mohawk Valley between the Appalachian plateau and the Adirondack Mountains. A rolling plateau northeast of the former Base reaches an elevation of 1,300 feet (ft) above mean sea level (AMSL). The New York State Barge Canal (NYSBC) and the Mohawk River valley south of the former Base lie below 430 ft AMSL. The topography across the former Base is relatively flat with elevations ranging from 435 ft AMSL in the southwest portion to 595 ft AMSL in the northwest portion.

10.2 Site Description and History of the Former Griffiss AFB

The mission of the former Griffiss AFB varied over the years. The base was activated on February 1, 1942, as Rome Air Depot, with the mission of storage, maintenance, and shipment of material for the U.S. Army Air Corps. Upon creation of the Air Force in 1947, the depot was renamed Griffiss AFB. The base became an electronics center in 1950, with the transfer of Watson Laboratory Complex (later Rome Air Development Center [1951], Air Force Research Laboratory/ Rome Research Site [AFRL/RRS], and then the Information Directorate at RRS was established with the mission of applied research, development, and testing of electronic air ground systems). The headquarters of the Ground Electronics Engineering Installations Agency was established in June 1958 to engineer and install ground communication equipment throughout the world. The 49th Fighter Interceptor Squadron served at Griffiss AFB from 1959 until its deactivation in 1987. On July 1, 1970, the 416th Bombardment Wing of the Strategic Air Command (SAC) was activated with the mission of maintenance and implementation of both effective air refueling operations and long-range bombardment capability.

The former Griffiss AFB was designated for realignment under BRAC in 1993 and 1995, resulting in deactivation of the 416th Bombardment Wing in September 1995. The RRS of the AFRL and the Northeast Air Defense Sector have continued to operate at their current locations; the New York Air National Guard operated the runway for the 10th Mountain Division deployments until October 1998, when they were relocated to Fort Drum, NY. As a result of the various national defense missions carried out at the former Griffiss AFB since 1942, hazardous and toxic substances were used and hazardous wastes were generated, stored, or disposed of at various sites on the installation. The defense missions involved, among others, procurement, storage, maintenance, and shipping of war material; research and development; and aircraft operation and maintenance (O&M).

Numerous studies, investigations, and remedial actions under the U.S. DoD Installation Restoration Program (IRP) have been performed to locate, assess, quantify, and remove contaminant sources at the past toxic and hazardous waste storage, disposal, and spill sites. Pursuant to Section 105 of CERCLA, Griffiss AFB was included on the National Priorities List (NPL) on July 15, 1987. On March 20, 2009, 2,897.2 of the 3,552 acres were deleted from the NPL. On August 21, 1990, the Air Force, USEPA, and NYSDEC entered into a Federal Facilities Agreement (FFA) under Section 120 of CERCLA.

10.3 Site SS017 (Lot 69)

The following information was obtained from the *Final Project Management Plan Performance Based Remediation at Former Griffiss Air Force Base, New York* (CAPE, May 2011).

10.3.1 Site History

Site SS017 (Lot 69) is located in the south central industrialized part of Griffiss AFB, east of the Building 20 site and bordered on the south side by Ellsworth Road (**Figure 3**). The SS017 (Lot 69) site area is now occupied by a Vehicle Maintenance Facility, including Buildings 11 and 15, and a paved area used for parking and equipment storage. SS017 (Lot 69) currently houses a Birnie Bus maintenance facility.

From 1965 to 1982, Site SS017 (Lot 69) was an unfenced interim storage area for containers of liquid and solid hazardous wastes generated at the Base. A review of aerial photographs indicates the location of Building 11 was the original storage area. Wastes managed at the site included soot from No. 6 fuel oil, flammable liquids, spent corrosives, trap grease, spent solvents, neutralized acids, spent paint thinners, fuel spill residues, and waste oils. The drums were stored outside on raised pallets, and the storage area was diked. During the period of use, spills were reported to have occurred.

In 1982, when the present Vehicle Maintenance Facility was constructed and the site was paved, the stored wastes were relocated temporarily to a location designated as Lot 69 East (i.e., the area around Building 15). After approximately 6 months, the stored wastes were transferred to Lot 11. No spills were reported.

An analysis of soils was conducted in 1982 (sample locations unknown) indicating the presence of several organic contaminants including trichloroethene (TCE), toluene, xylenes, and polychlorinated biphenyls (PCBs). A Remedial Investigation (RI) was performed in 1994 (LAW, 1996) to determine the nature and extent of contamination. The analyses of soil and groundwater included volatiles, semivolatiles, pesticides, herbicides, PCBs, metals, petroleum hydrocarbons, and total cyanide. Five groundwater samples resulted in concentrations of alpha-BHC and six metals exceeding federal and/or NYSDEC Class GA groundwater standards. Subsurface soil samples reported exceedances of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, barium, and chrysene above New York State (NYS) recommended soil cleanup objectives. Aroclor-1260 exceeded proposed RCRA corrective action levels and seven metals exceeded NYS background screening concentrations.

All contaminant detected in the soils and groundwater were considered chemicals of potential concern (COPCs), with the exception of a few inorganics (iron, magnesium, calcium, potassium, and sodium) deemed essential human nutrients, and selected for a human health risk assessment conducted during the RI. The total carcinogenic risk to occupational workers was below or within the USEPAs target risk range. The noncarcinogenic risk to occupational workers was below the benchmark value of 1 for every scenario with the exception of the potential risk to industrial workers from incidental ingestion of groundwater. Due to the highly developed area, no complete exposure pathways for ecological risk were identified. Therefore the results of the baseline risk assessment indicated that chemicals in soil do not present a risk to current and future occupational workers. A supplemental RI was performed in 1997 (Ecology and Environment, Inc. [E & E], 1998) with additional groundwater testing. No compounds exceeded action levels.

The Record of Decision (ROD) for Site SS017 (Lot 69) (Air Force Base Conversion Agency, December, 2004) was signed by the USEPA on March 17, 2005. In accordance with the ROD, institutional controls in the form of land use restrictions within the site boundaries for industrial/commercial use and groundwater use restrictions were implemented. Based on elevated metal detections in groundwater being associated with suspended solids and consistent with background levels (FPM Group, Ltd. [FPM], November 2004) no further groundwater monitoring was recommended and monitoring ceased. Site SS017 (Lot 69) monitoring wells were decommissioned in the winter of 2008/2009. The groundwater restriction under the ROD was accepted by the USEPA and removed in 2012.

10.3.2 Site Geology and Hydrogeology

Site SS017 (Lot 69) lies within the level, south central industrialized area close to the surface and groundwater drainage divide between Rainbow Creek and Three Mile Creek. East-west hydraulic gradients are extremely low in part because a storm drain with a very low gradient crosses the site leading to Rainbow Creek. Surface water runoff is channeled into the base storm drain system while some runoff drains to Rainbow Creek. The storm sewer system empties into the culverted portion of Six Mile Creek. Groundwater depths are approximately 5 to 9 ft below ground surface (bgs). The subsurface soils are tan to brown, silty, fine to coarse sand with little or no gravel and silty, fine to coarse sand with gravel below 2 feet.

10.3.3 Data Gaps for Unrestricted Site Closure

The soil analytical data is approximately 20 years old such that natural degradation may have occurred. In order to assess the site for unrestricted site closure, additional soil samples for Volatile Organic Compounds (VOCs), Target Analyte List (TAL) metals, pesticides, PCBs, and Polycyclic Aromatic Hydrocarbons (PAHs) will be collected at 2 ft intervals until groundwater is encountered. In addition one sample from 0 to 2 inches below vegetation or impervious surface will be collected to assess agricultural and human exposure to soil. No groundwater samples will be collected since the EPA approved the removal of groundwater restrictions from the SS017 (Lot 69) deed in June 2012 (USEPA, 2012). . Proposed sample locations based on previous boring locations are shown on **Figure 4**.

10.4 Site DP022 (Building 222)

The following information was obtained from the *Final Project Management Plan Performance Based Remediation at Former Griffiss Air Force Base, New York* (CAPE, May 2011).

10.4.1 Site History

Site DP022 (Building 222) is located in the west-central portion of Griffiss AFB (**Figure 5**) and formerly used as a truck maintenance facility and entomology laboratory. A battery acid disposal pit was located inside the building in a truck bay and was approximately 2 ft square covered with a steel grate. Baking soda neutralized battery acids were disposed of in the pit from the 1940s to 1984.

An initial site investigation was performed by the Air Force in 1985. Elevated concentrations of metals were detected in surface sludge and the contaminated soil was removed. Soil borings were installed through the pit to a depth of 12 ft. Analytical results showed elevated levels of metals that dropped abruptly below 2 ft and decreased with depth. The contaminated soil was removed and the pit covered with concrete in 1985.

An RI was performed in 1994 to determine nature and extent (LAW, 1996). Six soil samples, from one deep soil boring, and one grab groundwater sample were analyzed for volatiles, semivolatiles, pesticides/PCBs, and metals. The soil investigation resulted in exceedances of 3 semivolatiles (benzo(a)pyrene, benzoic acid, and chrysene) and 2 pesticides (dieldrin and heptachlor epoxide) above NYS recommended soil cleanup objectives. Eight metals exceeded New York background screening concentrations. The groundwater investigation resulted in exceedances of 12 metals above federal and/or NYSDEC Class GA groundwater standards. All contaminants detected in the soils and groundwater were considered COPCs, with the exception of a few inorganics (iron, magnesium, calcium, potassium, and sodium) deemed essential human nutrients, and selected for a human health risk assessment conducted during the RI. The total carcinogenic risk to occupational workers was within USEPAs target risk range. The noncarcinogenic risk to occupational workers was below the benchmark value of 1 for every scenario with the exception of the potential risk to construction workers from incidental ingestion of soils.

Toxicity values were qualitatively assessed for several contaminants of which lead in soils was determined to pose a health hazard to occupation workers. The ecological risk to low order species from exposure to surface soils was considered to be insignificant. Based upon these results an Interim Removal Action (IRA) was performed in 1998. The remaining contaminated subsurface soils beneath the north central portion of the floor were removed to mitigate the majority of contamination and subsequent risk. Confirmatory samples, analyzed for TAL metals, confirmed contamination was still present and the area was over-excavated until NYSDEC Technical and Administrative Guidance Memorandum (TAGM) 4046 Guidance values were met. A total of 45.8 cubic yards of soil were removed (Ocuto Blacktop and Paving Environmental Services [Ocuto], 2001).

The ROD for Site DP022 (Building 222) (Air Force Base Conversion Agency, June, 2001) was signed by the USEPA on September 27, 2001. In accordance with the ROD, no further action for soils with land use restrictions within the site boundaries for industrial/commercial use were implemented. During quarterly groundwater monitoring in 2001/2002, two exceedances for total metals were attributed to basewide background conditions (identified during the RI). Based on the groundwater results, a request to remove the groundwater restriction under the ROD was approved by the USEPA in 2012.

10.4.2 Site Geology and Hydrogeology

With less than 2 ft of relief occurring in the surrounding area, Site DP022 (Building 222) is considered to be on an area that is topographically level. It is not located near major natural surface water drainage features. The base storm drainage system channels runoff from the site and discharges to the New York State Barge Canal by way of Three Mile Creek. Groundwater flow is toward the south-southeast. Surface and subsurface soils consist of dark brown, fine to medium grained sand with gravel.

10.4.3 Data Gaps for Unrestricted Site Closure

Due to insufficient sample data from the 1998 IRA, additional soil sampling is necessary to evaluate the site for unrestricted site closure. One sample will be collected at 2 ft increments until groundwater is encountered in the area of the old battery acid pit location via angled borings or hand auguring, as determined by the Air Force, due to the location of the current buildings foundation (**Figure 6**). In addition one sample from 0 to 2 inches below vegetation or impervious surface will be collected to assess agricultural and human exposure to soil. The additional sample will be collected and analyzed for VOCs, TAL metals, pesticides, and PAHs. No groundwater samples will be collected because the explanation of significant difference (ESD) deletion of ROD requirements for the groundwater investigations was approved and signed by the USEPA on September 26, 2003 (USEPA, 2003).

10.5 Site SS025 (T-9 Storage Area)

The following information was obtained from the *Final Project Management Plan Performance Based Remediation at Former Griffiss Air Force Base, New York* (CAPE, May 2011).

10.5.1 Site History

Site SS025 (T-9 Storage Area) is located at the intersection between Brooks Road and Selfridge Street near the east-central portion of Griffiss AFB (**Figure 7**). The 30,000 square foot grass and gravel site was used for heavy equipment parking and storage of herbicides and petroleum-based paving products. A 550 gallon kerosene aboveground storage tank was reported to have leaked on several occasions and stained soils. In 1991, the kerosene storage tank was replaced with a mobile 275 gallon kerosene tank but was later moved adjacent to Building 8 and removed by the end of 1996. Additionally, asphalt carrying trucks were reportedly rinsed with kerosene which was discharged onto the ground.

Initial site investigations were conducted in 1986 and 1992; however, no remedial actions were performed prior to the RI. An RI was performed in 1994 (LAW, 1996) to determine nature and extent. Soil samples were analyzed for VOCs, Semi-volatile Organic Compounds (SVOCs), pesticides, PCBs, total cyanide, metals, and petroleum hydrocarbons. The soil results reported exceedances of SVOCs limited primarily to surface and shallow subsurface soils. Additionally, pesticides and PCBs exceeded NYS soil cleanup objects or proposed RCRA corrective action levels. The majority of metals reported exceedances of background screening concentrations. Groundwater samples exceeded screening standards for six metals and dieldrin. All contaminants detected in the soils and groundwater were considered COPCs, with the exception of a few inorganics (iron, magnesium, calcium, potassium, and sodium) deemed essential human nutrients, and selected for a human health risk assessment conducted during the RI. The total carcinogenic risk to occupational workers was within the USEPAs target risk range and Site SS025 (T-9 Storage Area) does not pose a current or potential carcinogenic risk to human health. The non-carcinogenic risk to occupational workers was below the benchmark value of 1 for every scenario. Toxicity values were qualitatively assessed for several contaminants all of which were below guidance values. An ecological risk assessment on low order species indicated a slight potential for adverse effects of aluminum to short-tailed shrews but the industrialized location of this site meant the risk was not considered to be significant.

A No Further Action Proposed Plan was issued in 1998. Due to public comments and deed restrictions, it was decided to perform contaminated soil removal activities at the site. An IRA was performed in 1998 with a total of approximately 11,760 cubic yards of contaminated soils removed and all excavated areas backfilled. The contaminants were remediated along with the petroleum contaminated soils associated with NYSDEC Spill # 9702173 discovered during a site assessment conducted in 1996 by PEER Consultants, P.C. (PEER, 2000). Additional groundwater sampling was conducted to confirm the presence/absence of petroleum contamination downgradient of Site SS025 (T-9 Storage Area).

The ROD for Site SS025 (T-9 Storage Area) Area of Concern (AOC) (Air Force Base Conversion Agency, March 2001) was signed by the USEPA on September 27, 2001. In accordance with the ROD, no further action for soils with land use restrictions within the site boundaries for industrial/commercial use were implemented. During quarterly groundwater monitoring conducted as part of the Petroleum Source Removal AOCs Monitoring Program at the former base in 2003/2004, only one exceedance for SVOCs was reported in September 2003. The consecutive sampling resulted in no groundwater exceedance of NYSDEC Groundwater Standards. Based on the groundwater results, a request to close Spill# 9702173 was accepted by the NYSDEC on September 24, 2004. Furthermore, removal of the groundwater restriction under the ROD was approved by the USEPA in 2013 since no contaminants of concern were detected above NYSDEC groundwater standards.

10.5.2 Site Geology and Hydrogeology

The T-9 Site runoff is collected in the base storm drain system which discharges to Rainbow Creek and the culverted portion of Six Mile Creek. The groundwater depth varies from 3 ft bgs in the west to 12 ft bgs in the north and flows in a south-to-southeasterly direction. Surface and subsurface soils were characterized as being brown, sandy, and gravelly silt.

10.5.3 Data Gaps for Unrestricted Site Closure

Due to insufficient sample data from the 1998 IRA, additional soil sampling is necessary to evaluate the site for unrestricted site closure. Soil sampling will include VOCs, PAHs, pesticides, PCBs, and TAL metals to address data gaps and is described on Worksheets 11, 14 and 16, 17, and 18. Samples will be collected in 2 ft intervals until groundwater is encountered. In addition one sample from 0 to 2 inches below vegetation or impervious surface will be collected to assess agricultural and human exposure to soil. Proposed sample locations, based on previous boring locations with SCO exceedances, are shown on **Figure 8**. No groundwater samples will be collected since the EPA approved the removal of groundwater restrictions from SS025 (T-9 Storage Area) on June 18, 2013 (USEPA, 2013).

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WORKSHEET 11 – PROJECT AND DATA QUALITY OBJECTIVES

Site-specific DQOs were developed to determine performance monitoring and sampling, and to obtain unrestricted site closure based upon residential land use. The DQOs were developed using the USEPA seven-step process (USEPA, February 2006). The Table below summarizes the DQOs.

Table 3. Data Quality Objectives

1	Problem Statement	Sites SS017 (Lot 69), DP022 (Building 222), and SS025 (T-9 Storage Area) currently have Land Use Controls (LUCs)/Institutional Controls for soil. Investigations and removal actions have been performed to locate and remove contamination. Additional soil analysis is required to determine if soil requires further remediation or currently meets unrestricted use standards.
2	Identify the Goals	Additional soil samples will be collected from all three sites. SS017 – Investigate the soils across the site to verify that the historical data supports unrestricted site closure criteria. DP022 – Investigate the soil below the building foundation located at the former battery acid disposal pit location to determine if excavation efforts removed contaminated soils and unrestricted site closure criteria is met. SS025 – Investigate soils across the site to determine if contaminated soils were removed in the excavation effort and fill in data gaps to meet unrestricted site closure criteria.
3	Inputs to the Decision	Soil analytical results will be used to determine if any residual contamination is still present and whether unrestricted site closure objectives are met.
4	Study Area Boundaries	Sampling will be limited to soil. Sampling will be completed at Sites SS017 (Lot 69), DP022 (Building 222), and SS025 (Site T-9 Storage Area).
5	Analytical Approach	Soil samples will be collected for previously detected analytes which will include analyses for VOCs, TAL metals, PAHs, pesticides, and PCBs (with the exception of DP022).
6	Acceptable Limits on Decision Error	All analytical data will be generated from soil samples sent to TestAmerica Laboratories, Inc. (TA). Samples will be duplicated in the field at a rate of 10% and analyzed by TA to assess sampling precision. Matrix spike/matrix spike duplicates (MS/MSD) will be collected at a rate of 5%. Additional QA/QC protocols (field and lab) are provided in Worksheets #20 and #22 through #33.

7	Develop the Plan	One sampling event will be conducted to assess if cleanup target goals were met. SS017 – Collect a minimum of 10 soil borings, each at 2 ft intervals until groundwater is encountered, for VOCs, TAL metals, pesticides, PCBs, and PAHs from across the site. DP022 - Collect one soil boring, at 2 ft intervals until groundwater is encountered, for VOCs, TAL metals, pesticides, and PAHs from the former battery acid disposal pit location. SS025 – Collect a minimum of 10 soil borings, each at 2 ft intervals until groundwater is encountered, for VOCs, TAL metals, PAHs, pesticides, and PCBs from across the site. Additionally, each site will collect a sample from 0 to 2 inches below vegetation or impervious surface. If contamination is identified, then additional step out sampling will be completed to delineate the contamination.

WORKSHEET 12 – MEASUREMENT PERFORMANCE DATA

This worksheet documents the quantitative measurement performance criteria (MPC) in terms of precision, bias, and sensitivity for both field and laboratory measurements and is used as guidance for selecting appropriate techniques and analytical methods. In conjunction with Worksheet 11 these MPCs ensure data will satisfy the project quality objectives (PQOs) and DQOs. MPCs should be determined for each matrix and analytical group.

MPC were established for each analytical parameter. Refer to the following worksheets for the required information in this worksheet:

- Worksheet 15 (Reference Limits and Evaluation) for data quality indicators (DQIs) consisting of precision and accuracy;
- Worksheet 24 (Analytical Instrument Calibration);
- Worksheet 28 (Laboratory Quality Control Sample Summary);
- Worksheet 36 (Data Validation Procedures - Validation [Step IIa and IIb] Summary) for data review and validation process; and
- Worksheet 37 (Data Usability Assessment) for precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS).

The quality of the data to be collected for this project will be verified using appropriate MPC established for both sampling procedures and analytical methods. The criteria will relate to the DQIs in the table below. The MPC follow those defined in the DoD Quality Systems Manual, Version 5.0 (DoD, July 2013). The sampling procedures and the quality of the laboratory results will be evaluated for compliance with the project-specific DQOs through a review of overall PARCCS, in accordance with procedures described in Worksheet 37 (Data Usability Assessment).

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Table 4. Quantitative Measurement Performance Criteria

QC Sample	Analytical Group/SOP	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error*
Trip Blank	VOCs by SW-846 8260B - Soil SOP DV-MS-0010	One per cooler containing VOC samples	Overall accuracy/bias (Contamination)	No target analyte ≥ LOQ; with the exception of common field/ laboratory contaminants	S
MS/MSD		One per 20 samples per matrix	Accuracy/Precision	See Worksheet 15	S&A
Laboratory Control Sample (LCS)/LCS Duplicate (LCSD)		At least one per batch	Accuracy/Precision	See Worksheet 15	A
Cooler Temperature Indicator		One per cooler	Accuracy/Representative	Between 0 and 6 degrees Celsius (°C)	S
Field Duplicates		As required per sampling event	Precision	Relative percent difference (RPD) ≤ 30%	S & A
Data Completeness Check		NA	Data Completeness	95% Overall	S & A
LOQ		NA	Sensitivity	Recovery within LCS limits (See Worksheet 15)	A
Field Duplicates	PAHs SW-846 8270D-SIM - Soil SOP DV-MS-0002	As required per sampling event	Precision	RPD ± 50%	S & A
Equipment/Rinsate Blanks		As required per sampling event	Bias/Contamination	No target analytes ≥ LOQ; with the exception of common field/ laboratory contaminants	S
MS/MSD		One per 20 sample per matrix	Accuracy/Precision	See Worksheet 15	S&A
LCS/LCSD		At least one per batch	Accuracy/Precision	See Worksheet 15	A
Cooler Temperature Indicator		One per cooler	Accuracy/Representative	Between 0°C and 6°C	S

QC Sample	Analytical Group/SOP	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error*
Data Completeness Check		NA	Data Completeness	95% Overall	S & A
Field Duplicates	Pesticides and PCBs SW8081B/8082A Soil	One per 10 samples per matrix	Precision	RPD ≤ 50 %	S & A
LCS/LCSD	SOP DV-GC-0020/DV-GC-0021	At least one per batch	Precision/Accuracy/Bias	See Worksheet 15	S
MS/MSD		One per 20 samples per matrix	Accuracy/Bias	See Worksheet 15	S&A
Equipment/Rinsate Blanks		As required per sampling event	Bias/Contamination	No target analytes ≥ LOQ	S
Data Completeness Check		NA	Data Completeness	95% Overall	S & A
Cooler Temperature Indicator		One per cooler	Accuracy/Representative	Between 0 and 6°C	S
Field Duplicates	Metals USEPA 6010C/7471A – Soil	As required per sampling event	Precision	RPD ±50%	S & A
LCS/LCSD	SOP DV-MT-0021 SOP DV-MT-0016	At least one per batch	Analytical Accuracy/ Precision	RPD ≤ 20%	A
MS/MSD		One per 20 sample matrix	Analytical Accuracy/Bias (matrix interference)	RPD ≤ 20%	S & A
Equipment/Rinsate Blanks		As required per sampling event	Bias/Contamination	No target analytes ≥ LOQ; with the exception of common field/laboratory contaminants	S
Data Completeness Check		NA	Data Completeness	95% Overall	S & A

Notes: *Sampling (S), Analytical (A) or both (S&A)
NA – not applicable or not available, SW = Solid Waste, SIM = Selected Ion Monitoring

WORKSHEET 13 – SECONDARY DATA CRITERIA AND LIMITATIONS

Secondary data refer to historical data and background information previously collected at the site. The source(s) of the data, date of collection, planned uses, and limitations of the secondary data are summarized in the following table.

Table 5. Secondary Data Criteria Limitations

Secondary Data	Date of Collection	Source	How Data Will Be Used	Limitations on Data Use
Groundwater and soil data	Varies by sites	Laboratory electronic data deliverables (EDDs)	Verifies compliance with RODs and ensures protection of human health and the environment.	None
Historical Soil Data	Historical documents/ previous site investigations	1994 - present	Evaluate data, the status of site contamination, and the effectiveness of the remedial action effort.	Knowledge of these data is limited to information available in Air Force Administrative Records

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WORKSHEETS 14 AND 16 – PROJECT TASKS AND SCHEDULE

This worksheet includes specific tasks, responsible parties, and planned start and end dates of the project schedule (see **Figure 9**). The proposed activities are based upon the portion of the Integrated Master Schedule (IMS) for SS017, DP022, and SS025. See Worksheet 17 for the details of each project task.

Sampling Tasks:

Proposed sampling locations are shown on Figures 4, 6, and 8. Discussion of the sampling approach and sampling design and rationale is provided in Worksheet #17. The sampling tasks are as follows:

- Soil sampling to confirm no contaminants are present above soil cleanup objectives.
- Soil sampling to confirm remediation of the excavated area to unrestricted closure.

Samples will be collected using the SOPs provided in Appendix B of this UFP-QAPP.

Analysis Tasks:

TA will analyze soil samples for VOCs via USEPA Method 8260B, PAHs via USEPA Method SW8270D SIM, pesticides/PCBs via USEPA Method 8081B/8082A, and TAL metals via USEPA Method 6010C/7471A.

Quality Control Tasks:

1. MS/MSDs will be collected at an approximate frequency of 5%.
2. Duplicates will be collected at a rate of 10% and analyzed by TA to assess field and laboratory precision.
3. Trip blank samples will be included in each cooler containing samples for VOC analysis.
4. Ambient blanks will be collected each day that PAH samples are collected.
5. Equipment blanks will be collected from each type of non-disposable, decontaminated sampling device.

Schedule

Figure 9 presents the anticipated schedule for this project, which shows the timeframes for the major activities and deliverables, as well as the individual tasks and their interrelationships.

The schedule has been structured to achieve efficiency during project execution. In some cases, significant changes in the schedule structure may be required if the planning assumptions are inconsistent with actual project requirements.

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WORKSHEET 15 – REFERENCE LIMITS AND EVALUATION

This worksheet includes laboratory quality control data for each matrix and analytical method. The goal is that the laboratory and method can provide accurate data at the detection limits. The planning process identified target analytes and reference limits on which detection limits are based. Reference limits and screening objectives for TA and applicable screening objectives are presented in the following tables.

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Table 6. Reference Limits and Evaluation – PAHs and VOCs in Soil

Analyte	CAS Number	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	NYSDEC Unrestricted Use Soil Cleanup Objectives*	USEPA Regional Screening Level Resident Soils**	Accuracy Control Limit (%R)	Precision Control Limit RPD (%)
Matrix: Solid Analytical Group: PAHs, 8270D SIM Units: µg/kg								
1-Methylnapthalene	90-12-0	5	0.500	0.260	NA	18,000	43-111	20
2-Methylnaphthalene	91-57-6	5	0.667	0.309	NA	24,000	39-114	20
Acenaphthene	83-32-9	5	0.267	0.160	20,000	360,000	44-111	20
Acenaphthylene	208-96-8	5	0.667	0.170	100,000	NA	39-116	20
Anthracene	120-12-7	5	2.50	0.720	100,000	1,800,000	50-114	20
Benzo(a)anthracene	56-55-3	5	2.50	0.900	1,000	160	54-122	20
Benzo(a)pyrene	50-32-8	5	2.50	0.740	1,000	16	50-125	20
Benzo(b)fluoranthene	205-99-2	5	2.50	1.20	1,000	160	53-128	20
Benzo(g,h,i)perylene	191-24-2	5	2.50	1.10	100,000	NA	49-127	20
Benzo(k)fluoranthene	207-08-9	5	2.50	1.00	800	1,600	56-123	20
Chrysene	218-01-9	5	2.50	1.00	1,000	16,000	57-118	20
Dibenz(a,h)anthracene	53-70-3	5	2.50	1.30	330	16	50-129	20
Fluoranthene	206-44-0	5	2.50	1.00	100,000	240,000	55-119	20
Fluorene	86-73-7	5	0.667	0.470	30,000	240,000	47-114	20
Indeno(1,2,3-cd)pyrene	193-39-5	5	2.50	1.10	500	160	49-130	20
Naphthalene	91-20-3	5	0.667	0.326	12,000	3,800	38-111	20
Phenanthrene	85-01-8	5	2.50	1.10	100,000	NA	49-113	20
Pyrene	129-00-0	5	2.50	1.10	100,000	180,000	55-117	20
2-Fluorobiphenyl (Surrogate)	321-60-8	NA	NA	NA	NA	NA	61-120	NA
Nitrobenzene-d5 (Surrogate)	4165-60-0	NA	NA	NA	NA	NA	63-120	NA
Terphenyl-d14 (Surrogate)	1718-51-0	NA	NA	NA	NA	NA	64-124	NA

Analyte	CAS Number	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	NYSDEC Unrestricted Use Soil Cleanup Objectives*	USEPA Regional Screening Level Resident Soils**	Accuracy Control Limit (%R)	Precision Control Limit RPD (%)
Matrix: Solid **Analytical Group: VOCs by 8260B** **Units: µg/kg**								
Acetone	67-64-1	20	12.8	5.38	50	6,100,000	36-164	20
Benzene	71-43-2	5	1.6	0.47	60	1,200	77-121	20
Bromobenzene	108-86-1	5	1.6	0.49	NA	29,000	78-121	20
Bromochloromethane	74-97-5	5	0.8	0.3	NA	15,000	78-125	20
Bromodichloromethane	75-27-4	5	0.8	0.22	NA	290	75-127	20
Bromoform	75-25-2	5	0.8	0.23	NA	19,000	67-132	20
Bromomethane	74-83-9	10	1.6	0.5	NA	680	53-143	20
2-Butanone	78-93-3	20	6.4	1.83	300	2,700,000	51-148	20
n-Butylbenzene	104-51-8	5	1.6	0.56	12,000	390,000	70-128	20
sec-Butylbenzene	135-98-8	5	1.6	0.77	11,000	780,000	73-126	20
tert-Butylbenzene	98-06-6	5	1.6	0.5	5,900	780,000	73-125	20
Carbon disulfide	75-15-0	5	1.6	0.42	2,700	77,000	63-132	20
Carbon tetrachloride	56-23-5	5	1.6	0.63	760	650	70-135	20
Chlorobenzene	108-90-7	5	1.6	0.54	1,100	28,000	79-120	20
Chloroethane	75-00-3	10	3.2	0.89	NA	1,400,000	59-139	20
Chloroform	67-66-3	10	0.8	0.29	370	320	78-123	20
Chloromethane	74-87-3	10	1.6	0.77	NA	11,000	50-136	20
2-Chlorotoluene	95-49-8	5	1.6	0.51	NA	160,000	75-122	20
4-Chlorotoluene	106-43-4	5	1.6	0.78	NA	160,000	72-124	20
Dibromochloromethane	124-48-1	5	1.6	0.57	NA	8,300	74-126	20
1,2-Dibromo-3-chloropropane	96-12-8	10	1.6	0.6	NA	5.3	61-132	20
1,2-Dibromoethane	106-93-4	5	1.6	0.52	NA	36	78-122	20
Dibromomethane	74-95-3	5	3.2	0.84	NA	2,400	78-125	20
1,2-Dichlorobenzene	95-50-1	5	1.6	0.45	1,100	180,000	78-121	20

Analyte	CAS Number	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	NYSDEC Unrestricted Use Soil Cleanup Objectives*	USEPA Regional Screening Level Resident Soils**	Accuracy Control Limit (%R)	Precision Control Limit RPD (%)
1,3-Dichlorobenzene	541-73-1	5	1.6	0.48	2,400	NA	77-121	20
1,4-Dichlorobenzene	106-46-7	5	1.6	0.78	1,800	2,600	75-120	20
1,2-Dichloroethane	107-06-2	5	1.6	0.7	20	460	73-128	20
Dichlorodifluoromethane	75-71-8	10	1.6	0.52	NA	8,700	29-149	20
1,1-Dichloroethane	75-34-3	5	0.8	0.21	270	3,600	76-125	20
1,1-Dichloroethene	75-35-4	5	1.6	0.59	330	23,000	70-131	20
1,2-Dichloroethene (total)	540-59-0	5	1.6	0.39	NA	NA	78-122	20
cis-1,2-Dichloroethene	156-59-2	5	1.6	0.56	250	16,000	77-123	20
trans-1,2-Dichloroethene	156-60-5	5	0.8	0.39	190	160,000	74-125	20
1,2-Dichloropropane	78-87-5	5	1.6	0.55	NA	1,000	76-123	20
1,3-Dichloropropane	142-28-9	5	1.6	0.51	NA	160,000	77-121	20
2,2-Dichloropropane	594-20-7	5	1.6	0.44	NA	NA	67-133	20
1,1-Dichloropropene	563-58-6	5	1.6	0.54	NA	NA	76-125	20
trans-1,3-Dichloropropene	10061-02-6	5	1.6	0.67	NA	NA	71-130	20
cis-1,3-Dichloropropene	10061-01-5	5	3.2	1.29	NA	NA	74-126	20
Isopropyl ether	108-20-3	50	8	2.72	NA	220,000	69-127	20
Ethylbenzene	100-41-4	5	1.6	0.67	1,000	5,800	76-122	20
Hexachlorobutadiene	87-68-3	5	1.6	0.55	NA	1,200	61-135	20
2-Hexanone (MBK)	591-78-6	20	12.8	4.89	NA	20,000	53-145	20
Isopropylbenzene	98-82-8	5	1.6	0.59	2,300	190,000	68-134	20
4-Isopropyltoluene	99-87-6	5	1.6	0.49	10,000	NA	73-127	20
4-Methyl-2-pentanone (MIBK)	108-10-1	20	12.8	4.36	NA	3,300,000	65-135	20
Methylene chloride	75-09-2	10	3.2	1.6	50	35,000	70-128	20
Methyl Iodide	74-88-4	5	1.6	0.44	NA	NA	71-131	20
Methyl-tert-butyl ether	1634-04-4	20	0.8	0.34	930	47,000	73-125	20
Naphthalene	91-20-3	5	1.6	0.63	12,000	3,800	62-129	20
n-Propylbenzene	103-65-1	5	1.6	0.58	3,900	380,000	73-125	20

Analyte	CAS Number	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	NYSDEC Unrestricted Use Soil Cleanup Objectives*	USEPA Regional Screening Level Resident Soils**	Accuracy Control Limit (%R)	Precision Control Limit RPD (%)
Styrene	100-42-5	5	1.6	0.63	NA	600,000	76-124	20
1,1,1,2-Tetrachloroethane	630-20-6	5	1.6	0.56	NA	2,000	78-125	20
1,1,2,2-Tetrachloroethane	79-34-5	5	1.6	0.61	600	600	70-124	20
Tetrachloroethene	127-18-4	5	1.6	0.59	1,300	8,100	73-128	20
Toluene	108-88-3	5	1.6	0.69	700	490,000	77-121	20
1,2,3-Trichlorobenzene	87-61-6	5	1.6	0.75	NA	6,300	66-130	20
1,2,4-Trichlorobenzene	120-82-1	5	1.6	0.73	3,400	5,800	67-129	20
1,1,2-Trichloroethane	79-00-5	5	3.2	0.88	NA	150	78-121	20
1,1,1-Trichloroethane	71-55-6	5	1.6	0.52	680	810,000	73-130	20
Trichloroethene	79-01-6	5	0.8	0.23	470	410	77-123	20
Trichlorofluoromethane	75-69-4	10	3.2	1.04	NA	2,300,000	62-140	20
1,2,3-Trichloropropane	96-18-4	5	3.2	0.81	340	5.1	73-125	20
1,2,4-Trimethylbenzene	95-63-6	5	1.6	0.58	3,600	5,800	75-123	20
1,3,5-Trimethylbenzene	108-67-8	5	1.6	0.57	8,400	78,000	73-124	20
Vinyl acetate	108-05-4	10	3.2	1.07	NA	91,000	50-151	20
Vinyl chloride	75-01-4	5	3.2	1.34	20	59	56-135	20
m,p-Xylene	136777-61-2	3.2	3.2	1.04	NA	NA	77-124	20
o-Xylene	95-47-6	5	1.6	0.61	NA	65,000	77-123	20
Xylenes (total)	1330-20-7	10	1	0.61	260	58,000	78-124	20
1,2-Dichloroethane-d4 (Surrogate)	17060-07-0	NA	NA	NA	NA	NA	62-129	NA
4-Bromofluorobenzene (Surrogate)	460-00-4	NA	NA	NA	NA	NA	85-120	NA
Dibromofluoromethane (Surrogate)	1868-53-7	NA	NA	NA	NA	NA	71-126	NA
Toluene-d8 (Surrogate)	2037-26-5	NA	NA	NA	NA	NA	85-115	NA

Notes: CAS – Chemical Abstract Service, DL – Detection limit, %R – Percent recovery, µg/kg = micrograms per kilogram
*6 NYCRR Part 375, Table 375-6.8(a): Unrestricted Use Soil Cleanup Objectives, ** USEPA Regional Screening Levels (RSLs), Resident Soil, May 2016, Hazard Quotient (HQ) = 0.1

Table 7. Reference Limits and Evaluation – PCBs, Pesticides, and TAL Metals in Soil

Analyte	CAS Number	LOQ	LOD	DL	NYSDEC Unrestricted Use Soil Cleanup Objectives*	USEPA Regional Screening Level Resident Soils (HQ=0.1)**	Accuracy Control Limit (%R)	Precision Control Limit RPD (%)
Matrix: Soil **Analytical Group: Pesticides by 8081B** **Units: µg/kg**								
Aldrin	309-00-2	1.7	0.67	0.251	5	39	45-136	30
alpha-BHC	319-84-6	1.7	0.67	0.214	20	86	45-137	30
beta-BHC	319-85-7	1.7	1.67	0.664	36	300	50-136	30
delta-BHC	319-86-8	1.7	1.0	0.401	40	NA	47-139	30
gamma-BHC (Lindane)	58-89-9	1.7	1.0	0.464	100	570	49-135	30
alpha-Chlordane	5103-71-9	1.7	0.67	0.323	94	NA	54-133	30
gamma-Chlordane	5103-74-2	1.7	0.67	0.266	NA	NA	53-135	30
4,4'-DDD	72-54-8	1.7	1.67	0.546	3.3	2,300	56-139	30
4,4'-DDE	72-55-9	1.7	0.67	0.238	3.3	2,000	56-134	30
4,4'-DDT	50-29-3	2	1.67	0.59	3.3	1,900	50-141	30
Dieldrin	60-57-1	1.7	0.67	0.21	5	34	56-136	30
Endosulfan I	959-98-8	1.7	0.67	0.176	2,400***	47,000***	53-132	30
Endosulfan II	33213-65-9	1.7	0.67	0.287	2,400***	47,000***	53-134	30
Endosulfan sulfate	1031-07-8	1.7	0.67	0.276	2,400***	47,000***	55-136	30
Endrin	72-20-8	1.7	0.67	0.306	14	1,900	57-140	30
Endrin aldehyde	7421-93-4	1.7	0.67	0.171	NA	NA	35-137	30
Heptachlor	76-44-8	1.7	0.67	0.214	42	130	47-136	30
Heptachlor epoxide	1024-57-3	1.7	1.0	0.426	NA	70	52-136	30
Methoxychlor	72-43-5	3.3	1.0	0.45	NA	32,000	52-143	30
Toxaphene	8001-35-2	170	33	15.8	NA	490	33-141	30
Decachlorobiphenyl (Surrogate)	2051-24-3	NA	NA	NA	NA	NA	55-130	NA

Analyte	CAS Number	LOQ	LOD	DL	NYSDEC Unrestricted Use Soil Cleanup Objectives*	USEPA Regional Screening Level Resident Soils (HQ=0.1)**	Accuracy Control Limit (%R)	Precision Control Limit RPD (%)
Tetrachloro-m-xylene (Surrogate)	877-09-8	NA	NA	NA	NA	NA	70-125	NA
Matrix: Soil **Analytical Group: PCBs by 8082A** **Units: µg/kg**								
Aroclor-1016	12674-11-2	33	15.0	5.09	1,000[1]	410	47-134	30
Aroclor-1221	11104-28-2	47	17.0	15.6	1,000[1]	200	NA*	NA*
Aroclor-1232	11141-16-5	33	15.0	5.12	1,000[1]	170	NA*	NA*
Aroclor-1242	53469-21-9	33	33.0	9.12	1,000[1]	230	NA*	NA*
Aroclor-1248	12672-29-6	33	20.0	5.61	1,000[1]	230	NA*	NA*
Aroclor-1254	11097-69-1	33	17.0	5.52	1,000[1]	120	NA*	NA*
Aroclor-1260	11096-82-5	33	7.70	2.65	1,000[1]	240	53-140	30
Decachlorobiphenyl (Surrogate)	2051-24-3	NA	NA	NA	NA	NA	60-125	NA
Matrix: Soil **Analytical Group: TAL metals by 6010C/7471A** **Units: Milligrams per kilogram (mg/kg)**								
Aluminum	7429-90-5	50	6	1.55	NA	7,700	74-119	20
Antimony	7440-36-0	2.00	1.50	0.380	NA	3.1	79-114	20
Arsenic	7440-38-2	2.50	2.50	0.660	13	0.68	82-111	20
Barium	7440-39-3	2.00	0.300	0.0760	350	1,500	83-113	20
Beryllium	7440-41-7	0.500	0.120	0.0330	7.2	16	83-113	20
Cadmium	7440-43-9	0.500	0.150	0.0410	2.5	7.1	82-113	20
Calcium	7440-70-2	100	50.0	14.1	NA	NA	82-116	20
Chromium	7440-47-3	3.50	0.200	0.0580	NA	NA	85-113	20
Cobalt	7440-48-4	1.00	0.400	0.100	NA	2.3	85-112	20
Copper	7440-50-8	5.00	0.800	0.217	50	310	81-117	20

Analyte	CAS Number	LOQ	LOD	DL	NYSDEC Unrestricted Use Soil Cleanup Objectives*	USEPA Regional Screening Level Resident Soils (HQ=0.1)**	Accuracy Control Limit (%R)	Precision Control Limit RPD (%)
Iron	7439-89-6	80.0	15.0	3.80	NA	5,500	81-118	20
Lead	7439-92-1	0.900	0.800	0.270	63	400	81-112	20
Magnesium	7439-95-4	30.0	14.0	3.70	NA	NA	78-115	20
Manganese	7439-96-5	4.50	0.400	0.100	1,600	180	84-114	20
Nickel	7440-02-0	4.00	0.450	0.123	30	150	83-113	20
Potassium	7440-09-7	300	160	41.0	NA	NA	81-116	20
Selenium	7782-49-2	3.00	3.00	0.860	3.9	39	78-111	20
Silver	7440-22-4	1.50	0.600	0.160	2	39	82-112	20
Sodium	7440-23-5	500	200	59.0	NA	NA	83-118	20
Thallium[2]	7440-28-0	3.00	2.50	0.650	NA	0.078	83-111	20
Vanadium	7440-62-2	2.00	0.350	0.0940	NA	39	82-114	20
Zinc	7440-66-6	8.00	1.50	0.398	109	2,300	82-113	20
Mercury	7439-97-6	0.0170	0.0133	0.00553	0.18	1.1	80-124	20

Notes: NA* = Not applicable - The QC samples are not spiked with these Aroclors
[1]Cumulative total for all Aroclors
[2]The screening criteria is below the detection limit. The Laboratory has confirmed that the listed DL is the lowest achievable detection limit, for the methods listed. If necessary, thallium can achieve lower detection limits via Method 6020.
*6 NYCRR Part 375, Table 6.8(a): Unrestricted Use Soil Cleanup Objectives
** USEPA RSLs, Resident Soil, May 2016
***The screening standard is for the sum of endosulfan I, endosulfan II, and endosulfan sulfate

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WORKSHEET 17 – SAMPLING DESIGN AND RATIONALE

This worksheet describes the sampling design/field investigation activities and basis for its selection. The field activities will be conducted in accordance with the field SOPs listed in Worksheet 21. The number of samples and the analytical parameters planned are summarized in Worksheet 18 (Sampling Locations and Methods).

Soil sampling will be conducted at Sites SS017 (Lot 69), DP022 (Building 222), and SS025 (T-9 Storage Area). Samples will be analyzed for VOCs, PAHs, pesticides, TAL metals, and PCBs as noted in Table 8. Sample locations are shown on **Figures 4, 6, and 8**. Soil sampling will be performed using hand auguring, direct push technology (DPT) or angled borings (Site DP022 if necessary), placed in the appropriate laboratory-provided container(s), and placed immediately on ice prior to shipping. Clean nitrile gloves will be donned prior to collecting each sample. The sample results will be compared to current cleanup objectives to determine if the site is eligible for site closure (SC).

All field parameter measurements will be documented in the daily QC reports.

Table 8. SS017, DP022, and SS025 Sample Design and Rationale

Site	Sample Depth	Sampling Rationale	Target Analytes/ USEPA Method Number	Matrix	# of Samples	Sampling Frequency	Evaluation Criteria
SS017	0 to 2 ft increments to water table and one sample 0 to 2 inches below vegetation or impervious surface	Verify historical data and confirm unrestricted cleanup standards are met	VOCs/8260B PAHs/8270D SIM PCBs/Pesticides – 8082A/8081B TAL metals/ 6010C/7471A	Soil	10	Once	6 New York Codes, Rules, and Regulations (NYCRR) Table 375-6.8(a) and RSL Summary Table, Resident Soil HQ=0.1
DP022	0 to 2 ft increments to water table and one sample 0 to 2 inches below vegetation or impervious surface	To confirm contamination was removed in the excavation effort and confirm unrestricted cleanup standards are met	VOCs/8260B PAHs/8270D SIM Pesticides/ 8081B TAL Metals/ 6010C/7471A	Soil	1	Once	6 NYCRR Table 375-6.8(a) and RSL Summary Table, Resident Soil HQ=0.1
SS025	0 to 2 ft increments to water table and one sample 0 to 2 inches below vegetation or impervious surface	To confirm contamination was removed in the excavation effort and confirm unrestricted cleanup standards are met	VOCs/8260B PAHs/8270D SIM PCBs/8082A Pesticides/8081B TAL metals/6010C/ 7471A	Soil	10	Once	6 NYCRR Table 375-6.8(a) and RSL Summary Table, Resident Soil HQ=0.1

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WORKSHEET 18 – SAMPLING LOCATIONS AND METHODS

The following table summarizes the sampling matrix, number of samples to be collected, analytical parameters, and the rationale for sampling locations described in Worksheet 17 (Sampling Design and Rationale).

Table 9. Sample Locations and Sampling SOP Requirements

Site	Matrix	Depth	Analytical Group	Estimated Number of Samples (identify field duplicates [FD])	Sampling SOP Reference	Rationale for Sampling Location
SS017	Soil	0 to 2 inches and 0 - 2 ft in 2ft intervals until groundwater is encountered	VOCs, PAHs, PCBs, Pesticides, Metals	10 + 1 FD	See Worksheet 21	See Worksheet 17
DP022	Soil	0 to 2 inches and 0 - 2 ft in 2ft intervals until groundwater is encountered	PAHs, VOCs, Pesticides, Metals	1 + 1 FD	See Worksheet 21	See Worksheet 17
SS025	Soil	0 to 2 inches and 0 - 2 ft in 2ft intervals until groundwater is encountered	VOCs, PAHs, PCBs, Pesticides, Metals	10 + 1 FD	See Worksheet 21	See Worksheet 17

The sample nomenclature for soil samples collected will be as follows:

SS025-SB_1016-x

- Site alpha numeric identifier: SS025 = Site SS025
- Sample type identifier: SB = soil boring number
- Sample date: October 2016
- x = Reserved for the following QA sample identifiers:

-a = field duplicate	-c = trip blanks	MS = matrix spike
-b = ambient blank	-d = equipment blanks	SD = matrix spike duplicate

Field duplicates will be collected at frequency of 10 percent and MS/MSD samples will be collected at a frequency of 5 percent.

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WORKSHEETS 19 AND 30 – SAMPLE CONTAINERS, PRESERVATION, AND HOLD TIMES

This worksheet summarizes the analytical methods for each sampling matrix, including the required sample volume, containers, preservation, and holding time requirements. Further information on the analytical SOPs is provided in Worksheet 23 (Analytical SOP References).

Table 10. Laboratory Delivery Information

Laboratory:	TestAmerica Denver, Colorado
Laboratory Contact, Title:	Jessica DeHerrera, Project Manager
Laboratory Address	4955 Yarrow St Arvada, CO 80002
Laboratory Telephone Numbers:	Main: 303-736-0100 PM Direct: 303-736-0165 Fax: 303-431-7171
Certification:	DoD Environmental Laboratory Accreditation Program (ELAP)
Accreditation Expiration:	10/2017
Sample Delivery Method:	FedEx Overnight services
Data Deliverable:	15 Calendar Days for results/21 days for Level IV

Table 11. Sample Containers, Preservation, and Hold Times

Analytical Group	Matrix	Method/SOP	Container	Preservation Requirements	Preparation Holding Time	Analytical Holding Time
VOCs	Soil	SW-846 5035A/8260B/ SOP DV-MS-0010	Terracore or other sampling device (3) 40 mL glass plus 2 oz jar	Cool to 0-6 °C, methanol and sodium bisulfate or deionized water	48 hours	14 days
PAHs	Soil	SW-846 3546, 8270D SIM/SOPs DV-OP-0015, DV-MS-0002	(1) 4 oz glass	Cool to 0-6°C	14 days to prep	40 days to analysis
Pesticides/ PCBs	Soil	SW-846 3546, 8081B, 8082A/SOPs DV-OP-0007, DV-OP-0015, DV-GC-0020, DV-GC-0021	(1) 4 oz glass jar	Cool 0 - 6°C	14 days	40 days

Analytical Group	Matrix	Method/SOP	Container	Preservation Requirements	Preparation Holding Time	Analytical Holding Time
Metals	Soil	SW6010C/7471A, 3050B/DV-MT-0021, DV-IP-0015, DV-MT-0016	(1) 4 oz glass jar	Cool 0 - 6°C	NA	6 months. 28 day for Hg
Notes: oz = Ounce, mL = Milliliters						

WORKSHEET 20 – FIELD QUALITY CONTROL SAMPLE SUMMARY

This worksheet summarizes the field QC samples to be collected from the site. The number of field QC samples for each sampling matrix and analytical parameter is provided in the table below.

Table 12. Field QC Sample Summary

Matrix	Analytical Group	Analytical Method	No. of Normal Field Samples	No. of FDs	No. of Trip Blanks	No. of Ambient Blanks	No. of Equipment Blanks	No. of MS/ MSD	Total No. of Samples to Lab
Soil	VOCs	8260B	21	3	3	3	3	6	39
Soil	PAHs	8270D SIM	21	3	NA	3	3	6	36
Soil	Pesticides	8081B	21	3	NA	3	3	6	36
Soil	PCBs	8082A	20	2	NA	3	3	6	34
Soil	TAL metals	6010C/ 7471A	21	3	NA	3	3	6	36

Field Duplicate

A field duplicate is an additional sample collected at the same time from the same location as the normal sample. They are intended to represent the same population and are taken through all steps of the analytical procedure in an identical manner. These samples are used to assess precision of the entire data collection activity, including sampling, analysis, and site heterogeneity.

Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and are treated in an identical manner during storage, transportation, and analysis. The samples may be either co-located samples or sub samples of a single sample collection. The sample containers are assigned a unique identification number in the field. Specific locations should be designated for collection of field duplicate samples before the beginning of sample collection. The standard collection frequency for duplicate samples is one for every 10 normal samples.

Equipment Blanks

An equipment blank, sometimes referred to as a rinsate blank, is a sample of ASTM International (formerly American Society for Testing and Materials [ASTM]) Type II reagent grade water poured through the sampling device and collected in a sample container for analysis. The results from these blanks are used to assess the effectiveness of equipment decontamination procedures. Equipment blanks will be collected, when appropriate, once per day, immediately after the equipment has been decontaminated. Collection of equipment blanks is only required in the case of non-dedicated sampling equipment. The blank will be analyzed for all laboratory analyses requested for the environmental samples collected at the site.

Matrix Spike/Matrix Spike Duplicate

A MS/MSD sample is used to document the bias of a method due to sample matrix. The MS/MSD samples are aliquots spiked with a known mass and concentration of specific analytes. The spiking occurs before sample preparation and analysis at the laboratory. To allow the analytical laboratory to run MS/MSD analyses, three aliquots of a single sample will be collected in the field to provide sufficient sample volume. The MS/MSD will be designated on the chain-of-custody form. The laboratory may spike additional samples to meet laboratory spike frequencies which are typically analyzed at a rate of approximately every 20 samples collected.

Ambient Blanks

Ambient blanks are used to assess the potential introduction of contaminants in the ambient environment. The ambient blank consists of a sample vial filled in the laboratory with ASTM Type II reagent-grade water, transported to the sampling site, handled like an environmental sample, opened at the site and exposed to the ambient conditions and returned to the laboratory for analysis.

Trip Blanks

Trip blanks are used to assess the potential introduction of contaminants to sample containers during the field collection event, including transportation and storage procedures. The trip blank consists of a volatile organic analyte sample vial filled in the laboratory with ASTM Type II reagent-grade water, transported to the sampling site, handled like an environmental sample (without being opened), and returned to the laboratory for analysis. Trip blanks will be used only when aqueous samples for VOCs are taken. One trip blank will accompany each cooler of aqueous samples sent to the laboratory for analysis of VOCs.

WORKSHEET 21 – PROJECT SAMPLING STANDARD OPERATING PROCEDURE REFERENCES

The field SOPs, associated with the project sampling (including, but not limited to, sample collection and sample handling and custody), are listed in the following table. The referenced field SOPs are provided in **Appendix B**.

Table 13. Sampling SOP References

Reference Number	Title	Originating Organization	Equipment Type
BSOP No.1	Soil Sampling and Subsurface Investigations	Bhate	Geoprobe, Direct Push and Hand Auger
BSOP No. 2	Site Access and Clearance on Federal Installations	Bhate	None
BSOP No. 3	Field Records and Documentation	Bhate	None
BSOP No. 4	Sample Nomenclature and Control	Bhate	None
BSOP No. 6	Quality Control Procedures for Field Equipment	Bhate	Field screening equipment
BSOP No. 7	Surface Water and Sediment Sampling	Bhate	Hand Auger, Corer, samplers
BSOP No. 8	Standard Field Parameter Measurements	Bhate	PID
BSOP No. 9	Field Screening Techniques	Bhate	Hydropunch™, test kits, DPT screening, portable gas chromatograph, PID
BSOP No. 11	Surveying	Bhate	Survey
BSOP No. 12	Well and Borehole Abandonment	Bhate	Drilling
BSOP No. 13	Standard Cleaning and Decontamination Procedures	Bhate	Decontamination

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WORKSHEET 22 – FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

This worksheet lists the field equipment and instruments to be used during the field investigation, requiring calibration, maintenance, testing, or inspection.

Field equipment and instruments to be used are identified on the following table.

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Table 14. Field Equipment and Instruments

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Organic Vapor Analyzer (PID/FID)	Before each use per manufacturer's specifications	None	Analyze reference standard as per manufacturer's specifications	Beginning of day (before use)	See manufacturer's specifications	Repeat calibration	Field Personnel	BSOP No. 9

Notes: PID = Photoionization Detector, FID = Flame ionization detector

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WORKSHEET 23 – ANALYTICAL STANDARD OPERATING PROCEDURE REFERENCES

The laboratory SOP references identified in the table below were provided by TA in Denver, Colorado. Note that the laboratory SOPs have not been modified specifically for this project and may not reflect the exact requirements of this document. The laboratory SOPs are supplemented by internal communication systems within the laboratory to disseminate the project requirements to technical staff. Laboratory SOPs are available upon request.

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Table 15. Analytical SOP References

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
DV-MS-0002	Polynuclear Aromatic Hydrocarbons by GC/MS Selected Ion Monitoring (SIM) (SW 846 Method 8270C and 8270D), Revision 10, 9/2/15	Definitive	Aqueous and Solid Extracts, PAHs	GC/MS	TA	N
DV-OP-0015	Microwave Extraction of Solid Samples by Method SW 3546, 1/31/16, Revision 6	Definitive	Organic Prep, Solid	NA	TA	N
DV-OP-0007	Concentration and Clean-up of Organic Extracts (SW-846 3510C, 3520C, 3540C, 3546, 3550B, 3550C, 3620C, 3660B, 3665A and USEPA 600 series), Revision 10, 12/31/15	Definitive	Organic Prep, Solid	NA	TA	N
DV-GC-0020	Chlorinated Pesticides (SW846 Method No. 8081A & 8081B), Revision 10, 7/31/15	Definitive	Aqueous and Solid, Pesticides	GC	TA	N
DV-GC-0021	Polychlorinated Biphenyls (PCBs) by GC/ECD (SW846 Method 8082 and 8082A), 6/3/16, Revision 11	Definitive	Aqueous and Solid, PCBs	GC	TA	N
DV-MT-0021	ICP Analysis for Trace Elements by SW-846 Method 6010C/D 12/31/15 Rev 4	Definitive	Metals, Solid	ICP	TA	N
DV-IP-0015	Acid Digestion of Solids [Method USEPA 3050B] 10/31/15 Rev 8	Definitive	Metals, Solid Extraction	NA	TA	N

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
DV-MT-0016	Mercury in Solids by Cold-Vapor Atomic Absorption [Methods 7471A and 7471B] 2/28/16 Rev 8	Definitive	Mercury, Solid	CVAA	TA	N
DV-MS-0010	The Determination of Volatile Organics by GC/MS (SW846 8260B and USEPA 624), Revision 16, 4/21/16	Definitive	Volatiles, soil	GC/MS	TA	N

Notes: GC/MS = Gas Chromatograph/Mass Spectrometer, ECD = Electron Capture Detector, ICP = Inductively Coupled Plasma, CVAA = Cold-Vapor Atomic Absorption

WORKSHEET 24 – ANALYTICAL INSTRUMENT CALIBRATION

To confirm that the analytical methods and the selected instrumentation meet the project requirements, each analytical instrument will be calibrated according to the procedures outlined in Worksheet 28 (Laboratory Quality Control Sample Summary) and the following table.

Specific analytical method SOP references are provided in Worksheet 23 (Analytical Standard Operating Procedure References). Full method QA/QC tables are provided for ease of use to the Bhate Project Chemist and the laboratory. This information provides documentation on corrective actions, flagging criteria for laboratory services and expectations for analytical services, and meets the requirements outlined in Worksheet 28 (Laboratory Quality Control Sample Summary) and reflects the requirements of the DoD Quality Systems Manual, Version 5.0 (DoD, July 2013).

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Table 16. Summary of Calibration and Quality Control Procedures for Method SW8082A/SW8081B/6010C/7471A

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
ECD – PCBs	Minimum five-point ICAL for Aroclor-1016/1260, one point calibration of all additional Aroclors	ICAL prior to sample analysis	Relative Standard Deviation (RSD) ≤20% for all compounds or linear or quadratic calibration r2 > 0.990	Repeat calibration if criterion is not met	Analyst, Supervisor	DV-GC-0021
ECD - PCBs	Second source calibration verification	Once after each ICAL	All analytes within ± 15% of expected value	Repeat ICAL and reanalyze all samples analyzed since the last successful calibration verification	Analyst, Supervisor	DV-GC-0021
ECD –PCBs	Calibration verification (initial [ICV] and continuing [CCV])	CCV after every 10 samples and at the end of the analytical sequence	Percent Difference or Drift (%D) < 20% for all analytes	Repeat ICAL and reanalyze all samples analyzed since the last successful Calibration verification	Analyst, Supervisor	DV-GC-0021
ECD –PCBs	Confirmation of positive results (second column or second detector)	All samples and QC	Detections agree within 40%	Report the higher concentration and include a narrative unless matrix interference is creating a high bias.	Analyst, Supervisor	DV-GC-0021
ECD –PCBs	LOD/LOQ verification	Quarterly	LOD meets method qualitative requirements or is at least 3X higher than noise; LOQ is within LCS/LCSD criteria.	Perform instrument maintenance and repeat failed LOD or LOQ study passing two consecutive tests or perform new DL study.	Analyst, Supervisor	DV-GC-0021

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
ECD – Pesticides	Breakdown check (Endrin/DDT Method 8081B only)	Each day prior to analysis and every 12 hours	Breakdown of Endrin and DDT not to exceed 15%	Instrument maintenance. Sample analysis cannot proceed until breakdown criteria is achieved.	Analyst, Supervisor	DV-GC-0020
ECD – Pesticides	Calibration verification (ICV and CCV)	CCV after every 10 samples and at the end of the analytical sequence	%D or Drift < 20% for all analytes	Repeat initial calibration and reanalyze all samples analyzed since the last successful Calibration verification	Analyst, Supervisor	DV-GC-0020
ECD – Pesticides	Confirmation of positive results (second column or second detector)	All samples and QC	Detections agree within 40%	Report the higher concentration and include a narrative unless matrix interference is creating a high bias.	Analyst, Supervisor	DV-GC-0020
ECD – Pesticides	Minimum five-point ICAL for all analytes	ICAL prior to sample analysis	RSD <20% for all compounds or linear or quadratic calibration r2 > 0.990	Repeat calibration if criterion is not met	Analyst, Supervisor	DV-GC-0020
ECD – Pesticides	Second source calibration verification	Once after each initial calibration	All analytes within ± 15% of expected value	Repeat ICAL and reanalyze all samples analyzed since the last successful calibration verification	Analyst, Supervisor	DV-GC-0020

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
ECD – Pesticides	Retention time (RT) window width calculated for each analyte and surrogate	After installing a new column, performing major maintenance or at initial set-up	Width is 3X standard deviation of a minimum of three injections over a minimum of 72 hours, or default of 0.03 minutes whichever is greater.	NA	Analyst, Supervisor	DV-GC-0020
ECD – Pesticides	RT window position establishment for each analyte and surrogate	Set using mid-point of ICAL or at first CCV of the day if ICAL is not performed.	NA	NA	Analyst, Supervisor	DV-GC-0020
ECD – Pesticides	LOD/LOQ verification	Quarterly	LOD meets method qualitative requirements or is at least 3X higher than noise; LOQ is within LCS/LCSD criteria.	Perform instrument maintenance and repeat failed LOD or LOQ study passing two consecutive tests or perform new DL study.	Analyst, Supervisor	DV-GC-0020
ICP	Linear Dynamic range/High level Check	Every 6 months	90-110% recovery	Repeat linear dynamic range/high level check at lower level	Analyst, Supervisor	DV-MT-0021
ICP	Low-level calibration check standard (ICP only)	Daily after calibration	80-120% recovery	Repeat initial calibration	Analyst, Supervisor	DV-MT-0021
ICP	Second source calibration verification (ICV)	Once after each initial calibration	All analytes within ± 10% of expected value	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification	Analyst, Supervisor	DV-MT-0021

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
ICP	CCV	After every 10 samples and at the end of the analysis sequence.	All analytes within ±10% of expected value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV	Analyst, Supervisor	DV-MT-0021
ICP	ICB/continuing calibration blank (CCB)	Before beginning a sample run, after every 10 field samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed.	Analyst, Supervisor	DV-MT-0021
ICP	ICAL for all analytes (minimum one standard and a blank)	Daily before sample analysis.	If more than one standard is used; r2 ≥ 0.99	If applicable, correct problem and repeat ICAL.	Analyst, Supervisor	DV-MT-0021
ICP	Method blank	One per preparatory batch.	No analytes detected > one-half LOQ (for common lab contaminants, no analytes detected >LOQ) and > one-tenth the amount measured in any sample or one-tenth the regulatory limit (whichever is greater).	Assess data. Correct problem. If necessary, re-prepare and reanalyze method blank and all samples processed with the contaminated blank.	Analyst, Supervisor	DV-MT-0021
ICP	Interference check solutions (ICS-A and ICS-AB)	At the beginning of an analytical run or once during a 12-hour period, whichever is more frequent.	ICS-A: Absolute value of all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes). ICS-AB: Within ±20% of expected value.	Terminate analysis; locate and correct problem; reanalyze ICS; reanalyze all affected samples.	Analyst, Supervisor	DV-MT-0021

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
ICP	LCS (must contain all analytes to be reported)	One per preparatory batch.	Acceptance criteria listed in LCS and MS/MSD tables. If the analyte(s) are not listed, use in-house limits if project limits are not specified.	If the LCS recovery is above the project acceptance limits and there are no detections in the samples, TA will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project	Analyst, Supervisor	DV-MT-0021
ICP	Dilution test only applicable for samples with concentrations > 50 × LOQ (prior to dilution).	One per preparatory batch if MS or MSD fails.	Five-fold dilution must agree within ±10% of the original determination.	NA	Analyst, Supervisor	DV-MT-0021
ICP	Post-digestion spike addition criteria applies for samples with concentrations < 50 × LOQ (prior to dilution).	One per preparatory batch if MS or MSD fails.	Recovery within 80 to 120% of expected results.	If dilution test fails, rerun the MS/MSD and dilution test for the elements that failed to see if recoveries are within control limits. If PDS fails, the parent sample will be re-spiked for the failed element(s) at an appropriate level based on the initial results, If either of these fail, after the second attempt, the	Analyst, Supervisor	DV-MT-0021

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
				matrix spike analysis will be analyzed only on the parent sample. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. Document in case narrative.		
ICP	MS/MSD	One per 20 samples per matrix as a minimum and as defined on the chain-of-custody form.	Acceptance criteria listed in LCS and MS/MSD tables. If the analyte(s) are not listed, use in-house limits if project limits are not specified.	Assess data to determine whether there is a matrix effect or analytical error. Analyze LCS for failed target analytes. Potential matrix effects should be communicated to project chemist so an evaluation can be made regarding the DQOs.	Analyst, Supervisor	DV-MT-0021
CVAA	Initial calibration (minimum 5 standards and a blank)	Daily initial calibration prior to sample analysis	$r2 \geq 0.99$	Correct problem then repeat initial calibration. If calibration fails again, re-digest the entire digestion batch.	Analyst, Supervisor	DV-MT-0016

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
CVAA	ICV	Run second-source standard once after each ICAL and prior to sample analysis.	Analytes within +10% of expected value	Correct problem then repeat initial calibration. If calibration fails again, re-digest the entire digestion batch.	Analyst, Supervisor	DV-MT-0016
CVAA	CCV	After every 10 field samples, and at the end of the analysis sequence	All analytes within 10% of expected value	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment with written approval from the client. Or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	Analyst, Supervisor	DV-MT-0016

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
CVAA	Calibration blank (ICB/CCB)	Before beginning a sample run, after every continuing calibration verification	No analytes detected >LOD	Correct any problems and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed. CCB failures due to carryover may not require an ICAL.	Analyst, Supervisor	DV-MT-0016

Notes: ICAL – Initial calibration, DDT - Dichlorodiphenyltrichloroethane, r2 – Correlation coefficient, DL – Detection limit

Table 17. Summary of Calibration and Quality Control Procedures for VOCs Method 8260B/PAH Method 8270D SIM

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC/MS	ICV	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All analytes within ±20% of expected value unless identified as a Poor Performer then ± 30%	Correct problem and verify second-source standard. Rerun second-source verification. If that fails, correct problem and repeat ICAL.	Analyst, Supervisor	See Worksheet 23
GC/MS	CCV	Daily before sample analysis; after every 12 hours of analysis time; and at the end of the analytical batch run.	All reported analytes and surrogates within ±20% of true value. All reported analytes (except poor performers) and surrogates within ±50% for end of analytical batch CCV.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	Analyst, Supervisor	See Worksheet 23
GC/MS	Multipoint ICAL for all analytes including surrogates. Minimum five levels for linear and six levels for quadratic.	At instrument set-up, prior to sample analysis.	Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤ 15%; Option 2: linear least squares regression for each analyte: r2 ≥ 0.99; Option 3: non-linear least squares regression (quadratic) for each analyte: r2 ≥ 0.99.	Correct problem, then repeat ICAL.	Analyst, Supervisor	See Worksheet 23

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC/MS	Second source calibration verification	Once after each initial calibration	All analytes within ± 20% of expected value	Remake standard, recalibrate if necessary	Analyst, Supervisor	See Worksheet 23
GC/MS	RT window verification for each analyte	Each sample.	RRT of the analyte within ±0.5 minute from the mid-level initial calibration standard for all compounds. RRTs may be updated based on the daily CCV. RRTs shall be compared with the most recently updated RRTs.	Correct problem, then reanalyze all samples analyzed since the last RT check.	Analyst, Supervisor	See Worksheet 23
GCMS	LCS (must contain all target analytes to be reported, including surrogates)	One LCS per preparatory batch.	Acceptance criteria listed in LCS and MS/MSD tables. If the analyte(s) are not listed, use in-house limits if project limits are not specified.	If the LCS recovery is above the project acceptance limits and there are no detections in the samples, TA will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project	Analyst, Supervisor	See Worksheet 23

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC/MS	MS/MSD	One per 20 samples per matrix as a minimum and as defined on the chain-of-custody form.	Acceptance criteria listed in LCS and MS/MSD tables. If the analyte(s) are not listed, use in-house limits if project limits are not specified.	Assess data to determine whether there is a matrix effect or analytical error. Potential matrix effects should be communicated to project chemist so an evaluation can be made regarding the DQOs.	Analyst, Supervisor	See Worksheet 23
GC/MS	Surrogate spike	All field and QC samples.	Acceptance criteria listed in LCS and MS/MSD tables. If the analyte(s) are not listed, use in-house limits if project limits are not specified.	Evaluate data, if samples are non-detect and surrogate recovery is above upper limits, report with case narrative comment. If obvious chromatographic interference with surrogate is present, discuss in case narrative. Otherwise, re-extract and re-analyze.	Analyst, Supervisor	See Worksheet 23
GC/MS	Internal standard	Each sample, standard, and QC sample.	Retention time within ±30 seconds from retention time of the midpoint standard in the ICAL; extracted ion current potential (EICP) area within - 50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions and make corrections as appropriate. Reanalysis of samples analyzed while the system was malfunctioning is mandatory.	Analyst, Supervisor	See Worksheet 23

Notes: RRT = relative retention time

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WORKSHEET 25 – ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION

To confirm that the analytical instrument and equipment are available and in working order when needed, all laboratory analytical equipment will be maintained and tested in accordance with procedures described in the laboratory SOPs as listed on Worksheet 23. The analytical instrument and equipment maintenance, testing, and inspection activities and acceptance criteria are provided in the following table.

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Table 18. Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS	Check for leaks, replace gas line filters, replace column, clean injection port/liner	PAHs, VOCs	Monitor instrument performance via CCV	As needed	No maintenance is required as long as instrument QC meets DoD criteria	Replace connections, clean source, replace gas line filters, replace GC column, clip column, replace injection port liner, clean injection port, replace Electron Multiplier	Analyst, Supervisor	DV-MS-0002/DV-MS-0010
GC/ECD	Clean injection port and replace liner Clip column Maintain pumps ECD wipe test	Pesticides/PCBs	Monitor instrument performance via Continuing Calibration	Daily Wipe test annually	Calibration and QC criteria met	Change column Instrument maintenance	Analyst, Supervisor	DV-GC-0020/DV-GC-0021
ICP	Replace pump windings and gas tanks, check standard and sample flow	Metals	Instrument performance and sensitivity	As needed	Monitor internal standard counts for variation	Replace windings, recalibrate and reanalyze	Analyst, Supervisor	DV-MT-0021
CVAA	Replace disposables, flush lines, check lamp current and gas flow	Mercury	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	Analyst	DV-MT-0016

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WORKSHEETS 26 AND 27 – SAMPLE HANDLING, CUSTODY, AND DISPOSAL

To verify sample authenticity and data defensibility, a proper sample handling system will be followed from the time of sample collection to final sample disposal.

The FOM or designee will be responsible for the sample collection, sample packing, and coordination of sample shipment. The samples will be sent to TA - Denver via FedEx Priority overnight.

A laboratory representative will acknowledge receipt of the sample coolers upon arrival. The laboratory technicians will prepare and analyze the field samples in accordance with the analytical methods and laboratory SOPs. The field samples will be stored at the laboratory for 60 days after a final report has been submitted to Bhate. The Laboratory Hazardous Waste Manager will be responsible for the final sample disposal upon notice from the Project Chemist.

Table 19. Sample Handling System

Sample Collection, Packaging, and Shipment	
Sample Collection (Personnel/Organization):	Dustin McNeil (Bhate) or trained designee
Sample Packaging (Personnel/Organization):	Dustin McNeil (Bhate) or trained designee
Coordination of Shipment (Personnel/Organization):	Dustin McNeil (Bahte) or trained designee Marcia Olive (Bhate)
Type of Shipment/Carrier:	FedEx Priority Overnight service
Sample Receipt and Analysis	
Sample Receipt (Personnel/Organization):	Roxxane Sullivan/TA-Denver
Sample Custody and Storage (Personnel/Organization):	Roxxane Sullivan /TA-Denver
Sample Preparation (Personnel/Organization):	Extractions, Prep Supervisor Cheyana Cokley/TA-Denver
Sample Determinative Analysis (Personnel/Organization):	Laboratory Manager Dennis Jonsrud/TA-Denver
Sample Archiving	
Field Sample Storage (number of days from sample collection):	30 days
Sample Extract/Digestate Storage (number of days from extraction/digestion):	30 days
Sample Disposal	
Personnel/Organization:	Waste Compliance Manager Dennis Jonsrud/TA-Denver
Number of Days from Analysis:	30 days

Proper sample handling, shipment, and maintenance of chain-of-custody forms are key components of building the documentation and support for data that can be used to make project decisions. The sections below summarize the field and laboratory sample custody procedures to be followed during the project.

Field Sample Custody Procedures

Field work for sampling activities will be conducted in accordance with the SOPs provided in Worksheet 21 (Project Sampling Standard Operating Procedure References) and located in **Appendix B**. These SOPs outline the methodologies for sampling, sample management, equipment decontamination, and chain-of-custody procedures. Sample nomenclature will follow the Environmental Resources Program Information Management System (ERPIMS) format. Sample packaging, shipment, and delivery to laboratory activities will be conducted in accordance with Worksheets 17-21.

Custody Requirement

Laboratory sample custody procedures will be conducted by the laboratory as described in the following sections.

Laboratory Sample Custody Procedures

The laboratory is not responsible for loss of or damage to samples until the laboratory accepts delivery of samples by notation on a chain of custody document or otherwise in writing. The laboratory, at its sole discretion, reserves the right to refuse or revoke Acknowledgment of Receipt for any sample due to insufficient sample volume, improper sample container, or risk of handling for any health, safety, environmental, or other reason. The laboratory does not accept samples that contain asbestos, biohazards, or radiological materials. Regardless of prior acceptance, the laboratory may return samples at its sole discretion if it is determined that the samples may pose a risk in handling, transport or processing, for any health, safety, environmental or other reason. Internal chain-of-custody procedures include the use of sample bar codes.

All samples must be scanned each time custody of the container is changed. This information is stored in the Laboratory Information Management System (LIMS), and includes a complete record of the sample custody from receipt to disposal. Information includes the location of the sample, the date and time of each custody transfer, unique initials of each person assuming custody, and a reason for the transfer.

The laboratory will retain all records related to sample analysis including raw test data, calculations, derived data, calibrations, and copies of test reports. These records are archived in accordance with regulatory requirements for a minimum of 5 years or as required by specific client contracts. If the laboratory is going out of business, Bhate will be notified at least 60 days (if time permits) prior to closure of the laboratory and will receive a final report for all submitted samples. The notification will request instructions on the retention or distribution of laboratory records and will provide contact information for after the closure. Software/hardware permitting the access of electronic data must be maintained.

A copy of Bhate reports is stored in a location with access restrictions. All reports must be signed out using the archived reports logbook. Bhate reports and chain of custodies are also scanned for electronic storage. All archived logbooks, corrective actions, training records, and other QA/QC reports are stored in a locked storage closet. Only members of the QA/QC Department have access to these records. Written and printed data records (bench sheets, logbooks, electronic printouts, etc.) are scanned before being boxed and placed in storage. Electronic data are stored on a dedicated server. This server is backed-up daily. Approximately 1 year of electronic data are accessible at workstations. Data removed from the servers and stored on tapes can be reloaded by submitting a request. The safety officer keeps safety and disposal information. The Comptroller keeps personnel information in locked files.

Archived data are stored on-site until capacity is met. The oldest archived data are then moved to a secure storage facility. The storage and on-site facility are monitored and protected from fire and theft. Electronic data storage is free from magnetic sources.

Sample Disposal

Samples are stored in the appropriate cooler for 30 days after receipt. After 30 days, samples are moved to a waste area. The samples are scanned out for disposal on the LIMS. The samples are then stored in the waste staging area until disposal into appropriate drums. Hazardous samples are returned to the client whenever possible to be disposed of with larger quantities of the sample material. Laboratory waste is segregated by laboratory personnel into waste streams, which have been established by the laboratory Regulatory Compliance Officer. The waste streams are determined by analysis of the waste and through process knowledge. All laboratory wastes are disposed of in the proper container. No waste is placed in regular trash containers or poured down the drain. Waste is stored in drums in satellite accumulation areas and then in the central accumulation facility. Waste disposal service is provided by approved vendors who will incinerate, landfill, treat, or reclaim the waste based on the characteristics.

Samples not consumed in testing will normally be retained for a maximum of 30 days before disposal. Samples will be returned to Bhate when requested in writing or when they would pose a disposal problem as a hazardous waste as determined by TA, at its sole discretion.

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WORKSHEET 28 – LABORATORY QUALITY CONTROL SAMPLE SUMMARY

This worksheet presents analytical QC requirements relevant to analysis of environmental samples that will be followed by laboratories producing definitive data. The purpose of the laboratory QC activities is to produce data of known quality that satisfy the project-specific DQOs. Laboratory QC samples will follow method specific requirements of the DoD Quality System Manual, Version 5.0 (Appendix F of the Quality Systems Manual).

Laboratory QC samples must be included in an analytical batch with the field samples. An analytical batch is a group of samples (not exceeding 20 environmental samples plus associated laboratory QC samples) similar in composition (matrix) that are extracted or digested at the same time and with the same lot of reagents and analyzed together as a group. The analytical batch also extends to cover samples that do not need separate extraction or digestion. The identity of each analytical batch will be clearly reported with the analyses so that a reviewer can identify the laboratory QC samples and the associated environmental samples. The type of laboratory QC samples and the frequency of use of these samples are discussed below and in method-specific laboratory SOPs.

Method Detection Limits

The method detection limit (MDL), as defined by Title 40 CFR Part 136, Appendix B, is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. The MDL will be considered the DL for the purposes of this project in accordance with the DoD Quality System Manual, Version 5.0 (DoD, July 2013). The laboratory has established DLs for each analyte, and provided them to Bhate. The DL is used along with other measurements of sensitivity, such as the LOD and LOQ.

The laboratory participating in this work effort, TA, will demonstrate the capability to achieve the MDLs for each instrument by presenting data for the most recent and comprehensive MDL studies for each instrument to be used to analyze project samples. If multiple instruments are used, the DL used for reporting purposes will represent the least sensitive instrument response for each analyte spiked.

Limit of Detection

The DL will be used to determine the LOD for each analyte and for all preparatory and cleanup methods routinely used on samples. The in-house LOD for each analyte is listed in the tables on Worksheet 15. The laboratory will be required to repeat the determination of the LOD if there are significant changes to the method or instrumentation prior to analysis of the first environmental samples for this project. The laboratory will maintain documentation for all DL and LOD determinations and verifications.

Limit of Quantitation

The in-house LOQ for each target analyte is presented in the tables on Worksheet 15. During analysis of the project environmental samples, the laboratory will verify LOQs by including a standard equal to or below the LOQ as the lowest point on the initial calibration curve.

If a result is greater than the DL but less than the LOQ, the result will be reported as a detected concentration and flagged "J". If no detected concentration is determined down to the DL, the result will be reported as not detected (flagged "U") at the LOD. The LOD will be adjusted for each sample based on dilution, final sample volume and sample weight. A detected result greater than or equal to the LOQ will be reported, by the laboratory, without a qualifying flag unless a specific QA/QC failure is associated with the data. For this project and for purposes of evaluation and reporting the LOQ will be considered equivalent to the reporting limit (RL).

At a minimum, the LOQ must be verified quarterly. The LOQ and associated precision and bias must meet project-specific requirements and must be reported after verification. If the method is modified or major changes made to the instrumentation, the LOQ must be verified and reported.

Sample dilution because of target and or non-target analyte concentrations or matrix interference could prevent LOQs from being achieved. Each sample must be initially analyzed while undiluted when reasonable. If dilution is necessary, both the original and diluted sample results must be reported and the dilution noted in the case narrative. Any samples that are not analyzed undiluted must have the express written approval of the Project Chemist within extraction and analysis holding time and supported by matrix interference documentation such as sample texture, color, odor or results from other analyses of the same sample, to show that undiluted analysis is not possible. Appropriate cleanup procedures must be followed to minimize matrix effects on LOQs.

Calibration

All analytes reported must be present in the initial and continuing calibration. The calibrations must meet the acceptance criteria specified in Worksheet 24 (Analytical Instrument Calibration). All results reported must be within the calibration range. Samples will be diluted, if necessary, to bring analyte responses within the calibration range. Records of standard preparation and instrument calibration will be maintained and available upon request. Records must clearly trace the standards and their use in calibration and quantitation of sample results.

Instrument calibration will be performed by beginning with the simplest approach first, the linear model through the origin and then progressing through other options until the acceptance criteria are met. In cases where an analyte has more than one acceptable calibration model, results from the simplest calibration model will be reported. If more than the minimum number of standards is analyzed for the ICV, all of the standards analyzed will be included in the ICV. The only exception to this rule is that a standard at either end of the calibration curve can be dropped from the calibration curve, providing that the requirement for the minimum number of standards is met and the low point of the calibration curve is at or below the quantitation limit for each analyte.

The CCV cannot be used as the LCS. A CCV will be performed daily before sample analysis, unless an ICAL and second-source standard verification is performed immediately before sample analysis, and as required by the method.

Laboratory Control Samples

An LCS is a sample of known composition that is spiked with all target analytes. The LCS is used with each analytical batch to determine whether the method is in control. Each analyte in the LCS will be spiked at a level less than or equal to the midpoint of the calibration curve, which is defined as the median point of the curve instead of the middle of the range. The LCS will be carried through the complete sample preparation and analysis procedure.

At least one LCS will be included in each analytical batch. If more than one LCS is analyzed in an analytical batch, results from all LCSs will be reported. Failure of an analyte in any LCS will necessitate appropriate corrective action, including qualification of the failed analyte in all of the samples as required.

The in-house LCS control limits will be used for the project until and unless new in-house limits are developed and approved for the project. When an analyte in the LCS is outside the acceptance limit, corrective action will be required. If an analyte in the LCS exceeds the upper or lower control limit and no corrective action is performed, or the corrective action taken is deemed to be ineffective, an appropriate data qualifier may be applied during data validation to all associated sample results.

Marginal Exceedance

The laboratory may not use marginal exceedances as part of their data review process but are encouraged to contact the Project Chemist to discuss the problem and corrective action to be taken.

Matrix Spike and Matrix Spike Duplicate Samples

An MS or MSD is an aliquot of sample collected in the field and spiked with known masses and concentrations of all target analytes in the laboratory. The spiking will occur before sample preparation and analysis. Each analyte in the MS and MSD must be spiked at a level less than or equal to the midpoint of the calibration curve for that analyte. The MS/MSD is used to document potential matrix effects associated with a site and will not be used to control the analytical process. The FOM will select the samples for MS/MSDs.

The performance of the MS/MSD will be evaluated against the accuracy and precision limits. If either the MS or the MSD is outside the acceptance limits, the data will be evaluated to determine whether there is a matrix effect or analytical error. The determination will be made during data validation. If the matrix effect is determined, the analytes in the parent sample will be qualified accordingly.

If the sample concentration exceeds the spike concentration by a factor of four or more, the associated parent sample data will not be qualified. The laboratory should communicate potential matrix difficulties to the Project Chemist so that an evaluation can be made with respect to the project-specific DQOs.

Surrogates

Surrogates are compounds similar to the target analytes in chemical composition and behavior in the analytical process, but not normally found in environmental samples. Surrogates are used to evaluate accuracy, method performance and extraction efficiency. Surrogates will be added to all environmental samples, controls, and blanks in accordance with method requirements.

The acceptance limits for the VOCs, PAHs, pesticides, PCBs, and metals are presented on Worksheet 15. If a surrogate recovery is outside the acceptance limit, corrective action must be performed. After the system problems have been resolved and system control has been re-established, the sample will be re-prepared and re-analyzed. If the surrogate outlier persists after re-analysis, the sample results from both the original and the re-analysis runs will be reported and discussed in the case narrative. The reported results will be evaluated during data validation and a decision on qualification of the affected data will be made.

Internal Standards

Internal standards are known amounts of standards that are added to a portion of a sample or sample extract and carried through the entire determination procedure. They are used as a reference for calibration and for controlling the precision and bias of the analytical method. Internal standards will be added to environmental samples, controls, and blanks, in accordance with the method requirements.

If the results of the internal standard are outside of the acceptance limits, corrective actions will be performed. After the system problems have been resolved and system control has been reestablished, all samples analyzed while the system was malfunctioning will be re-analyzed. If corrective actions are not performed or are ineffective, an appropriate flag will be applied to the sample results.

Retention Time Windows

RT windows are used in GC analysis for qualitative identification of analytes. They are calculated from replicate analyses of a standard on multiple days. The procedure and calculation method are given in each method. The center of the RT window is established for each analyte and surrogate using the RT of the midpoint standard of the initial calibration.

If the RT is outside of the acceptance limits, corrective action will be performed. This applies to all CCV subsequent to the ICV and to LCSs. If corrective actions are not performed or are ineffective, an appropriate flag will be applied to the sample results.

Method Blank

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is carried through the complete sample preparation and analytical procedure, and is used to assess potential contamination resulting from the analytical process.

A method blank will be included in every analytical batch. The presence of analytes in a method blank at concentrations greater than the LOD indicates the need for further assessment of the data. The source of contamination will be investigated and measures will be taken to correct, minimize, or eliminate the problem if the concentration exceeds one-half the LOQ. No analytical data will be corrected for the presence of analytes in the blanks.

If an analyte is detected in the method blank and in the associated samples and corrective actions are not performed or are ineffective, the data will be evaluated during data validation and a decision on qualification of data will be made at that time.

Quality Control Checks

Holding Time Compliance

All sample preparation and analyses will be performed within the method-required holding times. For methods not requiring sample preparation, holding time is calculated from the time of sample collection to the time of completion of all analytical runs. For methods requiring sample preparation before analysis, holding time is calculated from the time of preparation completion to the time of completion of all analytical runs.

Control Charts

Control charts are used to track laboratory performance over time. It is recommended that all analytes spiked into the LCS be tracked via control charts. These charts are useful for identifying trends and problems in an analytical method and the laboratory will use these charts to establish in-house LCS control limits. The control charts will be updated as needed (for example, when there is a significant change to the analytical system). At a minimum, the charts will be monitored on an on-going basis (at least quarterly) for shifts in mean recovery, changes in standard deviation and development of trends. These charts can also be used to benchmark a laboratory's performance against QAPP requirements to determine possible areas for improvement.

Standard Materials

Standard materials (including second source materials) used in calibration and sample preparation must be traceable to National Institute of Standards and Technology (NIST), USEPA, American Association of Laboratory Accreditation (A2LA), or other equivalent approved source, if available. If an NIST, USEPA, or A2LA standard material is not available, the standard material proposed for use must be included in an addendum to this QAPP and approved before use.

The standard materials must be current, and the following expiration policy must be followed:

- Expiration dates for ampulated solutions should not exceed the manufacturer's expiration date or one year from the open date, whichever comes first.
- Expiration dates for laboratory-prepared stock and diluted standards must be no later than the expiration date of the stock solution.
- Expiration dates for pure chemicals will be established by the laboratory and be based on chemical stability, possibility of contamination, and environmental and storage conditions.

- Expired standard materials will be discarded. The laboratory will label standard and QC materials with expiration dates.

A second source standard will be used to independently confirm the ICAL. A second source standard is a standard purchased from a vendor different from that supplying the material used in the initial calibration. The second source material can be used for the continuing calibration standards and/or for the LCS. Two different lot numbers from the same vendor do not normally constitute a second source. However, when a project requires analyses for which there is not a separate vendor source available, the use of different lot numbers from the same vendor will be acceptable to verify calibration.

Table 20. Laboratory QC Samples

QC Sample	Frequency Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Matrix: Soil **Analytical Group: VOCs and PAH** **Analytical Method/SOP Reference: SW-846 8260B and 8270D SIM / DV-MS-0002 and DV-MS-0010**						
Method Blank	One per preparatory batch	No analytes detected > ½ LOQ	Correct problem; reanalyze any sample associated with a blank that fails criteria, except when the sample analysis resulted in a non-detect.	Analyst, Supervisor, QA Manager	Bias Contamination	No analytes detected > ½ RL or > RL for common laboratory contaminants
Surrogates	All field and QC samples	QC acceptance criteria specified in Worksheet 15	Reanalyze and/or re-prep if sufficient sample is available unless recoveries are high with no detection of analytes. If re-prep and reanalysis confirms low recoveries, report and narrate.	Analyst, Supervisor, QA Manager	Accuracy Bias	Acceptance criteria specified in Worksheet 15
LCS	One LCS per preparatory batch	QC acceptance criteria specified in Worksheet 15	Reanalyze and/or re-prep all associated samples unless recoveries are high with no detection of analytes.	Analyst, Supervisor, QA Manager	Accuracy Bias	Acceptance criteria specified in Worksheet 15
Internal Standards	In all field samples and standards	Retention time ± 30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard	Inspect mass spectrometer or GC for malfunctions. Reanalyze all samples at a dilution until internal standard passes criteria.	Analyst, Supervisor, QA Manager	Accuracy Bias	Retention time ± 30 seconds; EICP area within -50% to +100% of midpoint of ICAL

QC Sample	Frequency Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
MS/MSD	One per preparatory batch per matrix	For matrix evaluation, use LCS recovery and RPD acceptance criteria specified in Worksheet 15	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Re-prep if sufficient sample is available when appropriate.	Analyst, Supervisor, QA Manager	Accuracy Bias Precision	Acceptance criteria specified in Worksheet 15
Matrix: Soil Analytical Group: Pesticides and PCBs Analytical Method/SOP Reference: USEPA 8082A and SW-846 8081B/ DV-GC-0020 & DV-GC-0021						
Method Blank	One per preparatory batch	No analytes detected > ½ RL	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >10x blank result or sample results are non-detect.	Group Analyst	Contamination	No analytes detected > ½ RL. For common laboratory contaminants, no analytes detected > RL.
Surrogates	All field and QC samples	QC acceptance criteria as specified in Worksheet 15	Correct problem; re-prep all failed samples for failed surrogates if sufficient sample is available.	Group Analyst	Accuracy	QC acceptance criteria as specified in Worksheet 15
LCS	LCS per preparatory batch	QC acceptance criteria as specified in Worksheet 15	Correct problem; re-analyze all samples in the associated prep batch for failed analytes.	Group Analyst	Accuracy	QC acceptance criteria as specified in Worksheet 15
MS/MSD	MS/MSD per preparatory batch per matrix	QC acceptance criteria as specified in Worksheet 15	Contact the Project Chemist to determine if additional measures are required.	Group Analyst	Accuracy	QC acceptance criteria as specified in Worksheet 15

QC Sample	Frequency Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Matrix: Soil **Analytical Group: Metals** **Analytical Method/SOP Reference: SW-846 6010C/7471A DV-MT-0021, DV-MT-0016, and DV-IP-0015**						
Method blank	One per batch of 20 or fewer samples	No analytes detected > ½ LOQ.	Correct problem; reanalyze any sample associated with a blank that fails criteria, except when the sample analysis resulted in a non-detect. If reanalysis is not possible, apply B-flag to all results for the specific analyte(s) in all samples processed with the contaminated blank. Must be explained in the case narrative.	Analyst, Supervisor, QA Manager	Bias Contamination	No analytes detected > ½ LOQ.
LCS	One per batch of 20 or fewer samples	QC acceptance criteria specified in Worksheet 15	Reanalyze and/or reprep all associated samples unless recoveries are high with no detection of analytes. If corrective action fails, apply Q-flag to specific analyte(s) in all samples in associated batch.	Analyst, Supervisor, QA Manager	Accuracy Bias	QC acceptance criteria specified in Worksheet 15
Dilution test	Each preparatory batch or when a new or unusual matrix is encountered	Five-fold dilution must agree within ± 10% of the original determination for samples with concentrations> 50x LOQ	Perform post-digestion spike (PDS) addition	Analyst, Supervisor, QA Manager	Accuracy Bias Precision	Five-fold dilution must agree within ± 10% of the original determination for samples with concentrations >50x LOQ

QC Sample	Frequency Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
PDS addition	When dilution test fails or analyte concentration in all samples is < 50 x LOD	Recovery within 75-125% of expected result	Contact the client to determine if additional measures are required.	Analyst, Supervisor, QA Manager	Accuracy Bias	75-125% Recovery
MS/MSD	One per batch of 20 or fewer samples	QC acceptance criteria specified in Worksheet 15	Report data with a narrative stating the sample is affected by a matrix interference. For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met.	Analyst, Supervisor, QA Manager	Accuracy Bias	QC acceptance criteria specified in Worksheet 15
Sample Duplicate	One per batch of 20 or fewer samples, sample dup is not required if MSD is performed	QC acceptance criteria specified in Worksheet 15	Contact the client to determine if additional measures are required.	Analyst, Supervisor, QA Manager	Precision	QC acceptance criteria specified in Worksheet 15 for concentrations > 5 times the RL

WORKSHEET 29 – PROJECT DOCUMENTS AND RECORDS

The required data package deliverables during every aspect of the project are identified in this worksheet. These include, but are not limited to: 1) sample collection and field measurement records, 2) analytical records, and 3) QC records.

Sample Collection and Field Measurement Records

Sample collection and field measurement records generally include field log books, photo documentation, equipment decontamination records, sampling instrument calibration records, soil sampling logs, chain-of-custody forms, and air bills.

Analytical Records

The data collection activities will include fixed laboratory data from the analysis of samples, Geographic Information System (GIS) data, field measurements, and other site-derived information. Supporting laboratory raw data information will be included in the laboratory submittal.

Chain-of-custody records will be scanned and uploaded within one day of sampling, in order to be reviewed for correct sample identifications and analysis request. Upon receipt of a sample shipment, the laboratory will upload data receipt logs to the laboratory website, and the Project Chemist will be notified.

Manual data verification will be conducted on all data collected for this project. In addition, data validation will be performed following a systematic review process to verify that precision and accuracy of the analytical data are adequate for the intended use.

ERPIMS Electronic Data

Bhate shall receive the ERPIMS ERPTOOLX file format from the laboratory and upload to the ERPIMS database. The data submission schedule is due to ERPIMS in 30 days and submission into the database within 90 days after sampling.

Quality Control Records

Table 21. Sample Collection and Field Records

Record	Generation	Verification	Storage location
Field logs	FOM	Project Manager	Project file
Chain-of-custody Forms	Field Crew	FOM	Project file/Laboratory

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WORKSHEETS 31, 32, AND 33 – ASSESSMENTS AND CORRECTIVE ACTIONS

Periodic assessments will be performed during the course of the project so that the planned project activities are implemented in accordance with this document. The type, frequency, and responsible parties of planned assessment activities to be performed for the project are summarized in the table below.

Table 22. Periodic Assessment Schedule

Assessment Type	Frequency	Person(s)/Organization Responsible for Performing Assessment	Person(s) Responsible for Identifying and Implementing Corrective Actions
Data Validation	After receiving data from lab	Marcia Olive/Bhate	Marcia Olive/Bhate
Field Procedure Assessment	Weekly	Dustin McNeil/Bhate	Dustin McNeil/Bhate
Field Document Review	Daily	Dustin McNeil/Bhate	Dustin McNeil/Bhate
Safety and Health Audit	As needed	Sally Smith/Bhate	Sally Smith/Bhate
Internal Project Report Review	Once per report	Kim Nemmers/Bhate	Kim Nemmers/Bhate
External Project Report Review	Once per report	AFCEC	AFCEC COR

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WORKSHEET 34 – DATA VERIFICATION AND VALIDATION INPUTS

To confirm that scientifically-sound data of known and documented quality are used in making project decisions, the following three-step data review will be performed:

- Step I (verification) will confirm that all sampling and analytical requirements have been completed and documented.
- Step II (validation) will assess whether the sampling and analytical processes conform to stated requirements including those in the contract, method and QAPP.
- Step III (usability assessment) will determine whether the resulting data are suitable as a basis for the decision being made.

Worksheet 35 (Data Verification Procedures), and 36 (Data Validation Procedures) describe the processes to be followed for the above steps, respectively. This worksheet establishes the procedures that will be followed to verify project data including, but are not limited to, sampling documents and analytical data package.

Table 23. Data Verification Worksheet

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved QAPP	X	
2	Contract	X	
3	Field SOPs	X	
4	Laboratory SOPs	X	
Field Records			
5	Field logbooks	X	X
6	Equipment calibration records	X	X
7	Chain-of-custody Forms	X	X
8	Sampling diagrams/surveys	X	X
9	Drilling logs	X	X
10	Geophysics reports	X	X
11	Relevant correspondence	X	X
12	Change orders/deviations	X	X
13	Field audit reports	X	X
14	Field corrective action reports	X	X
Analytical Data Package			
15	Cover sheet (laboratory identifying information)	X	X

Item	Description	Verification (completeness)	Validation (conformance to specifications)
16	Case narrative	X	X
17	Internal laboratory chain-of-custody	X	X
18	Sample receipt records	X	X
19	Sample chronology (dates and times of receipt, preparation, and analysis)	X	X
20	Communication records	X	X
21	DL/LOD/LOQ establishment and verification	X	X
22	Instrument calibration records	X	X
23	Definition of laboratory qualifiers	X	X
24	Results reporting forms	X	X
25	QC sample results	X	X
26	Corrective action reports	X	X
27	Electronic data deliverable	X	X

WORKSHEET 35 – DATA VERIFICATION PROCEDURES

Data verification is a completeness check to confirm that all required activities were conducted, all specified records are present, and the contents of the records are complete. It applies to both field and laboratory records.

Table 24. Data Verification Responsibilities

Records Reviewed	Description	Person(s) Responsible for Verification
Field SOPs	Verify that the sampling SOPs were followed	Dustin McNeil/FOM or Designee
Analytical SOPs	Verify that the analytical SOPs were followed	Laboratory QA Officer Marcia Olive/Project Chemist
Method QC Results	Verify that the required QC samples were run and met required limits	Laboratory QA Officer Marcia Olive/Project Chemist
Data Validation	Validate 100 percent of the data to confirm quality as defined in Worksheet 28 (Laboratory Quality Control Sample Summary)	Marcia Olive/Project Chemist
Data Usability Evaluation	Evaluate data based on precision, accuracy, representativeness, comparability, and completeness for project objectives	Marcia Olive/Project Chemist
Field Documentation	Verify accuracy and completeness of field notes	Dustin McNeil/FOM or Designee

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WORKSHEET 36 – DATA VALIDATION PROCEDURES

The objective of the data validation is to assess the performance associated with the analysis in order to determine the quality of the data. This will be accomplished by evaluating whether the collected data comply with the pre-defined project requirements (including method, procedural, or contractual requirements) and by comparing the collected data with criteria established based on the project DQOs.

All types of data, including screening data and definitive data, are relevant to the usability assessment. The following sections focus on the data review requirements for definite data only.

Table 25. Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Validation Criteria	Data Validator
IIa/IIb	Soil	VOCs	Defined below	Marcia Olive/Project Chemist
IIa/IIb	Soil	PAHs	Defined below	Marcia Olive/Project Chemist
IIa/IIb	Soil	Pesticides/PCBs	Defined below	Marcia Olive/Project Chemist
IIa/IIb	Soil	Metals	Defined below	Marcia Olive/Project Chemist

Data Review Requirements for Definitive Data

Scientifically sound data of known and documented quality that meet the PQOs are essential to the decision-making process. Data will be examined and evaluated to varying levels of detail and specificity by multiple personnel who have different responsibilities within the data management process. Data review includes verification, validation, and usability assessment. The data review process will be documented to facilitate efficient and accurate assessment of data quality and usability. The overall usability of the data is indicated with appropriate qualifiers.

Data verification is used to confirm that the specified requirements have been performed.

Data validation extends data verification and is used to confirm that the requirements for a specific intended use are fulfilled. Data validation is the systematic approach of evaluating the compliance of the data with the pre-defined requirements of the project (including method, procedural, or contractual requirements) and compliance of the data against criteria based on the quality objectives documented in this document. The purpose of data validation is to assess the performance associated with the analysis in order to determine the quality of the data. Data validation includes a determination, to the extent possible, of the reasons for any failure to meet performance requirements, and an evaluation of the impact of such failures on the usability of the data.

Data usability assessment is an evaluation based on the results of data verification and validation in the context of the overall project decisions or objectives. The assessment is used to determine whether the project execution and resulting data meet the PQOs. Both sampling and analytical activities must be considered, with the ultimate goal of assessing whether the final, qualified results support the decisions to be made with the data.

Laboratory Requirements

Each analytical data package must contain adequate information and be presented in a clear and concise manner. The contents of each package must be equivalent to a contract laboratory program (CLP)-like Level III data package. Minimum requirements include the following:

- Cover sheet, which identifies the laboratory generating the data and the project for which the data were generated and signed by the appropriate laboratory personnel
- Table of contents
- Case narrative, which summarizes samples, analyses, and discusses any issues that may affect data usability
- Analytical results
- Laboratory LODs and LOQs
- Sample management records
- CLP-like QC summary forms for the QC elements (including tuning, calibration, surrogates, LCS, MS/MSD, etc.)

Level IV data packages will include:

- All supporting raw data for project, field, and lab QC samples (including chromatograms, quantitation reports, formulas, and example calculations and mass spectral data)

Each laboratory data package should represent a group of samples received, prepared, and analyzed together in an analytical batch, with associated laboratory quality control samples (i.e. a sample delivery group [SDG]). The complete data package for each SDG will be submitted electronically as a computer readable file (such as Adobe's portable document format [PDF]). In addition to the PDF, an EDD in ERPToolsX will be submitted with each SDG. The EDD deliverables will be used to upload to the ERPIMS database.

A schedule should be established so that laboratory data deliverables (including the PDF and EDD for each SDG) are provided in a timely manner to Bhate for data review, validation, assessment, and use. The data deliverables for each SDG will not be considered complete until the Project Chemist has evaluated them for completeness and compliance and to determine the PARCCS of the data. Any deliverable found to be non-compliant will be returned to the laboratory for correction and re-submittal.

Laboratory Data Reporting Requirements

The case narrative of each analytical data package will include but is not be limited to the following:

- Table summarizing samples received, correlating field sample numbers, laboratory sample numbers, and laboratory tests completed

- Discussion of any and all issues that may affect data usability (such as temperature, preservation, sample containers, air bubbles, and multi-phases)
- Samples received but not analyzed and the reasons why
- Discussion of holding time exceedances for sample preparation and analyses
- Summary of any and all instances of outliers and corrective actions taken
- Identification of samples and analytes for which manual integration was necessary
- Discussion of all qualified data and definition of qualifying flags

The following requirements should also be met for the reporting:

- MDLs, LODs, LOQs and sample results should be reported with the appropriate number of significant figures for the measurement.

Samples will be analyzed undiluted if possible. Non-detects will be reported to the LODs. MDLs, LODs, and LOQs for minority chemicals in highly-contaminated samples may have to be adjusted because of dilutions.

Manual Integrations

Manual integrations are an integral part of the chromatographic analysis process and will be done only as a corrective action measure. Examples of instances where manual integration would be warranted include, but are not limited to, co-eluting compounds resulting in poor peak resolution, a misidentified peak, an incorrect retention time, or a problematic baseline.

When manual integrations are used, they must follow the procedures outlined in the laboratory's SOP for the method. Any and all instances of manual integration must be identified in the manual integration summary section of the report.

Laboratory Data Review Requirements

All definitive data will be reviewed first by the laboratory analyst and then by the laboratory supervisor of the respective analytical section using the same criteria before they are submitted to Bhate. This internal data review process, which is multi-tiered, should include all aspects of data generation, reduction, and QC assessment. Elements for review or verification at each level must include, but are not limited to, the following:

- Sample receipt procedures and conditions
- Sample preparation
- Appropriate laboratory SOPs and methodologies
- Accuracy and completeness of analytical results
- Correct interpretation of all raw data, including all manual integrations
- Appropriate application of QC samples and compliance with established control limits
- Verification of data transfers
- Documentation completeness

- Accuracy and completeness of data deliverables (hard copy and electronic)

Laboratory Data Evaluation

All definitive data will be reviewed, reduced, and validated by the laboratory following the procedures specified in the laboratory's SOPs for data reduction and validation.

Data qualifiers should be applied by the laboratory as part of their internal validation activities. The allowable data qualifiers for definitive data are Q, M, J, B, UJ, U, and 4. The definitions of the data qualifiers are provided on the table below. Flagging criteria apply when acceptance criteria are not met and corrective actions were not successful or not performed. The data qualifiers must be reviewed by the supervisor of the respective analytical sections.

The laboratory QA section should perform a 100 percent review of 10 percent of the completed data packages. The Project Chemist or designee will subsequently evaluate the flags applied by the laboratory as part of their data validation and usability assessment activities. The flags may be accepted, modified, or rejected. For all data qualifiers that are changed, clear justification will be provided. All Q-flagged data will be evaluated and either accepted without qualification, accepted with qualification, or rejected.

Table 26. Laboratory Data Qualifiers

Qualifier	Description
Q	This indicates that one or more QC criteria fail. Data must be carefully assessed by Bhate (or project team) with respect to the project-specific requirements and evaluated for usability. Subsequent assessment by DoD may result in rejection of data.
M	Manually integrated compound
J	The analyte was positively identified; the quantitation is an estimation because of discrepancies in meeting certain analyte-specific QC criteria.
B	The analyte was found in an associated blank above one half the LOQ, as well as in the sample.
U	The analyte was analyzed for but not detected.
UJ	The analyte was not detected; however, the result is estimated because of discrepancies in meeting certain analyte-specific QC criteria.
4	MS, MSD: The analyte present in the original sample is 4 times greater than the matrix spike concentration; therefore, control limits are not applicable.

Method Blank Evaluation Guidance

For method blanks, the source of contamination should be investigated and documented by the laboratory. The results of the investigation should be included in the case narrative. If all samples associated with method blank contamination are not reanalyzed, the results will be reported, by the Laboratory, with a B-flag, along with any other appropriate data qualifier. If an analyte is found only in the method blank, but not in any batch samples, no flagging is necessary. Sample results affected by the method blank contamination will be evaluated during data validation and the final result qualified accordingly.

Data Verification Guidelines

The Project Chemist will review the data verification performed by the laboratory for completeness and accuracy. Data verification may be done both electronically and manually (Project Chemist). Data verification may include but is not limited to the following:

- Sampling documentation (such as the chain-of-custody form);
- Preservation summary and holding times;
- Presence of all analyses and analytes requested;
- Use of required sample preparation and analysis procedures;
- LODs and LOQs;
- Correctness of concentration units; and
- Case narrative.

Data Validation Guidelines

Raw Data Review

The data validation process builds on data verification. Performing manual validation of the data, the Project Chemist will review and evaluate the samples results. The Project Chemist will also determine what, if any, flags need to be applied from assessing such QC as tuning verification, initial and continuing calibration, quantitation, multiple run samples, instrument performance, and sample preservation. The data validation qualifiers based on the manual data review will be incorporated into the final deliverables, discussed in the final data validation summary report, and incorporated into the final usability assessment.

Data validation guidelines have been developed in accordance with the method requirements, the USEPA's *National Functional Guidelines for Organic Data Review*, *USEPA's National Functional Guidelines for Inorganic Superfund Data Review*, professional judgment, and DoD Quality Systems Manual (Version 5.0) requirements. The following information will be reviewed as part of a Level-IV type summary data validation performed using the data management system platform:

- Chain-of-custody documentation
- Holding time
- QC sample frequencies
- Method blanks
- LCS
- Surrogate spikes
- MS/MSD
- Field and laboratory duplicate precision

- Initial and continuing calibration information
- Internal standards
- Case narrative review and other method specific criteria

Blank Evaluation Guidelines

The Project Chemist will evaluate laboratory B-qualified data such as method blanks, as well as other field blanks based on the concentration of the analyte in the samples in relation to the concentration in the blank. The B-flag may not be used if the analyte concentrations in the samples are much higher (≥ 5 times) than in the blank (≥ 10 times in case of common laboratory contaminants). Any blank contamination that may impact data usability must be discussed in conjunction with project-specific goals. When a data set contains low-level detects in field samples and has associated field or laboratory blanks that have detects at similar concentrations, this suggests that the low-level detects in these field samples may be artifacts because of either field or laboratory practices. A sample detect that is ≤ 5 times the blank concentration (≤ 10 times for common lab contaminants) may be considered a non-detect and flagged "UB".

Duplicate Evaluation Guidance

QC measures for precision include field duplicates, laboratory duplicates, MSDs, analytical replicates, and surrogates. These measures will be evaluated by the laboratory and qualified according to applicable procedures, with the exception of the field duplicates. Specifically, field duplicates should be sent to the laboratory as blind samples and should be given unique sample identification numbers. These sample results can be used to assess field sampling precision, laboratory precision, and, potentially, the representativeness of the matrix sampled. Flagging of results associated with field duplicates should be assigned such that the level of uncertainty required, as provided by the project-specific objectives, is taken into account.

Poor overall precision may be the result of one or more of the following: field instrument variation, analytical measurement variation, poor sampling technique, sample transport problems, or heterogeneous sample matrices. To identify the cause of imprecision, the project team should evaluate the field sampling design rationale and sampling techniques, and review both field and analytical duplicate sample results. If poor precision is indicated in both the field and analytical duplicates, then the laboratory may be the source of error. If poor precision is limited to the field duplicate results, then the sampling technique, field instrument variation, sample transport, and/or nature of the matrix may be the source of error.

Matrix Interference Evaluation Guidance

In the case of matrix interference, data validation qualifiers may be applied to additional samples from the same site and same matrix, based on the professional judgment of the data validator. In this case, it is the responsibility of the validator to document the reasons for the additional qualifiers.

Flagging Conventions

The allowable final data qualifiers for definitive data and the hierarchy of data qualifiers, listed in order of the most severe through the least severe, are R, J, UJ, and UB. Their definitions are summarized in below.

Table 27. Usability Assessment Data Qualifiers

Qualifier	Description
R	The data are rejected because of deficiencies in meeting QC criteria and may not be used for decision making.
J	The analyte was positively identified; the quantitation is an estimation because of discrepancies in meeting certain analyte-specific quality control criteria.
UJ	The analyte was not detected; however, the result is estimated because of discrepancies in meeting certain analyte-specific quality control criteria.
UB	The analyte was also detected in an associated laboratory or field blank at a concentration comparable to the concentration in the sample. The reported result has been re-qualified as not detected.

The following two tables present the specific guidelines for applying these data usability qualifiers.

Table 28. General Data Qualifying Conventions

QC Requirement	Criteria	Flag	Flag Applied To
Holding Time	Time exceeded for extraction or analysis	J for the positive results; R or UJ for non-detects*	All analytes in the sample
Sample Preservation	Water; not preserved >7 days Water; preserved >14 days Non aqueous; preserved or not	J positive results; R or UJ for non-detects* Use professional judgment	Sample
Temperature out of control	> 6°C	Professional judgment or if grossly outside; J for positive results; R or UJ for non-detects*	Sample
Sample Integrity (SW8260)	Bubbles in volatile vial > 1/4 inch used for analysis	J for the positive results; UJ for non-detects	Sample
Instrument Tuning	Ion abundance method-specific criteria not met	R for all results	All associated samples in analytical batch
Second Source Check or Continuing Calibration	All analytes must be within method-specified criteria	High Bias: J for positive results, no flag for non-detects Low Bias: J for positive results, UJ for non-detects	All associated samples in analytical batch

QC Requirement	Criteria	Flag	Flag Applied To
Low Level Calibration Check or Interference Check Sample	All analytes must be within 20% of expected value	High Bias: J for positive results, no flag for non-detects Low Bias: J for positive results, UJ for non-detects R for all non-detects greater than twice the control criteria	All associated samples in analytical batch
LCS	%R > Upper confidence limit (UCL) %R < Lower confidence limit (LCL)	J for the positive results; no qualification for the non-detects; J for the positive results; UJ for the non-detects	The specific analyte(s) in all samples in the associated analytical batch
Internal Standards	Area > UCL Area < LCL Sample is re-extracted and reanalyzed and recovery outside of criteria is confirmed as a matrix effect	J for positive results J for positive results; UJ for the non-detects	Sample
Surrogate Spikes	%R > UCL %R < LCL and >10% %R <10% Excessive dilution*	J for positive results J for positive results; UJ for non-detects J for positive results; R for non-detects No flag required	Sample
Blanks (Method, Equipment, Ambient, or Trip)	Analyte(s) detected > 1/2 LOQ (use the blank of the highest concentration)	UB for positive sample results < 5x highest blank concentration (<10x for common lab contaminants)	All samples in preparation, field or analytical batch, whichever applies
Field duplicates or field replicates	All analytes must be within method-specified criteria	J for the positive results	The specific analyte(s) in both parent and duplicate
MS/MSD	MS or MSD % R>UCL MS or MSD % R<LCL or MS/MSD RPD> Control limit (CL) Sample concentration > 4 times spike concentration Excessive dilution*	Cross reference with LCS. Possible J for positive results. Cross reference with LCS. Possible J for positive results. UJ for non-detects No flag required No flag required	The specific analyte(s) in the parent sample
Post-Digestion Spike (metals)	All analytes must be within 25% of expected value	High Bias: J for positive results Low Bias: J for positive results; UJ for non-detects	The specific analyte(s) in the parent sample

QC Requirement	Criteria	Flag	Flag Applied To
Serial Dilutions (metals)	All analytes must be within 10% of expected value	If Post Spike not analyzed High Bias: J for positive results Low Bias: J for positive results; UJ for non-detects	The specific analyte(s) in the parent sample
Retention Time Window	Analyte within established window	R for all results	Sample

* = Based on analyte-specific review

Table 29. Data Qualifying Conventions - Quantitation

Criteria	Flag
< DL	U, UJ at the LOD
≥ DL < LOQ	J
≥ LOQ	As needed
≥ High standard/linear range	J

Examples:

DL = 2, LOD = 4, LOQ = 15, sample is undiluted.

Example #1: Analytical result: not detected; reported result: <4U

Example #2: Analytical result: 10; reported result: 10J.

Sample #3: Analytical result: 15; reported result: 15

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WORKSHEET 37 – DATA USABILITY ASSESSMENT

The data usability assessment is an evaluation based on the results of data verification and validation in the context of the overall project decisions or objectives. The assessment is used to determine whether the project execution and resulting data meet the project DQOs. Both the sampling and analytical activities must be considered, with the ultimate goal of assessing whether the final, qualified results support the decisions to be made with the data.

The following sections summarize the processes to determine whether the collected data are of the right type, quality, and quantity to support the environmental decision-making for the project, and describe how data quality issues will be addressed and how limitations of the use of the data will be handled.

Personnel Responsible for Participating in the Data Usability Assessment

- Marcia Olive, Project Chemist
- Dustin McNeil, FOM
- Kim Nemmers, PM

Summary of Usability Assessment Processes

Data gaps may result if:

- A sample is not collected
- A sample is not analyzed for the requested parameters
- The data are determined to be unusable.

If data gaps exist, the need for further investigation will be determined by the project leaders.

The Project Chemist and the laboratory QA Officer will confirm that the collected data meet the LODs, LOQs, and laboratory QC limits specified in this document. During the data validation assessment, non-conformances will be documented, and data will be qualified accordingly. The Project Chemist will determine whether the data are usable based on the requirements specified in this document.

All data as qualified during data validation are considered useable, with the exception of rejected data ("R" qualified data). Estimated results are considered usable.

Usability Summary Documentation

To ensure that quality data are continuously produced during analysis, and to enable the subsequent compliance review, systematic QC checks are incorporated into the sampling and analyses to show that procedures and test results remain reproducible and that the analytical method is without unacceptable bias. Systematic QC checks include the comparability of field and laboratory duplicates as well as the laboratory performance for each batch of samples. Discussion will cover PARCCS.

Precision

Total precision is the measurement of the variability associated with the entire sampling and analytical process. The required levels of precision for each method, matrix and analyte are provided in Worksheet 15 (Reference Limits and Evaluation). Laboratory precision is measured by the variability associated with duplicate (two) analyses. The field precision will be evaluated through the use of field duplicates, while the laboratory precision will be evaluated through the use of spike duplicates. For duplicate sample results, the precision is evaluated using the RPD.

If calculated from duplicate measurements:

$$\left(\frac{x_1 - x_2}{(x_1 \quad + \quad x_2)/2}\right) \times \ 100$$

Where:
X_1= larger of the two observed values
X_2 = smaller of the two observed values

Accuracy

Accuracy reflects the total error associated with a measurement. A measurement is considered accurate when the reported value agrees with the true value or known concentration of the spike or standard within acceptable limits. The accuracy will be evaluated through the use of LCS, MS, and surrogates. In each case the accuracy will be determined by calculating the %R for each target analyte.

The formula for calculation of accuracy is included below as %R. Accuracy requirements are listed for each method, matrix, and analyte in Worksheet 15 (Reference Limits and Evaluation).

For measurements where matrix spikes are used:

(value of spiked sample – value of unspiked sampled)/value of added spike X 100

Representativeness

Representativeness is a qualitative term that is related to the sample collection procedures. Representativeness is determined by proper program design, with consideration of elements such as sampling locations. Samples that are improperly collected or preserved, or are analyzed beyond the method required holding time, would not provide data that represent the sampling site. In addition, if the laboratory subsampling criteria were not met (i.e., proper premixing and homogenizing), the resulting data would not be representative of the initial sample collected.

Comparability

Comparability is a qualitative indicator of the confidence with which one data set can be compared to another data set. The objective is to produce data with the greatest possible degree of comparability. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, using standardized data collection forms and using standard and comprehensive reporting formats. In order to ensure that the data sets are comparable, the same method will be used for each sampling event.

Completeness

Completeness is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples (for example, by site). Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not qualified with an R-flag after data validation. The goal for completeness is 90 percent for soil samples.

Completeness is calculated as follows for all measurements:

$$\%C = 100\,\% \times [A/T]$$

Where:

%C = percent completeness
A = number of individual analyte results deemed valid
T = total number of results

Sensitivity

Sensitivity is the ability of an analytical method or instrument to discriminate between measurement responses representing different concentrations. Sensitivity requirements include the establishment of various limits such as calibration requirements, instrument LODs and LOQs. The project QA/QC control on method requirements has been established to be compliant with the DoD Quality Systems Manual (Version 5.0). Project specific LOD and LOQs are established in Worksheet 15.

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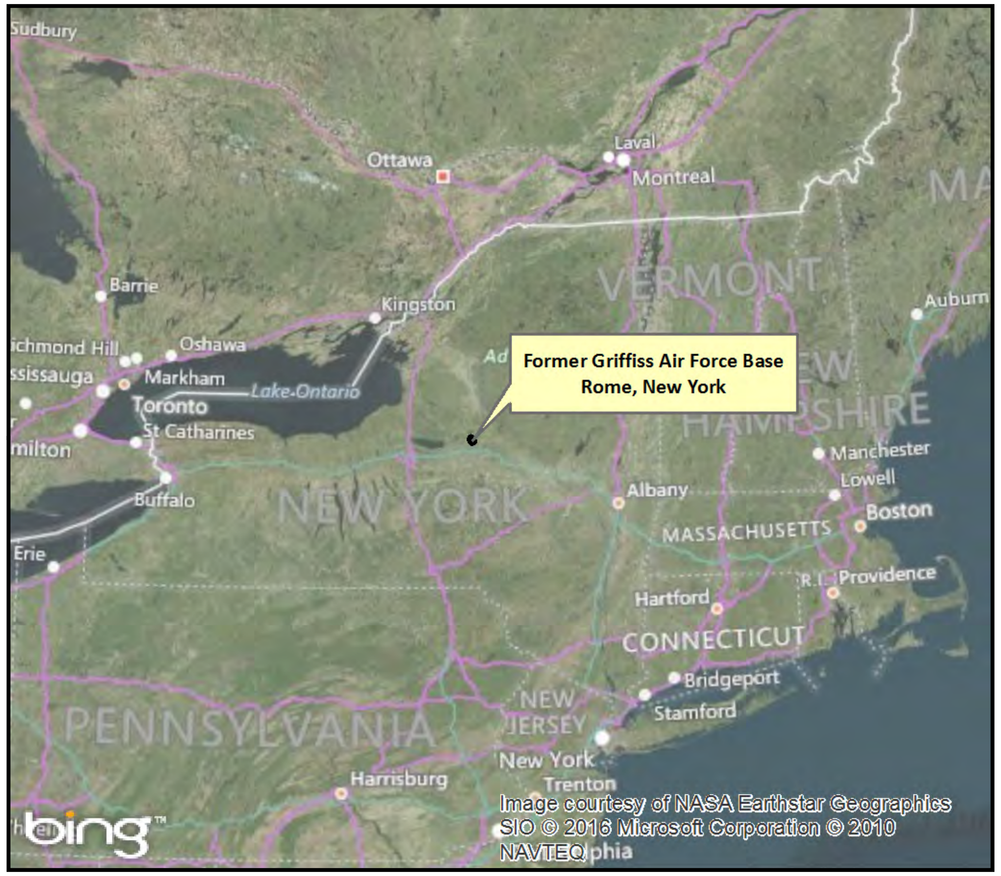
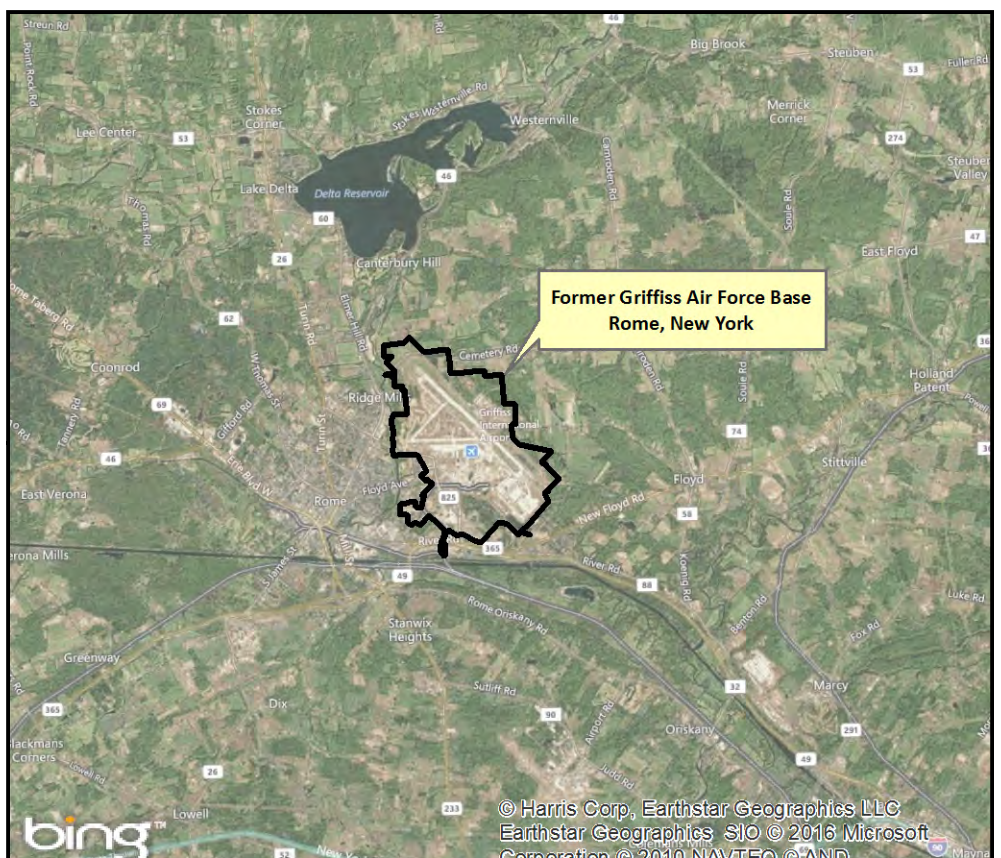
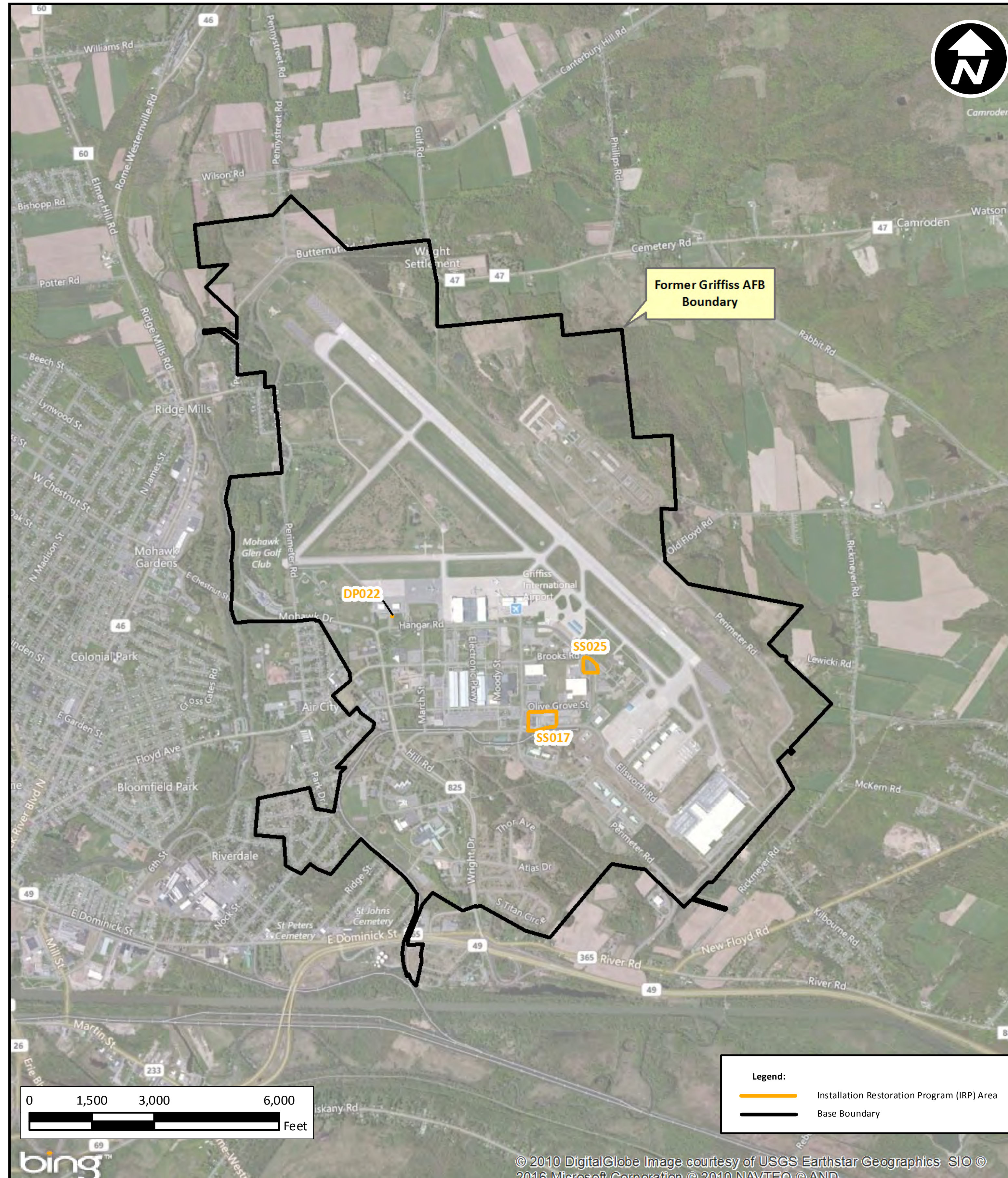
FIGURES







Former Griffiss AFB Site Location Map

Figure 2

UFP-QAPP Supplemental Investigation at Sites
SS017: Lot 69, DP022: Building 222 and SS025: T-9 Storage Area
Former Griffiss Air Force Base, Rome, New York

DRAWN BY:	MRM
DATE:	11/11/2016
SCALE:	As Shown
PROJECT NO:	AFCGSA3

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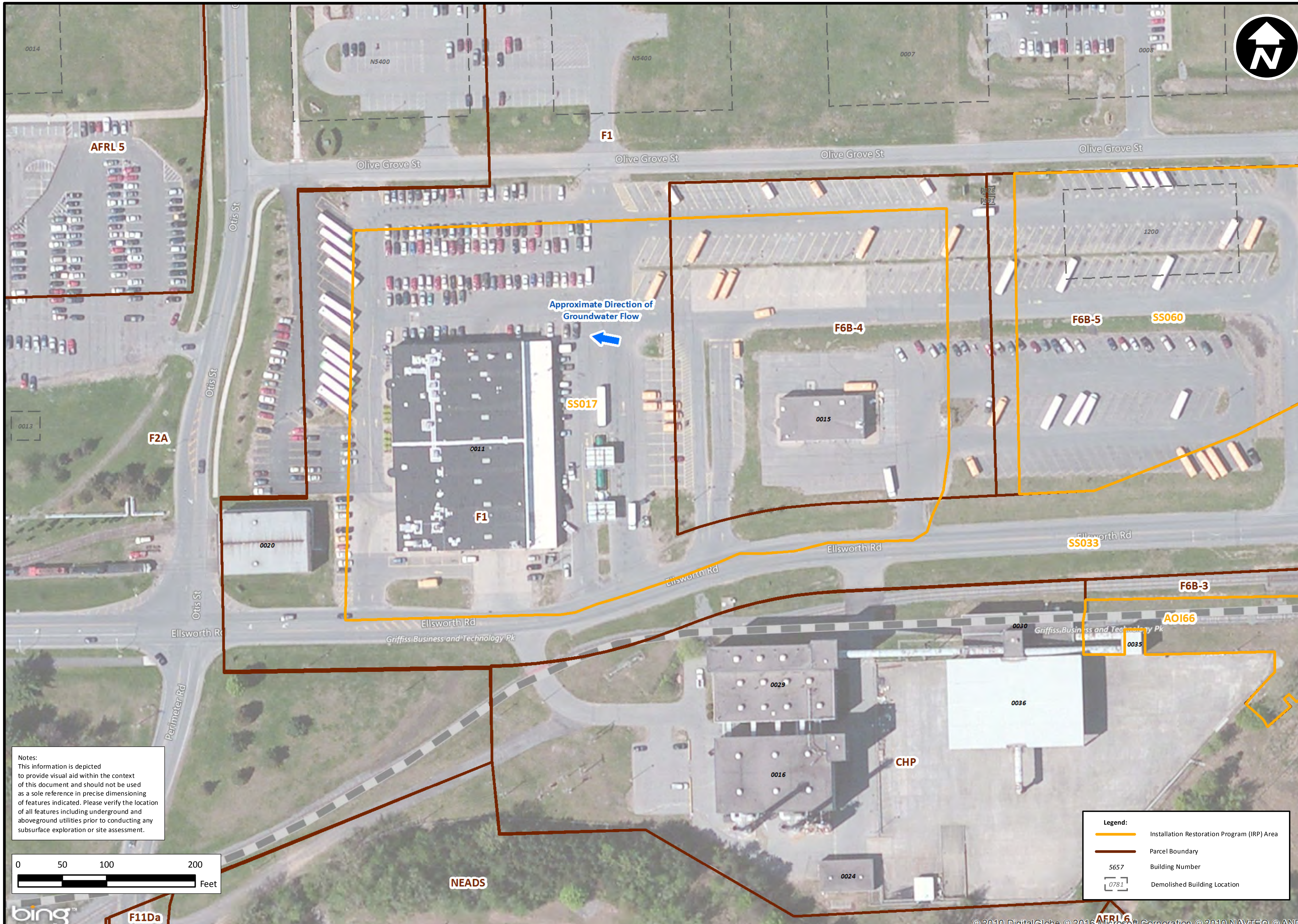

SS017 (Lot 69) - Former Hazardous Waste Storage Area Site Map

Figure 3

UFP-QAPP Supplemental Investigation at Sites
SS017: Lot 69, DP022: Building 222 and SS025: T-9 Storage Area
Former Griffiss Air Force Base, Rome, New York

DRAWN BY:	DATE:	SCALE:	PROJECT NO:
MRM	11/11/2016	As Shown	AFCGSA3

bhate ENVIRONMENT & INFRASTRUCTURE

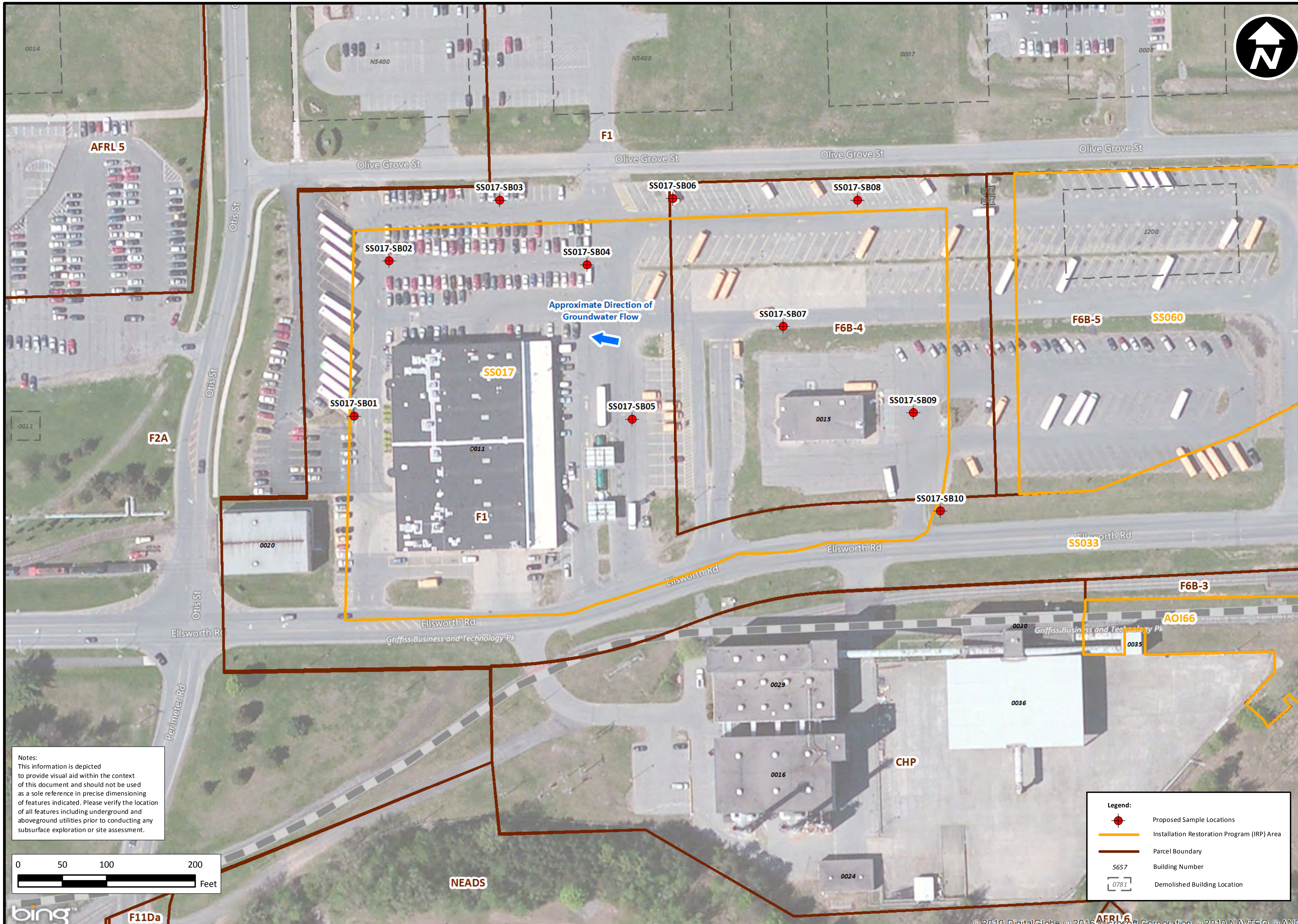

Figure 4

SS017 (Lot 69) - Former Hazardous Waste Storage Area Proposed Sample Locations

UFP-QAPP Supplemental Investigation at Sites SS017: Lot 69, DP022: Building 222 and SS025: T-9 Storage Area
Former Griffiss Air Force Base, Rome, New York

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DP022 - Building 222 Site Map

Figure 5

UFP-QAPP Supplemental Investigation at Sites
SS017: Lot 69, DP022: Building 222 and SS025: T-9 Storage Area
Former Griffiss Air Force Base, Rome, New York

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Figure 6

DP022 - Building 222
Proposed Sample Locations

UFP-QAPP Supplemental Investigation at Sites
SS017: Lot 69, DP022: Building 222 and SS025: T-9 Storage Area
Former Griffiss Air Force Base, Rome, New York

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MRM	11/11/2016	As Shown	AFCGSA3

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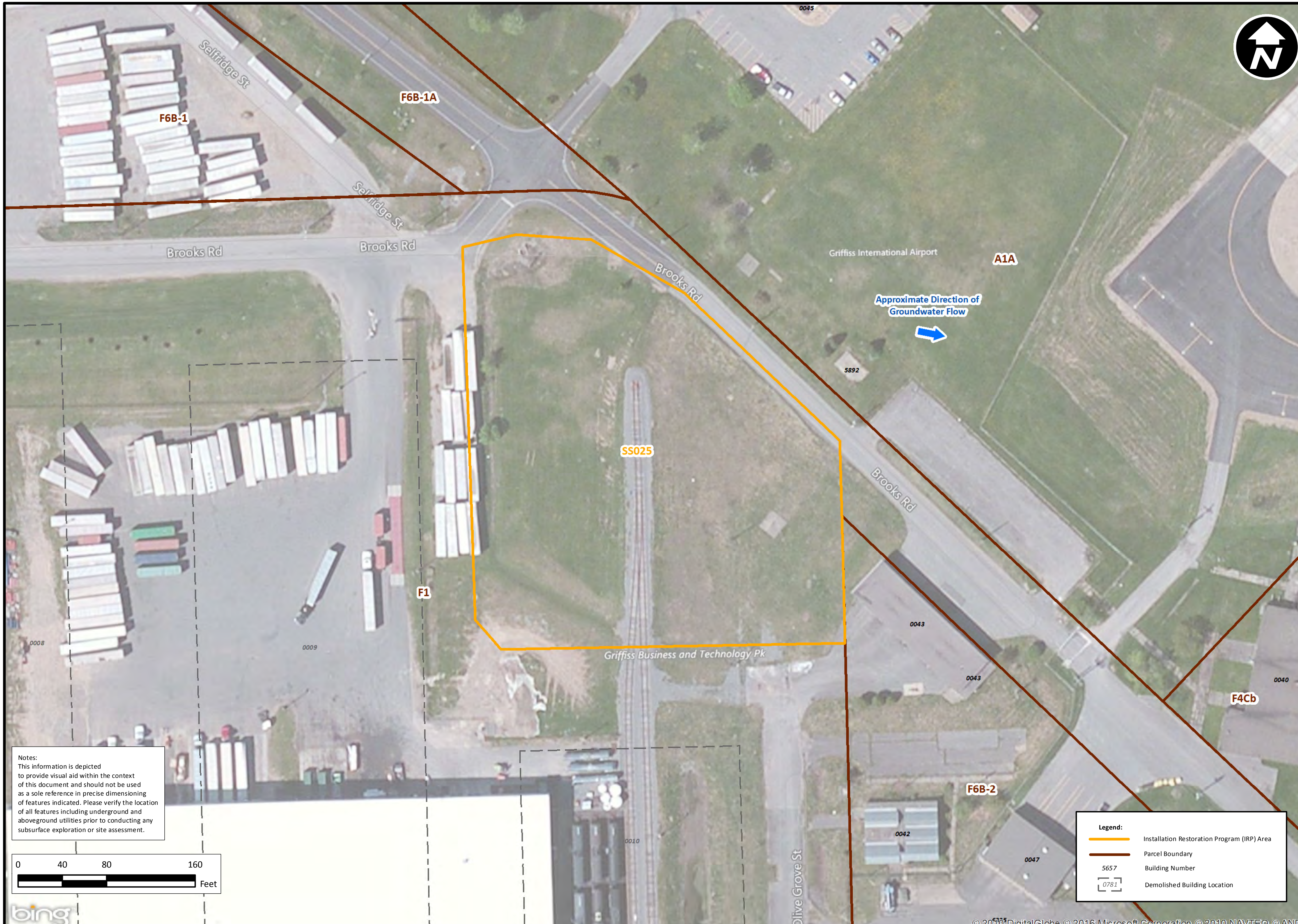

SS025 - T-9 Storage Area Site Map

Figure 7

UFP-QAPP Supplemental Investigation at Sites SS017: Lot 69, DP022: Building 222 and SS025: T-9 Storage Area Former Griffiss Air Force Base, Rome, New York

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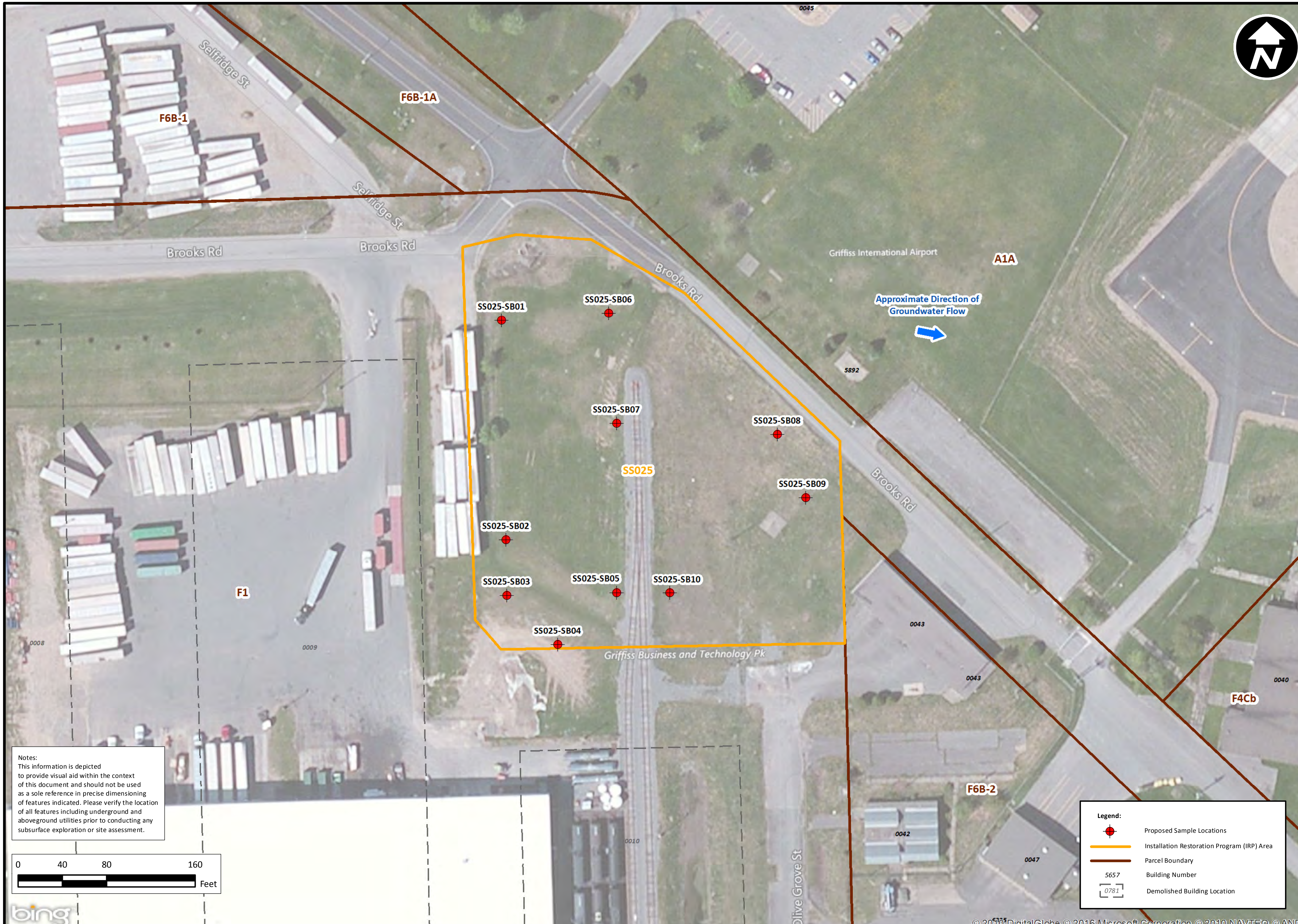


SS025 - T-9 Storage Area
Proposed Sample Locations

Figure 8

UFP-QAPP Supplemental Investigation at Sites
SS017: Lot 69, DP022: Building 222 and SS025: T-9 Storage Area
Former Griffiss Air Force Base, Rome, New York

DRAWN BY:	DATE:	SCALE:	PROJECT NO:
MRM	11/11/2016	As Shown	AFCGSA3

bhate ENVIRONMENT & INFRASTRUCTURE

Figure 9. Project Schedule

ID	Task Name	Duration	Start	Finish
1	**Environmental Services for Eastern Region Base Realignment and Closure (BRAC) Bases - Plattsburgh AFB**	**1310 days**	**Wed 6/8/16**	**Tue 6/15/21**
1248	**Environmental Services for Eastern Region Base Realignment and Closure (BRAC) Bases - Griffiss AFB**	**1542 days**	**Wed 7/29/15**	**Thu 6/24/21**
1249	**Contract Management**	**1313 days**	**Wed 6/8/16**	**Fri 6/18/21**
1371	**Landfills RC: LF001, LF002, LF003, LF007 and LF009**	**1228 days**	**Thu 6/9/16**	**Mon 2/22/21**
1515	**SC Site: ST006: Building 101**	**1226 days**	**Thu 10/13/16**	**Thu 6/24/21**
1614	**SQ Sites: SS008, SS033, SS044, SS060, AOI66**	**1062 days**	**Tue 9/20/16**	**Wed 10/14/20**
1686	**SC Sites SS017, DP022 and SS025**	**942 days**	**Thu 6/9/16**	**Fri 1/17/20**
1687	**Supplemental Investigation**	**719 days**	**Thu 6/9/16**	**Tue 3/12/19**
1688	**Supplemental Investigation (SI) Work Plan (in UFP-QAPP format)**	**190 days**	**Thu 6/9/16**	**Wed 3/1/17**
1689	Prepare Working Copy of SI Work Plan	90 days	Thu 6/9/16	Wed 10/12/16
1690	AF Review of Working Copy of SI Work Plan	22 days	Thu 10/13/16	Fri 11/11/16
1691	RTC AF Comments on Working Copy of SI Work Plan	10 days	Mon 11/14/16	Fri 11/25/16
1692	AF Approval of Draft SI Work Plan	0 days	Fri 11/25/16	Fri 11/25/16
1693	AF Approval of Draft SI Work Plan	0 days	Fri 11/25/16	Fri 11/25/16
1694	AF Approval of Draft SI Work Plan	0 days	Fri 11/25/16	Fri 11/25/16
1695	Submit Draft SI Work Plan to Regulators	5 days	Mon 11/28/16	Fri 12/2/16
1696	Regulator Review of Draft SI Work Plan	45 edays	Fri 12/2/16	Mon 1/16/17
1697	RTC Regulator Comments on Draft SI Work Plan	5 days	Tue 1/17/17	Mon 1/23/17
1698	Prepare Final SI Work Plan	5 days	Tue 1/24/17	Mon 1/30/17
1699	Regulator Approval of Final SI Work Plan	0 days	Wed 3/1/17	Wed 3/1/17
1700	Regulator Approval of Final SI Work Plan	0 days	Wed 3/1/17	Wed 3/1/17
1701	Regulator Approval of Final RA Work Plan	0 days	Wed 3/1/17	Wed 3/1/17
1702	**Complete Soil Sampling and Risk Assessment (if necessary)**	**494 days**	**Thu 4/20/17**	**Tue 3/12/19**
1703	Mobilization, Dig Permit and Sampling	30 days	Thu 4/20/17	Wed 5/31/17
1704	Laboratory Analysis	22 days	Mon 5/22/17	Tue 6/20/17
1705	Data Validation	15 days	Wed 6/21/17	Tue 7/11/17
1706	ERPIMS Submittal	1 day	Thu 9/21/17	Thu 9/21/17
1707	Prepare Risk Assessment (if necessary)	35 days	Wed 7/12/17	Tue 8/29/17
1708	Implement Contingent Action of Excavation	400 days	Wed 8/30/17	Tue 3/12/19
1709	**LTM**	**582 days**	**Thu 9/29/16**	**Fri 12/21/18**
1710	**LUC Inspections**	**525 days**	**Thu 9/29/16**	**Wed 10/3/18**
1711	LUC Inspections-Annual	5 days	Thu 9/29/16	Wed 10/5/16
1712	LUC Inspection-Annual (Contingency)	5 days	Thu 9/21/17	Wed 9/27/17

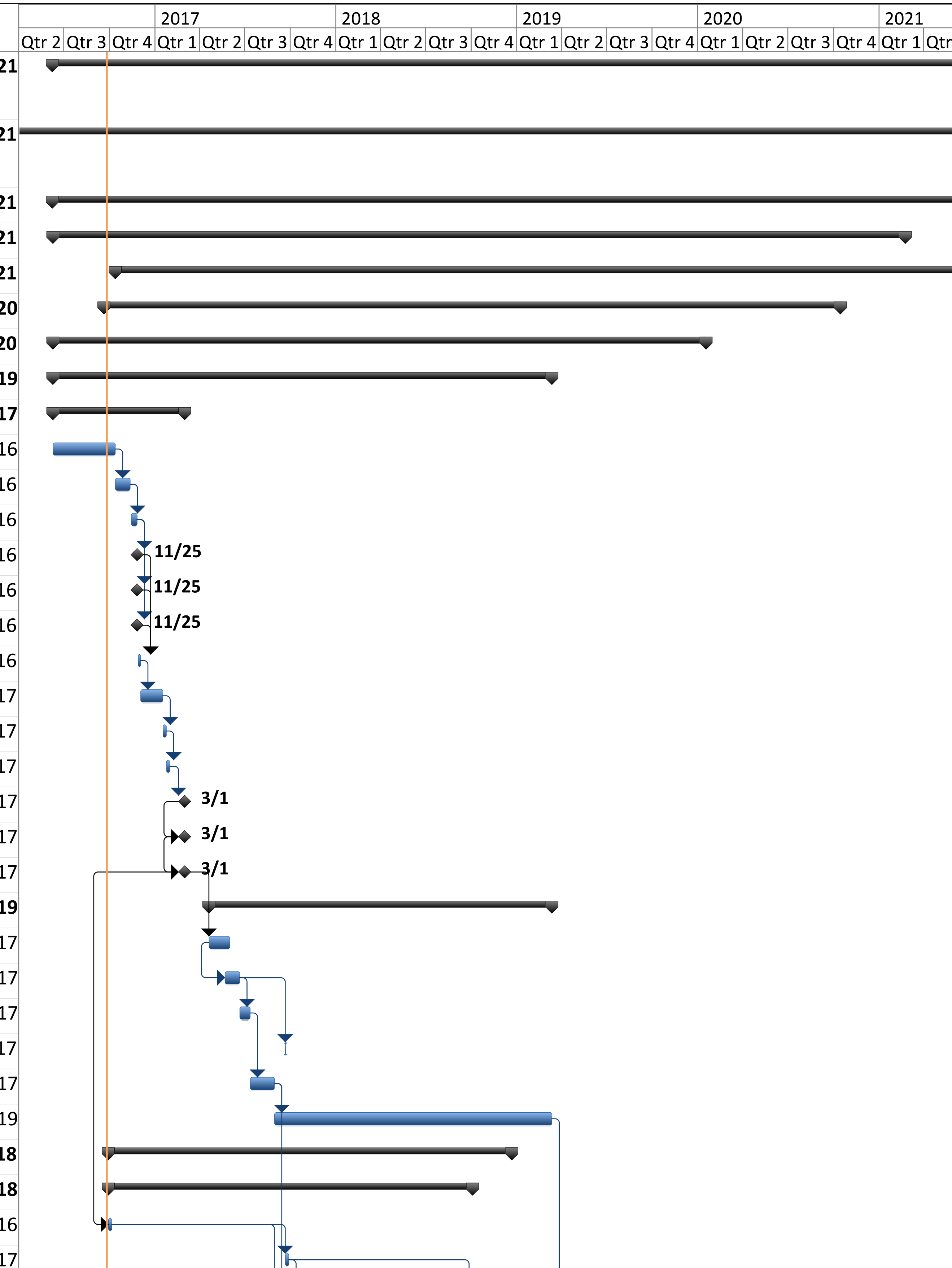


Figure 9. Project Schedule

ID	Task Name	Duration	Start	Finish
1713	LUC Inspections - Annual (Contingency)	5 days	Thu 9/27/18	Wed 10/3/18
1714	**LTM Reporting**	**343 days**	**Wed 8/30/17**	**Fri 12/21/18**
1715	**Annual Report - Year 2016**	**57 days**	**Wed 8/30/17**	**Thu 11/16/17**
1716	Prepare Working Copy of Annual Report	20 days	Wed 8/30/17	Tue 9/26/17
1717	AF Review of Working Copy of Annual Report	22 days	Wed 9/27/17	Thu 10/26/17
1718	RTC AF Comments on Working Copy of Annual Report	10 days	Fri 10/27/17	Thu 11/9/17
1719	AF Approval of Final Annual LUC Report-2016	0 days	Thu 11/9/17	Thu 11/9/17
1720	AF Approval of Final Annual LUC Report-2016	0 days	Thu 11/9/17	Thu 11/9/17
1721	AF Approval of Final Annual LUC Report-2016	0 days	Thu 11/9/17	Thu 11/9/17
1722	Submit Final Annual LUC Report to Regulators	5 days	Fri 11/10/17	Thu 11/16/17
1723	**Annual Report - Year 2017**	**57 days**	**Thu 9/28/17**	**Fri 12/15/17**
1724	Prepare Working Copy of Annual Report	20 days	Thu 9/28/17	Wed 10/25/17
1725	AF Review of Working Copy of Annual Report	22 days	Thu 10/26/17	Fri 11/24/17
1726	RTC AF Comments on Working Copy of Annual Report	10 days	Mon 11/27/17	Fri 12/8/17
1727	AF Approval of Final Annual LUC Report-2017	0 days	Fri 12/8/17	Fri 12/8/17
1728	AF Approval of Final Annual LUC Report-2017	0 days	Fri 12/8/17	Fri 12/8/17
1729	AF Approval of Final Annual LUC Report-2017	0 days	Fri 12/8/17	Fri 12/8/17
1730	Submit Final Annual LUC Report to Regulators	5 days	Mon 12/11/17	Fri 12/15/17
1731	**Annual Report - Year 2018**	**57 days**	**Thu 10/4/18**	**Fri 12/21/18**
1732	Prepare Working Copy of Annual Report	20 days	Thu 10/4/18	Wed 10/31/18
1733	AF Review of Working Copy of Annual Report	22 days	Thu 11/1/18	Fri 11/30/18
1734	RTC AF Comments on Working Copy of Annual Report	10 days	Mon 12/3/18	Fri 12/14/18
1735	AF Approval of Final Annual LUC Report-2018	0 days	Fri 12/14/18	Fri 12/14/18
1736	AF Approval of Final Annual LUC Report-2018	0 days	Fri 12/14/18	Fri 12/14/18
1737	AF Approval of Final Annual LUC Report-2018	0 days	Fri 12/14/18	Fri 12/14/18
1738	Submit Final Annual LUC Report to Regulators	5 days	Mon 12/17/18	Fri 12/21/18
1739	**Decision Document**	**151 days**	**Wed 3/13/19**	**Wed 10/9/19**
1740	**Explanation of Significant Difference (ESD)**	**151 days**	**Wed 3/13/19**	**Wed 10/9/19**
1741	Prepare Working Copy of ESD	30 days	Wed 3/13/19	Tue 4/23/19
1742	AF Review of Working Copy of ESD	22 days	Wed 4/24/19	Thu 5/23/19
1743	RTC AF Comments on Working Copy of ESD	10 days	Fri 5/24/19	Thu 6/6/19
1744	AF Approval of Draft ESD	0 days	Thu 6/6/19	Thu 6/6/19
1745	AF Approval of Draft ESD	0 days	Thu 6/6/19	Thu 6/6/19
1746	AF Approval of Draft ESD	0 days	Thu 6/6/19	Thu 6/6/19
1747	Submit Draft Annual Report to ESD	5 days	Fri 6/7/19	Thu 6/13/19

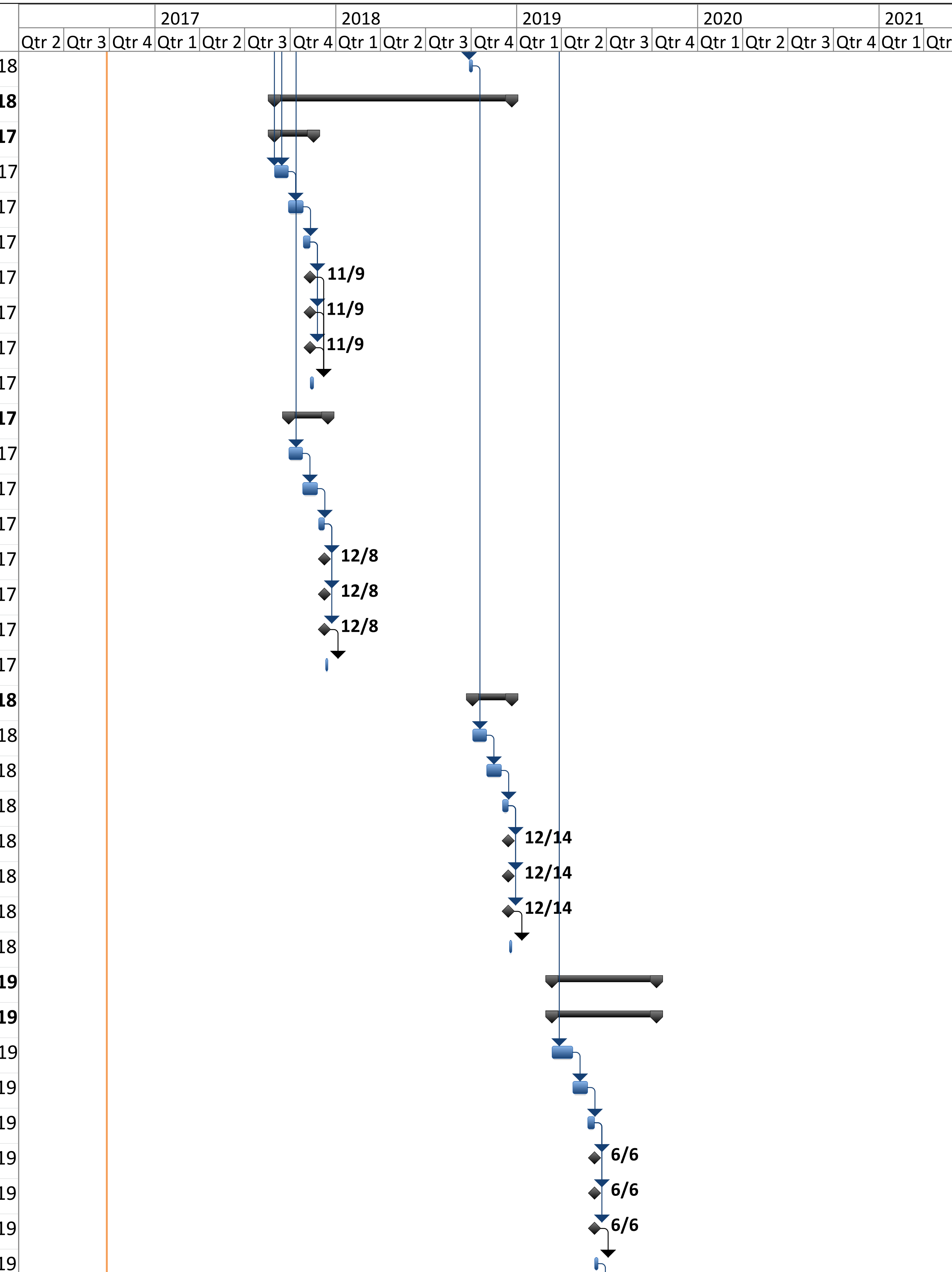
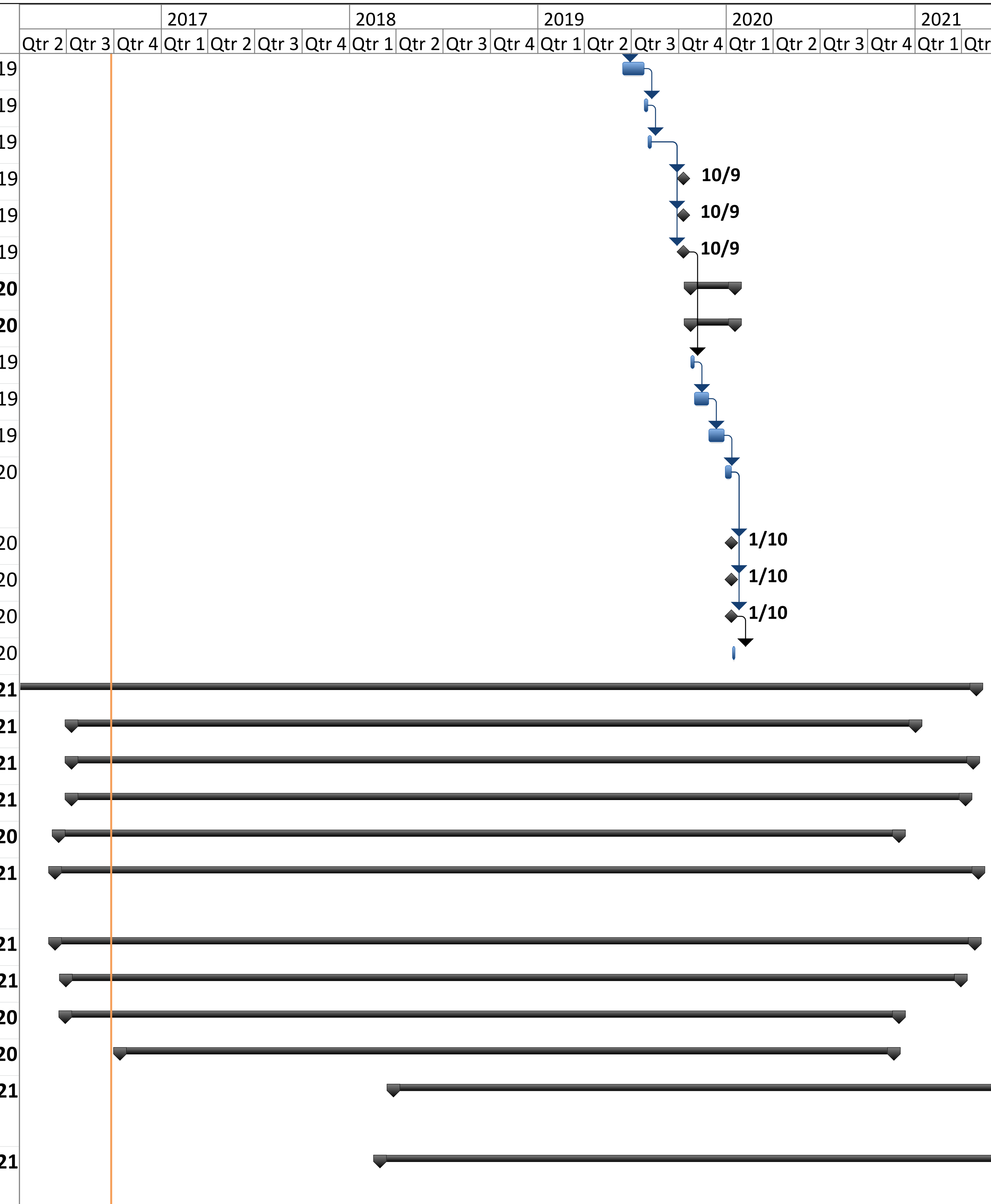


Figure 9. Project Schedule

ID	Task Name	Duration	Start	Finish
1748	Regulator Review of Draft ESD	30 days	Fri 6/14/19	Thu 7/25/19
1749	RTC Regulator Comments on Draft ESD	5 days	Fri 7/26/19	Thu 8/1/19
1750	Prepare Final ESD	5 days	Fri 8/2/19	Thu 8/8/19
1751	Regulator Approval of Final ESD	0 days	Wed 10/9/19	Wed 10/9/19
1752	Regulator Approval of Final ESD	0 days	Wed 10/9/19	Wed 10/9/19
1753	Regulator Approval of Final ESD	0 days	Wed 10/9/19	Wed 10/9/19
1754	**Site Closeout**	**62 days**	**Thu 10/24/19**	**Fri 1/17/20**
1755	**Site Closeout and Well Decommissioning Report**	**62 days**	**Thu 10/24/19**	**Fri 1/17/20**
1756	Decommission any existing wells or system, if present	5 days	Thu 10/24/19	Ved 10/30/19
1757	Prepare Working Copy of Site Closeout and Well Decommissioning Report	20 days	Thu 10/31/19	Ved 11/27/19
1758	AF Review of Working Copy of Site Closeout and Well Decommissioning Report	22 days	Thu 11/28/19	Fri 12/27/19
1759	RTC AF Comments on Working Copy of Site Closeout and Well Decommissioning Report	10 days	Mon 12/30/19	Fri 1/10/20
1760	AF Approval of Final Site Closeout and Well Decommissioning Report	0 days	Fri 1/10/20	Fri 1/10/20
1761	AF Approval of Final Site Closeout and Well Decommissioning Report	0 days	Fri 1/10/20	Fri 1/10/20
1762	AF Approval of Final Site Closeout and Well Decommissioning Report	0 days	Fri 1/10/20	Fri 1/10/20
1763	Submit Final Site Closeout and Well Decommissioning Report to Regulators	5 days	Mon 1/13/20	Fri 1/17/20
1764	**OES Site SD052-01: Apron 2 Chlorinated Plume**	**1502 days**	**Wed 7/29/15**	**Thu 4/29/21**
1880	**RC Site SD052-02: Bldg. 775, Pump house 3 - Chlorinated Plume**	**1170 days**	**Mon 7/11/16**	**Fri 1/1/21**
2017	**OES Site SD052-04: Landfill 6 Chlorinated Plume**	**1250 days**	**Mon 7/11/16**	**Fri 4/23/21**
2121	**OES Site SD052-05: Bldg. 817 Chlorinated Plume**	**1239 days**	**Mon 7/11/16**	**Thu 4/8/21**
2226	**OES Site SD052-SVI**	**1163 days**	**Thu 6/16/16**	**1on 11/30/20**
2321	**OES: Site SS054 Bldg. 781. Pump house-Free Product on Groundwater (NYDEC Spill #9202658)**	**1278 days**	**Thu 6/9/16**	**Mon 5/3/21**
2462	**OES Site SS062: AOC 9 Weapons Storage Area Landfill Chlorinated Plume**	**1273 days**	**Thu 6/9/16**	**Mon 4/26/21**
2566	**SC: TBD: Apron 1 Area LCP-E9 (NYSDEC Spill #1501553)**	**1239 days**	**Thu 6/30/16**	**Tue 3/30/21**
2701	**OES: SS067: Building 789 Type II Fuel system (NYSDEC Spill #9810713)**	**1154 days**	**Wed 6/29/16**	**1on 11/30/20**
2847	**SC: TBD: Building 785 Pipeline (NYSDEC Spill #1408594)**	**1072 days**	**Thu 10/13/16**	**Fri 11/20/20**
2953	**Environmental Services for Eastern Region Base Realignment and Closure (BRAC) Bases - Myrtle Beach AFB**	**841 days**	**Tue 3/27/18**	**Tue 6/15/21**
3532	**Environmental Services for Eastern Region Base Realignment and Closure (BRAC) Bases - England AFB**	**859 days**	**Thu 3/1/18**	**Tue 6/15/21**



APPENDIX A

GRIFFISS AFB PROGRAM HEALTH AND SAFETY PLAN

(PROVIDED ON CD)

FINAL
PROGRAM HEALTH AND SAFETY PLAN
FORMER GRIFFISS AIR FORCE BASE
ROME, NEW YORK

November 2016

Prepared For:

Air Force Civil Engineer Center
Building 171
2261 Hughes Avenue, Suite 155
JBSA Lackland, TX 78236-9853

Contract/Task Order No: FA8903-16-F-0012

Prepared By:

bhate ENVIRONMENT INFRASTRUCTURE

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Birmingham, Alabama 35205
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LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AHA	Activity Hazard Analysis
AIHA	American Industrial Hygiene Association
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
BEC	BRAC Environmental Coordinator
Bhate	Bhate Environmental Associates, Inc.
BRAC	Base Realignment and Closure
°C	Degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHMM	Certified Hazardous Materials Manager
CIH	Certified Industrial Hygienist
COR	Contracting Officer's Representative
CPEA	Certified Professional Environmental Auditor
CPR	Cardiopulmonary Resuscitation
CRZ	Contamination reduction zone
CSP	Certified Safety Professional
dBA	Decibels "A-weighting scale"
DPT	Direct Push Technology
EM	Engineering Manual
EMR	Experience Modification Rate
EZ	Exclusion Zone
°F	Degrees Fahrenheit
FOM	Field Operations Manager
ft^2	Square feet
GFCI	Ground fault circuit interrupter
HASP	Health and Safety Plan
HASP-C	Health and Safety Plan for Construction
HAZCOM-GHS	Hazard Communication-Global Harmonization System
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEC	Hazardous Energy Control
HPD	Hearing protective device
HSM	Health and Safety Manager
LEL	Lower explosive limit
LTM	Long Term Monitoring

MHS	Masters of Health Sciences
MSDS	Material Safety Data Sheet
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
PAT	Proficiency Analytical Testing
PBR	Performance-Based Remediation
PE	Professional Engineer
PM	Project Manager
PPE	Personal protective equipment
QC	Quality control
SDS	Safety Data Sheet
SOP	Standard Operating Procedure
SPF	Sun Protection Factor
SSHO	Site Safety and Health Officer
SSHP	Site-Specific Safety and Health Plan
SVE	Soil vapor extraction
SVI	Soil Vapor Intrusion
TLV	Threshold Limit Value
TWA	Time weighted average
SZ	Support Zone
UFP-QAPP	Uniform Federal Policy – Quality Assurance Project Plan
USACE	United States Army Corp of Engineers

1 SIGNATURE SHEET

PROGRAM HEALTH AND SAFETY PLAN

FORMER GRIFFISS AIR FORCE BASE
ROME, NEW YORK

COMMITMENT TO IMPLEMENT THIS PROGRAM HEALTH AND SAFETY PLAN	SIGNATURE
Prepared by: Sally S. Smith, MHS, CIH, CSP, CHMM, CPEA *Health and Safety Manager* 205-918-4032 Office 205-983-4150 Cell	Sally S Smith 11/6/16
Reviewed by: Kim Nemmers *Project Manager* 303-597-2450 Office 303-550-9239 Cell	[signature] 11/7/16
Concurrence by: Frank Gardner *Program Manager* 303-597-2450 Office 303-386-6454 Cell	[signature] 11-7-16
Concurrence by: Dustin McNeil *Site Safety and Health Officer/Field Operations Manager* 303-597-2450 Office 303-589-4564	Dustin McNeil 11/7/16

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2 PROJECT BACKGROUND AND SCOPE

a. Contractor

Bhate Environmental Associates, Inc. (Bhate) has been contracted by the Air Force Civil Engineer Center (AFCEC), under Contract/Task Order No: FA8903-16-F-0012, to prepare this Program Health and Safety Plan (HASP) for the Performance-Based Remediation (PBR) environmental work to be performed at the Former Griffiss Air Force Base (AFB) located in Rome, New York. This Program HASP is Appendix A of the Uniform Federal Policy – Quality Assurance Project Plan (UFP-QAPP).

b. Contract Number

The contract number is Contract/Task Order No: FA8903-16-F-0012.

c. Project Name

The project name is East Base Realignment and Closure (BRAC) PBR at the former Griffiss AFB in Rome, New York.

d. Project Description

Bhate has been contracted by the AFCEC, to implement PBR at various locations at the former Griffiss AFB. The tasks include: long-term management (LTM) at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites including groundwater sampling, surface water sampling, landfill gas monitoring, operations and maintenance (O&M) and optimizing of Soil Vapor Intrusion (SVI) and Soil Vapor Extraction (SVE) system, O&M of free product recovery and treatment systems, and land use control/institutional control inspection and maintenance.

This Program HASP outlines the health and safety policies and procedures to be implemented during environmental investigation and remediation activities, as well as O&M activities at Griffiss AFB. Site-Specific Safety and Health Plans (SSHPs) will be prepared as addendums to this Program HASP and submitted to AFCEC for approval before the tasks at the various Griffiss sites commence.

This document defines the health and safety requirements for field activities to be conducted at the Griffiss AFB sites. This document addresses applicable requirements of Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) Parts 1910 and 1926, and the *Bhate Corporate Health and Safety Plan*. All Bhate personnel and subcontractor personnel working at the site will be briefed on the information contained in this Program HASP at a safety orientation and will follow the procedures established within this Program HASP and any SSHP applicable to specific tasks at Griffiss AFB sites.

This Program HASP provides health and safety requirements applicable to the planned field operations. Field activities performed by Bhate and their subcontractors at the sites will be conducted in accordance with this Program HASP. Bhate's written safety procedures and programs are included in Attachment 4 and the health and safety field forms are included in Attachment 2.

Bhate's Field Operations Manager (FOM)/Site Safety and Health Officer (SSHO) will not allow fieldwork to begin at the site until this Program HASP has been reviewed by field personnel. Before work area entry, all Bhate personnel will attend a site-specific briefing/safety orientation session, to be conducted by the SSHO, on the potential site hazards and specific requirements of this Program HASP and any SSHP if applicable.

2.d.1 Phases of Work Requiring AHAs

The following phases of work require a process hazard analysis and the development of activity hazard analyses (AHAs):

- Mobilization, Site Preparation / Site Restoration, and Demobilization
- Soil Sampling
- Surface Water and Groundwater Sampling (Monitoring Wells)
- Landfill gas sampling
- Free product removal and handling
- Monitoring Well Installation
- Excavation
- Operations and Maintenance of treatment systems
- Monitoring Well Abandonment, if needed
- Injection by Direct-Push Technology, if needed

The AHA identifies potential safety, health, and environmental hazards, and provides for the protection of personnel, the community, and the environment. Because conditions may be constantly changing during the course of the environmental restoration project, supervisors must be aware of conditions that may harm site personnel, the community, or the environment. The FOM/SSHO must monitor these changing conditions and discuss them with the Corporate Health and Safety Manager (HSM). If needed, the HSM will write or approve addenda to modify the AHAs. AHAs for select phases of work are provided in Attachment 1 of this Program HASP. Additional AHAs may be prepared and submitted with the SSHP for the various tasks during the project.

3 CORPORATE HEALTH AND SAFETY POLICY STATEMENT

a. Safety and Health Expectations, Incentive Programs, and Compliance

As stated in Bhate's Corporate Health and Policy Statement, "Bhate management is committed to achieving positive health and safety results while maintaining high standards for production and quality. Protection of personnel, controlling liability, managing risk, and compliance with applicable Federal, State, and local regulations are project responsibilities. In order to succeed at the goals of the Corporate Health and Safety Policy Statement, Bhate has developed a Corporate HASP and a Corporate HASP for Construction (HASP-C), which will provide employees with health and safety policies, an overview of programs, and Standard Operating Procedures (SOPs) to promote consistency and uniformity throughout all of Bhate's operations."

For this project, as well as any project Bhate conducts, the goal is zero incidents. By achieving zero incidents, Bhate ensures that there will be no work related injury or illnesses, spills resulting in deleterious effects to the environment, or cases of property damage. Zero incidents are achieved through proper work planning, personnel tasking, and proper execution of the work. A safety incentive program will not be implemented for this project. It is expected that each Bhate employee will be accountable for their actions and responsible for fulfilling their duties in a safe manner. Bhate will refer to their Disciplinary Action for Personnel Safety Violations procedure to enforce non-compliance with safety directions, as needed. A copy of the Disciplinary Action for Personnel Safety Violations procedure will be maintained on-site at all times.

b. Safety Commitment - Corporate Health and Safety Policy Statement

Bhate is committed to achieving positive health and safety results while maintaining high standards for production and quality. Bhate believes in protecting the health and safety of our employees, clients, and community members impacted by our work. Bhate believes all jobs are important and proper planning is critical to the safe execution of work.

In order to achieve our goals of zero incidents and providing quality services, our work activities are guided by the following:

- The Bhate Principals will provide a safe workplace for their employees with safe work methods and adequate technical resources.
- Health and safety must be an integral part of Bhate's business operations; and therefore, must be an equal priority in every business decision and operation.
- Every job can and will be done safely.
- The safety of the employee will not be endangered to meet the requirements of production, service, or quality.

- All employees have a responsibility to comply with the health and safety policies, procedures, and work practices, which may constitute a condition of employment.

Every Bhate employee is accountable for their actions and is responsible for fulfilling their duties in a safe manner.

c. Project Safety Coordination

The health and safety requirements described in this Program HASP will apply to all field activities conducted at the sites. Bhate will enforce the requirements of this Program HASP for both site contractor and subcontractor personnel. Bhate's subcontractors will be required to comply with the requirements of this Program HASP. Subcontractors will also be responsible for site safety related to, or affected by, their operations. If any subcontractor activities are not listed in the hazard identification and control section of this Program HASP, then an addendum describing those hazards and controls will be prepared by the subcontractor and reviewed by Bhate.

A fully trained and experienced SSHO will continually be on-site during field activities to implement and enforce the health and safety procedures outlined in this Program HASP. The Bhate HSM will be responsible for the development, implementation, and oversight of the project health and safety program as presented in this Program HASP.

Before work area entry, all site personnel and visitors must attend a site-specific safety and health briefing session, to be conducted by the SSHO. The briefing will cover potential site hazards and specific requirements of this Program HASP and the SSHP if applicable. The SSHO will also conduct daily safety briefings with all on-site personnel to cover planned activities with associated hazards and controls required.

If there is any question whether an unplanned occurrence on-site may compromise health and safety, the SSHO has the authority to interrupt operations and to remove all personnel from the area. If work is stopped due to any health or safety concern, immediate attention will be given by health and safety personnel, working in cooperation with the Project Manager (PM), to identify and correct the cause of concern as quickly as possible. Any such incident will be fully documented by the SSHO in a report to the HSM and PM.

For emergency developments on the site, communications begin with the SSHO. The SSHO will report all safety and/or health related incidents to the HSM and the PM. The SSHO will contact others if additional assistance is needed.

Bhate has maintained an average Total Recordable Case Frequency Rate of 0.23 over the past 5 years. Over the last 3 years, Bhate's Experience Modification Rate (EMR) has not exceeded 0.84, which is below our industry's average. Attachment 5 contains Bhate's OSHA 300A Annual Summaries for Reporting Years 2013, 2014, and 2015 and Bhate's EMR Letter dated January 29, 2016.

4 RESPONSIBILITIES AND LINES OF AUTHORITY

a. Statement of Ultimate Responsibility

Bhate is ultimately responsible for the implementation of its Safety and Occupational Health Program and this Program HASP.

b. Responsible Personnel

Table 4-1 summarizes the operational and health and safety responsibilities of key persons. The project team members have safety and health-related responsibilities for the activities covered by this Program HASP. The SSHO (and alternate) are required to have a 30-hour Construction Safety Training certificate and OSHA's Hazardous Waste Operations and Emergency Response (HAZWOPER) initial and annual refresher training.

Table 4-1. Project Team Members with Project Health and Safety Responsibilities

Title	Name	Telephone
Corporate Health and Safety Manager	Sally S. Smith, MHS, CIH, CSP, CHMM, CPEA	205-918-4032 205-983-4150 cell
Project Manager	Kim Nemmers	720-463-3909 Office 303-550-9239 Cell
Field Operations Manager/Site Safety and Health Officer	Dustin McNeil	720-463-3904 Office 303-589-4564 Cell
Notes: MHS – Masters of Health Sciences, CIH – Certified Industrial Hygienist, CSP – Certified Safety Professional, CHMM – Certified Hazardous Materials Manager, CPEA - Certified Professional Environmental Auditor		

c. Competent Personnel

Table 4-2 lists the competent personnel. Proof of competency/qualification can be found in Attachment 3 of this Program HASP. The names of the subcontractor's OSHA competent and/or qualified person(s) for specific tasks will be provide with the SSHP for each task and added to Attachment 3 of this Program HASP. If Mr. Dustin McNeil cannot be onsite for field work, then an alternate SSHO will be assigned prior to the start of the work and his/her proof of competency/qualification will be added to Attachment 3 of this Program HASP.

Table 4-2. List of Competent Personnel

Title	Name	Telephone
Corporate Health and Safety Manager	Sally S. Smith, MHS, CIH, CSP, CHMM, CPEA	205-918-4032 205-983-4150 cell
Field Operations Manager/ Site Safety and Health Officer	Dustin McNeil	720-463-3904 Office 303-589-4564
Subcontractor Site Supervisors	To be determined	To be determined

d. Presence of Competent Personnel

No environmental work will be conducted on-site unless the designated SSHO or an alternate SSHO is present. Attachment 3 contains the safety qualifications of the SSHO. If OSHA competent persons for specific tasks are required, their safety qualifications will be submitted to the Contracting Officer's Representative (COR) before the task's preparatory meeting and added to Attachment 3. The OSHA competent person must be present on-site for any activities requiring an OSHA competent person.

e. Pre-task Safety and Health Analysis

The SSHO will review the hazard control requirements for safety and health as documented in the AHAs with the employees and the subcontractors' employees during the preparatory meeting before starting any task.

f. Lines of Authority

The lines of authority are illustrated in the organization chart in the UFP-QAPP. The Bhate PM will have day-to-day responsibility for technical, schedule, and budget issues. The FOM and other support personnel (as needed) will support the PM in the field. Under this contract, the FOM will also serve as the SSHO and will assume on-site quality control (QC) responsibilities. Individual responsibilities are described further in the following sections.

4.f.1 Project Manager

The Griffiss AFB PBR PM (Kimberly Nemmers, Professional Engineer [PE]) is in charge of the overall project and has full authority for project coordination and direction. The PM will also communicate directly with the BRAC Environmental Coordinator (BEC)/COR. The PM is the senior Bhate representative for the project. The PM reports directly to Bhate corporate management, and site contacts. The PM is committed to the overall success of the project, including performance of all site work in accordance with this Program HASP. The PM is responsible for the preparation, organization, and review of the Program HASP and is responsible for the selection, assignment, and conduct of site personnel. The PM coordinates field activities with appropriate site contacts, serves as liaison with the facility, and coordinates preparation of the project deliverables. The PM has overall responsibility for the health and safety of Bhate personnel and Bhate subcontractors working on-site. The site safety and health officer (SSHO) has the responsibility for implementation of this HASP and has the authority to stop work if a serious hazard warrants the action.

4.f.2 Field Operations Manager

The FOM is the primary liaison between the PM, technical support personnel, and subcontractors. The FOM is the primary field representative for the project. Additionally, the

FOM will act as the SSHO unless relieved of health and safety oversight duties by an alternate SSHO. The FOM reports directly to the PM. The FOM is committed to the performance of all site work in accordance with this Program HASP and the SSHP if applicable. The FOM is responsible for the conduct of site personnel including subcontractors. The FOM will assist the PM coordinating field activities with appropriate site contacts, and serving as liaison with the facility. The FOM provides direct oversight for the health and safety of Bhate personnel and Bhate subcontractors working on-site.

4.f.3 Health and Safety Manager

The HSM will assist with the development, implementation, and oversight of Bhate's Corporate HASP and HASP-C, this Program HASP, and the various task specific SSHPs. The HSM maintains records of personnel training and certifications and is the first point of contact with Bhate Corporate Management in the event of an accident or incident at the site.

This Program HASP will be signed and dated by the HSM prior to initiation of field activities.

4.f.4 Site Safety and Health Officer

The SSHO will be on-site at all times while work is in progress. The SSHO will report to the PM, with secondary reporting requirements to the HSM. The SSHO has delegated authority from the HSM and respective corporate management to stop work and enforce this Program HASP and SSHP if applicable. Under this contract, the SSHO will also serve as the FOM and will assume on-site QC responsibilities.

The SSHO is responsible for site health and safety practices. The SSHO has the authority and responsibility for stopping site work should activities jeopardize the health and safety of workers or the public. If practical, the PM and HSM should be consulted before any operation is interrupted. Additional responsibilities of the SSHO include:

- Provide site orientation safety training for all personnel actively involved in project field work.
- Conduct daily safety briefings.
- Inspect health and safety equipment daily.
- Select protective equipment and clothing in accordance with this Program HASP and the SSHP if applicable.
- Assess worker's suitability for performance of activities.
- Coordinate the project safety and health program with the BEC/COR.
- Monitor workers for adverse effects of hazardous contaminants.
- Inspect the work areas to ensure compliance with the safety and health requirements for the tasks to be completed and identify hazards.
- Coordinate medical care, as needed.

- Maintain daily exposure data (i.e., man-hours worked, documentation of incidents/injuries).
- Enforce the requirements of this Program HASP and the SSHP if applicable.

The SSHO will take the following action(s), as appropriate, and in accordance with this Program HASP:

- Report all safety and/or health related incidents to the HSM and the Bhate PM.
- Order the immediate shut-down of field activities in case of medical emergency or unsafe practice.
- Restrict visitors from areas of potential exposure to harmful substances or hazardous conditions.

The SSHO will maintain a log to document activities related to safety and health. This log will include daily safety meeting topics, training given, inspection results, first aid administered, visits of outside personnel, environmental monitoring, and documentation of all activities or incidents of a health and safety nature.

g. Noncompliance

All Bhate personnel are required to comply with designated health and safety procedures as defined in the Bhate Corporate HASP, SOPs, and/or specific project requirements. All field personnel are required to comply with this Program HASP and its Attachments. Failure to comply with safety rules and procedures will result in disciplinary action.

Disciplinary action for safety violations will follow a three-step process:

- Initial violation – a verbal warning is issued indicating the infraction, explanation of the possible outcomes of the infraction, and steps to prevent recurrence.
- Second violation – a written reprimand is issued and entered into the employee's personnel file.
- Third violation – employee is terminated and documentation of the infraction and reason for termination is included in the personnel file.

During each step of the process, the employee will be informed of the successive step in the disciplinary action procedure. Additionally, at each step of the procedure the employee will receive retraining at their supervisor's discretion.

Some discretion is permitted in the procedure. In some instances, infractions can be different violations with similar principles. For example, failure to wear proper personal protective equipment on one day and failure to use a seatbelt in a vehicle another day. Both of these infractions can be characterized as a failure to follow procedure.

If disputes arise in the administration of a disciplinary action for a safety violation, a Principal will render a final decision.

Some situations, due to the severity of the violation, may warrant immediate suspension and/or termination, including but not limited to:

- Willful violation of the Corporate HASP, SOPs, this Program HASP, and/or specific project requirements permitting an imminent danger situation.
- Withholding chemical information regarding a project and allowing personnel to work in such scenarios.
- Working continuously under suspended loads.
- Failure to use appropriate fall protection when required.
- Working in confined spaces without following the appropriate entry procedures.

As noted previously, discretion is permitted in implementing this procedure.

All disciplinary action is to be instituted upon witnessing and/or being informed of the infraction. The employee is to be reviewed and held accountable relative to bonuses, raises, and/or promotions during their annual review. The employee will be evaluated for improvement during the employee's subsequent annual review.

h. Manager and Supervisor Accountability

Bhate management (i.e., SSHO/FOM, PM, HSM) responsibility includes ensuring that all company activities are executed in accordance with the Bhate Corporate HASP, SOPs, and applicable regulations. Their annual performance evaluation includes elements of safety conformance and implementation of the Corporate HASP and Program HASPs and SSHPs.

Managers and subcontractor supervisors have the responsibility to integrate loss control principles into all operations and to ensure that:

- All projects are implemented in compliance with all applicable health and safety laws, regulations, and program requirements.
- HASPs are developed, approved, and implemented in accordance with Bhate requirements. For projects that do not require a HASP, the requirements of the Bhate Corporate HASP shall be enforced.
- Bhate personnel and subcontractors (as applicable) understand the requirements of this Program HASP and any SSHPs and each individual understands his/her responsibility for plan implementation.
- Personnel have all required training and are capable of performing all assigned tasks.
- Facilities and equipment meet manufacturer's requirements and government regulations.
- Work rules are enforced.
- Inspections and incident investigations are conducted per program requirements.

- Effective corrective actions are implemented following inspections, audits, incident investigations, etc.
- Clients are notified using Bhate incident reporting procedures.
- Appropriate disciplinary action is implemented when necessary.
- Promptly address safety problems or issues that employees bring to their attention and involve technical resource personnel as necessary.
- Provide positive feedback (either verbal or written) to employees who exhibit safe behaviors.

When unsafe behaviors are noticed, managers should:

- Stop the unsafe task immediately, and investigate safer method.
- Discuss the behavior with the employee(s), including the possible consequences of such unsafe behavior.
- Document the observations and results of the discussion with the employee for inclusion in the project and/or personnel files.
- Report the behavior should it result in an incident and investigate the root cause in accordance with the Incident Reporting and Investigation Procedure.
- Instruct employees on appropriate safe behaviors.
- When necessary, schedule retraining for employees. Training may be conducted by a manager, qualified peer employees, or other resources as necessary.

5 SUBCONTRACTORS AND SUPPLIERS

a. Subcontractor Coordination/Control

The anticipated subcontractor(s) and their responsibilities on the Bhate team will include:

- Parsons Corporation for LTM field efforts
- TestAmerica Laboratories - Laboratory
- Redox Tech, LLC for in-situ treatments
- Local drillers and surveyors

Bhate will enforce the requirements of this Program HASP for both contractor and subcontractor project personnel. Bhate's subcontractor(s) will be required to comply with the requirements of this Program HASP and the OSHA standards contained in Title 29 of CFR Parts 1910 and 1926. The subcontractor(s) will also be responsible for site safety related to, or affected by, their operations and actions.

Bhate holds each subcontractor employee responsible for his own safety as well as the safety of those around him. The employee will use equipment in a safe and responsible manner as directed by the SSHO. Subcontractor activities/site work will be coordinated by the on-site FOM/SSHO. QC of subcontractors (and all site work) will be conducted in accordance with the approved UFP-QAPP.

b. Safety Responsibilities for Subcontractors

Bhate will enforce the requirements of this Program HASP for both contractor and subcontractor project personnel. Bhate's subcontractor(s) will be required to comply with the requirements of this Program HASP and the OSHA standards contained in Title 29 of CFR Parts 1910 and 1926. The subcontractor(s) will also be responsible for site safety related to, or affected by, their operations and actions.

Bhate holds each subcontractor employee responsible for his own safety as well as the safety of those around him. The employee will use equipment provided in a safe and responsible manner as directed by the SSHO. When an activity requires an OSHA competent person be present (i.e., confined space entry, trenching, excavation, etc.), the relevant subcontractor will be responsible for providing the name(s) of their designated competent person(s) and proof of their competency. The name of the competent person and proof of their competency will be added to Attachment 3 (Training Certificates and Proof of OSHA Competency from Subcontractors) of this Program HASP and submitted as an addendum. When an OSHA competent person is required due to the field activities to be performed, such work shall not be performed unless a designated OSHA competent person is present at the job site.

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6 TRAINING

a. Safety Indoctrination

Training for all site personnel will be consistent with requirements in Engineering Manual (EM)-385-1-1, 29 CFR Parts 1926 and 1910, when applicable. Site-specific training concerning site hazards, general health and safety procedures, and the contents of the Program HASP and the AHAs will be performed by the SSHO for all Bhate on-site personnel before field work can commence. This will consist of a review of the specific hazards of concern, risks, symptoms of exposure, and an overview of the Program HASP to include safety procedures and emergency contacts. The relevant AHAs will be covered in a preparatory safety meeting as each phase of work commences.

b. Training Requirements

Personnel performing supervisory duties will have received appropriate OSHA training. Required worker training is indicted in Table 6-1.

Table 6-1. Required Worker Training and Site-Specific Training

Required Worker Training	Site-specific Training Requirements
OSHA Hazard Communication-Global Harmonization System - (HAZCOM-GHS) training required by December 1, 2013 (All workers on-site) OSHA 40-Hour HAZWOPER Hazardous Waste Worker training - (SSHO, SSHO Alternate, and all personnel working in an Exclusion/ Hot Zone) Current OSHA 8-Hour HAZWOPER Annual Refresher training - (SSHO, SSHO Alternate, and all personnel working in an Exclusion/ Hot Zone) OSHA 8-Hour HAZWOPER Hazardous Waste Supervisor training - (SSHO and Supervisor over personnel working in an Exclusion/ Hot Zone) OSHA 30-hour for Construction - Site Safety and Health Officer training (SSHO and Alternate) First Aid/Cardiopulmonary Resuscitation (CPR)/Blood borne Pathogens - (SSHO, alternate SSHO ,and another person such as subcontractor supervisor) OSHA Competent Person - (SSHO or Designated Subcontractor Supervisor) Competent Person – Electrical and Excavation - (Designated Subcontractor, as needed) Competent Person - Confined Space Entry Monitoring - (Designated Subcontractor, as needed)	All personnel working on-site shall attend site-specific safety orientation/ training prior to starting on-site project work. This safety orientation training will be facilitated by the SSHO/FOM. The site-specific orientation/training will provide at a minimum: an overview of the project, anticipated hazards, control measures, and emergency response procedures as explained in this Program HASP.

On-site personnel (including managers and supervisors) will attend tailgate safety briefings each morning prior to beginning fieldwork. The daily meetings will be facilitated by the SSHO/FOM. Employees will be instructed on the requirements of the Program HASP and any additional safety or health concerns and discuss the proposed activities scheduled for the day. Any employee not present at the scheduled daily safety meeting shall be thoroughly briefed by the SSHO prior to starting work for the day. The SSHO will review any potential inclement weather conditions and emergency procedures to follow in the event of an accident or illness. A thorough review of the potential hazards, the protective measures to be taken to avoid those hazards, the proper use of any personal protective equipment (PPE) to be used, and the contents of the Program HASP will be conducted. Records of attendance at daily safety briefings, any site-specific training, and an employee endorsement of the provisions of the Program HASP will be maintained by the SSHO.

c. Periodic Training

In addition to the training required in Table 6-1 and the daily safety meeting, periodic training will be given by the SSHO when there is a need to promptly address safety problems or issues that employees bring to their attention, or site walk-around inspections discover. When necessary, the SSHO will schedule retraining for employees. Training may be conducted by a manager, qualified peer employees, or other resources as necessary. The corporate health and safety program requires continuous improvement for supervisors, managers, and employees. Increased safety knowledge and proactive behavior is encouraged through a series of safety messages and communications, online training, “read and sign” PowerPoint training, and review of safety procedures.

d. Emergency Response Training

For this scope of work, Bhate will rely on the local emergency services to respond to emergency situations. Bhate personnel are trained only to the HAZWOPER Emergency Response Awareness Level [29 CFR, §1910.120(q)] and will not be responsible for performing emergency response activities beyond recognizing and reporting the emergency. Spill Control Kits and fire extinguishers will be onsite. The SSHO shall verify the means to summon emergency rescue, firefighting, and medical services if needed. Maps and addresses of the nearest hospital and emergency contact numbers will be posted on a central job board and / or be on the dash board of the SSHO vehicle.

Shelter and evacuation procedures will be established and covered with all subcontractors during the safety orientation by the SSHO and posted on a central job board and / or be on the dash board of the SSHO vehicle.

7 SAFETY AND HEALTH INSPECTIONS

a. Internal Safety and Health Inspections

The SSHO will conduct daily informal safety and health inspections of the active field work areas. The inspection shall cover workplace conditions, physical area safety, and employee work practices. The SSHO shall document any deficiencies and corrective actions on the *Bhate Safety Audit Findings / Discrepancy Tracking* form (included in Attachment 2). A copy of the Safety and Occupational Health deficiency tracking log shall be mounted on or be adjacent to the bulletin board or a notice on the bulletin board shall state the location where it may be accessed by workers upon request. It shall be updated daily, as needed. If there is not a field trailer, the Discrepancy Tracking Log will be maintained in a binder in the SSHO's vehicle, available for review.

A formal weekly inspection shall be conducted by the SSHO using the *Site Health and Safety Inspection Form* found in Attachment 2 of this Program HASP. The SSHO will be responsible for ensuring all deficiencies noted are corrected immediately. If deficiencies cannot be corrected immediately, appropriate temporary countermeasures will be implemented that will ensure safety until more permanent countermeasures can be put in place. Deficiency, countermeasure, and completion tracking is the responsibility of the SSHO and shall be completed throughout the duration of the project. Deficiencies, including safety inspection findings, will be tracked using the standardized safety audit tracking spreadsheet titled *Bhate Safety Audit Findings / Discrepancy Tracking* (included in Attachment 2) indicating corrective actions required, due dates, and individuals responsible. The SSHO will be responsible for ensuring items are followed up and completed as required to ensure continued compliance. The Deficiency Tracking Log will be posted on the project bulletin board and updated daily per EM 385-1-1; 01A.12.d. If there is not a field trailer, the Discrepancy Tracking Log will be maintained in a binder in the SSHO's vehicle, available for review.

See Attachment 2 for copies of the site safety forms.

See Attachment 3 for copies of the SSHO appropriate training certificates.

b. External Safety and Health Inspections

External Safety and Health Inspections are not anticipated for this scope of work.

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8 ACCIDENT REPORTING

a. Exposure Data

A report of the man-hours worked, by Bhate and subcontractors, will be generated monthly. At the conclusion of the field work, the man-hours will be tallied, summarized, and available for submission to AFCEC as requested.

b. Accident Investigations, Reports, and Logs

The SSHO shall be responsible for compiling any incident reports and incident investigations as necessary and submitting them to the HSM and the COR by the end of the day of the occurrence and/or no later than 24 hours following the occurrence. The SSHO shall use the Bhate Incident Reporting and Investigation procedures (see Attachment 4 of this Program HASP).

Bhate will thoroughly investigate an incident / accident and submit the findings along with the appropriate corrective action(s) to the COR as soon as possible, but no later than 5 working days following the incident. Except for rescue and emergency measures, efforts will be made to not disturb the incident scene until it has been released by the investigating official. Bhate will implement corrective actions as soon as reasonably possible.

c. Notification of Major Accidents

In the event of a major accident or injury, immediate notification shall be made by the SSHO to the local fire or emergency department, to initiate incident response. The following require immediate notification:

- A fatal injury;
- A permanent total disability;
- A permanent partial disability;
- The in-patient hospitalization of one or more people resulting from a single occurrence;
- An employee's amputation or an employee's loss of an eye, as a result of a work-related incident; or
- Property damage of $200,000 or more.

Additionally, the HSM and the BEC/COR for AFCEC will also be notified immediately (after notifying first responders) of any major accident or injury. The SSHO shall make additional notification to Bhate management in accordance with the Bhate Incident Report procedure (see Attachment 4 of this Program HASP).

Updates will be given by the SSHO to the BEC/COR on a weekly basis summarizing accidents, injuries, concerns, or other safety related issues for the prior work week.

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9 PLANS REQUIRED BY THE SAFETY MANUAL

a. Layout Plans

The UFP-QAPP for Griffiss AFB contains the figures and layout maps for the various tasks of this contract.

At sites where field activities such as monitoring well installation, or environmental soil or groundwater sampling will occur, in order to maintain a safe work area, Bhate will establish a support zone (SZ) for the purposes of staging equipment and supplies. An exclusion zone (EZ) and contamination reduction zone (CRZ) will be established in and adjacent to the immediate work area to limit access to the work area and provide a controlled area for personnel and equipment decontamination. Bhate will demarcate the area using a combination of traffic cones, caution tape, construction fencing, and signage. The SSHO will control access to the work area. Where necessary, Bhate will employ spotters to guide equipment operators and vehicles transporting materials in tight work areas.

b. Emergency Response Plans

The SSHO shall, upon arrival on-site, contact the nearest medical center to notify them of the locations of work and types of activities to be performed on-site to verify their ability to respond to potential emergency situations. Upon arrival on-site, the SSHO shall verify with the site representative the availability of the nearest medical services. In the event of a medical emergency, use of ambulance services and medical facilities shall be determined by the first responders.

An emergency situation requiring response is considered to exist if:

- Any member of the field crew is injured in an accident or experiences or exhibits any adverse effects or symptoms of chemical exposure, or heat or cold stress.
- Safety monitoring indicates site conditions are more hazardous than anticipated and cannot be controlled or that an immediate danger to life or health exists.

After initial contacts have been made and the situation has stabilized, the SSHO will notify the FOM, PM, and HSM, as appropriate. An Incident Report form must be completed within 24 hours of the incident and the Incident Investigation Form must be completed within 5 days of the incident.

Emergency numbers to summons emergency response organizations are identified in Table 9-1 below:

Table 9-1. Facility and Team Emergency Contact Information

Agency or Name	Phone Number
Rome Fire Department 158 Black River Blvd N Rome, NY 13440	911 (Emergency) 315-339-7733 (Non-Emergency)
Rome Police Department 301 N James St #1 Rome, NY 13440	911 (Emergency) 315-339-7780 (Non-Emergency)
Rome Memorial Hospital 1500 N. James Street Rome, NY 13440	911 (Emergency) 315-338-7000 (Administrative) (see Figure 9-1)
Mohawk Glen Urgent Care **(on base - not a hospital)** 91 Perimeter Road Suite 100 Rome, NY 13441	911 (Emergency) 315-337-2156 (Administrative) (see Figure 9-2)
Site Safety and Health Officer (SSHO) – Dustin McNeil	720-463-3904 Office Cell 303-589-4564
Health and Safety Manager – Sally Smith	205-918-4032 Cell 205-983-4150
Griffiss AFB BEC/COR - David Farnsworth	518-563-2871

For emergency medical treatment, the map and directions to the Rome Memorial Hospital are included as Figures 9-1A and 9-1B.

For non-emergency medical treatment, the map and directions to Mohawk Glen Urgent Care are included as Figures 9-2A and 9-2B.

The SSHO or the other designated First Aid/CPR trained person (i.e., alternate SSHO, Subcontractor Supervisors) will administer appropriate first-aid treatment, including CPR, in medical emergency situations as needed. The SSHO or designee will call 911, as needed. The following general emergency procedures will be carried out in the event of an injury:

1. Notify the SSHO of the incident.
2. If the victim can be moved safely, remove him from the work area to a safe location.
3. Administer first-aid.
4. If medical assistance or ambulance is needed, call on-site 911.
5. If ambulance is not needed, but further medical evaluation is needed, transport the victim to the local medical facility (Figure 9-1 and Figure 9-2 provide directions and maps to the hospital and medical clinic from Griffis AFB).
6. Immediately notify the HSM and Griffiss BEC/COR of the incident and describe the emergency response actions taken.

9.b.1 Emergency Contacts

In the event of an emergency, local sources of assistance will be used. Prior to the commencement of the work, the SSHO will familiarize the field team with the location of the closest medical facility. Phone numbers and facilities for emergency use are provided for Griffiss AFB in Table 9-1.

After initial contacts have been made and the situation has stabilized, notify the SSHO/FOM, HSM, and Griffiss BEC/COR, as appropriate.

Please note: if 911 is called, the caller must inform the operator where the call is from so that the proper emergency response authorities are notified.

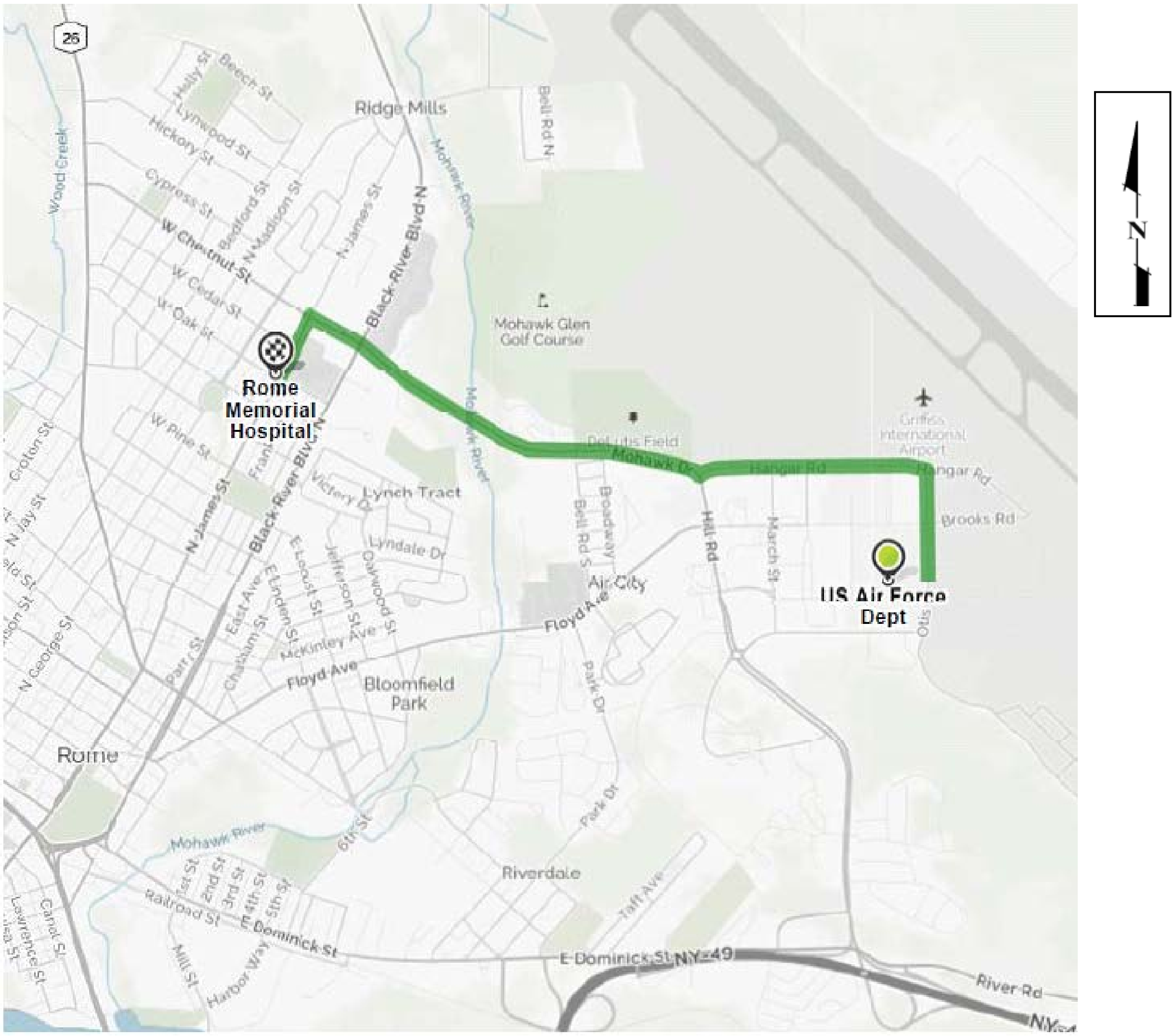
9.b.2 Directions to Designated Hospitals

See Figure 9-1A for map and Figure 9-1B for specific directions from Griffiss AFB to Rome Memorial Hospital.

See Figure 9-2A for map and Figure 9-2B for specific directions from Griffiss AFB to Mohawk Glen Urgent Care, a non-emergency medical facility on the base.

Figure 9-1A: Hospital Route Map

Rome Memorial Hospital



bhate ENVIRONMENT INFRASTRUCTURE	**HOSPITAL ROUTE MAP** Rome Memorial Hospital Phone: 315-338-7000 Source: Map Quest.com	GRIFFISS AFB Figure 9-1A
	Not to Scale / Date: November 2016	

Figure 9-1A: Hospital Route Directions

Rome Memorial Hospital

YOUR TRIP TO:
Rome Memorial Hospital

mapquest

5 MIN | 2.4 MI

Trip time based on traffic conditions as of 7:27 PM on June 27, 2016. Current Traffic: Light

From Griffiss AFB to Rome Memorial Hospital phone (315) 338-7000

1. Start out going **north** on Otis St toward Brooks Rd.

Then 0.33 miles — 0.33 total miles

2. Turn **left** onto Hangar Rd.

Hangar Rd is 0.1 miles past Brooks Rd.

Then 0.66 miles — 0.99 total miles

3. Turn **right** onto Mohawk Dr/NY-825. Continue to follow NY-825.

Then 1.26 miles — 2.25 total miles

4. Turn **left** onto N James St.

N James St is just past North Country National Scenic Trl.

Friendly's is on the corner.

If you are on W Chestnut St and reach North Country National Scenic Trl you've gone a little too far.

Then 0.20 miles — 2.45 total miles

5. Rome Memorial Hospital, 1500 N JAMES ST is on the **left**.

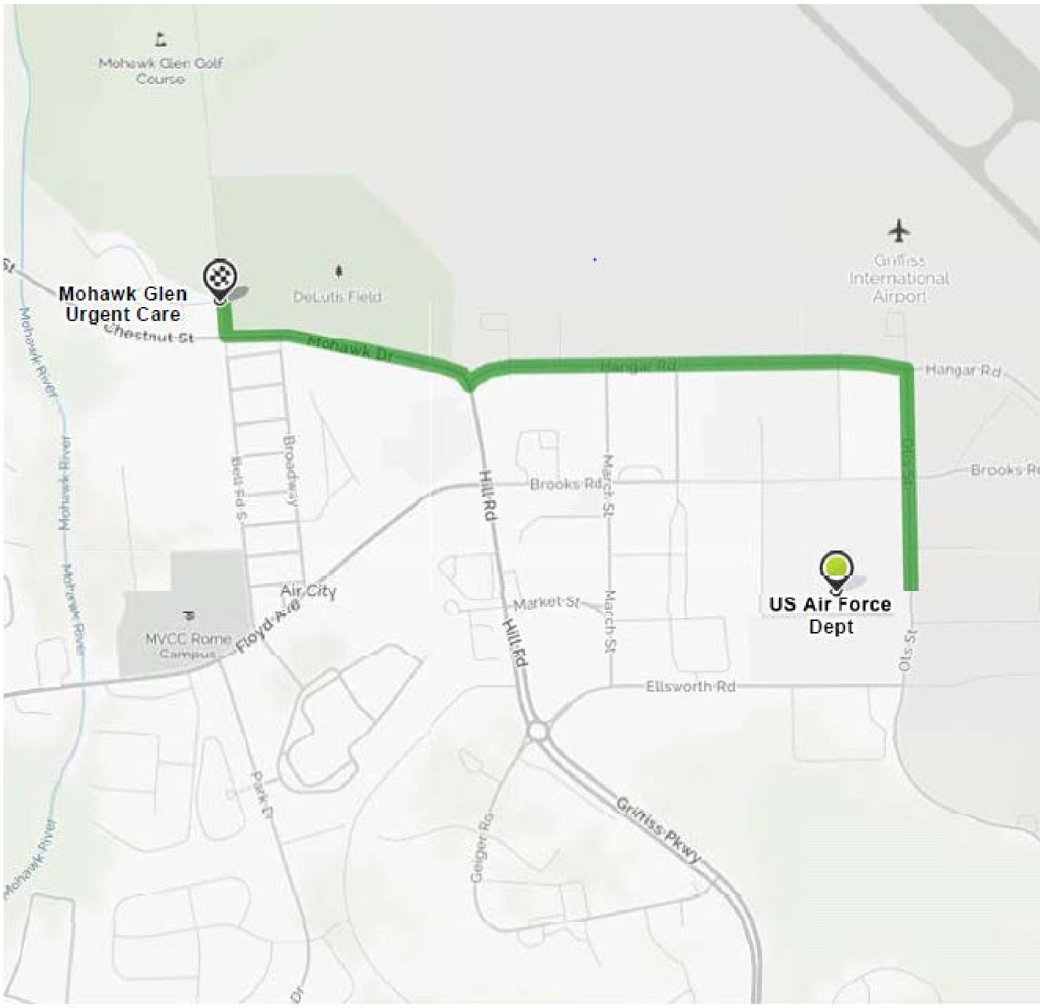
Your destination is just past W Cedar St.

If you reach E Oak St you've gone a little too far.

bhate ENVIRONMENT INFRASTRUCTURE	**HOSPITAL ROUTE MAP** Rome Memorial Hospital Phone: 315-338-7000 Source: MapQuest.com	GRIFFISS AFB Figure 9-1B
	Not to Scale / Date: November 2016	

Figure 9-2A: Clinic Route Map

Mohawk Glen Urgent Care



bhate ENVIRONMENT INFRASTRUCTURE	**CLINIC ROUTE MAP** Mohawk Glen Urgent Care Phone: 315-337-2156 Source: MapQuest.com	GRIFFISS AFB Figure 9-2A
	Not to Scale / Date: November 2016	

Figure 9-2B: Clinic Route Directions

Mohawk Glen Urgent Care

YOUR TRIP TO:

Mohawk Glen Urgent Care

3 MIN | 1.4 MI

Trip time based on traffic conditions as of 7:36 PM on June 27, 2016. Current Traffic: Light

From Griffiss AFB to Mohawk Glen Urgent Care (on base) Ph (315) 337-2156

1. Start out going **north** on Otis St toward Brooks Rd.
   Then 0.33 miles — 0.33 total miles
2. Turn **left** onto Hangar Rd.
   Then 0.66 miles — 0.99 total miles
3. Turn **right** onto Mohawk Dr/NY-825.
   Then 0.38 miles — 1.37 total miles
4. Take the 1st **right** onto Perimeter Rd.
   Then 0.05 miles — 1.42 total miles
5. Mohawk Glen Urgent Care, 91 PERIMETER RD is on the **left**.

bhate ENVIRONMENT INFRASTRUCTURE	**CLINIC ROUTE MAP** Mohawk Glen Urgent Care Phone: 315-337-2156 Source: MapQuest.com		GRIFFISS AFB Figure 9-2B
	Not to Scale	Date: November 2016	

9.b.3 Procedures for Evacuation of the Work Area

In the event that a member of the field crew is injured or experiences any adverse effects or symptoms of possible exposure (chemical or physical) while on-site, the impacted field crew will immediately halt work and act according to the instructions provided by the SSHO. The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated will result in the evacuation of the field team and reevaluation of the hazard and the level of protection required. If an emergency situation develops which requires evacuation of the work area, the evacuation procedures in Table 9-2 shall be followed.

Table 9-2. Evacuation Procedures

Evacuation Step	Methods and Comments
Notify affected workers	Use of site communication methods as applicable
Evacuate to safe location	Assemble at the rally point determined by Bhate and BEC
Assemble and account for workers	SSHO shall account for personnel using the Daily Safety Meeting Log
Notify Fire and Emergency Services	Notification as needed
Complete incident report	Follow the Incident Reporting and Investigation Procedure

Table 9-3 summarizes potential emergency situations and response actions that are applicable for the project.

Table 9-3. Potential Emergency Situations

In Case of	Response Actions
Injury or illness	Treat injury with applicable First Aid. All work related injuries beyond first aid will result in notification of Emergency Services and notification of the employee supervisor. Any employee requiring advanced medical treatment will be accompanied by a knowledgeable company employee that can answer potential questions on job duties and hazards. Make notifications in accordance with the Incident Reporting and Investigation Procedure.
Chemical exposure	First Aid shall be provided such as but not limited to: move victim to fresh air, remove contaminated clothing, flush affected skin with water, and seek medical attention.
Fire or explosion	Notify emergency services immediately. All personnel shall evacuate the immediate area of the fire and move to an upwind location. Personnel shall not engage in firefighting activities (use of fire extinguisher) unless trained to do so and only in the incipient stages of fire.
Adverse weather	Tornados, lightning, or other threatening weather conditions will result in an immediate shut down of operations and evacuation of personnel. Lightning proximity will be determined by measuring the time interval between the visually observed lightning flash and the subsequent sound of thunder. An interval less than 30 seconds will prompt the shutdown. **Operations will be shut down for the period of the storm passing plus an additional 30 minutes.**

In Case of	Response Actions
Material spill or release	Vehicles and equipment will be maintained and inspected so as to prevent fluid leaks. Should any vehicle fluid leaks occur, the equipment will be taken out of service to make necessary repairs and any contaminated material will be cleaned up and disposed of properly. Spill kits will be available to facilitate prompt containment and clean-up of spills. Notification will be made in accordance with the Incident Reporting and Investigation Procedure.

c. Alcohol and Drug Abuse Prevention Plan

The Bhate Substance Abuse Program is Section 3.11 in the Bhate Employee Manual and is administered under the direction of the Human Resources Manager. Section 3.11 is enforceable on-site and reads as follows:

"3.11 Substance Abuse

The Company is committed to the highest standards of integrity and professionalism in its work, and to the safety of its employees. For this reason, the Company does not condone abuse of alcohol or use of illegal drugs by employees. Illegal drugs include but are not limited to LSD, cocaine, crack, heroin, opiates, marijuana, or prescription or over-the-counter drugs used illegally. The term does not include proper use of a prescribed medication. The use or possession of illegal drugs, on or off duty, is inconsistent with law-abiding behavior and a potential threat to the safety of others and work efficiency. Further, possession or consumption of alcoholic beverages on company premises or while working, or being under the influence of alcohol while at work, is also a threat to employee safety and work efficiency.

Employees may be subject to discharge, even for a first offense, if the Company concludes that they are guilty of the following:

1. The use or unauthorized possession of alcohol on premises and/or Company worksite;
2. The on premises use (except for the proper use of prescribed drugs), manufacture, distribution, dispensing, possession, sale, soliciting, or purchase of any illegal drug or other controlled substance on Company premises or while working;
3. Testing positive for the presence of illegal drugs in the body;
4. Testing or behavior indicating the employee is under the influence of alcohol while at work or performing Company business;
5. Failing to properly notify the Company as to taking a legal drug the employee has reason to believe may create a safety risk to the employee or others;

6. The failure to report to the Company within five days any conviction (including guilty or nolo contendere plea) for a criminal drug offense in the workplace;
7. The conviction (including guilty or nolo contendere plea) of any criminal drug offense in the workplace;
8. The failure or refusal to consent to drug or alcohol testing, including, but not limited to, execution of appropriate authorizations to test , if so directed;
9. The attempt to alter, falsify, or interfere with a drug or alcohol test; and
10. Failure to cooperate with a search for illegal drugs or alcohol.

Knowledge of employees using, transferring, purchasing, or in possession of illegal drugs or controlled substances (unless legally prescribed) while working will immediately be called to the attention of the Human Resources Director. Failure to do so may result in discipline, including discharge.

Employees will not be disciplined for the proper use of a prescribed medication. However, any employee who has reason to believe that use of a prescribed drug or even an over-the-counter drug may present a safety risk to himself/herself or others must report such drug use to their supervisor in writing in advance of beginning work so that the Company can determine work-related consequences. The employee may be removed from working a job when, in the judgment of the supervisor, the employee’s performance while taking the medication presents a direct threat to the health or safety of the employee or others.

The Company may conduct searches for illegal drugs or alcohol on Company property, on worksites, and/or Company vehicles when management, at its sole discretion, determines there is reasonable suspicion to believe that illegal drugs or alcohol are present. At a Principal’s discretion, they may contact local law enforcement agencies to ask them to assist in the search. Those searches may include an employee's personal property, including, but not limited to the employee's vehicle, clothing, cooler, purse, parcels, and similar items.

Employees who believe they may have a substance abuse problem are encouraged to seek assistance. An employee's decision to seek assistance will not be used as the basis for disciplinary action. However, it is the responsibility of the employee to seek assistance before alcohol or drug use leads to conduct that results in disciplinary action. An employee's request to seek treatment will not be a defense to discipline imposed for prior misconduct. The Company may require an employee who is participating in a treatment program to undergo periodic testing at its discretion. Moreover, an employee seeking voluntary assistance, like any other employee, still must comply with all Company policies, and still may be disciplined or terminated for any noncompliance. Testing is not a necessary prerequisite to discipline or discharge if it is otherwise determined that this policy was violated.

3.11.1 Drug Screening

Employees may be required to take drug or alcohol tests;

1. When the employee is involved in a job related incident, which did or could have resulted in injury or property damage.
2. When the Company has reasonable suspicion to believe the employee is under the influence of drugs or alcohol. Employees may also be required to submit to random tests for illegal drugs.

An employee may also be disqualified from receiving employee benefits if the employee is discharged for the use of illegal drugs, or for refusal to submit to a test for illegal drugs or for alteration of a test specimen.

3.11.2 Work Related Accident - To Your Person, Others, or a Vehicle

Under Alabama law (Bhate corporate location), workers who are injured at the workplace or in the course of employment may be tested for drugs and alcohol, and if impaired, may not be paid benefits under the Alabama Worker's Compensation laws if the injury is a result of an accident caused by drug and/or alcohol impairment. Alabama Code §25-5-51 provides in part as follows:

A positive drug test conducted and evaluated pursuant to standards adopted for drug testing by the U.S. Department of Transportation in 49 [Code of Federal Regulations] CFR Part 40 will be a conclusive presumption of impairment resulting from the use of illegal drugs. No compensation will be allowed if the employee refuses to submit or cooperate with a blood or urine test as set forth above after the accident after being warned in writing by the employer that such refusal would forfeit the employee's right to recover benefits under this chapter.

The refusal to take tests for drugs and/or alcohol after an accident will forfeit your rights to recover benefits under the Alabama Worker's Compensation Act." **End of policy.**

d. Site Sanitation Plan

For this scope of work, the sanitation facilities will be provided, as necessary. At least one chemical toilet with adequate supply of toilet paper will be provided at the site. Additional chemical toilets will be provided when the site has 20 or more workers and the number increased as needed, in accordance with OSHA regulations. At least one additional chemical toilet will be provided when there are women and men workers on-site, in accordance with OSHA regulations.

A portable hand wash station will be provided. Hand towelettes are not sufficient. Bottled water will be provided when there is not potable water available.

Bhate will ensure any waste (common trash) generated during the performance of the work activities will be collected and disposed of properly. Housekeeping will be maintained continuously during the project.

e. Access and Haul Road Plan

Bhate will coordinate with the local staff at each location to establish defined routes as necessary for material handling and movement around the site. Where necessary, Bhate will employ spotters to guide heavy equipment operators and vehicles transporting materials in tight work areas. A general traffic pattern for the site will be established and will be communicated in advance to field personnel.

f. Respiratory Protection and PPE Plan

The use of respiratory protection is not expected to be required. However, if respirators are required, proof of medical clearance and fit testing will be provided to the BEC/COR for on-site personnel prior to use for those who wear respirators more than 30 days per year. A copy of the Bhate Respiratory Protection Program is included in Attachment 4 of this Program HASP. Table 9-4 lists the minimum PPE that will be required for the various activities within the scope of the project.

Table 9-4. Personal Protective Equipment by General Activity (Not by Task)

Activity	Head/Face	Foot	Hands	Respiratory	Clothing [3, 4]
Mobilization / Demobilization	Hard Hat (for overhead hazards), Safety Glasses[1] with rigid side shields	Steel toed safety boots	Leather gloves as needed	None	Minimum of long pants and shirts with a minimum 4-inch sleeve
General site labor	Hard Hat, Safety Glasses with rigid side shields, Face shield for grinding, Hearing Protection as needed	Steel toed safety boots	Leather gloves as needed	None Anticipated	Minimum of long pants and shirts with a minimum 4-inch sleeve, ANSI Class II Reflective Safety vests
Equipment Operation/ Monitoring Well Installation and Decommissioning	Hard Hat[2], Safety Glasses[1] with rigid side shields Hearing protection when working with noisy equipment (open cab) or tools Goggles for dusty conditions	Steel toed boots	Leather gloves as needed Nitrile or rubber gloves when handling fuels, wet grout, or other materials	Dust mask if mixing grout containing silica	Minimum of long pants and shirts with a minimum 4-inch sleeve ANSI Class II reflective safety vests when working around heavy equipment or traffic areas

Activity	Head/Face	Foot	Hands	Respiratory	Clothing [3, 4]
Soil, Surface Water, Soil Landfill Gas, or Groundwater Sampling	Hard Hat, Safety Glasses[1] with rigid side shields Hearing protection when working with noisy equipment (open cab) or tools	Steel toed boots	Leather gloves as needed Nitrile or rubber gloves when sampling	None	Minimum of long pants and shirts with a minimum 4-inch sleeve ANSI Class II reflective safety vests when working around heavy equipment or traffic areas
Fuels Recovery	Hard Hat, Safety Glasses[1] with rigid side shields Hearing protection when working with noisy equipment, motors or tools	Steel toed boots	Leather gloves as needed Nitrile or rubber gloves when contact with fuels	None	Minimum of long pants and shirts with a minimum 4-inch sleeve ANSI Class II reflective safety vests when working around heavy equipment or traffic areas
Excavation	Hard Hat[2], Safety Glasses[1] with rigid side shields Hearing protection when working with noisy equipment (open cab) or tools Goggles for dusty conditions	Steel toed boots	Leather gloves as needed Nitrile or rubber gloves when handling fuels, wet grout, or other materials	Dust mask if mixing grout containing silica	Minimum of long pants and shirts with a minimum 4-inch sleeve ANSI Class II reflective safety vests when working around heavy equipment or traffic areas
Injection of injectate using direct push technology (DPT)	Hard Hat[2], Safety Glasses[1] with rigid side shields Hearing protection when working with noisy equipment or tools Goggles for dusty or liquid conditions	Steel toed boots, disposable over bootie, as needed	Leather gloves as needed Nitrile or rubber gloves when handling injection materials, wet grout, or other materials	None	Minimum of long pants and shirts with a minimum 4-inch sleeve ANSI Class II reflective safety vests when working around heavy equipment or traffic areas

Notes: ANSI = American National Standards Institute
1 Safety Glasses with rigid side shields approved by ANSI Z-87 required at all times.
2 Hard hats are not required inside fully enclosed equipment cabs.
3 Disposable PPE (i.e. Tyvek coveralls, boot covers, chemical resistant gloves, etc.) may be used for the purpose of maintaining cleanliness.
4 Additional PPE may be included in the AHAs.
5 A portable hand/face wash station will be provided.

As indicated in Table 9-4, respiratory protection is not expected to be required during the project activities, except when there is potential exposure to silica dust. If required, respirators will be specified according to the hazard. Personnel who may be required to wear a respirator during any phase of site activities must comply with the requirements of the Bhate Respiratory Protection Program. A qualified person will be assigned as respiratory protection manager for the project as necessary.

g. Health Hazard Control Program

This Program HASP serves as the health hazard control program for this scope of work. Exposure through inhalation, ingestion, skin absorption, or physical contact, to any chemical, biological, or physical agent in excess of the acceptable regulatory limits specified in the most recently published American Conference of Governmental Industrial Hygienist (ACGIH) "*Threshold Limit Values and Biological Exposure Indices*" or by OSHA, whichever is more stringent, will be prohibited. Every effort will be made by Bhate and its subcontractors to reduce contaminant concentration levels as low as is reasonably achievable (ALARA). Personnel will minimize exposure potential by wearing the appropriate PPE at all times while inside the work area. Hazardous chemicals and physical agents will be assessed based on the activities performed.

Spills or leaks will be contained and immediately reported to the SSHO. Only employees trained in 40-hour OSHA HAZWOPER will be permitted to respond to spills or leaks.

Exposure monitoring will be conducted at the discretion of the SSHO based on-site conditions unless otherwise specified. In the absence of a noise survey, 85 decibels “A-weighting scale” (dBA) will be considered to be the level at which two persons with normal hearing, standing at arm’s length, cannot converse in normal tones and will require the use of appropriate hearing protective devices (HPDs) in the form of ear plugs or muffs.

If work is stopped due to any health and safety concern, immediate attention should be given by health and safety personnel working in cooperation with the PM to identify and correct the cause of concern as quickly as possible. Any such incident should be fully documented by the SSHO in a report to the HSM and PM. In the event of a work stoppage, the PM must be notified as soon as possible and kept apprised of progress in resolving the incident until normal operations are resumed.

h. Hazard Communication Program

9.h.1 Chemical Hazard Communication

Fuels, lubricants, and coolants necessary for equipment operation are the anticipated hazardous materials that will be brought on-site by Bhate or their subcontractors for this scope of work. A Safety Data Sheet (SDS)/Material Safety Data Sheet (MSDS) will be obtained for all materials and reviewed with all affected employees prior to use. A copy of the SDS/MSDS will also be submitted to the Bhate HSM. All containers will be properly labeled and kept closed when not in use.

A SDS/MSDS for all chemicals brought on-site must be submitted to the SSHO and the HSM. A copy of all SDSs/MSDSs must be kept on-site as well as in the Corporate Office. All employees on-site must review the SDS/MSDS for all chemicals used. New SDSs/MSDSs will be reviewed during the daily safety briefing conducted by the SSHO. All containers must be labeled at a minimum with the identity of the chemical contents and the associated hazards. The National

Fire Protection Association (NFPA) diamond label shall be used for all temporary or transfer containers used on-site. The appropriate rating will be filled in for each hazard category based on the SDS/MSDS. Red = Fire Hazards, Blue = Health Hazards, Yellow = Reactivity Hazards, and White = other hazards (i.e. water reactive or oxidizer). All subcontractors are responsible for submitting a SDS/MSDS for all chemical products brought on-site. A copy of the Bhate Hazard Communication Program is included in Attachment 4 of this Program HASP.

The types of hazardous chemicals (as defined in 29 CFR §1910.1200) that may be brought and used on-site are identified below in Table 9-5. The use of these materials shall be in accordance with their intended use. A project specific chemical inventory and file of applicable SDSs/MSDSs will be maintained by the SSHO at the project sites.

Table 9-5. Sample Chemical Identification

Chemical Name	Amount	Location	Purpose
Assorted fuels, lubricants, coolants, etc. necessary for equipment operation	Quantities limited to immediate use requirements of on-site equipment	On-site vehicles and equipment	Equipment servicing and operation
Grout and bentonite	Quantities limited to immediate use requirements	At monitoring wells	May be needed during monitoring well activities
Injection compound, if needed	To be determined	To be determined	Injecting using DPT

9.h.2 Communication Tools

Cellular telephones will be available to contact emergency services as required. Refer to the Corporate HASP and Section 9.b of this Program HASP for emergency situations and appropriate actions and contacts. Site communication amongst employees shall be a combination of audio, equipment/air horns, and/or line of sight hand communications. Some common hand communication signals include the following:

- Hand gripping throat: Can't breath
- Grip partner's wrist or both hands at waist: Leave area immediately
- Hands on top of head: Need assistance
- Thumbs up: OK, I'm all right, I understand
- Thumbs down: No, negative

Cellular telephone use is not permitted while operating equipment.

i. Process Safety Management Plan

Not applicable for this scope of work.

j. Lead Abatement Plan

Not applicable for this scope of work.

k. Asbestos Abatement Plan

Not applicable for this scope of work.

l. Radiation Safety Program

Not applicable for this scope of work.

m. Abrasive Blasting

Not applicable for this scope of work.

n. Heat/Cold Stress Monitoring Plan

9.n.1 Heat Stress

The prime objective of heat stress management is the prevention of heat stroke, which is life-threatening and the most serious of the heat-related disorders. Personnel will be made aware that heat stress can occur during periods of elevated ambient temperatures. This hazard significantly increases with moderate to heavy workloads and when impermeable protective clothing is in use. Personnel will be informed regarding the various forms of heat stress (e.g., heat cramps, heat exhaustion, and heat stroke) and the signs and symptoms of exposure. Initial symptoms of heat cramps and heat exhaustion are cramps, faintness, dizziness or disorientation, and pale, clammy skin. Heat stroke is an extremely serious medical emergency with sudden onset and symptoms that include dilated pupils, dry and hot skin, loss of consciousness, and/or convulsions. Heat stroke can be fatal if not promptly and properly treated.

At the beginning of the fieldwork, site safety training and discussions will focus on the heat stress monitoring plan. Training components will include:

- Knowledge of the hazards of heat stress;
- Recognition of predisposing factors, danger signs, and symptoms;
- Awareness of first-aid procedures for heat stroke;
- Employee responsibilities in avoiding heat stress;
- Increased risk of heat symptoms when taking some medicine;
- After work alcohol consumption increases risk of heat symptoms in hot work environments;
- Use of protective clothing and equipment; and

- Discussion of environmental and medical surveillance programs.

During the daily tailgate safety meetings, the SSHO will discuss the anticipated high temperature for the day with all personnel to be on-site. Tasks to be performed during the day will be scheduled such that heavier-load work will be accomplished during the cooler parts of the day, or so that work-rest breaks may be incorporated into the work schedule. A wet-bulb globe thermometer will be used on-site as needed.

Work-Load Assessment

Work-Load Assessment is categorized by caloric expenditure for each job position. Under conditions of high temperature (greater than 75 degrees Fahrenheit [°F]) and medium or heavy work-load, the SSHO will determine the work-load category of each job using the "Screening Criteria for Threshold Limit Values and Action Limit for Heat Stress Exposure" provided in Attachment 6 of this Program HASP.

9.n.2 Heat Stress Monitoring

A monitoring program for heat stress in accordance with ACGIH Threshold Limits Values (TLV) Booklet for Heat Stress (see Attachment 6) will be implemented for work in elevated ambient temperatures (greater than 70°F) and personnel wearing impermeable protective garments or work requiring the use of a respirator. Initial phases of work activity are closely monitored to identify personnel who are more susceptible to heat exposure or who may have other risk factors such as elevated alcohol/drug use or cardiovascular disease. A wet-bulb globe thermometer will be used on-site as needed. Workers are responsible for observing each other and themselves for development of heat stress symptoms.

Controls

Below is a summary of controls that may be used during fieldwork.

Skin Protection and Clothing Selection – Where employees are exposed to solar radiation for short periods and there is the potential for sunburn or exposure for prolonged periods where long-term exposure could lead to health effects such as skin cancer, employees will be provided sunscreen with a sun protection factor (SPF) appropriate for their skin type and exposure, at a minimum of SPF 15. Sunscreens will be used only in accordance with the manufacturer's recommendations. Lightweight, breathable reflective clothing will also be recommended to be worn by field personnel.

Fluid Replacement – Personnel will be encouraged to drink generous amounts of water and electrolyte replacement fluids (even if not thirsty) to prevent dehydration. Cool water or any cool liquid (except alcoholic beverages) will be made available to workers to encourage them to drink small amounts frequently, e.g., one cup every 20 minutes.

Sunshield or Other Shelter – Adequate shelter will be provided if determined necessary to protect personnel from direct sun exposure.

Wetted Clothing – Wetted clothing is a simple and inexpensive personal cooling technique that is particularly effective when reflective or other impermeable protective clothing is worn. A suggested method involves wetting a terry cloth towel with cold water and placing it on the back of the neck.

9.n.3 Cold Stress

Since prolonged exposure to cold air, or to immersion in cold water, at temperatures well above freezing can lead to dangerous hypothermia, whole body protection must be provided. Adequate insulating dry clothing to maintain core temperatures above 36 degrees Celsius (°C) (96.8 °F) must be provided to employees working in air temperatures below 4 °C (40 °F). Wind chill cooling rate and the cooling power of air are critical factors (see Attachment 6). Employees working under these conditions will use the work/warm-up schedule in Attachment 6 of this Program HASP. Personnel will be made aware of the signs and symptoms of cold stress during daily safety meetings and will review the cold stress plan during review of the related AHA.

Employees who become immersed in water or whose clothing becomes wet will immediately change into dry clothing/blankets and be treated for hypothermia. Blankets will be included as part of the first aid equipment on such activities, and employees will ensure they have a change of clothing.

Cold weather sheltering and clothing will be provided as follows:

- If wind chill is a factor at a work location, the cooling effect of the wind will be reduced by shielding the work area or requiring employees to wear an outer windbreak layer garment.
- Extremities, ears, toes, and nose will be protected from extreme cold by proper clothing such as hats, gloves, masks, etc. Employees whose clothing may become wet will wear an outer layer of clothing that is impermeable to water.
- Outer garments will provide for ventilation to prevent wetting of inner clothing by sweat.
- If clothing is wet, the employee will change into dry clothes before entering a cold environment.
- Employees will change socks and removable felt insoles at regular daily intervals or will use vapor barrier boots.
- Due to the added danger of cold injury due to evaporative cooling, employees handling evaporative liquid (such as gasoline, alcohol, or cleaning fluids) at air temperatures below 40 °F (4 °C) will take precautions to avoid soaking of clothing or contact with skin.
- Eyewear providing protection against ultraviolet light, glare, and blowing ice crystals will be provided to employees in snow and/or ice-covered terrain.

Environmental monitoring will be conducted in accordance with the guidelines set by the ACGIH TLV for Cold Stress (see Attachment 6).

If employees express a concern about their ability to work in a cold environment, they will provide medical documentation on their ability to work in cold weather (30 °F [-1 °C] or below). If medical documentation is provided that shows they are suffering from diseases or taking medication that interferes with normal body temperature regulation or reduces tolerance to work in cold environments, they will be excluded from the cold weather tasks.

Localized injuries resulting from cold are included in the generic term "frostbite."

o. Crystalline Silica Monitoring Plan (Assessment)

There is a potential for minimal employee exposure to silica dust during mixing of Portland cement when making grout for capping a monitoring well. Personal exposure to silica will be monitored in accordance with National Institute for Occupational Safety and Health (NIOSH) and OSHA sampling methods. Employee airborne exposure to crystalline silica shall not exceed the 8-hour time weighted aver (TWA) limit as specified by the ACGIH in their "Threshold Limit Values and Biological Exposure Indices" or by OSHA, whichever is more stringent.

9.o.1 Integrated Personal Air Monitoring

Integrated personal air monitoring refers to the continuous collection of a sample over a period of time for subsequent analysis, usually by a laboratory. Silica monitoring involves the use of portable sampling pumps, the filter media, and a cyclone to separate particle size.

Personal sampling and analysis will be performed in accordance with the OSHA Industrial Hygiene Technical Manual, the NIOSH Manual of Analytical Methods, or other acceptable industrial hygiene practices. Only analytical laboratories accredited by the American Industrial Hygiene Association (AIHA) shall perform sample analysis. The laboratory analysis will include field blanks, as required by the individual method or laboratory. The laboratory shall also be a successful participant in the NIOSH Proficiency Analytical Testing (PAT) program for the appropriate analytical category. Prior to sampling, the specific sampling and analytical method will be discussed with the receiving laboratory to determine any special requirements or variations to established methods necessary to collect an acceptable sample.

Sampling and analytical information for personal sampling shall be recorded on the Air Monitoring Data Sheet (Integrated Air Monitoring). To ensure timely reporting of analytical results, personal air sampling media shall be sent to the laboratory within 5 working days of the date collected or as specified by the laboratory analysis method and analyzed with normal laboratory turnaround time.

9.o.2 Training

Persons conducting site silica monitoring shall have adequate training and/or experience commensurate with the type and complexity of the monitoring program. They should be able to understand the limitations of the equipment they use, proper methods of calibration, proper methods of sealing and shipping samples, and the importance of chain-of-custody.

9.o.3 Calibration

All instruments shall be calibrated (or checked for proper function if appropriate) before use for each shift. Instrument calibration shall be documented on sample data sheets or in logbooks. Calibration checks may be necessary during the day and at the end of use to confirm instrument accuracy. Duplicate readings may be taken to confirm individual instrument response. Air sampling pumps will be calibrated with primary standards (e.g., dry calibrator or bubble-tube method).

9.o.4 Operation and Maintenance

All instruments shall be operated and maintained in accordance with the manufacturer's specifications. The manufacturer’s operation and maintenance manual will be kept at the site work location for each type of instrument that is being used.

9.o.5 Sample Shipment

Samples sent to a laboratory for analysis shall be packaged to prevent damage, spillage, or leaks. An air or bulk sample data sheet with chain-of-custody information must accompany any sample shipped.

Filter cassettes should be mailed in a cardboard box and packed with paper. Avoid using packaging peanuts or other static producing material because the static charge will draw material away and off the filter surface. Filter cassettes shall be taped over the top and bottom to keep the plugs on the end of the cassette and to prevent sample tampering prior to analysis.

9.o.6 Data Review

The HSM or other qualified person will assess and interpret monitoring data and results based on standard industry practices and her professional judgment. Calculations performed on raw data (e.g., time-weighted-average calculations) shall be documented and reviewed by another qualified person.

9.o.7 Recordkeeping and Posting

The SSHO is responsible for maintaining adequate records of site monitoring activities, communicating or posting exposure information, and informing employees of monitoring result as may be required. Integrated personal air sampling results shall be communicated in writing to affected employees within 5 days of receiving laboratory results. Employee exposure records are to be kept by the employer and made available in accordance with 29 CFR §1910.1020 and §1926.33.

p. Night Operations Lighting Plan

Most work is expected to be performed during daylight hours. Bhate will arrange for overhead lighting when night work will be scheduled and will use lighting systems for visibility and hazard identification at night as necessary.

q. Fire Prevention Plan

Accumulation of flammable materials shall be monitored and overseen by the SSHO or the competent person appointed by the SSHO adhering to OSHA standards.

Equipment and systems which are potential ignition sources shall be monitored and overseen by the SSHO or the competent person appointed by the SSHO.

Housekeeping will be done on a daily basis and overseen by the SSHO. Materials will be disposed of in containers designated for this use.

Anticipated fire ignition sources would include matches or lighters for personal smoking use and sparks from saws, grinders, and other power tools. Smoking is discouraged and shall only be conducted in locations outside the work area designated by the SSHO on personal break time. Any spark or flame producing activity on-site will require a hot work permit issued by the local contact to be approved by the SSHO as described in Section 25 of Attachment 4. Flammable and combustible materials will be kept at a distance of at least 50 feet during any spark producing activity. Based on moderate hazard levels, one fire extinguisher rated 2A-10BC shall be positioned for every 3,000 square feet (ft^2) of floor space on each level and no further than 75 feet from any work area.

It is not anticipated that hot work operations will be conducted during the environmental restoration program activities. If needed, an AHA will be prepared and the subcontractor shall obtain a hot work permit from the installation staff/fire department prior to any hot work operations on the project site. The subcontractor must provide a fire watch in the immediate area with a fire extinguisher for all hot work activities. The fire watch employee must be present during all hot work and for a period of 1 hour after the hot work is complete.

r. Wild Land Fire Management Plan

Not applicable for this scope of work.

s. Hazardous Energy Control Plan

Temporary power sources used will be equipped with ground fault circuit interrupters (GFCI).

The intended use of this Hazardous Energy Control (HEC) Plan is to safeguard all personnel working and on this project from all potential forms of hazardous energy. Hazardous energy is defined as electrical, mechanical, hydraulic, pneumatic, chemical, thermal, gravitational or any other form of energy that could cause injury due to the unintended motion energizing, start-up, or release of such stored or residual energy in machinery, equipment, piping, pipelines, or process systems.

In order to coordinate and communicate the HEC activities, Weekly Safety Meetings specific to the tasks being accomplished shall be conducted by the SSHO and will be held with all personnel about the potential impacts and requirements of this plan. This Plan will be on-site and available at all times to all employees.

Bhate will fully coordinate control activities with the BEC throughout the planning and implementation of these activities. Each shall inform the other of their HEC plans and procedures, ensure that their own personnel understand and comply with rules and restrictions of the procedures agreed upon to be used for the job, and ensure that their employees affected by the hazardous energy control activity are notified when the procedural steps outlined in the HEC plan are to be initiated.

To document the applicability of Lockout/Tagout or the appropriate alternative safety procedure, the *Lockout/Tagout Permit* form shall be completed including each piece of equipment (or generally for multiple machines) and maintenance tasks, the required energy isolation and lockout point or alternative procedure which is applicable.

Before work is begun, the person in charge shall ascertain by inquiry, by direct observation, or by instruments, whether any part of an electric power circuit (exposed or concealed) is located such that the performance of work could bring any person, tool, or machine into physical or electrical contact with it.

Alternative to Lockout/Tagout:

a) Extension tools or procedures that eliminate exposure to hazardous machinery movement when the equipment must be in operation during servicing are provided and available and employees are trained and familiar with these practices.

b) Unplugging an electrical power cord or completely separating equipment from its energy source and releasing all stored energy, if the craftsman/operator has exclusive control (observation) of the plug or other connection equipment and /or a locking or disabling safety device is affixed to the plug or other connecting equipment.

The following procedural steps for shutting down, isolating, blocking, and securing machines or equipment to control hazardous energy shall be implemented in the order indicated.

a) The person responsible for the lockout/tagout shall notify other affected employees.

b) An authorized employee shall identify the type of energy source and how to control the energy.

c) An authorized employee shall initiate the shutdown procedure if the machinery is running.

d) The energy isolating devices (s) will be deactivated.

e) Lockout of the energy isolating devices with assigned individual locks and tagging to notify other employees shall be affixed to the lockout point.

f) Stored energy shall be released by grounding, bleeding, blocking etc.

g) A log shall be maintained of all lockout/tagout including the date and time on and the date and time off, the affected machinery and purpose of the lockout as well as the name and phone number of the person responsible.

h) Upon completion of the lockout/tagout job, procedures to restore equipment to service shall be used, including notifying affected employees and safe startup methods shall be implemented. Before the last lock or tag is removed, the authorized person shall check to ensure that all tools have been removed from the work area and the system is completely assembled. As each employee completes their work task, they shall remove their own lock or tag. All employees are to be clear of the equipment. All employees who work in the area are notified that the lockout/tagout is being removed. The supervisor shall then be advised that the equipment is ready to be put back in service.

Any personal grounds needed for grounding equipment shall be placed only by a certified electrician. A written notice of the date the ground was set and who set the ground shall be included in the daily report. The ground shall only be removed by the person who placed it.

Testing to verify effective de-energization and the effectiveness of isolation and lockout/tagout devices shall be conducted thru the use of calibrated voltmeters set to the correct voltage. Before starting work on locked out equipment, authorized employees must know that the equipment has been de-energized by showing that the main disconnect switch or circuit breaker can’t be moved to the on position, by pushing buttons or other normal operating control(s) and/or by other test to make sure that the equipment will not operate. Other energy isolating devices include but are not limited to: a manually operated electrical circuit breaker; a disconnect switch a line valve; a block or similar device that block or isolates energy.

In the event that responsibility for a lockout needs to be transferred, the following procedures shall apply:

a) Transfers when both responsible parties are present shall be accomplished by the removal of the current lock and tag and replacement by the transferred lock. The transferee shall complete and affix a tag or sign to the lockout.

b) Transfers which cannot be accomplished with both responsible parties present shall be accomplished through an intermediary, who will affix his lock and tag to the lockout point during the interim period.

There will be No Multi-Shifts on this project.

GFCI will be used on all electrical tools, extension cords, equipment, and temporary power.

Only construction grade hard duty extension cords will be used. Cords will be protected from damage and/or standing water at all times.

All electrical tools, cords, and equipment shall be inspected daily for damage. Damaged tools, cords, or equipment will be tagged and taken out of service immediately.

"Plug in hand" procedure with the device unplugged and the plug under exclusive control of the operator will be followed when changing bits, saw blades, or other attachments on powered hand tools. Lockout/tagout procedures will be followed where the operator cannot maintain exclusive control of the plug and/or where a guard or other safety device must be removed/disconnected.

All equipment shall be covered by a safe clearance (or lockout/tagout procedures) and all energy sources shall be controlled before performing service or maintenance on equipment in which the unexpected energizing, startup, or release of stored energy could occur and cause any of the following: personal injury, property damage, loss of content, loss of protection, loss of capacity, or harm to the environment.

No work will be performed on live circuits.

Bhate is responsible for the HEC procedure of their subcontractors.

Only authorized employees may apply their locks.

All employees are to be notified before completion of application and removal of locks.

9.s.1 Work Near Power Lines

Not applicable for this scope of work.

t. Critical Lift Procedures

Critical lifts are defined as lifts for which any of the following conditions exist:

- Any lift of 30,000 pounds or more;
- The weight of the lift exceeds 75 percent of the crane's rated capacity in the configuration that will be used during the lift;
- Lifts for which the path of travel is out of the operator's view;
- Lifts made with more than one piece of lifting equipment;
- Lifts involving non-routine or difficult rigging arrangements;
- Hoisting of personnel with a crane or derrick;
- Lifts involving high value items where damage would result in an unacceptable financial or production loss; or
- Any lift which the lifting equipment operator believes should be considered critical.

u. Contingency Plan for Severe Weather

In the event of adverse weather such as tornados, lightning, or other threatening weather conditions, the SSHO will shut down all work activities and personnel will be required to evacuate or seek shelter, as directed by the National Weather Service (or as appropriate). If required, personnel will assemble at the rally point determined by Bhate and the COR and then go to the safe shelter. The SSHO will monitor National Weather Service announcements/warnings/advisories to keep up with weather conditions during the project.

Site operations will be curtailed and all field employees will shelter in project vehicles or trailers if the time interval between lightning flashes and the subsequent thunder is 10 seconds or less. Site work may resume when lightning and thunder is no longer detected or after 30 minutes have passed from the last detection of lightning and thunder that is greater than a 10 second interval. Tornado warnings issued for the work site area shall result in a stoppage of work for the duration of the warning. Sustained winds in excess of 35 miles per hour shall result in a stoppage of work.

Bhate personnel will adhere to Griffiss AFB's Severe Weather Plans and rally points, as required.

v. Float Plan

Not applicable for this scope of work.

w. Site Specific Fall Protection and Prevention Plan

All work from greater than (>) 6 feet in elevation on an unprotected ledge or work surface will require the use of fall protection (i.e. full body harness, lanyard, sling, lifeline, etc.). This includes work from ladders, all work from extendable reach and aerial lift platforms/manlifts, roof work, any area with incomplete guardrails, and any other affected areas.

Bhate's subcontractors shall be responsible for implementing an appropriate Fall Protection Plan as necessary for their work conducted on-site. Employees shall only be allowed to work on walking/working surfaces which have the strength and integrity to support employees safely.

Employees performing work on a walking/working surface with an unprotected side or edge which is 6 feet or more above a lower level shall be protected from falling by the use of guardrail systems, safety net systems, or personal fall arrest systems. Any use of man lifts or scissor lifts shall require the use of personal fall arrest systems. All scissor lifts will be equipped with guardrails and only qualified, trained personnel will operate this equipment.

For roof work on low-slope roofs, work on steep roofs, and work near wall openings, fall protection provisions as described in 29 CFR §1926.501(b) shall be used.

Ladders will be inspected by a competent person or the SSHO on a daily basis and conform to OSHA regulations.

The SSHO and an appointed competent person will have the responsibility to implement the fall protection plan.

A copy of the Bhate Fall Protection Plan is included in Attachment 4 of this Program HASP.

x. Demolition Plan

Bhate will develop an operational approach for any demolition if it is needed within the scope of the project. This approach will be based on firsthand experience with similar projects and consultation with in-house specialists. The plan will be protective of Bhate and subcontractor personnel, as well as, the environment.

If demolition were needed, characterization of demolition material to be removed and handled at the site will be conducted. The characterization will allow for waste recycling/disposal and identify potential hazards that could be encountered by workers on-site.

y. Excavation and Trenching Plan

9.y.1.1 Purpose

This program provides the requirements for activities involving excavations.

9.y.2 Scope

These requirements are applicable to all Bhate operations.

9.y.3 Definitions

Benching

Benching is a method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

Competent Person

A competent person is one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Excavation

Any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal is considered excavation.

Hazardous Atmosphere

An atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Protective Systems

Protective systems are a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Sloping

A method of protecting employees from cave-ins by forming sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Support System

Support system is a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.

Trench

A narrow excavation made below the surface of the ground. In general the depth is greater than the width, but the width of a trench measured at the bottom is not greater than 15 feet. If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet or less, the excavation is also considered to be a trench.

9.y.4 Discussion

Responsibilities of the Competent Person

The competent person(s) will be responsible for:

- Day-to-day oversight of open excavations and trenches;
- Conducting soil classifications;
- Selection of protective systems;
- Conducting daily inspections of open excavations and trenches; and
- Maintaining all the required documentation in the project files on a daily basis.

Project Management Personnel

The FOM will be responsible for:

- Ensuring compliance with this procedure;
- Providing the necessary resources for compliance with this procedure; and
- Designating competent personnel in consultation with the HSM.

Health and Safety Manager

The HSM will be responsible for:

- Providing oversight on the implementation of the requirements contained in this procedure;
- Conducting periodic reviews of open trenches and excavations;
- Consulting with the project manager and competent person on excavation issues; and
- Ensuring required documentation is maintained.

9.y.5 Designation of Competent Personnel

Prior to the start of any excavation work the project manager will designate a competent person to fulfill the requirements of this procedure.

9.y.6 General Requirements

The following section provides general requirements governing activities in and around excavation and trenches, as well as the requirements for the selection and use of protective systems.

- Surfaces surrounding open trenches and excavations will have all surface hazards removed.
- All utilities will be located and cleared prior to initiating digging. Public or facility utility groups will be utilized where possible for this purpose. In the absence of either, the HSM will specify the procedures to be used to clear utilities in consultation with the FOM and PM. When the excavation is open, utilities will be supported and protected from damage. Clearance and support methods will be documented on the daily inspection checklist.
- Where structural ramps are used for egress they will be installed in accordance with 29 CFR §1926.651(c) (1).
- Stairways, ladders, or ramps will be provided as means of egress in all trenches 4-feet or more in depth. Travel distance will be no more than 25-feet between means of exit.
- Employees exposed to vehicular traffic will wear reflective traffic vests.
- No employee will be permitted under loads being lifted or under loads being unloaded from vehicles.
- When vehicles and machinery are operating adjacent to excavations, warning systems such as stop logs or barricades will be utilized to prevent vehicles from entering the excavation or trench.
- Scaling or barricades will be used to prevent rock and soils from falling on employees.
- Excavated and loose materials shall be kept at least 2 feet from the edge of excavations, preferably more.
- Walkways or bridges with standard railing will be provided at points employees are to cross over excavations or trenches.
- Barriers will be provided to prevent personnel from inadvertently falling into an excavation.

9.y.7 Hazardous Atmospheres

Where atmospheres containing less than 19.5 percent oxygen or other types of hazardous atmospheres may exist, the following requirements will be implemented.

- Atmospheric testing will be done prior to employees entering excavations 4-feet or greater in depth.
- Testing methods will be listed on the daily inspection checklist and results documented daily in field logs.
- Control measures such as ventilation and PPE will be used to control employee exposure to hazardous atmospheres below published exposure limits.

- Ventilation will be used to control flammable and combustible vapors to below 10 percent of their lower explosive limit (LEL).
- Testing will be repeated as often as necessary to ensure safe levels of airborne contaminants.
- Emergency equipment will be provided and attended when the potential for a hazardous atmosphere exists. This equipment will include but not be limited to emergency breathing apparatus, harnesses, lifelines, and basket stretchers. Required equipment will be listed on the daily inspection checklist and reviewed daily.

9.y.8 Protection from Water Hazards

When water has collected or is collected in excavations and trenches the following requirements will be applied.

- Employees will not work in excavations in which water has, or is, accumulating without the use of additional protection such as special support systems or water removal.
- Water removal will be monitored by a competent person.
- Barriers such as ditches and dikes will be used to divert runoff from excavations and trenches.
- Trenches will be re-inspected prior to re-entry after water accumulation due to heavy rainfall or seepage.

9.y.9 Stability of Adjacent Structures

When excavating or trenching near an adjacent structure the following practices will be implemented.

- Support systems such as shoring, bracing, or underpinning will be provided where the stability of buildings, walls, or other structures is endangered by excavation.
- Excavation bases or footings of foundations will be prohibited unless support systems are used, the excavation is in stable rock, and a professional engineer has determined the structure is sufficiently removed from the site as to not pose a hazard, or a Professional Engineer determines that the excavation will not pose a hazard to employees due to the structure.
- Support systems will be used when it is necessary to undermine sidewalks, pavements, and appurtenant structures.
- Surcharge load sources and adjacent encumbrances will be listed with their evaluation date on the daily inspection checklist.

9.y.10 Daily Inspections

Inspections will be performed daily on all excavations, adjacent areas, and protective systems before personnel enter the trench.

9.y.11 Soil Classification

To perform soil classification, the competent person will use a thumb test, pocket penetrometer, or shear vane to determine the unconfined compressive strength of the soils being excavated. In soils with properties that change (i.e., one soil type mixed with another within a given area) several tests may be necessary. When different soil types are present the overall classification will be that of the type with the lowest unconfined compressive strength. Classifications will result in a soil rating of Stable Rock, Type A, Type B, or Type C in accordance with 29 CFR §1926.652, Appendix A.

9.y.12 Sloping and Benching

Sloping and benching will be done in accordance with 29 CFR §1926.652, Appendix B. Selection of the sloping method and evaluation of surface surcharge loads will be made by a competent person familiar with the requirements contained therein. Sloping and benching methods and specifications will be listed on the daily inspection checklist.

9.y.13 Protective Systems

Protective systems are required on all excavations over 5 feet in depth or in excavations less than 5 feet when examination of the ground by a competent person reveals conditions that may result in cave-ins.

Selection and installation of protective systems will be done in accordance with 29 CFR §1926.652, Appendices C and D, or manufacturers data for shoring and shielding systems. Selection of a protective system will be made based upon soil classification and job requirements by a competent person. Protective systems used and specifications will be listed on the daily inspection checklist.

9.y.14 Training

Competent persons will have an adequate combination of experience and training to classify soil types and select protective systems as outlined in 29 CFR §1926.652. Training and experience pertaining to qualification as a competent person will be documented and include the following:

- General safety practices related to working in or near open excavations;
- Inspection requirements and techniques;
- Classification of soils in accordance with 29 CFR §1926.652, Appendix A; and
- Uses, limitations, and specifications of protective systems in accordance with 29 CFR §1926.652.

z. Emergency Rescue (Tunneling)

Not applicable for this scope of work.

aa. Underground Construction Fire Prevention and Protection Plan

Not applicable for this scope of work.

bb. Compressed Air Plan

Not applicable for this scope of work.

cc. Formwork and Shoring Erection and Removal Plans

Not applicable for this scope of work.

dd. Precast Concrete Plan

Not applicable for this scope of work.

ee. Lift Slab Plan

Not applicable for this scope of work.

ff. Steel Erection Plan

Not applicable for this scope of work.

gg. Site Safety and Health Plan for Hazardous Waste Site Work (HAZWOPER)

This Program HASP serves as the Hazardous Waste Site Safety and Health Plan for Hazardous Waste Work. SSHP Addendums will be developed and submitted to the BEC for approval before performing the various activities of this contract.

hh. Blasting Plan

Not applicable for this scope of work.

ii. Diving Plan

Not applicable for this scope of work.

jj. Confined Space

9.jj.1 Purpose

This project should not have the potential for a permit-confined space entry. However, if required, this program provides the requirements to ensure a safe working environment within and around confined space operations by evaluating confined space hazards, implementing necessary controls, and regulating employee entry into confined spaces. Confined space entries should only be made if there is not a feasible method of performing the task from outside of the confined space.

9.jj.2 Scope

This program applies to all Bhate employees, operations, and subcontractors.

9.jj.3 Definitions

Acceptable Entry Conditions

The conditions that must exist in a permit space to allow entry and to ensure that employees involved with a permit-required confined space (PRCS) entry can safely enter into and work within the space.

Attendant

An individual stationed outside one or more permit spaces who monitors the authorized entrants and who performs all attendant's duties assigned in the employer's permit space program.

Confined Space

An enclosed area which exhibits the following characteristics:

- Is large enough and so configured that an employee can bodily enter;
- Has limited or restricted means for entry or exit; and
- Is not designed for continuous occupancy.

Double Block and Bleed

The closure of a line, duct, or pipe by closing and locking or tagging two in-line valves and by opening and locking or tagging a drain or vent valve in the line between the two closed valves.

Engulfment

The surrounding and effective capture of a person by a liquid or finely divided solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

Confined Space Entry Permit

The completed document which specifies the hazards, controls, and procedures for a confined space entry.

Entry

The action by which a person passes through an opening into a confined space. Entry is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

Entry Supervisor

The person responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry and overseeing entry operations, and for terminating entry as required by this section.

Hazardous Atmosphere

An atmosphere which meets one or more of the following criteria:

- Flammable gas, vapor, or mist in excess of 10 percent of the lower explosive limit (LEL); or
- An airborne concentration of a dust at a concentration that meets or exceeds its lower explosive limit (rule of thumb - visibility obscured at a distance of 5 feet); or
- Atmospheric concentration of any substance which could result in employee exposure in excess of its recommended exposure limit, i.e., PEL, TLV, or manufacturer's limit; or immediately dangerous to life and health (IDLH).

Inerting

Inerting is defined as the displacement of the atmosphere in a permit space by a noncombustible gas to such an extent that the resulting atmosphere is noncombustible.

Isolation

A pre-entry requirement which assures that the confined space has been completely taken out of service and insures that accidental introduction of hazardous substances into the confined space may not take place. Isolation may include blinding, double blocking with bleed valves, capping, and/or lockout/tag-out.

Line Breaking

The intentional opening of a pipe, line, or duct that is, or has been, carrying flammable, corrosive, or toxic material, an inert gas, or any fluid at a volume, pressure, or temperature capable of causing injury.

Non-Permit Required Confined Space (NPRCS)

A confined space that does not contain or, with respect to atmospheric hazards, have the potential to contain, any hazard capable of causing death or serious physical harm.

Oxygen Deficient

An atmosphere containing less than 19.5 percent oxygen by volume is considered oxygen deficient.

Oxygen Enriched

An atmosphere containing 22.0 percent or more oxygen by volume is considered oxygen enriched. (Note: The 22% upper limit is a National Fire Protection Association (NFPA) 306k, Certification of Hot Work, Consensus Standard.)

Permit Required Confined Space (PRCS)

A confined space which has one or more of the following characteristics:

- Contains or has the potential to contain a hazardous atmosphere;
- Contains a material that has the potential for engulfment of the entrant; or
- Has an internal configuration that could trap or asphyxiate an entrant.

Prohibited Conditions

Any condition in a permit space that is not allowed by the permit during the period when entry is authorized is a prohibited condition.

Retrieval System

The equipment used for non-entry rescue of persons from permit spaces.

9.jj.4 Discussion

Responsibilities of Authorized Entrants

Entrants are responsible for the following:

- Inspection of operability and integrity of all respiratory apparatus, safety equipment, and PPE to be used/worn.
- Knowing hazards, mode of exposure, signs and symptoms, and consequences of hazardous exposure.
- Communicating with the attendant as necessary to enable the attendant to monitor entrant status and to enable the attendant to alert entrants of the need to evacuate the space.
- Notifying the attendant of undetected/unnoticed hazards which could cause harm or injury to team personnel, warning signs and symptoms of exposure, and prohibited conditions;
- Properly wearing the designated respiratory apparatus, safety equipment, and PPE;
- Knowing the emergency procedures.
- Exiting from the permit space when evacuation is ordered, warning signs or symptoms of exposure are noted, a prohibited condition is noted, or an alarm is activated.

Responsibilities of Attendants

Attendants are required to assume the following duties and responsibilities:

- Inspection of operability and integrity of all respiratory apparatus, safety equipment, and PPE to be used.
- Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure.
- Be aware of possible behavioral effects of hazard exposure in authorized entrants.
- Communicate with authorized entrants as necessary to monitor entrant status and to alert entrants of the need to evacuate the space.
- Leave their position only after being physically replaced by another qualified attendant. If required to leave their post and no replacement is available, they must evacuate all personnel from within the confined space before leaving.
- Monitor activities inside and outside the space to determine if it is safe for entrants to remain in the space and order the authorized entrants to evacuate the permit space immediately if a prohibited condition is noted, if an authorized entrant shows behavioral effects of a hazard exposure, if a saturation develops outside the confined space that may endanger the entrants, or if the attendant cannot effectively and safely perform his or her required duties.
- Summon rescue and emergency services.
- Warn unauthorized persons that they must stay away from the permit space, advise them to exit immediately if they enter the permit space, and inform the entry supervisor if they enter the space.
- Perform non-entry rescues.
- Perform no duties that interfere with the attendant's primary duty to monitor and protect the authorized entrants.
- Remain in constant communication with the entrant at all times.
- Perform atmospheric monitoring per the confined space permit under the direction of the entry supervisor, if trained to perform the monitoring.

Responsibilities of Entry Supervisors

Entry supervisors have the following responsibilities:

- Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposures;
- Verify by checking that the appropriate entries have been made on the permit, that all tests specified by the permit have been conducted and that all procedures and equipment specified by the permit are in place before endorsing the permit and allowing entry to begin;

- Verify that rescue services are available and that the means for summoning them are operable;
- Remove unauthorized individuals who enter or who attempt to enter the permit space during entry operations;
- Determine, whenever responsibility for a permit space entry operation is transferred and at intervals dictated by the hazards and operations performed within the space, that entry operations remain consistent with terms of the entry permit and that acceptable entry conditions are maintained;
- Ensure full compliance with Bhate and customer permit requirements;
- Ensure that all confined space pre-entry precautions have been taken;
- Ensure that atmosphere/personnel monitoring is performed at adequate frequencies to protect the safety and well-being of the entry personnel;
- Ensure that emergency procedures and individual assignments are clearly defined, and coordinate rescue procedures if necessary; and
- Terminate the entry and cancel the permit.

The entry supervisor may also serve as attendant.

Responsibilities of Project Management Personnel

Project Management personnel have the overall responsibility for:

- Ensuring implementation of the confined space entry program
- Ensuring that only trained, qualified, and medically fit personnel participate in confined space entry operations
- Ensuring that adequate, appropriate, and properly maintained equipment is provided to safely enter a confined space and successfully complete the task

9.jj.5 Procedure

The following sections provide the requirements for pre-entry activities, pre-entry briefings, confined space operations, and program review requirements. Complete implementation of these requirements is necessary to ensure the health and safety of personnel during confined space operations.

No entries will be made into confined spaces with:

- IDLH atmospheres;
- LEL readings in excess of 10% of LEL or a combustible dust atmosphere in excess of the LEL;
- An oxygen content of less than 19.5% or greater than 22.0%;
- Carbon monoxide levels > 25 ppm (parts per million); and
- Hydrogen sulfide levels > 10 ppm.

9.jj.6 Hazard Evaluation

Prior to the initiation of a confined space entry, a hazard evaluation of the space will be conducted by the entry supervisor to determine what chemical and physical hazards are present. This review will be documented on the entry permit and include, but not be limited to the following:

- Potential for oxygen deficient or enriched atmosphere;
- Presence of a flammable atmosphere;
- Presence of toxic air contaminants;
- Presence of physical hazards;
- Sources of hazardous energy that must be de-energized to effectively isolate the confined space;
- Other permits, such as hot-work or lockout/tagout, required to control hazards; and
- Acceptable entry conditions.

Various sources of information for hazard identification that may be used include blueprints, as-built drawings, client employee knowledge, past entry information, air monitoring data, and physical inspection. For each hazard identified, an effective means of control will be documented on the confined space entry permit.

9.jj.7 Atmospheric Testing

The atmosphere of the confined space will be tested to determine the initial concentrations of the following:

- Oxygen content;
- Flammable or combustible gases or vapors; and
- Toxic air contaminants.

Testing for the initial concentrations will be conducted in the order given and documented on the entry permit. Additional LEL, oxygen, and toxicity readings must be taken at least every 15 minutes. If isolation of the space is unfeasible because the space is large or part of a continuous system, the monitoring will be continuous. Frequency for periodic monitoring during the confined space entry will be specified and documented on the permit.

9.jj.8 Ventilation

Mechanical ventilation will be initiated where necessary to prevent exposure of employees to hazardous atmospheres. The ventilation will meet the following requirements:

- It will be continuous;
- It will be directed into the immediate area authorized entrants will work in; and
- The air supply will be from a clean source and will not increase the hazards in the area.

In addition:

- Employees will not enter the space until the ventilation clears the hazardous atmosphere;
- When ventilation practices cannot be used, a supplied air respirator must be used. Exceptions may be made by the HSM; and
- Ventilation equipment must be bonded and grounded prior to operation. Ventilator exhausts must be directed downwind from personnel and/or areas that contain buildings, equipment, etc.

9.jj.9 Isolation

All permitted spaces will be removed from service and completely protected against the release of energy and material into the space. Means used to isolate the space include but are not limited to the following:

- Lockout/tagout in accordance with approved lockout/tagout procedures;
- Disconnection of mechanical linkages and hazards;
- Blanking, blinding, or misaligning piping; or
- Double blocking and bleeding.

9.jj.10 Equipment Staging

The following equipment will be available as necessary and inspected prior to use:

- Testing and monitoring equipment;
- Ventilation equipment;
- Communications equipment;
- Personal protective equipment;
- Lighting equipment (caged, waterproof, and low voltage);
- Barriers and shields;
- Ingress and egress equipment;
- Rescue and emergency equipment; and
- Any other equipment required to make safe entry into the space.

In spaces where the potential for flammable or combustible atmospheres exists, equipment will be non-sparking and intrinsically safe. Electrical systems will be GFCI protected.

9.jj.11 Emergency and Rescue Procedures

Based upon the location, hazards, and configuration of the confined space, the entry supervisor will ensure that the following items are addressed:

- Rescue and emergency services to be used and means of summoning;
- Means of rescuing entrants;

- Rescue and emergency to be used at the site;
- Duties of personnel during emergencies; and
- Prevention of unauthorized entry during rescues.

9.jj.12 Client/Contractor Coordination

To ensure safe and efficient operations when Bhate personnel and client or subcontractor employees will make entry together into the same confined space, the following will be completed by the entry supervisor:

- Inform Bhate contractors of existing confined spaces;
- Provide Bhate contractors with a copy of this program;
- Inform the contractor of known hazards in the space;
- Provide a list of controls implemented previously;
- Coordinate the entry of the personnel; and
- Debrief the contractor regarding this program and any hazards encountered.

When Bhate personnel are required to perform confined space entry in support of client work, the entry supervisor will complete the following in addition to the above requirements:

- Obtain any available information on the space from the client;
- Coordinate the entry operations with client personnel; and
- Inform the client of entry hazards encountered.

9.jj.13 Pre-Entry Briefing

Prior to initiating a confined space entry, the entry supervisor will conduct a safety briefing with the authorized entrants, attendants, and other relevant personnel. The briefing will cover the following at a minimum:

- HAZCOM (including the signs, symptoms, and modalities of chemical over exposure);
- Physical hazards present;
- All hazard controls;
- Acceptable entry conditions;
- Emergency procedures;
- Rescue procedures;
- Duties of entrants and attendants during routine and emergency operations;
- Frequency and types of air monitoring;
- Communications system and backup to be used;
- Review of work to be accomplished during entry;
- Decontamination procedures (if necessary);

- PPE disposal; and
- Potential emergencies that may occur outside the confined space.

A checklist will be used to document the pre-entry briefing. At the end of the briefing, all personnel will be given opportunity to ask questions and review the permit. After review, each authorized entrant and attendant will print and sign his/her name on the permit. The completed permit will be posted at the entry site and serve as a roster for monitoring entry and exit of personnel from the space.

9.jj.14 Confined Space Operations

The following practices will be adhered to during actual confined space entries:

- All confined spaces will be treated as permit-required confined spaces unless the HSM specifically provides an exemption in the SSHP. Prior to entry, a properly executed permit will be in place and signed by the entry supervisor, attendant, and each entrant.
- The Entry Supervisor will certify that all equipment is in place and operable, acceptable entry conditions are present, all personnel have been fully briefed, and all personnel have signed the permit prior to initiating entry.
- The work area outside the space will be barricaded to prevent unauthorized personnel from interrupting the attendants or entering the space. Unauthorized personnel will be asked to leave the barricaded area. If unauthorized personnel refuse to leave the area, operations will be terminated.
- Atmospheric monitoring for oxygen, LEL, and toxic air contaminants will be conducted at the frequency noted on the permit. Results will be logged on the permit.

No confined space will be entered without:

- A full body harness;
- A 6' lanyard attached to the harness "D" ring; and
- A lifeline attached to the lanyard with the opposite end secured outside the confined space. The lanyard and lifeline must have double locking rings.

Note: Wristlets may be used in lieu of a full body harness if the body harness is infeasible or creates a greater hazard.

- Top entries with a fall potential greater than 5 feet will be made with fall protection. Fall protection will meet the criteria specified in 29 CFR, §1926.502(d).
- At least one attendant is required for permit-required entries. The attendant will maintain visual or voice communications with entrants at all times. Attendants will not leave their post unless formally relieved by another authorized attendant. The replacement will be fully briefed by the entry supervisor on all information covered in the pre-entry briefing. Entry supervisors may also serve as attendants.

- When any confined space is entered where the noise level or respirator used prevents voice communication, visual contact between the attendant and entrants must be maintained.
- Metal ladders, hand tools, or other instruments which may spark or cause a source of ignition, are not to be used within confined spaces where any detectable amounts of LEL's are present.
- No burning, grinding, chipping, or other operation which produces heat, sparks, or ignition sources are to be performed without a hot work permit.
- One attendant will be dressed in the same PPE as the authorized entrants, except for respiratory protection. Attendant supplied air will be from a different source than that of authorized entrants.
- The entry supervisor will terminate operations when the work is completed, an unacceptable entry condition is detected, or another emergency inside or outside the space is detected. Authorized entrants will immediately evacuate upon notification of the termination.
- Attendants may monitor multiple sites only if they are able to maintain continuous visual or voice communications with entrants. If continuous communications cannot be maintained, additional attendants will be used.
- Attendants will perform non-entry rescues in emergencies using rescue equipment staged at the site.
- Upon completion of work and exit of the entrants, the permit will be canceled by the entry supervisor and forwarded to the FOM. Permits will be maintained as a part of the project file.

9.jj.15 Deviation from Program Requirements

Any deviation from this procedure requires the approval of the HSM. Approval for entry into permit-required confined spaces with air purifying respirators will be given if:

- The composition of the hazardous substance(s) in the confined space is well defined;
- The hazardous substance(s) have good warning properties;
- Short-term exposure to the hazardous substance(s) in excess of the recommended exposure limit will not result in serious physical harm;
- The efficiency of the cartridge versus the hazardous substance(s) is known;
- Forced air ventilation is utilized;
- Reliable monitoring methods are available; and
- Monitoring shows airborne concentrations to be less than the recommended exposure level for the contaminants.

9.jj.16 Identification of Confined Spaces

A survey of the sites will be performed prior to the start of work and documented to identify permit-required confined spaces (PRCS). All permit-required confined spaces will be identified with a sign. The sign will contain the following wording or equivalent:

DANGER - PERMIT-REQUIRED CONFINED SPACE
DO NOT ENTER

9.jj.17 Program Review

The effectiveness of program implementation will be reviewed by the HSM during site inspections pursuant to using the canceled permits and relevant incident information. The program will be modified, as necessary, on the basis of the HSM program reviews.

9.jj.18 Training

Authorized entrants, attendants, and entry supervisors will be trained in accordance with 29 CFR §1910.146 (g) including the following topics as appropriate:

- The contents of this procedure;
- Their respective duties;
- CPR/First Aid (attendants and entry supervisors if they are serving as rescue personnel);
- Hazards commonly found in confined spaces;
- Lockout/tag-out procedures;
- Isolation practices;
- Ventilation of confined spaces;
- Supplied air respiratory protection and SCBAs;
- Self-rescue;
- Methods of communication;
- Atmospheric monitoring; and
- Rescues

Training will establish employee proficiency in the skills required for confined space entry and the understanding and knowledge for the safe performance of all duties required by this procedure. Before employees entering confined spaces will be trained to understand the requirements of the Griffiss/site-specific confined space program.

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10 RISK MANAGEMENT PROCESSES

a. Hazard Control Measures

The potential health and safety hazards of this project are summarized below in Table 10-1. The potential for encountering these hazards is ranked (high, moderate, or low) based on the work to be performed and the hazard control measures to be used. Each phase of work associated with this project with a potential hazard is listed in Attachment 1 and will require an AHA be developed to control the hazard and the AHAs can be found in Attachment 1.

Table 10-1. Task Hazards Summary

Summary	Hazard potential [High, Moderate, or Low]	Description of potential hazards
__√__**Safety** (i.e. Walking and working surfaces, heavy equipment, traffic, falls, excavations, power and hand tools, materials handling, hoisting and rigging, electrical safety, etc.)	• High	• Uneven walking and working surfaces • Slips, trips, and falls • Materials handling • Heavy equipment operation • Falling or dropped objects • Electrical
__√__**Utilities**	• Moderate	-Dig Safe will not be able to locate the abandoned utilities at many of the sites -Underground and overhead utilities may be present -All utilities shall be disconnected by qualified technicians prior to the initiation of activities impacted
__√__**Chemical**	• Moderate	• Gasoline (fuel for equipment) • Diesel (fuel for equipment) • Lubricants (i.e. oil or grease)
__√__**Physical** (i.e. Heat, cold, noise)	• Moderate	• Thermal stressors (variable weather anticipated) • Sun exposure • Noise from heavy equipment • Some sites require snowshoeing and sleds to hike into the area during large or extended snowfall events.

Summary	Hazard potential [High, Moderate, or Low]	Description of potential hazards
__√__ **Biological** (i.e. Plants, animals, insects, spiders, ticks)	• Moderate	• Insect stings and bites (mosquitos, birds dive bombing, and woodchucks) • Poisonous animals and plants in overgrown vegetation • Snakes • Ticks

b. Hazard Control Measures

All site personnel must attend the Daily Safety Briefing, sign-in daily for emergency accountability, and follow general safety rules listed in Section 6 of Attachment 4 *Written Procedures and Programs* of this Program HASP. The SSHO and all subcontractor supervisors are responsible for performing daily proactive inspections to maintain hazard controls as stated in the relevant AHAs for the various project activities. Each subcontractor's employees will read and sign the form *Minimum Safety Requirements for Subcontractors,* as found in Attachment 2 of this Program HASP.

Coordination with AFCEC and Griffiss AFB representatives is a mandatory requirement for performing the work at this site. Bhate will be responsible for coordinating site access for subcontractors. Bhate will establish a SZ at the site. The SZ will serve as a staging area and a command center outside the immediate work area. An EZ and CRZ as necessary, will be established in order to maintain a safe working area. Bhate will use any existing fencing to restrict access to unauthorized personnel. Temporary project fencing (or a substitute acceptable to AFCEC and Griffiss AFB) shall be provided for areas of active use by members of the public, including those areas in close proximity to family housing areas and/or school facilities. Fencing shall extend from grade to a minimum of 48 in (1.2 m) above grade and shall have a maximum mesh size of 2 in (50 mm). Fencing shall remain rigid/taut with a minimum of 200 lbs (0.9 kN) of force exerted on it from any direction with less than 4 in (100 mm) of deflection.

The Bhate FOM/ SSHO will monitor and control EZ access. Bhate will establish defined routes for material handling and equipment movement around the site. A general traffic pattern for the site will be established and will be communicated in advance to field personnel. Unauthorized vehicle access into the site will be controlled. In addition, Bhate will coordinate any required roadway closures with AFCEC and Griffiss AFB officials.

11 REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH), *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*.

Bhate. *Corporate Health and Safety Plan*.

Bhate. *Corporate Health and Safety Plan for Construction*.

Bhate. *Corporate Employee Manual*.

United States Army Corps of Engineers (USACE). *EM 385-1-1, Safety and Health Requirements Manual,* November 2014.

U.S. Department of Labor, Title 29 Code of Federal Regulations Part 1910.

U.S. Department of Labor, Title 29 Code of Federal Regulations Part 1926.

U.S. Department of Health and Human Services, National Institute of Occupational Safety and Health (NIOSH), *Pocket Guide to Chemical Hazards*, 2008.

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ATTACHMENT 1
ACTIVITY HAZARD ANALYSIS

Activity Hazard Analysis – 01

Task: General Site Activities; Site Mobilization, Demobilization, and Management of Investigative Derived Waste (IDW)	**Project:** Former Griffiss AFB PBR	**AHA Reviewed by:** Sally S. Smith, CIH, CSP, CHMM, CPEA
Minimum Personal Protective Equipment (PPE): Level D PPE (Hard Hat, Safety Glasses with rigid side shields, steel toe work boots, leather gloves)	**Location:** Rome, New York	**AHA Reviewed date:** November 2016

Activity	Potential Hazard(s)	Control Measures
General site activities, mobilization, demobilization, and management of IDW [NOTE: The hazards and control measures presented in AHA 01 are applicable to all phases of the project]	Slips, trips, or falls on walking and working surfaces	• Be alert for uneven terrain and steep slopes • Keep work area free of dirt, grease, slippery materials, debris, and tools; practice good housekeeping • Provide adequate lighting in all work areas • Keep all stairways and walkways clear of debris/tools to prevent trips •
	Site traffic	• Be aware of potential vehicle traffic while on site • Follow posted warnings and rules for travel around site • All onsite personnel must wear highly reflective orange or yellow safety vests in traffic areas and/or when working around heavy equipment
	Exposure to high noise from heavy equipment and power tools	• Hearing protection will be worn with a noise reduction rating capable of maintaining personal exposure below 85 dBA (ear muffs or plugs) • SSHO/FOM will determine the need for hearing protection • All equipment will be equipped with manufacturer's required mufflers
	Eye injury	• Use approved safety glasses with rigid side shields
	Overhead hazards	• Personnel will be required to wear hard hats that meet ANSI Standard Z89.1 in any construction areas, and areas with overhead hazards
	Dropped objects	• Steel toe boots meeting ANSI Standard Z41 shall be worn

AHA – 01 (continued)

Task: General Site Activities; Site Mobilization, Demobilization and Management of IDW	**Project:** Former Griffiss AFB PBR	**AHA Reviewed by:** Sally S. Smith, CIH, CSP, CHMM, CPEA
Minimum Personal Protective Equipment (PPE): Level D PPE (Hard Hat, Safety Glasses with rigid side shields, steel toe work boots, leather gloves)	**Location:** Rome, New York	**AHA Reviewed date:** November 2016

Activity	Potential Hazard(s)	Control Measures
General site activities, mobilization, demobilization, and management of IDW (continued) [NOTE: The hazards and control measures presented in AHA 01 are applicable to all phases of the project]	Back injury from lifting heavy loads	• Site personnel will be instructed on proper lifting techniques – bend with the knees and not with the back; avoid twisting at the waist, use your feet to turn • Mechanical devices should be used to reduce manual handling of materials • Team lifting should be used if mechanical devices are not available
	Inclement weather (Thunderstorms and tornadoes)	• Halt activities immediately and take cover during thunderstorm or tornado warnings, shelter in a building if possible, stay away from windows • If outdoors, stay close to the ground • Listen to radio or television announcements for pending weather information • Do not try to outrun a tornado on foot or in a vehicle
	Biological hazards (spiders, snakes, etc.)	• Workers will inspect the work area carefully and avoid placing hands and feet into concealed areas • Look in direction of travel for biological hazards to avoid • Wear insect repellant as needed
	Thermal Stressors and other hazards (i.e. heat stress, cold stress)	• Employees will have appropriate clothing for variable weather • Wear long sleeves and long pants and sunscreen with a high sun protection factor (SPF) on exposed skin • Employees will take breaks and drink plenty of fluids, as necessary, to prevent heat stress alternating between water and Gatorade-type drinks • Take periodic warming breaks and drink warm sweet liquids when working in cold weather • Protect skin from becoming wet in cold weather; replace clothing that becomes wet as soon as possible • Wear insect repellant as needed • Refer to the Bhate Corporate HASP for detailed information on heat and cold stress
	Sharp objects, if encountered	• All exposed rebar and other sharp objects that could cut or impale someone must be protected (i.e. rebar caps - mushroom type is not acceptable for impalement protection) • All exposed nails must be bent over or removed; all loose nails must be kept off the ground • Wear leather or Kevlar gloves while handling sharp objects to prevent lacerations

AHA – 01 (continued)

Task: General Site Activities; Site Mobilization, Demobilization and Management of IDW	**Project:** Former Griffiss AFB PBR	**AHA Reviewed by:** Sally S. Smith, CIH, CSP, CHMM, CPEA
Minimum Personal Protective Equipment (PPE): Level D PPE (Hard Hat, Safety Glasses with rigid side shields, steel toe work boots, leather gloves)	**Location:** Rome, New York	**AHA Reviewed date:** November 2016

Activity	Potential Hazard(s)	Control Measures
General site activities, mobilization, demobilization, and management of IDW (continued) [NOTE: The hazards and control measures presented in AHA 01 are applicable to all phases of the project]	Overhead/buried utilities	• Dig Safe will not be able to locate the abandoned utilities at many of the sites • Underground and overhead utilities may be present • All utilities shall be disconnected by qualified technicians prior to the initiation of activities impacted • Conduct a utility locate to identify the location of underground utilities in locations where drilling activities will occur • Overhead utilities should be considered live until determined otherwise • Maintain a minimum distance of > 25 feet from overhead utilities • All underground utilities must be clearly marked before beginning work • No intrusive work shall be conducted within a 4 foot "Buffer Zone" of any underground utility marking
	Spills/Fire	• Fuel cans will be NFPA approved and equipped with pouring spout or funnel • Spill and absorbent materials will be readily available • Smoking and open flames are not permitted in fueling/greasing areas or in the work area • All heavy equipment will be equipped with a ABC type fire extinguishers which will be inspected weekly and documented • Provide fire extinguishers near all welding, soldering, or other sources of ignition • Keep fire extinguishers easy to see and reach in case of an emergency • Store gasoline and other flammable liquids in a safety can with flame arrestor outdoors or in an approved flammable cabinet • Don't store LP gas tanks inside buildings • Keep temporary heaters at least 50 feet away from any LP gas container or any other flammable/combustible material • Ensure that leaks or spills of flammable or combustible materials are cleaned up promptly • Oily or solvent soaked rags must be disposed of in a metal self closing safety can and must be emptied and properly disposed of on a daily basis

AHA – 01 (continued)

<table>
<tr><td colspan="2">Task: General Site Activities; Site Mobilization, Demobilization and Management of IDW</td><td>Project: Former Griffiss AFB PBR</td><td>AHA Reviewed by:
Sally S. Smith, CIH, CSP, CHMM, CPEA</td></tr>
<tr><td colspan="2">Minimum Personal Protective Equipment (PPE): Level D PPE (Hard Hat, Safety Glasses with rigid side shields, steel toe work boots, leather gloves)</td><td>Location: Rome, New York</td><td>AHA Reviewed date: November 2016</td></tr>
<tr><th>Activity</th><th>Potential Hazard(s)</th><th colspan="2">Control Measures</th></tr>
<tr><td rowspan="3">General site activities, mobilization, demobilization, and management of IDW (continued)

[NOTE: The hazards and control measures presented in AHA 01 are applicable to all phases of the project]</td><td>Electrical, when used</td><td colspan="2">• Ensure ground fault circuit interrupters (GFCI) are used in all outdoor environments, in any areas subject to moisture, and for all temporary power
• Ensure all cords and electrical tools are in good repair. Do not attempt to repair a cord with tape; discard damaged cords immediately. Ensure ground prong is in place and insulation is not damaged on all extension cords/equipment.
• Inspect all tools; take damaged tools out of service and tag – “damaged – do not use”
• Ensure breaker boxes, electrical boxes, junction boxes, outlets, have covers in place. Ensure there are no openings where someone can come in contact with live electricals; all knockout holes are covered with proper plugs.
• Keep cords and electrical tools out of traffic areas where they may be damaged
• Prohibit work on new and existing energized (hot) electrical circuits until all power is shut off and a positive Lockout/Tagout System is in place. ONLY TRAINED ELECTRICIANS ARE PERMITTED TO WORK ON ELECTRICAL CIRCUITRY.
• VIOLATION OF A LOCKOUT/TAGOUT REQUIREMENT CAN RESULT IN IMMEDIATE REMOVAL FROM THE JOB SITE AND TERMINATION FROM THE COMPANY AND/OR BAN ON FUTURE BUSINESS FOR SUBCONTRACTORS</td></tr>
<tr><td>Ergonomics</td><td colspan="2">• Avoid awkward postures
• Avoid repetitive motions; switch hands and take rest breaks to give your affected body parts time to rest
• Avoid excessive contact stress; provide padding if contact with a fixed object is prolonged such as the floor or a wall</td></tr>
<tr><td>Vehicular traffic in work area and heavy equipment operation</td><td colspan="2">• Wear ANSI Class II reflective traffic vest and cordon off work area
• Maintain awareness of vehicle movement in work area and exercise caution when approaching heavy equipment exercise caution when approaching heavy equipment
• Equipment will be equipped with functioning back-up alarms, signal lamps, lights, and alerting horns
• Operators are required to use seat belts at all times
• Only qualified / licensed operators will operate mobile equipment
• All equipment must be inspected using the appropriate forms prior to use on each day of use</td></tr>
</table>

AHA – 01 (continued)

<table>
<tr><td colspan="2">Task: General Site Activities; Site Mobilization, Demobilization and Management of IDW</td><td colspan="2">Project: Former Griffiss AFB PBR</td><td>AHA Reviewed by:
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<tr><th>Activity</th><th>Potential Hazard(s)</th><th colspan="3">Control Measures</th></tr>
<tr><td>General site activities, mobilization, demobilization, and management of IDW (continued)

[NOTE: The hazards and control measures presented in AHA 01 are applicable to all phases of the project]</td><td>Exposure to potential contaminants during management of IDW</td><td colspan="3">• Collect all PPE and disposable sampling equipment and place in properly labeled DOT container for proper disposal
• Wash hands and face prior to eating, drinking, or smoking</td></tr>
<tr><th>Equipment Used</th><th colspan="2">Inspection Requirements</th><th colspan="2">Training Requirements</th></tr>
<tr><td>Level D PPE
Fire Extinguishers
First Aid Kits
Eyewash</td><td colspan="2">Employees inspect their own PPE.
Weekly inspections will be performed on fire extinguishers.
Weekly inspections will be performed on first aid kits and eyewash.
Informal daily inspections are to be conducted by the SSHO.
Formal weekly safety inspections are to be conducted and documented on field inspection form by the SSHO.</td><td colspan="2">Personnel have read and understand the Program HASP, SSHP, hospital route map, MSDSs, and AHAs
At least two designated individuals onsite will have current CPR and First Aid training</td></tr>
</table>

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Activity Hazard Analysis – 02

Tasks: Installing delineation borings, monitoring well installation, groundwater sampling, injection if required, and operations and maintenance of treatment systems	**Project:** Former Griffiss AFB PBR	**AHA Reviewed by:** Sally S. Smith, CIH, CSP, CHMM, CPEA
Minimum Personal Protective Equipment (PPE): Modified Level D PPE - hard hats, steel toed boots, safety glasses with rigid side shields and face shield when mixing cement and use of other chemicals, and as needed, hearing protection. [NOTE: Upgrade to Level C based on air monitoring with PID.]	**Location:** Rome, New York	**AHA Reviewed date:** November 2016

Activity	Potential Hazard(s)	Control Measures
Installing delineation borings and monitoring well installation [NOTE: Hazards and recommended controls from AHA-01 apply]	Drill Rig Hazards	• Drill rig is to be operated and maintained by qualified operators • A Drill Rig Inspection Checklist (Attachment 2) should be completed to ensure that the rig is operating properly (the inspection will include fittings, cables, pins, connections, lubrication points, controls, emergency stops, etc.) • To the extent possible, the terrain should be level and the condition of the ground such that unexpected movement of the rig is unlikely • Stabilize the rig prior to boring in accordance with manufacturer's recommendations • Wear required PPE (hard hat, safety glasses, work gloves, ear muffs or plugs, steel toe work boots), ensure loose clothing is secured • Maintain good housekeeping on and around drill rig • Keep hands, fingers, and other body parts clear of all moving machinery; ensure machine guards are in place while in operation
	Overhead/buried utilities	• Dig Safe will not be able to locate the abandoned utilities at many of the sites • Work activity adjacent to overhead electric power lines will not be initiated until a survey has been conducted to ascertain the safe clearance distance from energized lines. • Refer to the U.S. Army Corps of Engineers Safety and Health Requirements Manual (EM 385-1-1, 2008) for a complete description of procedures required when working at a location adjacent to overhead power lines. • The minimum required clearance distances from energized overhead electric lines are provided below.

Nominal System Voltage	Minimum Rated Clearance
0 to 50 kilovolts (kV)	10 feet (ft) (3 meters [m])
51 to 200 kV	15 ft (4.6 m)
201 to 350 kV	20 ft (6 m)
351 to 500 kV	25 ft) (7.6 m)
501 to 650 kV	30 ft (9.1 m)
651 to 800 kV	35 ft (10.7 m)
801 to 950 kV	40 ft (12.2 m)
951 to 1,100 kV	45 ft (13.7 m)

Activity Hazard Analysis – 02 (continued)

Tasks: Installing delineation borings, monitoring well installation, groundwater sampling, injection if required, and operations and maintenance of treatment systems	**Project:** Former Griffiss AFB PBR	**AHA Reviewed by:** Sally S. Smith, CIH, CSP, CHMM, CPEA
Minimum Personal Protective Equipment (PPE): Modified Level D PPE - hard hats, steel toed boots, safety glasses with rigid side shields and face shield when mixing cement and RA chemicals, and as needed, hearing protection. [NOTE: Upgrade to Level C based on air monitoring with PID.]	**Location:** Rome, New York	**AHA Reviewed date:** November 2016

Activity	Potential Hazard(s)	Control Measures
Installing delineation borings and monitoring well installation (continued) [NOTE: Hazards and recommended controls from AHA-01 apply]	Overhead/buried utilities (continued)	• Dig Safe will not be able to locate the abandoned utilities at many of the sites • Underground and overhead utilities may be present • All utilities shall be disconnected by qualified technicians prior to the initiation of activities impacted • For other overhead or in-workplace utilities, workers must be instructed to use care in working under or around utilities to avoid hot surfaces, pressurized gases or air, leaking pipelines, and discharging steam or hot liquids, and must work to prevent accidental contact or damage. • Overhead utilities should be considered live until determined otherwise • All underground utilities must be clearly marked before beginning work • No borings shall be made within a 4 foot "Buffer Zone" of any utility marking
	Exposure to contaminants	• To the extent feasible, limit contact with subsurface materials • Wear chemical resistant gloves (nitrile inner and outer) when handling soil and groundwater samples • SSHO shall conduct breathing zone monitoring for volatile organic compounds (VOCs) with a photoionization detector (PID)/flame ionization detector (FID) if any odors or visible soil staining are encountered (SSHO may require an upgrade in PPE or modification to work based on monitoring results) • Wash hands and face prior to eating, drinking, or smoking after handling potentially contaminated materials
	Spills/residue material	• Have absorbent materials available to control possible spills or leaks
	Heavy lifting (sample shipping containers)	• Use proper lifting techniques
	Electrical Hazards (Extension cords, electrical equipment, temporary lighting, building electricity) if encountered	• Equipment must be inspected prior to use and must be in good condition • The use of extension cords or other portable electrical connections or devices that are not rated for use in wet environments is strictly prohibited • Only ground fault circuit interrupter outlets may be used • During operations and maintenance of treatment systems, beware of activated wiring. Use LO/TO during maintenance

Activity Hazard Analysis – 02 (continued)

Tasks: Installing delineation borings, monitoring well installation, groundwater sampling, injection if required, and operations and maintenance of treatment systems	**Project:** Former Griffiss AFB PBR	**AHA Reviewed by:** Sally S. Smith, CIH, CSP, CHMM, CPEA
Minimum Personal Protective Equipment (PPE): Modified Level D PPE - hard hats, steel toed boots, safety glasses with rigid side shields and face shield when mixing cement and RA chemicals, and as needed, hearing protection. [NOTE: Upgrade to Level C based on air monitoring with PID.]	**Location:** Rome, New York	**AHA Reviewed date:** November 2016

Activity	Potential Hazard(s)	Control Measures
Installing delineation borings and monitoring well installation (continued) [NOTE: Hazards and recommended controls from AHA-01 apply]	Noise	• Drill Rig operation may result in high noise levels • Appropriate hearing protection with a NRR >26 shall be worn while operating the drill rig
	Pinch points	• Use appropriate PPE (leather gloves) when handling well casings and tools
	Dust	• Use care when installing well materials (sand, bentonite, Portland cement) into monitoring well to prevent dust generation • Position body in an upwind location from materials while installing • Use wet methods to prevent dust generation
	Cut hazards	• Use care when handling glassware • Do not reach "blindly" into sample container cooler
	Spills/residue material	• Have absorbent materials available to control possible spills or leaks
Implementing the RA At Staging Area: 1. Injection compound will be off-loaded from delivery truck 2. Operate a forklift for receiving, storage, and movement of supplies and chemicals from storage to mixing tank 3. Abandon bore holes with Portland cement (and bentonite, as needed)	Chemical exposure during mixing of oxidation product	• Use proper lifting techniques and material handling devices to move chemicals from storage • Position body upwind to minimize dust exposure • Wear Modified Level D PPE with face shield and safety glasses to avoid splash and exposure including chemical resistant gloves (nitrile inner and neoprene outer) and Tyvek coveralls to minimize potential contact with chemicals, as appropriate • Conduct work activities in a manner that minimizes potential contact with chemicals • Collect all PPE and disposable equipment and dispose of properly • Wash hands and face prior to eating, drinking, or smoking
	Spills/residue material	• Have absorbent materials available to control possible spills or leaks
	Nip points during operation of aboveground mixing tank	• Wear ANSI Class II reflective safety vest and cordon off work area • When delivering and removing mixer, moving equipment will be equipped with functioning back-up alarms, signal lamps, lights, and alerting horns • When delivering and removing mixer, operators are required to use seat belts at all times • Only qualified / licensed operators will operate mixing tank and mobile equipment • All equipment must be inspected using the appropriate forms prior to use on each day of use • Lock-out/Tag-out procedures required if mixing tank needs repairs

Activity Hazard Analysis – 02 (continued)

Task: Installing delineation borings, monitoring well installation, groundwater sampling, injection if required, and operations and maintenance of treatment systems	**Project:** Former Griffiss AFB PBR	**AHA Reviewed by:** Sally S. Smith, CIH, CSP, CHMM, CPEA
Minimum Personal Protective Equipment (PPE): Modified Level D PPE - hard hats, steel toed boots, safety glasses with rigid side shields and face shield when mixing cement and RA chemicals, and as needed, hearing protection. [NOTE: Upgrade to Level C based on air monitoring with PID.]	**Location:** Rome, New York	**AHA Reviewed date:** November 2016

Activity	Potential Hazard(s)	Control Measures
Implementing the RA At Staging Area: 1. Injection compound will be off-loaded from delivery truck 2. Operate a forklift for receiving, storage, and movement of supplies and chemicals from storage to mixing tank 3. Abandon bore holes with Portland cement (and bentonite, as needed)	Exposure to high noise from mixer and power tools	• Hearing protection will be worn with a noise reduction rating capable of maintaining personal exposure below 85 dBA (ear muffs or plugs – NRR of 26 dBA) • SSHO/FOM will determine the need for hearing protection • All equipment will be equipped with manufacturer's required mufflers
	Hazards from forklift operation: • Vehicular Accidents • injuries • Dropping of loads • Falling off vehicle	• Only qualified personnel will operate the forklift. • Confirm OSHA-required forklift training of operators (Forklift Operator Training is required to operate a forklift) • Watch Out, Be Alert For Traffic • Drive defensively, report violations, follow all traffic rules • Secure unsteady or unbalanced loads in vehicles or on forklifts • Wear ANSI Class II reflective safety vest • Maintain awareness of vehicle movement in work area and exercise caution • Moving equipment will be equipped with functioning back-up alarms, signal lamps, lights and alerting horns • Operators are required to use seat belts at all times
Preparing shipping container after sampling	Heavy lifting (heavy from ice in sample shipping containers)	• Do not overload shipping containers with ice and with samples • Use proper lifting techniques • Wear disposable gloves to avoid contact

Activity Hazard Analysis – 02 (continued)

Task: Installing delineation borings, monitoring well installation, groundwater sampling, injection if required, and operations and maintenance of treatment systems	**Project:** Former Griffiss AFB PBR	**AHA Reviewed by:** Sally S. Smith, CIH, CSP, CHMM, CPEA
Minimum Personal Protective Equipment (PPE): Modified Level D PPE - hard hats, steel toed boots, safety glasses with rigid side shields and face shield when mixing cement and RA chemicals, and as needed, hearing protection. [NOTE: Upgrade to Level C based on air monitoring with PID.]	**Location:** Rome, New York	**AHA Reviewed date:** November 2016

Equipment Used	Inspection Requirements	Training Requirements
Modified Level D PPE (Level C, if SSHO determines needed) Face shield when mixing chemicals or Portland cement First Aid Kits Eyewash Hand wash station (not hand sanitizer) when Portland cement being used. Fire Extinguishers Peristaltic pump, if needed Direct Push Technology (DPT) rig or Hollow Stem Auger or Sonic drilling Forklift(s) Poly tanks for injection materials Mixing tank(s)	Employees inspect their own PPE. Weekly inspections will be performed on fire extinguishers. Weekly inspections will be performed on first aid kits and eyewash. Informal daily inspections are to be conducted by the SSHO. Formal weekly safety inspections are to be conducted and documented on field inspection form by the SSHO.	Personnel have read and understand the Program HASP, SSHP, hospital route map, MSDSs, and AHAs At least two designated individuals onsite will have current CPR and First Aid training Fork Lift Operator must have completed OSHA required training

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Media centre

Zika virus

Fact sheet
Updated 18 March 2016

Key facts

- Zika virus disease is caused by a virus transmitted by *Aedes* mosquitoes.
- People with Zika virus disease usually have symptoms that can include mild fever, skin rashes, conjunctivitis, muscle and joint pain, malaise or headache. These symptoms normally last for 2-7 days.
- There is no specific treatment or vaccine currently available.
- The best form of prevention is protection against mosquito bites.
- The virus is known to circulate in Africa, the Americas, Asia and the Pacific.

Introduction

Zika virus is an emerging mosquito-borne virus that was first identified in Uganda in 1947 in rhesus monkeys through a monitoring network of sylvatic yellow fever. It was subsequently identified in humans in 1952 in Uganda and the United Republic of Tanzania. Outbreaks of Zika virus disease have been recorded in Africa, the Americas, Asia and the Pacific.

- Genre: Flavivirus
- Vector: *Aedes* mosquitoes (which usually bite during the morning and late afternoon/evening hours)
- Reservoir: Unknown
-
-
-

Signs and Symptoms

The incubation period (the time from exposure to symptoms) of Zika virus disease is not clear, but is likely to be a few days. The symptoms are similar to other arbovirus infections such as dengue, and include fever, skin rashes, conjunctivitis, muscle and joint pain, malaise, and headache. These symptoms are usually mild and last for 2-7 days.

Potential complications of Zika virus disease

During large outbreaks in French Polynesia and Brazil in 2013 and 2015 respectively, national health authorities reported potential neurological and auto-immune complications of Zika virus disease. Recently in Brazil, local health authorities have observed an increase in Guillain-Barré syndrome which coincided with Zika virus infections in the general public, as well as an increase in babies born with microcephaly in northeast Brazil. Agencies investigating the Zika outbreaks are finding an increasing body of evidence about the link between Zika virus and microcephaly. However, more investigation is needed to better understand the relationship between microcephaly in babies and the Zika virus. Other potential causes are also being investigated.

Transmission

Zika virus is transmitted to people through the bite of an infected mosquito from the *Aedes* genus, mainly *Aedes aegypti* in tropical regions. This is the same mosquito that transmits dengue, chikungunya and yellow fever. However, sexual transmission of Zika virus has been described in 2 cases, and the presence of the Zika virus in semen in 1 additional case.

Zika virus disease outbreaks were reported for the first time from the Pacific in 2007 and 2013 (Yap and French Polynesia, respectively), and in 2015 from the Americas (Brazil and Colombia) and Africa (Cabo Verde). In addition, more than 13 countries in the Americas have reported sporadic Zika virus infections indicating rapid geographic expansion of Zika virus.

Diagnosis

Infection with Zika virus may be suspected based on symptoms and recent history (e.g. residence or travel to an area where Zika virus is known to be present). Zika virus diagnosis can only be confirmed by laboratory testing for the presence of Zika virus RNA in the blood or other body fluids, such as urine or saliva.

Prevention

Mosquitoes and their breeding sites pose a significant risk factor for Zika virus infection. Prevention and control relies on reducing mosquitoes through source reduction (removal and modification of breeding sites) and reducing contact between mosquitoes and people.

This can be done by using insect repellent regularly; wearing clothes (preferably light-coloured) that cover as much of the body as possible; using physical barriers such as window screens, closed doors and windows; and if needed, additional personal protection, such as sleeping under mosquito nets during the day. It is extremely important to empty, clean or cover containers regularly that can store water, such as buckets, drums, pots etc. Other mosquito breeding sites should be cleaned or removed including flower pots, used tyres and roof gutters. Communities must support the efforts of the local government to reduce the density of mosquitoes in their locality.

Repellents should contain DEET (N, N-diethyl-3-methylbenzamide), IR3535 (3-[N-acetyl-N-butyl]-aminopropionic acid ethyl ester) or icaridin (1-piperidinecarboxylic acid, 2-(2-hydroxyethyl)-1-methylpropylester). Product label instructions should be strictly followed. Special attention and help should be given to those who may not be able to protect themselves adequately, such as young children, the sick or elderly.

During outbreaks, health authorities may advise that spraying of insecticides be carried out. Insecticides recommended by the WHO Pesticide Evaluation Scheme may also be used as larvicides to treat relatively large water containers.

Travellers should take the basic precautions described above to protect themselves from mosquito bites.

Treatment

Zika virus disease is usually relatively mild and requires no specific treatment. People sick with Zika virus should get plenty of rest, drink enough fluids, and treat pain and fever with common medicines. If symptoms worsen, they should seek medical care and advice. There is currently no vaccine available.

WHO response

WHO is supporting countries to control Zika virus disease through:

- Define and prioritize research into Zika virus disease by convening experts and partners.
- Enhance surveillance of Zika virus and potential complications.
- Strengthen capacity in risk communication to help countries meet their commitments under the International Health Regulations.
- Provide training on clinical management, diagnosis and vector control including through a number of WHO Collaborating Centres.
- Strengthen the capacity of laboratories to detect the virus.
- Support health authorities to implement vector control strategies aimed at reducing *Aedes* mosquito populations such as providing larvicide to treat still water sites that cannot be treated in other ways, such as cleaning, emptying, and covering them.
- Prepare recommendations for clinical care and follow-up of people with Zika virus, in collaboration with experts and other health agencies.

Zika virus/complications »

This page links all WHO information to its response on the Public Health Emergency of International Concern.

Zika virus fact sheet

- Portuguese
- Arabic
- Chinese
- French
- Russian
- Spanish

Related links

Zika virus disease

- Zika virus fact sheet in Portuguese
- Zika virus Q&A
- More on Zika virus

Microcephaly

- Microcephaly key facts
- Q&A: Women, Microcephaly and Zika virus (English version)
- Q&A: Women, Microcephaly and Zika virus (Portuguese version)
- More on Microcephaly

Guillain–Barré syndrome

- Guillain–Barré syndrome fact sheet
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Zika virus disease

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Women in the context of microcephaly and Zika virus disease

Latest Ebola outbreak over in Liberia; West Africa is at zero, but new flare-ups are likely to occur

Commission on Ending Childhood Obesity

Middle East respiratory syndrome coronavirus (MERS-CoV) – Saudi Arabia

Mosquito Bite Prevention (United States)

Not all mosquitoes are the same. Different mosquitoes spread different viruses and bite at different times of the day.

Type of Mosquito	Viruses spread	Biting habits
Aedes aegypti, *Aedes albopictus*	Chikungunya, Dengue, Zika	Primarily daytime, but can also bite at night
Culex species	West Nile	Evening to morning

Protect yourself and your family from mosquito bites

Use insect repellent

Use an Environmental Protection Agency (EPA)-registered insect repellent with one of the following active ingredients. When used as directed, EPA-registered insect repellents are proven safe and effective, even for pregnant and breastfeeding women.

Active ingredient Higher percentages of active ingredient provide longer protection	**Some brand name examples***
DEET	Off!, Cutter, Sawyer, Ultrathon
Picaridin, also known as **KBR 3023, Bayrepel**, and **icaridin**	Cutter Advanced, Skin So Soft Bug Guard Plus, Autan (outside the United States)
Oil of lemon eucalyptus (OLE) or **para-menthane-diol** (PMD)	Repel
IR3535	Skin So Soft Bug Guard Plus Expedition, SkinSmart

* Insect repellent brand names are provided for your information only. The Centers for Disease Control and Prevention and the U.S. Department of Health and Human Services cannot recommend or endorse any name brand products.

CS258143A February 17, 2016

Protect yourself and your family from mosquito bites *(continued)*

- Always follow the product label instructions.
- Reapply insect repellent every few hours, depending on which product and strength you choose.
  - » Do not spray repellent on the skin under clothing.
  - » If you are also using sunscreen, apply sunscreen first and insect repellent second.

Natural insect repellents (repellents not registered with EPA)

- The effectiveness of non-EPA registered insect repellents, including some natural repellents, is not known.
- To protect yourself against diseases like chikungunya, dengue, and Zika, CDC and EPA recommend using an EPA-registered insect repellent.
- When used as directed, EPA-registered insect repellents are proven safe and effective.
- For more information: www2.epa.gov/insect-repellents

If you have a baby or child

- Always follow instructions when applying insect repellent to children.
- Do not use insect repellent on babies younger than 2 months of age.
- Dress your child in clothing that covers arms and legs, or
- Cover crib, stroller, and baby carrier with mosquito netting.
- Do not apply insect repellent onto a child's hands, eyes, mouth, and cut or irritated skin.
  - » Adults: Spray insect repellent onto your hands and then apply to a child's face.
- Do not use products containing oil of lemon eucalyptus (OLE) or para-menthane-diol (PMD) on children under 3 years of age.

Treat clothing and gear

- Treat items such as boots, pants, socks, and tents with permethrin or purchase permethrin-treated clothing and gear.
  - » Permethrin-treated clothing will protect you after multiple washings. See product information to find out how long the protection will last.
  - » If treating items yourself, follow the product instructions.
  - » Do not use permethrin products directly on skin.

Mosquito-proof your home

- Use screens on windows and doors. Repair holes in screens to keep mosquitoes outside.
- Use air conditioning when available.
- Keep mosquitoes from laying eggs in and near standing water.
  - » Once a week, empty and scrub, turn over, cover, or throw out items that hold water, such as tires, buckets, planters, toys, pools, birdbaths, flowerpots, or trash containers. Check inside and outside your home.

www.cdc.gov/features/StopMosquitoes

ATTACHMENT 2
BHATE HEALTH AND SAFETY
FIELD FORMS

Confined Space Entry Permit

Permit Valid for one shift only. All Permit copies to remain at project site until completion of the project.

Project Location (Address, City, State, Site Description):	Date:	Time:	Project Number:

Supervisor on Duty:	Supervisor Phone Number:	Purpose of Entry:

Communication Procedures:

Rescue Procedures and Phone Numbers:

Requirements Completed					
	Date	Time		Date	Time
Breathing Apparatus			Line(s) Broken-Capped Blank		
Emergency Escape/Fall Retrieval Equipment			Lighting (Explosive Proof)		
Full Body Harness w/ "D" Ring			Fire Extinguishers		
Lifelines			Secure Area (Post and Flag)		
Protective Clothing			Ventilation		
Respiratory Protection			Purge-Flush and Vent		
Standby Safety Personnel					

Note: For items that do not apply, enter N/A in the blank.

Instrumentation
Manufacturer:
Model:
Serial #:
Date of Last Factory Calibration:

Pre-Entry Calibration Data		
Date and Time		
Gas Type	**Concentration**	**Instrument Reading**

Post-Entry Calibration Data		
Date and Time		
Gas Type	**Concentration**	**Instrument Reading**

Air Monitoring Record Monitoring Results At Least Every ¼ Hour							
Parameters	**Permissible Entry Level**	**Times**					
Percent Oxygen	**19.5% - 22.0%**						
Lower Flammable Level	**< 10%**						

Entry Participants		
Name	**Signature**	**Duty (Supervisor, Entrant, Attendant)**

Remarks:

Entry Authorization Supervisor has reviewed the permit and verified the confined space conditions	
Supervisor Signature:	**Date/Time:**

bhate ENVIRONMENT INFRASTRUCTURE

EMPLOYEE and SUBCONTRACTOR WARNING REPORT

Employee's Name ________________________ Date of Warning: _________
Job Number: ____________

Type of Violation: ☐Attendance ☐ Carelessness ☐ Disobedience Violation Date:_______
☐ Safety ☐ Tardiness ☐ Work Quality Violation Time: ________
☐ Other(Describe Below) Location Violation Occurred: ____________
(area on job site, bldg #, floor etc.)

BHATE STATEMENT

____
____
____
____
____
____
____
____
____

EMPLOYEE STAEMENT

Check paper box:
☐ I concur with Bhate's Company Statement
☐ I disagree with Bhate's Company Statement for the following reasons:
____
____
____

My signature confirms that I have checked off the appropriate box and/or entered my statement of the above matter:

____
Employee's Signature Date

CORRECTIVE ACTION TAKEN

____
____
____
____

Approved by: ____
Name Title Date

LIST ALL PREVIOUS WARNINGS (BELOW)
When warned (Date) and by Whom:
Previous Warning: (1st Warning)
Date: ______ By Whom: __________
☐Verbal
☐Written

Previous Warning :(2nd Warning)
Date: ______ By Whom: __________
☐Verbal
☐Written

Previous Warning: (3rd Warning)
Date: ______ By Whom: __________
☐Verbal
☐Written

I Have read this "warning decision" and understand it.

____
Employee's Signature Date

____
Signature of person warning Date

____
Supervisor's Signature Date

Copy Distribution: Employee
Safety Records Binder
Employee File
Monthly Safety Report

All Signatures are required Original copy shall be filed @ the job site in Safety Records Binder.

Site Health and Safety Inspection Form

Project Location (Address, City, State, Site Description):	Date:	Project Number:
Type of Inspection: ☐ Weekly		
Tasks or Activities Observed:		

Personnel Participating in Inspection:

Name	Organization	Name	Organization

General Workplace Conditions:

Category	Observations (N/A if Not Applicable)	Action required - Yes or No
Walking/Working Surfaces		
Aisles and Passageways		
Platforms/Scaffolding		
Ladders		
Stairs		
Exits/Egress		
Roadways		
Excavations/Trenches		
Ventilation		
Lighting		
Noise Exposure		
Ergonomics		
Potable Water		
Sanitation Facilities		
Temperature Extremes		

Hazardous Materials Use & Storage:

Category	Observations (N/A if Not Applicable)	Action required - Yes or No
Safety Data Sheets *SDSs) Available		
Material Labeling		
Storage Conditions		
Storage Containers Condition		
Chemical Storage Compatibility		
Compressed Gas Storage & Use		
Waste Storage/Disposal		

Motor Vehicles & Power Equipment:		
Category	**Observations (N/A if Not Applicable)**	**Action required - Yes or No**
Seatbelts & Back-up Alarms		
Dozer Equipment		
Scraper Equipment		
Road Grader Equipment		
Water Trucks		
Front End Loader/Backhoe Equipment		
Cranes/ Hoists & Rigging		
Forklifts		
Other Heavy Equipment		
Loads Secure on Vehicles		
Wheels Chocked		

Hazard Controls:		
Category	**Observations (N/A if Not Applicable)**	**Action required - Yes or No**
General Site Controls		
Work Zone Delineation		
Lockout/Tagout Systems		
Accident Prevention Signs and Tags		
Barricades		
Hole Covers		
Electrical Grounding & GFCI Use		

Emergency Systems:		
Category	**Observations (N/A if Not Applicable)**	**Action required - Yes or No**
Emergency Instructions/Postings		
Fire Protection		
Eye Wash and Showers		
First Aid Kits/Stations		
Emergency Rescue Equipment		

Personal Protective Equipment:		
Category	**Observations (N/A if Not Applicable)**	**Action required - Yes or No**
Eye Protection		
Ear Protection		
Respiratory Protection		
Head Protection		
Hand Protection		
Foot Protection		
Body Protection		
Fall Protection		

Hand/Power Tools and Power Systems:		
Category	**Observations (N/A if Not Applicable)**	**Action required - Yes or No**
Hand Tools Condition		
Portable Power Tools Condition		
Welding/Burning Equipment		
Power Tools Guarding		
Electrical Power Generator		
Pneumatic Power Generator		
Remediation Waste Management:		
Category	**Observations (N/A if Not Applicable)**	**Action required - Yes or No**
Waste Properly Categorized		
Cross Contamination Minimized		
Storage Containers in Good Condition		
Waste Storage Location		
Staging/Stockpiling of Soil/Debris		
Decontamination Water		
Environmental Controls:		
Category	**Observations (N/A if Not Applicable)**	**Action required - Yes or No**
Dust Control		
Odor Control		
Oil and Spill Prevention		
Stormwater/Erosion Control Activities		
Other Health and Safety Related Conditions or Work Practices		

Project Location (Address, City, State, Site Description):	Date:	Project Number:

Type of Inspection: ☐ Weekly ☐ Monthly

Summary and Recommendations

Hazard Classification*	Findings and Recommended Corrective Action	Date Corrected	Corrected or Verified by

*Classify as Major or Minor – Major findings indicate that a potential or imminent hazard to people, property, or the environment exists

U.S. Department of Labor

OSHA®
Occupational Safety and Health Administration

Job Safety and Health
IT'S THE LAW!

All workers have the right to:

- A safe workplace.
- Raise a safety or health concern with your employer or OSHA, or report a work-related injury or illness, without being retaliated against.
- Receive information and training on job hazards, including all hazardous substances in your workplace.
- Request an OSHA inspection of your workplace if you believe there are unsafe or unhealthy conditions. OSHA will keep your name confidential. You have the right to have a representative contact OSHA on your behalf.
- Participate (or have your representative participate) in an OSHA inspection and speak in private to the inspector.
- File a complaint with OSHA within 30 days (by phone, online or by mail) if you have been retaliated against for using your rights.
- See any OSHA citations issued to your employer.
- Request copies of your medical records, tests that measure hazards in the workplace, and the workplace injury and illness log.

This poster is available free from OSHA.

Employers must:

- Provide employees a workplace free from recognized hazards. It is illegal to retaliate against an employee for using any of their rights under the law, including raising a health and safety concern with you or with OSHA, or reporting a work-related injury or illness.
- Comply with all applicable OSHA standards.
- Report to OSHA all work-related fatalities within 8 hours, and all inpatient hospitalizations, amputations and losses of an eye within 24 hours.
- Provide required training to all workers in a language and vocabulary they can understand.
- Prominently display this poster in the workplace.
- Post OSHA citations at or near the place of the alleged violations.

FREE ASSISTANCE to identify and correct hazards is available to small and medium-sized employers, without citation or penalty, through OSHA-supported consultation programs in every state.

Contact OSHA. We can help.

1-800-321-OSHA (6742) • TTY 1-877-889-5627 • www.osha.gov

OSHA 3165-04R 2015

bhate
ENVIRONMENT
INFRASTRUCTURE

Minimum Safety Requirements for Subcontractors

- Subcontractor is required to supply their employees with the proper personal protective equipment as required.
- ANSI approved hard hats must be worn while in the work area as indicated on the Site Safety and Health Plan.
- ANSI approved safety glasses with rigid side shields must be worn while in the work area.
- Substantial/sturdy work boots are required while on site. Sandals, tennis shoes, or any other soft cloth, nylon, and/or low cut shoes are NOT permitted. Steel toe shoes and/or foot guards may be required for trades or any activities that could present an impact or compression hazard to the foot (i.e. steel erectors, masonry, work that involves lifting, rolling, material handling, jack hammering, compacting, pile driving, drilling, or any other activity that is otherwise indicated on the Site Safety and Health Plan (SSHP)).
- Work gloves (leather, Kevlar, or other) must be worn while handling sharp or abrasive objects.
- Long pants are required. Nylon warm-up suits are NOT permitted on the job site.
- Work shirts with at least 4” sleeves are required. Sleeveless and tank top shirts are NOT permitted.
- Hearing protection, respiratory protection, chemical resistant clothing, gloves, boots, and other personal protective equipment shall be worn when required based on the hazard assessment of the job site as indicated on the SSHP.
- All employees shall wear full body safety harnesses when working 6 feet or more above the ground on any unprotected ledge or work platform. The lanyard shall be secured 100% of the time and shall allow a max fall distance of 6 feet. Safety harnesses shall also be worn while working out of extensible and articulating boom platforms or suspended scaffolds. All employees required to use fall protection shall have received appropriate training by the subcontractor.
- All hand, power tools, and any associated parts such as electrical cords, air lines, etc. shall be maintained in a safe condition and inspected prior to each use and monthly. Damaged tools must be tagged and taken out of service until repairs can be made. Electrical cords may not be spliced and taped back together.
- Ground fault circuit interrupters (GFCI) shall be used for all electrical equipment that may come in contact with moisture, on all temporary power, and on all portable generators > 5000 watts.
- Compressed gas cylinders shall be secured and stored in an appropriate area in an upright position at all times.
- Oxygen and acetylene cylinders or other combustible materials shall be separated by a minimum distance of 20 feet or a non-combustible barrier 5 feet high with a ½ hour fire rating; Anti-flash back valves are required on oxygen/acetylene.
- All scaffolds will be erected, used, and dismantled under the supervision of a trained, competent person designated by the subcontractor. Scaffolds must be inspected + tagged by the subcontractor competent person prior to each work shift
- All cranes and derricks shall be certified by a competent person designated by the subcontractor as being in safe operating condition prior to use onsite and inspected monthly thereafter; all rigging equipment will be inspected prior to use and monthly by a competent person designated by the subcontractor; the swing radius of the crane counterweight shall be barricaded. Personnel are not permitted to walk under loads while being lifted and loads are not permitted to be swung over personnel; Critical lifts (lifts that require more than one crane or over 75% of the manufacturer’s recommended lift capacity) must be approved by Bhate Corporate Health and Safety.
- Equipment will not be operated within 25 feet of any overhead utilities.
- All equipment and motor vehicles must be inspected with documentation prior to use and monthly by the subcontractor.
- Defective equipment or vehicles will be repaired or taken out of service immediately.
- All mobile equipment will be equipped with roll-over protection and seat belts to be worn at all times while in operation.
- All operators of construction equipment must be certified by a competent person designated by the subcontractor.

Minimum Safety Requirements for Subcontractors

- All mobile equipment onsite must have a functioning back-up alarm where equipped by the manufacturer. If a piece of equipment was not equipped with a back-up alarm, the horn shall be used prior to and during backing.
- All electrical work, installation, and wire capacities shall be in accordance with the pertinent provisions of the NEC, ANSI, and OSHA.
- Bhate shall issue a lockout and tag procedure.
- All temporary power panels shall have covers installed at all times. All open or exposed breaker spaces shall be adequately covered and labeled. Knockout plugs shall be replaced immediately.
- The use of damaged ladders is prohibited.
- Metal ladders are not to be used where electrical hazards exist.
- Ladders shall extend 36" above landing and be secured to prevent displacement.
- Floor and wall openings shall be guarded by a standard guardrail and toe board, or adequately covered and labeled
- Stairs with four or more risers must have railings installed.
- The subcontractor must notify the Bhate Superintendent prior to conducting any excavation activity. Underground utilities must be identified prior to performing excavations by calling 811 (one call utility locate service). No excavations can occur within a 4 foot "buffer zone" of any underground utility.
- Excavations must be inspected daily with documentation by a competent person and after each rainfall and/or any other hazard increasing occurrence to determine their safety. All excavations four feet or more in depth shall be tested at least daily to determine that the atmosphere within the excavation is safe if there is reason to believe an atmospheric hazard has the potential to exist.
- All banks five feet high or more shall be sloped to the angle of repose (i.e. Type A soil = 53 degree angle from horizontal; Type B = 45 degrees; and Type C = 34 degrees), shall be shielded, or shall be adequately shored. The protection system used for the excavation shall be determined by classifying the soil by a competent person.
- Ladders or steps shall be provided for all trenches or excavations 4 feet or more in depth and shall be located to require no more than 25 feet of lateral travel before having access or egress.
- Excavated or loose materials must be kept at least 2 feet from the edge of the excavation.
- All trenches and excavations shall be properly barricaded to prevent persons walking into them.
- Steel erection shall not commence until approval is obtained by Bhate; all personnel performing steel erection must be trained in fall protection, and any specialized training for connectors for employees working in the controlled decking zone.
- As applicable the subcontractors shall have a confined space program submitted to and approved by Bhate including entry procedures to be used when employees are required to work in confined spaces. All affected employees must be properly trained. Atmospheric testing must be conducted prior to entry and hazards must be communicated with affected individuals. Bhate shall be notified prior to any confined space work.
- The subcontractor is responsible for supplying the necessary equipment and calibration gases to conduct atmospheric testing for their affected employees as required by OSHA and/or the SSHP.
- Housekeeping must be maintained by the subcontractor while working on site. Bhate must be notified of any hazardous material brought on site with MSDS provided by the subcontractor and/or of any hazardous waste generated at the site. The subcontractor is responsible for storage of their hazardous waste and proper disposal. Documentation of proper disposal must be submitted to Bhate.
- All protruding nail, tie rods and wires shall be removed from foundations or boards as soon as forms are stripped. Nails shall be bent over if not removed.
- All protruding rebar must have cap impalement protectors in place.
- No open fires of scrap lumber or any other material are permitted. Smoking is only allowed in pre-designated areas.

Minimum Safety Requirements for Subcontractors

- Subcontractor will make provisions for prompt medical attention in case of emergency. The subcontractor will ensure that at least one employee on site has First Aid/CPR training. The subcontractor will provide first aid supplies for their employees and will provide proper equipment for transportation of the injured person to a physician or hospital or a communication system for contacting necessary ambulance services.
- No alcohol or illegal substances are allowed on site. Drug testing will be required of any employee for reasonable cause of suspicious behavior or activity including accidents or incidents.
- All injuries, accidents, near misses, chemical spills, fires, property damage, or other incidents must be reported immediately to Bhate.
- Prior to any demolition projects, Bhate may require an engineering survey to be completed and used to evaluate the hazards; all affected utilities must be disconnected by the utility companies; provisions must be made for prompt medical attention in the event of an emergency; a fire prevention and protection plan must be developed and implemented.
- The subcontractor must designate a competent person as their safety representative who will be responsible for attending and/or conducting weekly safety meetings, daily inspections of the work areas, formal weekly inspections, as well as all aforementioned monthly inspections. Documentation of all inspections must be maintained and available upon request.
- The subcontractor may be required to submit a copy of all written safety programs that covers the subcontractor's activities to the Bhate prior to start of work for approval; the subcontractor is responsible for ensuring all affected employees have all required health and safety training to perform the assigned tasks.
- There is a company ban on text messaging while driving.

This list includes some highlighted components of the health and safety rules while working onsite and is not all inclusive. Subcontractors are expected to comply with all applicable regulations to include but not limited to OSHA, EPA, DOT, site specific safety, and local and state regulations. Only through a written request detailing to Bhate Corporate Health and Safety may any subcontractor requirement be downgraded either based on a lack of hazard or a situation where the requirement increases the hazard.

bhate ENVIRONMENT INFRASTRUCTURE

Lockout/Tagout Permit

Section A			
Project Location (Address, City, State, Site Description):	Date:	Time:	Project Number:
Equipment Description and Location:	Reason for Lockout/Tagout:		
Lockout Locations:	Supervisor on Duty:	Authorized Employee:	

Section B	
Requestor:	
Notifier:	
Shut Down By:	
Isolator:	
Verifier:	
Approved By:	

Section C			Section D				Section E		
Device Description	Location	Isolation Position	Applied By	Lock #	Date	Time	Removed By	Date	Time

Special Instructions for Removal or Releasing Stored Energy:

INCIDENT REPORT

Date of Report: ____________________ **Bhate Report No:** __________________
(To be assigned by the HSM)

TYPE OF INCIDENT (check all that apply)

❒ INJURY/ILLNESS ❒ VEHICLE DAMAGE ❒ HIGH LOSS POTENTIAL (NEAR MISS) ❒ FIRE
❒ SPILL/RELEASE ❒ PROPERTY LOSS/DAMAGE ❒ PERMIT OR EQUIV. EXCEEDANCE ❒ OTHER

GENERAL INFORMATION

PROJECT: TASK:

COMPANY OR SUBCONTRACTOR NAME(S):

DATE OF INCIDENT: DAY OF WEEK: MILITARY TIME:

SUPERVISOR ON DUTY: PHONE: SUPV ON SCENE? ❒ YES ❒ NO

LOCATION OF INCIDENT:

WEATHER/LIGHTING CONDITIONS:

DESCRIBE WHAT HAPPENED (step by step, use additional pages if necessary)

1. What was the employee doing, or what was happening, just before the incident occurred? Describe the activity, as well as the equipment, tools, or materials in use. *Be specific, e.g. "climbing a ladder while carrying tools" or "driving westbound on Main St."*

2. What happened? What was the contact or event and how did it occur? e.g. "When the ladder slipped on the wet floor, employee fell 20 feet" or "was distracted by bee, swerved off right side of road and struck the stop sign"

IMMEDIATE CORRECTIVE ACTIONS (use additional pages if necessary)

AFFECTED EMPLOYEE INFORMATION (Include injured person or employees whose activities resulted in incident) ❒N/A

NAME: ❒ MALE ❒ FEMALE COMPANY:

HOME ADDRESS:

SOCIAL SECURITY OR EMPLOYEE #: HOME PHONE #:

JOB CLASSIFICATION: YEARS IN JOB CLASSIFICATION:

TIME EMPLOYEE BEGAN WORK: DATE OF HIRE: AGE:

DID INCIDENT RELATE TO ROUTINE TASK FOR JOB CLASSIFICATION?: ❒ YES ❒ NO

INJURY/ILLNESS INFORMATION ❒N/A

NATURE OF INJURY OR ILLNESS (Body part affected and how it was affected, e.g. strained back):

OBJECT/EQUIPMENT/SUBSTANCE CAUSING HARM:

FIRST AID PROVIDED: ❒ YES ❒ NO IF YES, WHERE: ❒ ON SITE ❒ OFF SITE

IF YES, WHO PROVIDED FIRST AID?:

WILL THE INJURY/ILLNESS RESULT IN: ❒ RESTRICTED DUTY ❒ LOST TIME ❒ UNKNOWN

ENVIRONMENT INFRASTRUCTURE

INCIDENT REPORT (Continued)

TREATMENT OR EVALUATION INFORMATION (Attach Provider's Report/Statement) ❒ N/A

WAS TREATMENT OR EVALUATION PROVIDED? ❒ YES ❒ NO ❒ FIRST AID ❒ EVALUATION ❒ MEDICAL TREATMENT

IF YES, WHERE? ❒ ON SITE ❒ DR'S OFFICE ❒ HOSPITAL ❒ OTHER:

NAME OF PERSON(S) PROVIDING TREATMENT OR EVALUATION:

ADDRESS WHERE TREATMENT OR EVALUATION WAS PROVIDED:

TYPE OF TREATMENT OR EVALUATION:

PROPERTY LOSS OR DAMAGE INFORMATION ❒ N/A

PROPERTY OR VEHICLE INVOLVED:

DESCRIPTION OF LOSS OR DAMAGE: ESTIMATED $ LOST:

SPILL OR RELEASE INFORMATION ❒ N/A

SUBSTANCE SPILLED OR RELEASED: FROM WHERE: TO WHERE:

ESTIMATED QUANTITY/DURATION:

REPORTABLE QUANTITY (RQ): RQ EXCEEDED? ❒ YES ❒ NO

RELEASED TO WATERS OF STATE? ❒ YES ❒ NO CERCLA HAZARDOUS SUBSTANCE? ❒ YES ❒ NO

RESPONSE ACTIONS TAKEN:

PERMIT OR EQUIVALENT EXCEEDANCE ❒ N/A

TYPE OF PERMIT: PERMIT #:

DATE OF EXCEEDANCE: DATE FIRST KNOWLEDGE OF EXCEEDANCE:

PERMITTED LEVEL OR CRITERIA (e.g., Water quality, Air Quality):

EXCEEDANCE LEVEL OR CRITERIA: EXCEEDANCE DURATION:

RESPONSE ACTIONS TAKEN:

PERSONS PREPARING REPORT (Employee and Supervisor to Complete Report)

EMPLOYEE'S NAME (PRINT): SIGN: DATE:

EMPLOYEE'S NAME (PRINT): SIGN: DATE:

SUPERVISOR'S NAME (PRINT): SIGN: DATE:

PERSONNEL NOTIFIED (check all that apply)

ORGANIZATION	NAME(S)	DATE/TIME
❒ Bhate Site Safety and Health Officer		
❒ Bhate Site Manager		
❒ Site Emergency Services		
❒ Other Organizations Notified		

RECEIVED BY Bhate Health and Safety Manager Date:

INCIDENT REPORT INSTRUCTIONS

General: The incident report (2 pages) must be completed within 24 hours of the incident. If any information is unknown, it can be provided later as the information is available. Complete all applicable sections of the form. If a section does not apply, indicate this by using "N/A". Names, dates, and signatures should be complete.

Type of Incident: Check all that apply. A Near Miss (High Loss Potential) incident is one that does not result in loss, but under slightly different circumstances, could have resulted in an OSHA Recordable injury, spill, release, permit exceedance, fire, or vehicle/property damage in excess of $500. All Near Miss (High Loss Potential) incidents are to be investigated.

General Information

Project/Task: Give the Project Name and task being performed.

Supervisor on Duty: The Supervisor on Duty responsible for the work effort involving the incident.

Location of Incident: The specific location on the project (a street address or facility building numbers)

Weather/Lighting Conditions: Temperature, precipitation, approximate wind speed and direction, lighting conditions, cloud cover, relative humidity. This information may be included in the description section, and must be given in detail whenever it is a factor in the cause or impact, e.g., spill, release, heat stress, windblown material.

Describe What Happened: This section must be completed in sufficient detail to describe the events and conditions leading up to and resulting from the incident. Try to answer the questions who, what, where, when, and how. This information is then used to determine why (cause). Provide details such as work objective, procedure being used, body position, and PPE. Include diagrams or sketches for all incidents involving vehicles/equipment and other incidents where they aid in providing detail or perspective. Consider attaching photographs.

Immediate Corrective Actions

List what corrective actions were taken immediately as a result of the incident such as containing spills, first aid, temporary barriers, work stoppage, and similar actions.

Affected Employee Information

Employee: Direct hire, whether professional, administrative, or craft; full-time or part-time; permanent or temporary and/or Subcontractor employee.

Hours Worked on Shift Prior to the Incident: Only include the amount of time the employee worked that shift or day prior to the incident.

Years with the Company: Give the number of years employed with the current company in years and/or months.

Injury/Illness Information

Nature of Injury or Illness: Give a brief description of the body part affected and type of injury or illness, as applicable.

First Aid Provided: First Aid is any treatment that does not have to be provided by a health care professional. A clinic may provide first aid depending on the severity of the injury.

Will the Injury Result In: Do not delay the report if this information is unknown.

Medical Treatment Information

Was Medical Treatment Provided? Medical treatment is that treatment that must be provided by a licensed medical practitioner.

Type of Treatment: This information is important in determining OSHA recordability. Attach a copy of the treating professional's statement/work release.

Property Loss or Damage Information

Property or Vehicle Involved: For vehicles, indicate VIN and vehicle ownership.

Description of Loss or Damage: Be specific as to the identity of damaged part, location, and extent.

Estimated $ Lost: Estimate the monetary amount of loss or damage.

Spill or Release Information

Substance Spilled or Released: For pure substances, list materials by common name/chemical. For wastes, indicate waste code. For mixtures or contaminated media, provide contaminant name, CAS No., concentration.

RQ Exceeded? Specify the Reportable Quantity for the material.

Response Action Taken: Describe the mitigation efforts, as well as any reports made, beyond initial notification.

Permit or Equivalent Exceedance

Type of Permit: List name of permit or equivalent including the agency name where applicable (e.g., NPDES, NESHAP, etc.).

Date of Exceedance: Specify date exceedance occurred (e.g., date discharge in excess of permit limits occurred).

Date First Knowledge of Exceedance: Specify date when first knew there was an exceedance (i.e., date analytical received). This date may be different from the date of the exceedance listed above.

Permitted Level or Criteria: List discharge or emission limit or narrative criteria specified in the permit.

Exceedance Level or Criteria: Specify an actual discharge/emission limit or narrative criterion which was exceeded.

Exceedance Duration: Specify time frame by date and hours (using military time) during which exceedance occurred.

See "**Spill or Release Information**" (above) for description of remaining questions.

Persons Preparing Report

Employee's Name: The affected employee described on page 1 should review the report and sign here, as well as any other employees witnessing or involved in the incident.

Supervisor's Name: The Supervisor must review and sign the report indicating agreement. The Supervisor should be involved in conducting the investigation.

INCIDENT INVESTIGATION

Bhate Report No: ________________________

1. GENERAL INFORMATION

COMPANY:	**DATE OF INCIDENT:**	**DATE OF INVESTIGATION REPORT:**
INCIDENT COST:	ESTIMATED: $	ACTUAL: $
OSHA RECORDABLE: ❒ YES ❒ NO	# RESTRICTED DAYS:	# DAYS AWAY FROM WORK:
WAS THE ACTIVITY ADDRESSED IN AN AHA?:	❒ YES (Attach a copy)	❒ NO

2. CAUSE ANALYSIS

IMMEDIATE CAUSES – WHAT ACTIONS AND CONDITIONS CONTRIBUTED TO THIS EVENT? (SEE EXAMPLES NEXT PAGE)

BASIC CAUSES - WHAT SPECIFIC PERSONAL OR JOB FACTORS CONTRIBUTED TO THIS EVENT? (SEE EXAMPLES NEXT PAGE)

3. ACTION PLAN

REMEDIAL ACTIONS - WHAT HAS BEEN AND/OR SHOULD BE DONE TO CONTROL THE CAUSES LISTED? INCLUDE MANAGEMENT PROGRAMS (SEE ATTACHED LIST) FOR CONTROL OF INCIDENTS IF APPLICABLE.

ACTION	PERSON RESPONSIBLE	TARGET DATE	DATE COMPLETE	VERIFIED BY

4. PERSONNEL PERFORMING INVESTIGATION

NAME: (PRINT)	SIGN:	DATE:
NAME: (PRINT)	SIGN:	DATE:
NAME: (PRINT)	SIGN:	DATE:

5. MANAGEMENT REVIEW

Project Manager (PRINT)	SIGN:	DATE:
COMMENTS:		
Bhate Health and Safety Manager (PRINT)	SIGN:	DATE:
COMMENTS:		

NOTE: Attach additional information as necessary. Site Manager to forward copy of Investigation Report to the Bhate Health and Safety Manager as soon as possible, but no later than 72 hours after the incident.

INCIDENT INVESTIGATION (Continued)

EXAMPLES OF IMMEDIATE CAUSES

SUBSTANDARD ACTIONS	SUBSTANDARD CONDITIONS
1. Operating Equipment without Authority	1. Inadequate Guards or Barriers
2. Failure to Warn	2. Inadequate or Improper Protective Equipment
3. Failure to Secure	3. Defective Tools, Equipment, or Materials
4. Operating at Improper Speed	4. Congestion or Restricted Action
5. Making Safety Devices Inoperable	5. Inadequate Warning System
6. Using Defective Equipment	6. Fire and Explosion Hazards
7. Failure to Use PPE Properly	7. Poor Housekeeping/Disorder
8. Improper Loading	8. Noise Exposure
9. Improper Placement	9. Exposure to Radiation/Hazardous Materials
10. Improper Lifting	10. Exposure to Temperature Extremes
11. Improper Position for Task	11. Inadequate Illumination
12. Servicing Equipment in Operation	12. Inadequate Ventilation
13. Horseplay	13. Hazardous Environmental Conditions
14. Under Influence of Alcohol/Drugs	
15. Using Equipment Improperly	
16. Failure to Follow Procedure	

EXAMPLES OF BASIC CAUSES

PERSONAL FACTORS	JOB FACTORS
1. Inadequate Physical/Physiological Capability	1. Inadequate Leadership/Supervision
2. Inadequate Mental/Psychological Capability Knowledge	2. Inadequate Engineering
3. Physical or Psychological Stress	3. Inadequate Purchasing
4. Mental or Psychological Stress	4. Inadequate Maintenance
5. Lack of Knowledge	5. Inadequate Tools/Equipment
6. Lack of Skill	6. Inadequate Work Standards
7. Improper Motivation	7. Excessive Wear and Tear
	8. Abuse or Misuse

MANAGEMENT PROGRAMS FOR CONTROL OF INCIDENTS

1. Leadership and Administration	10. Health Control
2. Management Training	11. Program Audits
3. Planned Inspections and Maintenance	12. Engineering and Change Management
4. Task Analysis and Procedures	13. Personal Communications
5. Task Observation	14. Group Communications
6. Emergency Preparedness	15. General Promotion/Awareness
7. Rules and Work Permits	16. Hiring and Placement
8. Accident/Incident Analysis	17. Purchasing Controls
9. Personal Protective Equipment	18. Off-the-Job Safety

NOTIFICATION REMINDER

Fatalities or hospitalization (admittance) of three or more individuals requires notification to OSHA within 8 hours. Contact the Bhate Operations Manager to make the notification. If unavailable, the senior operations person on site should make the notification.

INCIDENT INVESTIGATION INSTRUCTIONS

Report No.: This is the same as the incident report number assigned by the Bhate Health and Safety Manager

Date of Investigation Report: This date should be within 72 hours of the incident. In cases where the investigation is not completed until a later date, submit the incomplete report within the 72 hours, and a revised report should be submitted when the missing information is obtained.

Incident Cost: For all vehicle/equipment or property damage cases, an estimated or actual loss value must be entered. If an estimated value is entered, the report must be revised when the actual costs are known.

OSHA Recordable: This section should be completed in consultation with the Health and Safety Manager.

No. of Restricted Days: This relates to days of restricted work activity, not restrictions on motion or physical capability. If the employee is capable of doing his normal job the day after the injury and thereafter, there are no restricted days, even if the physician indicates a physical restriction. It does not include the day of the injury.

No. of Days Away from Work: The number of days after the day of the injury that the employee was scheduled to work but could not due to an occupational injury. If the treating physician releases an employee to return to work, but the employee chooses not to come to work, do not count those days. In this case the Health and Safety Manager should be consulted.

Cause Analysis

Immediate Causes: Determine the immediate causes, using the examples on page 2 of the Incident Investigation form. If one or more of the examples fits the circumstance, use those words in the cause description. However, do not confine your cause determination to the guide words.

Basic Causes: Like the Immediate Causes, use the guide words in the attachment whenever appropriate and explain. For example, improper motivation may be because the correct way takes more time or effort; short cutting standard procedure is tolerated or positively reinforced; or the person thinks there is no personal benefit to always doing the job correctly.

Remedial Actions: Include all actions taken or those that should be taken to prevent recurrence. Be sure that actions address the causes. For example, training (safety meetings) may be a necessary response for lack of knowledge, but may be inadequate for improper motivation. If completion dates are not verified prior to submitting the report, a revised report must be submitted or verification of closeout noted on the original report.

Personnel Performing Investigation: The primary investigator is the Supervisor in charge of the work where the incident occurred. Others participating in the investigation should also sign the report.

Management Review: The Bhate Project Manager and the Bhate Health and Safety Manager must sign the report indicating their satisfaction with the thoroughness of the investigation and the report, and their concurrence that the action items address the identified causes.

Hot Work Permit

Project Location (Address, City, State, Site Description):	Permit Issuance Date:	Permit Issuance Time:	Project Number:
	Permit Expiration Date:	Permit Expiration Time:	
Describe the Hot Work to be completed:			

Safety Zone for work established by (check all that apply)				
____ Cones	____ Caution Tape	_____ Natural Barrier	_____ Welding Screen	_____ Building
Other, explain:				

Safety Equipment (check all that apply)			
____ Respirator	____ Welders Mask	_____ Burning Goggles	_____ Face Shield
Other, explain:			

Safety Requirements		
Fire Extinguisher properly rated	_____Yes	_____No
Fire watch present	_____Yes	_____No
Combustibles covered or removed within 50 feet	_____Yes	_____No
Work area clean	_____Yes	_____No
Cables, hose lines, regulators, cylinders, electric sources checked	_____Yes	_____No
Are special fire protection procedures being implemented? If so, explain		

Air Monitoring Requirements, as specified by the SSHO							
Instrumentation	Background	Times					
FID/PID							
Oxygen Level							
Combustible Gas Indicator							

Hot Work Authorization	
Supervisor Signature:	Date/Time:
SSHO Signature:	Date/Time:
Fire Watch Signature:	Date/Time:

Safety Data Sheets (SDS) Binder - Hazardous Chemical Inventory List

Facility Location (Address, City, State, Site Description):		Date Inventory Prepared:
Individual Preparing List:	**Phone Number:**	**Page ____of____**

Name of Chemical/Product	Manufacturer	Location

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FIELD SSHP REVIEW SHEET

I have been trained in the contents of the Site Specific Safety and Health Plan (SSHP) and have been advised of the locations of copies available for review. I will comply with the provisions contained therein.

Name:	Date:

Excavation Soils Analysis Form

(To Be Completed by a "Competent Person")

This checklist must be completed when soil analysis is made to determine the soil type(s) present in the excavation. A separate analysis must be performed on each layer of soil in excavation walls or if the length of the excavation is in different soil types.

Project Location (Address, City, State, Site Description):	**Date:**	**Time:**	**Project Number:**
	Weather Conditions:		
Competent Person:	**Excavation Dimensions:**		
	Depth	**Width**	**Length**
Location Where Soil Sample Obtained:			

Visual Observations				
Particle type:	______ Fine Grained (cohesive)	______ Course grained (sand or gravel)		
Water conditions:	____ Wet	_____ Dry	_____ Surface water present	____ Submerged
Previously disturbed soils?	_____Yes	_____No		
Underground utilities?	_____Yes	_____No		
Layered soils?	_____Yes	_____No		
Layered soil dipping into excavation?	_____Yes	_____No		
Excavation exposed to vibrations?	_____Yes	_____No		
Crack-like openings or spallings observed?	_____Yes	_____No		
Conditions that may create a hazardous atmosphere? If yes, identify condition and source in comments.	_____Yes	_____No		
Surface encumbrances?	_____Yes	_____No		
Work to be performed near public vehicular traffic?	_____Yes	_____No		
Possible confined space exposure?	_____Yes	_____No		

Manual Tests		
Plasticity:	_____Cohesive	_____Non-cohesive
Dry Strength:	_____Granular (crumbles easily)	_____Cohesive (broken with difficulty)

NOTE: The following unconfined compressive strength tests should be performed on undisturbed soils.

Thumb Test (used to estimate unconfined compressive strength of cohesive soil)

Test performed:_____Yes _____No

_____Type A (soil indented by thumb with very great effort)
_____Type B (soil indented by thumb with some effort)
_____Type C (soil easily penetrated several inches by thumb with little or no effort). If soil is submerged, seeping water, subjected to surface water, runoff, exposed to wetting.

Penetrometer or Shearvane (used to estimate unconfined compressive strength of cohesive soils)

Test performed:_____Yes _____No

_____Type A (soil with unconfined compressive strength of 1.5 tons per square foot (tsf)or greater)
_____Type B (soil with unconfined compressive strength of 0.5 tsf to 1.5 tsf)
_____Type C (soil with unconfined compressive strength of 1.5 tsf or less). If soil is submerged, seeping water, subjected to surface water, runoff, exposed to wetting.

Wet Shaking Test (used to determined percentage of granular and cohesive materials).
Compare results to soil textural classification chart to determine soil type.

Test performed:_____Yes _____No

_____Type A (clay, silty clay, sandy clay, clay loam, and in some cases silty clay, loam and sandy clay loam)
_____Type B (angular gravel [similar to crushed rock], silt, silt loam, sandy loam, silty clay loam and sandy clay loam)
_____Type C (granular soil including gravel, sand, and loamy sand)
_____% granular _____% cohesive _____% silt

NOTE: Although OSHA will accept the above tests in most cases, some states will not. Check your state safety requirements for trenching regulations.

Soil Classification		
_____Type A	**_____Type B**	**_____Type C**

Selection of Protective System		
_____Sloping, Specify angle:_____	**_____Aluminum Hydraulic Shoring**	**_____Timber Shoring**

Comments

Date:	Is Equipment a rental? Yes No Equipment/Model Type:
Project/Phase No.:	Serial/License No.:
Location:	Owner/Operator:

Place an X in the "Yes" column if the requirement has been met. If a "No" is encountered, equipment must be removed from operation until the deficiency has been corrected. Use the Comment column to note any additional information needed to certify the equipment.

Inspection Item	Requirement	Yes	No	Comments/Corrections
Hydraulic systems controls and levers	No leaks from fittings or connections Levers are in good operating condition Fluid levels are full			
Fuel, oil, water, and coolant lines	No leaks			
Hoses	No leaks in hoses or connections No signs of excessive wear, kinked or bent hoses			
Gauges	Operational and visible to operator			
Emergency kill switch and life line	Operational and accessible to operator			
Shear pins	In place			
Drive chains	No signs of excessive wear, broken, or defective links			
Parking brakes	Set and operational			
Outriggers	No leaks Set on pads (as necessary to avoid damage)			
Windshield wipers	Operational			
Lights (head, brake, signal, and running lights)	Operational without cracked lenses			
Back-up alarm	Operational, spotter used			
Cables and ropes	No fraying, birdnesting, flattening, stretching Must be braided or properly clamped at connections			
Pulleys, drums, and spools	No excessive wear or cracking			
Derrick/mast	Locked in position Frame is not cracked or bent			
Hoists	Properly spooled cable, rated to lift loads			
Safety Equipment	Safety harnesses, fire extinguisher, flares, safety reflectors, first aid kit, grounding wire for fueling, and spill response equipment (for fueling and repairs)			
Guards	Power take-offs (PTOs) and all rotating parts designed with guards are present Guards must have warning levels			
Miscellaneous (as applicable)	Diverter systems, auger and head seals, cyclones, grout plant guards Other:			

Inspection Conducted and Certified by Owner/Operator:

Printed Name Signature Date

BHATE SAFETY AUDIT FINDINGS / DISCREPANCY TRACKING

Item #	Organization Audited	Rank	Location	Date	Project Number	Finding	Picture if available	Countermeasure	Date Assigned	Date Due	Date Complete/ Confirmed	Responsibility	Comments

bhate ENVIRONMENT INFRASTRUCTURE

DAILY SITE SAFETY MEETING

Project: ______________________ **Date:** ______________

Project/Phase Number: ______________________ **Time:** ______________

Meeting Conducted By: ______________________ ______________________

Print Name *Signature*

1. AWARENESS (e.g., special EHS concerns, pollution prevention, recent incidents, etc.):

2. OTHER ISSUES (HASP changes, new AHAs, attendee comments, etc.):

3. DISCUSSION OF DAILY ACTIVITIES/TASKS AND SAFETY MEASURES TO BE USED:

4. ATTENDEES (Print Name):

1.	2.
3.	4.
5.	6.
7.	8.
9.	10.
11.	12.
13.	14.
15.	16.
17.	18.
19.	20.
21.	22.
23.	24.
25.	26.
27.	28.
29.	30.

This Site Safety Meeting Log documents the safety briefing conducted in accordance with 29 CFR 1910.120 *Hazardous Waste Operations and Emergency Response* as well as other applicable regulatory requirements. Personnel who perform work operations onsite are required to attend each safety briefing and acknowledge receipt of such briefings daily.

Daily Excavation Inspection Checklist

(To Be Completed by a "Competent Person")

Project Location (Address, City, State, Site Description):	Date:	Time:	Project Number:
	Weather Conditions:		

Competent Person:	Soils Type:	Soil Classification	
		Type A	
	Excavation Dimensions: Depth: Width: Length:	Type B	
		Type C	

Type of Protective System Used:

General Inspection of Job Site	Yes	No	Not Applicable (N/A)
Surface encumbrances removed or supported			
Employees protected from loose rock or soil that could pose a hazard by falling or rolling into the excavation			
Hard hats worn by all employees			
Spoils, materials, and equipment set back at least 2 feet from the edge of the excavation			
Barriers provided at all remotely located excavations, wells, pits, shafts, etc.			
Walkways and bridges over excavations 4 feet or more in depth are equipped with standard guardrails			
Warning vests or other highly visible clothing provided and worn by all employees exposed to public vehicular traffic			
Warning system established and utilized when mobile equipment is operated near the edge of the excavation			
Employees prohibited from working on the faces of sloped or benched excavations above other employees			
Utilities			
Utility companies contacted and/or utilities located			
Exact location of utilities marked when approaching the utilities			
Underground installations protected, supported or removed when excavation is open			
Means of Access and Egress			
Lateral travel to means of egress no greater than 25 feet in excavations 4 feet or more in depth			
Ladders used in excavations secured and extended 3 feet above the edge of the trench			
Structural ramps used by employees designed by a competent person			
Structural ramps used for equipment designed by a registered professional engineer (RPE)			
Ramps constructed of materials of uniform thickness, cleated together on the bottom, equipped with a no-slip surface			
Employees protected from cave-ins when entering or exiting the excavation			

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Daily Excavation Inspection Checklist

Wet Conditions	Yes	No	Not Applicable (N/A)
Precautions taken to protect employees from the accumulation of water			
Water removal equipment monitored by a competent person			
Surface water or runoff diverted or controlled to prevent accumulation in the excavation			
Inspections made after every rainstorm or other hazard increasing occurrence			
Hazardous Atmospheres			
Atmosphere within the excavation tested when there is a possibility of an oxygen deficiency, combustible or other harmful contaminant exposing employees to a hazard			
Ventilation			
Testing conducted often to ensure that the atmosphere remains safe			
Emergency equipment, such as breathing apparatus, safety harness and line, and basket stretcher readily available where hazardous atmospheres could or do exist			
Safety harness and life line used and individually attended when entering deep confined excavations			
Support Systems			
Materials and/or equipment for support systems selected based on soil analysis, trench depth, and expected loads			
Materials and equipment used for protective systems inspected and in good condition			
Materials and equipment not in good condition have been removed from service			
Damaged materials and equipment used for protective systems inspected by a RPE after repairs and before being placed back into service			
Protective systems installed without exposing employees to the hazards of cave-ins, collapses or from being struck by materials or equipment			
Members of support system securely fastened to prevent failure			
Support systems provided to insure stability of adjacent structures, buildings, roadways, sidewalks, walls, etc.			
Excavations below the level of the base or footing approved by an RPE			
Removal of support systems progresses from the bottom and members are released slowly as to note any indication of possible failure			
Backfilling progresses with removal of support system			
Excavation of material to a level no greater than 2 feet below the bottom of the support system and only if the system is designed to support the loads calculated for the full depth			
Shield system placed to prevent lateral movement			
Employees are prohibited from remaining in shield system during vertical movement			

Comments

Construction Equipment Inspection Checklist

Project Name:	**Date /Time:** **S M T W Th F S (Please circle the day)**
Type of Inspection: **(Please check the inspection type)** **Incoming ____** **Outgoing ____** **Daily ____**	**Is Equipment a Rental? Y N Equipment Make/Description:** **Equipment Model Number:** **Equipment ID/Plate Number:**
Inspected By: (Name and Signature):	

Equipment	Acceptable	Not Acceptable	NA	Comments and Actions Taken
Operation/Owners Manual				
Brakes				
Brake Lights				
Reverse Signal Alarm				
Horn/Air Horn				
Tires/Tracks				
Steering				
Seat Belt				
Operating Controls				
Fire Extinguisher				
Lights				
Defroster				
Mirrors				
Instruments				
Coupling Devices				
Bed/Cargo Area				
Tailgate and Latch				
Tarps/covers				
Windshield/Window Glass				
Windshield Wipers				
Mudflaps/Rock Guards				
Exhaust Systems				
Hitches and Safety Cables				
Hydraulic Lines and Air Hoses				
Engine Oil				
Hydraulic Fluid				
Rollover Equipment				
Cleanliness				

Comments:

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Confined Space Pre-Entry Briefing Checklist

Project Location (Address, City, State, Site Description):	**Date:**	**Time:**	**Project Number:**
Checklist Completed By:	**Attendee(s):**		

- ☐ Hazard Communication (including the signs, symptoms, and modalities of chemical overexposure)
- ☐ Physical hazards present
- ☐ All hazard controls
- ☐ Acceptable entry conditions
- ☐ Emergency procedures
- ☐ Rescue procedures
- ☐ Duties of entrants and attendants during routine and emergency operations
- ☐ Frequency and Types of Monitoring
- ☐ Communications system backup to be used
- ☐ Review of work to be accomplished during entry
- ☐ Decontamination procedures (if necessary)
- ☐ PPE disposal
- ☐ Potential emergencies that may occur outside the confined space

ATTACHMENT 3

SAFETY TRAINING CERTIFICATES AND PROOF OF OSHA COMPETENCY FROM SUBCONTRACTORS

Name of Person	Job Duty or Subcontractor Task
Dustin McNeil	Field Operations Manager / Site Safety and Health Officer

OSHA Competent Person	Subcontractor	Task Requiring OSHA Competent Person
Add As Needed		

Safety Certifications for Site Safety and Health Officer (SSHO)

Dustin McNeil

Certificate of Completion

This is to certify that

Dustin McNeil

Has completed

HAZWOPER 8 hr Annual Refresher

360training.com, Inc. is authorized by IACET to offer 0.8 **CEUs for this program.**

Completion Date: 11/03/2015

Course Duration: 8.0

ISHM Institute for Safety and Health Management

ASU Arizona State University

ACCREDITED IACET PROVIDER

360training.com®

360training.com ♦ 13801 Burnet Rd., Suite 100 ♦ Austin, TX 78727 ♦ 800-442-1149 ♦ www.360trainingsupport.com

(CUT HERE)

This is your pocket card which may be used for proof of completion of your training. This training is intended to provide supervisor awareness for recognizing and preventing hazards on a construction site. Workers must receive additional training as required for the specific hazards of their job or federal, state, and local requirements.

360training.com, Inc. is accredited by the International Association for Continuing Education and Training (IACET) and is authorized to issue the IACET CEU.

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Questions? Visit www.oshacampus.com

safety@oshacampus.com 1-800-442-1149

This Card May Not Be Reproduced

(FOLD)

360training.com

This certifies that the person named below successfully completed a

Dustin McNeil

HAZWOPER 8 hr Annual Refresher

F. Marie Athey, OHST
Trainer Name

11/03/2015
Completed

Association of
Bay Area Governments

ABAG Training Center
www.hazmatschool.com

CERTIFICATE OF COMPLETION

Dustin McNeil

has successfully completed the course titled

OSHA 8-hr Training for Supervisors

Satisfies 29 CFR 1910.120(e)(4)

on

September 30, 2008

and has earned

IACET authorized 0.8 CEUs (Continuing Education Units) from the program

Certificate No 68430
(verify at www.hazmatschool.com)

Brian Kirking, Training Director
Sharon McCreadie, Training Coordinator
www.abag.ca.gov; (510) 464-7964

Paul W. Gantt

Paul W. Gantt, CSP, REA
Safety Compliance Management, Inc.

American Red Cross

Dustin McNeil

has successfully completed requirements for

Adult First Aid/CPR/AED: valid 2 Years

Date Completed: 04/06/2015

conducted by: American Red Cross

Instructor: Kathryn L Hancock-Tubbs

ID: 0WKFNQ

Scan code or visit:

redcross.org/confirm

OSHA Occupational Safety and Health Administration

36-600708528

This card acknowledges that the recipient has successfully completed a 30-hour Occupational Safety and Health Training Course in

Construction Safety and Health

DUSTIN MCNEIL

Michael Millsap	4/12/2010
(Trainer name – print or type)	(Course end date)

OSHA recommends Outreach Training Courses as an orientation to occupational safety and health for workers. Participation is voluntary. Workers must receive additional training on specific hazards of their job. This course completion card does not expire.

Use or distribution of this card for fraudulent purposes, including false claims of having received training, may result in prosecution under 18 U.S.C. 1001. Potential penalties include substantial criminal fines, imprisonment up to five years, or both.

For OSHA Outreach Training Program go to "Training" at www.osha.gov

Rev. 12/2009

This is to certify that

Dustin McNeil

NAME

has successfully completed

Behavior-Based Safety Training

AUTHORIZED BY Sally S. Smith DATE January 2015

This is to certify that

Dustin McNeil

NAME

has successfully completed

Work Zone Safety

AUTHORIZED BY Sally S. Smith DATE February 2015

This is to certify that

Dustin McNeil

NAME

has successfully completed

Scaffold Safety for Construction Training

AUTHORIZED BY Sally S. Smith DATE March 2015

This is to certify that

Dustin McNeil

NAME

has successfully completed

Respiratory Protection Training

AUTHORIZED BY Sally S. Smith DATE April 2015

This is to certify that

Dustin McNeil

NAME

has successfully completed

Materials Handling, Storage, Use and Disposal for Construction Training

AUTHORIZED BY Sally S. Smith DATE May 2015

This is to certify that

Dustin McNeil

NAME

has successfully completed

Lead Exposure for Construction Training

AUTHORIZED BY Sally S. Smith DATE June 2015

This is to certify that

Dustin McNeil

NAME

has successfully completed

Ladders and Stairs Training

AUTHORIZED BY Sally S. Smith DATE July 2015

This is to certify that

Dustin McNeil

NAME

has successfully completed

Heat Stress Training

AUTHORIZED BY Sally S. Smith DATE August 2015

This is to certify that

Dustin McNeil

NAME

has successfully completed

Fire Protection and Prevention for Construction Training

AUTHORIZED BY Sally S. Smith DATE September 2015

This is to certify that

Dustin McNeil

NAME

has successfully completed

Fall Protection for Construction Training

AUTHORIZED BY Sally S. Smith DATE October 2015

This is to certify that

Dustin McNeil

NAME

has successfully completed

Electrical Safety for Construction Training

AUTHORIZED BY Sally S. Smith DATE November 2015

This is to certify that

Dustin McNeil

NAME

has successfully completed

Concrete and Masonry for Construction Training

AUTHORIZED BY Sally S. Smith DATE December 2015

ATTACHMENT 4

WRITTEN SAFETY PROCEDURES AND PROGRAMS

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
AHA	Activity Hazard Analysis
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute
Bhate	Bhate Environmental Associates, Inc.
CDL	Commercial driver's license
CFR	Code of Federal Regulations
CGI	Combustible gas indicator
CIH	Certified Industrial Hygienist
CMC	Corporate Medical Consultant
CPR	Cardiopulmonary resuscitation
dBA	Decibels "A-weighted" scale
DOT	U.S. Department of Transportation
ECT	Equivalent chill temperature
EPA	U.S. Environmental Protection Agency
FID	Flame ionization detector
GFCI	Ground fault circuit interrupter
GHS	Global Harmonization System
HASP	Health and Safety Plan
HAZCOM	Hazard Communication
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCP	Hearing Conservation Program
HPD	Hearing protective device
HSM	Health and Safety Manager
IATA	International Air Transport Association
IDLH	Immediately Dangerous to Life or Health
kV	Kilovolts
lb	Pound
LEL	Lower explosive limit
LDR	Land Disposal Restriction
LMP	Local Medical Provider
m	Meter
MSHA	Mine Safety and Health Administration
MSDS	Material Safety Data Sheet (older term)
mg/M^3	Milligrams per cubic meter of air
NFPA	National Fire Protection Association
NPL	National Priority Site List
NRC	Nuclear Regulatory Commission
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated biphenyl

PE	Professional Engineer
PEL	Permissible exposure limit
PID	Photoionization detector
PPE	Personal protective equipment
RCRA	Resource Conservation and Recovery Act
RPE	Respiratory protective equipment
RSO	Radiation Safety Officer
SCBA	Self-contained breathing apparatus
SDS	Safety Data Sheet (correct term)
SLM	Sound level meter
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
SSHP	Site Specific Health and Safety Plan
TLV	Threshold Limit Value
USACE	US Army Corps of Engineers
VOC	Volatile Organic Compound
XRF	X-Ray Fluorescence

1 INCIDENT REPORTING AND INVESTIGATION

1.1 Purpose

The purpose of this program is to specify the types of incidents to be reported and investigated, to define internal incident notification requirements, to ensure proper management and follow-up of each incident, and to meet regulatory notification and investigation requirements.

1.2 Scope

Incident reporting requirements apply to all Bhate operations, including subcontractor activities.

1.3 Definitions

1.3.1 Incident

For the purposes of this program, an incident is:

- A work-related injury or illness;
- An exposure to a hazardous substance above the allowable exposure limit;
- Property/vehicle/equipment damage;
- An unplanned fire or explosion;
- An unplanned spill or release (including air releases) to the environment;
- A permit or permit equivalent exceedance;
- Any unexpected contact with or damage to aboveground or belowground utilities;
- Discovery of an unknown and potentially hazardous material;
- A "near miss" or an unplanned event or workplace condition that has a reasonable probability of resulting in one of the outcomes described above had the circumstances been different, and for which modifications to management programs will reduce the probability of occurrence or the severity of the outcome.

1.3.2 "Serious" Incident

A "serious" incident includes the following:

- Imminent danger safety conditions;
- Any incident (including near miss) involving the general public or visitors;
- Work-related injury or illness requiring more than First Aid;

- Spills or release of hazardous material or contaminated media in excess of 1 gallon, the Reportable Quantity*, or any spill or release to surface water;
- Any unexpected contact with or damage to aboveground or belowground utilities; or
- Other unusual incidents of a serious nature that could result in an injury or regulatory violation.

*Note: The Reportable Quantity for various hazardous substances is defined by 40 CFR 302.4. If you are uncertain of the Reportable Quantity, report the spill first, and then seek assistance in determining the Reportable Quantity.

1.4 Discussion

1.4.1 Responsibilities

All Bhate Employees

All personnel have the responsibility to immediately report any incident to their supervisor. The report can be verbal or in writing.

1.4.2 Project Management Personnel

Project Managers and/or Site Managers are responsible for identifying a SSHO for each project, for implementation of this program, and for making all client notifications as pertaining to incidents.

Project Managers and/or Site Managers are responsible for:

- Implementing the appropriate internal notifications as required by this program as soon as an incident becomes known;
- Completing the Incident Report and Investigation Form, as required;
- Ensuring that a copy of the report is forwarded to the HSM; and
- Ensuring that effective follow-up activities are conducted.

1.4.3 Site Safety and Health Officer

The designated SSHO where the incident occurred has the responsibility to:

- Ensure that all notifications are made promptly;
- Ensure that all reports are fully completed;
- Ensure that all insurance and workers compensation forms are completed and submitted as necessary;

- Participate in incident investigations of all Occupational Safety and Health Administration (OSHA) recordable injuries/illnesses, spills, releases, and other investigations as requested;
- Maintain a file of all incident reports and investigations within their area of responsibility;
- Communicate information about the incident to all site and/or office employees; and
- Transmit a copy of the incident report and investigation, and workers compensation forms to the HSM.

1.4.4 Health and Safety Manager

The HSM or his/her designee has responsibility to provide site specific training to the designated SSHO regarding implementation of this procedure onsite. Other responsibilities of the HSM include:

- Assisting with notifications to OSHA of any injuries or illnesses as required;
- Reviewing/maintaining a log of all investigations which may include basic causes, immediate causes, and management control issues;
- Distributing summaries of incidents with periodic management reports;
- Communicating significant incidents to key personnel within Bhate;
- Assisting with statistical and root cause analyses of Bhate incidents; and,
- Recommending Health and Safety Plan modifications, as necessary.

1.5 Incident Reporting and Internal Notification

1.5.1 Reporting Incidents to Supervision

Bhate employees are required to notify the Project Manager and/or their supervisor as soon as possible after an incident has occurred. The notification may be verbal or in writing, but it should be done as soon as reasonably possible.

1.5.2 Completion of the Incident Report

The Incident Report is to be completed by the end of the day of the incident if possible, but no later than 24 hours after the incident was reported by the Project Manager and employee(s) involved in the incident.

Completion of the form is self-explanatory. If the Project Manager or the employee has any questions regarding completion of the report, the SSHO should be contacted for assistance.

Both the employee(s) and the employee's Project Manager must sign the Incident Report.

1.5.3 Transmittal and Filing of the Incident Report

A copy of the Incident Report should be sent within 24 hours to the Project Manager and the HSM.

The SSHO shall maintain a copy of each Incident Report in the project or office files and, for OSHA recordable injuries/illnesses with the OSHA 300 log for each office or project. Do not include the investigation portion of the form with the OSHA log.

1.6 Incident Investigations

Unless otherwise indicated by the HSM, incident investigations are to be initiated and completed as soon as possible, but no later than 72 hours after the incident has been reported.

The Project Manager for the project where the incident occurred has the prime responsibility for coordinating and conducting the incident investigation. At a minimum, the SSHO will participate in investigations of OSHA recordable injuries or illnesses, spills, releases, and permit exceedance.

Copies of the completed Investigation Report should be sent within 72 hours to the Project Manager and the HSM for review and signature. The Project Manager shall ensure that all corrective actions identified on the Investigation Report are completed and closure is properly documented.

Investigations which fall within the scope of the OSHA Process Safety Management Standard must meet the requirements of 29 CFR 1910.119(m).

1.7 External Notifications

1.7.1 OSHA Notification

Notification to OSHA is required within 8 hours if the incident resulted in one or more fatalities and/or three or more hospitalized individuals. The 8-hour notification to OSHA is also required if a fatality or hospitalization of three individuals occurs within 30 days after the incident.

A Bhate Principal or his designee in consultation with the HSM has the responsibility for making the OSHA notification. The local OSHA area office number can be found in the phone book. Most offices have 24-hour message machines.

The Project Manager is responsible for notifying the client of any required OSHA notifications.

1.7.2 Agency Notifications for Environmental Spills, Releases, and Permit Exceedance

Prior to initiation of project field activities, the Project Manager and the client shall establish regulatory agency notification responsibilities and procedures as part of the project Communications Plan. If a Communications Plan is not developed, the Project Manager shall document the agreements made with the client concerning regulatory agency notification responsibilities and procedures. It is Bhate's policy that if a spill, release, or permit exceedance is determined to be reportable, Bhate or the client shall perform the reporting in a timely fashion as defined by federal, state, or local laws and regulations.

The Project Manager must determine if a spill, release, or permit exceedance is reportable to a regulatory agency under federal, state, and/or local laws and regulations or permit conditions. This determination must be made quickly since many laws and regulations have short time frames for requiring notifications (e.g. immediately upon knowledge, but no later than 24 hours).

If a spill or release is determined not to be reportable, the Project Manager, shall evaluate whether the spill or release poses a threat to human health (e.g., has or may release into known drinking water sources, has or may cause contamination of surface soils/materials/air accessible to the public, etc.). If determined to pose a threat to human health, the Project Manager shall consult with the client to determine whether the spill or release should be reported to a regulatory agency.

The client shall be notified regarding the spill, release, or permit exceedance and Bhate's notification determination. Notifications shall be made per the contract or the project Communications Plan.

The Project Manager should allow a Bhate Principal or his designee to review any written notification prior to submittal to the agency.

1.7.3 Documentation of Agency and Client Notifications

All agency and client notifications shall be documented on the Incident Report and Investigation Form and maintained in the project files. Other documentation generated regarding verbal or written agency notifications (if required), including agency response to such notification, shall be maintained in the project file.

In instances where the client conducts the reporting, documentation shall be obtained from the client indicating that the agency was notified in accordance with federal, state, or local regulations and maintained in the project files. In instances where the client verbally notifies Bhate that the notification was made, the Project Manager shall document the conversation with the client indicating that the agency notification was made.

Copies of the Incident Report and Investigation Form and other documentation regarding agency notification shall be maintained in the project files.

If the spill, release, or permit exceedance is determined to not be reportable, the Report and Investigation Form shall include the rationale for not reporting the spill, release, or permit exceedance to a regulatory agency.

1.8 Training

Conducting a thorough incident investigation requires training in loss control principles and incident investigation techniques. The HSM has the responsibility for ensuring that site and supervisory personnel have the appropriate training to conduct incident investigations.

2 DISCIPLINARY ACTION FOR PERSONNEL SAFETY VIOLATIONS

2.1 Purpose

The purpose of the Disciplinary Action for Personnel Safety Violations procedure is to provide a mechanism for holding personnel accountable for their actions resulting in safety violations occurring on projects managed by Bhate or acting as a representative of Bhate.

2.2 Scope

The Disciplinary Action for Personnel Safety Violations procedure applies to all Bhate personnel.

2.3 Definitions

2.3.1 Safety Violation

Any deviation from 29 CFR 1910, 29 CFR 1926, Bhate Corporate Health and Safety Plan, SSHP, client safety requirements, or accepted industry practice with regards to health and safety.

2.3.2 Imminent Danger

Where conditions or practices exist which could reasonably be expected to cause death or serious physical harm.

2.4 Discussion

- All Bhate personnel are required to comply with designated health and safety procedures as defined in the Corporate Health and Safety Plan, procedures, and/or specific project requirements.
- Disciplinary action for safety violations will follow a three-step process:
  - Initial violation – a verbal warning is issued indicating the infraction, explanation of the possible outcomes of the infraction, and steps to prevent recurrence.
  - Second violation – a written reprimand is issued and entered into the employee's personnel file.
  - Third violation – employee is terminated and documentation of the infraction and reason for termination is included in the personnel file.
- During each step of the process, the employee will be informed of the successive step in the disciplinary action procedure. Additionally, at each step of the procedure the employee will receive retraining at their supervisor's discretion.
- Some discretion is permitted in the procedure. In some instances, infractions can be different violations with similar principles. For example, failure to wear proper personal

protective equipment on one day and failure to use a seatbelt in a vehicle another day. Both of these infractions can be characterized as a failure to follow procedure.

- If disputes arise in the administration of a disciplinary action for a safety violation, a Bhate Principal will render a final decision.
- Some situations, due to the severity of the violation may warrant immediate suspension and/or termination, including but not limited to:
  - Willful violation of the Corporate Health and Safety Plan, procedures, and/or specific project requirements permitting an imminent danger situation.
  - Withholding chemical information regarding a project and allowing personnel to work in such scenarios.
  - Working continuously under suspended loads.
  - Failure to use appropriate fall protection when required.
  - Working in confined spaces without following the appropriate entry procedures.
  - Failure to follow lockout procedures where required.

As noted previously, discretion is permitted in implementing this procedure.

All disciplinary action is to be instituted upon witnessing and/or being informed of the infraction. The employee is to be reviewed and held accountable relative to bonuses, raises, and/or promotions during their annual review. The employee will be evaluated for improvement during the employee's subsequent annual review at which time written reprimands will be removed from the personnel file.

3 MEDICAL SURVEILLANCE

3.1 Purpose

The purpose of this program is to ensure that the Bhate medical surveillance program addresses the needs of Bhate personnel, that employee medical records are up-to-date and properly maintained, that all Local Medical Providers (LMPs) participating in the Bhate medical surveillance program utilize the same minimum testing criteria in examining employees, and that the Bhate medical surveillance program meets the requirements of applicable regulations including OSHA 29 CFR 1910.120.

3.2 Scope

This program applies to medical examinations and biological monitoring provided to Bhate personnel included in the Bhate medical surveillance program.

3.3 Maintenance

The HSM is responsible for updating this procedure. Approval authority rests with Bhate's Principals. Suggestions for revision shall be submitted to the HSM.

3.4 Definitions

None.

3.5 Discussion

3.5.1 Responsibilities

The HSM administers the overall Bhate Medical Surveillance Program.

Project Managers and Site Supervisors assist in implementation of the program at Bhate offices and project locations. The Project Manager and Site Supervisor assists the HSM in defining additional medical surveillance parameters or biological monitoring for projects.

The Project Manager and Site Supervisor are responsible for ensuring that personnel working on a project have the required medical surveillance examinations and have documentation of a qualified physician's opinion approving the worker for hazardous waste site work, asbestos work, and respirator qualification, as necessary.

3.5.2 Scheduling of Medical Surveillance Examinations

Human Resources personnel or the HSM are authorized to initiate the scheduling of medical surveillance examinations for Bhate personnel. As needed, Human Resources personnel or the HSM will contact the employee to verify the name, social security number, office or project location, phone number, preferred timeframe for the examination, type of examination required (pre-employment, baseline, periodic/annual, or termination/exit), and other special testing required. The LMP will then be contacted to schedule the examination, and written (fax or electronic) confirmation of the examination appointment will be provided to the employee. The HSM will ensure that the employee is provided with the necessary paperwork package to be completed by the employee prior to the scheduled examination.

3.5.3 LMP Procedures

The LMP will furnish each Bhate employee with a written opinion which includes the following:

- An opinion as to whether the employee has any detectable medical conditions which would place the employee at increased risk of material impairment of the employee's health from work in hazardous waste operations or emergency response, or from respirator use;
- The recommended limitations upon the employee's assigned work;
- The results of the medical examination and tests; and
- A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further examination or treatment.

The LMP will complete the Certification for Hazardous Waste and Respirator Use form following each hazardous waste examination and provide a copy to the HSM.

All employee medical records will be turned over to the HSM for cataloging and maintenance in a secure, access controlled storage location.

3.5.4 Baseline Physical Examination Protocol

All employees who are expected to participate in onsite activities where they are potentially exposed to health or safety hazards and/or will wear respiratory protection shall be required to complete a baseline physical examination. The contents of the baseline physical examination are outlined as follows:

A. A completed medical, occupational, and smoking history questionnaire with an emphasis on the following systems: nervous, skin, lung, blood forming, cardiovascular, gastrointestinal, reproductive, as well as ears, nose, and throat. The examinee is required to fast for 8 hours, abstain from alcohol for 3 days before this examination, and avoid high noise exposure for 14 hours before the examination.

B. A complete physical exam, including and evaluation of the following, at a minimum:

1. Height, weight, temperature, pulse, respiration, and blood pressure
2. Head, nose, and throat
3. Eyes (Snellen)
4. Ears (with audiometric testing in accordance with 29 CFR 1910.95)
5. Chest (heart and lungs)
6. Peripheral vascular system
7. Abdomen (liver, spleen, kidney)
8. Musculoskeletal system
9. Genitourinary system
10. Nervous system

C. Completed tests, including at least the following, at a minimum:

1. Complete blood counts and chemistries including the following:
    a. White blood cell, differential cell, and platelet counts
    b. Hemoglobin and/or hematocrit
    c. Albumin, globulin, total protein, and total bilirubin
    d. Serum glutamic oxalacetic transaminase (SGOT) and serum glutamic-pyruvic transaminase (SGPT)
    e. Lactic dehydrogenase (LDH)
    f. Alkaline phosphatase and Gamma Glutamine Trans Peptidase (GGTP)
    g. Calcium
    h. Phosphorous
    i. Uric acid
    j. Creatinine

k. Urea nitrogen

l. Cholesterol and triglycerides

m. Glucose

n. Five Panel Drug Screen to include: amphetamines, cannabinoids (THC), cocaine, Opiates, PCP, and metabolites

o. Blood Alcohol

2. Urinalysis (clean catch), including the following:

    a. Color and character

    b. Specific gravity

    c. pH

    d. Protein

    e. Acetone

    f. Glucose

    g. Microscopic examination

3. Pulmonary function test to include, at a minimum, the following:

    a. Forced Vital Capacity (FVC)

    b. Forced Expiratory Volume, one second (FEV10)

    c. The FEV10 FVC ratio

    d. A minimum of three good tracings

4. A 12-lead resting EKG

5. Chest X-ray (14- by 17-inch PA and lateral performed for the baseline exam, as necessary)

3.5.5 Annual Periodic Physical Examination Protocol

Employees shall be provided an annual/periodic physical examination within 30 days of the anniversary of their previous physical examination. Employees who wear a respirator less than

30 days/year or employees who are only involved in site visits, but not actual site work, may be on a 2-year periodicity for physical examinations. The contents of the annual medical examination are the same as the baseline except as follows:

- Chest X-ray will be performed every 3 or 4 years depending on employee classification unless the physician determines that increased periodicity is necessary.
- The EKG will be performed according to the following schedule: every 3 years for those under the age of 40, every 2 years for those 40 to 50 years of age, and annually for those more than 50 years of age.

3.5.6 Termination/Reassignment Physical Examination Protocol

Physical examinations are made available to employees who participated in the medical surveillance program when they terminate employment with Bhate or upon reassignment to a job position which does not require participation in the program except as follows:

Last Physical Examination	Hazardous Waste Site Activity Since Last Examination	Termination/Reassignment Examination Decision
Within past 6 months	No field work	Examination not offered unless required by project specifications or other OSHA standards
Within past 6 months	Field work	The decision will be based upon the nature of the previous site(s)' contaminants and job site activities, documented exposure levels, and/or the results of the previous medical examination

In the event that a termination/reassignment examination is waived, documentation of the rationale for the waiver shall be included in the employee's medical file.

When medical examinations are performed, the content shall be the same as for the annual/periodic examination except that the LMP shall determine when a chest X-ray is indicated if it has been less than 5 years since the last chest X-ray.

Employees who do not wish to avail themselves of the termination/reassignment examination will be requested to complete and sign the Medical Examination Refusal form. If the employee does not take the examination and does not sign the refusal form, then Bhate's efforts to make the examination available shall be documented in the project and employee's medical file.

Project specifications may require exit examinations when personnel leave the project or when a project ends. Project requirements will take precedent over the Bhate program requirements. If the LMP feels that the exit examination can be waived, then the client should be notified for concurrence and appropriate contract modifications made as necessary.

3.5.7 Biological Monitoring

Additional medical surveillance parameters and biological monitoring may be performed as appropriate based on the potential for exposures to specific chemicals during site activities. The HSM will determine the need for additional medical surveillance and biological monitoring on a project-specific basis.

3.5.8 Injury or Illness Examinations

Any employee who is injured, becomes ill, or develops signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation will be provided consultation and/or examination as directed by the LMP and HSM.

3.5.9 Return to Work Examinations

Return to work clearance shall be obtained from the LMP for all occupational and non-occupational injuries and illnesses which resulted in or involved:

- Hospitalization
- Five lost workdays - days away from work
- Unconsciousness
- Seizures

Return to work clearances shall also be required when indicated by the LMP, HSM, or the Human Resources Department.

3.5.10Release of Medical Records

Employees who wish to obtain copies of medical records should notify the HSM and complete the Employee Release of Medical Records form.

4 TRAINING

4.1 Purpose

The purpose of this program is to ensure that Bhate employees have the necessary health and safety training to safely perform their assigned tasks and to meet regulatory training requirements.

4.2 Scope

This program addresses the training requirements mandated by OSHA, the U.S. Environmental Protection Agency (EPA), U.S. Department of Transportation (DOT), and internal Bhate requirements. Individual state and local requirements may be more stringent than federal requirements; therefore, consult applicable state and local regulations.

4.3 Definitions

4.3.1 Competent Person

A competent person is one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

4.3.2 Qualified Person

A qualified person is one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his or her ability to solve or resolve problems relating to the subject matter, the work, or the project.

4.3.3 Hazardous Material

Any material, equipment, substance, or waste that transportation authorities have deemed capable of posing risks in transport, or are listed in the regulations, their appendices or in a hazardous material table or the list of dangerous goods.

4.3.4 Hazardous Waste Site

OSHA, in its Hazardous Waste Operations and Emergency Response standard, defines hazardous waste site activities as covering the following operations, unless the employer can demonstrate that the operation does not involve the potential for employee exposure or the reasonable possibility for employee exposure to safety or health hazards:

- Cleanup operations, required by a governmental body, involving hazardous substances, that are conducted at uncontrolled hazardous waste sites, including, but not limited to the following: the EPA's National Priority Site List (NPL), state priority site lists, sites recommended for the EPA NPL, Emergency Community Response Action, underground storage tanks, and initial site investigations conducted before the presence or absence of hazardous substances has been ascertained
- Corrective actions involving cleanup operations at sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) as amended (42 USC 6901 et seq.)
- Voluntary cleanup operations at sites recognized by federal, state, local, or other governmental bodies
- Operations involving hazardous wastes that are conducted at treatment, storage, and disposal facilities regulated by 40 CFR 264 and 265 pursuant to RCRA, or by agencies under agreement with EPA to implement RCRA regulations
- Emergency response operations for releases of, or substantial threats of releases of, hazardous substances without regard to the location of the hazard

4.3.5 Hazardous Materials Employee

A person who directly affects hazardous materials transportation safety through any of the following activities:

- Determines proper shipping names
- Selects packaging for hazardous materials
- Packages, marks, and labels hazardous materials
- Completes shipping papers for hazardous materials
- Loads or unloads hazardous materials
- Operates a vehicle carrying hazardous materials
- Oversees employees and activities listed above

4.4 Discussion

4.4.1 Responsibilities

4.4.1.1 Project Management Personnel

Project Managers and/or Site Managers are responsible for:

- Providing the resources necessary for the implementation of the training program
- Making personnel available for scheduled training courses
- Ensuring that new employees have or receive required training prior to job assignment

4.4.1.2 Health and Safety Manager

The HSM is responsible for:

- Determining the training needs of Bhate's operations
- Implementing the health and safety training program
- Conducting in-house training and/or ensuring that qualified personnel are assigned to perform the training
- Ensuring that special training requirements for projects (i.e. lead or asbestos abatement) are identified and that the training is conducted
- Ensuring that appropriate outlines and training materials, as necessary, are developed for site specific training
- Developing and approving course materials for all in-house training programs
- Maintaining master records and documentation for health and safety training courses
- Ensuring that training is properly documented

4.4.1.3 Site Safety and Health Officers

The SSHOs are responsible for:

- Ensuring that personnel have the required training and appropriate documentation before being allowed to work on site.
- Ensuring that site specific training is conducted per the SSHP.
- Ensuring that site personnel have the necessary training to safely use the personal protective equipment (PPE) selected for the project site.

4.4.2 Hazardous Waste Operations and Emergency Response (HAZWOPER) Training

4.4.2.1 Initial HAZWOPER Training

All Bhate personnel performing work at hazardous waste sites shall meet the initial training criteria under 29 CFR 1910.120(e). At a minimum, all Bhate personnel performing work at hazardous waste sites shall attend an initial training course for hazardous waste site operations. The initial course shall include, but not be limited to, the recommended topics in 29 CFR 1910.120, Appendix E.

Where state requirements for hazardous waste worker training are more stringent, the SSHO shall ensure that site workers have training which meets the additional state requirements.

4.4.2.2 8-Hour Annual Hazardous Waste Worker Refresher Training

Hazardous waste workers are required to attend an 8-hour annual refresher course. The course shall include, but not be limited to, the recommended topics in 29 CFR 1910.120, Appendix E.

This course should be completed each calendar year as close as reasonably possible to the anniversary of the initial training or the previous year's refresher course, but no later than 30 days after the anniversary of initial training or the last refresher course. If training has not been completed within 30 days of the anniversary of the previous training, and personnel need to enter an exclusion zone, then an explanatory record shall be placed in the employee's training file which explains why the training has not been conducted and which specifies that the training shall be completed within 60 days of the anniversary date. No extensions shall be permitted after 60 days and individuals shall not be permitted in the exclusion zones of hazardous waste sites.

Note that some clients and states have more restrictive policies regarding the time frame for completion of the 8-hour refresher course.

If an individual has not attended refresher training for more than two years, or it has been more than two years since initial training, then the individual shall be required to demonstrate knowledge of the information for the initial training through a written test. After three years, from initial training or the last refresher course, the individual shall be required to attend 40-hour initial HAZWOPER training again.

4.4.2.3 8-Hour Supervisory Training

Onsite personnel who directly manage and/or supervise personnel engaged in hazardous waste operations (e.g., Project Managers, Site Managers, Site Safety and Health Officers) are required to attend 8 hours of specialized training at the time of job assignment. This course shall include 8 hours of training on topics such as the Bhate Health and Safety program and procedures, health and safety training requirements, PPE, emergency preparedness programs/procedures, and health hazard monitoring procedures and techniques.

Supervisor training will constitute refresher training if the training includes the required topics for annual refresher training.

4.4.2.4 24-Hour On-The-Job Supervision

Bhate personnel who have attended initial 40-hour HAZWOPER training are required to have 24 hours of supervised on-the-job experience by an individual who has completed the supervisory training and is an experienced hazardous waste worker. Site specific orientation training shall be considered to constitute a component of this training. Personnel shall work under direct field supervision until the on-the-job training has been completed and documented.

4.4.2.5 Site Specific Training for Workers

Prior to beginning work at each project, Bhate and subcontractor employees shall receive site specific training, conducted by the SSHO or their designee. The topics covered shall include those addressed in the SSHP; hazard communication for chemicals onsite; PPE required; when it is required to be used; and how to use the PPE, if necessary; and the necessary and/or applicable topics contained in 29 CFR 1910.120, Appendix E, and 29 CFR 1910.20 through 1910.28 for construction activities.

4.4.2.6 First Aid/Cardiopulmonary Resuscitation Training

At least two members of each site team shall be certified in first aid and cardiopulmonary resuscitation (CPR) when working on any field project. One certified individual must be a Bhate employee. The other certified individual may be a client or subcontractor employee. The certified members must be working in close enough proximity to other team members so that they can administer CPR or first aid in a timely manner. Courses must be taught by a certified instructor and approved by an organization such as the American Red Cross or American Heart and Lung Association.

4.4.2.7 DOT Training and IATA Dangerous Goods Regulations Training

DOT and International Air Transport Association (IATA) training is required for any Bhate employee or subcontractor who functions as a "hazmat employee.” New employees who perform a hazmat function must be trained within 90 days of employment. Until such training has occurred, the employee must perform work under the direct supervision of a DOT/IATA trained and knowledgeable employee.

Subcontractors must provide certification of training at the start of the project, but no later than prior to performing a hazmat function. The Project Manager is responsible for ensuring the project files contain the subcontractors’ certification of training.

The Bhate program requires that DOT/IATA refresher training occur every 2 years (where subcontractors are performing shipper's responsibilities for non-air shipments, DOT requires training every 3 years).

The DOT/IATA training course will consist of a minimum of 4 hours training. The course shall include, but not be limited to, the requirements specified in 49 CFR 172.704, General Awareness/Familiarization Training, applicable function-specific training (e.g., packing, marking, labeling, etc.) and safety training. The safety training will be met through the HAZWOPER 8-hour refresher training. Additional function-specific training may be conducted on a project-specific basis. The training course will also provide general awareness of IATA dangerous goods regulations, air shipment requirements, and Bhate policies associated with transportation of hazardous materials.

Training received at an external course will satisfy the DOT training requirement.

Unless otherwise authorized, all shipments of hazardous materials shall be limited to ground transport only.

4.4.2.8 Waste Management Training, 40 CFR 264.16 or 265.16

Waste management training is required for all Bhate employees who characterize, handle, manage, package, mark/label, inspect, and coordinate offsite transportation and disposal of hazardous wastes, including state-regulated hazardous waste. This training is strongly recommended for personnel who perform similar functions for non-hazardous, special, and polychlorinated biphenyl (PCB) wastes. Subcontractors who perform onsite hazardous waste management activities must have documented 40 CFR 264.16 or 265.16 training.

New employees who manage or otherwise handle hazardous waste must be trained within 6 months of employment. Until such training has occurred, the employee must perform work under the direct supervision of a trained, knowledgeable employee.

Refresher training is required on an annual basis.

The waste management training course will consist of a minimum of 4 hours training. The training course will include instruction in hazardous waste management, including general requirements for contingency plan and emergency response in accordance with 40 CFR 265.16. The training course will also include instruction of waste characterization, Land Disposal Restriction (LDR) compliance, and offsite transportation and disposal as well as Bhate policies associated with these topics. The course will include discussions regarding hazardous waste as well as PCBs, state-regulated, and non-hazardous wastes. Additional waste management training may be conducted on a project-specific basis to supplement this 4-hour training course.

Training at an external course will satisfy 40 CFR 264.16 or 265.16 requirements.

4.4.3 Competent and Qualified Person Requirements

OSHA uses the term competent or qualified person in over 150 instances within 29 CFR 1910 and 1926.

Project Managers have the responsibility for ensuring that personnel assigned to the project meet the competent and qualified persons requirements identified in SSHP. Project Managers should consult with the HSM personnel as necessary to determine requirements.

4.4.4 Proficiency Assessment

All Bhate developed courses shall utilize written assessment and/or skill demonstration. For courses of 8 hours or longer, written tests shall include at least 50 questions. If a written test in conjunction with a skills demonstration is used for the courses of 8 hours or longer, a minimum of 25 questions will be used. Proficiency testing for other training will be at the discretion of the instructor, but it must include a written test or a skills demonstration. The means of proficiency testing shall be documented.

4.4.5 Recordkeeping

4.4.5.1 Course Documentation

The documentation for each Bhate training course shall include a course sign-in sheet for each day of the course which indicates the date of the presentation, the length of the course, the topics covered, the names and signatures of the attendees, and the name(s) of the course instructor(s).

Copies of the training documentation for each course (except for project-specific training) including handouts, agenda, sign-in sheets, listing of audiovisuals, and tests will be maintained. For non-Bhate training courses, a copy of the certificate of completion will be maintained.

4.4.5.2 Course Certificates

Each student successfully completing a Bhate course shall be issued a certificate which includes:

- Attendee's name
- Course title and date(s)
- Statement that the student has successfully completed the course
- Identification of specific regulatory requirement for which certification was provided, if applicable
- Corporation name
- Location of the training
- Signature and title of instructor(s)

Original certificates will be forwarded to the attendee. Copies will be maintained in each employee's training file.

4.4.5.3 On-The-Job Training

On-the-job training shall be documented.

4.4.5.4 SSHO Approval

All Bhate personnel who are assigned SSHO responsibilities shall be approved by the Project Manager or their designee.

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5 RECORDKEEPING

5.1 Purpose

The purpose of the health and safety recordkeeping program is to ensure that all primary health and safety records are maintained in a consistent manner that meet applicable laws and regulations, company objectives, and contract requirements, and to have an easily retrievable record of health and safety project activities.

5.2 Scope

This program applies to all Bhate office and project locations which generate, receive, or store health and safety records.

5.3 Definitions

5.3.1 Employee Health and Safety Training and Certification Records

Documentation of employee health and safety training and medical certificates that are maintained in a central location by the HSM.

5.3.2 Employee Medical Records

Documentation of any medical testing or evaluation of an employee's health status, e.g. laboratory results, X-Rays, audiograms, pulmonary function test results, biological monitoring or bioassay results, and physician evaluation reports that are maintained in a central location.

5.3.3 Project Health and Safety Records

Project health and safety records include site specific training records and certificates, logbooks, periodic reports and summaries, employee exposure records, pertinent sampling results, meeting records, documentation of disciplinary actions related to health and safety, permits, plans, and correspondence that are maintained as part of the project records.

5.3.4 Incident Records

Documentation of all incident and investigation reports including injuries and illnesses, spills and releases, permit exceedances, OSHA logs, and employees’ first report of injury.

5.3.5 Health and Safety Training Program Documentation

Training records, including training course curriculum, attendance rosters, and course materials such as copies of overheads, handouts, and performance tests, that are maintained in a central location by the HSM.

5.4 Discussion

5.4.1 Responsibilities

5.4.1.1 Site Safety and Health Officer

The SSHO is responsible for managing the incident records for each project, for coordinating with the HSM to ensure that employee health and safety training and certification records are complete and up-to-date, and for ensuring that complete and accurate project health and safety records are generated and maintained. The SSHO is also responsible for forwarding project health and safety records to the responsible person for project close-out.

5.4.1.2 Health and Safety Manager

The HSM is responsible for managing employee health and safety training and certification records, employee medical records, and health and safety training program documentation.

5.4.1.3 Employee Health and Safety Training and Certification Records

The employee health and safety training and certification records will contain the records listed below:

- Medical Qualification - The Bhate Certification for Hazardous Waste Work and Respirator Use per the Bhate Medical Surveillance Program
- Training Records - Training records consist of documentation that an employee has completed required health and safety training

Documentation of health and safety training which is specific to one site or project, and is not intended to qualify an employee to conduct similar tasks at other work locations will only be kept in the project health and safety records.

5.5 Employee Medical Record

The employee medical record will contain records as defined in the Medical Surveillance Program. The employee medical records will be maintained in a centralized location. Original hard-copy records where possible, will be kept, by employee name. Bhate will ensure that confidentiality is maintained, records are maintained in a safe and secure facility, and Bhate and its employee can access the medical records in a timely manner.

5.6 Project Health and Safety Records

Project health and safety records are part of the overall project records and will be maintained. Project health and safety records will be maintained for each Bhate project where employee health and safety information is generated or required and where environmental or health and safety laws and regulations require maintenance of such documents.

The project health and safety record will contain the following information as applicable:

- Health and Safety Correspondence - Any health and safety correspondence including memorandum, letters, incident reports, internal or external audit or inspection reports, faxes, written phone conversation summaries, and similar documentation
- Project Health and Safety Plans - Signed copies of the project health and safety plan as required, along with any associated field change requests or addenda
- Project Health and Safety Logbooks - Original project health and safety logbooks as required, (or copies of the logbooks if the originals must be maintained in another file or delivered to the client)
- Exposure Sampling and Monitoring Records - A complete copy of documentation related to personal exposure sampling (air sampling/calibration data sheet, laboratory report, calculation sheets, and sampling report if generated) and any other real time instruments, detector tube, noise dosimeter, or other sampling or monitoring performed
- Health and Safety Compliance Documentation - All documents required by environmental or safety and health laws and regulations and the Bhate health and safety program including (but not limited to) decision documents, permits, approvals, agency correspondence, monitoring and waste analysis data, manifests/shipping papers, reports, notifications, training records, certifications/licenses, and the OSHA 300 log
- Other Pertinent Information - Other information generated or available which may contain information concerning potential employee exposure to physical or chemical agents. This information would include wipe sampling results or Safety Data Sheets (SDSs) [previously called Material Safety Data Sheets (MSDSs)] if not already included in the project health and safety plan, final report, or elsewhere.
- Other pertinent records would include fit-test results conducted at the site, confined space or hot work permits, trench or excavation inspection forms, site safety briefing records, subcontractor safety submittals, worker medical data sheets, and site specific training records for hazard communication, confined space, or materials handling.

5.7 Injury and Illness Records

- Illness and injury records will consist of the following:

- Bhate Incident and Investigation Reports - The use, maintenance, and procedures for completion of the Bhate Incident and Investigation Reports are covered in Incident Reporting and Investigation Procedure.
- OSHA 300 Log - An OSHA 300 Log will be maintained for each Bhate office and for each field project location where work will be performed for 3 months duration or longer. For field project locations where work will be performed for less than 3 months, the home office of the affected employee will be responsible for forwarding the necessary information to the appropriate office.
- OSHA 101 - The Bhate Incident Report is an acceptable alternative record to the OSHA 101.

The OSHA 300 Log will be completed in the detail provided on the form and instructions given on the back side of the form. Bureau of Labor Statistics guidelines shall be used to determine OSHA recordability. All entries will be made as soon as practicable, after receiving information that a recordable injury or illness has occurred.

The OSHA 300 Log summary, totals, and certification will be completed by January 30 each year by the Health and Safety Manager. The OSHA 300 Log will be posted in the workplace (office or active field location) from February 1 to May 1 of each year. If no injuries or illness were recorded during the year, zeros will be entered on the totals line, and the form posted as required. The OSHA 300 Log will be retained in each office and active field location for 5 years following posting.

5.8 Health and Safety Training Program Record

Health and safety training program records will be maintained in a centralized file. This file will be maintained by the HSM and will be retrievable by training date and type of training.

Personnel arranging for or providing health and safety training are responsible for sending copies of training course documentation to the HSM.

5.9 Access to Employee Exposure and Medical Records

Access to employee exposure and medical records shall meet the requirements of 29 CFR 1910.1020 or other applicable state standards. Requirements of this section will not supersede any existing legal or ethical obligations regarding medical record confidentiality, duty to disclose information, or related patient/employee relationship.

Potential employee exposure records and medical records will be provided to an employee or authorized representative within 15 days after a request for access has been made. The HSM shall be notified of any request for access. The request should be made in writing and dated. Normally, the records will be reproduced and sent to the authorized requestor by the holder of the project health and safety record.

5.10 Training

OSHA requires that employees be provided with certain information regarding access to employee exposure and medical records per 29 CFR 1910.1020(g). The employees' supervisor shall inform new employees during orientation of: 1) the existence, location, and availability of any records covered by 29 CFR 1910.1020(g); 2) the person(s) responsible for maintaining and providing access to records; and 3) each employee's rights of access to these records. This information shall be in accordance with the requirements of this program. There are no formal training requirements associated with the other aspects of this program.

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6 GENERAL WORK AND SAFETY RULES

All site personnel will adhere to the following general safety rules. These precautionary measures are designed to reduce the risks of inadvertent or accidental injury or chemical exposure during onsite operations.

1. All site personnel must attend each day's Daily Safety Briefing.
2. Be familiar with standard operating procedures and adhere to all instructions and requirements in the Corporate Health and Safety Plan or SSHP.
3. Any individual taking prescribed drugs shall inform the SSHO of the type of medication. The SSHO will review the matter with the HSM, as necessary, who will decide if the employee can safely work onsite while taking the medication.
4. Medicine and alcohol can exacerbate the effects from exposure to toxic chemicals. While field operations are in effect, alcoholic beverage intake should be minimized or avoided during off-work hours. Personnel performing onsite operations should not take prescribed drugs where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Do not work when ill.
5. The personal protective equipment specified by the Corporate Health and Safety Plan or SSHP shall be worn by all site personnel. This includes hard hats and safety glasses which must be worn at all times in active work areas.
6. Facial hair (beards, long sideburns, or mustaches) which may interfere with a satisfactory fit of a respirator mask is not allowed on any person who may be required to wear a respirator.
7. Eating, drinking, chewing tobacco or gum, smoking, and any other practice that may increase the possibility of hand-to-mouth contact is prohibited in the work area. (Exceptions may be permitted by the SSHO to allow fluid intake during heat stress conditions.)
8. All lighters, matches, cigarettes, and other forms of tobacco are prohibited in the work area.
9. All signs and demarcations shall be followed. Such signs and demarcations shall not be removed except as authorized by the SSHO.
10. No one shall enter a permit-required confined space without a permit. Confined space entry permits shall be implemented as issued.
11. All personnel must follow Hot Work Permits as issued.
12. All personnel must follow the work-rest regimens and other practices required by the heat stress program.
13. Rest breaks shall be taken in approved locations.
14. All personnel must follow lockout/tagout procedures when working on equipment involving moving parts or hazardous energy sources.
15. No person shall operate equipment unless trained and authorized.
16. No one may enter an excavation greater than 4 feet deep unless authorized by the Competent Person. Excavations must be sloped or shored properly. Safe means of access and egress from excavations must be maintained.

17. Ladders and scaffolds shall be solidly constructed, in good working condition, and inspected prior to use. No one may use defective ladders or scaffolds.
18. Fall protection or fall arrest systems must be in place when working at elevations greater than 6 feet for temporary working surfaces and 4 feet for fixed platforms.
19. Safety belts, harnesses, and lanyards must be selected by the Site Manager. The user must inspect the equipment prior to use. No defective personal fall protection equipment shall be used. Personal fall protection that has been shock loaded must be discarded.
20. Hand and portable power tools must be inspected prior to use. Defective tools and equipment shall not be used.
21. Ground fault interrupters shall be used for cord and plug equipment used outdoors or in damp locations. Electrical cords shall be kept out of walkways and puddles unless protected and rated for the service.
22. Improper use, mishandling, or tampering with health and safety equipment and samples is prohibited.
23. Horseplay of any kind is prohibited.
24. Possession or use of alcoholic beverages, controlled substances or firearms on any site is forbidden.
25. All incidents, no matter how minor must be reported immediately to the Site Manager.
26. All personnel shall be familiar with the Site Emergency Response Plan.

The above health and safety rules are not all inclusive and it is your responsibility to comply with all regulations set forth by OSHA, the Bhate Corporate Health and Safety Plan, SSHPs, or our Clients.

7 SITE HEALTH AND SAFETY INSPECTIONS

Regular inspections of active field work areas, including remediation projects and site support operations, shall be conducted to identify and correct potential worksite hazards as outlined below. The inspections shall be comprehensive and include such areas as project trailers, offices, vehicles, and sanitary facilities. Administrative operations such as office and warehouse areas have less frequent inspection requirements as the working conditions and work practices in these areas are not expected to change as rapidly as active field work areas.

7.1 Daily Inspections

The SSHO shall perform daily informal inspections of their active field work area(s). The inspection shall cover workplace conditions, physical facility safety, and employee work practices. The SSHO shall document any deficiencies and corrective actions in a logbook.

7.2 Weekly Inspections

The Site Manager and SSHO shall perform formal weekly inspections of the active field work area(s). Employees and/or employee representatives shall be afforded the opportunity, and encouraged to participate in weekly inspections. The inspection shall include a review of work activities and an evaluation of compliance with established SSHPs, a walk-around of the site, physical facility safety, and employee work practices.

The inspection shall be documented using the Site Health and Safety Inspection Form. The form shall identify the name of the inspector(s), the date of the inspection, the work area inspected, and a description of the inspection findings. Both compliant and noncompliant inspection findings shall be identified. Inspection findings and recommended corrective actions shall be clearly identified. Closure of findings shall be documented on the form by entering the date of corrective action and the name of the person who completed or verified the corrective action. If the actual corrective action is significantly different from the recommended corrective action, this change shall be noted on the form.

7.3 Monthly Inspections

The Project Manager and Site Manager should perform monthly inspections of their active field work area(s). Employees and/or employee representatives shall be afforded the opportunity and encouraged to participate in monthly inspections. The inspection format and documentation requirements shall be the same as the weekly inspection. The Weekly Inspection is not required the week that a monthly inspection is performed.

7.4 Corrective Actions

Corrective actions shall be implemented in a timely manner and tracked through completion. Findings for weekly and monthly site inspections not completed or verified by the next scheduled inspection shall be reentered on the subsequent inspection form (with the date of the original inspection added at the end of the corrective action). Corrective actions should be carried forward on each subsequent inspection until the corrective action is completed and verified.

The Site Manager shall implement corrective actions to inspection findings at the time of the inspection, where feasible. Interim corrective actions shall be implemented as necessary for areas that present an immediate hazard to site workers. Interim corrective actions may include suspension of work, barricading unsafe areas, posting of warning signs, or other similar measures to effectively mitigate the immediate hazard.

8 ENVIRONMENTAL MONITORING

8.1 General

Site monitoring shall be performed as necessary for site remediation and clean construction work. This section covers general site monitoring for employee exposure to physical and chemical hazards including air contaminants (dust, metals, volatile organic compounds (VOCs), and other specific compounds).

Minimum site monitoring requirements are determined during the project design stage, and are specified in the SSHP for each project. Site monitoring shall be performed by, or under the direction of a SSHO.

8.2 Required Site Monitoring

Site monitoring is required under the following conditions:

- When required by the contract, or SSHP
- When required by specific OSHA standards (e.g., 29 CFR 1910.120, hearing conservation, asbestos, benzene, cadmium, inorganic arsenic, lead, formaldehyde, vinyl chloride, etc.)
- When worker exposure is reasonably anticipated to be greater than 50% of the OSHA Permissible Exposure Limit (PEL), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV), or other recognized occupational exposure limit
- When necessary to verify the adequacy of hazard control measures and/or PPE, including respiratory protection
- When necessary to assess and evaluate worker exposure, or to resolve worker complaints or concerns

With the concurrence of the HSM, site monitoring may be discontinued after representative initial monitoring is conducted and worker exposures are shown to be adequately controlled through the use of engineering, work practice, or PPE control measures. If work activities change so that the initial monitoring is no longer representative of worker exposure, monitoring must be reinitiated.

8.3 Monitoring Strategy

Where site monitoring is required, the SSHP will detail a site monitoring program that considers the factors that may affect worker exposure and the following elements:

- Monitoring requirements, contaminants, and monitoring equipment limitations

- Specific work locations, work activities, work practices, personnel, and equipment to be used onsite
- Any additional site specific hazard information gathered during development of the SSHP
- Health and safety program requirements for site monitoring

The monitoring strategy and approach shall be documented in the SSHP. Documentation shall include a discussion of rationale used to determine the site monitoring requirements that sufficiently justifies the approach. Background information, such as exposure modeling calculations and previous (or similar) exposure monitoring data, shall be included as necessary. The approach shall include the type of monitoring (direct reading, personal, perimeter, or area monitoring), activities or locations to be monitored, contaminants, monitoring instrumentation, monitoring methods, and frequency of monitoring as appropriate.

8.4 Typical Site Monitoring

8.4.1 Direct Reading Exposure Monitoring

Direct reading instruments for exposure monitoring are extremely useful on construction and hazardous waste sites. The primary advantages include ease of use, ability to monitor constantly changing conditions, and the rapid detection of flammable atmospheres, oxygen deficiency, certain gases and vapors, and physical hazards including noise and radiation.

The following are some of the instruments that may be used for exposure monitoring:

- Photoionization detector (PID)
- Flame ionization detector (FID)
- Combustible gas indicator (CGI)
- Specific gas monitors (e.g., oxygen, carbon monoxide, hydrogen sulfide)
- Real-time aerosol monitor
- Radiation detection instruments
- Colorimetric indicating tubes (e.g., Draeger tubes)
- Mercury vapor analyzer
- Specialized air monitors
- Noise dosimeter
- Sound level meter (SLM)

Routine direct reading monitoring results (date/time, calibration information, results, and activities monitored) shall be recorded on the Air Monitoring Data Sheet (Real-Time Air Monitoring) or an equivalent form if approved by the Health and Safety Manager. Monitoring results shall be recorded initially and periodically throughout the monitoring period (e.g., every 15 minutes, when results are above background levels, when site operations or locations change, or when unexpected site conditions arise). When direct reading air monitoring results at the work location equal or exceed the action levels specified in the SSHP for the project, the SSHO shall conduct exclusion zone perimeter air monitoring. If the air concentrations at the perimeter of the exclusion zone equal or exceed the action level(s), the boundaries of the exclusion zone shall be expanded as necessary to maintain exclusion zone air contaminant concentrations below the action level(s).

8.5 Integrated Personal Air Monitoring

Integrated personal air monitoring refers to the continuous collection of a sample over a period of time for subsequent analysis, usually by a laboratory. This monitoring typically involves the use of portable sampling pumps and an appropriate collection media such as filters, impingers, or adsorption tubes. Integrated monitoring can also be performed using organic vapor monitors and other passive sampling devices.

Personal sampling and analysis will be performed in accordance with the OSHA Industrial Hygiene Technical Manual, the National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods, or other acceptable industrial hygiene practices. Only analytical laboratories accredited by the American Industrial Hygiene Association (AIHA) shall perform sample analysis. The laboratory analysis will include field blanks, as required by the individual method or laboratory. The laboratory shall also be a successful participant in the NIOSH Proficiency Analytical Testing program for the appropriate analytical category. Prior to sampling, the specific sampling and analytical method should be discussed with the receiving laboratory to determine any special requirements or variations to established methods necessary to collect an acceptable sample.

Sampling and analytical information for personal sampling shall be recorded on the Air Monitoring Data Sheet (Integrated Air Monitoring). To ensure timely reporting of analytical results, personal air sampling media shall be sent to the laboratory within 5 working days of the date collected or as specified by the laboratory analysis method and analyzed with normal laboratory turnaround time.

8.6 Training

Persons conducting site monitoring shall have adequate training and/or experience commensurate with the type and complexity of the monitoring program. They should be able to understand the limitations of the equipment they use, proper methods of calibration, proper methods of sealing and shipping samples, and the importance of chain-of-custody.

8.7 Calibration

All instruments shall be calibrated (or checked for proper function if appropriate) before use for each shift. Instrument calibration shall be documented on sample data sheets or in logbooks. Calibration checks may be necessary during the day and at the end of use to confirm instrument accuracy. Duplicate readings may be taken to confirm individual instrument response. Air sampling pumps will be calibrated with primary standards (e.g., dry calibrator or bubble-tube method).

8.8 Operation and Maintenance

All instruments shall be operated and maintained in accordance with the manufacturer's specifications. The manufacturer's operation and maintenance manual will be kept at the site work location for each type of instrument that is being used.

8.9 Sample Shipment

Samples sent to a laboratory for analysis shall be packaged to prevent damage, spillage, or leaks. An air or bulk sample data sheet with chain-of-custody information must accompany any sample shipped.

- Filter Cassettes – Filter cassettes should be mailed in a cardboard box and packed with paper. Avoid using packaging peanuts or other static producing material because the static charge will draw material away and off the filter surface. This is especially true for asbestos fiber samples. Filter cassettes shall be taped over the top and bottom to keep the plugs on the end of the cassette and to prevent sample tampering prior to analysis.
- Charcoal Tubes – Charcoal tubes should be mailed in a cardboard box and adequately packaged to prevent breakage during shipment. Charcoal tubes must never be shipped in the same package as bulk samples.
- Bulk Samples – Bulk samples shall be packaged in labeled containers compatible with the sample and tightly sealed to prevent leaks and spills. Remember that some bulk samples may be considered hazardous materials by the Department of Transportation and have special requirements for packaging, labeling, and method of shipment. Bulk samples must never be shipped in the same package as charcoal tubes.

8.10 Data Review

The designated SSHO or other qualified person will assess and interpret monitoring data and results based on standard industry practices and his/her professional judgment. All calculations performed on raw data (e.g., time-weighted-average calculations) shall be documented and reviewed by another qualified person.

8.11 Recordkeeping and Posting

The SSHO is responsible for maintaining adequate records of site monitoring activities, communicating or posting exposure information, and informing employees of monitoring results as may be required. All integrated personal air sampling results shall be communicated in writing to affected employees within 5 days of receiving laboratory results. All employee exposure records are to be kept by the employer and made available in accordance with 29 CFR 1910.1020.

8.12 Additional Site Monitoring Considerations

8.12.1 Monitoring Frequency

Monitoring or sampling frequency will be influenced by a number of factors including the following:

- Frequency of contaminant release (i.e., continuously, intermittently, one-time release)
- Frequency of operation
- Number of samples required
- Number of different work groups requiring assessment
- Number of work shifts requiring monitoring

Each of these factors should be considered to determine the monitoring frequency.

8.12.2 Monitoring Duration

When monitoring a worker's exposure for comparison to a published exposure limit value such as the OSHA PELs or ACGIH TLVs, monitoring may need to be conducted over a full 8-hour (or longer) work shift or a 10- to 15-minute period of time. In some cases, monitoring may need to be continuous if there is the potential for buildup of a dangerous atmosphere. Monitoring duration can also be affected by the duration of the operation being monitored (i.e., it may only operate 1 hour a day) or by the length of time a worker performs an operation. Duration can also be affected by the contaminant concentration in air. Often, higher concentrations of air contaminants will require the collection of shorter-term samples to avoid overloading the sample collection device being used.

8.12.3 Monitoring Location

The monitoring location will be influenced by the purpose for monitoring. When monitoring for compliance with employee exposure limit values such as PELs or TLVs, monitoring close to the person's breathing zone will normally be required. Ambient or area monitoring is often used to determine air concentrations in a general area that may then be used to estimate worker exposures when they are working in the area.

The location of monitoring will also be influenced by where the contaminant or hazard source originates and/or the dispersion pattern, which may be influenced by atmospheric conditions.

8.12.4Number of Samples

The number of samples that need to be collected and analyzed will be influenced by the purpose for the monitoring and the degree of confidence necessary. If the purpose of the monitoring is to collect subjective data to determine the magnitude of the airborne contamination, then only a few samples will be necessary. However, if the purpose is to determine and document compliance with a regulation, then a “statistically” significant number of samples will be necessary. In this case it may be necessary to consult with a statistician who can help develop a monitoring strategy to achieve sufficient statistical power. In many cases, three or more samples may be necessary to draw any preliminary conclusions.

8.12.5Observation of Monitoring

Observation of monitoring refers to two different aspects. First, all air monitoring needs to be checked throughout the day by the person performing the monitoring. All air monitoring devices are subject to breakdown and tampering and thus they need to be checked periodically. Never set up a device and leave it unattended until the end of the monitoring period. If the monitoring period is only 10 to 30 minutes long, then it should be observed the entire time.

The other aspect to observation of monitoring is the right of employees or their representative to observe the monitoring. Employees have a right to observe monitoring (that affects them) and this right should be explained to them.

9 HAZARD COMMUNICATION

9.1 Purpose

The purpose of this program is to ensure that employees understand the potential hazards of chemicals used in the workplace in accordance with the Hazard Communication (HAZCOM) Regulation, 29 CFR 1910.1200.

9.2 Scope

This program applies to all Bhate operations where employees have potential exposure to hazardous chemicals as a result of their normal job duties or a foreseeable emergency. This program does not apply to hazardous wastes. However, Bhate will provide employees with information on the potential hazards of wastes in accordance with 29 CFR 1910.120(e) and (i).

9.3 Definitions

9.4 Chemical Manufacturer

A workplace where chemicals(s) are produced for use or distribution.

9.5 Exposed Worker

Any worker subjected to a hazardous chemical in the workplace through any route of entry (inhalation, ingestion, skin contact, absorption, etc.).

9.6 Foreseeable Emergency

Any potential occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment that could result in an uncontrolled release of a hazardous chemical into the workplace.

9.7 Hazardous Chemical

Any chemical that constitutes a physical or health hazard. Chemicals with a label containing the words CAUTION, WARNING, or DANGER indicate the chemical is hazardous. Consumer products are not considered hazardous where it can be demonstrated that the products are used in the workplace in the same manner as for normal consumer use.

9.8 Safety Data Sheet

Written or printed material describing characteristics, hazards, and controls associated with a specific or combination of chemicals.

9.9 Work Area

A room or defined space in a workplace where hazardous chemicals are produced or used, and where employees are present.

9.10 Discussion

9.10.1Responsibilities

9.10.1.1 Health and Safety Manager

The HSM shall ensure that:

- A list(s) of hazardous chemicals is developed for each work site or office;
- A current SDS is maintained on file;
- SDSs are available to employees; and
- Employees understand how to read an SDS;
- Know the location of the SDSs, and understand the potential hazards of the chemicals with which they are working.

9.10.1.2 Purchasing Requestors

Personnel purchasing affected chemical products are responsible for ensuring that:

- An SDS is received with all new shipments of hazardous chemicals;
- The supplier is contacted when an SDS is not received; and
- A copy of the SDS is forwarded to the HSM.

9.11 General Guidelines

The HAZCOM-GHS regulation sets requirements for information and training on hazardous chemicals used in the workplace. Federal law requires that all states comply with hazard communication regulations, and many states and local governments have adopted their own "equally or more stringent" hazard communication standards. Therefore, applicable state and local requirements must be consulted when conducting projects in states that have their own standards. The following are guidelines for complying with federal requirements.

9.12 Labeling

The HAZCOM regulation requires that the employer ensure the following:

Each container of hazardous chemical in the workplace is labeled, tagged, or marked with the following information:

- Identity of the hazardous chemical(s)
- Appropriate hazard warnings
- Name and address of the chemical manufacturer, importer, or other responsible party
- HAZCOM also requires that:
- Existing labels on incoming containers of hazardous chemicals are not removed or defaced, unless the container is immediately marked with the required information
- Labels or other forms of warning are legible, are in English, and are prominently displayed on the container, or readily available in the work area throughout each work shift

9.13 Label Warning System

The types of common warning systems are:

- The National Fire Protection Association (NFPA) Standard defines five degrees of hazard in each of the following three categories: emergency health hazard, fire hazard, and instability or reactivity hazard. NFPA warning labels are an acceptable means of labeling hazardous chemicals provided that employees are trained on the NFPA labeling system.
- The Consumer Product Safety Commission requires precautionary labeling on every hazardous chemical intended for household use. Basic precautionary information and labeling terms have been identified by the Manufacturing Chemists Association including the following:
  - Toxic
  - Highly toxic
  - Flammable
  - Extremely flammable
  - Corrosive
  - Irritant
  - Poison

DOT requires shipping containers of hazardous chemicals to be labeled in accordance with the appropriate hazard class. DOT has established nine hazard classes:

- Class 1 -Explosives
- Class 2 -Gases
- Class 3 -Flammable liquids

- Class 4 -Flammable solids
- Class 5 Oxidizers/organic peroxide
- Class 6 -Poisons/infectious substances
- Class 7 -Radioactive materials
- Class 8 -Corrosives
- Class 9 -Miscellaneous hazardous materials

All Bhate projects shall use the name of the hazardous chemical and the NFPA system for labeling portable and stationary containers that are not appropriately labeled. This includes containers that are for general use (e.g., gasoline cans) and containers that have materials transferred to them from original containers.

"Prop 65" rules in California require special warnings when personnel may be exposed to substances "Known to the State" to be carcinogens or reproductive hazards. If materials which are subject to "Prop 65" are used at a California site, review the warnings referenced below during the HAZCOM portion of the site specific training. In addition, the SSHPs will identify contaminants of concern that fall under "Prop 65".

For exposure to a chemical known to the State of California to cause cancer:

"WARNING: This product contains a chemical known to the Sate of California to cause cancer."

For exposure to a chemical known to the state to cause reproductive toxicity:

"WARNING: This product contains a chemical known to the State of California to cause birth defects or other reproductive harm."

9.14 Personal Responsibilities

Personnel using or handling any chemical shall complete the following steps when handling chemicals:

- Read the label on the container. If special instructions are provided, they will usually be part of the label.
- Look for information concerning special precautions for personal protection.
- Note appropriate first aid in case of an exposure.
- Become familiar with the various types of labels and their warnings.
- Consult the SDS for further warnings or requirements.

9.15 Specific Labeling Requirements

Hazardous substances that have specific labeling requirements under other standards include the following:

- Carcinogens
- Lead
- Asbestos
- Hydrogen, oxygen, and anhydrous ammonia
- Cotton dust
- Formaldehyde

9.16 Safety Data Sheet

9.16.1 General Information

The SDS is used to relay chemical hazard information from the manufacturer/importer to the employer and employee. The HAZCOM regulation requires an SDS for each hazardous material product an employee packages, handles, or transfers. The HAZCOM regulation does not require an SDS sheet for hazardous wastes. Only those hazardous chemicals brought onto the job site by the contractor are required to have an SDS sheet. The SSHPs will contain similar information on the known or potential site contaminants.

9.16.2 SDS Content

SDSs that are received with incoming shipments of hazardous chemicals shall be maintained in an onsite file or office file by the HSM and shall be made available to all site or office employees. Each SDS shall include the following information:

- Trade name of the chemical (if appropriate)
- Name, address, and telephone number for hazard and emergency information
- Date of SDS preparation
- Chemical and common name of all ingredients
- OSHA PELs, ACGIH TLVs, and other applicable limits
- Physical and chemical characteristics
- Physical hazards
- Primary route(s) of entry into the body, such as inhalation, ingestion, or skin absorption
- Acute and chronic health hazards, including signs and symptoms of exposure and medical conditions aggravated by exposure

- Carcinogenic hazards
- Emergency and first aid procedures
- Precautions for safe handling and use
- Engineering/exposure control measures and personal protective equipment

Upon receipt of an SDS (with a shipment of chemicals or otherwise) the following steps shall be performed:

- The SDS shall be given to the HSM who inspects it for completeness. If incomplete, the SDS is returned to the manufacturer with a written request for a complete SDS. After sending the request, the supplier or manufacturer should be contacted by phone.
- If the SDS is complete, the HSM places a copy of the complete SDS into the site project or office file.
- If a revised version of an SDS is received, the old version of the SDS is stapled to the revised SDS and placed in the site project or office file.
- If no SDS is received with a shipment of chemicals, a written request shall be used to request an SDS from the supplier or the manufacturer. After sending the request, the supplier or manufacturer should be contacted by phone.
- Copies of all correspondence, phone contacts, and SDSs shall be maintained in the project or office files.

SDSs are a good source of information for those seeking quick hazardous material references. In the case of emergencies, however, not all of the pertinent information is provided and at times the information may be more damaging than helpful. Response to any emergency requires quick judgment calls. If there is any question of which first aid procedures to follow, it is best to call the emergency number provided on each SDS specific to the material in question.

9.17 Non-Routine Activities

All Bhate employees and subcontractors must be informed of the hazards associated with chemicals involved in non-routine activities. For the purpose of this guideline, non-routine activities include, but are not limited to, line breaking/pipe opening, confined space entry, tank cleaning, and other maintenance of process equipment.

Hazards of non-routine tasks are addressed in SSHPs and Activity Hazard Analyses (AHAs) and are reviewed with the work crew during preparatory meetings of daily briefings.

9.18 Employee Information and Training

Employee information and training shall be provided as part of the employee's EHS training. This documentation includes the initial hazardous waste training certification and the site specific or office training documentation.

The following are required elements of the information and training program:

- An overview of HAZCOM;
- A review of any operations in their work areas that may involve hazardous materials;
- The location and availability of the written Hazard Communication Program, including the list(s) of hazardous chemicals and SDSs;
- Methods and observations that may be used for detecting the presence or release of hazardous chemicals;
- An understanding of the physical and health hazards of hazardous chemicals in the work area;
- How to understand the information in SDSs;
- How to read the warnings on container labels including the NFPA system;
- When and how to report leaks and spills;
- How to recognize the symptoms of overexposure and how to protect against it; and
- How to implement exposure control methods including work practices, engineering controls, administrative controls, personal protective equipment, and emergency procedures.

Hazard communication training is provided during initial training, site specific and office orientation, supervisor training, and 8-hour refresher training.

In the event that a new chemical hazard or new task is introduced in the workplace, the HSM or designee shall conduct additional training that includes the following:

- Objectives of the task, if applicable;
- Physical and health hazards associated with the new chemical hazard or task;
- Methods to detect the presence or release of the hazardous chemicals;
- Procedures and practices recommended to protect themselves from the hazards;
- Emergency procedures in the event of a hazardous situation or exposure; and
- Location and availability of the written program, lists of chemicals, and SDS.

9.19 Subcontractors

Subcontractors working for Bhate shall be required to meet the EHS requirements outlined in their contracts. To help meet these requirements, subcontractors are informed of Bhate procedures by the HSM or designee and instructed where to find information on hazardous chemicals being used on the project.

10 PERSONAL PROTECTIVE EQUIPMENT

10.1 Purpose

The purpose of this program is to ensure that PPE is selected in accordance with 29 CFR 1910.132, properly used and maintained, and that Bhate personnel are properly trained in the inspection, use, and maintenance of PPE.

10.2 Scope

This program applies to all Bhate operations including the activities of contractors on Bhate-managed projects.

10.3 Definition

10.3.1Personal Protective Equipment

Items which are worn and are designed to protect the health and safety of an employee. This includes, but it is not limited to, chemical resistant shoes, boots, gloves, chemical protective clothing, hard hats, safety glasses, hearing protection, cooling/heating vests, life-lines and harnesses, and respirators. Additional program requirements for respirators are provided in the Respiratory Protection Program.

10.4 Discussion

10.4.1Responsibilities

10.4.1.1 All Bhate Personnel

All personnel required to use PPE are responsible for wearing the appropriate PPE when required, inspecting the PPE prior to use, properly wearing the PPE, and as necessary, properly maintaining the PPE.

10.4.1.2 Project Management Personnel

Site Managers are responsible for understanding the specific PPE requirements for each project task and ensuring that PPE is provided and worn when required and in the intended manner.

10.4.1.3 Health and Safety Manager

The HSM is responsible for:

- Ensuring that PPE is selected in accordance with the hazard assessment requirements of 29 CFR 1910.132(d)
- Approving changes to PPE requirements through plan modifications or by incorporating criteria into the SSHP which enable the SSHO to authorize changes to the PPE requirements

10.4.1.4 Site Safety and Health Officer

The SSHO is responsible for:

- Monitoring PPE usage;
- Recommending modifications to PPE requirements to project management and the HSM, as necessary;
- Ensuring that project personnel have the proper training on the PPE which they are required to use, and performing training and retraining, as necessary; and
- Providing notifications to laundries which clean Bhate work clothing, as required.

10.5 Intended Use

PPE is intended for use when engineering controls, administrative procedures, and/or work practices are not feasible, when control measures are shown to be ineffective for exposure minimization, when uncertainty exists regarding the nature and level of potential exposure, and as a precautionary measure to prevent exposure due to accidental releases of hazardous materials.

10.6 Hazard Assessment and Selection

Hazard assessments shall be performed during the preparation of all SSHPs. The hazard assessment shall include consideration for:

- Potential chemical, physical, and biological hazards present
- Work operations to be performed
- Potential routes of exposure
- Concentrations of contaminants present
- Characteristics, capabilities, and limitations of PPE, and any hazards that the PPE presents or magnifies such as heat stress

The SSHP shall be used as the written documentation of the hazard assessment to comply with 29 CFR 1910.132(d)(2), and shall include the identification of the workplace evaluated, the person certifying that the evaluation has been performed, and the date(s) of the hazard assessment.

10.7 PPE Requirements

All PPE shall be of safe design and construction for the work to be performed and shall meet applicable American National Standards Institute (ANSI) standards and/or OSHA regulations.

PPE used exclusively for site work shall be provided at no cost to Bhate personnel. Field personnel will be provided $75.00 biennially for purchasing appropriate leather safety shoes. Prescription safety glasses are not provided to personnel by Bhate. [from NV JV III HASP-“”]PPE used exclusively for site work shall be provided at no cost to Nationview-Bhate personnel. Field personnel will be provided $75.00 per year for purchasing appropriate leather steel toe safety shoes. Prescription safety glasses are provided to personnel by Nationview-Bhate at a cost not to exceed $150 per year.

Personnel responsible for the issuance of PPE shall ensure that PPE properly fits each affected. Respirator fit will be evaluated in accordance the Respiratory Protection Program.

Eye and/or face protection shall be provided when hazards exist from flying particles, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation. Regarding eye and/or face protection:

- Side shields shall be used whenever site plans require the use of safety glasses. Employees who wear prescription lenses must use ANSI approved industrial prescription safety glasses with fixed side shields and/or prescription inserts for full face respirators as necessary to meet project requirements. The cost of eye examinations is the responsibility of the employee.
- Filter lenses for operations which involve hazardous light radiation shall be in accordance with 29 CFR 1910.133(a)(5).
- A full-face respirator is required whenever operations involve corrosive liquids and the operation requires the use of a respirator to provide for maximum eye protection; if the operation does not require a respirator, then splash goggles at a minimum shall be worn. Face shields are not a substitute for splash goggles.

Hard hats shall be provided whenever hazards from falling objects, overhead hazards, low clearance hazards exist, or required by a SSHP.

10.8 Field Work Clothing

PPE is designed and prescribed to protect employees from the risk of injury by creating a barrier against workplace hazards. PPE is not a substitute for good engineering, administrative controls, or good work practices, but should be used in conjunction with these controls to ensure the safety and health of employees. PPE will be provided, used, and maintained by the employee when it has been determined that its use is required and that such use will lessen the likelihood of incurring an occupational injury and/or illness.

The use of PPE can itself create significant worker hazards such as heat stress, physical and psychological stress, impaired vision, reduced mobility, and difficulties with communication. For any given situation, PPE must be selected to provide the appropriate level of protection without creating unnecessary risk to the wearer.

The following is a list of minimum required clothing and PPE for Bhate projects:

- Shirts with at least a 4-inch sleeve (tank tops, sleeveless shirts, and/or unbuttoned shirts are not acceptable);
- Long pants (loose-fitting pants are not permitted);
- Leather or similar material steel-toed work boots;
- Hard hats;
- Safety glasses with rigid side-shields; and
- Leather or similar material work gloves.

Additional equipment to be utilized will be selected on the basis of potential hazards of each project. The actual equipment to be utilized will be chosen on the basis of potential hazards of each project and specified in the SSHP and may include but is not limited to any of the following:

- Hearing protective devices (plugs or muffs)
- Faceshields and/or chemical resistant splash goggles
- Welding helmets or goggles
- Chemical resistant gloves
- Chemical resistant boots and/or boot covers
- Tyvek® or other impermeable coveralls
- Respiratory protection

10.9 Inspection

Each employee is responsible for inspecting his/her PPE before and after each use. Any damaged or defective PPE is to be taken out of service immediately and repaired or replaced.

10.10 Cleaning, Maintenance, and Disposal

Used, disposable PPE items are placed in containers at job sites for disposal. The Project Manager or Site Manager in consultation with the HSM shall determine the proper method of disposal.

Non-disposable items such as hard hats and rubber boots are to be decontaminated at the job site. Personnel are responsible for cleaning their own PPE after each work shift unless other arrangements are made for the project. Site specific cleaning procedures are listed in the SSHP for each job site.

10.11 Medical Evaluation

Medical surveillance examinations for personnel required to wear PPE will include an evaluation of the person's ability to tolerate the physical stresses posed by protective equipment.

10.12 Training

10.12.1 Initial Training

Training in PPE inspection, use, and maintenance is conducted as part of the initial hazardous waste 40-hour training. This training provides personnel with an understanding of the inspection, use (including donning, doffing, adjusting, and wearing), limitations, care, and maintenance of PPE.

10.12.2 Site Specific Orientation

Site specific orientations shall be used to communicate selection decisions to site personnel to meet the requirements of 29 CFR 1910.132(d)(1)(ii). The site specific orientation shall ensure that site personnel:

- Understand when PPE is necessary, what PPE is necessary, the limitations of the PPE, and the proper disposal of the PPE;
- Understand how to use the specific PPE required by the project; and
- Has retained the basic PPE knowledge from the initial training.

10.12.3 Retraining

Retraining shall be performed:

- Whenever Bhate personnel have reason to believe that a person does not have the requisite understanding and skill to properly and safely use PPE;
- When changes in the workplace or work plans require modifications to the types of selected PPE; and
- As necessary, to inform Bhate personnel of changes to the requirements of this program.

10.13 Documentation

PPE training shall be documented through a written certification that contains the name of each person trained, the date(s) of the training, and the identification of the subject of the certification. Training certification may be accomplished as follows:

- For initial, supervisor, and refresher training, Bhate shall maintain a copy of the course certificate.
- For site specific orientation, site specific training and required retraining, the training sign-in sheet shall contain the required information identified above.

11 RESPIRATORY PROTECTION

11.1 Purpose

The purpose of this program is to establish minimum requirements for the proper selection, use, and care of respiratory protection equipment by workers at Bhate project sites and to ensure compliance with 29 CFR 1910.134.

11.2 Scope

This program applies to all Bhate respiratory protective equipment users.

11.3 Definitions

11.3.1Hazardous Atmosphere

Any atmosphere containing a potentially toxic gas, vapor, dust, fume, mist, or pesticide, or any oxygen-deficient atmosphere.

11.3.2Oxygen-Deficient Atmosphere

An atmosphere containing less than 19.5 percent oxygen by volume at sea level.

11.3.3Discussion

11.4 Responsibilities

11.4.1Project Management Personnel

Site Managers are responsible for ensuring that the proper respiratory protective equipment (RPE) is used when required in accordance with the SSHP in the intended manner.

The HSM is responsible for assisting the Site Managers with annual training and fit testing for the use of RPE.

The Site Managers and HSM are responsible for selection and specification of RPE in accordance with the requirements of this program and applicable regulations.

The Site Manager is responsible for:

- Ensuring that personnel have the necessary training and fit testing for the use of each type of respirator and ensuring that proper documentation is available;
- Monitoring the use of RPE; and

- Ensuring that RPE is maintained and inspected in accordance with the SSHP and program requirements.

11.4.2Health and Safety Manager

The HSM is responsible for evaluating the effectiveness of the respiratory protection program on each site; and recommending changes to the types of RPE being used, as necessary.

11.5 Selection of Respiratory Protective Equipment

All respiratory equipment utilized on Bhate projects shall be certified by the NIOSH and the Mine Safety and Health Administration (MSHA). The type of respiratory protection selected is based upon potential hazards at a specific site. Selection of appropriate respiratory protection is documented in the SSHP and approved by the HSM.

There are three general classes of respiratory protection available:

- Self-contained breathing apparatus (SCBA);
- Air-supplied devices; and
- Air-purifying devices.

To select which type of respiratory protection is appropriate for a given project, the following questions must be answered:

1. Is there a possibility of an oxygen-deficient atmosphere?
2. Are the contaminants and concentrations in the worker breathing zones known or unknown?
3. What are the allowable concentration limits (permissible exposure limits or threshold limit values) for the contaminants? What are their physical properties?
4. What are the maximum expected concentrations of known contaminants? Are the concentrations Immediately Dangerous to Life or Health (IDLH)?
5. What is the expected duration of personnel exposure?
6. What are the warning properties and symptoms of the contaminants?
7. Can the contaminant be absorbed through the skin and/or eyes?
8. Are the contaminants flammable?
9. Is there any other information concerning the contaminants that may be pertinent to selecting appropriate respiratory protection?

Atmosphere-supplying respirators (i.e., pressure demand SCBAs or airline systems) shall be used when one of the following occurs:

1. The hazardous substance has been identified and requires the highest level of protection based on the measured (or potential for) high concentration of atmospheric vapors, gases, or particulates;

2. Site operations involve a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates; or
3. Operations are being conducted in confined, poorly ventilated areas that could contain hazardous concentrations of atmospheric vapors, gases, or particulates and/or reduced oxygen concentrations less than 19.5 percent.

Escape packs are used with all airline systems. Employees shall not be permitted to enter atmospheres that are immediately dangerous to life or health without the approval of the HSM, or without documentation of specific hazardous atmosphere rescue training.

Negative pressure air purifying respirators, equipped with appropriate filter cartridges for the expected contaminants, may be used only when the atmospheric contaminants have been identified, and expected concentrations are within limits that can be effectively removed by the respirator cartridges. For air purifying respirators used for protection against gases or vapors, a cartridge change schedule shall be included in the SSHP along with a description of the information or data relied upon to develop the schedule. In most cases this will consist of recommendations by the manufacturers when they become available.

11.6 Fit Testing

A qualitative fit test shall be conducted for each employee during the initial 40-hour health and safety training course and/or at site specific training and annually thereafter. Fit testing may also be performed when a condition that may affect the face fit of the respirator has occurred, such as weight gain or loss, dental work, facial surgery, or deformity. Employees shall be clean shaven during fit testing.

Qualitative fit tests shall be administered using irritant smoke or Bitrex in accordance with the OSHA Respiratory Protection Standard in 29 CFR 1910.134.

Qualitative fit testing will be limited to situations where a negative pressure respirator is used and a protection factor of 10 or less is needed. If a protection factor of greater than 10 is needed, the SSHP will require either a positive pressure/pressure demand respirator or quantitative fit-testing of the negative pressure respirator.

All positive pressure/pressure demand respirators with tight-fitting facepieces will be fit-tested qualitatively or quantitatively in the negative pressure mode.

A record of the fit test shall be maintained utilizing the qualitative respirator fit test record form. Records of employee respiratory protection training shall be maintained by the Bhate Corporate office.

11.7 Respirator Use

All Bhate personnel are required to:

- Use RPE when required and in the proper manner;
- Inspect RPE prior to each use and obtain replacement equipment when found to be defective;
- Perform a user seal check each time they put on a tight-fitting respirator;
- Take proper care of the RPE;
- Be clean shaven where the seal of the respirator contacts the face whenever using RPE; and
- Leave the respirator use areas whenever necessary to wash their face or respirator to avoid skin irritation; if they detect contaminant breakthrough, a change in breathing resistance, or leakage of the facepiece; or to change filters or cylinders.

Low temperatures may fog the lenses of the respirator and use of anti-fog spray and a nose cup may be beneficial. Nose cups are part of the NIOSH approval for air supplied respirators at ambient temperatures of 32°F and below. Minimum temperatures recommended by the manufacturer for operation of a SCBA shall be consulted prior to use in low temperatures.

Under no circumstances are employees permitted to use escape provisions of atmosphere-supplying respirators for routine entry and non-emergency egress of work areas.

Wearing any respirator in conjunction with other types of protective equipment will impose some physiological stress on the wearer. Use of respirators in conjunction with protective clothing can greatly affect human response and endurance, especially in hot environments.

11.8 Cleaning and Storage

Each person has the responsibility to clean, disinfect, and care for their respirator in accordance with the training they have received. The following procedures shall be followed for cleaning and storage of respiratory protection equipment:

- Personal respirators shall be cleaned and disinfected after each day's use, or more frequently, if necessary.
- Respirators for emergency use and all SCBAs shall be cleaned and inspected after each use, and inspected on a monthly basis. Monthly inspections shall be documented, including serial number, date, findings, and remedial action and signature of the inspector.
- Routine cleaning shall be completed as follows:
  - Remove the filters and dispose of per the SSHP requirements, if applicable.
  - Wash respirator in disinfecting solution.
  - Rinse respirator in clean water.
  - Allow respirator adequate time to air dry.
- Routine inspection shall be completed as follows:
  - Check all connections for gaskets and "O" rings and proper tightness.

    - Check the condition of the face piece and its parts for tears, cracks, abrasions, or brittleness.
    - Check the condition of the connecting air hose, regulator, and harness, if applicable.
    - Check the condition of the headband for tears, cracks, abrasions, or brittleness.
    - Inspect all rubber or elastic parts for pliability and signs of deterioration.
    - Check alarms, if applicable.
    - Report any worn, missing, or broken parts to health and safety personnel onsite.
- Clean and dry respirators shall be stored in zippered plastic bags. These bags shall be placed in a clean, dry place out of direct heat and sunlight.
- Repairs and parts replacements will only be made by individuals trained to do so using only the manufacturer's NIOSH approved parts. Only manufacturers or technicians trained by the manufacturer can repair\replace reducing and admission valves, regulators, and alarms.

11.9 Air Monitoring of Work Areas

To determine if the selected respiratory protection is appropriate, the work area shall be monitored for contaminant concentrations at the beginning of each phase of work activity as required by the site safety plan. Sampling should be in the breathing zone of the exposed employee. Periodic sampling throughout the project will be conducted per the SSHP to ensure that the selected respirator protection is appropriate.

11.10 Evaluation of the Program

Site Managers and the HSM shall monitor the project implementation of the respiratory program during routine and informal inspections. The HSM will perform evaluations of project implementation of the program during site inspections. The inspections shall include consultation with affected employees required to use respirators. The HSM will evaluate overall program implementation through a review of inspection reports, incident reports and investigations, and audit reports.

11.11 Medical Surveillance

Site personnel shall meet the medical surveillance requirements of 29 CFR 1910.134, 1926.103 and 1910.120, for respirator use prior to engaging in any field work requiring or potentially requiring the use of a respirator. Personnel with medical conditions which prevent or limit their ability to wear a respirator shall be notified in writing by the LMP.

11.12 IDLH Atmospheres

Bhate personnel shall immediately evacuate areas where an IDLH atmosphere develops. Bhate personnel shall not enter IDLH atmospheres except for rescue or when authorized by the HSM. If necessary, at least one standby person equipped with proper rescue equipment and a pressure demand SCBA should be present. Communication between the field team and the standby person should be maintained at all times. If the IDLH atmosphere exists in a confined space, the entry shall be conducted in accordance with the Confined Space Entry Program requirements.

11.13 Training

Personnel required to use respiratory protection shall be trained in the selection, use, and maintenance of the equipment. Respiratory protection training is included as part of the initial health and safety training, the 8-hour refresher course, and/or the site specific training. The training shall be conducted annually. Site specific respiratory protection training includes the following:

- Hazard identification to include symptoms of exposure;
- Use of engineering controls to minimize exposure and an explanation of why engineering controls are not feasible;
- A description of the type of respiratory protection chosen and the protection provided to the employee;
- Assurance that the employee understands the protection capabilities and limitations of the method of respiratory protection utilized;
- Recognition of medical signs and symptoms that may limit or prevent effective use of respirators;
- A thorough demonstration of the selected method of respiratory protection to include how to put it on, how to check the seals, use, troubleshooting, and maintenance followed by hands-on training by the employee;
- How to use the respirator in an emergency, including situations in which the respirator malfunctions; and
- A description of the on site storage and maintenance facilities for maintaining respiratory protection equipment.

12 HEARING CONSERVATION

12.1 Purpose

The purpose of this program is to establish guidelines that will ensure that personnel exposures to occupational noise are maintained below the acceptable limits as defined by 29 CFR 1910.95 and 29 CFR 1926.52.

12.2 Scope

This program applies to all Bhate operations where employees have potential noise exposures equal to or exceeding an 8-hour time-weighted average of 85 decibels on the "A-weighting" scale (dBA).

12.3 Discussion

12.3.1Responsibilities

12.3.1.1 Employees

All affected employees are responsible for complying with the requirements of this practice and the SSHP required hearing conservation requirements.

12.3.1.2 Project Management Personnel

The Project Manager or Site Manager shall ensure the implementation of the hearing conservation program as applicable.

12.3.1.3 Site Safety and Health Officer

The SSHO shall assist the Site Manager with the implementation of the project hearing conservation requirements. The SSHO shall be responsible for conducting the necessary surveys and monitoring to identify and document areas and/or processes that generate high noise. The SSHO shall provide training on the use and care of hearing protective devices, as needed and ensure that the Noise Reduction Rating for hearing protective devices provides adequate noise attenuation.

12.3.1.4 Health and Safety Manager

The HSM will provide assistance as needed with the implementation of the hearing conservation program. The HSM will be responsible for reviewing project noise evaluation data, maintaining employee exposure documentation, and conducting periodic program evaluations.

12.4 Noise Hazard Recognition

If the ear is subjected to high levels of continuous noise for an extended period of time or high impact noises (e.g., intermittent noise from pneumatic hammer drills), some hearing loss can occur. However, there are many factors that can affect the degree and severity of hearing loss:

- The intensity and loudness of the noise
- The frequency of the noise (high or low)
- Duration of exposure each day
- Individual susceptibility (is the person on medicine or taking drugs which can affect susceptibility to noise)
- Age of the individual
- Preexisting or coexisting hearing loss and ear diseases
- Character of the surroundings in which noise is produced
- Distance from the source of the noise

Hearing loss can also be caused by non-occupational noise, diseases, or disorders of the outer or middle ear which can keep sound from being transmitted to the inner cells of the ear. These hearing losses can also be hazardous to the employee's health and can alter an individual's work performance and job safety. Age-related hearing loss (presbycusis) is also an important aspect of determining noise-induced hearing loss. As we age, our hearing capabilities decrease and health facilities take into account this typical hearing loss when determining if noise-induced hearing loss has occurred. Many women's and children's voices are at noise frequencies where noise and age-induced hearing loss can first be identified.

Employee noise exposure is expressed as an 8-hour time-weighted average in decibels on the "A-weighting" scale (dBA). The action level for noise exposure is 85 dBA. Noise exposures at levels exceeding the action level mandate the administration of a Hearing Conservation Program (HCP). Employees with reasonable probability of exposure exceeding the action level are enrolled in the HCP.

Some of the sources of noise at hazardous materials sites, demolition operations, construction, and other industrial sites that can cause hearing damage include: vehicle engines, compressors, pneumatic tools, heavy equipment, hammer blows, etc. Examples of approximate noise levels are shown in Table 12-1.

Table 12-1. Approximate Noise Levels

Noise Source or Activity	Noise Levels
Subsurface Drilling	Up to 115 dBA
Chain Saws	Up to 125 dBA
Heavy Equipment	Up to 95 to 110 dBA
Demolition	Up to 117 dBA
Factory	Up to 90 dBA
Office	70 to 80 dBA
Normal Speech	60 dBA

12.5 Noise Evaluation

Noise evaluations will be conducted by qualified personnel using appropriate, calibrated noise monitoring equipment. The type (area survey or personal dosimetry) of noise monitoring required (if any) will be identified in the project SSHP. Both surveys and dosimetry may be utilized as needed to meet the requirements of 29 CFR 1910.95. Additional surveys and/or dosimetry may be required if there are changes in equipment or processes.

If impact noise is present, the peak noise levels and the frequency of the impacts shall be determined. The results of any impact noise assessment will be compared to the exposure limits for impact noise specified by OSHA and the ACGIH.

12.6 Noise Control Methods

12.6.1Engineering Controls

The primary means of reducing or eliminating personnel exposure to hazardous noise is through engineering controls. Engineering controls can be defined as any modification or replacement of equipment, or related physical change at the noise source or along the path of transmission that will reduce the noise level at the receptor. Engineering controls may include mufflers, sound baffles, equipment mounting isolators, and process or operator enclosures.

12.6.2Administrative Controls

Administrative controls are defined as changes in the work schedules or operations which reduce noise exposures to employees. These controls can include increasing the distance between the noise source and the employee, and reduction in exposure duration.

Administrative controls may not be utilized for noise exposures greater than 115 dBA. Noise levels exceeding 115 dBA will require an evacuation of the work area.

12.6.3Hearing Protective Devices

When engineering controls prove to be impractical or cost prohibitive, hearing protective devices (HPDs) in the form of ear muffs or plugs should be utilized. The use of hearing protective devices is intended to reduce employee noise exposures below 85 dBA for employees with a standard threshold shift and top below 90 dBA for all other employees.

The use of HPDs will be mandatory in the flowing situations:

- The 8-hour time weighted average may equal or exceed 85 dBA;
- Any employee with a standard threshold shift exposed to greater than 85 dBA;
- Any noise equal to or greater than 115 dB; and/or
- Anywhere “Hearing Protection Required” is posted.

12.7 Audiometry

Audiometric testing is performed to evaluate the hearing of all employees who are routinely exposed to 8-hour time-weighted averages of 85 dBA or greater.

12.8 Training

Initial and annual training shall be provided to employees included in the HCP. The training will include:

- The effects of noise on hearing;
- The purpose of hearing protection and the selection, fitting, use, attenuation characteristics, advantages, and disadvantages of various types of HPDs;
- The purposes of audiometric tests and the testing procedures; and
- Recognition of hazardous noise.

These training topics should be covered in each employee’s initial and refresher HAZWOPER training courses.

13 CONFINED SPACE ENTRY

13.1 Purpose

When required, this program provides the requirements to ensure a safe working environment within and around confined space operations by evaluating confined space hazards, implementing necessary controls, and regulating employee entry into confined spaces. Confined space entries should only be made if there is not a feasible method of performing the task from outside of the confined space.

13.2 Scope

This program applies to all Bhate employees, operations, and subcontractors.

13.3 Definitions

13.3.1 Acceptable Entry Conditions

The conditions that must exist in a permit space to allow entry and to ensure that employees involved with a permit-required confined space entry can safely enter into and work within the space.

13.3.2 Attendant

An individual stationed outside one or more permit spaces who monitors the authorized entrants and who performs all attendant's duties assigned in the employer's permit space program.

13.3.3 Confined Space

An enclosed area which exhibits the following characteristics:

- Is large enough and so configured that an employee can bodily enter;
- Has limited or restricted means for entry or exit; and
- Is not designed for continuous occupancy.

13.3.4 Double Block and Bleed

The closure of a line, duct, or pipe by closing and locking or tagging two in-line valves and by opening and locking or tagging a drain or vent valve in the line between the two closed valves.

13.3.5 Engulfment

The surrounding and effective capture of a person by a liquid or finely divided solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

13.3.6 Confined Space Entry Permit

The completed document which specifies the hazards, controls, and procedures for a confined space entry.

13.3.7 Entry

The action by which a person passes through an opening into a confined space. Entry is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

13.3.8 Entry Supervisor

The person responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry and overseeing entry operations, and for terminating entry as required by this section.

13.3.9 Hazardous Atmosphere

An atmosphere which meets one or more of the following criteria:

- Flammable gas, vapor, or mist in excess of 10 percent of the lower explosive limit (LEL); or
- An airborne concentration of a dust at a concentration that meets or exceeds its lower explosive limit (rule of thumb - visibility obscured at a distance of 5 feet); or
- Atmospheric concentration of any substance which could result in employee exposure in excess of its recommended exposure limit, i.e., PEL, TLV, or manufacturer's limit; or IDLH.

13.3.10 Inerting

The displacement of the atmosphere in a permit space by a noncombustible gas to such an extent that the resulting atmosphere is noncombustible.

13.3.11 Isolation

A pre-entry requirement which assures that the confined space has been completely taken out of service and insures that accidental introduction of hazardous substances into the confined space may not take place. Isolation may include blinding, double blocking with bleed valves, capping, and/or lockout/tagout.

13.3.12 Line Breaking

The intentional opening of a pipe, line, or duct that is or has been carrying flammable, corrosive, or toxic material, an inert gas, or any fluid at a volume, pressure, or temperature capable of causing injury.

13.3.13 Non-Permit Required Confined Space

A confined space that does not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or serious physical harm.

13.3.14 Oxygen Deficient

An atmosphere containing less than 19.5 percent oxygen by volume.

13.3.15 Oxygen Enriched

An atmosphere containing 22.0 percent or more oxygen by volume. (Note: The 22% upper limit is an NFPA 306k, Certification of Hot Work, Consensus Standard.)

13.3.16 Permit Required Confined Space

A confined space which has one or more of the following characteristics:

- Contains or has the potential to contain a hazardous atmosphere;
- Contains a material that has the potential for engulfment of the entrant; or
- Has an internal configuration that could trap or asphyxiate an entrant.

13.4 Prohibited Conditions

Any condition in a permit space that is not allowed by the permit during the period when entry is authorized.

13.5 Retrieval System

The equipment used for non-entry rescue of persons from permit spaces.

13.5.1Discussion

13.5.1.1 Responsibilities

Authorized Entrants

Entrants are responsible for the following:

- Inspection of operability and integrity of all respiratory apparatus, safety equipment, and PPE to be used/worn;
- Knowing hazards, mode of exposure, signs and symptoms, and consequences of hazardous exposure;
- Communicating with the attendant as necessary to enable the attendant to monitor entrant status and to enable the attendant to alert entrants of the need to evacuate the space;
- Notifying the attendant of undetected/unnoticed hazards which could cause harm or injury to team personnel, warning signs and symptoms of exposure, and prohibited conditions;
- Properly wearing the designated respiratory apparatus, safety equipment, and PPE;
- Knowing the emergency procedures; and
- Exiting from the permit space when evacuation is ordered, warning signs or symptoms of exposure are noted, a prohibited condition is noted, or an alarm is activated.

Attendants

Attendants are required to assume the following duties and responsibilities:

- Inspection of operability and integrity of all respiratory apparatus, safety equipment, and PPE to be used.
- Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure.
- Be aware of possible behavioral effects of hazard exposure in authorized entrants.
- Communicate with authorized entrants as necessary to monitor entrant status and to alert entrants of the need to evacuate the space.
- Leave their position only after being physically replaced by another qualified attendant. If required to leave their post and no replacement is available, they must evacuate all personnel from within the confined space before leaving.
- Monitor activities inside and outside the space to determine if it is safe for entrants to remain in the space and order the authorized entrants to evacuate the permit space immediately if a prohibited condition is noted, if an authorized entrant shows behavioral effects of a hazard exposure, if a saturation develops outside the confined space that may endanger the entrants, or if the attendant cannot effectively and safely perform his or her required duties.
- Summon rescue and emergency services.
- Warn unauthorized persons that they must stay away from the permit space, advise them to exit immediately if they enter the permit space, and inform the entry supervisor if they enter the space.
- Perform non-entry rescues.

- Perform no duties that interfere with the attendant's primary duty to monitor and protect the authorized entrants.
- Remain in constant communication with the entrant at all times.
- Perform atmospheric monitoring per the confined space permit under the direction of the entry supervisor, if trained to perform the monitoring.

Entry Supervisors

Entry supervisors have the following responsibilities:

- Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposures;
- Verify by checking that the appropriate entries have been made on the permit, that all tests specified by the permit have been conducted and that all procedures and equipment specified by the permit are in place before endorsing the permit and allowing entry to begin;
- Verify that rescue services are available and that the means for summoning them are operable;
- Remove unauthorized individuals who enter or who attempt to enter the permit space during entry operations;
- Determine, whenever responsibility for a permit space entry operation is transferred and at intervals dictated by the hazards and operations performed within the space, that entry operations remain consistent with terms of the entry permit and that acceptable entry conditions are maintained;
- Ensure full compliance with Bhate and customer permit requirements;
- Ensure that all confined space pre-entry precautions have been taken;
- Ensure that atmosphere/personnel monitoring is performed at adequate frequencies to protect the safety and well being of the entry personnel;
- Ensure that emergency procedures and individual assignments are clearly defined, and coordinate rescue procedures if necessary; and
- Terminate the entry and cancel the permit.

The entry supervisor may also serve as attendant.

Project Management Personnel

The Site Manager has the responsibility for:

- Ensuring implementation of the confined space entry program

- Ensuring that only trained, qualified, and medically fit personnel participate in confined space entry operations
- Ensuring that adequate, appropriate, and properly maintained equipment is provided to safely enter a confined space and successfully complete the task

13.6 Procedure

The following sections provide the requirements for pre-entry activities, pre-entry briefings, confined space operations, and program review requirements. Complete implementation of these requirements is necessary to ensure the health and safety of personnel during confined space operations.

No entries shall be made into confined spaces with:

- IDLH atmospheres
- LEL readings in excess of 10% or a combustible dust atmosphere in excess of the LEL
- An oxygen content of less than 19.5% or greater than 22.0%
- Carbon monoxide levels > 25 ppm
- Hydrogen sulfide levels > 10 ppm

13.7 Hazard Evaluation

Prior to the initiation of a confined space entry, a hazard evaluation of the space shall be conducted by the entry supervisor to determine what chemical and physical hazards are present. This review shall be documented on the entry permit and include, but not be limited to the following:

- Potential for oxygen deficient or enriched atmosphere;
- Presence of a flammable atmosphere;
- Presence of toxic air contaminants;
- Presence of physical hazards;
- Sources of hazardous energy that must be de-energized to effectively isolate the confined space;
- Other permits, such as hot-work or lockout/tagout, required to control hazards; and
- Acceptable entry conditions.

Various sources of information for hazard identification that may be used include blueprints, as-built drawings, client employee knowledge, past entry information, air monitoring data, and physical inspection. For each hazard identified, an effective means of control shall be documented on the confined space entry permit.

13.8 Atmospheric Testing

The atmosphere of the confined space shall be tested to determine the initial concentrations of the following:

- Oxygen content;
- Flammable or combustible gases or vapors; and
- Toxic air contaminants.

Testing for the initial concentrations shall be conducted in the order given and documented on the entry permit. Additional LEL, oxygen, and toxicity readings must be taken at least every 15 minutes. If isolation of the space is unfeasible because the space is large or part of a continuous system, the monitoring shall be continuous. Frequency for periodic monitoring during the confined space entry shall be specified and documented on the permit.

13.9 Ventilation

Mechanical ventilation shall be initiated where necessary to prevent exposure of employees to hazardous atmospheres. The ventilation shall meet the following requirements:

- It shall be continuous
- It shall be directed into the immediate area authorized entrants shall work in
- The air supply shall be from a clean source and shall not increase the hazards in the area
- In addition:; and
- Employees shall not enter the space until the ventilation clears the hazardous atmosphere.
- When ventilation practices cannot be used, a supplied air respirator must be utilized. Exceptions may be made by the HSM.
- Ventilation equipment must be bonded and grounded prior to operation. Ventilator exhausts must be directed down wind from personnel and/or areas that contain buildings, equipment, etc.

13.10 Isolation

All permitted spaces shall be removed from service and completely protected against the release of energy and material into the space. Means used to isolate the space include but are not limited to the following:

- Lockout/tagout in accordance with approved lockout/tagout procedures;
- Disconnection of mechanical linkages and hazards;
- Blanking, blinding, or misaligning piping; or

- Double blocking and bleeding.

13.11 Equipment Staging

The following equipment shall be available as necessary and inspected prior to use:

- Testing and monitoring equipment;
- Ventilation equipment;
- Communications equipment;
- Personal protective equipment;
- Lighting equipment (caged, waterproof, and low voltage);
- Barriers and shields;
- Ingress and egress equipment;
- Rescue and emergency equipment; and
- Any other equipment required to make safe entry into the space.

In spaces where the potential for flammable or combustible atmospheres exists, equipment shall be non-sparking and intrinsically safe. Electrical systems shall be ground fault circuit interrupter (GFCI) protected.

13.12 Emergency and Rescue Procedures

Based upon the location, hazards, and configuration of the confined space, the entry supervisor shall ensure that the following items are addressed:

- Rescue and emergency services to be used and means of summoning;
- Means of rescuing entrants;
- Rescue and emergency to be used at the site;
- Duties of personnel during emergencies; and
- Prevention of unauthorized entry during rescues.

13.13 Client/Contractor Coordination

To ensure safe and efficient operations when Bhate personnel and client or subcontractor employees will make entry together into the same confined space, the following shall be completed by the entry supervisor:

- Inform Bhate contractors of existing confined spaces;
- Provide Bhate contractors with a copy of this program;
- Inform the contractor of known hazards in the space;

- Provide a list of controls implemented previously;
- Coordinate the entry of the personnel; and
- Debrief the contractor regarding this program and any hazards encountered.

When Bhate personnel are required to perform confined space entry in support of client work, the entry supervisor shall complete the following in addition to the above requirements:

- Obtain any available information on the space from the client;
- Coordinate the entry operations with client personnel; and
- Inform the client of entry hazards encountered.

13.14 Pre-Entry Briefing

Prior to initiating a confined space entry, the entry supervisor shall conduct a safety briefing with the authorized entrants, attendants, and other relevant personnel. The briefing shall cover the following at a minimum:

- HAZCOM (including the signs, symptoms, and modalities of chemical over exposure);
- Physical hazards present;
- All hazard controls;
- Acceptable entry conditions;
- Emergency procedures;
- Rescue procedures;
- Duties of entrants and attendants during routine and emergency operations;
- Frequency and types of air monitoring;
- Communications system and backup to be used;
- Review of work to be accomplished during entry;
- Decontamination procedures (if necessary);
- PPE disposal; and
- Potential emergencies that may occur outside the confined space.

A checklist shall be used to document the pre-entry briefing. At the end of the briefing, all personnel shall be given opportunity to ask questions and review the permit. After review, each authorized entrant and attendant shall print and sign his/her name on the permit. The completed permit shall be posted at the entry site and serve as a roster for monitoring entry and exit of personnel from the space.

13.15 Confined Space Operations

The following practices shall be adhered to during actual confined space entries:

- All confined spaces will be treated as permit-required confined spaces unless the HSM specifically provides an exemption in the SSHP. Prior to entry, a properly executed permit shall be in place and signed by the entry supervisor, attendant, and each entrant.
- The Entry Supervisor shall certify that all equipment is in place and operable, acceptable entry conditions are present, all personnel have been fully briefed, and all personnel have signed the permit prior to initiating entry.
- The work area outside the space shall be barricaded to prevent unauthorized personnel from interrupting the attendants or entering the space. Unauthorized personnel shall be asked to leave the barricaded area. If unauthorized personnel refuse to leave the area, operations shall be terminated.
- Atmospheric monitoring for oxygen, LEL, and toxic air contaminants shall be conducted at the frequency noted on the permit. Results shall be logged on the permit.

No confined space shall be entered without:

- A full body harness;
- A 6' lanyard attached to the harness "D" ring; and
- A lifeline attached to the lanyard with the opposite end secured outside the confined space. The lanyard and lifeline must have double locking rings.

Note: Wristlets may be used in lieu of a full body harness if the body harness is infeasible or creates a greater hazard.

- Top entries with a fall potential greater than 5 feet shall be made with fall protection. Fall protection shall meet the criteria specified in 29 CFR 1926.502(d).
- At least one attendant is required for permit-required entries. The attendant shall maintain visual or voice communications with entrants at all times. Attendants shall not leave their post unless formally relieved by another authorized attendant. The replacement shall be fully briefed by the entry supervisor on all information covered in the pre-entry briefing. Entry supervisors may also serve as attendants.
- When any confined space is entered where the noise level or respirator used prevents voice communication, visual contact between the attendant and entrants must be maintained.
- Metal ladders, hand tools, or other instruments which may spark or cause a source of ignition, are not to be used within confined spaces where any detectable amounts of LEL's are present.
- No burning, grinding, chipping, or other operation which produces heat, sparks, or ignition sources are to be performed without a hot work permit.

- One attendant shall be dressed in the same PPE as the authorized entrants, except for respiratory protection. Attendant supplied air shall be from a different source than that of authorized entrants.
- The entry supervisor shall terminate operations when the work is completed, an unacceptable entry condition is detected, or another emergency inside or outside the space is detected. Authorized entrants shall immediately evacuate upon notification of the termination.
- Attendants may monitor multiple sites only if they are able to maintain continuous visual or voice communications with entrants. If continuous communications cannot be maintained, additional attendants shall be used.
- Attendants shall perform non-entry rescues in emergencies using rescue equipment staged at the site.
- Upon completion of work and exit of the entrants, the permit shall be canceled by the entry supervisor and forwarded to the Site Manager. Permits shall be maintained as a part of the project file.

13.16 Deviation from Program Requirements

Any deviation from this procedure requires the approval of the HSM. Approval for entry into permit-required confined spaces with air purifying respirators will be given if:

- The composition of the hazardous substance(s) in the confined space is well defined;
- The hazardous substance(s) have good warning properties;
- Short-term exposure to the hazardous substance(s) in excess of the recommended exposure limit will not result in serious physical harm;
- The efficiency of the cartridge versus the hazardous substance(s) is known;
- Forced air ventilation is utilized;
- Reliable monitoring methods are available; and
- Monitoring shows airborne concentrations to be less than the recommended exposure level for the contaminants.

13.17 Identification of Confined Spaces

A survey of the sites shall be performed prior to the start of work and documented to identify permit-required confined spaces. All permit-required confined spaces shall be identified with a sign. The sign shall contain the following wording or equivalent:

DANGER - PERMIT-REQUIRED CONFINED SPACE

DO NOT ENTER

13.18 Program Review

The effectiveness of program implementation shall be reviewed by the HSM during site inspections pursuant to using the canceled permits and relevant incident information. The program will be modified, as necessary, on the basis of the HSM program reviews.

13.19 Training

Authorized entrants, attendants, and entry supervisors shall be trained in accordance with 29 CFR 1910.146 (g) including the following topics as appropriate:

- The contents of this procedure;
- Their respective duties;
- CPR/First Aid (attendants and entry supervisors if they are serving as rescue personnel);
- Hazards commonly found in confined spaces;
- Lockout/tagout procedures;
- Isolation practices;
- Ventilation of confined spaces;
- Supplied air respiratory protection and SCBAs;
- Self rescue;
- Methods of communication;
- Atmospheric monitoring; and
- Rescues.

Training shall establish employee proficiency in the skills required for confined space entry and the understanding and knowledge for the safe performance of all duties required by this procedure.

14 EXCAVATION AND TRENCHING

14.1 Purpose

This program provides the requirements for activities involving excavations.

14.2 Scope

These requirements are applicable to all Bhate operations.

14.3 Definitions

14.3.1 Benching

A method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

14.3.2Competent Person

A competent person is one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

14.3.3 Excavation

Any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

14.3.4 Hazardous Atmosphere

An atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

14.3.5 Protective Systems

A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

14.3.6 Sloping

A method of protecting employees from cave-ins by forming sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

14.3.7 Support System

A structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.

14.3.8 Trench

A narrow excavation made below the surface of the ground. In general the depth is greater than the width, but the width of a trench measured at the bottom is not greater than 15 feet. If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet or less, the excavation is also considered to be a trench.

14.4 Discussion

14.4.1 Responsibilities

14.4.1.1 Competent Person

The competent person(s) shall be responsible for:

- Day-to-day oversight of open excavations and trenches
- Conducting soil classifications
- Selection of protective systems
- Conducting daily inspections of open excavations and trenches
- Maintaining all the required documentation in the project files on a daily basis

14.4.1.2 Project Management Personnel

The Site Manager shall be responsible for:

- Ensuring compliance with this procedure
- Providing the necessary resources for compliance with this procedure
- Designating competent personnel in consultation with the HSM

14.4.1.3 Health and Safety Manager

The HSM shall be responsible for:

- Providing oversight on the implementation of the requirements contained in this procedure
- Conducting periodic reviews of open trenches and excavations
- Consulting with the project manager and competent person on excavation issues
- Ensuring required documentation in maintained

14.5 Designation of Competent Personnel

Prior to the start of any excavation work the project manager shall designate a competent person to fulfill the requirements of this procedure.

14.6 General Requirements

The following section provides general requirements governing activities in and around excavation and trenches, as well as the requirements for the selection and use of protective systems.

- Surfaces surrounding open trenches and excavations shall have all surface hazards removed.
- All utilities shall be located and cleared prior to initiating digging. Public or facility utility groups shall be utilized where possible for this purpose. In the absence of either, the HSM shall specify the procedures to be used to clear utilities in consultation with the Site Manager and Project Manager. When the excavation is open, utilities shall be supported and protected from damage. Clearance and support methods shall be documented on the daily inspection checklist.
- Where structural ramps are used for egress they shall be installed in accordance with 29 CFR 1926.651(c) (1).
- Stairways, ladders, or ramps shall be provided as means of egress in all trenches 4-feet or more in depth. Travel distance shall be no more than 25-feet between means of exit.
- Employees exposed to vehicular traffic shall wear reflective traffic vests.
- No employee shall be permitted under loads being lifted or under loads being unloaded from vehicles.
- When vehicles and machinery are operating adjacent to excavations, warning systems such as stop logs or barricades shall be utilized to prevent vehicles from entering the excavation or trench.
- Scaling or barricades shall be used to prevent rock and soils from falling on employees.

- Excavated and loose materials should be kept at least 2 feet from the edge of excavations, preferably more.
- Walkways or bridges with standard railing shall be provided at points employees are to cross over excavations or trenches.
- Barriers shall be provided to prevent personnel from inadvertently falling into an excavation.

14.7 Hazardous Atmospheres

Where atmospheres containing less than 19.5 percent oxygen or other types of hazardous atmospheres may exist, the following requirements shall be implemented.

- Atmospheric testing shall be done prior to employees entering excavations 4-feet or greater in depth.
- Testing methods shall be listed on the daily inspection checklist and results documented daily in field logs.
- Control measures such as ventilation and PPE shall be used to control employee exposure to hazardous atmospheres below published exposure limits.
- Ventilation shall be used to control flammable and combustible vapors to below 10 percent of their LEL.
- Testing shall be repeated as often as necessary to ensure safe levels of airborne contaminants.
- Emergency equipment shall be provided and attended when the potential for a hazardous atmosphere exists. This equipment shall include but not be limited to emergency breathing apparatus, harnesses, lifelines, and basket stretchers. Required equipment will be listed on the daily inspection checklist and reviewed daily.

14.8 Protection from Water Hazards

When water has collected or is collected in excavations and trenches the following requirements shall be applied.

- Employees shall not work in excavations in which water has, or is, accumulating without the use of additional protection such as special support systems or water removal.
- Water removal shall be monitored by a competent person.
- Barriers such as ditches and dikes shall be used to divert runoff from excavations and trenches.
- Trenches shall be re-inspected prior to re-entry after water accumulation due to heavy rainfall or seepage.

14.9 Stability of Adjacent Structures

When excavating or trenching near an adjacent structure the following practices shall be implemented.

- Support systems such as shoring, bracing, or underpinning shall be provided where the stability of buildings, walls, or other structures is endangered by excavation.
- Excavation bases or footings of foundations shall be prohibited unless support systems are used, the excavation is in stable rock, a professional engineer has determined the structure is sufficiently removed from the site as to not pose a hazard, or a Professional Engineer (PE) determines that the excavation shall not pose a hazard to employees due to the structure.
- Support systems shall be used when it is necessary to undermine sidewalks, pavements, and appurtenant structures.
- Surcharge load sources and adjacent encumbrances shall be listed with their evaluation date on the daily inspection checklist.

14.10 Daily Inspections

Inspections shall be performed daily on all excavations, adjacent areas, and protective systems before personnel enter the trench.

14.11 Soil Classification

To perform soil classification, the competent person shall use a thumb test, pocket penetrometer, or shear vane to determine the unconfined compressive strength of the soils being excavated. In soils with properties that change (i.e., one soil type mixed with another within a given area) several tests may be necessary. When different soil types are present the overall classification shall be that of the type with the lowest unconfined compressive strength. Classifications shall result in a soil rating of Stable Rock, Type A, Type B, or Type C in accordance with 29 CFR 1926.652, Appendix A.

14.12 Sloping and Benching

All sloping and benching shall be done in accordance with 29 CFR 1926.652, Appendix B. Selection of the sloping method and evaluation of surface surcharge loads shall be made by a competent person familiar with the requirements contained therein. Sloping and benching methods and specifications shall be listed on the daily inspection checklist.

14.13 Protective Systems

Protective systems are required on all excavations over 5 feet in depth or in excavations less than 5 feet when examination of the ground by a competent person reveals conditions that may result in cave-ins.

Selection and installation of protective systems shall be done in accordance with 29 CFR 1926.652, Appendices C & D, or manufacturers data for shoring and shielding systems. Selection of a protective system shall be made based upon soil classification and job requirements by a competent person. Protective systems used and specifications shall be listed on the daily inspection checklist.

14.14 Training

Competent persons shall have an adequate combination of experience and training to classify soil types and select protective systems as outlined in 29 CFR 1926.652. Training and experience pertaining to qualification as a competent person shall be documented and include the following:

- General safety practices related to working in or near open excavations;
- Inspection requirements and techniques;
- Classification of soils in accordance with 29 CFR 1926.652, Appendix A; and
- Uses, limitations, and specifications of protective systems in accordance with 29 CFR 1926.652.

15 LOCKOUT/TAGOUT

15.1 Purpose

The purpose of this program is to establish the minimum requirements and procedures for performing lockout/tagout on machines and equipment in accordance with 29 CFR 1910.147, Control of Hazardous Energy (Lockout/Tagout).

15.2 Scope

This program applies to all Bhate operations, except as follows:

- Work on cord and plug connected electrical equipment where the plug is under the control of the employee performing the work;
- Hot tap operations; and
- Work involving minor changes and adjustments to equipment during routine operations (such as small tooling adjustments).

15.3 Definitions

15.3.1 Affected Employee

An employee whose job requires them to operate or use a machine or equipment on which servicing, maintenance, or other work is performed under lockout/tagout or whose job requires them to work in an area in which equipment is locked out.

15.3.2 Authorized Employee

A person who locks out or implements a lockout/tagout system procedure on machines or equipment. Authorized and affected employees may be the same person when the authorized employee's duties also include performing work on a machine or equipment upon which lockout/tagout is implemented.

15.3.3 Energized

Connected to an energy source or containing residual or stored energy.

15.3.4 Energy Isolating Device

A mechanical device that may be used to physically prevent the transmission, flow, or release of energy, including but not limited to the following:

- Electrical circuit breakers

- Slide gate
- Disconnect switches
- Piping flanges
- Control switches
- Other similar devices

15.3.5 Energy Source

Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, potential, or other energy.

15.3.6 Lockout

The placement of a lockout device and tag on a lockout device ensuring that the energy isolation device and equipment cannot be operated until the device is removed.

15.3.7 Lockout Device

A device that physically controls the configuration of an energy isolation point. Lockout devices include but are not limited to the following:

- Locks
- Chains
- Valve covers
- Circuit breaker hasps
- Blind flanges
- Slip blinds
- Multiple lock hasps

15.3.8 Supervisor Lock

A lock installed by an authorized supervisor for the purpose of maintaining control of a machine or piece of equipment for a period greater than one work shift.

15.4 Discussion

15.4.1 Responsibilities

15.4.1.1 Authorized Employees

Authorized employees shall lockout and tag all energy isolation devices which are required to be locked out by this procedure. The employee shall complete all permits and tags in accordance with instructions and shall remove their locks and tags and return them at the end of their shift or the end of the procedure.

15.4.1.2 Project Management Personnel

Supervisors shall ensure proper implementation of the lockout/tagout procedure, providing the training required in this procedure to craft employees, approval of permits, maintenance of personal locks, and a log of lock assignments. In group lockout procedures the supervisor shall lock and tag all the appropriate energy isolation devices and deposit his/her key in the lockbox.

15.4.1.3 Health and Safety Manager

The HSM is responsible for oversight of the lockout/tagout program and conducting periodic inspections to ensure this procedure is effectively implemented. The HSM may also implement lockout/tagout procedures as required.

15.5 General Requirements

Following are the steps to be followed in preparing for, applying, and releasing a machine or piece of equipment from lockout. These steps shall be completed, in order, using the corresponding permit. While work is being performed under the lockout, a copy of the completed permit shall be posted at the equipment controls or work area as appropriate.

1. Complete the general information in Section A of the permit
2. Identify Isolation Points

   The first step required to isolate a piece of equipment is to identify the sources of hazardous energy present. To identify the sources, the authorized employee shall complete the following steps:

   - Survey the equipment and related schematics, blueprints, or as-builts, if available, for hazardous energy sources;
   - Identify the isolation points and device positions for controlling each source of hazardous energy; and,
   - Identify the isolation method to be used on each source.

The above information shall be documented in Section B of the Lockout/Tagout Permit as each point is identified.

3. Notifications

   Prior to applying a lockout, the authorized employee shall notify affected employees of the equipment to be locked out and sign Section C of the Lockout/Tagout Permit on the "Notifier" line.

4. Equipment Shutdown

   Shut down the equipment or place into the desired configuration using normal operating procedures. The authorized employee shall sign Section C of the Lockout/Tagout Permit on the "Shutdown by" line.

5. Equipment Isolation

   To apply a lockout to a piece of equipment, complete the following steps:

   - Place each energy isolation device into a position that will prevent the transmission of hazardous energy; and,
   - The authorized employee shall lockout devices to each isolation point and control the key for each lock at all times. Only one key is permitted per lock.

   Complete Section D of the permit as each device is placed and sign the "Isolator" line in Section C.

   Note:

   - Any lockout device not containing an integral locking mechanism must be used in conjunction with a keyed lock.
   - Any energy isolation point not capable of being locked out must be controlled physically through such means as removal of handles and disconnecting.

6. Release of Stored Energy

   After the equipment has been locked and tagged as required in Section D, all remaining stored energy must be released. Methods for the release of stored energy include, but are not limited to the following:

   - Discharge and grounding of capacitors;
   - Bleeding pressure from vessels and lines; and,
   - Releasing mechanical sources of energy to engage blocks.

   If stored energy has the potential to re-accumulate, verification of isolation shall continue until work is complete. After releasing stored energy, complete Section E of the permit.

7. Lockout/Tagout Verification

   After completing the lockout of the desired piece of equipment, the effectiveness of the lockout must be verified by the authorized employee by attempting to operate the machine. After attempting to operate the machine, sign Section C of the permit on the "Verifier" line.

8. Performance of Work

   After verifying and receiving the supervisor's approval signature, work may be performed on the equipment which was locked/tagged.

9. Lockout/Tagout Removal

   After work has been completed, the following steps shall be followed to release equipment from lockout/tagout:

   - The area affected by the lockout shall be inspected to ensure that releasing the machine does not present a hazard to people and property;
   - Lockout devices and tags shall be removed;
   - Isolation devices shall be returned to their operating positions;
   - The equipment started; and
   - Affected employees shall be notified of the release.

   Section F of the permit shall be completed as the equipment is returned to service.

15.6 Testing/Positioning

When necessary to interrupt lockout/tagout for testing or repositioning, the steps contained in Section 19.5 shall be followed.

15.7 Group Lockouts

When multiple people are scheduled to work on a system, the following group lockout procedure should be implemented as follows:

- The Site Manager shall place their lock on the energy isolation device(s) using a multi-lock hasp
- Authorized employees shall place their individual locks on the multi-lock hasp
- When the group has completed their work, the supervisor shall verify all employee locks have been removed before the supervisor removes his/her lock

15.8 Tagout

The use of tags without locks is prohibited, except in those cases where it is physically impossible to attach a locking device to an isolation point. When it is necessary to use tags without locks the following shall be completed.

- The isolation point shall be placed in the correct position to prevent the flow of energy;
- The device shall be physically disconnected;
- A tag shall be placed on the disconnected device; and
- Employees shall be warned not to tamper with the tag or isolation point.

15.9 Equipment-Specific Lockout/Tagout Procedures

As Bhate does not normally perform lockouts of machinery on a repetitive basis, the lockout/tagout permit contained in the Attachments is designed for initial and one-of-a-kind lockouts. Should it become necessary to repetitively lockout the same piece of equipment, specific procedures and permits for the equipment shall be developed.

Information contained in the equipment-specific procedure and permit should be the same as the information in the permit in the Attachments. The procedures shall be generated by trained and knowledgeable project personnel and be reviewed and approved by the HSM. Equipment-specific procedures are not required when all of the following conditions are present:

- The machine has no potential for stored energy or the re-accumulation of energy after shutdown; and
- The equipment has a single, readily identifiable, and isolated source of energy; and
- Isolation and lockout of the source will completely de-energize and deactivate the equipment; and
- The machine is locked out and isolated from that energy source during servicing and maintenance; and
- A single lockout device will achieve a locked-out condition; and
- The servicing or maintenance does not create a hazard to other employees.

15.10 Shift Changes

When necessary to maintain the status of a locked out machine or device past the end of the shift when the lockout was initially installed, the following procedures shall be adhered to:

- The incoming authorized employee shall place their lock hasp on the lockout point and complete a new permit.

- The outgoing employees shall remove their lock(s) after the new lock(s) are applied.
- If multiple shifts are not used, the initial locks may be left in place until the following day or until the equipment is released from lockout/tagout.
- The new shift supervisor shall sign the permit before work is begun on the new shift. The last supervisor whose name is on the lockout/tagout permit is responsible for all activities related to the work activity.

15.11 Failure to Clear Locks

If a person should fail to clear a lockout and their lock remains in place, the supervisor will attempt to contact the person who applied the lock and resolve the issue.

If the person cannot be contacted, the supervisor will investigate the situation and determine that removal of the lock will not create a hazard in the work zone. The supervisor will then verify that the work zone is clear, and blocking devices have been removed and the system has been restored to the normal configuration. The supervisor will then cut the lock off and restore energy to the system.

15.12 Subcontractors

The supervisor shall be familiar with the nature of any subcontractor work onsite that may involve hazardous energy and assure that they follow work practices that are at least as strict as this procedure.

For any lockout/tagout requirements, the supervisor shall review and approve all subcontractor work set up, apply his locks to the scheme, and sign the appropriate lockout/tagout procedure checklist.

15.13 Periodic Inspections

Periodic inspections shall be completed during the monthly inspections by the HSM or qualified designee to ensure that the lockout/tagout program is being effectively implemented. As a minimum the following shall be done:

- Existing lockouts will be reviewed for effectiveness;
- Permits for each existing lockout shall be reviewed for adequacy;
- Incident reports and past permits shall be reviewed to determine if programmatic deficiencies exist;
- Corrections to the system will be made as warranted; and,
- Results will be logged in the health and safety logbook.

15.14 Training

Following are the training requirements for various personnel involved with or affected by lockout/tagout.

- Authorized Employees shall receive training in the following prior to being allowed to use lockout/tagout procedures:
  - Recognition of hazardous energy sources;
  - Types and magnitudes of energies available at the site;
  - Methods and means needed for energy isolation and control; and
  - The requirements of this procedure and 29 CFR 1910.147.
- Affected Employees shall be instructed in the following:
  - Purpose of the lockout/tagout program;
  - Use and requirements of this procedure and 29 CFR 1910.147;
  - Prohibitions of restarting or tampering with equipment that has been locked out; and
  - Prohibitions of tampering with locks and tags installed on equipment.

16 HOT WORK

16.1 Purpose

The purpose of this program is to establish a method to prevent fires as a result of welding and hot work.

16.2 Scope

This document applies to all welding, cutting, open flame, grinding, or other spark-producing activities on Bhate project sites.

16.3 Discussion

16.3.1 Responsibilities

16.3.1.1 Project Management Personnel

Supervisors are responsible for:

- Ensuring implementation of the program requirements,
- Signing and issuing hot work permits, and
- Maintaining files of hot work permits.

16.3.1.2 Health and Safety Manager

The HSM is responsible for:

- Providing oversight for program implementation
- Assisting with training of site personnel on program requirements

16.4 Cutting, Welding, Open Flame, and Flame/Spark-Producing Equipment

If the work involves cutting, welding, or other flame/spark-producing equipment, the supervisor shall examine the area where the work is to be done and shall ensure the following:

- Sprinklers, where provided, are in commission and will not be taken out of service until this work has been completed.
- There is no flammable lint, dust, vapors, and liquids or un-purged tanks or equipment previously containing such materials in the areas.
- This work will be confined to the area or equipment specified in the permit.

- Floors and surroundings have been swept clean, combustible floors and construction formwork (if any) are wet down.
- A suitable fire extinguisher is available.
- Welding and cutting is performed by a qualified person.
- Proper PPE is being worn by persons performing the hot work.
- All combustibles have been located 50 feet from the operation and the remainder protected with a metal guard, or flame-proofed curtains or covers (not ordinary tarpaulins).
- All floor and wall openings within 40 feet of the operations have been covered tightly.
- A fire watch has been assigned to watch for dangerous sparks in the area, as well as in floors above and below, and the fire watch stays in the area for 1 hour after the end of the activity.
- Arrangements have been made for a patrol of the area, including floors above and below, during any lunch or rest period. Hot work permits are good for one shift only.
- Flame or spark-producing equipment to be used has been inspected and found in good repair.
- The hot work permit has been completed.

16.5 Welding in Confined Spaces

Confined spaces must be adequately ventilated with clean air to prevent the accumulation of toxic materials or possible oxygen deficiency during welding or cutting in confined spaces. In circumstances where it is impossible to provide such ventilation, an air-supplied respirator shall be used.

When welding or cutting is being performed in a confined space, welding machines and cylinders shall be left outside. Heavy portable equipment mounted on wheels shall be securely blocked to prevent accidental movement. In addition to a hot work permit, all the requirements of Confined Space Entry shall be followed, including the completion of a confined space entry permit.

16.6 Welding on Systems that Contain or Have Contained Flammable Liquids

The following precautions shall be taken when welding/cutting on systems that contain or contained flammable liquids.

- The part of the system being worked on must be isolated from other parts of the system containing flammable liquids or vapors. Isolation may be accomplished by plugging (i.e., using approved procedures and equipment), blanking, or removing from the system. Other approaches must be reviewed by the HSM.

- The isolated system must be purged, ventilated, or cleaned before welding, cutting, or brazing may be performed.
- Before purging, written calculations must be done to determine the time required to purge a certain size system with a given flow rate of an inert gas.
- After ventilation or cleaning a system, a LEL reading must be taken in the area to be worked to ensure that there are no residual flammable vapors before welding is conducted. A reading of 10% of the LEL is considered acceptable.
- When a part of a system (i.e., a pipe) is worked in-place, protection must be accomplished by a combination of purging and blanking-off or cleaning and blanking-off.
- A hot work permit must be completed.

16.7 Recordkeeping

Completed hot work permits shall be shall be maintained as part of the project file.

16.8 Training

All persons involved in welding/hot work activities shall receive training on the requirements of this program.

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17 THERMAL STRESSORS

17.1 Purpose

The purpose of this program is to communicate to employees the inherent hazards posed by workers working in hot or cold environments and the precautions they should take to protect themselves from the associated hazards.

17.2 Scope

This program applies to all Bhate employees, operations, and subcontractors.

17.3 Discussion

17.3.1 Heat Stress

When the body temperature rises, the body seeks to dissipate the excess heat. Wearing PPE can impair the ability of the body to rid itself of excess heat as well as add to the metabolic workload of the worker. High relative humidity will also impair the body's ability to lose heat by evaporative cooling. The major disorders due to heat stress are heat rash, heat cramps, heat exhaustion, and heat stroke. The following factors affect an individual's ability to tolerate heat: physical fitness, acclimatization, age, degree of hydration, weight, alcohol and drug use, presence of infection, sunburn, diarrhea, and chronic disease. The symptoms and recommended prevention for each are listed below:

- Heat rash - may result from continuous exposure to heat or humid air and is aggravated by the chafing action of clothes. Signs and symptoms include localized reddening of the skin and a decreased ability to tolerate heat.
- Heat cramps - painful spasms that may occur in the muscles of workers who have perspired profusely in the heat. If this occurs work should be stopped and the worker should be supplied with fluids.
- Heat exhaustion - characterized by extreme weakness or fatigue, dizziness, nausea, and headache. In serious cases, a worker may vomit or lose consciousness. The skin is clammy and moist, complexion pale or flushed, and the body temperature can be normal or slightly higher than normal. Treatment consists of rest in a cool place and replacement of body water lost by perspiration. Mild cases may recover spontaneously with this treatment. Severe cases may require care for several days. There are no permanent effects.
- Heat stroke - caused by the breakdown of the body's heat regulating mechanism. The skin is very dry and hot with a red or bluish appearance. Unconsciousness, mental confusion, or convulsions may occur. Heat stroke is a medical emergency requiring immediate medical intervention to prevent permanent brain damage or death. The person should be moved to

a cool place and medical aid summoned. Body heat should be reduced artificially by soaking the person's clothes with water.

The following steps will be taken to reduce the potential for heat stress:

- Acclimate the body to the work environment. This may take up to a week of progressively more intense work in the hot environment.
- Adjust work schedules according to monitoring requirements. Enforce work slowdowns if necessary.
- Rotate personnel or increase staff so that workload is decreased.
- Perform work during the cooler hours of the day if possible.
- Provide a shaded or air conditioned shelter for rest breaks.
- Encourage workers to maintain a normal weight and optimal physical fitness.
- Drink cool water to replace body fluids lost during sweating. **Site personnel taking prescribed heart and/or high blood pressure medication may require electrolyte replenishing liquids to combat heat stress. It is recommended that each individual taking prescribed heart and/or high blood pressure medication consult his personal physician prior to consuming these drinks.**
- Wear personal cooling devices.
- Wear supplied air suits or respirators equipped with a vortex tube that cools the air being supplied.
- Train personnel to recognize and respond to signs and symptoms of heat stress. Inform supervisors to allow workers complaining of heat disorders to rest or seek medical attention depending on severity.

The ambient temperature of the environment should be taken with a dry bulb thermometer, in the shade. When the temperature is above 70°F (21°C) workers should be monitored for heat stress. Pulse measurements will be taken and the work cycle time adjusted as needed. Count pulse rate during a 30-second period as early as possible in the rest break. If the heart rate exceeds 110 beats per minute at the beginning of the rest break, shorten the next work cycle by one-third and keep the rest break the same. If the heart rate still exceeds 110 beats per minute at the next rest break, shorten the following work cycle by one-third.

Table 17-1. Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers

Adjusted Temperature*	Normal Work Ensemble**	Impermeable Work Ensemble
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5 - 90°F (30.8 - 32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5 - 87.5°F (28.1 - 30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5 - 82.5°F (25.3 - 28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5 - 77.5°F (22.5 - 25.3°C)	After each 150 minutes of work	After each 120 minutes of work

+Work levels of 250 kilocalories per hour

*Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 x % sunshine). Measure the air temperature (ta) with a standard mercury in glass thermometer, with the bulb shielded from radiant heat. Estimate the percent sunshine by judging what percent time the sun is not covered by clouds thick enough to produce a shadow (100% sunshine = no cloud cover and a sharp, distinct shadow; 0% sunshine = no shadows).

**A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

17.3.2 Cold Stress

Personnel working outdoors in temperatures at or below freezing or in warmer temperatures but with damp or wet conditions are susceptible to cold related injury. Cold related injuries vary in severity with potential results of permanent tissue damage and/or death.

Extreme cold for a short time may cause injury to the surface of the body or result in profound generalized cooling. Areas of the body that have a high surface-area-to-volume ratio, such as fingers, toes, and ears, are the most susceptible. For exposed skin, continuous exposure should not be permitted when the air speed and temperature results in an equivalent chill temperature of -32°C (-25.6°F). Superficial or deep local tissue freezing will occur only at temperatures below -1°C (30.2°F) regardless of wind speed. It is imperative that workers who become immersed in water or whose clothing becomes wet be immediately provided a change of clothing and treated for hypothermia, when air temperatures are 2°C(35.6°F) or less

Localized injuries resulting from cold are included in the generic term “frostbite.” Several degrees of damage are possible. Frostbite of the extremities can be placed into the following categories:

- Frost nip or incipient frostbite - characterized by initial reddening of the skin, then changing to white. No freezing of tissue occurs.

- Superficial frostbite - characterized by skin that presents a waxy or white appearance that is firm, yet resilient to the touch. This condition affects the skin and the tissue just beneath the skin. The skin turns purple and may tingle and burn during warming.
- Deep frostbite - characterized by cold, pale, and solid tissue. This condition indicates an extremely serious injury and can result in permanent tissue loss.

First aid for frostbite includes the following:

- Move the person into a warm area.
- Warm the affected area with body heat or warm (not hot) water.
- Do not rub or massage the affected area.
- Seek medical attention.

Since prolonged exposure to cold air or immersion in cold water at temperatures well above freezing can lead to dangerous hypothermia, whole body protection must be provided. Adequate insulating dry clothing to maintain core temperatures above 36°C (96.8°F) must be provided to workers if work is performed in air temperatures below 4°C (40°F). Wind chill cooling rate and the cooling power of air are critical factors. (Wind chill cooling rate is defined as heat loss from a body expressed in watts per meter squared which is a function of the air temperature and wind velocity upon the exposed body.) The higher the wind speed and the lower the temperature in the work area, the greater the insulation value for the protective clothing required.

To prevent the onset of hypothermia, workers should be protected from exposure to cold so that the deep core temperature does not fall below 36°C (96.8°F). Lower body temperatures will very likely result in reduced mental alertness, reduction in rational decision-making, or loss of consciousness with the threat of fatal consequences. Symptoms of systemic hypothermia (by exposure to freezing or rapidly dropping temperature) normally progress through five stages:

1. Shivering;
2. Apathy, listlessness, sleepiness, and sometimes rapid cooling of the body to less than 95°F;
3. Unconsciousness, glassy stare, slow pulse, and slow respiratory rate;
4. Freezing of the extremities; and
5. Death.

First aid for hypothermia includes the following:

- Move the person into a warm area.
- Remove any wet clothing and begin to warm the center of the body (torso) with electric blanket if available or body heat under dry blankets, clothing, towels, or sheets.
- Warm, nonalcoholic liquids may be given to a conscious person.

- Seek medical attention.

If work is performed continuously in the cold at an equivalent chill temperature (ECT) or below -7°C (19.4°F), heated warming shelters should be made available nearby. Workers should be encouraged and allowed to utilize the shelters at regular intervals throughout the work period depending on the severity of the climatic conditions. Inside the heated shelter, the employees' outer layer of clothing should be removed and inner layers loosened to promote the evaporation of perspiration or the worker should change into dry clothing before returning to work.

Work in cold environments does not diminish the need for proper hydration. Warm sweet drinks and soups should be provided in addition to water to facilitate warming and maintain proper hydration. The intake of caffeinated drinks should be limited due to the potential diuretic and circulatory effects.

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18 FALL PROTECTION

18.1 Purpose

The purpose of this program is to prevent injuries due to falls from elevated work surfaces and to comply with OSHA fall protection standards in 29 CFR 1926, Subpart M.

18.2 Scope

This document applies to all work from elevated surfaces on Bhate project sites.

18.3 Definitions

18.3.1 Competent Person

A person possessing the skills, knowledge, experience, and judgment to perform assigned tasks or activities satisfactorily.

18.3.2 Dangerous Equipment

Dangerous equipment means equipment which, as a result of form or function, may be hazardous to employees who fall onto or into such equipment. Examples provided in Subpart M include tanks, degreasing units, machinery, and electrical equipment.

18.3.3 Hole

Hole means a gap or void 2 inches or more in its least dimension, in a floor, roof, or other walking/working surface.

18.3.4 Opening

An opening means a gap or void 30 inches or more high and 18 inches or more wide through which employees can fall to a lower level.

18.3.5 Personal Fall Arrest System

A personal fall arrest system consists of an anchorage, connectors, body harness, and may include a lanyard, deceleration device, lifeline, or suitable combination of these. Body belts are not permitted in personal fall arrest systems on Bhate projects.

18.3.6 Walking/Working Surface

A walking/working surface is any surface, whether horizontal or vertical, on which an employee walks or works, including but not limited to floors, roofs, ramps, bridges, runways, formwork, and concrete reinforcing steel, but not including ladders, vehicles, or trailers on which employees must access to perform their job duties.

18.4 Discussion

18.4.1 Responsibilities

18.4.1.1 Project Management Personnel

Site Managers have the responsibility to ensure that fall protection is provided as required by this program.

The Site Manager is responsible for providing fall protection training for all Bhate site personnel and monitoring compliance with this program.

18.4.1.2 Health and Safety Manager

The HSM will audit implementation of this program as part of field inspections.

18.5 General Requirements

Employees shall only be allowed to work on walking/working surfaces which have the strength and integrity to support employees safely. Walking/working surfaces for this requirement include the edges of trenches.

Employees performing work on a walking/working surface with an unprotected side or edge which is 6 feet or more above a lower level shall be protected from falling by the use of guardrail systems, safety net systems, or personal fall arrest systems.

For roof work on low-slope roofs, work on steep roofs, and work near wall openings, fall protection provisions as described in 29 CFR 1926.501(b) shall be utilized.

18.6 Hoist Areas

Employees in a hoist area shall be protected from falling 6 feet or more to lower levels by guardrail systems or personal fall arrest systems. If guardrail systems are removed to facilitate the hoisting operations and the employee must lean out over the edge of the platform to guide the materials being hoisted, then a personal fall arrest system shall be used.

18.7 Excavations

The edge of an excavation 6 feet or more in depth shall be demarcated by guardrail systems, fences, or barricades when the excavation is not readily seen. The measures described above or covers shall be used for wells, pits, shafts, or similar excavations.

The Site Manager and HSM shall determine when employees must use personal fall arrest systems at the edge of an excavation 6 feet or more in depth. The decision shall be based on the condition of the soil at the edge of the excavation, i.e., slippery, stable, etc., and the nature of the work at the edge of the excavation.

18.8 Dangerous Equipment

Each employee working 6 feet or less above dangerous equipment shall be protected by guardrail systems or by equipment guards or if working at more than 6 feet from guardrail systems, personal fall arrest systems or safety net systems should be used.

18.9 Guardrail Systems

Guardrail systems must meet the criteria specified in 29 CFR 1926.502(b).

18.10 Personal Fall Arrest Systems

Personal fall arrest systems shall meet the criteria specified in 29 CFR 1926.502(d).

18.11 Protection from Falling Objects

Toeboards, when used as falling object protection, shall meet the criteria specified in 29 CFR 1926.502(j); shall have a minimum of 3.5 inches from their top edge to the level of the walking/working surface; and no more than a 0.25 inch clearance from the bottom edge to the walking/working surface.

18.12 Other Fall Protection Requirements

Whenever a fall hazard of 6 feet or more exists on a Bhate jobsite, 29 CFR 1926, Subpart M shall be consulted for applicable requirements. If Subpart M does not specifically address the fall hazard, then the Site Manager shall determine if fall protection measures are required.

18.13 Training

18.13.1General

All site personnel who might be exposed to fall hazards on a Bhate jobsite shall receive training by a competent person. The training shall be conducted at the time of the site orientation. The competent person must meet the applicable requirements of 29 CFR 1926.503(a) (2). The training shall include enabling the employee to recognize the hazards of falling and the procedures to be followed in order to minimize fall hazards.

18.13.2 Retraining

Retraining shall be conducted when changes occur in the workplace which present a new fall hazard, when fall protection systems or equipment is changed, or when it appears that the employee has not retained the requisite understanding or skill regarding the fall hazards or protective measures.

18.13.3 Certification of Training

Certification of training or retraining shall include the name of the employee, the date of the training, the content of the training, and the signature of the person who conducted the training.

Training certification shall be maintained as part of the project file.

18.13.4 Previous Training

Bhate shall not rely on fall protection training from other employers to meet the training requirements of this program unless the Site Manager prepares a new certification record which indicates the date it was determined that the prior training was adequate and why it was considered adequate.

19 CRANES/LIFTING EQUIPMENT

Any piece of equipment used for lifting materials or personnel shall be used and maintained in strict accordance with the manufacturer's recommendations and applicable regulations. All equipment shall have load limits visibly posted on the equipment. Only qualified operators shall be permitted to operate lifting equipment. All equipment shall be inspected and certified in accordance with the manufacturer's recommendations and shall be inspected prior to use onsite, daily. Crane operations shall be conducted in accordance with 29 CFR 1926.550, Cranes and Derricks. Rigging of loads being lifted by cranes shall comply with the requirements of 29 CFR 1926.251, Rigging Equipment for Material Handling.

All critical lifts require a specific plan reviewed and approved by the Project Manager or Site Manager prior to the lift occurring. Critical lifts are defined as lifts for which any of the following conditions exist:

- Any lift of 30,000 pounds or more;
- The weight of the lift exceeds 75 percent of the crane's rated capacity in the configuration that will be used during the lift;
- Lifts for which the path of travel is out of the operator's view;
- Lifts made with more than one piece of lifting equipment;
- Lifts involving non-routine or difficult rigging arrangements;
- Hoisting of personnel with a crane or derrick;
- Lifts involving high value items where damage would result in an unacceptable financial or production loss; or,

Any lift which the lifting equipment operator believes should be considered critical.

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20 HEAVY EQUIPMENT OPERATION

Use and operation of construction equipment such as motorized vehicles, heavy equipment, water trucks, and haul trucks (excluding passenger vehicles and pickup trucks) shall conform to the requirements of 29 CFR 1926 Subpart O and Subpart W and shall meet the following requirements:

- Onsite equipment shall meet the requirements of all relevant OSHA standards.
- Equipment will be inspected by the SSHO or designee upon arrival at the project site. The inspection will include a check for cleanliness, fluid leaks, and confirming installation of appropriate safety devices, including seat belts, headlamps and brake lights, backup alarms, and rollover protection. Results of the inspection will be documented on an inspection checklist. Deficiencies found shall be corrected before use. The HSM will randomly check compliance with equipment inspection requirements.
- Operators shall complete inspections on all construction equipment prior to use each day to ensure that parts, accessories, and equipment are in safe operating condition and free of apparent damage. The inspection shall be documented and should include, as a minimum, basic equipment and motor vehicle components and systems such as service brakes, parking brakes, emergency brakes, horn, steering mechanisms, operating controls, windshields, windows, mirrors, tires, lights, seat belts, headlamps, brake lights, rollover protection structures, backup alarms, and evidence of fluid leaks. Deficiencies shall be noted and corrected prior to use. Copies of the inspections shall be maintained onsite and readily available for inspection. Vehicles are to be taken out of service if they do not pass inspection.
- Operators of over-the-road vehicles such as haul trucks and water trucks on project sites must possess a valid commercial driver's license (CDL) if a CDL is normally required when operating such vehicles on public roads.
- The Subcontractor shall obtain copies of valid and relevant vehicle operator licenses such as a CDL (or have a system in place to verify possession of current licenses) and/or training records.
- Construction equipment used for demolition or materials handling shall be equipped with a demolition cage, wire screen, or equivalent structures to prevent materials or debris from breaking cab windows where the potential for window breakage hazards exists.
- Construction equipment shall be equipped with operable audible backup alarms.
- When equipped, construction equipment shall have operable visual backup indicators.
- Skid steer equipment (e.g., Bobcats) shall not be used on elevated surfaces without adequate barriers and approval from the SSHO.

- Eating, drinking, smoking, and using cellular telephones (including the use of a hands-free feature in conjunction with a cellular phone) is prohibited when operating construction equipment.
- Construction equipment operators shall have the experience, skills, and knowledge to safely operate the equipment to be used. The Site Manager or designee shall:
- Evaluate each operator's skills prior to unsupervised operation of the vehicles or equipment.
- Evaluate each operator's experience relative to the job task(s).
- Over-the-road haul vehicles shall have documentation of annual inspections in accordance with Department of Transportation requirements given in 40 CFR 396, Subpart B, Appendix G, Minimum Periodic Inspection Standards.
- Haul trucks shall not be loaded beyond the truck/trailer manufacturer's recommendations.
- All construction equipment is to have documented preventive maintenance compliant with the manufacturer's minimum recommendations. The preventive maintenance program is to be implemented by a trained/qualified individual and preventive maintenance records shall be maintained onsite. For rental equipment, copies of recent preventive maintenance records shall be obtained from the vendor and maintained onsite while the equipment remains onsite.
- Work shall not be conducted on heavy equipment from heights greater than 6-feet without proper manlifts, work platforms, fall protection, or an approved AHA if fall protection is not required.
- Operators shall not jump to the ground from vehicle ladders, cabs, or platforms.
- Equipment shall be operated on grades in accordance with the equipment manufacturer's recommendations.
- Whenever the equipment is parked, the parking brake shall be set. Equipment parked on inclines shall have the wheels chocked and the parking brake set.
- Chocking is required whenever a worker is under any part of any construction equipment or associated loads and during decontamination or cleaning processes (unless a written AHA is in place requiring control measures that provide equivalent protection).
- Chocking is not required for tracked equipment or rubber-tired equipment if the parking brakes are set and components such as blades, buckets, outriggers, etc. are fully lowered to the ground and the equipment is completely stabilized.
- Equipment shall be parked in a zero energy condition (blades, dump bodies, buckets, load, etc.) so that there is no retained energy remaining in the equipment.
- Onsite equipment maintenance operations that pose a hazard to personnel shall be addressed in the SSHP or AHA.

- Personnel in areas in which heavy equipment is being operated shall wear high visibility traffic safety vests and make eye contact with the operator before approaching.

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21 MATERIALS HANDLING

21.1 Purpose

The purpose of this procedure is to outline materials handling guidelines for the prevention of injuries and damage to property and goods.

21.2 Manual Lifting

In order to safely lift and handle materials, utilize the safe lifting techniques outlined below that are designed to prevent injuries to the back and other body extremities.

- Squat down close to the object while keeping your feet apart, back straight, and chin tucked.
- Test the weight of the object by lifting or tilting a corner.
- If the object is too heavy:
  - Divide into smaller loads,
  - Get someone to help, or
  - Use a mechanical device.
- Grasp object firmly (wear gloves where appropriate).
- Lift while keeping the object close to the body while straightening the legs and tightening the stomach and buttock muscles.

When lifting:

- Never twist or jerk the body.
- Avoid lifting to the side.
- Avoid overextending and reaching too far.

To safely carry an object:

- Select a clear route of travel and maintain an awareness of surface conditions.
- Keep a firm grip on the object and carry it close to the body.
- Do not allow the load to obstruct your view.
- Do not twist the body; change direction by moving the feet.

To safely set an object down:

- Face the spot where the object is to be placed.
- Squat down, keeping the back straight.
- Lower the object, first onto one corner or onto a support to avoid finger injuries.
- Lower the object into final position keeping the fingers out of the way.

21.3 Material Storage Practices

- SDSs will be available to employees handling hazardous substances.
- Store materials in an orderly fashion and allow adequate access for re-handling.
- Chock round items so they cannot roll. Stack loose items no higher than 7-feet and cross tie loose items such as bags or blocks.
- Place pallets under materials for easier re-handling and for more stable stacking.
- Keep banding straps in place during storage.
- Never place a heavier material on a weaker material.
- Materials should be stacked so as to prevent toppling, sliding, or rolling. In general, heavy materials should be stored in such a manner as to be accessible when needed.
- Whenever possible, boxes should be placed on the side with the greatest surface area.
- Nails, ends of wire, or bands of metal must not be left projecting from boards, boxes, packing crates, etc. Nails should be removed from loose lumber or have points bent down, or the lumber should be disposed of so as not to pose a hazard.
- Particular caution should be exercised when packing or unpacking glass, porcelain, and other fragile or sharp objects.
- All access areas (e.g., walkways, stairways, exits, fire escapes, fire fighting equipment) must be kept clear and unobstructed of material storage.
- Unpacked material and equipment must be stored in authorized locations.
- Boxes and crates that are used to reship equipment must be closed and stored in approved locations or storerooms.
- Combustible material such as boxes and cardboard should be disposed of daily outside of buildings in approved locations.
- Plastic and foam types of packing should be removed immediately or stored in an approved fire rated storage area.
- Compressed gas cylinders must be kept to a minimum, stored upright in a well ventilated area at least 20 feet from combustibles and secured with a chain or approved cable.

Conduct material storage and handling in accordance with the requirements of 29 CFR 1926 Subpart H, Materials Handling, Storage, Use, and Disposal.

21.4 Hand Trucks

The use of a hand truck may be necessary to safely move heavier loads, however, the safe use of hand trucks requires the following practices:

- Hand trucks must be maintained in safe operating condition.

- Load trucks with weight over the wheels.
- Push, do not pull, when transporting loads.
- Push so as not to create a tripping or obstruction hazard.

21.5 Mechanical Lifting Devices

The use of mechanical lifting devices or aids (forklifts, palletjacks, and hoists) where lifting "heavy" or awkwardly packaged materials has the potential to injure employees. Use of such devices requires adherence to the following practices.

21.6 Inspection and Testing

A daily inspection of all operating controls must be conducted in accordance with the manufacturer's operating instructions and documented using the "Forklift/Palletjack Operator's Daily Inspection Checklist" form. Each operator is responsible for the safety inspection of the equipment prior to use and must ensure that all nameplates and caution and instruction markings are in place and legible. Defective equipment must be tagged and removed from service until all defects are repaired.

Maintenance records must be available to allow the operator to check on the servicing of the equipment in case of questions.

21.7 Work Practices

- Only trained personnel will be allowed to operate forklifts/palletjacks.
- Proper personal protective equipment such as safety glasses, hard hats, and proper footwear must be worn.
- The rated load capacity of the equipment must not be exceeded.
- The operator must consider load dimensions that could affect capacities or operation.
- If the forklift is equipped with seatbelts, they must be properly worn.
- When moving palletized loads, the operator must inspect the pallet for excessive wear or defects before loading or unloading the pallet.
- The operator must ensure that dockboards or bridgeplates are secured if used during loading/unloading operations.
- The rated capacity of dockboards or bridgeplates must not be exceeded.
- Trucks and trailers must be secured from movement during loading/unloading operations with chocks or other appropriate equipment.
- Pedestrians must not be allowed to pass under any raised load.
- Forklifts and palletjacks must have a clearly audible warning device (e.g., horn, buzzer, etc.).

- The parking brake must be set and the key removed from the ignition when the equipment is unattended and forks must be lowered to the ground.
- When operating a palletjack, stand or walk to the side when the palletjack is moving forward.
- Forklifts operating in areas where flammable gases or vapors, combustible dusts, or ignitable fibers may be present in the atmosphere must be approved for such locations with a tag showing such approval posted on the lift.
- Directional lighting must be provided on forklifts that operate in areas with less than 2 foot-candles per square foot of general lighting.
- Forklifts with internal combustion engines, operated in buildings or enclosed areas, must be checked to ensure that the operation of vehicles does not generate dangerous concentrations of gases.
- Electric equipment is recommended for indoor/enclosed areas.

21.8 Battery Charging Requirements for Electric Vehicles

- Battery charging must be performed in an area designated for that purpose and adequately ventilated for dispersal of gases from charging batteries.
- Emergency eyewash/shower facilities must be provided for quick drenching or flushing of the eyes and body in the event of splashing with electrolyte.
- Materials must be provided for neutralizing spilled electrolyte.
- Smoking is prohibited in the vicinity of the charging area.
- Vehicles must be properly positioned with the brake applied and the key switch turned OFF before charging.
- Vent caps must be in place and functioning.
- Care should be taken to avoid direct contact with the charger housing after the connection has been made.
- Before disconnecting the charger, ensure the charger is turned OFF.

21.9 Refueling Guidelines for Propane Powered Forklifts

- The engine must be off during refueling operations.
- Refueling must be performed in a well ventilated area.
- Park vehicle away from sources of heat or open flames.
- No smoking is permitted within the vicinity of the refueling operation.
- Do not refuel propane powered equipment near or over floor drains, sumps, or open pits.
- Always use a non-ferrous metal wrench to loosen and tighten connections.

- Permanently mounted propane tanks must be refueled outdoors.
- Propane cylinders must be properly attached to the vehicle utilizing the manufacturer's support bracket.
- The refueling of cylinders must be done by properly trained personnel.

21.10 Refueling Guidelines for Gas/Diesel Powered Forklifts

- The engine must be off during refueling operations.
- Spillage of fuel must be properly cleaned up and the fuel tank cap replaced before re-starting the engine.

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22 HOUSEKEEPING

Proper housekeeping of the project site is necessary to maintain a safe project site. The following are rules regarding housekeeping and orderliness:

- Keep projects clean and orderly.
- Avoid muddy or wet locations when operating vehicles and knock off loose material prior to leaving the work area onto public access ways.
- Remove from storage only those tools necessary to do the job.
- Put scraps, trash, and other waste in their proper receptacles. Keep oily rags, waste, or other combustible debris in properly labeled metal containers provided for that purpose.
- Smoke only in designated areas and utilize approved butt cans.
- Do not allow extension cords, welding, leads, air hoses, or other hoses and lines to be placed where they can be a trip hazard.
- Do not use extension cords as a substitute for permanent wiring.
- Keep work areas clear of waste materials, packaging, and refuse.
- Keep all material, tools, and equipment tied, stacked, or chocked to prevent rolling or falling.
- Immediately remove or bend down items such as protruding nails and screws to prevent puncture injuries.
- Maintain clear pathways through and around all work areas.

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23 AERIAL LIFTS/MANLIFTS

Aerial lifts, aerial ladders, articulating boom platforms, vertical towers, or any combination thereof, shall be used on accordance with the requirements of 29 CFR 1926.556, Aerial Lifts, and the manufacturer specifications.

- Electrical systems must be tested in accordance with Section 5 of ANSI Standard A92.2.
- Critical hydraulic lines must have bursting capacities four times the normal operating pressure. Non-critical lines must have a 200 percent burst capacity.
- Aerial lifts must be equipped with backup safety devices to prevent free descent if power supply systems or primary suspension systems fail.
- Secondary controls that can override the platform and emergency descent systems must also be provided.
- Mechanical poser transmission apparatus must be appropriately guarded and the guards kept in place.
- The electrical insulating capacity of the equipment must be prominently displayed.

Lifts may not be field modified unless certified in writing by the manufacturer or recognized testing laboratory to be at least as safe as the configuration prior to the modification.

Aerial lifts must be maintained in a safe operating condition at all times or removed from service. Daily inspections shall be conducted and documented. During the inspections, the inspector must, at a minimum, ensure the ground and elevated controls are operational, welds are not cracked, lifting cables are sound, hydraulic lines are tight and free from defects, electrical connections are sound, and the tires are in acceptable condition.

Aerial lifts must be operated by a qualified and authorized operator who is completely familiar with the safety and operating instructions of the equipment. Any personnel working from an aerial lift or manlift shall utilize fall protection equipment regardless of working height.

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24 LADDERS AND SCAFFOLDING

Portable ladders shall be used for their designed purpose only. The use and maintenance of portable ladders shall conform to the requirements of 29 CFR 1926.1053 and manufacturer's instructions.

24.1 Ladder Inspection and Use

Portable ladders must be inspected for defects prior to use. The inspection shall include at a minimum:

- Joints between rungs or steps are tight.
- All rungs or steps are present.
- Hardware and fittings are secure, and rivets are not sheared.
- Metal bearings are lubricated.
- Extension ladder halyards are in good condition.
- Side rails are not cracked, bent, or dented and are free of slivers or burrs.
- Check Load Rating Label to ensure the ladder has adequate load capacity.

Defective ladders shall not be used!

24.2 Straight and Extension Ladder Use

Rules regarding straight and extension ladder use include the following:

- Secure extension ladders to prevent tipping, sliding, or falling, prior to use.
- Ladders must be set on flat, firm surfaces with both side rails in contact with the upper support that is sufficiently strong and rigid.
- The angle of the ladder shall be 1:4 (1 foot horizontal from the structure for every 4 vertical feet).
- The ladder must extend 36 inches above the landing and shall be tied off.
- Only ladders with non-skid safety feet shall be used.
- Verify that the safety dogs or rung locks are engaged and that the halyard is secured to the base section of the ladder.
- Do not use extension ladder sections separately.
- Workers must maintain at least three points of contact when ascending, descending, or working from a ladder.

- Work from a ladder shall not be conducted if the worker must lean more than one half of their body width outside the side rail to access the work.
- Ladders must not be placed in front of doors that open toward the ladder unless the door can be locked and key maintained by the ladder user, or the door is blocked open with an attendant.
- Do not carry tools or equipment by hand when ascending or descending a ladder. Use a tool carrier and raise tools when at the working level.

24.3 Stepladders

Rules regarding stepladder use include the following:

- Always lock the legs of the stepladder in an open position and set all four feet level on the ground. **Do not use a stepladder as a straight ladder**.
- Never stand on the platform or top step of a stepladder unless the ladder is specifically designed for that purpose.
- Do not place tools or materials on the steps.
- Ladders must not be placed in front of doors that open toward the ladder unless the door can be locked and key maintained by the ladder user, or the door is blocked open with an attendant.

24.4 Scaffolding

Scaffolding, like ladders shall be used for its designed purpose only. The use and maintenance of scaffolding shall conform to the requirements of 29 CFR 1926 Subpart L, Scaffolding, and manufacturer's instructions.

Personnel must receive appropriate training in accordance with 29 CFR 1926.454 prior to working on scaffolding, overseeing projects requiring the use of scaffolding, or operating a scissor lift. Scaffolds must be designed by a qualified person and constructed and used in accordance with the design. Additionally, scaffolds must be erected and inspected before each use by a competent person.

There are many different types of scaffolding each having specific requirements for safety. The general requirements listed below pertain to tube and coupler, tubular welded frame steel, and manually propelled mobile scaffolding.

24.5 General Scaffold Construction

General rules to follow regarding scaffolding include:

- Scaffolds must be designed by a Qualified Person and must be constructed and loaded in accordance with that design.

- Install all components and accessories according to the manufacturer's instructions, using parts and sections that came from the same manufacturer.
- Do not alter components and accessories.
- Deck the full width of the scaffold at least two standard scaffold planks wide. Cleat planks to prevent slipping off the supports. Planking must extend a minimum of 6 inches and a maximum of 12 inches past the end supports for planks 10 feet in length or less. For planks greater than 10 feet, the planking must extend a minimum of 6 inches and maximum of 18 inches past the end supports.
- Do not use scaffold planks for any other purpose.
- Level, plumb, and place scaffolds on a firm base.
- Tie off or stabilize scaffolds with outriggers when the height is more than four times the smallest dimension of the base.
- Except as allowed within 29 CFR 1926.451(b)(3), the front edge of all platforms shall not be more than 14 inches from the face of the work unless guardrail systems and/or fall arrest systems are used.

24.6 General Scaffold Inspection

Scaffolds must be inspected and properly tagged by a competent person when being erected, altered, moved or dismantled. The user must visually examine scaffolds prior to use and daily to ensure at a minimum the following:

- The planking is not broken or cracked, or cleats loosened.
- The planking is not painted, muddy, oily, or otherwise unsafe.
- The guardrail members are not broken, rails split, or clamps loose.
- The scaffold was tagged for use and signed off by a competent person.
- The scaffold is free of debris and rubbish.
- All wheels are securely locked on rolling or movable scaffolding.
- Signs of damage or change in the scaffolding have not made it unsafe.

24.7 General Scaffold Use

- General rules to follow regarding scaffolding use include:
- Always read the tag prior to using the scaffold. Do not climb or use any scaffold that has a tag indicating "Defective – Do Not Use" or has no tag.
- When accessing or exiting a scaffold, use only the attached ladder system.
- Do not overload a scaffold. Make sure it will hold four times the load it is to bear.

- Keep trash and excess material off scaffolding to have the maximum amount of walking and working space available.
- Do not work on slick, snow, or ice-covered scaffolds.
- Wear appropriate fall protection equipment when required.
- Do not change or remove scaffold members unless authorized by the competent person.
- Do not ride on a rolling scaffold. Remove and/or secure all tools prior to moving a rolling scaffold.
- Only use rolling scaffolds on smooth, level surfaces. Watch for overhead clearance when moving and lock wheels to prevent movement prior to ascending.
- Do not rig any portion of the scaffold for lifting.

25 FIRE PREVENTION/PROTECTION/RESPONSE PLANS

There are several components to an effective construction fire prevention, protection, and response plan aimed at protecting the worker and property. Prior to conducting onsite activities it is necessary to ensure the following:

- Designate an Emergency Action Coordinator and Alternate - names and phone numbers should be posted
- Ensure that employees are trained for emergency situations
- Communicate emergency information to employees as needed - it is important to keep employees apprised of pertinent information during and after an emergency situation
- Immediately report emergency situations to emergency responders - report all serious incidents
- Be prepared to provide support - this may include use of fire extinguishers, assisting with evacuations, providing first aid, of providing pertinent information to emergency responders

All work operations shall comply with the requirements of 29 CFR 1926, Subpart F, Fire Protection. In an effort to minimize the potential for fire, the following is required:

- Smoking is prohibited in any structure (e.g., building, trailer, shed) regardless of ownership.
- Smoking is prohibited within 50 feet of any structure.
- Fire extinguishers rated 2A-10 B:C shall be installed in all portable trailers and for not more than every 3,000 square feet of buildings on each level, adjacent to each stairway, and within 50 feet of the work area(s).
- Fire extinguishers shall be inspected and maintained monthly and equipped with inspection tags.
- Flammable and combustible liquid and gas storage and dispensing areas shall be posted "No Smoking or Open Flame."
- Spill containment, collection, and cleanup materials shall be provided in refueling areas.
- For dispensing flammable or combustible liquids transfer containers shall be bonded together electrically.
- All spark-producing equipment in the immediate vicinity of flammable liquid dispensing operations shall be shut down. Adequate cool-down time for generators, pumps, and other portable equipment shall be provided prior to refueling.
- Pressure buildup in portable fuel cans shall be relieved away from hot surfaces and spark-producing equipment.
- Dispensing nozzles shall have an automatic shutoff and no "latch open" devices.

- Disconnect switches for refueling equipment shall be located away from refueling operations.
- A fire extinguisher rated no less than 40-B:C, shall be securely placed between 25 and 75 feet from each refueling operation.
- Only properly labeled and approved safety containers shall be used for handling and storage. Flammable storage cans shall not be stored in direct sunlight.
- For indoor storage of flammable liquids, no more than 25 gallons of flammable liquids may be stored outside of a flammable cabinet, so long as the material is stored in 5-gallon safety cans within 10 feet of a minimum 20 B:C fire extinguisher.
- A fire extinguisher rated no less than 20-B:C, shall be securely placed between 25 and 75 feet from outside storage of flammable materials other than vehicle refueling facilities (e.g., 5-gallon safety cans of gasoline).
- Exits and other means of egress shall not be blocked or used for storage.
- All non-bulk materials shall be stored in a flammable cabinet. Stored quantities shall not exceed 60 gallons per cabinet. No more than three cabinets shall be placed in a single area.
- Outdoor portable tanks shall be separated by a minimum 5-foot clear area.
- A 12-foot wide access shall be maintained for fire equipment to reach outdoor storage areas.
- Outdoor storage areas shall be maintained free of weeds, rubbish, and other fuel sources.
- Outdoor storage tanks shall have adequate venting capacity.

26 UTILITIES

26.1 Recognition and Risk Assessment

Aboveground and buried utility lines may pose serious safety risks that can be avoided through proper attention to, and knowledge of the presence and characteristics of the utility. A risk assessment of potential utilities in the work area should be conducted in the planning stages of the project by developing a task or hazard analysis for the hazards associated with the specific utilities. The risk assessment should not be limited to employee safety but also consider the impact to the end users of the utility.

Prior to conducting intrusive work on sites in or around facilities, buildings, or other structures that could be served by or connected to various utilities, a search must be performed to identify any overhead, underground, and potentially impacted utilities such as:

- Electrical lines and transmission equipment
- Gas lines
- Pipelines
- Process lines
- Steam lines
- Water and Sewer lines
- Communication cable

26.2 Utility Protection

The location of any utility that could pose a risk to workers must be communicated to all workers during the site safety indoctrination. Utilities should be marked or access otherwise restricted to reduce chances of accidental contact.

Utilities shall be considered “live” or active until a reliable source has documented them to be otherwise.

26.3 Overhead Utilities

Transmission and distribution lines carried on towers and poles normally provide safe clearance over roadways and structures. Overhead or aboveground electric lines shall be considered live or active until a reliable source has documented them to be otherwise.

Elevated work platforms, ladders, scaffolding, man-lifts, drilling rigs or vehicle superstructures shall be erected a minimum of 10 feet (actual distance is dependent on the voltage of the line) from overhead electrical lines until the line is either de-energized and grounded or shielded, and a competent electrician has certified that arcing cannot occur between the workplace or superstructure.

Work activity adjacent to overhead electric power lines will not be initiated until a survey has been conducted to ascertain the safe clearance distance from energized lines. Please refer to the U.S. Army Corps of Engineers (USACE) *Safety and Health Requirements Manual* (EM 385-1-1, 2008) for a complete description of procedures required when working at a location adjacent to overhead power lines. The minimum required clearance distances from energized overhead electric lines are provided.

Table 26-1. Minimum Clearance from Energized Overhead Electric Lines

Nominal System Voltage	Minimum Rated Clearance
0 to 50 kV	3 m (10 ft)
51 to 200 kV	4.6 m (15 ft)
201 to 350 kV	6 m (20 ft)
351 to 500 kV	7.6 m (25 ft)
501 to 650 kV	9.1 m (30 ft)
651 to 800 kV	10.7 m (35 ft)
801 to 950 kV	12.2 m (40 ft)
951 to 1100 kV	13.7 m (45 ft)
Note: kV = Kilovolts, m = Meter, ft = feet	

For other overhead or in-workplace utilities, workers must be instructed to use care in working under or around utilities to avoid hot surfaces, pressurized gases or air, leaking pipelines, and discharging steam or hot liquids, and must work to prevent accidental contact or damage.

26.4 Underground Utility Searches

Contacting underground utilities while performing intrusive soil activities can be extremely hazardous. Prior to excavating, drilling, or boring at the site, the Project Manager is responsible for ensuring the excavation area is marked or “white lined”, and verify that the utility locate using field instruments, potholing, or other methods deemed appropriate by the Client has been performed. No excavating, drilling, or boring shall be done until a thorough underground utility locate has been conducted by knowledgeable persons or agencies. The “one call” service (phone # 811) for the state in which work is performed must be contacted prior to any excavation activities to ensure utilities are properly located and marked.

Intrusive soil activities conducted within a 4-foot “Buffer Zone” (horizontal or vertical, as measured from the outside edge of the utility) of any utility (electric, gas, high pressure, chemical storage tanks, pipelines, sewers, etc.) requires the use of non-aggressive excavation methods such as hand excavation using non-conductive hand tools, use of an air spade, hydroexcavation, or similar means. The boundaries of the Buffer Zone will be observed at all times and aggressive excavation methods (excavators, backhoes, drill rigs, and other mechanized equipment) shall be restricted to areas outside the Buffer Zone. Additionally, as feasible, the utility will be de-energized (and purged if necessary) verified as de-energized, and locked out. Methods for de-energizing will depend on the utility or material being conveyed and shall physically prevent the transmission, flow, or release of energy. De-energizing utilities shall be verified by demonstration (e.g. opening valve, switching on equipment, or through use of electrical test equipment by qualified electrical workers) and be in accordance with an approved Lockout/Tagout program.

There may be occasions where it is necessary to use aggressive excavation methods inside the Buffer Zone, or where utilities cannot be de-energized. These situations require prior approval by the Project Manager and the HSM. Additional safe work practices such as use of an excavation observer, protection of utilities, use of additional PPE, and similar precautions may be required as a condition of approval.

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27 ELECTRICAL SAFETY

Electrical work conducted on Bhate projects sites shall be performed by qualified personnel and in accordance with the requirements of 29 CFR 1926 Subpart K, Electrical.

27.1 General Electrical Rules

General rules regarding electrical work are as follows:

- Do not work on live electrical equipment without authorization from your supervisor.
- Use guards over the bulbs of temporary lighting equipment.
- Ground metal guards.
- Low voltage lighting is recommended for use in confined spaces or Class I, Division I explosion-proof lighting equipment in any confined space with a potentially flammable atmosphere.
- Do not bypass or damage a circuit ground wire.
- Keep extension cords appropriately guarded and maintained in good condition. Keep extension cords out of water and mud, and at least 7 feet above walkways.
- Label disconnect switches to show the equipment or service they feed and check them before operation.
- Shut down electrical equipment before servicing, repairing, or investigating a questionable function.
- Follow the lockout/tagout procedure.
- Ground fault circuit interrupters shall be used in the absence of properly grounded circuits or when portable tools must be used around wet areas.

27.2 High Voltage Work

Whenever possible, electrical equipment and electrical conductive equipment will be guarded or de-energized as a means of an engineering control. When it is necessary to work with or around energized power transmission equipment, and use of permanent guarding is infeasible, grounding and personnel protective equipment is required. Work must be performed by personnel who have been specifically trained to work around high voltage electricity.

- Live line work or work within the safe distances specified in 29 CFR 1926.950 must be performed by a qualified, competent person.
- Personal protective equipment must be non-conductive rubber material with electrical and mechanical protection. Rubber protective equipment must be in accordance with ANSI. The personal protective equipment must be:

  - Visually inspected by a competent person before each use
  - Air tested before each use
  - Laboratory tested in accordance with manufacturer's specifications
  - Stored to prevent damage from sunlight or folding and crushing of the material

- Hard hats worn must meet ANSI Z89.2 Class B specifications

- Fall protection equipment must be able to:

  - Withstand an alternating current dielectric test of not less than 25,000 volts per foot dry for 3 minutes without visible deterioration
  - Allow less than one milliampere leakage when 3,000 volts are applied 12 inches apart

- Hot line tools must be able to withstand voltages of 100,000 volts per foot if fiberglass, or 75,000 volts per foot if wood

28 HAND AND POWER TOOLS

Work with any tool other than the simplest non-powered hand tool shall be performed by competent persons as determined by formal training or documented work experience. Proper PPE must be used when operating any tool.

Unsafe hand tools shall not be issued. All hand tools will be kept in good repair and used for only the purposes they were designed for. Tools that have defects that will impair the tool strength or render them unsafe will be tagged "Do Not Use" and removed from service.

All manufacturers' guards as specified with the tool shall be in place during the operation of all power tools. Belts, gears, shafts, drums, flywheels, chains or, other rotating, reciprocating, or moving parts exposed to potential employee contact or other hazards, must be guarded.

28.1 Hand Tools

- Keep hand tools in like new condition.
- Take tools with mushroomed heads, split handles, or any defect out of service.
- Do not strike two hardened surfaces together (e.g. two hammers or a hammer on a hardened rivet).
- Do not use any tool as a pry bar. Use of "cheater" bars is not permitted.
- Use non-sparking tools when flammable vapors are present.
- Use tools with insulated handles on or around electrical equipment and circuits.

28.2 Portable Electric Tools

- Inspect every portable electrical tool prior to use, daily.
- Only use trigger locks on power tools as allowed by OSHA, such as drills, tappers, certain grinders, belt sanders, reciprocating saws, etc. Check the trigger locks daily for proper function.
- Always use ground fault circuit interrupting receptacles or breaker to power all portable electric tools.
- Never leave electrical tools unattended unless the tools are unplugged from the power source.
- Remove bits from drills when left unattended.
- Become familiar with the torque, potential for flying debris, potential for contact with moving parts, and the power source for the use of portable electric tools.
- Do not remove or alter guards or shields on portable power tools. Do not use portable power tools with the guards or shields in place.

28.3 Hydraulic and Pneumatic Tools

- Inspect hydraulic and pneumatic tools prior to operation. Check for hose and seal leaks, hose tightness, controls, any electrical controls, and hoses and fittings for defects.
- Do not exceed the manufacturer's safe operating pressures or rating capacity.
- Use only fire resistant hydraulic fluids.
- Ensure pneumatics have hose whips secured.
- Shut off the hydraulic or pneumatic pressure and bleed off residual pressure prior to servicing a tool.
- Never use compressed air to blow yourself or someone else off. The pressure used may be enough to cause significant injury to body parts exposed. Compressed air > 30 p.s.i. must not be used to clean any surface.

28.4 Powder Actuated Tools

Powder actuated tools may not be used without specific approval and documentation of an appropriate training course. Use of powder actuated tools must be accompanied by an AHA describing the use of the tool and the safety precautions designing into the activity.

29 ILLUMINATION

Bhate requires that all construction areas, corridors, offices, shop areas, and storage areas are lighted so as to permit the safe performance of work. To that effect all Bhate construction project sites shall maintain minimum light requirements in accordance with 29 CFR 1926.56, Illumination.

The minimum lighting requirements for a general construction work area is 5 foot-candles intensity. The minimum lighting requirements for other tasks are summarized below:

- 5 Foot-Candles – General construction areas, indoor: warehousing areas, corridors, hallways, exits, tunnels, shafts, and general underground work areas.
- 10 Foot-Candles – Tunnel and shaft heading during drilling, mucking, or scaling, general construction plant, and shops.
- 30 Foot-Candles – First Aid stations, infirmaries, and offices.

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30 EMERGENCY PROCEDURES

Some risk of personal injury or possibly chemical exposure is inherent in general construction and renovation activities. These risks and the effects of unpredictable events such as injury, chemical exposure, fire, or explosion will be minimized by the following practices:

- Adhering to good work practices;
- Using PPE appropriate for existing field conditions and activities performed;
- Performing adequate monitoring of individuals and ambient field conditions; and
- Staying alert both to personal performance and to that of co-workers.
- Prior to initiating site activity, the SSHO must positively identify the availability of emergency responders and local emergency medical facilities to handle potential injuries and illnesses. Project specific emergency contacts are presented in an appendix in the SSHP and posted in a centralized location for employee reference.

30.1 General Emergency Procedures

In the event of an emergency, guidelines set in the emergency action plan and the SSHP should be followed.

The following is a general plan for an emergency situation:

- In the event that a member of the field crew experiences any adverse effects or symptoms of exposure while on the scene, the entire field crew will immediately halt work and act according to the instructions provided by the SSHO. This includes heat and cold exposure or chemical exposure.
- The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated will result in the evacuation of the field team and reevaluation of the hazard and the level of protection required.
- In the event that an accident occurs, the SSHO is to complete an incident report. Follow-up action will be taken to correct the situation that caused the incident.
- The client will be notified of the emergency according to the requirements of the contract.

30.2 Personal Injury/Medical Emergencies

The SSHO and one additional site worker (functioning as an alternate first aid responder) will be trained in American Red Cross first aid procedures and may administer appropriate first aid treatment, including cardiopulmonary resuscitation (CPR), in emergency situations. First aid and blood borne pathogen kits will be maintained and readily available onsite. The following general emergency procedures will be carried out in the event of injury:

- The SSHO will direct all emergency activities.
- If the victim can be moved safely, remove to a safe area where first aid can be administered.
- Administer first aid.
- Transport victim to nearest hospital or emergency medical center or call for ambulance transport, as appropriate.
- Notify the Bhate HSM of the incident and describe the emergency response actions taken.

30.3 Fire or Explosion

In the event of a fire or explosion:

- Immediately evacuate the area.
- Supervisors shall conduct accountability of their personnel.
- Notify emergency services.
- Administer first aid as appropriate.
- Notify the Bhate HSM, the Bhate Project Manager, and the client.

30.4 Emergency Contacts

An appropriate and current emergency contact shall be maintained at a central project location and included in any SSHP, as appropriate.

It is imperative that the emergency contacts be verified. In most areas of the country emergency services can be reached by dialing 911. For ambulance, fire, or police contacts, give the name of the road and the nearest intersection. In the event no land-based telephone can be reached, cellular phones can be utilized to call the emergency contacts. Notify the Bhate HSM, the Bhate PM, and the client after emergency contacts have been made.

The HSM should be contacted if unforeseen circumstances require the immediate procurement of additional personal protective or emergency equipment. Attending emergency physicians should be given the telephone number of the Bhate Human Resources Manger to obtain immediate access to an employee's medical records and for consultation purposes.

In conjunction with local street maps, site figures located in the project work plan will be used to identify the appropriate hospital route from each site. A site specific hospital route map will be posted at each field location by the SSHO. The SSHO will also brief site personnel on the appropriate hospital directions.

30.5 Emergency Equipment

All individuals will be familiar with the site and be able to identify the location of the following required emergency equipment:

- First aid kit(s)
- Blood-borne Pathogen kit(s)
- Fire Extinguisher(s), Type ABC
- Eye Wash (1.5 liters per minute potable water for 15 minute capacity/two per decontamination station). Eye washes will be compliant with ANSI Z-358.1-1990.
- Portable Telephone or Two-way Radio
- Portable Sprayer, 5-10 gallon capacity
- Mini-Air horn

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31 RADIATION SAFETY

31.1 Policy Statement

Bhate Environmental Associates, Inc. (Bhate) will make every effort and shall use, to the extent practicable, procedures, and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to individual members of the public as low as reasonably achievable.

31.2 Purpose

The Radiation Safety Program was established to ensure that the use of radiation producing equipment at Bhate job sites is done safely and in accordance with Federal and State requirements. A copy of this policy, the radioactive materials license, and our operating procedures are located in the Health and Safety Director/Radiation Safety Officer (RSO) office. A copy of the state posting forms is maintained in the break area.

31.3 Scope

Procedures listed in this program are related to the NITON X-Ray Fluorescence (XRF) models currently approved for use at Bhate as listed on the Alabama Radiation License #1173. Bhate uses XRF analyzers as needed for lead based paint surveys. Bhate does not own XRF analyzers. Analyzers are rented on an "as needed" basis and are not stored on site. The rental company is responsible for all leak-testing of the rented equipment. This radiation safety program applies to all Authorized Individuals of Bhate or Bhate owned companies who receive, possess, use, or transport radiation-producing XRF devices used to measure lead content in paint or other coatings, during which activities employees have potential exposure to radiation. Bhate takes all precautions to ensure exposures are maintained as low as reasonably achievable and comply with Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1926.53, 1910.1026, and Nuclear Regulatory Commission (NRC) Title 10 Part 20 with regard to the use of all radioactive devices. This program applies to the safe use of the XRF Analyzer.

31.4 Definitions

1. **ALARA**: "as low as is reasonably achievable", is the philosophy upon which the Bhate Radiation Safety Program is based. This means that persons who handle radioactive devices must make every effort to keep radiation exposures and releases as far below the legal limits as is reasonably achievable.
2. **AUTHORIZED INDIVIDUALS**: persons authorized by the State of Alabama radiation license to use equipment containing radioactive materials. Authorized individuals oversee and are responsible for the use and handling of radioactive materials in their possession and

control. The license requires manufacturer radiation safety training for all authorized users of the XRF analyzers.

3. **CONTROLLED AREAS**: areas in which radioactive materials or radiation producing devices are used; they have sign requirements and restricted access. All other areas are termed non-controlled areas.
4. **FILM BADGE**: a type of personnel monitoring equipment used to measure personal and area radiation exposure.
5. **HSM**: Health and Safety Manger
6. **OCCUPATIONAL RADIATION DOSE**: the dose of radiation received as a result of work with radioactive materials. The does to an individual may not exceed the following annual limits:
   A. Whole body, blood forming organs, gonads: 5,000 mrem/year
   B. Lens of eye: 15,000 mrem/year
   C. Extremities and skin: 50,000 mrem/year
   D. Fetal: 500 mrem/gestation period
   E. General Public: 100 mrem/year
7. **REM**: means a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of 1 roentgen (r) of X-rays (1 millirem (mrem)=0.001 rem). The relation of the rem to other dose units depends upon the biological effect under consideration and upon the conditions for irradiation.
8. **RADIATION**: means ionizing radiation including alpha and beta particles, gamma and X rays, neutrons, high speed electrons, high speed protons, and any other atomic particles producing ionization; does not include sound or radio waves, or visible, infrared or ultraviolet light.
9. **RADIATION DOSE**: the quantity of radiation absorbed, in rads, per unit mass (or per unit mass per unit time) by any body tissue or whole body.
10. **RSO**: Radiation Safety Officer and Radiation Safety Office, there being no distinction between these entities.
11. **XRF**: X-Ray fluorescence technology used to detect lead content in paint.

31.5 Discussion

31.5.1Responsibilities

All affected personnel are responsible for taking appropriate protective measures in accordance with this plan to insure against inadvertent exposure to radiation. Only authorized associates (those who are trained and approved by the Health and Safety Manager/Radiation Safety Officer (HSM/RSO) to receive, possess, use, or transport radiation-producing devices used to measure lead content in paint or other coatings) are permitted to perform such work using the XRF analyzer. All authorized personnel are required to follow safe procedures detailed in this program and recommended by the device manufacturer to ensure exposures are kept as low as reasonably achievable (ALARA).

The HSM/RSO or his/her designee has responsibility to provide site specific training to the authorized associates regarding implementation of this procedure at various customer job sites. Other responsibilities of the HSM/RSO include:

- Serving as RSO;
- Assisting with notifications to OSHA and Department of Public Health Office of Radiation Control of any exposures or accidental damage to radiation equipment as required;
- Reviewing/maintaining a log of all investigations which may include basic causes, immediate causes, and management control issues;
- Distributing summaries of incidents with periodic management reports;
- Communicating significant incidents to key personnel within Bhate;
- Assisting with statistical and root cause analyses of Bhate incidents; and,
- Reviewing Health and Safety Plan and recommending modifications, as necessary,
- Ensuring all licensing and training is maintained as required.

31.6 General Guidelines

31.6.1Using the XRF Safely

Each XRF Analyzer is designed to minimize the potential for external exposure to any part of the instrument when the shutter is closed. When used according to the manufacturer's instructions, there is minimal radiation exposure even with the shutters in the open position. XRF Analyzer contains sealed cadmium109 or cobalt 57 radioactive sources. The source is designed to remain secure even under extreme conditions. The source is completely secure in its housing. The source is secure in a solid metal source holder. A plug is screwed into the access hole and secured with a set screw and locktite. The aperture at the other end of the housing is smaller than the source. The small aperture is sealed with a beryllium metal window that is transparent to the cadmium or cobalt x-rays and gamma-rays. The source assembly is secured in the XRF Analyzer's aluminum case. The case has tamper proof screws. The following guidelines are provided to insure your safety and the safety of those around you.

Always be aware of the location of you instrument's radioactive source and the direction of its beam of x-rays. The location of the source and the direction of its beam are both clearly marked on the front and top side of your XRF Analyzer XRF.

Open the shutter only to perform a test. During testing a strong beam of x-ray and gamma ray radiation is continuously emitted through the beryllium window at the bottom of the XRF Analyzer. There will be some radiation at the front and top-front of the instrument. Do not put your hand on the end plate of the XRF Analyzer while measuring. Never point the XRF Analyzer at yourself or anyone else when the shutter is open. Always avoid standing in the path and/or putting any body parts in the path of the XRF Analyzer radiation beam. The direction of the beam is drawn on the cover of the instrument.

31.6.2XRF Analyzer Shutter Safety

The XRF Analyzer is designed so you cannot accidentally open the shutter or leave it open accidentally when the instrument is lifted from a surface. To perform a test, the instrument must be held against a surface. The shutter will close as soon as you cease to hold the XRF Analyzer against a surface. The shutter should be open only during a test. Under no circumstances should the shutter be open when the instrument is not in use. The XRF Analyzer clearly indicates any time the shutter is open. The plunger will stick up through the instrument case whenever the shutter is open.

31.6.3Monitoring your radiation exposure

All Authorized personnel must wear a dosimeter badge at all times while using the instrument. The dosimeter should be placed on a finger (ring-style badge) of the hand holding the instrument and must be worn during the entire sampling period. Note that wearing a dosimeter badge does not protect one against exposure. A dosimeter badge measures your cumulative exposure after the fact. Ring badges should be ordered through Landauer, Inc., 2 Science Road, Glenwood, IL 60425 and received prior to start of work. Once the job is complete the ring badge is returned with a control badge to Landauer for analysis. The control badge is used to subtract background radiation from the cumulative dose. Care must be taken not to expose the ring badges or the control to other sources of radiation. Ring badges must not be purposely placed in the path of the radiation beam or otherwise tampered with in a way that would result in inaccurate readings of radiation exposure. Each ring badge wearer will be notified of his/her exposure results as they are received.

31.6.4Leak Testing

The instrument supplier is required to perform and maintain all leak test documentation. The supplier is required to send a current copy of the leak test documentation with the instrument when rented. A leak test must be performed by the supplier every 6 months and performed per manufacturer’s instructions. The authorized associate must verify the presence of the leak test documentation and must keep a copy of the leak test record in the project file. A copy of the leak test must also be given to the HSM/RSO when work is complete.

31.6.5Unpacking the XRF Analyzer

Typically, the XRF will be shipped directed from the rental company to the job site in question.

Inspect the shipping carton for signs of damage such as crushed or water damaged packaging. Immediately notify the shipper and XRF Analyzer if damage is noted.

Open the packing carton. If your XRF Analyzer is not packed in its carrying case, please call the shipper and XRF Analyzer immediately.

Verify the contents of the shipping container against the packing list. Record any discrepancies and notify the shipper.

Open the carrying cased and visually inspect the instrument for damage before removing it from the case. Call the shipper and XRF Analyzer if you find any damage to the case or its contents.

Save the shipping carton and all packing materials. Store them in a safe, dry area. Use these shipping materials when the analyzer is shipped back.

Ensure two copies of the leak test, chain of custody, shipping receipt and any other paperwork that accompanies the instrument are made. One copy should be kept in the project file and the other copy delivered to the HSM/RSO.

31.6.6Operating the XRF Analyzer

These operating instructions are based on the NITON XRF. Turn on the instrument. Use the arrow buttons to select set up menu from the main menu. Press Clear/Enter. Use the arrow buttons to select Setup Paint Mode from the setup menu. Press Clear/Enter. From the setup paint screen select one of the three paint testing modes: Standard, Standard + Spectra, or K&L Readings + Spectra. The instrument will automatically return to the Main menu when a testing mode is selected. Select calibrate and test. Once calibration is complete the instrument will beep and display ready to test. Ensure date and time are correct prior to testing. Always treat radiation with respect. Do not put your hand on the end plate of the XRF Analyzer while measuring. Never point the XRF Analyzer at yourself or anyone else when the shutter is open. Caution: when testing the exterior of the window sash from the inside of a room, avoid standing in the path of the XRF Analyzer's radiation beam. The direction of the beam is drawn on the cover of the instrument. Holding the instrument in your right hand makes it easier to avoid the beam.

Push the safety slide (that locks the shutter release) out from under the shutter release. Place the XRF Analyzer on the painted surface, squeeze the shutter release, and press the XRF Analyzer against the surface. Note, the instrument must be flush against the surface and the shutter release trigger must be activated to take reliable readings. Continue holding the instrument against the surface throughout each measurement. You do not need to hold the shutter release continuously. When the test is finished, lift the XRF Analyzer from the surface. The shutter will close automatically. For curved surface ensure the window is flat on the surface. Please refer to the manufacturer's operations manual for more specifics on reading the display, instrument diagrams, and general operation of the instrument.

For more detailed operating procedures please reference the manufacturer's operations manual.

Never attempt to perform maintenance or otherwise compromise the integrity of the instrument housing. Call the shipper and XRF Analyzer for all required maintenance.

31.6.7Shipping the XRF

All XRF Analyzer instruments must be packed in their original padded carrying cases for shipment. Pack the XRF Analyzer XRF in its original case and ship in either the original carton and packing material or their equivalent. Do not ship the instrument back to the supplier without FIRST notifying them and receiving a Return Authorization Number, if applicable. Always include a copy of the leak test originally sent with the instrument when shipping the instrument back. Keep a copy of the following statement in the XRF Analyzer case whenever the instrument is shipped:

> THE XRF ANALYZER CONFORMS TO THE CONDITIONS AND LIMITATIONS SPECIFIED IN 49 CFR 173.422 FOR EXCEPTED RADIOACTIVE MATERIAL, INSTRUMENTS AND ARTICLES, N.O.S. UN-2910.
>
> **THIS PACKAGE CONTAINS NO MORE THAN 50 mCi CADMIUM109 IN A PLATED, SOLID, SEALED SOURCE INSTALLED IN AN X-RAY FLUOURESCENCE ANALYZER.**

The battery pack must be disconnected from the unit. Package the XRF Analyzer case in a box. This box should be labeled:

> **Radioactive Material, excepted package, instruments and articles. UN 2911**

31.6.8XRF Emergency Procedures

If the XRF should be damaged in any way, halt all activities and follow the emergency procedures outlined below.

1. Keep all personnel away from the XRF analyzer.
2. Assess the extent of the damage.

   If the XRF instrument appears to be superficially damaged (i.e. dent, wet, or other minor breaks) and no indication of compromised housing, or inoperable shutter, go to **Step 3**.

   If the XRF device is broken, severely burned, lies crushed, or the source holder is visibly damaged, go to **Step 6**.

MINOR DAMAGE

3. DO NOT walk through the site where the instrument was dropped or damaged. Without exposing face or eyes, visually inspect the front end of the instrument to determine damage to the shutter or source mounting.
4. If the device is intact and shutter mechanism is closed, pick up the instrument, place it in its storage container, and return to a secure, unoccupied storage area.
5. Contact Bhate's HSM/RSO (205-918-4000) and contact the NITON RSO (XRF ANALYZER 800-875-1578) for assistance in shipping the device back to the factory for repair.

MAJOR DAMAGE

6. Rope off the site with a circle around the source, 20 feet in diameter. Do not walk through the site.
7. Notify Bhate's HSM/RSO immediately at 205-918-4000. The Bhate HSM/RSO will notify the State Department of Public Health at 800-843-0699 or 334-324-0076.

31.7 Training

The HSM / RSO ensures that all Authorized associates are trained according to the manufacturer's procedures and Radiation Safety.

Prior to conducting work involving the XRF the "XRF Lead Based Paint Survey Checklist" must be completed.

The complete Radiation Program is located in the RSO/HSM office in Birmingham, AL.

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32 ASBESTOS INSPECTION AND BULK SAMPLING

32.1 Purpose

- To ensure employees involved with inspecting and/or sampling suspect asbestos containing materials are aware of the hazards and practice safe procedures to prevent exposure to themselves or members of the public
- To ensure safe procedures are standardized and utilized to maintain compliance with OSHA when inspecting and sampling for asbestos
- To ensure members of the public are protected when asbestos inspections and/or sampling are conducted
- To supplement existing programs in the Corporate Health and Safety Plan (HASP), Corporate Health and Safety Plan for Construction (HASP-C), and Site Specific Health and Safety Plans (SSHP)
- To ensure only personnel who have been properly trained are permitted to handle or otherwise disturb asbestos containing materials during inspections

32.2 Scope

- This policy applies to all Bhate Environmental and Red Mountain Associates operations where asbestos or suspect asbestos containing materials are inspected and/or sampled by trained personnel
- Training must be from an accredited asbestos AHERA training program for building inspectors
- Training must be current
- Individuals performing asbestos inspections and/or bulk sampling must be licensed in the state in which the work is to be conducted.
- Untrained personnel are not permitted to touch, remove or otherwise disturb asbestos containing and/or any materials suspected to contain asbestos
- This policy applies to all subcontractors involved in construction, demolition, asbestos inspection, and/or sampling

32.3 Definitions/Descriptions/Background

1. Asbestos - Asbestos is a widely used, naturally occurring mineral mined from the earth that is resistant to heat and corrosive chemicals. Typically, asbestos appears as a whitish, fibrous material, which may release fibers that range in texture from coarse to silky; however, airborne fibers that can cause health damage may be too small to see with the naked eye. Additionally, due to their size, density, and shape fibers that have been released can remain

airborne for an indefinite amount of time. The three most common types of asbestos are chrysotile (white asbestos, most common), amosite (brown asbestos), and crocidolite (blue asbestos).

2. Asbestos containing materials

   - Thermal system insulation (TSI), including block insulation, pipe insulation on steam, water, or other utility lines.
   - Surfacing materials, including sprayed-on fireproofing, acoustical ceiling, textured coatings, paint, etc.
   - Miscellaneous and/or structural components, including materials such as roofing shingles, felt, asphalt and flashing, siding, flooring tile, vinyl and mastic, ceiling materials, valve packing, electrical wiring insulators, cement wall board, and mounting materials.
   - These categories (TSI, Surfacing and Miscellaneous) of materials must be treated as asbestos unless known or determined to be asbestos free. *Keep in mind that even though TSI and surfacing materials containing asbestos were banned in the 1970's, post 1980 buildings can contain these materials. Also, flooring, mastics, and roofing materials have never been banned.* Only personnel trained and accredited as Asbestos Inspectors are permitted to take samples for analysis and only trained/certified Asbestos Abatement contractors are permitted to abate or remove asbestos containing materials. Any legitimate concern regarding the presence of asbestos in a specific material should be addressed even if the material is not on the list. Contact the Health and Safety Manager or Phase I Group Manager for assistance if suspect materials are discovered and/or damaged.

32.4 Procedure

- All asbestos inspection and/or bulk sampling work are to be performed only by competent, trained, and certified personnel.
- Only personnel that have attended an approved AHERA three day Asbestos Inspector course and are approved as Asbestos Inspectors in the State(s) where work is to be performed are authorized to do so.
- Prior to bulk sampling and within the prior 12 month period the inspector will obtain medical clearance to wear respiratory protection, receive training on using respiratory protection, and be issued a tight fitting air purifying respirator w/ HEPA cartridges to be used during sampling.
- Respiratory protection training is required annually for respirator users
- A physical exam including an evaluation of lung capacity and ability to wear a respirator is required annually for all respirator users
- In addition to the minimum required PPE (safety glasses, hard hat, steel toe work boots, and gloves), the asbestos inspector must inspect and don (put on) the air purifying respirator

equipped with high efficiency particulate air (HEPA) filters, tyvek coveralls (as needed), boot covers (as needed), and disposable gloves prior to conducting sampling.

- The floor under the area to be sampled will be covered with a plastic drop cloth.
- The area to be sampled will be wetted with amended water using a lightly sprayed mist over the suspect material so as not to dislodge the material from its substrate.
- A sample will be obtained taking care not to disturb any more material that what is absolutely necessary to obtain a sample.
- The sample will then be placed into an air tight sealed container of sufficient strength so as not to get damaged during transport to the lab.
- The exposed surface from which the sample was taken will then be treated with an encapsulant to prevent release of fibers from the area sampled.
- Building/room occupants should be cleared prior to the sampling event. Alternatively, sampling should be conducted during breaks, at night or on the weekend to avoid concern from building occupants/by-standers.
- Please note: asbestos contamination on clothing or equipment represents a significant hazard to others as this material can be inhaled by anyone handling contaminated laundry or equipment. Care must be taken to prevent the spread of contamination by using the proper protective coveralls/clothing when needed. Tools and other equipment used during the bulk sampling event should be cleaned at the job site in the aforementioned PPE and stored in sealed plastic when not in use. All contaminated PPE, plastic, and residue from cleaning must be properly disposed of in accordance with EPA/OSHA regulations.
- Bhate and Red Mountain personnel who are not specifically authorized for asbestos work are not permitted to disturb any material which is known or suspected to contain asbestos. In addition, if employees, contractor employees, or other personnel encounter suspect asbestos-containing materials which are damaged, deteriorated, or must be removed prior to renovations/restorations of an existing structure; they should notify their supervisor immediately.
- During a pre-bid situation on a renovation project, previous asbestos surveys if available should be obtained to determine what if any of the materials to be disturbed contain asbestos. If a survey is not available, the customer should be referred to a licensed asbestos inspector for a survey of the building. Any asbestos containing materials that might be disturbed during renovations must first be removed or abated by a licensed asbestos contractor.
- Unless a negative exposure assessment has been conducted for same type of sampling to be performed (i.e. same asbestos containing materials, condition, quantity, type, environment, etc.) within the previous 12 month period, personal exposure/industrial hygiene monitoring must be conducted utilizing an approved NIOSH sampling method.

- All monitoring results must be submitted to the Health and Safety Manager (HSM) for review and to issue exposure notifications to the employee(s) monitored.

33 REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH), *Threshold Limit Values for Chemical Substances and Physical Agents, 2008*.

American National Standards Institute (ANSI), 1990. *American National Standard for Emergency Eyewash and Shower Equipment*, ANSI Z358.1-1990.

American National Standards Institute, 1992. *American National Standard for Respiratory Protection*, ANSI Z88.2.

Clayton, George D. and T.E. Clayton, *Patty's Industrial Hygiene and Toxicology*, 3rd Edition, Volume IIA, Wiley-Inter-Science Publication, 1981.

National Safety Council (NSC), *First Aid and CPR,* Fourth Edition, 2001.

NIOSH/OSHA/USG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, October 1985.

U.S. Army Corps of Engineers, *Safety and Health Requirements Manual*, EM 385-1-1, 2003 and 2008.

U.S. Department of Health and Human Services, *NIOSH Pocket Guide to Chemical Hazards,* 2006.

U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Title 29 Code of Federal Regulations Parts 1910 and 1926.

U.S. Department of Transportation (DOT) Title 49 Code of Federal Regulations 100-181, Hazardous Materials Transportation.

U.S. Environmental Protection Agency, *Standard Operating Safety Guide*, October 1985.

http://140.194.76.129/publications/eng-manuals/em385-1-80/toc.htm

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ATTACHMENT 5
OSHA 300A SUMMARY LOGS AND
EXPERIENCE MODIFICATION RATES

OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

Year 2015

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the log. If you had no cases write "0."

Employees former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR 1904.35, in OSHA's Recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	0	0	0
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
0	0
(K)	(L)

Injury and Illness Types

Total number of...
(M)

(1) Injury	0	(4) Poisoning	0
(2) Skin Disorder	0	(5) Hearing Loss	0
(3) Respiratory Condition	0	(6) All Other Illnesses	0

Post this Summary page from February 1 to April 30 of the year following the year covered by the form

Public reporting burden for this collection of information is estimated to average 58 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

Establishment information

Your establishment name: Bhate Environmental Associates Inc.

Street: 1608 13th Avenue South Suite 300

City: Birmingham State: Alabama Zip: 35205

Industry description (e.g., Manufacture of motor truck trailers): Construction and Environmental Management Services

Standard Industrial Classification (SIC), if known (e.g., SIC 3715): ___ ___ ___ ___

OR North American Industrial Classification (NAICS), if known (e.g., 336212): 5 6 2 9 1 0

Employment information

Annual average number of employees: 87

Total hours worked by all employees last year: 192,576

Sign here

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

[signature] Company executive — CEO Title

(205) 918-4000 Phone — 29-Jan-15 Date

OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

Year 2014

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the log. If you had no cases write "0."

Employees former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR 1904.35, in OSHA's Recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	0	0	0
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
0	0
(K)	(L)

Injury and Illness Types

Total number of...
(M)

(1) Injury	0	(4) Poisoning	0
(2) Skin Disorder	0	(5) Hearing Loss	0
(3) Respiratory Condition	0	(6) All Other Illnesses	0

Post this Summary page from February 1 to April 30 of the year following the year covered by the form

Public reporting burden for this collection of information is estimated to average 58 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

Establishment information

Your establishment name: Bhate Environmental Associates Inc.

Street: 1608 13th Avenue South Suite 300

City: Birmingham State: Alabama Zip: 35205

Industry description (e.g., Manufacture of motor truck trailers): Construction and Environmental Management Services

Standard Industrial Classification (SIC), if known (e.g., SIC 3715): ___ ___ ___ ___

OR North American Industrial Classification (NAICS), if known (e.g., 336212): 5 6 2 9 1 0

Employment information

Annual average number of employees: 85

Total hours worked by all employees last year: 144,081

Sign here

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

[signature]
Company executive

CEO
Title

(205) 918-4000
Phone

30 January 2015
Date

OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

Year 2013

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the log. If you had no cases write "0."

Employees former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR 1904.35, in OSHA's Recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	0	0	0
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
0	0
(K)	(L)

Injury and Illness Types

Total number of...
(M)

(1) Injury	0	(4) Poisoning	0
(2) Skin Disorder	0	(5) Hearing Loss	0
(3) Respiratory Condition	0	(6) All Other Illnesses	0

Post this Summary page from February 1 to April 30 of the year following the year covered by the form

Public reporting burden for this collection of information is estimated to average 58 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

Establishment information

Your establishment name: Bhate Environmental Associates, Inc.

Street: 1608 13th Avenue South Suite 300

City: Birmingham State: AL Zip: 35205

Industry description (e.g., Manufacture of motor truck trailers): Construction and Environmental Management Services

Standard Industrial Classification (SIC), if known (e.g., SIC 3715): ___ ___ ___ ___

OR North American Industrial Classification (NAICS), if known (e.g., 336212): 5 6 2 9 1 0

Employment information

Annual average number of employees: 75

Total hours worked by all employees last year: 143,240

Sign here

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete

[signature] Company executive — CEO Title

(205) 918-4000 Phone — 1/30/14 Date

Willis

Telephone: 205-871-3300
Fax: 205-871-0602
Website: www.willis.com

Direct Line: 205-868-0383
Direct Fax: 205-871-0602
E-mail: colleen.davis@willis.com

January 29, 2016

Mr. Doug Sanders
Bhate Environmental Associates, Inc.
1608 13th Avenue, South
Birmingham, AL 35205

Re: Experience Modification Factor - Alabama

Dear Doug:

This is to confirm your Experience Modification Factors for Alabama have been as follows:

2005	.85
2006	.82
2007	.80
2008	.77
2009	.77
2010	.76
2011	.80
2012	.83
2013	.84
2014	.80
2015	.77
2016	.78

If you have any questions, please feel free to contact me.

Sincerely,

Colleen Davis

Colleen Davis, CIC
Sr. Client Services Specialist

ATTACHMENT 6

ACGIH-TLV GUIDELINES EXCERPT

– THERMAL STRESSORS

TLV®

BEI®

ACGIH®

Defining the Science of Occupational and Environmental Health®

1330 Kemper Meadow Drive
Cincinnati, Ohio 45240-4148
Phone: (513)742-2020; Fax: (513)742-3355
www.acgih.org

ACGIH®

ISBN: 978-1-607260-84-4

2016

TLVs® and BEIs®

Based on the Documentation of the

Threshold Limit Values
for Chemical Substances and Physical Agents

&

Biological Exposure Indices

ACGIH®

Defining the Science of Occupational and Environmental Health®

Signature Publications

where: $a_w(8)$ = The daily (8-hour) vibration exposure for the *l*-axis (ms^{-2} rms)

a_{wlj} = The overall weighted rms acceleration for the *l*-axis over the time period T_j, (*l* = x, y, or z) (ms^{-2} rms) (from Equations 1 or 2)

T_0 = The reference duration of 8 hours or 28,800 seconds

8. With reference to ISO 2631-1, Section 6.3 (ISO, 1997), the weighted rms method described above may underestimate the effects of vibration with high crest factors (> 9), such as transient vibration and vibration combined with occasional small shocks. In addition to the rms method described above, the fourth power Vibration Dose Value (*VDV*) may be calculated in each direction as:

$$VDV = k_l\left(\int_0^T\left[a_{wl}(t)^4\right]dt\right)^{\frac{1}{4}} \quad (6)$$

It is noted that, unlike the overall weighted acceleration calculated in accordance with Equations 1 and 2, the *VDV* is dependent on the duration of the measurement. When using this method, the TLV® in any direction shall not exceed a *VDV* value of 17.0 $ms^{-1.75}$ to avoid health risks. It is highly recommended that vibration mitigation activity be undertaken to reduce any *VDV* falling between 8.5 and 17.0 $ms^{-1.75}$. The *VDV* method should not be applied to exposures lasting more than 8 hours.

TLV®–PA

References

International Standards Organization (ISO): ISO 10326-1:1992: Mechanical Vibration–Laboratory Method for Evaluating Vehicle Seat Vibration–Part 1: Basic Requirements. Switzerland, Geneva (1992).

International Standards Organization (ISO): ISO 2631-1:1997: Mechanical Vibration and Shock–Evaluation of Human Exposure to Whole-Body Vibration–Part 1: General Requirements. Geneva, Switzerland (1997).

International Standards Organization (ISO): ISO 2631-1:1997/Amd.1:2010: Mechanical Vibration and Shock–Evaluation of Human Exposure to Whole-Body Vibration–Part 1: General Requirements, Amendment 1. ISO, Geneva, Switzerland (2010).

THERMAL STRESS

COLD STRESS

The cold stress TLVs® are intended to protect workers from the severest effects of cold stress (hypothermia) and cold injury and to describe exposures to cold working conditions under which it is believed nearly all workers can be repeatedly exposed without adverse health effects. The TLV® objective is to prevent the deep body temperature from falling below 36°C (96.8°F) and to prevent cold injury to body extremities (deep body temperature is the core temperature of the body determined by conventional methods for rectal temperature measurements). For a single, occasional exposure to a cold environment, a drop in core temperature to no lower that 35°C (95°F) should be permitted. In addition to provisions for total body protection, the TLV® objective is to protect all parts of the body with emphasis on hands, feet, and head from cold injury.

Introduction

Fatal exposures to cold among workers have almost always resulted from accidental exposures involving failure to escape from low environmental air temperatures or from immersion in low temperature water. The single most important aspect of life-threatening hypothermia is the fall in the deep core temperature of the body. The clinical presentations of victims of hypothermia are shown in Table 1. Workers should be protected from exposure to cold so that the deep core temperature does not fall below 36°C (96.8°F); lower body temperatures will very likely result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences.

Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering develops when the body temperature has fallen to 35°C (95°F). This must be taken as a sign of danger to the workers and exposure to cold should be immediately terminated for any workers when severe shivering becomes evident. Useful physical or mental work is limited when severe shivering occurs.

Since prolonged exposure to cold air, or to immersion in cold water, at temperatures well above freezing can lead to dangerous hypothermia, whole body protection must be provided.

1. Adequate insulating dry clothing to maintain core temperatures above 36°C (96.8°F) must be provided to workers if work is performed in air temperatures below 4°C (40°F). Wind chill cooling rate and the cooling power of air are critical factors. [Wind chill cooling rate is defined as heat loss from a body expressed in watts per meter squared which is a function of the air temperature and wind velocity upon the exposed body.] The higher the wind speed and the lower the temperature in the work area, the greater the insulation value of the protective clothing required. An equivalent chill temperature chart relating the actual dry bulb air temperature and the wind velocity is presented in Table 2. The equivalent chill temperature should beused when estimating the combined cooling effect of wind and low air temperatures on exposed skin or when determining clothing insulation requirements to maintain the deep body core temperature.

TLV®–PA

TABLE 1. Progressive Clinical Presentations of Hypothermia☆

Core Temperature °C	°F	Clinical Signs
37.6	99.6	"Normal" rectal temperature
37	98.6	"Normal" oral temperature
36	96.8	Metabolic rate increases in an attempt to compensate for heat loss
35	95.0	Maximum shivering
34	93.2	Victim conscious and responsive, with normal blood pressure
33	91.4	Severe hypothermia below this temperature
32 } 31 }	89.6 } 87.8 }	Consciousness clouded; blood pressure becomes difficult to obtain; pupils dilated but react to light; shivering ceases
30 } 29 }	86.0 } 84.2 }	Progressive loss of consciousness; muscular rigidity increases; pulse and blood pressure difficult to obtain; respiratory rate decreases
28	82.4	Ventricular fibrillation possible with myocardial irritability
27	80.6	Voluntary motion ceases; pupils nonreactive to light; deep tendon and superficial reflexes absent
26	78.8	Victim seldom conscious
25	77.0	Ventricular fibrillation may occur spontaneously
24	75.2	Pulmonary edema
22 } 21 }	71.6 } 69.8 }	Maximum risk of ventricular fibrillation
20	68.0	Cardiac standstill
18	64.4	Lowest accidental hypothermia victim to recover
1 7	62.6	Isoelectric electroencephalogram
9	48.2	Lowest artificially cooled hypothermia patient to recover

☆Presentations approximately related to core temperature. Reprinted from the January 1982 issue of *American Family Physician*, published by the American Academy of Family Physicians.

2. Unless there are unusual or extenuating circumstances, cold injury to other than hands, feet, and head is not likely to occur without the development of the initial signs of hypothermia. Older workers or workers with circulatory problems require special precautionary protection against cold injury. The use of extra insulating clothing and/or a reduction in the duration of the exposure period are among the special precautions which should be considered. The precautionary actions to be taken will depend upon the physical condition of the worker and should be determined with the advice of a physician with knowledge of the cold stress factors and the medical condition of the worker.

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TABLE 2. Cooling Power of Wind on Exposed Flesh Expressed as Equivalent Temperature (under calm conditions)*

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	–10	–20	–30	–40	–50	–60
	Equivalent Chill Temperature (°F)											
calm	50	40	30	20	10	0	–10	–20	–30	–40	–50	–60
5	48	37	27	16	6	–5	–15	–26	–36	–47	–57	–68
10	40	28	16	4	–9	–24	–33	–46	–58	–70	–83	–95
15	36	22	9	–5	–18	–32	–45	–58	–72	–85	–99	–112
20	32	18	4	–10	–25	–39	–53	–67	–82	–96	–110	–121
25	30	16	0	–15	–29	–44	–59	–74	–88	–104	–118	–133
30	28	13	–2	–18	–33	–48	–63	–79	–94	–109	–125	–140
35	27	11	–4	–20	–35	–51	–67	–82	–98	–113	–129	–145
40	26	10	–6	–21	–37	–53	–69	–85	–100	–116	–132	–148
(Wind speeds greater than 40 mph have little additional effect.)	*LITTLE DANGER* In < hr with dry skin. Maximum danger of false sense of security.				*INCREASING DANGER* Danger from freezing of exposed flesh within one minute.				*GREAT DANGER* Flesh may freeze within 30 seconds.			
	Trenchfoot and immersion foot may occur at any point on this chart.											

* Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA.

▢ Equivalent chill temperature requiring dry clothing to maintain core body temperature above 36°C (96.8°F) per cold stress TLV®.

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Evaluation and Control

For exposed skin, continuous exposure should not be permitted when the air speed and temperature results in an equivalent chill temperature of −32°C (−25.6°F). Superficial or deep local tissue freezing will occur only at temperatures below −1°C (30.2°F) regardless of wind speed.

At air temperatures of 2°C (35.6°F) or less, it is imperative that workers who become immersed in water or whose clothing becomes wet be immediately provided a change of clothing and be treated for hypothermia.

TLVs® recommended for properly clothed workers for periods of work at temperatures below freezing are shown in Table 3.

Special protection of the hands is required to maintain manual dexterity for the prevention of accidents:

1. If fine work is to be performed with bare hands for more than 10 to 20 minutes in an environment below 16°C (60.8°F), special provisions should be established for keeping the workers' hands warm. For this purpose, warm air jets, radiant heaters (fuel burner or electric radiator), or contact warm plates may be utilized. Metal handles of tools and control bars should be covered by thermal insulating material at temperatures below −1°C (30.2°F).
2. If the air temperature falls below 16°C (60.8°F) for sedentary, 4°C (39.2°F) for light, −7°C (19.4°F) for moderate work, and fine manual dexterity is not required, then gloves should be used by the workers.

To prevent contact frostbite, the workers should wear anticontact gloves.

1. When cold surfaces below −7°C (19.4°F) are within reach, a warning should be given to each worker to prevent inadvertent contact by bare skin.
2. If the air temperature is −17.5°C (0°F) or less, the hands should be protected by mittens. Machine controls and tools for use in cold conditions should be designed so that they can be handled without removing the mittens.

Provisions for additional total body protection are required if work is performed in an environment at or below 4°C (39.2°F). The workers should wear cold protective clothing appropriate for the level of cold and physical activity:

1. If the air velocity at the job site is increased by wind, draft, or artificial ventilating equipment, the cooling effect of the wind should be reduced by shielding the work area or by wearing an easily removable windbreak garment.
2. If only light work is involved and if the clothing on the worker may become wet on the job site, the outer layer of the clothing in use may be of a type impermeable to water. With more severe work under such conditions, the outer layer should be water repellent, and the outerwear should be changed as it becomes wetted. The outer garments should include provisions for easy ventilation in order to prevent wetting of inner layers by sweat. If work is done at normal temperatures or in a hot environment before entering the cold area, the employee should make sure that clothing is not wet as a consequence of sweating. If clothing is wet, the employee should change into dry clothes before entering the cold area. The workers should change socks and any removable felt insoles at regular daily intervals or use vapor barrier boots. The optimal frequency of change should be determined empirically and will vary individually and according to the type of shoe worn and how much the individual's feet sweat.
3. If exposed areas of the body cannot be protected sufficiently to prevent sensation of excessive cold or frostbite, protective items should be supplied in auxiliary heated versions.
4. If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work should be modified or suspended until adequate clothing is made available or until weather conditions improve.
5. Workers handling evaporative liquid (gasoline, alcohol or cleaning fluids) at air temperatures below 4°C (39.2°F) should take special precautions to avoid soaking of clothing or gloves with the liquids because of the added danger of cold injury due to evaporative cooling. Special note should be taken of the particularly acute effects of splashes of "cryogenic fluids" or those liquids with a boiling point that is just above ambient temperature.

Work–Warming Regimen

If work is performed continuously in the cold at an equivalent chill temperature (ECT) or below −7°C (19.4°F), heated warming shelters (tents, cabins, rest rooms, etc.) should be made available nearby. The workers should be encouraged to use these shelters at regular intervals, the frequency depending on the severity of the environmental exposure. The onset of heavy shivering, minor frostbite (frostnip), the feeling of excessive fatigue, drowsiness, irritability, or euphoria are indications for immediate return to the shelter. When entering the heated shelter, the outer layer of clothing should be removed and the remainder of the clothing loosened to permit sweat evaporation or a change of dry work clothing provided. A change of dry work clothing should be provided as necessary to prevent workers from returning to work with wet clothing. Dehydration, or the loss of body fluids, occurs insidiously in the cold environment and may increase the susceptibility of the worker to cold injury due to a significant change in blood flow to the extremities. Warm sweet drinks and soups should be provided at the work site to provide caloric intake and fluid volume. The intake of coffee should be limited because of the diuretic and circulatory effects. For work practices at or below −12°C (10.4°F) ECT, the following should apply:

1. The worker should be under constant protective observation (buddy system or supervision).
2. The work rate should not be so high as to cause heavy sweating that will result in wet clothing; if heavy work must be done, rest periods should be taken in heated shelters and opportunity for changing into dry clothing should be provided.

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TABLE 3. TLVs® Work/Warm-up Schedule for a 4-Hour Shift☆

Air Temperature—Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
°C (approx.)	°F (approx.)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
–26° to –28°	–15° to –19°	(Norm. Breaks)	1	(Norm. Breaks)	1	75 min	2	55 min	3	40 min	4
–29° to –31°	–20° to –24°	(Norm. Breaks)	1	75 min	2	55 min	3	40 min	4	30 min	5
–32° to –34°	–25° to –29°	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency work should cease	
–35° to –37°	–30° to –34°	55 min	3	40 min	4	30 min	5	Non-emergency work should cease		↓	
–38° to –39°	–35° to –39°	40 min	4	30 min	5	Non-emergency work should cease		↓		↓	
–40° to –42°	–40° to –44°	30 min	5	Non-emergency work should cease		↓		↓		↓	
–43° & below	–45° & below	Non-emergency work should cease		↓		↓		↓		↓	

NOTES for Table 3:

1. Schedule applies to any 4-hour work period with moderate to heavy work activity, with warm-up periods of ten (10) minutes in a warm location and with an extended break (e.g., lunch) at the end of the 4-hour work period in a warm location. For Light-to-Moderate Work (limited physical movement): apply the schedule one step lower. For example, at –35°C (–30°F) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period (Step 5).
2. The following is suggested as a guide for estimating wind velocity if accurate information is not available:
   5 mph: light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.
3. If only the wind chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: 1) special warm-up breaks should be initiated at a wind chill cooling rate of about 1750 W/m^2; 2) all non-emergency work should have ceased at or before a wind chill of 2250 W/m^2. In general, the warmup schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges because windy conditions rarely prevail at extremely low temperatures.
4. TLVs® apply only for workers in dry clothing.

☆Adapted from Occupational Health & Safety Division, Saskatchewan Department of Labour.

3. New employees should not be required to work fulltime in the cold during the first days of employment until they become accustomed to the working conditions and required protective clothing.
4. The weight and bulkiness of clothing should be included in estimating the required work performance and weights to be lifted by the worker.
5. The work should be arranged in such a way that sitting still or standing still for long periods is minimized. Unprotected metal chair seats should not be used. The worker should be protected from drafts to the greatest extent possible.
6. The workers should be instructed in safety and health procedures. The training program should include as a minimum instruction in:
    a. Proper rewarming procedures and appropriate first aid treatment.
    b. Proper clothing practices.
    c. Proper eating and drinking habits.
    d. Recognition of impending frostbite.
    e. Recognition of signs and symptoms of impending hypothermia or excessive cooling of the body even when shivering does not occur.
    f. Safe work practices.

Special Workplace Recommendations

Special design requirements for refrigerator rooms include the following:

1. In refrigerator rooms, the air velocity should be minimized as much as possible and should not exceed 1 meter/sec (200 fpm) at the job site. This can be achieved by properly designed air distribution systems.
2. Special wind protective clothing should be provided based upon existing air velocities to which workers are exposed.

Special caution should be exercised when working with toxic substances and when workers are exposed to vibration. Cold exposure may require reduced exposure limits.

Eye protection for workers employed out-of-doors in a snow and/or ice-covered terrain should be supplied. Special safety goggles to protect against ultraviolet light and glare (which can produce temporary conjunctivitis and/or temporary loss of vision) and blowing ice crystals should be required when there is an expanse of snow coverage causing a potential eye exposure hazard.

Workplace monitoring is required as follows:

1. Suitable thermometry should be arranged at any workplace where the environmental temperature is below 16°C (60.8°F) so that overall compliance with the requirements of the TLV® can be maintained.
2. Whenever the air temperature at a workplace falls below –1°C (30.2°F), the dry bulb temperature should be measured and recorded at least every 4 hours.

3. In indoor workplaces, the wind speed should also be recorded at least every 4 hours whenever the rate of air movement exceeds 2 meters per second (5 mph).
4. In outdoor work situations, the wind speed should be measured and recorded together with the air temperature whenever the air temperature is below –1°C (30.2°F).
5. The equivalent chill temperature should be obtained from Table 2 in all cases where air movement measurements are required; it should be recorded with the other data whenever the equivalent chill temperature is below –7°C (19.4°F).

Employees should be excluded from work in cold at –1°C (30.2°F) or below if they are suffering from diseases or taking medication which interferes with normal body temperature regulation or reduces tolerance to work in cold environments. Workers who are routinely exposed to temperatures below –24°C (–11.2°F) with wind speeds less than five miles per hour, or air temperatures below –18°C (0°F) with wind speeds above five miles per hour, should be medically certified as suitable for such exposures.

Trauma sustained in freezing or subzero conditions requires special attention because an injured worker is predisposed to cold injury. Special provisions should be made to prevent hypothermia and freezing of damaged tissues in addition to providing for first aid treatment.

TLV®–PA

HEAT STRESS AND HEAT STRAIN

The goal of this TLV® is to maintain body core temperature within + 1°C of normal (37°C). This core body temperature range can be exceeded under certain circumstances with selected populations, environmental and physiologic monitoring, and other controls.

More than any other physical agent, the potential health hazards from work in hot environments depends strongly on physiological factors that lead to a range of susceptibilities depending on the level of acclimatization. Therefore, professional judgment is of particular importance in assessing the level of heat stress and physiological heat strain to adequately provide guidance for protecting nearly all healthy workers with due consideration of individual factors and the type of work. Assessment of both heat stress and heat strain can be used for evaluating the risk to worker safety and health. A decision making process is suggested in Figure 1. The exposure guidance provided in Figures 1 and 2 and in the associated *Documentation* of the TLV® represents conditions under which it is believed that nearly all heat acclimatized, adequately hydrated, unmedicated, healthy workers may be repeatedly exposed without adverse health effects. The Action Limit (AL) is similarly protective of unacclimatized workers and represents conditions for which a heat stress management program should be considered. While not part of the TLV®, elements of a heat stress management program are offered. The exposure guidance is not a fine line between safe and dangerous levels.

Heat Stress is the net heat load to which a worker may be exposed from the combined contributions of metabolic heat, environmental factors, (i.e., air temperature, humidity, air movement, and radiant heat), and clothing requirements. A mild or moderate heat stress may cause discomfort and may adversely affect performance and safety, but it is not harmful to health. As the heat stress approaches human tolerance limits, the risk of heat-related disorders increases.

Heat Strain is the overall physiological response resulting from heat stress. The physiological responses are dedicated to dissipating excess heat from the body.

Acclimatization is a gradual physiological adaptation that improves an individual's ability to tolerate heat stress. Acclimatization requires physical activity under heat-stress conditions similar to those anticipated for the work. With a recent history of heat-stress exposures of at least two continuous hours (e.g., 5 of the last 7 days to 10 of 14 days), a worker can be considered acclimatized for the purposes of the TLV®. Its loss begins when the activity under those heat stress conditions is discontinued, and a noticeable loss occurs after four days and may be completely lost in three to four weeks. Because acclimatization is to the level of the heat stress exposure, a person will not be fully acclimatized to a sudden higher level; such as during a heat wave.

The decision process illustrated in Figure 1, should be started if (1) a qualitative exposure assessment indicates the possibility of heat stress, (2) there are reports of discomfort due to heat stress, or (3) professional judgment indicates heat stress conditions.

Section 1: *Clothing.* Ideally, free movement of cool, dry air over the skin's surface maximizes heat removal by both evaporation and convection.

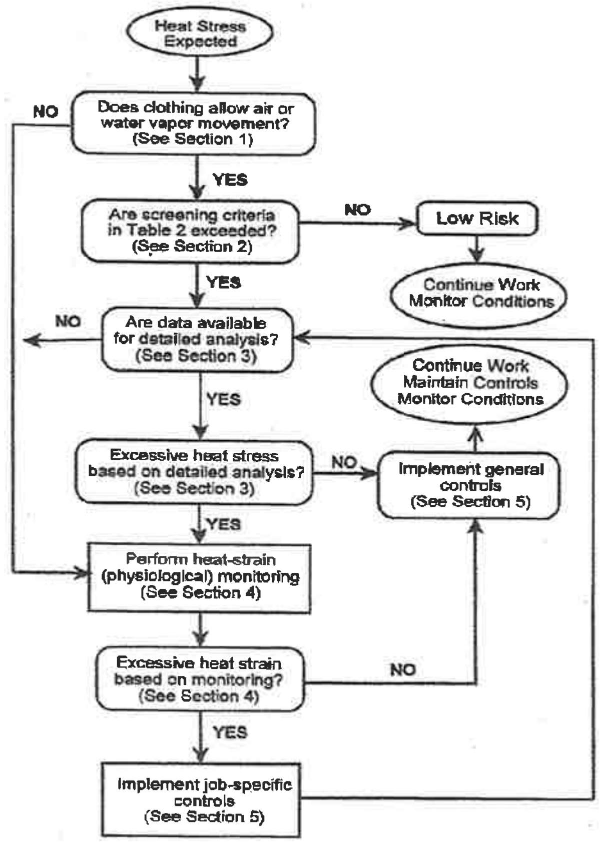

FIGURE 1. Evaluating heat stress and strain.

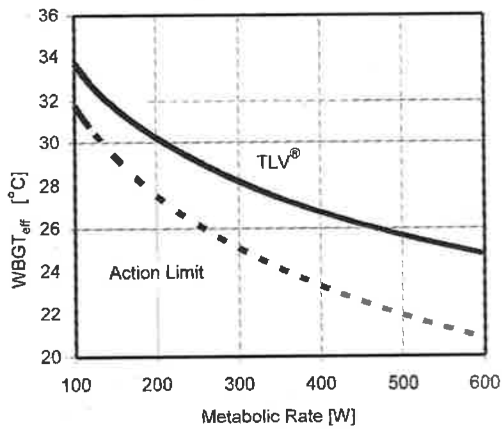

FIGURE 2. TLV® (solid line) and Action Limit (broken line) for heat stress. $WBGT_{eff}$ is the measured WBGT plus the Clothing-Adjustment Factor.

Evaporation of sweat from the skin is the predominant heat removal mechanism. Water-vapor-impermeable, air-impermeable, and thermally insulating clothing, as well as encapsulating suits and multiple layers of clothing, severely restrict heat removal. With heat removal hampered by clothing, metabolic heat may produce excessive heat strain even when ambient conditions are considered cool.

Figure 1 requires a decision about clothing and how it might affect heat loss. The WBGT-based heat exposure assessment was developed for a traditional work uniform of a long-sleeve shirt and pants. If the required clothing is adequately described by one of the ensembles in Table 1 or by other available data, then the "YES" branch is selected.

If workers are required to wear clothing not represented by an ensemble in Table 1, then the "NO" branch should be taken. This decision is especially applicable for clothing ensembles that are 1) totally encapsulating suits or 2) multiple layers where no data are available for adjustments. For these kinds of ensembles, Table 2 is not a useful screening method to determine a threshold for heat-stress management actions and some risk must be assumed. Unless a detailed analysis method appropriate to the clothing requirements is available, physiological and signs/symptoms monitoring described in Section 4 and Table 4 should be followed to assess the exposure.

Section 2: *Screening Threshold Based on Wet-Bulb Globe Temperature (WBGT).* The WBGT offers a useful first order index of the environmental contribution to heat stress. It is influenced by air temperature, radiant heat, air movement, and humidity. As an approximation, it does not fully account for all the interactions between a person and the environment and cannot account for special conditions such as heating from a radiofrequency/microwave source.

TABLE 1. Clothing-Adjustment Factors for Some Clothing Ensembles*

Clothing Type	Addition to WBGT [°C]
Work clothes (long sleeve shirt and pants)	0
Cloth (woven material) coveralls	0
Double-layer woven clothing	3
SMS polypropylene coveralls	0.5
Polyolefin coveralls	1
Limited-use vapor-barrier coveralls	11

*These values must not be used for completely encapsulating suits, often called Level A. Clothing Adjustment Factors cannot be added for multiple layers. The coveralls assume that only modesty clothing is worn underneath, not a second layer of clothing.

WBGT values are calculated using one of the following equations:

With direct exposure to sunlight:

$$WBGT_{out} = 0.7\ T_{nwb} + 0.2\ T_g + 0.1\ T_{db}$$

Without direct exposure to the sun:

$$WBGT_{in} = 0.7\ T_{nwb} + 0.3\ T_g$$

where:

T_{nwb} = natural wet-bulb temperature (sometimes called NWB)
T_g = globe temperature (sometimes called GT)
T_{db} = dry-bulb (air) temperature (sometimes called DB)

Because WBGT is only an index of the environment, the screening criteria are adjusted for the contributions of work demands and clothing. Table 2 provides WBGT criteria suitable for screening purposes. For clothing ensembles listed in Table 1, Table 2 can be used when the clothing adjustment factors are added to the environmental WBGT.

To determine the degree of heat stress exposure, the work pattern and demands must be considered. If the work (and rest) is distributed over more than one location, then a time-weighted average WBGT should be used for comparison to Table 2 limits.

As metabolic rate increases (i.e., work demands increase), the criteria values in the table decrease to ensure that most workers will not have a core body temperature above 38°C. Correct assessment of work rate is of equal importance to environmental assessment in evaluating heat stress. Table 3 provides broad guidance for selecting the work rate category to be used in Table 2. Often there are natural or prescribed rest breaks within an hour of work, and Table 2 provides the screening criteria for three allocations of work and rest.

Based on metabolic rate category for the work and the approximate proportion of work within an hour, a WBGT criterion can be found in Table 2 for

TABLE 2. Screening Criteria for TLV® and Action Limit for Heat Stress Exposure

Allocation of Work in a Cycle of Work and Recovery	TLV® (WBGT values in °C)				Action Limit (WBGT values in °C)			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75 to 100%	31.0	28.0	–	–	28.0	25.0	–	–
50 to75%	31.0	29.0	27.5	–	28.5	26.0	24.0	–
25 to 50%	32.0	30.0	29.0	28.0	29.5	27.0	25.5	24.5
0 to 25%	32.5	31.5	30.5	30.0	30.0	29.0	28.0	27.0

Notes:

- See Table 3 and the *Documentation* for work demand categories.
- WBGT values are expressed to the nearest 0.5°C.
- The thresholds are computed as a TWA-Metabolic Rate where the metabolic rate for rest is taken as 115 W and work is the representative (mid-range) value of Table 3. The time base is taken as the proportion of work at the upper limit of the percent work range (e.g., 50% for the range of 25 to 50%).
- If work and rest environments are different, hourly time-weighted averages (TWA) WBGT should be calculated and used. TWAs for work rates should also be used when the work demands vary within the hour, but note that the metabolic rate for rest is already factored into the screening limit.
- Values in the table are applied by reference to the "Work-Rest Regimen" section of the *Documentation* and assume 8-hour workdays in a 5-day workweek with conventional breaks as discussed in the *Documentation*. When workdays are extended, consult the "Application of the TLV®" section of the *Documentation*.
- Because of the physiological strain associated with Heavy and Very Heavy work among less fit workers regardless of WBGT, criteria values are not provided for continuous work and for up to 25% rest in an hour for Very Heavy. The screening criteria are not recommended, and a detailed analysis and/or physiological monitoring should be used.
- Table 2 is intended as an initial screening tool to evaluate whether a heat stress situation may exist (according to Figure 1) and thus, the table is more protective than the TLV® or Action Limit (Figure 2). Because the values are more protective, they are not intended to prescribe work and recovery periods.

TABLE 3. Metabolic Rate Categories and the Representative Metabolic Rate with Example Activities

Category	Metabolic Rate [W] *	Examples
Rest	115	Sitting
Light	180	Sitting with light manual work with hands or hands and arms, and driving. Standing with some light arm work and occasional walking.
Moderate	300	Sustained moderate hand and arm work, moderate arm and leg work, moderate arm and trunk work, or light pushing and pulling. Normal walking.
Heavy	415	Intense arm and trunk work, carrying, shoveling, manual sawing; pushing and pulling heavy loads; and walking at a fast pace.
Very Heavy	520	Very intense activity at fast to maximum pace.

* The effect of body weight on the estimated metabolic rate can be accounted for by multiplying the estimated rate by the ratio of actual body weight divided by 70 kg (154 lb).

the TLV® and for the Action Limit. If the measured time-weighted average WBGT adjusted for clothing is less than the table value for the Action Limit, the NO branch in Figure 1 is taken, and there is little risk of excessive exposures to heat stress. If the conditions are above the Action Limit, but below the TLV®, then consider general controls described in Table 5. If there are reports of the symptoms of heat-related disorders such as fatigue, nausea, dizziness, and lightheadedness, then the analysis should be reconsidered.

If the work conditions are above the TLV® screening criteria in Table 2, then a further analysis is required following the YES branch.

Section 3: *Detailed Analysis.* Table 2 is intended to be used as a screening step. It is possible that a condition may be above the TLV® or Action Limit criteria provided in Table 2 and still not represent an exposure above the TLV® or the Action Limit. To make this determination, a detailed analysis is required. Methods are fully described in the *Documentation*, in industrial hygiene and safety books, and in other sources.

Provided that there is adequate information on the heat stress effects of the required clothing, the first level of detailed analysis is a task analysis that includes a time-weighted average of the Effective WBGT (environmental WBGT plus clothing adjustment factor) and the metabolic rate. Some clothing adjustment factors have been suggested in Table 1. Factors for other clothing ensembles appearing in the literature can be used in similar fashion following good professional judgment. The TLV® and Action Limit are shown in Figure 2.

The second level of detailed analysis would follow a rational model of heat stress, such as the International Standards Organization (ISO) Predicted Heat Strain (ISO 7933 2004; Malchaire et al., 2001). While a rational method (versus the empirically derived WBGT thresholds) is computationally more difficult, it permits a better understanding of the sources of the heat stress and is a means to appreciate the benefits of proposed modifications in the exposure. Guidance to the ISO method and other rational methods is described in the literature.

The screening criteria require the minimal set of data to make a determination. Detailed analyses require more data about the exposures. Following Figure 1, the next question asks about the availability of data for a detailed analysis. If these data are not available, the NO branch takes the evaluation to physiological monitoring to assess the degree of heat strain.

If the data for a detailed analysis are available, the next step in Figure 1 is the detailed analysis. If the exposure does not exceed the criteria for the Action Limit (or unacclimatized workers) for the appropriate detailed analysis (e.g., WBGT analysis, another empirical method, or a rational method), then the NO branch can be taken. If the Action Limit criteria are exceeded but the criteria for the TLV® (or acclimatized workers) in the detailed analysis are not exceeded, then implement general controls and continue to monitor the conditions. General controls include training for workers and supervisors, heat stress hygiene practices, and medical surveillance. If the exposure exceeds the limits for acclimatized workers in the detailed analysis, the YES branch leads to physiological monitoring as the only alternative to demonstrate that adequate protection is provided.

Section 4: *Heat Strain.* The risk and severity of excessive heat strain will vary widely among people, even under identical heat stress conditions. The normal physiological responses to heat stress provide an opportunity to monitor heat strain among workers and to use this information to assess the level of heat strain present in the workforce, to control exposures, and to assess the effectiveness of implemented controls. Table 4 provides guidance for acceptable limits of heat strain.

Following good industrial hygiene sampling practice, which considers likely extremes and the less tolerant workers, the absence of any of these limiting observations indicates acceptable management of the heat stress exposures. With acceptable levels of heat strain, the NO branch in Figure 1 is taken. Nevertheless, if the heat strain among workers is considered acceptable at the time, consideration of the general controls is recommended. In addition, periodic physiological monitoring should be continued to ensure acceptable levels of heat strain.

If limiting heat strain is found during the physiological assessments, then the YES branch is taken. This means that suitable job-specific controls should be implemented to a sufficient extent to control heat strain. The job-specific controls include engineering controls, administrative controls, and personal protection.

After implementation of the job-specific controls, it is necessary to assess their effectiveness and to adjust them as needed.

TABLE 4. Guidelines for Limiting Heat Strain

Monitoring heat strain and signs and symptoms of heat-related disorders is sound industrial hygiene practice, especially when clothing may significantly reduce heat loss. For surveillance purposes, a pattern of workers exceeding the heat strain limits is indicative of a need to control the exposures. On an individual basis, the limits represent a time to cease an exposure and allow for recovery.

One or more of the following measures may mark excessive heat strain, and an individual's exposure to heat stress should be discontinued when any of the following occur:

- Sustained (several minutes) heart rate is in excess of 180 bpm (beats per minute) minus the individual's age in years (e.g., 180 – age), for individuals with assessed normal cardiac performance; or
- Body core temperature is greater than 38.5°C (101.3°F) for medically selected and acclimatized personnel; or greater than 38°C (100.4°F) in unselected, unacclimatized workers; or
- Recovery heart rate at one minute after a peak work effort is greater than 120 bpm; or
- There are symptoms of sudden and severe fatigue, nausea, dizziness, or lightheadedness.

An individual may be at greater risk of heat-related disorders if:

- Profuse sweating is sustained over hours; or
- Weight loss over a shift is greater than 1.5% of body weight; or
- 24-hour urinary sodium excretion is less than 50 mmoles

EMERGENCY RESPONSE: If a worker appears to be disoriented or confused, suffers inexplicable irritability, malaise, or chills, the worker should be removed for rest in a cool location with rapidly circulating air and kept under skilled observation. Absent medical advice to the contrary, treat this as an emergency with immediate transport to a hospital. An emergency response plan is necessary.

— NEVER ignore anyone's signs or symptoms of heat-related disorders —

Section 5: *Heat Stress Management and Controls.* The elements of a heat stress management program including general and job-specific controls should be considered in the light of local conditions and the judgment of the industrial hygienist. The recommendation to initiate a heat stress management program is marked by 1) heat stress levels that exceed the Action Limit or 2) work in clothing ensembles that limit heat loss. In either case, general controls should be considered (Table 5).

Heat stress hygiene practices are particularly important because they reduce the risk that an individual may suffer a heat-related disorder. The key elements are fluid replacement, self-determination of exposures, health status monitoring, maintenance of a healthy lifestyle, and adjustment of expectations based on acclimatization state. The hygiene practices require the full cooperation of supervision and workers.

Stress Management Program

Monitor heat stress (e.g., WBGT Screening Criteria in Table 2) and heat strain (Table 4) to confirm adequate control

General Controls

- Provide accurate verbal and written instructions, annual training programs, and other information about heat stress and strain
- Encourage drinking small volumes (approximately 1 cup) of cool, palatable water (or other acceptable fluid replacement drink) about every 20 minutes
- Encourage employees to report symptoms of heat-related disorders to a supervisor
- Encourage self-limitation of exposures when a supervisor is not present
- Encourage co-worker observation to detect signs and symptoms of heat strain in others
- Counsel and monitor those who take medications that may compromise normal cardiovascular, blood pressure, body temperature regulation, renal, or sweat gland functions; and those who abuse or are recovering from the abuse of alcohol or other intoxicants
- Encourage healthy lifestyles, ideal body weight and electrolyte balance
- Adjust expectations of those returning to work after absence from hot exposure situations and encourage consumption of salty foods (with approval of physician if on a salt-restricted diet)
- Consider pre-placement medical screening to identify those susceptible to systemic heat injury
- Monitor the heat stress conditions and reports of heat-related disorders

Job-Specific Controls

- Consider engineering controls that reduce the metabolic rate, provide general air movement, reduce process heat and water vapor release, and shield radiant heat sources, among others
- Consider administrative controls that set acceptable exposure times, allow sufficient recovery, and limit physiological strain
- Consider personal protection that is demonstrated effective for the specific work practices and conditions at the location

— NEVER ignore anyone's signs or symptoms of heat-related disorders —

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In addition to general controls, appropriate job-specific controls are often required to provide adequate protection. During the consideration of job-specific controls, Table 2 and Figure 2, along with Tables 1 and 3, provide a framework to appreciate the interactions among acclimatization state, metabolic rate, work-rest cycles, and clothing. Among administrative controls, Table 4 provides acceptable physiological and signs/symptoms limits. The mix of job-specific controls can be selected and implemented only after a review of the demands and constraints of any particular situation. Once implemented, their effectiveness must be confirmed and the controls maintained.

The prime objective of heat stress management is the prevention of heat stroke, which is life-threatening and the most serious of the heat-related disorders. The heat stroke victim is often manic, disoriented, confused, delirious, or unconscious. The victim's body core temperature is greater than 40°C (104°F). If signs of heat stroke appear, aggressive cooling should be started immediately, and emergency care and hospitalization are essential. The prompt treatment of other heat-related disorders generally results in full recovery, but medical advice should be sought for treatment and return-to-work protocols. It is worth noting that the possibility of accidents and injury increases with the level of heat stress.

Prolonged increases in deep body temperatures and chronic exposures to high levels of heat stress are associated with other disorders such as temporary infertility (male and female), elevated heart rate, sleep disturbance, fatigue, and irritability. During the first trimester of pregnancy, a sustained core temperature greater than 39°C may endanger the fetus.

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References

1. International Organization for Standardization (ISO): Ergonomics of the thermal environment – Analytical determination and interpretation of heat stress using calculation of the predicted heat strain. ISO 7933:2004. ISO, Geneva (2004).
2. Malchaire J; Piette A; Kampmann B; et al.: Development and validation of the predicted heat strain model. Ann Occup Hyg. 45(2):123–135 (2001).

APPENDIX B
BHATE FIELD SAMPLING SOPS
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BHATE STANDARD OPERATING PROCEDURES (BSOP) FOR FEDERAL PROGRAMS

No: 1-13
AUGUST 2002

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BHATE STANDARD OPERATING PROCEDURES

FIELD PROCEDURES 1 – 13

AUGUST 2002

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BSOP No. 2: Site Access and Clearance on Federal Installations

BSOP No. 3: Field Records and Documentation

BSOP No. 4: Sample Nomenclature and Control

BSOP No. 5: Geophysical Investigation Methods

BSOP No. 6: Quality Control Procedures for Field Equipment

BSOP No. 7: Surface Water and Sediment Sampling

BSOP No. 8: Standard Field Parameter Measurements

BSOP No. 9: Field Screening Techniques

BSOP No. 10: Subsurface Water Investigation

BSOP No. 11: Surveying

BSOP No. 12: Well and Borehole Abandonment

BSOP No. 13: Standard Cleaning and Decontamination Procedures

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BHATE STANDARD OPERAtING PROCEDURES

FIELD PROCEDURES 1 - 13

Approved for Implementation:

Greg Gainer, Operations Manager — Date: 9/25/02

Jay D. Carter, Principal — Date: 9/25/02

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BSOP NO. 1

SOIL SAMPLING AND SUBSURFACE INVESTIGATIONS

BHATE STANDARD OPERATING PROCEDURE NO. 1

SOIL SAMPLING AND SUBSURFACE INVESTIGATIONS

Bhate Standard Operating Procedure (BSOP) No. 1 and associated attachments are intended to aid in developing a systematic approach to performing soil sampling and subsurface soil investigations at various types of federal installations. The focus, structure, and organization of BSOP No. 1 are tailored to address sampling protocols and policies for Bhate Environmental Associates, Inc. field personnel in the absence of specific regulatory or installation environmental program requirements and standard operating procedures.

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BSOP NO. 1

SOIL SAMPLING AND SUBSURFACE INVESTIGATIONS

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1 EQUIPMENT

Prior to mobilization to the field, personnel shall assemble equipment necessary to classify, describe, and log soil samples and subsurface soil conditions. At a minimum, this should include the following equipment:

- Site specific log book
- Indelible pens
- Clipboard, preferably aluminum and water proof 9 inches by 12 inches
- Straightedge
- Scale, engineer's
- Engineer's ruler (6-foot) or retractable steel tape with increments in 10ths and 100ths of feet
- Appropriate field forms (e.g., Drilling Logs)
- Standard grain size reference for sands
- ASTM Group Symbol, Group Name Charts
- Munsell™ color chart
- Eight ounce glass sample jar with lid for settling tests
- Pocket calculator
- Hand lens
- No. 200 sieve
- Pocket knife or small spatula
- Water-level tape

Additional items, which may be necessary include:

- Pocket penetrometer
- Tape, fiberglass, 100 feet with increments in 10ths and 100ths of feet
- Stainless steel weight (tag bar)

- Indelible felt-tip marking pens (Sharpie® or equivalent)

- Dilute (10 percent) hydrochloric acid

Sand grain size will be classified in accordance with the Unified Soil Classification System (USCS) scale and will be determined using field measurement tools such as the 5 x 7-inch USCS Geotechnical Gauge manufactured by W.F. McCollough of Beltsville, Maryland.

Boring logs will be prepared in the field on a Hazardous Toxic Waste (HTW) Drilling Log Form by a geologist or geotechnical engineer. Both a blank and completed example log are presented as Attachment 1-1. A geologist or geotechnical engineer will review and sign the completed log. Detailed requirements for the preparation of the HTW Drilling Log are provided in Chapter 4 of this BSOP.

2 FIELD PROCEDURE FOR SOIL CLASSIFICATION

Exploratory soil borings typically represent the single most important source of information used for characterizing subsurface soil conditions for environmental or geotechnical studies. This Chapter is intended to provide a basis for consistency among field personnel responsible for documenting subsurface soil conditions encountered in exploratory soil borings.

This BSOP presents detailed procedures for classifying and describing soils based upon the USCS and standard practices developed by the American Society for Testing and Materials (ASTM). The following descriptive elements are recommended as a minimum basis for all soil descriptions:

- Material classification
- Density or consistency
- Moisture condition
- Color
- Texture/particle size distribution
- Plasticity/cohesiveness
- Stratification/structure
- Geologic origin and/or formation name

Other factors which should be described as needed include gradation or sorting; the presence of boulders, cobbles, or bedrock fragments; angularity and shape of granular components; hardness of granular components; weathering; accessory mineral lithology; cementation; odor; and the presence of any other feature which may affect the strength or stability of the soil or contribute to secondary porosity (e.g., channel from roots or animal burrows and voids resulting from subsidence).

All of the classification procedures described in this BSOP are based upon visual inspection and simple manual tests, which can be performed in the field. It must be clearly stated in reporting that classification is based upon visual-manual procedures. If more quantitative data are required, laboratory testing should be performed on representative samples to support field descriptions.

Soils rarely exist in nature as individual components (gravel, sand, silt, or clay). Mixtures of the individual components in varying proportions are much more common. Each component contributes to the characteristics of the soil mixture. In order to classify a soil mixture, the relative percentages of the component grain sizes must be determined. The first step is to determine whether the soil is predominantly coarse-grained (gravel and/or sand) or fine-grained (silt and/or clay). Although the USCS is based on percentage by weight, estimation of the relative percentage of soil components in the field must be based upon visual assessment of the relative volumes of materials present. After this has been performed, a mental adjustment to weight percentage, based upon experience, is accomplished. Periodic comparison of field descriptions to laboratory test results is crucial to develop this skill.

Spreading the sample out in the palm of the hand and making a visual estimate can make a rough determination of the relative weight percentages of the components present. Carefully washing the fines from a portion of a sample by mixing the soil with water and pouring off the clouded suspension of fines and water will aid in estimating the percentage of fines present by comparison with an unaltered portion. Mixing a sample with water in a jar and allowing the mixture to settle is also helpful. The coarse-grained components will fall completely out of suspension in 20 to 30 seconds.

When describing bulk samples or soils exposed in an excavation, the percentages of cobbles and boulders should be estimated by volume. The remaining soil matrix should be described independently.

Soil descriptions include estimates of the weight percentages and plasticity characteristics of the soils, which can only be determined accurately by laboratory testing. With care and experience, however, sufficient accuracy for most purposes can be attained using visual/manual techniques. Laboratory testing can therefore be minimized.

2.1 Identification

The USCS groups soils into three major divisions: coarse-grained soils, fine-grained soils, and highly organic soils. The characteristics, which define these soil groups and procedures involved in identifying the individual components, are described in the following paragraphs.

2.1.1 Coarse-Grained Soils

Coarse-grained soil components are defined as materials which would pass through the 3-inch sieve and which would be retained on the Number 200 sieve (0.075 millimeters (mm)). Coarse-grained soil components are further sub-divided by grain size as defined in Attachment 2-1. A soil is considered coarse-grained if 50 percent or more of a sample (by dry weight) is larger than 0.075 mm. The range of both fine- and coarse-grained soil components present in a sample should be determined by careful examination.

2.1.2 Fine-Grained Soils

A soil is considered fine-grained if 50 percent or more of a sample (by dry weight) is smaller than 0.075 mm (Number 200 sieve). Fines can be subdivided into silt and clay. Classification of fine-grained soil components may be based upon mineralogy, grain-size, or physical behavior. Grain-size is difficult to estimate because of the size classes involved and the limitations imposed by field equipment such as hand lenses. Additionally, textural classification of fines can be misleading in terms of geotechnical properties. For these reasons the USCS defines the terms “silt” and “clay” solely on the basis of the plasticity characteristics of material finer than 0.075 mm.

In the field, simple tests, which can be used as indicators of plasticity, can be performed. Attachment 2-1 describes how the results of these field tests can be correlated with plasticity. Field test procedures for estimating the plasticity of soils and identifying fine-grained soil components are discussed below and summarized in Attachment 2-3. Knowledge of local soil types is also helpful for accurate field classification of fines.

2.1.3 Organic Soils

Organic soils contain sufficient organic matter, living or decaying, to significantly affect the engineering properties of the soil. Most organic soils can be considered as a special category of fine-grained soils. Topsoil, humus, peat, organic silt, organic clay, and diatomaceous earth are common examples. The water content of organic soils is typically very high. Organic soils invariably have very low shear strength in their natural state, but may exhibit high tensile strength in certain directions due to fibrous materials.

Observations of color and odor are of particular value for the identification of organic soils. Dark gray, black, and various shades of brown are characteristic colors. Any color may be expected of inorganic fines. Organic soils frequently change color when exposed to air. Many organic soils, particularly marine peats and silts, have a distinctive odor of hydrogen sulfide. This odor is especially apparent in fresh samples. Heating the sample intensifies the odor.

Organic silts and clays typically exhibit slight to medium plasticity (see Attachment 2-2 for the Criteria for Estimating Plasticity and Field Classification of Fine-Grained Soils) and form threads that are very weak, soft, and spongy near the plastic limit. Less effort is required to pull fine-grained non-fibrous organic soils apart than inorganic fines. A clean break is generally formed. The smear of organic silts and clays, although smooth, is very dull.

Peat is an organic soil characterized by the presence of vegetable matter (for example, leaves, sticks, grass, wood, and/or moss) in various stages of decomposition. These components generally impart a fibrous texture to the soil. Peat is typically brown or black in color. Peat and organic silt are common components of fresh water swamps, bogs, and tidal flats.

Diatomaceous earth is an organic soil commonly found in the lower stratum of peat bogs. This material is composed primarily of the siliceous skeletal remains of diatoms, which accumulated in lakes and swamps. The amount and nature of impurities is highly variable and may include sponge spicules and radiolarian remains as well as organic and inorganic silt and clay. Color ranges from white to yellow to various shades of brown and gray.

Another important consideration in the identification of organic soils may be the location with respect to topography. Low-lying swampy areas commonly contain highly organic soils.

2.2 Descriptive Format and Terminology

The USCS provides useful information about soil gradation and plasticity. However, critical information necessary for site interpretation and evaluation are not included in the USCS. For example, nearly all the fine-grained deposits in northeastern Illinois and southeastern Wisconsin (loess, several till members or formations, and various glaciolacustrine and glaciofluvial deposits) can be classified as a LEAN CLAY (CL) using the USCS alone, yet each of these sediment types differ significantly in density and shear strength, lateral and vertical variability, and hydraulic conductivity. The USCS should therefore be supplemented with additional information. The following discussion identifies features, which should be evaluated and described to supplement the USCS.

2.2.1 Order of Description

The descriptive format begins with the USCS group name and symbol, which is discussed in more detail below. A detailed description, based upon ASTM standards, follows the USCS classification. For consistency, the primary descriptive elements listed below should be included in all soil descriptions, presented in the following standardized order:

- USCS group name and symbol (underlined and capitalized)
- Density or consistency
- Moisture condition
- Color
- Gradation (relative percentages of all soil components)
- Plasticity and cohesiveness
- Stratification and structure

A description of other pertinent properties should be included, as needed, following the primary descriptive elements listed above.

Following the detailed soil description, the probable geologic origin should be provided (in capital letters as shown). A typical description is presented below:

Poorly Graded Sand With Gravel (SP)

Loose, dry, pale yellow (2.5 YR 7/3), mostly coarse to fine sand, little gravel, cohesionless, rounded to subrounded grains; occasional layers (1 inch thick) of dry, light yellowish brown (2.5 YR 6/3) lean clay, low plasticity, cohesive (CL). ALLUVIUM.

Soil/sediment descriptions should be as comprehensive as possible, without excessive emphasis on insignificant details. Good judgment and common sense based on an understanding of geology and engineering behavior of soils is required.

2.3 Primary Descriptive Elements

2.3.1 Soil Type (Group Name and Symbol)

USCS group names and symbols should be assigned according to the flow charts presented on Attachment 2-4.

If a soil is classified as a gravel or sand and it contains 12 percent or less fines, it is considered to be either well-graded or poorly-graded, depending upon the distribution of grain sizes (gradation) present.

- Well-graded is an engineering term which indicates a continuous distribution of particle sizes from the coarsest to finest particle size of the relevant fraction. Poorly-graded pertains to sediments which lack a continuous distribution of grain sizes. Poorly-graded include uniformly-graded (predominantly one particle size or well sorted) and gap-graded or step-graded (one or more particle sizes absent) sediments.

- If a soil contains any cobbles or boulders, add “with cobbles” or “with boulders” to the group name.

- If a fine-grained soil contains (little) 15 to 25 percent sand, gravel or both, add “with sand” or “with gravel” to the group name (whichever is more predominant). Use “with sand” if the related percentages are equal.

- If a granular soil contains 10 percent (few) fines, add “with silt” or “clay” to the group name.

Use of an adjective modifier:

- If a fine-grained soil contains 30 percent or more sand or gravel (some), add “sandy” or “gravelly” to the group name (e.g., SANDY SILT, GRAVELLY LEAN CLAY).

- If a granular soil contains more than 15 percent (little) fines, use an adjective modifier (e.g., SILTY SAND, CLAYEY GRAVEL).

Use of dual USCS symbols:

- If a granular soil is estimated to contain 10 percent fines use a dual symbol.
- The first symbol should correspond to a clean gravel or sand.
- The second symbol should correspond to a gravel or sand with fines (e.g., GW-GC, SP-SM).
- Based on the USCS Plasticity Chart, do not use the combination CL-ML unless substantiated by laboratory analyses.

Use of borderline USCS symbols:

- Use to indicate a soil with properties that do not distinctly place the soil into a specific group (e.g., CL/CH, GM/SM, ML/SM).

Use of the term "and":

- Using the USCS, "and" may be used to indicate that soils are interbedded by linking group names (e.g., LEAN CLAY [CL] AND POORLY GRADED SAND [SP])

2.3.2 Density or Consistency

Density relates to cohesionless (predominantly coarse-grained) materials, while consistency relates to cohesive (predominantly fine-grained) soil. Both can be estimated from the standard penetration test. The standard penetration test is defined as the number of blows required to drive a standard 2-inch outside diameter split-barrel (spoon) sampler through 12 inches of undisturbed soil using a free falling 140 pound weight being dropped from a height of 30 inches. The blow count is recorded in 6-inch increments. The sampler may be driven 18 or 24 inches, typically corresponding to the internal length of the sample barrel. The first 6 inches is considered to be a seating drive. The sum of the blows required for the second and third 6-inch increments is defined as the penetration resistance (N-value). Standard penetration tests should be performed in accordance with procedures described in ASTM D 1586. It is essential to ensure that standard penetration test procedures adhere to this ASTM standard so that blow counts yield meaningful N-values.

Consistency can also be readily evaluated by feel or with a pocket penetrometer (PP) or vane shear instrument such as a torvane (TV). When using these methods to estimate consistency, sample disturbance should be considered critically.

Terms for describing the density or consistency of a soil are presented in Table 2-1 below:

Table 2-1. Cohesionless (Predominantly Coarse-Grained) Soils

N-Value (Blows per Foot)	Relative Density in Percent	Field Test	Density
0-4	0 – 15	Easily penetrated with ½-inch reinforcing rod pushed by hand.	Very loose
5-10	15 – 35	Easily penetrated with ½-inch reinforcing rod pushed by hand.	Loose
11-30	35 – 65	Penetrate 1 foot with ½-inch reinforcing rod driven with 5-lb hammer	Medium dense
31-50	65 – 85	Penetrate 1 foot with ½-inch reinforcing rod driven with 5-lb hammer	Dense

Table 2-2. Cohesive (Predominantly Fine-Grained) Soils

N-Value	Consistency	Manual Criteria	Unconfined Compressive Strength, q_u (Tons/Sq. Ft.)*	Undrained Shear Strength, S_u (Tons/Sq. Ft.)**
<2	Very Soft	Thumb will easily penetrate soil more than 1 inch. Exudes between thumb and fingers when squeezed in hand.	<0.25	< 0.12
2-4	Soft	Thumb will easily penetrate soil about 1 inch. Molded by light finger pressure.	0.25 - 0.5	0.12 - 0.25
5-8	Medium stiff	Thumb will indent soil about ¼ inch with moderate effort. Molded by strong finger pressure	0.5 - 1	0.25 - 0.5
9-15	Stiff	Indented by thumb ¼ inch only with great effort.	1 - 2	0.5 - 1
16-30	Very stiff	Thumb will not indent soil. Readily indented with fingernail.	2 - 4	1 - 2
31 +	Hard	Indented with difficulty with thumbnail.	>4	> 2

* Measured with pocket penetrometer.
** Measured with Torvane or similar vane shear instrument.

Since the terms for density and consistency are the first entries of the written description, the first word of the description should be capitalized and a comma used as illustrated by the following examples:

- Very soft
- Very loose

2.3.3 Moisture Condition

The moisture condition of the soil shall be described on the field boring log. Soils are described as being dry, moist, slightly moist, wet, or saturated with increasing degrees of saturation when formed into a ball in the palm of a gloved hand. Moisture condition is based on the following criteria:

Table 2-3. Moisture Determination

Description	Criteria
Dry	Forms a very weak ball, aggregated and individual soil grains break away easily from ball, dusty.
Slightly Moist	Forms a weak ball with defined finger marks, darkened color, no water staining on fingers, grains break away.
Moist	Forms a ball with defined finger marks, very light soil/water staining on fingers, darkened color will not stick.
Wet	Forms a ball with wet outline left on hand, light to medium staining on fingers, makes a weak ribbon between the thumb and forefinger.
Saturated	Forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, medium to heavy soil/water coating on fingers.

2.3.4 Color

Color should be based on the Munsell™ Soil Color Charts. The charts provide a semi-quantitative aid in correlation across a site. It also provides information to help assess secondary weathering zones and moisture relationships.

When naturally wet soils are described after being allowed to dry, it should be noted on the log. Color description should not be capitalized and should be followed by the alpha-numeric Munsell™ code in parentheses as shown in the following examples:

- pale red (2.5 YR 6/2)

- very dark brown (7.5 YR 2.5/2)

2.3.5 Gradation

The soil components present in a sample should be identified as described at the beginning of this Chapter. The relative percentages of the different fractions present should be described based upon the estimations outlined in Table 2-4, using the following terms from ASTM D 2488:

Table 2-4. Gradation Determination

Description	Percentages
Mostly	50 - 100 percent
Some	30 - 45 percent
Little	15 - 25 percent
Few	5 - 10 percent
Trace	Particles are present but estimated to be less than 5 percent

The component with the highest percentage should be recorded first with the next highest percentage recorded next.

Gradation within the sand and gravel fractions must be defined or it is assumed that all fractions are present. When recording gradation, always begin with the coarser fraction, (e.g., mostly coarse to fine gravel, and mostly medium to fine sand).

2.3.6 Plasticity and Cohesiveness

If a sediment sample is predominantly fine-grained, a plasticity designation should be provided. Plasticity designations are provided on Attachment 2-2.

Additionally, the cohesiveness of soils including both fine- and coarse-grained components should be noted. Soils in which the adsorbed water and particle attraction work together to produce a mass, which holds together and deforms plastically at varying water contents are known as cohesive soils. A predominantly coarse-grained soil could be cohesive in character with as little as 20 percent fines, depending upon the overall gradation of the material and the plasticity characteristics of the fines. A soil accurately classified, as GC or SC would always be cohesive.

Mixtures of coarse- and fine-grained soils should be described as either cohesive or cohesionless.

2.3.7 Stratification/Structure

Most geologic structures may be characterized as stratified or massive, or some variation. Some terminology for describing soil structure or stratification are defined below:

Table 2-5. Stratification/Structure Determination

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Massive (Homogeneous)	Same color and appearance throughout
Bedding Attitude	Horizontal or Inclined (with angle)
Lithologic Contact	Sharp or Gradational (with nature of gradation)

The identification of naturally occurring fractures or planes of weakness (as opposed to those which may have been produced by the drilling or sampling process) can be made through the recognition of surface coatings, changes in oxidation state of adjacent materials, or stress surfaces such as slickensides. Common surface coatings include carbonates, organics, secondary iron, manganese oxide, and silt or clay. Changes or mottling in color adjacent to a fracture surface are generally indicative of a change in oxidation state associated with a naturally occurring fracture.

2.3.8 Geologic Interpretation

A geologic interpretation may be provided with each description. This may include a genetic interpretation (such as alluvium or saprolite), geologic age, and/or formation name. Accurate field interpretation of geologic origin may support geologic evaluations conducted later in the office. Identification of geologic origin or depositional environment is often necessary to support interpretations of the distribution, uniformity, or variability of subsurface soils and sediments. The geomorphic position of individual boring locations (e.g., crest of a hill, terrace, edge of a flood plain, etc.) should be considered when making this determination. Common soil types and geologic interpretations are included in Attachment 2-5.

2.3.9 Other Descriptive Elements

The understanding of subsurface conditions at a site is dependent upon detailed descriptions of soil or sediment samples. The following additional characteristics should be considered and described, if pertinent. It is the responsibility of the field geologist and project staff to determine the extent of detail required. These additional elements should be appended to the primary description, separated by a semicolon.

- Angularity and shape of coarse-grained components
- Hardness of coarse-grained components
- Presence of boulders or cobbles
- Fossils
- Accessory minerals
- Lithology of coarse-grained components
- Cementation or presence of calcareous materials
- Odor
- Weathering zone
- Presence of roots, root holes, animal burrows or other macro-pores

2.3.10 Angularity and Shape of Coarse-Grained Components

The description of the angularity of coarse-grained sand, gravel, cobbles, and boulders may provide a basis for interpretation of geologic origin and correlation of geologic units encountered at different locations. The following terminology should be used:

Table 2-6. Angularity Descriptions

Description	Criteria
Angular	Particles have sharp edges and relatively planar sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly planar sides but have well-rounded edges.
Rounded	Particles have smoothly curved sides and no edges.

The shape of gravel, cobbles and boulders should be described as follows:

Table 2-7. Shape Descriptions

Description	Criteria
Flat	Particles with width/thickness >3 cm
Elongated	Particles with length/width >3 cm
Flat and elongated	Particles meet criteria for both flat and elongated

2.3.11 Hardness of Coarse-Grained Components

Coarse sand and larger particles may be described as “hard” if particles do not crack, fracture, or crumble under a hammer blow. Alternatively, state what happens when particles are hit with a hammer.

2.3.12 Presence of Cobbles and Boulders

The presence of cobbles or boulders should be noted. This may be evident through observation of drill advance or by fragments recovered in samples. If possible (such as in a test pit) a volumetric estimate of the percent of cobbles or boulder present should be made. Alternatively, a qualitative description such as “occasional” or “numerous” cobbles or boulders should be provided. If any cobbles or boulders are present, “with cobbles” or “with boulders” should be appended to the USCS group name.

2.3.13 Fossils, Accessory Minerals, or Lithology of Coarse-Grained Components

Fossils are generally fragmented in cores and drill holes; however, some whole fossils may be found in cores (Mayer, 1964). The fossils present in a sample may be difficult to classify, depending on the type and quality of the specimen.

Accessory minerals constitute only a minor percentage of the bulk of a sediment sample. However, these minerals provide significant indicators of depositional environment and are useful in correlation.

Common accessory minerals include:

- Glauconite
- Sulfides (Pyrite and Marcasite)
- Feldspar
- Mica
- Siderite
- Lignite
- Heavy Minerals
- Manganese oxide
- Chert
- Kaolin
- Gypsum
- Iron oxide

Lignite and manganese oxide are frequently encountered and frequently confused with each other.

The lithology of coarse-grained soil components can also provide a valuable clue to assist with interpretations of depositional history and stratigraphic correlation. Notations such as “sand predominantly quartz” or “gravel predominantly shale fragments” may be appended to the primary description.

2.3.14 Cementation or Presence of Calcareous Materials

The degree of cementation of coarse grained soils should be described, if relevant to the sample. The criteria for this description is shown in Table 2-8:

Table 2-8. Descriptions of Degrees of Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Calcium carbonate is a common cementing agent. The amount of calcareous material present in a sample can be classified according to the reaction with dilute hydrochloric acid. The classification is as follows:

Table 2-9. Calcium Carbonate Content Descriptions

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

2.3.15 Weathering

The recognition and correlation of weathered zones can provide valuable clues for deciphering site stratigraphy. It is important to recognize, however, that soils, in the engineering sense, encompass a wide range of materials, all of which represent various stages in the weathering of bedrock. Additionally, a clear distinction must be made between the weathering of transported superficial deposits and the in-place development of residual soils from a rock mass. The recognition and description of buried weathered zones is particularly useful in terraines characterized by transported soils and sediments.

2.3.16 Roots, Root Holes, Animal Burrows, or Other Macro-Pores

Any potential source of secondary porosity, which could be significant in terms of the infiltration and movement of water or the migration of contaminants, should be described. This may include root channels (relic or active); animal burrows; cracks related to desiccation and wetting, freezing and thawing, or subsidence; or other features not discussed herein.

2.3.17 Odor

Odors should be described if unusual or organic. Soils containing sufficient amount of organic material usually have a distinctive odor. If the samples are dried, odor may be revived by wetting the sample. Appropriate personal protective equipment should be worn when making odor determinations and handling toxic materials.

2.4 Field Tests For Classifying Fines

Several tests can be performed in the field to help determine the plasticity and hence the assignment of a group name to a soil sample. These tests, which include the dilatancy test, soil thread test, toughness, dry strength, smear and stickiness, and the test tube test, are described below. Attachment 2-2 summarizes how the results of these tests can be used to determine the plasticity and field classification of fine-grained soils.

The use of all of these tests provides a more accurate determination of the fine-grained material present in a soil sample; however, some of these tests are time consuming and may not be practical in many field situations. At a minimum, the thread test and smear test should be performed. The dilatancy test should be performed whenever possible. If however, a number of borings are to be drilled through a fine-grained stratum, it may be advisable to perform all of the tests on a few selected representative samples of each distinct lithologic unit from different boring locations. The results can then be used as a benchmark for classification of samples collected throughout the field program.

2.4.1 Dilantancy Test

A dilatancy test is a method (ASTM D 2488) is used to identify fine-grained soils, in particular silts versus clays. Select a representative sample (approximately 0.5 cubic inch volume) and add water, if necessary, until the soil has a soft, but not sticky consistency. Form a pat of the wet soil in the palm of one hand and shake it horizontally, vigorously striking the side of the hand with the other hand several times. Alternately squeeze and release the pat of wet soil. Note the rate at which water appears while shaking and disappears while squeezing. Materials which are predominantly silt will show a dull-dry surface upon squeezing and a glassy-wet surface upon releasing the pressure and upon shaking or vibrating the pat. With increasing clay content this phenomenon becomes less pronounced due to lower mobility of pore water. Rapid reaction to the shaking test is typical for uniform fine sand and diatomaceous earth as well as for inorganic silts. Criteria for describing dilatancy are included in Attachment 2-3.

2.4.2 Soil Thread Test

Following completion of the dilatancy test, attempt to roll the test specimen into a thread between the palms or by hand on a smooth surface. Roll the sample into the smallest thread possible, adjusting the water content as needed. If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation. If it is too dry, add water a few drops at a time, thoroughly kneading the soil to assure a uniform moisture content. Note the final minimum diameter attained before the thread breaks or crumbles.

The very fact that a soil can be rolled into threads indicates plasticity and the presence of clay. The smallest thread diameter possible without crumbling is indicative of the degree of plasticity. Refer to Attachment 2-2 for correlations between minimum thread diameter, plasticity, and appropriate soil descriptions.

2.4.3 Toughness

Fold the sample thread from the test above and re-roll the sample into a thread about 1/8 inch in diameter. Repeat this procedure until the thread crumbles at a diameter of approximately 1/8 inch. The thread will crumble at a diameter of 1/8 inch when the soil is near the plastic limit (the boundary between the plastic and semi-solid state). Note the strength of the thread and the pressure required to roll the thread near the plastic limit.

After the thread crumbles, lump the pieces together and knead the sample until the lump crumbles. Note the toughness of the material during kneading.

The higher the degree of plasticity of the soil, the stiffer are the threads as their water content approaches the plastic limit and the tougher are the lumps as the soil is remolded after rolling. The distinction in the toughness of the threads can only be felt at water contents close to the plastic limit. The greater the number of times the soil can be rolled prior to reaching the plastic limit for soils started at the same water content, the more plastic is the material. Cohesive soils containing significant amounts of organic material or mica form threads that are very soft or spongy near the plastic limit. The terminology for describing toughness is presented in Attachment 2-3.

2.4.4 Dry Strength

Mold the test sample to the consistency of putty, adding water if necessary. Shape the test specimen into a ball or angular fragment about 0.5 inches in diameter. Allow the sample to dry completely using air, sun, or oven, as long as the temperature does not exceed 60 degrees Centigrade. Test the strength of the fragment by crushing between the fingers. The dry strength increases with increasing plasticity. Occasionally the presence of high-strength water-soluble cementing materials such as calcium carbonate may cause exceptionally high dry strength. The presence of calcium carbonate can be detected with dilute hydrochloric acid. Silty fine sands and silts have about the same slight dry strength; however, they can be distinguished by the feel upon crushing. Fine sand feels gritty, whereas silt typically has the smooth feel of flour. Terminology for describing dry strength is presented in Attachment 2-3.

2.4.5 Smear and Stickiness

A high degree of stickiness and a very smooth smear in the natural state are indicative of high plasticity.

Although the primary basis for classification of fines is soil plasticity as discussed previously, the procedure described below for estimating the grain-size distribution of fine-grained soil components can also be helpful.

2.4.6 Test Tube Test

Silt and clay size particles may also be differentiated by determining their approximate settling rates in water. The settling rate may be measured in the field by shaking a small sample of the soil to be identified in a test tube or an 8-ounce clear glass jar filled with water and then allowing the particles to settle. The time required for particles to fall a distance of 4 inches is about 30 seconds for 0.074 mm size (the boundary between sand and silt) and about 50 minutes for particles 0.005 mm in size (the boundary between silt and clay). An approximate idea of the grain sizes present in a sample of fined-grained soil may be obtained by this method.

An additional aid in distinguishing silt and clay is by visual inspection under a hand lens. If grains are visible to indistinctly visible under 6.3x magnification, the sample is silt. If the sample has no visible grains under 6.3x magnification, then the sample is clay (Maher, 1964). Since most hand lenses are equipped with 10x magnification, this method is approximate as some clay grains may be indistinctly visible under 10x magnification.

The above tests are approximate and may not correlate precisely to results of laboratory grain size or mineralogical analyses. The tests do provide a method for consistent field classification, however.

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3 PROCEDURES FOR LOGGING EXPLORATORY BORINGS

All drilling logs shall be prepared in the field, as borings are drilled, by a geologist. Each log shall be signed by the preparer. Entries shall be printed neatly in indelible ink. Printing should be dark enough for copying. As a general rule, abbreviations should not be used. When necessary, they should be kept to a minimum to avoid confusion. Abbreviations used should be defined on the log. All lines shall be drawn with a straight edge, not by free hand. Logs shall be prepared on an approved Hazardous and Toxic Waste (HTW) Drilling Log form. The log scale should be selected in advance to provide sufficient space for the detail required for a specific project; generally the log scale should be 1 inch equals 1 foot.

All general information blanks in the log heading shall be completed before drilling. If surveyed horizontal control is not available at the time of drilling, a location sketch with references to measured distances from prominent surface features shall be included on the back of the first page of the log. The borehole numbering system should be determined in advance to facilitate communications between field and office staff and avoid inconsistencies between final logs and field documentation. Logs shall include the total depth of penetration and sampling. The bottom of each boring shall be indicated by a straight solid double line extending completely across the page at the appropriate scale depth with the notation, "Bottom of Exploration at x feet," beneath the line. A note should be added to indicate the disposition of the borehole (e.g., "Note: Installed 2.0 inch Schedule 40 PVC monitoring well. Screened interval 21.6 to 30.6 ft. bls." or "Note: The borehole was abandoned by tremie-grouting from 25.0 ft. to the ground surface"). All borehole depth information shall be from direct measurements accurate to $1/10^{th}$ of a foot. Upon completion, all blanks in the log shall be completed. If information for a particular blank is not applicable to that boring, then an "NA" will be inserted.

3.1 Description of Surface Conditions

Each drilling log should include a description of surface conditions near the borehole location. This should include geomorphic position (e.g., ridgetop or swale), vegetative characteristics (e.g., Bermuda Grass), and proximity to potential sources of contaminants (e.g., 20 feet south of petroleum underground storage tank, adjacent to drainage ditch, etc.).

3.2 Documentation of Drilling Procedures and Performance

The manufacturer's designation of the drill rig should be recorded, including notation of the type of vehicle on which the drill is mounted (e.g., truck mounted or rubber tired all terrain vehicle). Sizes and types of drilling equipment used should be recorded on each boring log. This should include the diameters and lengths of samplers and other equipment. Depths at which drilling or sampling equipment are changed should also be included. The logs shall show depths and types of temporary casing used.

The behavior of drilling tools provides valuable information for interpreting geologic conditions and planning future drilling projects. This should include observations made by the driller or geologist. Occurrences such as changes in penetration rate and the degree of chattering of the bit provide indirect evidence of soil or sediment types and the depths of stratigraphic contacts. This information is particularly important when sample recoveries are low. Adjustments made to improve sample recovery should be noted. Any special drilling or sampling problems shall be recorded, including descriptions of problem resolutions. A good and continual rapport with the driller is essential to maximize the value of these indirect observations.

If drilling fluids are used, zones where significant amounts of drilling fluids are lost are important to note. This should include depths at which losses occur, the rate of loss, and an estimate of the total volume lost. Changes made to drilling fluid dynamics should also be included. Zones where circulation is entirely lost are of particular importance. When drilling fluids are used, the following information should be provided, as appropriate:

- Water source
- Drilling fluid additives by brand and product name
- Mixture proportions
- Type of compressor and filter for compressed air

It is also helpful to measure and record the fluid density (mud weight), viscosity, and percentage of suspended solids periodically when drilling fluids are used.

3.3 Sampling Data

Soil sampling data shall include the interval sampled, the type of sampler used, and the length of sample recovered for each sample collected. The interval over which sampling was attempted should always be recorded, even if no sample is retrieved. The logs shall also clearly show the depth interval retained. If a scheduled sampling interval was 2 feet in length (24-inch split spoon), and due to refusal, the total interval was not sampled, then the depth of penetration (e.g., 1.5 feet) becomes the sample interval. For example, if a planned sample interval was from 20 to 22 feet below land surface (bls) and the split-spoon was only advanced 1.2 feet, the recorded interval will be 20 to 21.2 feet bls. Horizontal lines should be drawn across the appropriate columns at the scaled depths to document sampling intervals. Sample type may be identified using sequential numbers with a prefix identifying the type of sampler used. Unless alternate notation is provided in an approved, site-specific work plan, the following nomenclature is recommended:

- S = Split-spoon
- T = Shelby™ Tube

- U = Undisturbed Tube Sampler
- C = Core Barrel
- CS = Continuous Sampler
- A = Auger (sample collected off auger flights)

The number of blow counts used to drive a split-spoon sampler should be recorded. Blow counts should be provided and recorded for each 0.5-foot interval driven during sampling. When possible, the geologist should count the blows rather than the driller. Do not apply more than 50 blows for each 0.5-foot interval. If less than 0.5 feet is penetrated after 50 blows, write the number of blows, slash (/), and the total length penetrated (e.g., 50/0.2 feet). Penetration should be recorded in tenths of feet.

3.4 Description of Soils and Unconsolidated Sediments

Inspection of samples should be augmented by careful observation of drill cuttings to provide as complete a description of subsurface conditions as possible. Unconsolidated soils and sediments should be described in accordance with the USCS and ASTM guidance. This nomenclature should also be used to describe rock materials effectively reduced to soil by weathering.

3.5 Stratigraphic Contacts and Lithologic Changes

Identifying stratigraphic contacts and lithologic changes is a field responsibility. Changes in the nature of subsurface materials should be identified by a horizontal line at the appropriate scaled depth. A solid horizontal line should be used to denote the depth of distinct lithologic changes. These changes may be identified directly from split-spoon samples or indirectly from drilling behavior (e.g., change in advancement rate of drill rods). If a contact is gradational or inferred between two consecutive but separated samples, a dashed line should be used. Inferred or gradational contacts should also be defined as such (e.g., write “inferred contact” or “gradational change”). If the actual depth between two separated samples is unknown, the contact line shall be drawn at half the distance between the samples.

3.6 Groundwater Observations

Boring logs shall identify the depth at which the geologic material is dry, moist, or wet. Record the depth to water observed in the borehole during and at the completion of drilling, and the stabilized depth to groundwater (whenever possible). Stabilized water level data shall include the time allowed for levels to stabilize. The absence of water in borings shall also be indicated. If a borehole is left open overnight, water level observations should be taken before leaving the site and before starting work the next day.

3.7 Environmental Field Measurements and Observations

Evidence of the presence of contaminants in samples or cuttings should be provided. Comments should describe any unusual discolorations, coatings (sheens), odors, or other potential evidence of contamination. The results of field headspace screening or other field screening test results should be included in the appropriate space in the boring log.

3.8 Borehole Stability

Logs shall identify any interval of borehole instability. Conditions such as running or heaving sands should be described, including the depths at which such conditions were encountered.

4 SOIL TEST BORINGS METHODS

Test borings will be completed using an appropriate procedure dictated by site-specific conditions and sampling requirements. Soil borings in unconsolidated sediments for collection of geologic samples will be drilled using hollow-stem augers, if possible, or mud-rotary techniques, if necessary, to maintain the integrity of open borehole. For test borings to be completed as groundwater monitoring wells, or where soil samples are to be chemically analyzed, the use of drilling fluid will be minimized to the extent possible.

Observations and notes of the complete drilling operation including, at a minimum, site-specific conditions, drilling rate/pressures, geologic sample depths/recoveries, assessment/classification of drill cuttings, and other pertinent drilling conditions encountered will be recorded on the HTW Drilling Log Form and in the Field Log Book. For contaminant investigations, all drilling equipment, split-spoons and soil sampling equipment will be steam-cleaned prior to site entry, between each borehole to be drilled, and prior to leaving the site.

Soil test boring procedures will be designed to ensure that contaminated groundwater does not enter contaminant-free geologic formations. If warranted, based on the potential for cross contamination, a large diameter borehole will be completed in the unit immediately above the lower (i.e., uncontaminated) formation. A shallow casing will be emplaced and the borehole will be grouted. After the grout has cured (minimum 24 hours) a smaller diameter inner borehole will be drilled through the shallow casing into the lower formation to the desired depth. In general, this type of well is known as a double cased well.

4.1 Hollow Stem Auger

Hollow-stem augering is the most common drilling method used in unconsolidated formations when the total depth of the borehole is less than 150 feet. Hollow-stem augers remove cuttings by a series of continuous flights which are welded onto large diameter pipe (2.5- to 12-inch inside diameter (ID)). A drill bit or cutter head is attached to the bottom auger and additional augers are added via an adapter cap at the top of each auger. A center stem of drill rods is connected to a drag bit at the bottom and commonly used as a plug to keep formation material from entering the auger flights. This interior assembly of drill rods can be removed to take relatively undisturbed soil samples or split-spoon samples from below the cutter head.

4.2 Mud Rotary Drilling

Mud rotary drilling techniques are typically used when drilling in areas of poorly consolidated sediments to prevent the borehole from caving when trying to reach depths unattainable by hollow-stem auger methods. In mud rotary drilling, a drilling fluid is pumped down drill rods through a bit that is attached to the lower end of the drill rods. The fluid circulates back to the surface by moving up the annular space between the drill rods and the borehole wall. The drilling fluid is used to stabilize the borehole and to provide a medium to transport the drill cuttings out of the borehole. The use of the drilling fluid creates several disadvantages, including difficulty in removing the drilling fluid mud cake from the borehole wall and the alteration of the groundwater chemistry during the interaction with the drilling fluid.

Mud rotary drilling should only be utilized after careful consideration of its influence on the subsurface environment. Wash rotary drilling, using only potable water, is preferable. But if a mud drilling fluid must be used, it should be composed only of pure (no additives) bentonite drilling mud or an environmental drilling mud such as Revert™.

If a deep borehole that requires drilling through contaminated units is planned, drilling mud, if used, will be replaced with new mud immediately before the lower unit is penetrated to preclude contamination in overlying formations from entering the lower and possibly uncontaminated formation.

4.3 Air Rotary Drilling

Air rotary drilling is generally conducted in semi-consolidated or consolidated materials. Methods of air rotary drilling are similar to those of mud rotary except that, instead of the drilling mud, compressed air is forced down the drill pipe and up the borehole annulus to remove cuttings. Potable water is sometimes added to control dust. Foam, although sometimes used for this purpose in the water well industry, is not acceptable for environmental applications. The absence of drilling mud minimizes the risk of introducing contaminants into the aquifer.

When using air rotary, the air compressor will have an in-line organic filter system to filter the air coming from the compressor. The organic filter system will be regularly inspected to ensure that the system is functioning properly. Air compressors that do not have in-line organic filter systems are not acceptable for air rotary drilling. A cyclone velocity dissipater or similar air containment system will also be used to funnel the cuttings to one location instead of letting the cuttings blow uncontrolled out of the borehole. The conventional air rotary method does not control cuttings blowing out of the borehole and is unacceptable. Air rotary that employs the dual-tube (reverse circulation) drilling system is acceptable since the cuttings are contained in the drill stems and blown to the surface through the cyclone velocity dissipater and can be directed to the point of discharge.

4.4 Rotasonic Drilling

Rotasonic drilling utilizes ultrasonic vibrations to advance a core pipe to the target depth. Drill cuttings are captured in the core pipe; minimal wastes or drill cuttings are produced outside the borehole. Drilling rates using rotasonic drilling are much faster than drilling rates using mud rotary or auger techniques, and well development water typically clears up faster than from mud rotary boreholes.

A sonic drill rig advances a 4-inch to 12-inch diameter core barrel for sampling first. Upon reaching the desired depth or the end of the stroke, an outer casing is advanced to the same depth. Then the core barrel and rods are removed. The core is displaced from the core barrel by using a low vibration and is contained in a clear plastic tube. The core tube is then placed in a trough for examination, logging, and sampling.

Once the core is removed from the barrel, the core barrel and rods are lowered to the bottom of the hole. Another rod is added and the system is ready to advance again. The outer casing prevents cross contamination and formation mixing and allows for controlled placement of well installation materials.

4.5 Direct Push Technology (DPT) Sampling

The DPT rig uses a hammered hydraulic drive unit, a stainless steel sampling point, and a sampling rod to collect samples. The hydraulic drive unit is first positioned at the proposed boring location. A hydraulic percussion hammer is then used to drive a 1.3- or 2.25-inch outside diameter core barrel to the target depth. The nose piston is then retracted, allowing soil to enter the core barrel, the sampler is then hydraulically driven and filled. The sampler is a stainless steel tube that contains an inner Teflon or acetate sleeve. The rod and sampler is then retrieved hydraulically and the sleeve containing the soil sample is removed from the sampler. The sleeve is split open to retrieve the sample. This method is very useful in collecting discrete intervals and reduces occurrence of cross contamination. Generally DPT is also much faster then augering and does not produce cuttings that need to be managed.

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5 SURFACE SOIL SAMPLING PROCEDURES

For samples collected from land surface to 1 foot bls, the following procedure, using a stainless steel hand auger, will be adhered to:

1. Clean and decontaminate soil sampling equipment in a consistent manner, as specified in BSOP No. 13.

2. Carefully remove the top layer of soil to the desired sample depth interval with a pre-cleaned hand auger.

3. Using the same stainless steel auger itself, or a pre-cleaned stainless steel spoon, transfer an adequate volume of sample for the chosen analytical technique into a pre-cleaned mixing bowl. The preferential order of sample collection is VOCs with an Encore™ sampler, headspace screening sample (which can also be used for geotechnical purposes), SVOCs, polychlorinated biphenyls (PCBs)/pesticides, and metals. If the sample is to be composited, the quartering method will be used, as described below. If the sample is composited from several subsamples, a subsample aliquot or an Encore™ sample will immediately be collected from each subsample location for potential VOCs analysis. A headspace screening sample will also be collected at each subsample location. The VOC sample to be analyzed for the composited area will be selected from the subsample aliquots based on the relatively high subsample headspace screening results. The collection of SVOCs, PCBs/pesticides, and metals samples will be collected from the composited sample.

4. It is important that soil samples be mixed as thoroughly as possible to ensure that the sample is representative. The most common method of mixing is referred to as quartering. The soil in the sample pan is divided into quarters. Each quarter is mixed, then all quarters are mixed into the center of the pan. This procedure is followed several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion and occasionally turning the material over. The sample containers should be filled completely; no head space should remain in the sample containers.

5. Visually check to ensure that a Teflon liner is present in the cap (if required). Secure the cap tightly.

6. Immediately after the sample is collected, label the sample containers.

7. If no map of the sampling locations is available prior to sampling, a simple drawing of the site (not necessarily to scale) will be included in the field log book to provide an illustration of all sampling points.

8. A Chain-of-Custody Form will be completed to maintain an accurate record of sample collection, transport, analysis, and disposal.

9. Decontaminate equipment between each soil sampling location and after each sampling event.

10. Discard contaminated personal protective clothing (e.g., gloves and Tyveks).

6 SUBSURFACE SOIL SAMPLING PROCEDURES

The following procedure will be used for soil samples collected from greater than 1 foot bls. The subsurface soils will be obtained by manually advancing stainless steel hand augers, driving standard split-spoon samplers, pressing or driving thin-wall tubes (Shelby™ tubes), or by continuous coring, in accordance with approved procedures.

Collection of soil samples from the subsurface requires the use of a variety of pieces of equipment. To minimize the risk of cross-contamination between discrete sampling intervals the following procedures will be followed.

6.1 Sampling with a Hand Auger

Hand augering is a common method used to collect shallow subsurface soil samples, defined as those samples collected from depths of 1 foot bls to a site-specific depth where sample collection using manual methods becomes impractical.

Before beginning to advance the hand auger boring, vegetation and any surface debris shall be cleared from the immediate vicinity of the boring. When collecting a shallow subsurface soil sample from a discrete depth interval, the hand auger boring will be advanced to a depth immediately above the desired soil sampling interval. A new, cleaned hand auger bucket will then be installed onto the hand auger rods to prevent cross contamination, and the soil sample will be retrieved to the surface. The top several inches should be removed from the upper part of the bucket to minimize the chances of cross contamination by fall-in material from the shallower parts of the borehole. If the sample from the boring is to be a vertical composite of all of the intervals, then the same hand auger bucket can be used for the entire extent of the boring.

6.2 Sampling with a Split-Spoon

If split-spoon sampling is used to obtain soil samples, the samples will be collected as specified in ASTM D 1586 using a stainless steel split-spoon sampler. Each split-spoon sample will be taken according to the following procedures:

1. Decontaminate sampler as specified in BSOP No. 13.

2. Advance the drill string to the desired sampling depth by one of the drilling methods described in, Section 4.

3. Carefully measure the length of the split-spoon sampler, drill rods, subsidiary attachments, and drill bit to ensure that the sample is collected from the designated interval.

4. Attach the split-spoon sampler to the drill rods and lower the sampler to the bottom of the borehole without penetrating undisturbed soil or sediments.

5. Attach the hammer to the drill rods. If excessive drill cuttings are encountered, remove the drill rods and sampler and clean the borehole.

6. Mark the drill rods in 6-inch increments (24 inches total) prior to driving the split-spoon sampler.

7. The 2-inch outside diameter (OD) sampler is driven with a 140-pound hammer, or a 3-inch OD sampler is driven with a 300-pound hammer. Both hammer weights will fall 30 inches. The field personnel shall record the number of blows required to penetrate every 6 inches. The first 6-inch increment is considered the seating blow, the second and third are totaled to obtain the N-value, and the last 6-inch blow is recorded but means little.

8. After the sampler has been driven 24 inches, or to refusal, remove the sampler from the borehole and place it on a clean surface (for example, foil or plastic) when sampling for analytical parameters. Open the sampler, discard slough materials, record the length of remaining sample recovered, and describe the sample as specified in Section 2.

9. Sample aliquots will be removed from the split-spoon sampler using an Encore™ sampler (for VOCs), and a decontaminated stainless steel spoon (for all other analyses). The parts of the split spoon sample intended for VOC analysis will immediately be sampled with an Encore™ sampler, and the part for headspace screening techniques will be immediately transferred to appropriate sample containers. The remaining parts of the sample intended for other laboratory analyses, such as SVOCs, Pesticides, or PCBs, will be homogenized in a cleaned stainless steel bowl, as described in Section 5. The preferential order of sample collection is VOCs, headspace screening sample (which can be used for geotechnical purposes), SVOCs, PCBs/pesticides, and metals. Handling of soil samples to transfer the soil to the sample container should be minimized, using only properly decontaminated sampling equipment. If the sample must be handled by hand, the nitrile gloves should be worn.

10. Immediately after the sample is collected, label the sample containers per procedures defined in BSOP No. 4.

11. If no map of the sampling locations is available prior to sampling, a simple drawing of the site (not necessarily to scale; but provide distances between important locations) will be included in the field logbook to provide an illustration of all sampling points. Refer to BSOP No. 3 for field documentation procedures.

12. A Chain-of-Custody Form will be completed to maintain an accurate record of sample collection, transport, analysis, and disposal. Refer to BSOP No. 4 for Chain-of-Custody labeling procedures.

13. Decontaminate equipment after each sampling event as described in BSOP No. 13.

14. Discard contaminated personal protective clothing (e.g., gloves and tyveks).

15. All samples will be handled and packaged in accordance with the procedures specified in BSOP No. 4.

6.3 Shelby™ Tube Sampling

Undisturbed soil samples for geotechnical analyses will be obtained as specified in ASTM D 1587, which describes the methodology for thin walled tube soil sampling. The undisturbed sample is collected in 36-inch long, 3-inch OD, 16-gauge, steel tubing known as a Shelby™ tube sampler. The sampler is attached to the drill rods and pushed into the bottom of the borehole in one continuous motion. The sampler is then withdrawn and carefully stored and shipped to the laboratory performing the analysis. Collection of soil samples with a Shelby™ tube will follow the following procedures:

1. Carefully measure the sampler tube, sampler head, drill rods, drill bit, and subs to ensure accurate depths are maintained throughout all phases of drilling and sampling.

2. Advance the drill string to the desired sampling depth by a drilling method described in Section 5.

3. Connect the tube to the drill rods and rest the bottom of the tube at the bottom of the borehole.

4. Mark the drill rods in 1-foot increments (3 feet total) prior to pushing the Shelby™ tube and record the maximum amount of pressure exerted during the push.

5. Advance the sampler in a continuous motion without rotating and record the length of penetration.

6. Carefully withdraw the Shelby™ tube from the borehole. Attempt to minimize disturbances which may dislodge some of the sample.

7. After removing the tube, measure the amount of sample recovered. If Shelby™ tubes are not successful in collecting samples, split-spoons or other options will be used to collect disturbed soil samples.

8. Remove 0.5 inches of soil from each end with a stainless steel spatula or putty knife, and level the sample surface within the tube. Be sure that any cuttings or slough have been removed from the sides of the Shelby™ tube.

9. The space at each tube end should now be filled with hot paraffin or wax, expandable packers, Teflon plugs, or stainless steel plugs.

10. After an air tight seal has been set, fill any remaining void space with clean sand or paper.

11. Close the tube ends with metal or plastic caps and securely tape the caps to the tube with duct tape. If it is considered necessary to ensure the seal on the tube, the sample collector may dip the taped ends of the tube in hot wax to complete the sealing process.

12. Label the top foot of the tube in indelible ink. Information on the tube should include "TOP" and "BOTTOM" references, the project number, project name, date sample collected, boring number, sample number, and sample depth interval.

13. Tubes should be stored and transported upright in a vertical position to minimize disturbance to the sample. The tube will be transported to a designated soils laboratory for analysis. Tubes will be stored and shipped in padded boxes.

7 TEST PIT AND TRENCHING PROCEDURES

Following are the general procedures that apply to the excavation of the test pit or trench and collection of soil samples from these structures.

7.1 Excavation

1. Relative to the intended purpose and data requirements, determine the general location of the test pit or trench with topographic maps or site plans. Determine the appropriate depth of the test pit or trench.

2. The test pit or trench walls should be cut as near vertical as possible to facilitate the interpretation of the subsurface lithologic information and to ensure that the soil samples are being collected from the designated sample interval. The test pits or trenches will be excavated in compliance with applicable safety regulations, including the consideration of both physical and chemical hazards.

3. When necessary to determine the boulder content of test pits or trenches, the boulders will be separated from the soil matrix, measured and counted, and the data recorded.

4. The geologist will record the width, length and depth of the excavation in the field log book and a description of the type and depth of the lithologies and features encountered within the excavation. The geologist will describe any subsurface disposed material that may be in exposed in the test pit. These descriptions will be recorded in a form similar to that illustrated in Attachment 7-1, Test Pit Report. Photographs will be taken of the test pits and any material that may be exposed.

5. After documenting the contents of the test pits and collecting any soil samples, the test pit will be backfilled to original grade with the same material that was excavated and compacted according to contract specifications. If subsurface material was exposed but not removed from the pit, then efforts will be made to restore the surface to its former condition. For example, a layer of clay may need to be applied to the surface of the restored test pit to prevent subsurface material from migrating to the surface via preferential erosion.

Once the designated depth of the test pit or trench has been achieved, soil samples will be collected from either the sidewalls or bottom of the excavation. Following are the procedures for collecting soil samples from the excavation:

7.2 Collection of Soil Samples

1. If it is safe to enter the excavation (walls are stable and excavation is less than 4 feet in depth), collect the designated samples from the bottom and/or sidewall of the excavation with a stainless steel spoon or stainless steel hand auger. **In no instance, should a worker enter an excavation, if it is determined to be unsafe, or without proper supervision.**

2. If an excavation is considered a confined space (i.e., large enough for a worker to enter, limited openings for entry and exit, unfavorable natural ventilation, and not designed for continuous worker occupancy) it is not considered safe to enter. If this is the case, collect the sample material from the bucket of the backhoe. If the backhoe bucket is used to retrieve a sample for chemical analyses (field screening or laboratory analyses), the bucket will be steam cleaned prior to collection of the sample. All samples will be collected, as practicable, from soils that have not come into contact with the blade or sides of the bucket (i.e., from soil at the top of the load). The latter method is appropriate for the collection of bulk samples such as may be used in treatability study sampling or for general characterization purposes.

3. When an adequate volume of material has been collected from the sample point or the backhoe bucket, use a stainless-steel spoon to fill the appropriate bottles.

4. Immediately after the sample is collected, label the sample containers in accordance with the procedures defined in BSOP No. 4.

5. If no map of the sampling locations is available prior to sampling, a simple drawing of the locations of the excavation (not necessarily to scale) will be included in the field log book to provide an illustration of all sampling points. Refer to BSOP No. 3 for field documentation procedures.

6. A Chain-of-Custody Form will be completed to maintain an accurate record of sample collection, transport, analysis, and disposal. Refer to BSOP No. 4 for Chain-of-Custody labeling procedures.

7. Decontaminate equipment after each sample as described in BSOP No. 13.

8. Discard contaminated personal protective clothing (e.g., gloves, and Tyveks).

9. Place sample in cooler immediately. Once the cooler is filled with samples, it will be taped and secured in a sampling vehicle or other secure storage facility until the completion of the day's sampling activities. All samples will be packaged in a manner consistent with the procedures outlined in BSOP No. 4.

10. The test pit or trench will be backfilled to original grade and compacted.

8 REFERENCES

American Society for Testing and Materials, *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*, ASTM Designation: D 1586-8, 1984 (Reapproved 1992).

American Society for Testing and Materials, *Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)*, ASTM Designation: D2487-00, 2000.

American Society for Testing and Materials, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, ASTM Designation: D 2488-00, 2000.

Buckman, H.O. and Brady, N.C., *The Nature and Properties of Soils*, 1969.

Travis, R.B., *Classification of Rocks*, Colorado School of Mines Quarterly, Vol. 50, Number 1, 1955.

U.S. Environmental Protection Agency, *Description and Sampling of Contaminated Soils*: A Field Pocket Guide, 1991.

U.S. Environmental Protection Agency (EPA) Region 4, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, Environmental Services Division, May 1996.

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ATTACHMENT 1-1

HTW DRILLING LOG

HTW DRILLING LOG

		HOLE NO.
1. COMPANY NAME	2. DRILLING CONTRACTOR	SHEET OF SHEETS

3. PROJECT	4. LOCATION
5. NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL
7. SIZES & TYPES OF DRILLING & SAMPLING EQUIPMENT	8. HOLE LOCATION North East
	9. SURFACE ELEVATION (ft. NGVD)
	10. DATE STARTED / 11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES		
20. SAMPLES FOR CHEMICAL ANALYSIS	**VOC**	**METALS**	**OTHER (SPECIFY)**	**OTHER (SPECIFY)**	**OTHER (SPECIFY)**

21. TOTAL CORE REC %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	Field Screening Results d	Geotech Sample or Core Box No. e	Analytical Sample No. f	Blow Counts g	REMARKS h
	0						
	1						
	2						
	3						
	4						
	5						

PROJECT | HOLE NO.

HTW DRILLING LOG

HOLE NO.		
PROJECT	INSPECTOR	SHEET OF SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	Field Screening Results d	Geotech Sample or Core Box No. e	Analytical Sample No. f	Blow Counts g	REMARKS h
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						

PROJECT

HOLE NO.

HTW DRILLING LOG

HOLE NO.		
PROJECT	INSPECTOR	SHEET OF SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	Field Screening Results d	Geotech Sample or Core Box No. e	Analytical Sample No. f	Blow Counts g	REMARKS h
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						

PROJECT

HOLE NO.

HTW DRILLING LOG

1. COMPANY NAME …ate Environmental Associates	2. DRILLING CONTRACTOR ABC Drilling Company	HOLE NO. PI503-MW-01 SHEET 1 OF 2 SHEETS
3. PROJECT Fort XYZ	4. LOCATION POI No. 503 Cattle Dipping Vat - Bear Creek	
5. NAME OF DRILLER Bill D. Riller	6. MANUFACTURER'S DESIGNATION OF DRILL Mobile B-61	
7. SIZES & TYPES OF DRILLING & SAMPLING EQUIPMENT: 4.25-inch ID HSA; 2.0 inch OD Split spoon; 6.63-inch ID HSA	8. HOLE LOCATION North East	
	9. SURFACE ELEVATION (ft. NGVD) 200.2	
	10. DATE STARTED 19-Oct-2002	11. DATE COMPLETED 19-Oct-2002
12. OVERBURDEN THICKNESS N/A	15. DEPTH GROUNDWATER ENCOUNTERED ~11 Ft bls	
13. DEPTH DRILLED INTO ROCK N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED 9.82 ft bls/~2 hours after drilling	
14. TOTAL DEPTH OF HOLE 20.0 feet bls	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY) N/A	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES			
Yes	4	0	N/A			
20. SAMPLES FOR CHEMICAL ANALYSIS	**VOC**	**METALS**	**OTHER (SPECIFY)**	**OTHER (SPECIFY)**	**OTHER (SPECIFY)**	**21. TOTAL CORE REC %**
None	N/A	N/A	N/A	N/A	N/A	N/A
22. DISPOSITION OF HOLE	**BACKFILLED**	**MONITORING WELL**	**OTHER (SPECIFY)**	**23. SIGNATURE OF INSPECTOR**		
X		X		Jane Doe		

ELEV a	DEPTH b	DESCRIPTION OF MATERIALS c	Field Screening Results d	Geotech Sample or Core Box No e	Analytical Sample No f	Blow Counts g	REMARKS h
200.2	0						
199.2	1						
198.2	2						
197.2	3	POORLY GRADED SAND (SP) Loose, dry, light yellowish brown (10 YR 6/4), mostly fine sand with trace silt; quartz	No instrument response	S-05	N/A	2 2 3 3	
196.2	4						
	5						

PROJECT: Fort XYZ

HOLE NO.: PI503-MW-01

HTW DRILLING LOG

JECT rt XYZ	INSPECTOR Jane Doe
HOLE NO. PI503-MW-01	SHEET 2 OF 2 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	Field Screening Results d	Geotech Sample or Core Box No. e	Analytical Sample No. f	Blow Counts g	REMARKS h
194.2	6						
193.2	7						
192.2	8	POORLY GRADED SAND (SP) Medium dense, moist, pale yellow (2.5 YR 7/4), mostly fine sand with trace silt; heavy minerals, quartz	No instrument response	S-10	N/A	5 5 7 7	
191.2	9						
190.2	10						
189.2	11						Groundwater encountered at approximately 11.0 feet bls
188.2	12						
187.2	13	POORLY GRADED SAND (SP) Medium dense, wet, dark yellowish brown (10 YR 4/4), mostly medium to fine sand with trace silt; heavy minerals, quartz	No instrument response	S-15		5 8	
186.2	14						

ATTACHMENT 2-1

DEFINITIONS OF SOIL COMPONENTS AND FRACTIONS

ATTACHMENT 2-1
DEFINITIONS OF SOIL COMPONENTS AND FRACTIONS

Soil Component	Definition	Fractions	Sieve Limits* (Grain Size Range)	
			Upper	**Lower**
Boulder	Material too large to pass through an opening 12-inch square	-	-	12 in.
Cobbles	Material passing through	-	12 in.	3 in.
Gravel	Material passing the 3-inch sieve and retained on the No. 4 sieve	Coarse Fine	3 in. 3/4 in.	3/4 in. No. 4 (4.76 mm)
Sand	Material passing the No. 4 sieve and retained on the No. 200 sieve	Coarse Medium Fine	No. 4 (4.76 mm) No. 10 (2.0 mm) No. 40 (0.42 mm)	No. 10 (2.00 mm) No. 40 (0.42 mm) No. 200 (0.074 mm)
Silt	Material passing the No. 200 sieve that is non-plastic or very slightly plastic and exhibits little or no strength	-	No. 200 (0.074 mm)	-
Clay	Material passing the No. 200 sieve that can be made to exhibit plasticity within a range of water contents and which exhibits considerable strength when air dried			

A particular size graph is available as AGI Data Sheet 16.1 (American Geological Institute, 1982)
* U.S. Bureau of Standards

ATTACHMENT 2-2

CRITERIA FOR ESTIMATING PLASTICITY AND FIELD CLASSIFICATION OF FINE-GRAINED SOIL

ATTACHMENT 2-2
CRITERIA FOR ESTIMATING PLASTICITY AND FIELD CLASSIFICATION OF FINE-GRAINED SOILS

Plasticity Designation	Results of Visual/Manual Classification Tests[3]					USCS* Group Symbols	Typical USCS Group Names
	Dilatancy (reaction to shaking)	Soil Thread Test (smallest thread that can be rolled in inches)	Toughness[5] (consistency near plastic limit)	Dry Strength (crushing characteristics)	Smear		
Non-Plastic	Rapid[4]	No threads can be rolled	Thread cannot be rolled	None	None	ML	Silt
Slightly Plastic	Rapid to Medium	1/4 → 1/8	Low	Low	Dull	ML	Silt
						OL	Organic Silt
Low Plasticity	Medium to Slow	1/8 → 1/16	Low to Medium	Low to Medium	Dull to Slightly Shiny	OL	Organic Silty Clay
						MH	Organic Clayey Silt
						CL	Clayey Silt, Elastic Silt Silty Clay
Medium Plasticity	Slow	1/32	Medium	Medium to High	Slightly Shiny to Shiny	CL	Silty Clay
						MH	Lean Clay
						OH, CH	Organic Clay
Highly Plastic	None	1/64	High	High[7]	Shiny	CH	Fat Clay

Notes:
1. Based on ASTM 2488, the Unified Soil Classification System* and D.M. Burmister
2. See Attachment 2-3 for definitions of terminology used for test results.
3. Plasticity designations are defined by the visual/manual test results.
4. Rapid reaction to the dilatancy test is also characteristic of uniform fine sands and diatomaceous earth.
5. Cohesive soils containing organic material or much mica form threads that are very soft or spongy near the plastic limit.
6. Dry strength may be significantly diminished by the presence of fine sand or organic material. Organic clay may exhibit only low dry strength.
7. High dry strength may result from the presence of water soluble cementing agents such as calcium carbonate or iron or manganese oxides.
8. Organic silts typically display only slow dilatancy.

ATTACHMENT 2-3

VISUAL/MANUAL CLASSIFICATION TEST TERMINOLOGY

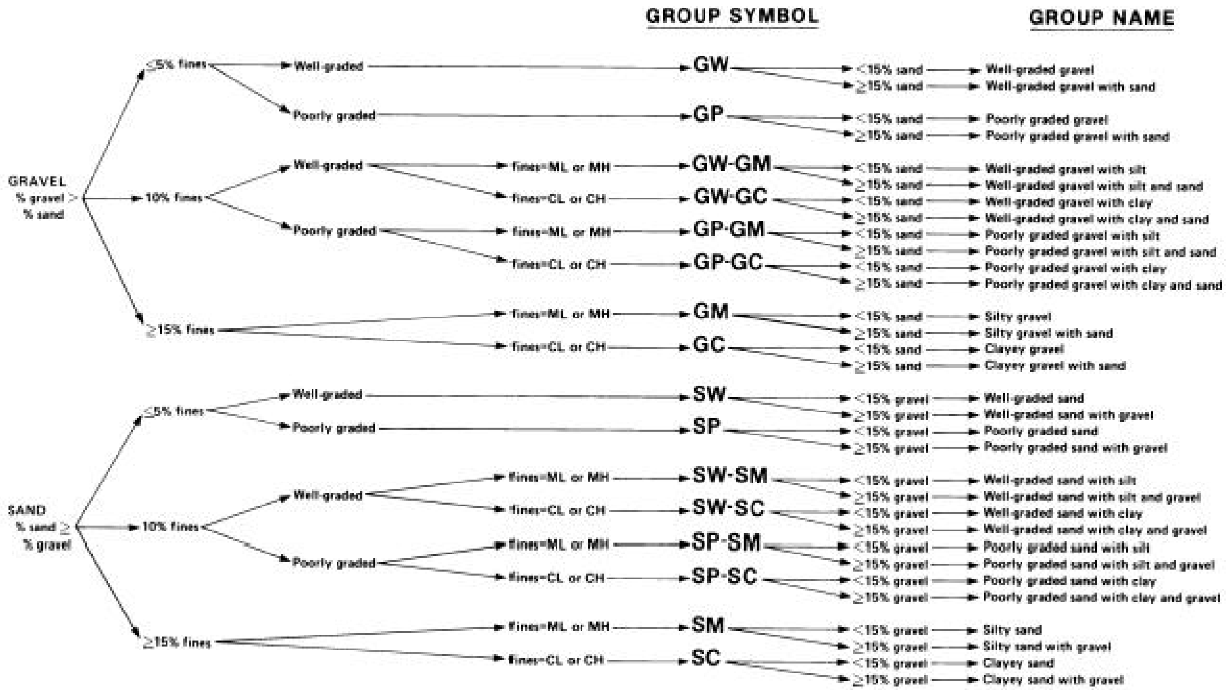
ATTACHMENT 2-3
VISUAL/MANUAL CLASSIFICATION TEST TERMINOLOGY

Description	Criteria
Criteria for Describing Dilatancy	
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Medium	Water appears at a moderate rate on the surface of the specimen during shaking and disappears relatively slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.
Criteria for Describing Toughness	
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread near the plastic limit. The thread and the lump have very high stiffness.
Criteria for Describing Dry Strength	
None	The dry specimen crumbles into powder with mere pressure of handling.
Low	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface.

ATTACHMENT 2-4

ASTM FLOW CHART FOR IDENTIFYING SOILS

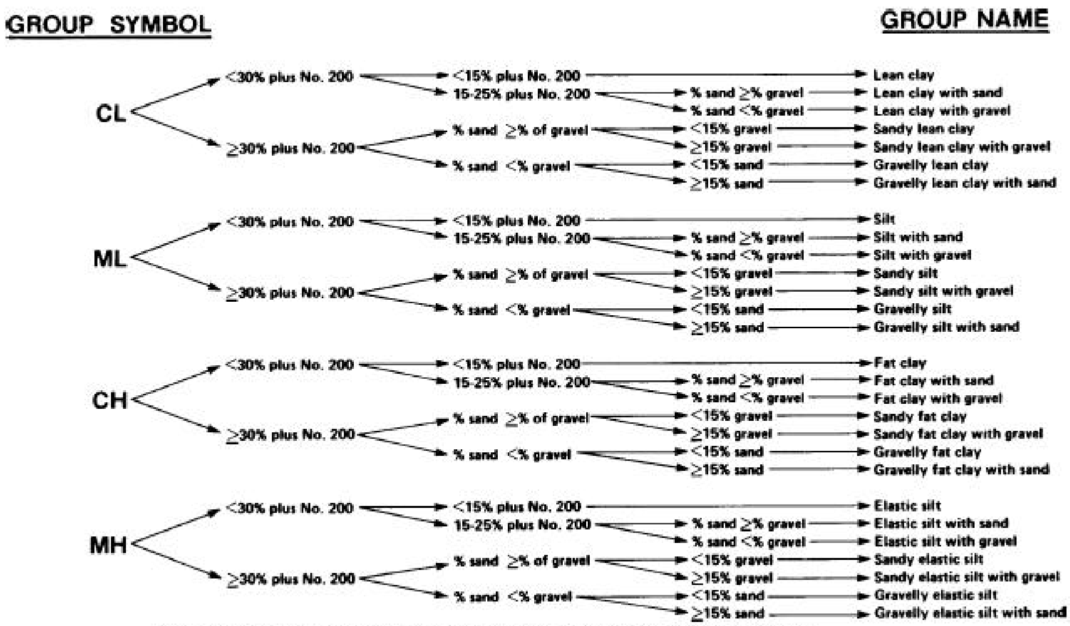
ATTACHMENT 2-4
ASTM FLOW CHARTS FOR IDENTIFYING SOILS



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

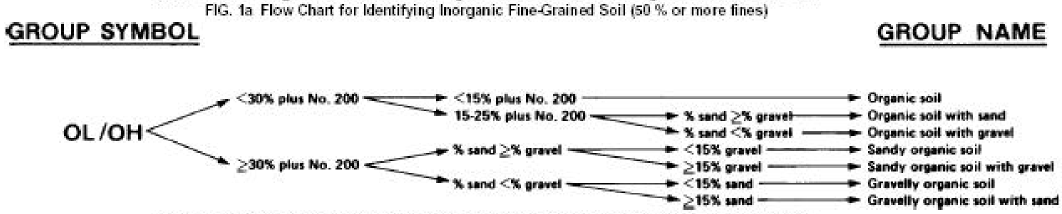
FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

ATTACHMENT 2-4 (CONT'D)
FLOW CHART FOR IDENTIFYING INORGANIC FINE-GRAINED SOIL



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

ATTACHMENT 2-5

PRINCIPAL SOIL DEPOSITS

ATTACHMENT 2-5
PRINCIPAL SOIL DEPOSITS

Major Division	Principal Soil Deposits	Pertinent Engineering Characteristics
Transported Soils		
Alluvial		
Material transported and deposited by running water	Floodplain Deposits: Deposits laid down by a stream within that portion of its valley subject to inundation by floodwaters.	
	Point Bar: Alternating deposits of arcuate ridges and swales (lows) formed on the inside of convex bank of migrating river bends. Ridge deposits consist primarily of silt and sand, swales are clay-filled	Generally favorable foundation conditions; however, detailed investigations are necessary to locate discontinuities. Flow slides may be a problem along river-banks. Soils are quite pervious.
	Channel Fill: Deposits laid down in abandoned meander loops isolated when rivers shorten their course. Composed primarily of clay; however, silty and sandy soils are found at the upstream and downstream ends.	Fine-grained soils are usually compressible. Portions may be very heterogeneous. Silty soils generally present favorable foundation conditions.
	Backswamp: The prolonged accumulation of floodwater sediments in flood basins bordering a river. Materials are generally clays but tend to become more silty near riverbanks.	Relatively uniform in a horizontal direction. Clays are usually subjected to seasonal volume changes.
	Alluvial Terrace Deposits: Relatively narrow, flat-surfaced, river-flanking remnants of floodplain deposits formed by entrenchment of river and associated processes.	Usually drained, oxidized. Generally favorable foundation conditions.
Materials	Estuarine Deposits: Mixed deposits of marine and alluvial origin laid down in widened channels at mouths of rivers and influenced by tide of body of water into which they are deposited.	Generally fine-grained and compressible. Many local variations in soil conditions.
	Alluvial-Lacustrine Deposits: Material deposited within lakes (other than those associated with glaciation) by waves, currents, and organo-chemical processes. Deposits consist of unstratified organic clay or clay in central portions of the lake and typically grade to stratified silts and sands in peripheral zones.	Usually very uniform in horizontal direction. Fine-grained soils generally compressible.
	Deltaic Deposits: Deposits formed at the mouths of rivers which result in extension of the shoreline.	Generally fine-grained and compressible. Many local variations in soil condition.
	Piedmont Deposits: Alluvial deposits at foot of hills or mountains. Extensive plains or alluvial fans.	Generally favorable foundation conditions.

ATTACHMENT 2-5 (CONT'D)
PRINCIPAL SOIL DEPOSITS

Major Division	Principal Soil Deposits	Pertinent Engineering Characteristics
Aeolian		
Material	Loess: A calcarious, unstratified deposit of silts or sandy of clayey silt traversed by a network of tubes formed by root fibers now decayed.	Relatively uniform deposits characterized by ability to stand in vertical cuts. Collapsible structure. Deep weathering or saturation can modify characteristics.
	Dune Sands: Mounds, ridges, and hills of uniform fine sand characteristically exhibiting rounded grains.	Very uniform grain size; may exist in relatively loose condition.
Colluvial		
Material	Talus: Deposits created by gradual accumulation of unsorted rock fragments and debris at base of cliffs.	Previous movement indicates possible future difficulties. Generally unstable foundation conditions.
	Hillwash: Fine colluvium consisting of clayey sand, sand silt, or clay.	
	Landslide Deposits: Considerable masses of soil or rock that have slopped down, more or less as units, from their former position on steep slopes.	
Pyroclastic		
Material	Ejecta: Loose deposits of volcanic ash, lapilli, bombs, etc.	Typically shardlike particles of silt size with larger volcanic debris. Weathering and redeposition produce highly plastic, compressible clay. Unusual and difficult foundation conditions.
	Pumice: Frequently associated with lava flows and mud flows, or may be mixed with nonvolcanic sediments.	
Glacial		
Material	Glacial Till: An accumulation of debris, deposited beneath, at the side (lateral moraines), or at the lower limit of a glacier (terminal moraine). Material lowered to ground surface in an irregular sheet by a melting glacier is known as a ground moraine.	Consists of material of all sizes in various proportions from boulders and gravel to clay. Deposits are unstratified. Generally present favorable foundation conditions; but, rapid changes in conditions are common.

ATTACHMENT 2-5 (CONT'D)
PRINCIPAL SOIL DEPOSITS

Major Division	Principal Soil Deposits	Pertinent Engineering Characteristics
Material (cont'd)	Glacio-Fluvial Deposits: Coarse and fine-grained material deposited by streams of meltwater from glaciers. Material deposited on ground surface beyond terminal of glacier is known as an outwash plain. Gravel ridges know as kames and eskers.	Many local variations. Generally present favorable foundation conditions.
	Glacio-Lacustrine Deposits: Material deposited within lakes by meltwater from glaciers. Consisting of clay in central portions of lake and alternate layers of silty clay or silt and clay (varved clay) in peripheral zones.	Very uniform in a horizontal direction.
Marine		
Material transported and deposited by ocean waves and currents in shore and offshore areas	Shore Deposits: Deposits of sands and/or gravels formed by the transporting, destructive, and sorting actions of waves on the shoreline.	Relatively uniform and of moderate to high density.
	Marine Clays: Organic and inorganic shore and deposits of fine-grained material offshore areas.	Generally very uniform in composition. Compressible and usually very sensitive to remolding.
Sedimentary Soils		
Residual		
Material formed by disintegration of underlying parent rock or partially indurated material.	Residual sands and fragments of gravel size formed by solution and leaching of cementing material, leaving the more resistant particles; commonly quartz.	Generally favorable foundation conditions.
	Residual clays formed by decomposition of silicate rocks, disintegration of shales, and solution of carbonates in limestone. With few exceptions becomes more compact, rockier, and less weathered with increasing depth. At intermediate stage, may reflect composition, structure and stratification of parent rock.	Variable properties requiring detailed investigation. Deposits present favorable foundation conditions except in humid and tropical climates, where depth and rate of weathering are very great.
Organic		
Accumulation of highly organic material formed in place by the growth and subsequent decay of plant life.	Peat: A somewhat fibrous aggregate of decayed and decaying vegetation matter having a dark color and odor of decay.	Very compressible. Entirely unsuitable for supporting building foundations.

ATTACHMENT 7-1

TEST PIT REPORT

TEST PIT REPORT

TEST PIT NO. ____________________

Project:		**Job Number:**	
Location:		**Elevation:**	
		Date Start:	
Client:		**Date End:**	
Contractor:		**Field Representative:**	
Equipment:			

Depth (Feet)	Sample Number and Depth Range	Strata Change (feet)	Field Classification	Remarks
0				
2				
4				
6				
8				
10				
12				ASTM Component %
14				Mostly 50 – 100% Some 30 – 45% Little 15 – 25% Few 5 – 10% Trace <5%

Groundwater		
Date	**Time***	**Depth (ft)**

Pit Dimensions (feet)

____________X__________X_____________=____________ cubic feet

Length Width Depth

Boulders

12 to 18-inch diameter: No, ____________ = _____________cubic feet

Over 18-inch diameter: No._____________= _____________cubic feet

Not Encountered	***Hours after completion**	**Test Pit No.**

TEST PIT REPORT

TEST PIT NO. 9

Project:	Contamination Assessment	**Job Number:**	9010022
Location:	IRP Site No. LF-266 Mills Dump Site/Encroachment Landfill	**Elevation:**	N/A
		Date Start:	21-Mar-2000
Client:	USACE – Omaha District	**Date End:**	21-Mar-2000
Contractor:	Southern Waste Services	**Field Representative:**	B. Jackson
Equipment:	John Deer 690 ELC Excavator		

Depth (Feet)	**Sample Number and Depth Range**	**Strata Change (feet)**	**Field Classification**	**Remarks**
0			Light brown sand. Two automobile fuel tanks, metal soda cans. Few areas of household garbage, automobile drive shaft. Appears most of the material on the northern end of the pit is confined to top 4.0 feet. On the southern ed is vinyl siding, refrigerator, fiberglass truck cab.	
2				
4				
6				
8				
10				
12			Light brown clay at 12.0 feet bls. No debris observed.	ASTM Component % Mostly 50 – 100% Some 30 – 45% Little 15 – 25% Few 5 – 10% Trace <5%
14				

Groundwater		
Date	**Time***	**Depth (ft)**

Pit Dimensions (feet)

_________X_______X________=___________ cubic feet
Length Width Depth

Boulders

12 to 18-inch diameter: No, ___________ = __________cubic feet

Over 18-inch diameter: No.____________= ___________cubic feet

Not Encountered

***Hours after completion**

Test Pit No. 9

BSOP NO. 2

SITE ACCESS AND CLEARANCE

BHATE STANDARD OPERATING PROCEDURE NO. 2

SITE ACCESS AND CLEARANCE ON FEDERAL INSTALLATIONS

The objective of this Bhate Standard Operating Procedure (BSOP) document is to provide general guidance to field personnel for obtaining vehicle passes and personnel passes, temporary access to sites across an installation and digging permits. These are general guidelines typical to Federal Installations and should only be referenced in the absence of specific installation site access and clearance procedures.

Site access and clearance should be discussed specifically during the initial project kick-off meeting. The procedures outlined in this BSOP should be reviewed and any changes made at the time noted in a copy of the BSOP.

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BSOP NO. 2

SITE ACCESS AND CLEARANCE ON FEDERAL INSTALLATIONS

TABLE OF CONTENTS

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1 PROCEDURES

1.1 Personnel and Vehicle Passes

Upon the initial arrival at the installation guard gate, indicate that you are an environmental contractor working for the base Environmental / Restoration Program (site specific name of the division you are working for). Also, convey to personnel at the guard gate, the client point of contact (POC). You should have the client address and pertinent phone numbers with you at all times.

Following check-in at the guard gate, most federal installations will require contractor's to obtain individual personnel passes or contractor's badges. Information typically needed to obtain personnel passes include vehicle license plate numbers, forms of identification such as a driver's license or a social security card and proof of insurance. In addition, the pass office may require Bhate to acquire a pass letter from the installation environmental department manager, which identifies individuals who require a pass, number of hours needed for access (typically 24 hours), and the number of days per week access is needed (typically 7 days). Usually the maximum validation period for contractor passes is one year.

1.2 Digging Permits

A digging permit should be maintained within the on-site field folder or at the Bhate field trailer or office. The digging permit may be in the form of a "Base Civil Engineering Work Clearance Request" form or other similar installation request form. The "digging permit" is intended to inform different departments within the installation as well as privately owned underground utilities, that sampling, drilling, or excavation activities are planned for a particular site. The various departments (for example, water/sewer, electric, etc.), should identify underground structures at the site that their department is responsible for. Any installation digging permit request form should be completed prior to any invasive site activities (e.g., hand augering, drilling, or excavation).

It is Bhate's responsibility to route this any appropriate form, obtain appropriate approval signatures, and arrange site visits, if required. A map indicating the location of the intrusive activity at the site will be attached to the digging permit request. During the site visit, Bhate personnel will stake or flag the boring or digging locations, showing the representative of the department where the drilling, excavation or other intrusive activities will take place. Bhate personnel will ask the representative to identify the locations of the underground structure(s) and utilities, with flagging or paint.

1.3 Range Clearance

Access to many areas across a federal installation, especially military, is restricted, and requires clearance during missions and other training operations. Typically, for such areas, range clearance must be obtained each time the site is accessed on a daily basis.

Most installations will have a range control office, which schedules missions and operations in these restricted areas. Bhate personnel should contact this office prior to entering a restricted area and obtain clearance. Information typically needed by a range control office include the following:

- The specific location of the work site
- Estimated time of arrival on site and departure off site
- Name of the individual calling range control and his/her affiliation
- Number of individuals and vehicles accessing the site
- Reason for entering the restricted area
- The installation POC
- Mobile phone and beeper numbers

When describing to range control the location of the site, a detailed map of the range, for example a Vitro Range Map or Range Control Grid Map, is helpful. These maps typically show features on the range such as numbered range roads. During the conversation with the range control office, it is very important to record the time of the call, the name of the person who provided the clearance, the site name, clearance number or designation and the agreed upon time period that the clearance is valid. When all personnel have left the restricted area, it is essential to terminate your clearance by contacting the range control office.

Remember, under no circumstances should Bhate personnel enter a restricted area or open closed range gates within the restricted area without first obtaining clearance from the range control office.

2 REFERENCES

No documents or materials, which are not defined within this section, are referenced as part of this document.

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BSOP NO. 3

FIELD RECORDS AND DOCUMENTATION

BHATE STANDARD OPERATING PROCEDURE NO. 3

FIELD RECORDS AND DOCUMENTATION

The objective of this Bhate Standard Operating Procedure (BSOP) document is to provide consistent procedures and formats by which field records will be maintained, activities documented, and a methodology by which field records will be managed.

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BSOP NO. 3

FIELD RECORDS AND DOCUMENTATION

TABLE OF CONTENTS

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1 PROCEDURES FOR FIELD DOCUMENTATION

Materials to be used for proper field documentation include:

- Field log books
- Pens, containing indelible water-proof ink
- Standard forms
- Watch with field team-synchronized time

1.1 Documentation in Field Log Books

Management of the field log books will be based on specific conditions of the project. The management program, however, will ensure that all field notes can be efficiently traced, filed, and retrieved.

Each project will have one log book designated for it. A field book will be assigned to the field team leader by the Project Manager. It is that persons responsibility to record pertinent field information within the site-specific log book. In the absence of the field team leader, the Project Manager will designate an individual from the on site field crew to record information within the log book. In the event that there is a change in field crew personnel or project management responsibilities, it will be up to original Project Manager reassign the log book and familiarize the new Project Manager and field crew with any site specific details that might need to be included within the log book.

All entries will be recorded in indelible, waterproof ink. If errors are made in any field log book, field record (form), chain-of-custody (COC) record, or any other field record document, corrections will be made by crossing a single line through the error, entering the correct information, initialing, and dating the correction.

Entries will be made in the following format:

- Documentation and reporting of events and activities will be made in chronological order on the right page of an open log book.
- The left page of the log book will be used for auxiliary reporting, such as sketches, tables, providing details or comments on events reported sequentially, or interpretations.

Field forms have been adopted to facilitate the collection of consistent data. This will preclude, for example, detailed lithologic descriptions in the field log book. A reference, however, to use of each specific form must be made in the log book.

- The date will be placed at the top of every page in the left-hand side of the right page.
- If an entry is made in a non-dedicated field book, then the date, project name, and project number will be entered left to right, respectively, along the top of the right page.

- At the beginning of each day, the first three entries will be “Personnel/Contractors on Site”, “Weather”, and “Anticipated Scope of Work for the Day”.
- At the end of each day’s entry or particular event, if appropriate, the personnel should draw a diagonal line originating from the bottom left hand corner of the page to the conclusion of the entry and sign along the line indicating the conclusion of the entry or the day’s activity.

All entries in field log books will be printed legibly and will contain accurate and inclusive documentation of all project activities (e.g., investigation, monitoring remediation, closure, or maintenance). Information pertaining to health and safety aspects, personnel on site, visitors’ names, association, and time of arrival/departure, etc., should also be logged.

1.2 Tracking of Field Log Books

An electronic ledger will be maintained for each project by the Bhate Project Administrator, to track the whereabouts and in whose possession field log books reside. The Project Administrator will assign each log book a specific serial number to aid the tracking system. The log book copying requirements, will be tracked by the Project Administrator. Deficiencies will result in a notification to the personnel assigned the log book to correct the specific deficiencies.

The last four pages of the log book will be reserved for compiling a “List of Contents” for the log book. Information recorded will include the project name, project number, duration of involvement, brief description of activities, the page numbers in the log book, the last page number copied to file, and date copied. The “List of Contents” should be updated on a weekly basis by the personnel assigned the log book. In addition, log books will be audited quarterly by the Quality Assurance (QA) manager and corrective actions will be implemented.

1.3 Copying and Filing Field Records

Field log books will be copied on a weekly basis. The person to whom the log book is assigned is responsible for making copies of the new pages of each log book on Friday or Monday of each week. The Project Administrator is responsible for ensuring that copies are submitted and filed. One copy will be required from each personnel assigned a field log book. It will be provided to the Project Manager for the project file.

When an individual log book is full or the personnel’s involvement has ended, the log book will be submitted to the Project Administrator within two working days for final cataloging and filing. The log books will be stored in the Bhate Project File.

All non-bound field records (e.g., Daily Quality Control Reports (DQCRs)(as discussed in Section 1.4), drilling logs, well construction forms, sampling records, and chain-of-custody copies) will be completed the day the associated activity occurs and will subsequently be turned in to and copied by the Project Administrator the following work day. The originals will be filed by the Project Administrator, or the Project Administrator’s designated representative, on a weekly basis (at a minimum) in the Bhate Project File for permanent storage, located in Birmingham, Alabama.

All field data collected using electronic data loggers or computer entry forms will be downloaded, as soon as practical, to an appropriate electronic filing system. If possible, the data will be downloaded on a daily basis by the person collecting the data. This person will be responsible for ensuring that all data collected are adequately represented in electronic media and in the file. A hard copy of the data, and any graphical representation produced by logging software, will also be printed out and duplicated. One copy of the electronic media and printed output will be filed in the Field File (file maintained on site for use by the team leader and field crew), and one copy will be filed in the contractor Project File for permanent storage.

1.4 Daily Quality Control Reports

If required as part of the project deliverables, Daily Quality Control Reports (DQCRs) will be completed daily by each field team. A copy of the DQCR is presented in Attachment 1-1. The purpose of these reports is to provide a written log of daily field activities to the Bhate Project Manager, Installation Project Manager (PM), and appropriate contracting offices, if necessary. The information contained on the DQCR, is basic and can be adapted/modified to meet any project need. Information to be provided in these daily reports includes:

- Project and Delivery Order numbers
- Date
- Project name and location
- Temperature range
- Wind conditions
- Personnel on site
- Summary of site activities
- Level of health and safety protection
- Instruments used (including serial numbers)
- Calibrations performed
- Instrument problems
- Corrective actions
- Samples collected
- Summary of sample collection methods
- QC samples collected
- Additional remarks

The DQCRs will be maintained in the Bhate office files.

2 REFERENCES

U.S. Environmental Protection Agency (EPA) Region 4, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1996.

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ATTACHMENT 1-1

DAILY QUALITY CONTROL REPORT

DAILY QUALITY CONTROL REPORT

Project Number/Name:				DQCR No.:	
Date		Time On-Site:		Time Off-Site:	
Site Name:		Weather:		Temperature:	
Contractor Personnel On-Site:					

Visitors On-Site:

Summary of Work Performed:

Level of Health & Safety Protection:

Equipment Used:

Calibration(s) Performed:

Equipment Problem(s)/Remedies:

Samples Collected *:	Time	Analysis/Method #		Analysis/Method #	Type

Sample Collection Method:

Quality Control:

Proposed Schedule for Tomorrow:

Additional Remarks:

Signature:		Job Title:	**Site Manager/SSHO**

[Insert Name here]

*Indicates sample media: groundwater, surface water, soil or sediment; sample type: composite, grab, split, duplicate, rinsate, and sample I.D. numbers

BSOP NO. 4

SAMPLE NOMENCLATURE AND CONTROL

BHATE STANDARD OPERATING PROCEDURE NO. 4

SAMPLE NOMENCLATURE AND CONTROL

The general objective of Bhate Standard Operating Procedure (BSOP) No. 4 is to present procedures for sample identification, sample control, chain of custody, and sample handling.

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BSOP NO. 4

SAMPLE NOMENCLATURE AND CONTROL

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1 SAMPLE LABELING AND PROCEDURES

All sample identification, field records, and chain of custody records will be recorded in waterproof, indelible ink. If errors are made in any of these documents, personnel will cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.

If information is entered onto sample tags, log books, or sample containers utilizing stick-on labels, subsequent removal of these labels should not be possible without leaving obvious indications of the attempt. Labels should never be placed over previously recorded information. Corrections to information recorded on stick-on labels should be made as stated in the previous paragraph.

All soil, surface water, sediment, groundwater, waste, ambient air, and vapor emission samples collected will be labeled according to the following procedures. These procedures are consistent with the current Environmental Resources Program Information Management System (ERPIMS; Section 2) format, which is widely used at federal installations.

1. Label each sample container with the following information:
   - Date and time
   - Sample ID number
   - Project number
   - Sampler (name)
   - Sample location and depth, if applicable
   - Preservative, if any
   - Analytical method number (for example, 8260B for VOCs)
2. Enter sample collection information in field log book. Begin the sample collection entry with the time at which the sample is collected (or collection is begun). Make the entry chronologically on the right-hand page of the logbook (see BSOP No. 3). Also, include the following information in the field book:
   - Date
   - Time
   - Weather conditions
   - Field personnel present
   - Level personal protection
   - List of on-site visitors and the level of personal protection of the visitors
   - Signature of the person making the entry
3. If no map of sampling locations is available prior to sampling, sketch a drawing of the site (not necessarily to scale) on the left-hand page of the field log book to provide an illustration of all sampling points. Provide measured distances from sampling points to a fixed reference

point to allow accurate placement of sample locations on figures or maps. If a site map is available, use it to plot sampling locations.

1.1 Sample Identification Format

The sample identification format contains specific information about the sample, including sample matrix and location. An example of a sample container label is provided in Attachment 1-1. The sample designation format is discussed below. Sample identification will include the following:

1. Acronyms used by a specific client or federal installation (e.g., Installation Restoration Program (IRP), Area of Concern (AOC), or Point of Interest (POI) site number)

2. Sample location designation (i.e., soil boring, monitoring well, etc.), two letters, as defined below

3. Sample location or sequence number, two digits

4. Sample depth, in feet below land surface (bls; if applicable)

5. Quality control (QC) extension (if applicable)

All components of the sample ID will be separated by a hyphen. The sample location designations (item 2 above) are as follows:

HC – Hydrocone

HP – Hydropunch

MW – Monitoring Well

EW – Extraction Well

PW – Private Well

SE – Sediment

TE – Tissue Ecological

PC – Paint Chip

BP – Borrow Pit

SP – Spring Water

SB – Subsurface Soil, Soil Boring or Geocone, etc.

SL - Sludge

ST – Storm Water

WS - Waste

WW – Waste Water

VW – Cattle Dip Vat Water

VS – Cattle Dip Vat Solid

SW – Surface Water

Quality Control (QC) samples are denoted by adding a QC extension to the end of the sample ID. The extensions are as follows:

-dis	=	dissolved phase (field filtered)
-a	=	field duplicate
-b	=	filed split (to USACE quality assurance laboratory)
-c	=	trip blank
-d	=	rinsate or equipment blank
-e	=	field blank
-ms	=	matrix spike
-msd	=	matrix spike duplicate

ERPIMS requires that the sample identification for all samples collected from a geographic location (for example, latitude and longitude) be consistent. On the basis of this structure, Bhate will refer to soil samples and groundwater samples associated with a particular boring into which a monitoring well is installed with the "MW" identifier, as described below. This should not be problematic to readers of environmental reports if the reports adhere to a specific structure. This structure will include the following:

- Present soil sampling location maps and groundwater sampling location maps separately.
- Provide a clear legend noting that the sampling points represent soil, sediment, surface water, or groundwater, as applicable.
- Discuss the results for each different media in separate sections of the report.

The ERPIMS database contains several different fields, which provide the user with information regarding the sample media, collection date and method, and sample depth interval. In the database input or downloading process, ERPIMS requires information on the sample media or matrix. Therefore, the media (either soil or groundwater) is included in the pertinent ERPIMS fields. Additional information that can be used to distinguish between the soil and groundwater samples is the depth modifier itself, the units (e.g., ug/Kg vs. ug/L), and the sample collection method.

It should be noted here that monitoring wells/soil boring nomenclature may change as a site passes through the different phases of the investigation process. In these cases, the prefix descriptor of the site name (e.g., "AC015-" for AOC No. 15 or "OT082-" for IRP Site No. OT-82) will reflect the current site name, but the sampling point numbers will be maintained in consecutive order (e.g., AC015-MW-01, OT082-MW-02).

A discussion of the specific sampling media, with sample ID examples, is presented in the following sections.

1.2 Soils

Soil samples collected from a soil boring, geocone, hand auger, or similar mechanism are identified with the matrix qualifier "SB" and from a monitoring well installation boring with "MW". These qualifiers are preceded by the particular site number (for example AOC/POI), and followed by a sequential sampling location number corresponding to either the soil boring location or the monitoring well location. In the absence of a client assigned site number, Bhate will assign the site number. Soil boring location numbers will begin with –01 (e.g., AC111-SB-01, AC0024-SB-01) at each site and will continue consecutively for additional soil boring locations at that site. Soil samples collected from a monitoring well boring will incorporate the monitoring well location number. The –SB- or –MW- location designation and soil sampling location number are followed by the actual bottom depth (bls) of the sampling interval in feet.

For example, a soil sample collected at AOC No. 111 from monitoring well boring MW-05 at a sample interval of 23 to 25 feet bls would be denoted as:

AC111-MW-05-25

QA/QC samples will follow the same ID scheme, with appropriate extension included at the end of the sample ID. For example, a duplicate soil sample collected at AOC No. 24 from soil boring number –02 at a sample interval of 10 to 12 feet bls would be as follows:

AC024-SB-02-12-a

1.3 Sediment

Sediment samples are denoted with the location designation –SE-, preceded by the site number. The sediment location number at a given site begins with –01 and continues consecutively for additional sediment samples at the site. QA/QC samples will be labeled in the same manner as soils, with the appropriate extension following the sample number. For example, the third sediment sample collected at AOC No. 89 would be identified as:

AC089-SE-03

The QA/QC rinsate blank for this sample would be:

AC089-SE-03-d

1.4 Surface Water

Surface water samples are designated by "SW", preceded by the site number. The surface water location number at a given site begins with –01 and continues consecutively for additional surface water samples at the site. QA/QC samples will be labeled in the same manner as soils, with the appropriate extension following the sample number. For example, the second surface water sample collected at AOC No. 10 would be identified as:

AC010-SW-02

The QA/QC rinsate blank for this sample would be:

AC010-SW-02-d

1.5 Groundwater

Groundwater samples collected from a monitoring well are designated by "MW", which denotes a monitoring well, preceded by the appropriate site number. The "MW" designation will be followed by the sequential well location number. Well location numbers at a site will begin with –01 and continue consecutively.

For example, a groundwater sample collected from well MW-14 at AOC No. 7 would be identified as:

AC007-MW-14

A duplicate sample from this well would be:

AC007-MW-14-a

1.6 Field Screening

Field screening samples may be analyzed with immumoassay test kits, gas chromatograph (GC) units, or mobile laboratories, etc. Field screening tests may be conducted on any media (e.g., groundwater, soil, sediment, or surface water). Therefore, in order to track a laboratory analytical sample with its associated field screening sample, the field screening sample ID will include all of the ID components discussed above, followed by the extension "s". For example, a field screening soil sample collected at AOC No. 111 from well boring MW-70 at a sample interval of 23 to 25 beet would be denoted as:

AC111-MW-70-25-s

A field screening sample for groundwater collected from well MW-14 at AOC No. 7 would be identified as:

AC007-MW-14-s

1.7 Wastes

Waste samples may be in aqueous, semi-solid (sludge), or solid form. The samples are denoted with the location designations listed in Section 1, preceded by the site number. The location designation will be followed by the sequential waste sample location number, followed by the actual bottom depth of the sampling interval.

QA/QC samples will use the above ID scheme with the appropriate extension added to the end of the sample ID. For example, a duplicative wastewater sample collected from AOC No. 215, from wastewater sample location number –05, at a sample interval of 13 to 15 feet, would be denoted as:

AC215-WW-05-15-a

2 ERPIMS FIELDS

The data generated by environmental activities conducted at federal installations will typically be formatted to an approved installation data management system in conjunction with agencies such as USACE or AFCEE. The Bhate chain-of-custody is designed to include all necessary information to accommodate these management systems. However, the data entry fields located on the Bhate chain-of-custody can be used (filled in vs. not filled in) based on client and project specific requirements.

The Laboratory Information Management System (LIMS) utilized by USACE and AFCEE is the ERPIMS.

The following is a discussion of the ERPIMS field and codes, which are typically used for USACE and AFCEE projects.

- Field Sample ID is a unique sample identifier that identifies all characteristics of the environmental media under investigation. The field sample ID will consist of the site identifier, location identification, location number, beginning and ending depth and any QC extension. Each element of the field sample ID is separated by hyphens and is limited to a total of 30 characters.

- Location Identification (LOCID) is a unique location identifier assigned to a location within the installation where measurements or samples are taken and assigned to a specific location. For field samples being sent to the laboratory, the LOCID will consist of the first three parts of the sample ID (Site identifier, location designation, location number). A maximum of 15 characters can be used.

- Date Collected must be recorded by month, day and year. Zeros are used as placeholders if the month or day is not a two digit number and the year is designated by four numbers of the year. All numbers are separated by hyphens (e.g., 03-14-2000) would represent March 14, 2000.

- Time is recorded in military time (1315) is 1:15 PM.

- SA Code indicates the sample type. Sample type may be a normal environmental sample designated by (N) or various types of QC samples. Many of the commonly used SA Codes are listed on the bottom of the Bhate chain of custody. The full list of SA Codes valid values can be found in Attachment 2-1.

- Sample Number is the total number of sample containers taken at each sampling point. For example if 8260B (3 VOC vials), 8270C (2 1L amber bottles) and 6010B (1 500 ml plastic bottle) are collected from a monitoring well, the sample number would be equal to six.

- Sample Matrix Code identifies the matrix from which the sample was obtained. Several of the most common matrix codes can be found on the bottom of the Bhate chain of custody. The full list of sample matrix codes can be found in Attachment 2-2.

3 CHAIN-OF-CUSTODY PROCEDURES

Once the sample has been collected, steps must be taken to preserve the sample's chemical and physical integrity during transport and storage prior to analysis. Inclusion of a chain-of-custody form in each cooler containing samples will document that the integrity of the samples has been maintained during transport. A completed chain-of-custody that is intended to be used as an example is also included in Attachment 3-1.

Table 3-1. Quality Assurance Sample Designations

Label	Description
(1)	**Ambient Condition Blank (AB)** The ambient condition blank is designated by the month day and year (mmddyy) followed by a "0" if an AB was not used. The count should start at "1" for the first AB and continue with "2" for the second AB, on up as needed for the ABs used for each day.
(2)	**Equipment Blank (EB)** The equipment blank is designated by month day and year (mmddyy) followed by a "0" if an EB was not used. The count should start at "1" for the first EB and continue with "2" for the second EB, on up as needed for the EBs used for each day.
(3)	**Trip Blank (TB)** The trip blank is designated by month day and year (mmddyy) followed by a "0" if a TB was not used. The count should start at "1" for the first TB and continue with "2" for the second TB, on up as needed for the TBs used for each day.
A	**Cooler Designation** The count should start at "A" for the first cooler and continue with "B" for the second cooler, on up as needed for the shipping coolers used for each day.

The chain-of-custody is a documentation of the continuous possession of samples from their origin to completion of analysis and archiving/disposal in the laboratory. This uninterrupted possession is required to maintain integrity of samples. The following method is prescribed for documenting chain-of-custody.

- To simplify the chain-of-custody record and eliminate potential litigation problems, as few people as possible should handle the sample or physical evidence during the investigation or inspection.
- The field investigator is responsible for the proper handling and custody of the samples collected until they are properly and formally transferred to another person or facility.
- Sample labels shall be completed for each sample, using waterproof, indelible ink.
- All samples must be sealed immediately upon collection utilizing the custody seal. The custody seal is a special adhesive tape that is placed over the opening of the cooler. If the cooler is opened prior its arrival to the laboratory, the custody seal will be broken and the

possibility of sample tampering will have to be investigated. This requirement can be waived if the field investigator keeps the samples in his/her continuous custody from the time of collection until they are delivered to the laboratory analyzing the samples.

- All samples must be documented in bound field log books.

- A chain-of-custody record will be completed for all samples or materials collected.

- All samples should be accompanied by the chain-of-custody record. One copy of the record will be retained by the field investigator or project leader. This copy will become a part of the project file. Arrangements should be made to make copies of the chain-of-custody prior to the sampling event.

To complete the chain-of-custody and to maintain an accurate record of sample collection, transport, analysis and disposal, the following methodology will be used:

1. Samples will be accompanied by a chain-of-custody form at all times.

2. The chain-of-custody form will be used by personnel responsible for ensuring the integrity of samples from the time of collection until shipment to the laboratory.

3. The chain-of-custody form will be signed by each individual who has the samples in his or her possession.

4. The chain-of-custody form will be initialed in the field by the person collecting the sample, for every sample. In addition, the chain-of-custody may be initiated electronically prior to field activities. However, as each sample is collected, the sampler should still initial the appropriate sample designation. If a sample is not collected, or if there is a change in the scope of work, and a change needs to be made to an electronically initiated chain-of-custody, a single line strikethrough should be made through the change and the individual making the change should initial beside the single line strikethrough. Every sample will be assigned a unique identification number, to be entered on the chain-of-custody form. Up to 13 samples can be grouped for shipment using a single form and, depending on sample size, any number of chain-of-custody forms and related samples can be shipped together.

5. The record will be completed in the field to indicate project, sampling team, etc.

6. If the person collecting the sample does not transport the samples to the laboratory or deliver the sample containers for shipment, the first block for “Relinquished by” “Received by” will be completed in the field.

7. The person transporting the samples to the laboratory or delivering them for shipment will sign the record form as “Relinquished by.”

8. If the samples are transported directly to the laboratory, the chain-of-custody form will be kept in the possession of the person delivering the samples.

9. If the samples are shipped to the laboratory by commercial carrier, the chain-of-custody form will be sealed in a watertight container, taped on the inside lid, and the shipping container sealed prior to being given to the carrier.

   a. For samples shipped by commercial carrier, the waybill will serve as an extension of the chain-of-custody record between the final field custodian and receipt in the laboratory. The waybill tracking number must be entered into the log book and on the COC.

   b. Upon receipt in the laboratory, the sample recipient will open the shipping containers, compare the contents with the chain-of-custody record, ensure that document control information is accurate and complete, and sign and date the record. Any discrepancies will be documented by the laboratory on an internal laboratory condition upon receipt form or equivalent.

   c. In the event of the discrepancies, the samples in question will be segregated from normal sample storage and the field personnel immediately notified.

   d. The chain-of-custody form is completed upon receipt of the samples by the analytical laboratory. The completed chain-of-custody form will be returned to the Bhate Project Manager and maintained in the project file.

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4 SAMPLE HANDLING PROCEDURES

Upon collection, all samples will be placed on ice immediately, and taken to a proper location for packing, re-icing, and shipment. This will insure samples are stored at proper temperatures.

When preparing the samples for shipment to the laboratory, the following procedures will be employed:

1. Place sample in cooler immediately. Once the cooler is filled with samples, it will be locked/taped with Custody tape and securely positioned in a sampling vehicle or other secure storage facility until the completion of the day's sampling activities. The following protocol will be used for packaging of samples:

   - Only waterproof metal or equivalent strength plastic ice chests and coolers will be used.
   - Samples will be packed properly for shipment so that bottles will not dislodge and/or break during shipment.
   - Approximately three inches of inert cushioning material will be placed in the bottom of the cooler.
   - The sample containers will be placed upright in the cooler in such a way that they do not touch and will not touch during shipment. In addition, all sample containers will be placed in clear, plastic, leak proof bags. Care will then be taken to ensure that sample labels are legible through the bag.
   - Additional inert packing material will be placed in the cooler to partially cover the sample containers. A temperature blank will be placed in the middle of the cooler. Ice placed in doubled Ziploc™ bags will be placed around, among, and on top of the sample containers.
   - Each cooler will be filled with additional cushioning materials to prevent movement of samples during shipment.
   - The chain-of-custody form will be placed in a waterproof plastic bag and taped to the inside lid of the cooler. Methodology of shipment, courier name(s), and other pertinent information will be recorded on the chain-of-custody form.
   - If the cooler is equipped with a drain plug, it will be taped shut.
   - The lid will be secured with Custody tape at a minimum of two locations. No labels will be covered.
   - The completed shipping label will be attached to the top of the cooler.
   - "This Side Up" arrow labels will be placed on two sides of the cooler, and "Fragile" labels will be placed on all four sides.
   - Numbered and signed custody seals will be placed on the front right and back left of each cooler. These seals will be covered with clear tape.

2. Samples will be transported by courier in an approved, cooled shipping container, ensuring that the maximum holding times between sample collection and analysis will not be violated.

3. The weight limit of the shipper will be observed.

4. All records pertaining to the shipment of a sample will be retained in the project file (e.g., freight bills, post office receipts, and bills of lading).

5. The packaged samples will meet all applicable Department of Transportation (DOT) and International Air Transportation Authority (IATA) requirements prior to shipment. The samples must be classified as either environmental or hazardous material samples. Environmental samples include drinking water, most groundwater and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, biological specimens, and any other sample which is not expected to be contaminated with high levels of hazardous materials. Shipping of environmental samples must be in accordance with the DOT Final National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Laboratory Samples, March 1981. Hazardous material samples may include samples from process wastewater streams, drums, bulk storage tanks, and soil, sediment, or water collected from areas suspected of being highly contaminated. Such samples may require shipment as dangerous goods under the IATA regulations. If a sample is collected of a material listed in the Dangerous Goods List (Section 4-2, IATA) then the sample must be identified, handled, and shipped in accordance with the specific IATA instructions for that material (U.S. EPA, 1996).

5 REFERENCES

ERPIMS Data Loading Valid Value List 1998.

Department of Transportation, *Final National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Laboratory Samples*, March 1981.

United States Army Corps of Engineers, *General Chemistry Supplement to the Scope of Services*, December 1993.

United States Environmental Protection Agency (EPA) Region 4, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1996.

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ATTACHMENT 1-1

SAMPLE CONTAINER LABEL

ATTACHMENT 1-1
SAMPLE CONTAINER LABEL

Bhate Environmental
205-918-4000
Project Name
Project Number

Sample: Sample Location or ID ____________

Analysis: Analysis ____________

Preservative: Cool to 4°C ____________

Date: ___/___/___ Time: ____:____ By: GST

ATTACHMENT 2-1

SA CODE DESIGNATIONS

ATTACHMENT 2-1
SA CODE DESIGNATIONS

CODE	NAME	UPUSER	UPDATE
AB	Ambient Conditions Blank	AFCEE	12-Dec-00
BD	Blank Spike Duplicate	AFCEE	12-Dec-00
BS	Blank Spike	AFCEE	12-Dec-00
EB	Equipment Blank	AFCEE	12-Dec-00
FB	Field Blank	AFCEE	12-Dec-00
FD	Field Duplicate	AFCEE	12-Dec-00
FR	Field Replicate	AFCEE	12-Dec-00
FS	Field Spike	AFCEE	12-Dec-00
KD	Known (External Reference Material) Duplicate	AFCEE	12-Dec-00
LB	Lab Blank	AFCEE	12-Dec-00
LR	Lab Replicate	AFCEE	12-Dec-00
MB	Material Blank	AFCEE	12-Dec-00
MS	Lab Matrix Spike	AFCEE	12-Dec-00
N	Normal Environmental Sample	AFCEE	12-Dec-00
RB	Material Rinse Blank	AFCEE	12-Dec-00
RD	Regulatory Duplicate	AFCEE	12-Dec-00
RM	Known (External Reference Material)	AFCEE	12-Dec-00
SD	Lab Matrix Spike Duplicate	AFCEE	12-Dec-00
TB	Trip Blank	AFCEE	12-Dec-00

ATTACHMENT 2-2

SAMPLE MATRIX CODING

ATTACHMENT 2-2

SAMPLE MATRIX CODING

Code	Name
AA	Ambient Air
AD	Drilling Air
AE	Air, Vapor Extraction Well Effluent
AQ	Air Quality Control Matrix
AZ	AIR FOR QAPP PROJECTS
CA	Cinder-Ash
CF	Fly Ash Cinder
GE	Gaseous Effluent (Stack Gas)
GL	Headspace of Liquid Sample
GQ	Headspace or Gaseous Phase QC Matrix
GS	Soil Gas
LA	Aqueous Phase of a Multiple Phase Liquid or Solid Sample
LC	Liquid Condensate
LD	Drilling Fluid
LE	Liquid Emulsion
LF	Floating/Free Product on Groundwater Table
LH	Free-Flowing, or Liquid Waste Containing Less than 0.5% Dry Solids
LM	Multiple Phase Liquid Waste Sample
LO	Organic Liquid
LQ	ORGANIC LIQUID QUALITY CONTROL MATRIX
LV	Liquid From Vadose Zone
SB	Bentonite
SC	Cement
SD	Drill Cuttings, Solid Matrix
SE	Sediment (associated with surface water)
SF	Filter Sandpack
SH	Solid Waste Containing Greater than or Equal to 0.5% Dry Solids

Code	Name
SK	Asphalt
SL	Sludge
SM	Water Filter (Solid Material used to Filter Water)
SN	Miscellaneous Solid Materials - Building Materials
SO	Soil
SP	Casing (PVC, Stainless Steel, Cast Iron, Iron Piping, etc.)
SQ	Soil/Solid Quality Control Matrix
SR	Water Filter Residue (Solid That Gets Filtered Out of Water)
SS	Scrapings
ST	Solid Waste
SW	Swab or Wipe
SZ	SOIL FOR QAPP PROJECTS
TA	Animal Tissue
TP	Plant Tissue
TQ	Tissue Quality Control Matrix
WA	Drill Cuttings, Aqueous Matrix
WC	Drilling Water (Used for Well Construction)
WD	Well Development Water
WE	Estuary
WG	Ground Water
WH	Equipment Wash Water, i.e. Water used for Washing Equipment
WO	Ocean Water
WP	Drinking Water
WQ	Water Quality Control Matrix
WS	Surface Water
WV	Water From Vadose Zone
WW	Waste Water
WZ	WATER FOR QAPP PROJECTS

Source: AFCEE ERPIMS Valid Values List, July 2002.

ATTACHMENT 3-1

CHAIN OF CUSTODY FORM EXAMPLE

BHATE
Environmental Associates, Inc.
1608 13th Avenue South, Suite 300
Birmingham, Alabama 35205
Tel: 205-918-4000
Fax: 205-918-4050

Chain of Custody and Analytical Request

Page ______ of ______

Project Number: ______________

Chain of Custody Number [1]: ______________

LIMS Number: ______________

Facility/Base I.D.:

Project Name / Site Name:

Client Name:

Collected by:

Field Sample ID (30 Characters Max)	ERPIMS LOCID (15 Characters Max)	Date Collected (dd-mmm-yyyy)	Time Collected (Military) (hhmm)	Sample Depth (beginning - ending)	SA Code [2]	Sample Number [3]	Sample Matrix [4]	Number of containers	Sample Analysis Requested [5]								Quality Assurance Samples [6]: Ambient Blank Lot Control Number	Equipment Blank Lot Control Number	Trip Blank Lot Control Number	Cooler ID
				-																
				-																
				-																
				-																
				-																
				-																
				-																
				-																
				-																
				-																
				-																

COMMENTS: ____

Custody Transfers Prior to Receipt by Laboratory

Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time
1.			1.		
2.			2.		
3.			3.		

Sample Delivery Details / Laboratory Receipt

Delivered Directly to Lab: ________ Shipped No.: ________
Method of Shipment: ________ Airbill Number: ________
Analytical Lab: ________ Delivery Location: ________
Lab Recipient: ________ Delivery Date/Time: ________

1.) Chain of Custody Number = date collected + custody number (e.g. 09-02-1999-01)
2.) Sample Type (SA) Codes: N = Normal Sample, TB = Trip Blank (-c) Sample, FD = Field Duplicate (-a) Samples, FR = Field Replicate (-b) Samples, EB = Equipment Blank (-d) Samples, MS = Matrix Spike, SD = Matrix Spike Duplicate, AB = Ambient Blank (-e)
3.) Sample Number: Unique sample number collected from a particular location per day. (e.g. Groundwater sample collected from MW-1 on 10/10/99 = 01, if sampled again on 10/10/99 = 02, etc.)
4.) Matrix Codes: GS = Soil Gas, WG = Groundwater, WS = Surface Water, SO = Soil, SE = Sediment, SL = Sludge, SS = Surface Soil Samples, WQ = Aqueous Blank Samples (trip, equipment, ambient, etc.), SQ = Soil Blanks
5.) Sample Analysis Requested: Analytical method requested and number of containers provided for each.
6.) Quality assurance samples are assigned by date (ddmmyy) and the sample number associated with the sample (01, 02, etc) (e.g. Equipment blank collected in association with MW-1 on 10/10/99 will be designated 10109901 in the Equipment Blank Lot Control)

DISTRIBUTION: WHITE COPY - Project File YELLOW COPY - Lab Copy PINK COPY - Working File

BHATE

Environmental Engineers and Scientists

Chain of Custody and Analytical Request

Page 2 of 2

Project Number: 9010304

Chain of Custody Number [1]: 25060201

LIMS Number:

Facility/Base I.D.: Cannon Air Force Base / Canon

Project Name / Site Name: Cannon Air Force Base / Landfill - 25

Client Name: USACE-Omaha District

Collected by: M. Wenzel

Field Sample ID (30 Characters Max)	ERPIMS LOCID (15 Characters Max)	Date Collected (dd-mmm-yyyy)	Time Collected (Military) (hhmm)	Sample Depth (beginning - ending)	SA Code [2]	Sample Number [3]	Sample Matrix [4]	Number of containers	Sulfates (9038/9056)	Nitrates (9056)	Chloride (9251/9056)	Total Phenols (9066)					Ambient Blank Lot Control Number	Equipment Blank Lot Control Number	Trip Blank Lot Control Number	Cooler ID
LF25-MW-Ra	LF25-MW-Ra	25-Jun-2002		0 - 0	N	1	GW		√		√	√					25060200	25060200	25060201	
LF25-MW-Ra-a	LF25-MW-Ra	25-Jun-2002		0 - 0	FD	1	WQ			√							25060200	25060200	25060201	
Temperature Blank		25-Jun-2002		-																
				-																
				-																
				-																
				-																

SAMPLE

COMMENTS: Samples to be delivered to **TestAmerica** of Nashville, Tennessee. Standard TAT required. Please fax preliminary results to Brad Jackson (850) 244-7655.
Send hard copy report to Brad Jackson, 220 Eglin Parkway, SE., Suite 1A, Ft.Walton Beach, Florida 32548

Custody Transfers Prior to Receipt by Laboratory

Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time
1.			1.		
2.			2.		
3.			3.		

Sample Delivery Details / Laboratory Receipt

Delivered Directly to Lab:		Shipped No.:	
Method of Shipment:	Federal Express	Airbill Number:	
Analytical Lab:	TestAmerica	Delivery Location:	Nashville, Tennessee
Lab Recipient:		Delivery Date/Time:	June 26, 2002/

1.) Chain of Custody Number = date collected + custody number (e.g. 09-02-1999-01)
2.) Sample Type (SA) Codes: N = Normal Sample, TB = Trip Blank (-c) Sample, FD = Field Duplicate (-a) Samples, FR = Field Replicate (-b) Samples, EB = Equipment Blank (-d) Samples, MS = Matrix Spike, SD = Matrix Spike Duplicate, AB = Ambient Blank (-e)
3.) Sample Number: Unique sample number collected from a particular location per day. (e.g. Groundwater sample collected from MW-1 on 10/10/99 = 01, if sampled again on 10/10/99 = 02, etc.)
4.) Matrix Codes: GS = Soil Gas, WG = Groundwater, WS = Surface Water, SO = Soil, SE = Sediment, SL = Sludge, SS = Surface Soil Samples, WQ = Aqueous Blank Samples (trip, equipment, ambient, etc), SQ = Soil Blanks
5.) Sample Analysis Requested: Analytical method requested and number of containers provided for each.
6.) Quality assurance samples are assigned by date (ddmmyy) and the sample number associated with the sample (01, 02, etc) (e.g. Equipment blank collected in association with MW-1 on 10/10/99 will be designated 10109901 in the Equipment Blank Lot Control

BSOP NO. 5

GEOPHYSICAL INVESTIGATION METHODS

BHATE STANDARD OPERATING PROCEDURE NO. 5

GEOPHYSICAL INVESTIGATION METHODS

The purpose of Bhate Standard Operating Procedure (BSOP) No. 5 is to provide guidance for conducting geophysical investigations at federal installations as well as commercial facilities.

Bhate's policy regarding geophysical investigations is that all selected surface and borehole geophysical applications must be performed in accordance with the appropriate guidelines described in the equipment operating manuals and technical specifications for each instrument and system. Before any geophysical investigation at a particular site, the intended targets and objectives of the survey must be evaluated and clearly defined in the project work plan or scoping document. This evaluation will result in the selection of the best geophysical systems to use, in what order to use them, and what modes of operation to use for a particular system, as well as the survey layout and instrument configuration. The recommended approach and procedures should be summarized in writing in the project work plan.

All appropriate site preparation and required site access clearance must be completed prior to the geophysical survey. In addition, all field notes and data collection or measurement information must be logged into an appropriate field log book. A field form supplied by the contractor or a geophysical subcontractor that meets this BSOP's data requirements may also be utilized. Pertinent information and notes will be sketched on a site map to complement field notes. In cases where automated data logging is employed, sufficient data will be manually recorded to provide adequate backup and quality control on the data interpretation. Notes will include information on factors affecting the effectiveness of the survey, such as measurements of "noise", documentation of potential problems, areas of possible interference, and instrument condition. Only qualified and appropriately trained personnel will perform or evaluate data generated from geophysical surveys and technical references. It is therefore assumed that in most instances a geophysical subcontractor will conduct the geophysical work and Bhate personnel will provide an oversight technician to monitor the work.

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BSOP NO. 5

GEOPHYSICAL INVESTIGATION METHODS

TABLE OF CONTENTS

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1 SURFACE GEOPHYSICAL INVESTIGATION PROCEDURES

Surface geophysical systems are those, which make measurements of the subsurface characteristics of earth materials and other foreign objects or material contained therein. All measurements are made with instruments positioned at or slightly above the ground surface. Surface geophysical techniques are commonly used during the initial phases of site investigations for preliminary characterization of the geologic/hydrogeologic settings and contaminant plumes, and to identify the presence of buried waste. Bhate personnel must ensure that the recommended approach is followed in the field and, at a minimum, the following are obtained: instrument calibration is conducted daily (and at the end of day if instrument accuracy is known to vary with prolonged use), survey grid or survey lines are flagged and sketched on a site map while in the field; appropriate QA/QC survey lines are run; and field notes are recorded and managed appropriately. If digitally recorded data are collected, the field personnel must ensure that the recorded data are downloaded at least once a day from the data logger at the end of a particular task, and that the contractor receives disk copies of the data sets. The site grid corners and other flagged locations at each grid site must also be surveyed-in or located with a Global Positioning System (GPS), in accordance with BSOP No. 11. Surveying may be performed by the geophysics subcontractor or a professional surveying subcontractor. It is the responsibility of the geophysical subcontractor to arrive on site with fully functioning equipment and enough spare parts to compensate for periodic equipment breakdowns.

Before mobilizing the geophysical subcontractor to the site, the Bhate personnel should consider that the site may need to be cleared of obstructions (trees, underbrush, etc.) which may restrict access of geophysical instruments. Bhate personnel should notify the installation project manager if additional clearing is needed. The clearing activities will either precede or be performed coincidentally with the geophysical work.

The procedures and methods for utilizing the three surface geophysical surveying methods presented in this document (electromagnetic induction, magnetometry, and ground penetrating radar) are discussed below.

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2 ELECTROMAGNETICS

Electromagnetic (EM) surveys measure the electrical conductivity of subsurface soil, rock, and groundwater. Contrasts and anomalies from background conductivity values are interpreted from EM data to help identify potential waste source areas, contaminant plumes, or geologic structures. EM surveys are typically used for rapid reconnaissance of large areas, and when significant differences (for example, 20% or more) in conductivity between background and target impacts are expected. The latter condition may be present at dumps or trenches, groundwater plumes, metal objects, and major changes in soil type or rock structure. EM data are not definitive. The instrument is commonly used as a reconnaissance tool to help locate confirmation borings or monitoring wells, or to tie-in observations between widely spaced borings or monitoring wells.

EM surveys for environmental projects are typically performed with frequency-domain instruments such as the Geonics EM-31 or EM-34-3XL. Recently, time-domain instruments such as the Geonics EM-61 have been employed. Electromagnetic systems are very effective for rapid site reconnaissance and the detection of buried metal objects and conductive groundwater plumes.

The frequency-domain instruments are designed to make two measurements: quadrature phase for terrain conductivity measurements and in-phase for metal detection. These measurements can be made individually or simultaneously (if the data logger is employed). These instruments can be used in a coarse screening or a detail screening mode, depending on the targets and project objectives.

The time-domain instrument (EM-61) is designed for buried metal detection and can be used when there is some surface metal present. Utilization of the EM-61 instrument is generally limited to a relatively tight spaced survey due to its limited sensing width, but it can be used for more coarse surveys if large targets are sought.

2.1 EM-31

The Geonics EM-31 terrain conductivity meter, which measures terrain conductivity directly in millimhos/meter, consists of a transmitting coil and a receiving coil which can be aligned in a vertical plane (horizontal dipole mode) or a horizontal plane (vertical dipole mode). The intercoil spacing (L) determines the effective exploration depth (z) for each operational dipole mode of the EM-31. In the horizontal dipole mode (H), the effective exploration depth is approximately 0.75 times the intercoil spacing (0.75L). In the vertical dipole mode (V), the effective exploration depth is approximately 1.5L. Detailed assembly, calibration, and operating procedures for the EM-31 are described in the user’s manual provided by Geonics, Ltd. This instrument is typically selected for moderate to large targets which lie at less than 10 to 15 feet below land surface (bls), or small targets at less than approximately 5 feet bls. This device is also useful for determining changes in the electrical conductivity of shallow groundwater.

2.2 EM-34-3XL

The Geonics EM-34-3XL terrain conductivity meter is used to collect the same data as the EM-31, but at three greater depths of sensing. The EM-34 has a transmitting and receiving coil but the intercoil spacing can be set at 33, 66, and 131 feet for up to 197 feet depth of exploration. This instrument requires two field operators. Detailed assembly, calibration, and operating procedures for the EM-34-3XL are described in the User's Manual provided by Geonics, Ltd.

This instrument is typically used for deeper targets than the EM-31 and may require, for correlation purposes, additional information provided by borehole logs, borehole geophysical logs, or D.C. resistivity soundings at the site.

2.3 EM-61

The Geonics EM-61 metal detection instrument is used to accurately locate buried metal objects and provide an estimate of depth to the object. The instrument consists of two 3.28-foot wide square loop coils, mounted horizontally, above each other in a frame. This frame can be carried by a single operator from a shoulder harness or towed by the operator when two wheels are mounted to the frame. The hand-held data-logger controls the operation of the EM-61. Readings, in millivolts, are typically made in the continuous measurement mode. Data are downloaded from the data logger and processed with a PC computer.

2.4 Survey Procedures

The type of instrumentation and its setup geometry should be specified in the site specific work plan to ensure that the intended targets can be detected with the field equipment. The initial set-up and operating procedure for electromagnetic instruments should be conducted in accordance with the manufacturer's operating instructions. Instrument calibration is conducted at the factory, and field calibration is performed in background areas near the investigation site. If possible, the same setup area at each project site should be used for daily calibration if more than 1 day is required to cover the site.

Either a grid pattern or a random walk pattern can be used when conducting an EM survey, as long as appropriate steps are followed: logging and/or flagging the locations of readings in the field, noting profile line direction (by compass direction), noting coil orientation (vertical, horizontal, or both), noting which measurements recorded, and noting if measurements are made only parallel to the profile line or if other instrument orientations are used. If the EM-34 is used, note the coil spacing(s) used, and if soundings are performed, the use of a single (40M) cable should be noted and how the coil positions are located relative to the station location (i.e., coils centered about station, or transmitter or receiver positioned at station).

All field data not automatically recorded must be logged into a field log book, and where pertinent, noted on a field map, including:

- Site location*
- Field sketch
- Date, time, and field measurement
- Operator name(s)
- Grid pattern and corresponding station designation*
- Background calibration data, time, location and measurement
- Intercoil spacing, for EM-34-3XL, if applicable
- Compass direction of profile line from an identifiable source*
- Locations of public utility lines*
- Locations of cultural features (i.e., metal fences, railroad lines, wells, benchmarks, etc.)*
- Weather conditions
- Technical difficulties*. Areas of a site where technical difficulties with geophysical equipment are encountered should be noted on the site map.

* These features should also be noted on field map.

Once the site is screened with the EM instrument(s), and gross trends or possible targets are identified, additional survey lines or stations may be added to better define the anomalies. Also, variations in conductivity should be compared to those obtained in nearby background areas of known characteristics to help determine the significance of the anomalies. Existing borehole data (geologic and geophysical) should be consulted.

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3 MAGNETOMETRY

3.1 Description

Magnetometry surveys measure the strength of the magnetic field at each survey location. Contrasts and anomalies from background field values are interpreted from the magnetometry data to help identify potential buried *ferrous* objects or materials, such as steel drums or tanks, subgrade utilities, and geologic structure when magnetic contrasts are suitable. As with the EM data, magnetometry data are not definitive. The instruments are commonly used as a reconnaissance tool to help locate test pits, confirmation borings, or monitoring wells.

Magnetometric (or magnetometer) surveys are performed using a total field magnetometer or a gradiometer, and both are designed for detecting buried metal objects. The total field magnetometer measures the *total intensity* of the earth's magnetic field at a given location, and is useful as a rapid reconnaissance tool for identifying the location, approximate depth, and gross size and shape of ferrous sources. The gradiometer measures the *vertical gradient* of the earth's magnetic field, and is useful for detailed definition of the location, depth, size and shape of the ferrous sources. A gradiometer is actually just two total field sensors mounted a fixed distance vertically apart. Both surveys can be conducted in two modes, discrete station or continuous line.

Total field intensity varies with latitude, and is affected by local perturbations in the earth's magnetic field resulting from interference by naturally occurring or anthropogenic concentrations of ferrous metals. In addition, temporal variations in the earth's magnetic field occur as a result of sunspot activity. Station operation therefore usually requires normalization and correction to baseline data so that the total field intensity readings across a large site can be compared. This phenomenon dictates that total field magnetometric surveys are best conducted during periods of relative sunspot quiescence, or in conjunction with one or more fixed instruments to serve as base stations. Gradiometer surveys have no such constraint, because the background variation cancels-out in computation of the vertical magnetic gradient.

Deciding whether to use gradiometer transects or a total station grid, or a combination of both, is a function of the size of the exploration target relative to the required coverage, and other factors including solar activity and the amount of cultural interferences.

3.2 Procedures

The type of instrumentation and its set up geometry should be specified in the project work plan to assure that the intended targets can be detected with the field equipment. The initial set-up and operating procedures of the instruments must be conducted in accordance with the manufacturer's operating instructions. Instrument calibration is conducted at the factory, but operating parameters such as total field strength may need to be entered by the operator. Detailed calibration and operating procedures for the Unimag II Portable Proton Magnetometer

Mode G-846 are presented in the U.S. Environmental Protection Agency, *Use of Airborne, Surface, and Borehole Geophysical Techniques at Contaminated Sites* (U.S. EPA, 1993). If other magnetometers or gradiometers are used, the instrument set-up and calibration procedures described in their user manuals must be followed.

Whether operating an instrument in a grid pattern, transect, or random walk (gradiometer only) mode, appropriate steps should be taken to properly identify the location of the survey. If not laid out ahead of time, stakes should be set for subsequent land survey or a GPS should be used so that data and results of the magnetometric survey may be accurately represented on maps.

The field procedure of magnetometric surveys generally consists of placing a staff, at the top of which is located the receiving unit, on the ground at sequential locations and operating the data logger (typically contained in a box suspended from a shoulder harness). While automatic recording of data is a commonly available option, depending on the scope of the survey, manual data collection may be appropriate. If data are being recorded automatically, a predetermined percentage of data values should also be recorded manually for QC reasons. All manually recorded field data must be logged into a field log book, and where pertinent, noted on a field map, including:

- Site location*
- Field sketch
- Date, time and field measurement
- Operators name(s)
- Survey pattern and corresponding station designation
- Background calibration data, time location and measurement
- Compass direction of profile line from a identifiable source*
- Locations of public utility lines*
- Locations of cultural features (i.e., metal fences, railroad lines, wells, benchmarks, etc.)*
- Weather conditions
- Technical difficulties*. Areas of a site where technical difficulties with geophysical equipment are encountered should be noted on the site map.

  * These features should also be noted on the field map.

Temporal variation of magnetometric data obtained from base station operation should be incorporated into the mapping of magnetometric data as necessary.

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4 GROUND PENETRATING RADAR

4.1 Description

Ground penetrating radar (GPR) units radiate short duration electromagnetic pulses directly into the ground from an antenna near the surface. The microwave pulses are reflected back to the receiver from interfaces of materials with differing dielectric properties, and are plotted on a strip chart recorder, or digitally recorded for later plotting or post processing and plotting.

The depth of GPR penetration is a function of the attenuation of the electromagnetic pulses, and range from as little as 3 feet in clay to as much as 100 feet in dry quartz sand. Depths are further reduced if groundwater electrical conductivity is high. The great advantage of GPR is that it enables construction of a continuous subsurface profile. GPR is generally useful in defining boundaries of buried trenches and other subsurface disturbances. However, it may perform poorly in silty or clayey soils.

4.2 Procedures

The type of instrumentation and its set up geometry should be specified in the project work plan to assure that the intended targets can be detected with the field equipment. Use of this geophysical investigation method will follow the standard operating procedures of the designated subcontractor.

In addition to the information and records maintained during the survey by the performing GPR subcontractor, the contractor oversight technician should record the following information at minimum, into the field log book (and on a field map) including:

- Site location*
- Field sketch
- Date, time and field measurement
- Operators name(s)/company, address, telephone
- Survey pattern and corresponding station designation
- Background calibration data, time location and measurement
- Compass direction of profile line from a identifiable source*
- Locations of public utility lines*
- Locations of cultural features (i.e., metal fences, railroad lines, wells, benchmarks, etc.)*

- Weather conditions
- Technical difficulties*. Areas of a site where technical difficulties with geophysical equipment are encountered should be noted on the site map.

  * These features should also be noted on a field map.

5 BOREHOLE GEOPHYSICAL LOGGING

5.1 Description

Borehole geophysical logging will be accomplished by either a qualified subcontractor or by Bhate staff. It is assumed that geophysical subcontractors are knowledgeable in the function and operation of their equipment. It is the responsibility of Bhate oversight personnel to make sure of the following:

- The predetermined suite of borehole logs are run by the subcontractor.
- For open borehole logging of newly drilled boreholes, the subcontractor is contacted in advance so that they mobilize on site when they are needed. This will minimize driller downtime and minimize the amount of hole backfilling of sloughing sidewall materials.
- The equipment used should be properly functioning and maintained.
- All the downhole tools and cable are decontaminated in accordance with BSOP No. 13 prior to and following use in each borehole.

When contractor staff and equipment are to be used, the operator shall be experienced in the use of the equipment. He or she shall be responsible for the equipment being onsite prior to the drilling and in operable working order.

5.2 Objectives

This section presents general information regarding borehole geophysical logging and procedures to be followed during logging programs typically performed during environmental projects. Several types of geophysical logs provide useful information applicable to environmental programs. Some of these logs, including borehole caliper, resistivity and spontaneous potential electric logs, natural gamma ray logs, neutron logging, fluid conductivity, induction, sonic, gamma-gamma, and borehole video camera, are discussed below.

5.2.1 Borehole Caliper

Caliper logs are utilized to determine the hole diameter throughout a borehole. Caliper logging utilizes a probe with legs (feelers) that trace the walls of the borehole as the probe is withdrawn. Typically the probe consists of a motor-activated three or four arm probe having a diameter range between 0.6 and 2.3 feet. As the legs open and close, the resistance of a potentiometer is changed and monitored by voltage changes at the surface. The voltage change (measured in millivolts) is calibrated in inches and plotted versus depth to show the average borehole diameter at various depths. The caliper tool is operated only in the uphole direction. Caliper data are definitive.

5.2.2 Resistivity and Spontaneous Potential Electric Logs

The purpose of conducting resistivity and spontaneous potential (SP) logging is to locate the top and bottom of distinct formations, to evaluate relative water quality, and to identify sand layers which are relatively free of fine material. Resistivity logs measure the resistance of the formation and fluid materials with depth. Variations in resistivity are dependent on the character of geologic materials and the fluids they contain. Spontaneous potential logs measure the potentials (voltages) that develop at the contacts between different lithologies, or with a change in water quality. Spontaneous potential, developed between the formation and borehole fluids, also varies with the character of geologic materials and fluids. These variations in resistivity and spontaneous potential can be used to characterize and delineate geologic formations.

Resistivity logging utilizes two electrodes in which a current is forced to flow from one to the other. The resultant current loss is measured in ohms-m^2/m, and is recorded versus depth in the borehole to produce a graph. Normal resistivity utilizes two electrodes downhole. Single point resistivity is conducted with one electrode downhole and one at land surface.

Short normal resistivity utilizes an electrode separation of 16 inches, and long normal resistivity utilizes an electrode separation of 64 inches. Larger spacing of the electrodes creates greater current penetration into the formation and reflects a truer resistivity of the formation. Shorter spacing represents resistivity of a smaller part of the formation and can be used to locate thin formations. Resistivity data are not definitive.

SP data are obtained by lowering an electrode connected to a millivolt meter to the desired depth in the borehole. A second terminal will be connected to ground at surface level. Any current resulting from electrochemical action within subsurface fluids is transmitted to the surface through the drilling fluid and recorded. This procedure will be repeated with the first electrode at various depths. The change in potential (in millivolts) versus depth is then plotted on a strip chart. SP data are not definitive.

Normal resistivity, SP logging, and single point resistance logging, if applicable, must be conducted prior to any casing installation, and only in boreholes containing water or drilling fluid. An effort should be made to keep the fluid level as high as possible in the borehole to obtain good results at shallow depths. All resistivity and spontaneous potential logging equipment must be calibrated prior to entering the borehole. Calibrations will be performed in accordance with the manufacturer's specifications; written evidence of this calibration must be provided.

5.2.3 Natural Gamma Ray Logs

Natural gamma ray logs measure the total natural gamma radiation (commonly K-40, U-238, and Th-232) that is within a selected energy range. The intensity of gamma radiation can be used to distinguish between different types of geologic materials. Igneous rocks, metamorphic rocks, and clay particles often contain radioactive elements that emit relatively high levels of radiation. In contrast, mature quartz sands and gravels, limestone, and dolomite tend to emit low levels of radiation. Gamma ray intensity also decreases with an increase in the distance pulses must travel to the detector or the density of the material through which they travel. Thus, shifts in gamma logs caused by borehole media, casing, hole diameter, gravel pack, grout, and well development should be considered while interpreting data, as should the random nature of gamma ray emission.

Gamma ray logging may be conducted in either cased or uncased and dry or fluid-filled holes. The logging subcontractor must calibrate the instrument as per the manufacturer's specifications, and provide written evidence of calibration. The probe design will consist of a scintilometer type gamma ray detector consisting of thallium-activated sodium iodide crystals. Natural gamma data are not definitive.

5.2.4 Neutron Logging

Neutron logging is used primarily to evaluate the total porosity of subsurface materials under saturated conditions. The type of radiation measured is dependent on the type of source and detector, shielding materials, and spacing between the source and detector. A neutron source and detector are lowered into the borehole, and the number of neutrons colliding with the detector is recorded. Neutron energy is lost as neutrons collide with various particles, most commonly hydrogen, and are captured prior to reaching the detector. The loss in neutron energy is approximately related to the amount of water present in geologic materials (which can be generally correlated to their porosity) because water possesses a dense hydrogen concentration. Neutron logging should be used in conjunction with other geophysical logging techniques to evaluate permeability because "bound" water in silts and clays produces a strong neutron response. Neutron logging can be used to estimate moisture content above the water table, provided the geologic matrix is well understood.

Neutron logging may be conducted in either cased or uncased and dry or fluid-filled holes. The logging subcontractor must calibrate the instrument as per the manufacturer's specifications, and written evidence of which must be provided. A probe, consisting of a neutron-emitting source attached to a detector, will be lowered to the bottom of the borehole. Particular care should be observed in handling the radioactive probes. Contractors must be trained and licensed in handling this equipment. Neutron logging data are not definitive.

5.2.5 Fluid Conductivity

Fluid conductivity logs (the reciprocal of resistivity) measure the resistance to flow of electric current in a borehole. The resistance information can be associated with groundwater chemistry in studies of groundwater origin or contaminant plumes. The instrumentation consists of two closely-spaced electrodes in a probe, a power supply and a recording unit. The probe is lowered and retrieved through the water column, and records the resistance to electric current flow between the electrodes. Conductivity data are not definitive.

5.2.6 Sonic

Sonic logs are used to measure porosity and fractures in rock, by recording the travel time (velocity) and amplitude of compression waves (*P*-waves) and shear waves (*S*-waves) between the instrument's source and receiver. The logs can be interpreted to infer rock porosity, as well as the relative extent of rock fracturing and solution features. The instrumentation consists of a sonic source and two to four receivers in a long probe on a cable, a power supply and recording unit. The probe is lowered and retrieved through the borehole or water column, emitting a sonic energy pulse, and receiving and recording the *P*- and *S*- waves. Sonic log data are not definitive.

5.2.7 Gamma-Gamma

Gamma-gamma logs measure the decay of induced radiation between the instrument's radioactive source and receiver. The logs can be interpreted to infer rock and soil bulk density, porosity, the relative extent of rock fracturing and solution features, and the amount of cement behind a well casing. The instrumentation consists of an activated radioactive source and a receiver on a cable, a power supply, and a recording unit. As the probe is lowered and retrieved through the borehole or water column, gamma radiation emitted from the probe source, is scattered by the density of the surrounding soil and rock, and is detected by the probe receiver. The radius of investigation is determined by the source material and the source-receiver spacing in the probe, but is typically no more than 6 to 10 inches. Gamma-gamma log data are not definitive.

5.2.8 Borehole Video Camera

Borehole video is used to directly view well screens or casings, rock boreholes, and other industrial uses. The video information can be used to identify corroded or encrusted well pipe or screens, and rock fractures. The instrumentation consists of a video camera and light in a probe on a cable, a scanner, and a TV monitor. As the probe is lowered through the well or borehole, the focus and view angle is controlled remotely from the surface and a picture is recorded on videotape (with an audio track for comments) and displayed on the monitor. Video data are definitive.

5.2.9 Downhole Flowmeter

Flowmeter logs are used to measure vertical fluid movement in a water column. The logs can be interpreted to identify water bearing zones in a multilayered groundwater system. The instrumentation consists of an impeller flowmeter, a power supply, and recording unit. As the probe is lowered and retrieved through the water column, changes in groundwater flow velocity are measured by the flowmeter and recorded. Downhole flow meter data are not definitive.

5.2.10 Procedures for Borehole Logging

Borehole logging tools used for environmental work typically include caliper, natural gamma, spontaneous potential, single point resistance, short and long normal resistivity, temperature, fluid conductivity, and/or sonic detection devices. Other tools sometimes used are nuclear source tools (radioactive) such as neutron and gamma-gamma, borehole video camera, and flowmeter. Typically the maximum borehole logging speed should be 20 ft/min for most logging tools. However, slower or faster speeds may be required based on instrument-specific SOPs and/or project-specific data quality objectives.

When the drilling subcontractor has finished cleaning out the borehole and “conditioned” the drilling fluid for logging, or all pumps and piping are removed from cased holes, the contractor oversight should make sure the geophysical subcontractor, or contractor geophysical tool operator, follows the following applicable procedures:

1. Geophysical tools (sondes) are lowered into the borehole or casing to the total depth or bottom of zone to be logged. For all tools, other than the caliper tool, the range of values can be evaluated during the downward travel.

2. After setting up digital recording equipment, and if possible, strip chart printer, the logging proceeds on the upward travel direction.

3. Data recorded digitally should be reviewed before moving from the site to make sure high quality data were recorded. Strip chart plots should be made, if possible.

4. If resistivity tools are used, the specific conductance of the borehole fluid should be measured and recorded in the field log book. This will assist in the evaluation of instrument sensitivity to the borehole fluid.

Nuclear source tools (neutron and gamma-gamma) require special handling. Only qualified personnel should be directly involved in the task. Dropping of nuclear sources into an open borehole presents a significant environmental hazard and can be very expensive to recover.

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6 REFERENCES

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BSOP NO. 6

QUALITY CONTROL PROCEDURES FOR FIELD EQUIPMENT

BHATE STANDARD OPERATING PROCEDURE NO. 6

QUALITY CONTROL PROCEDURES FOR FIELD EQUIPMENT

Quality control procedures for field analysis, and field analytical and test instrumentation calibration are an essential part of these BSOPs. All field analyses must be traceable to the personnel performing the analyses. Time records shall be kept in local time using the military 24:00 hour format and shall be recorded to the minute. The time, method, and result of each field analysis shall be entered into the field log books chronologically for each analyses performed.

All field analytical procedures shall be conducted in duplicate at least ten percent of the time. A record of these duplicate analyses shall be kept in the field log book. A significant difference in the replicate analyses (greater than specified in the following sections) shall result in recalibration of the instruments used, re-examination of the analytical methodology being used, or re-examination of the sampling location.

A specific calibration and/or standardization plan for commonly utilized field analytical equipment is presented in this subsection. All calibration information, including individuals making the calibrations and dates of calibration, shall be recorded in a field log book. Additional field analytical equipment beyond those specified here may be used depending on the project requirements and the scope of work, but usage must be in accordance with the manufacturer's recommended procedures.

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BSOP NO. 6

QUALITY CONTROL PROCEDURES FOR FIELD EQUIPMENT

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1 PROCEDURES

This section describes the procedures for equipment standards, inspection, calibration, and documentation. Documentation of field instrument calibrations will be the responsibility of field personnel. All instruments shall be checked before each field trip for any mechanical or electrical failures, weak batteries, and/or fouled electrodes where applicable. All calibration records shall be maintained in the field log book. In addition, the following information shall be recorded in the log book:

- Equipment type (e.g., pH meter)
- Manufacturer and model number
- Serial number
- Name of person who calibrated instrument
- Calibration standards used including lot numbers and expiration dates

Entries in the log book will be made at the beginning of each sampling or measuring effort and when each instrument is calibrated. All documentation in the log book will be made in ink, in accordance with BSOP No. 3. If an error occurs, corrections will be made by crossing a line through the error and entering the correct information. Changes will be dated and initialed. No entries will be obliterated or rendered unreadable. Records will be kept for all instruments requiring calibration.

1.1 Water Analysis

Water quality instruments allow for immediate measurements of parameters including pH, temperature, specific conductivity (SC), Dissolved Oxygen (DO), Oxidation-Reduction Potential (ORP or redox), and turbidity. A wide variety of instruments are available which, depending on the unit chosen, will measure each individual or any combination of parameters desired. It is recommended that measurement of field parameters be conducted under flow through cell or insitu conditions, due to aeration and/or contact with atmosphere can alter readings. For parameters such as hardness and specific ions, a field test kit can be purchased to measure analytes separately.

1.1.1 Temperature

A National Bureau of Standards (NBS) thermometer or one that has been compared to a NBS certification will be used for field screening. To field screen aqueous samples for temperature the thermometer or multi-parameter instrument will be immersed in the sample until the reading stabilizes, typically less than 1 minute. The temperature will be read directly off the instrument in degrees Celsius to the nearest 0.5 C. All temperature data collected will be recorded in the field log book.

1.1.2 Concentration of Hydrogen Ions (pH)

Only electronic (portable) pH meters with automatic temperature compensation should be used. Because of the potential use of a variety of pH meters, calibration will be in accordance to the manufacturer's specifications and project or client-specific requirements. Once the pH meter is calibrated, a calibration check to a pH 7 buffer solution should be analyzed and results documented in the field log. While in the field, the meter should be calibrated daily before use with two buffers bracketing the expected sample pH. Buffer solutions will be replaced on a weekly basis, at a minimum. To field screen aqueous samples for pH, the meter will be inspected and be allowed to equilibrate to ambient temperatures. The pH probe will be rinsed with deionized (DI) water, immersed in the water sample, and the meter reading will be allowed to equilibrate. The pH values will be read directly off the analog or digital display and recorded in the field log book. Depending on the unit used the pH probe may need to be stored in DI water when not in use. The pH should be reported to the nearest 0.1 pH unit.

1.1.3 Dissolved Oxygen

Dissolved oxygen (DO) will be measured using a DO meter. DO meters shall be checked before each field trip by inspecting the membrane for air bubbles and holes. If the membrane is in doubt, it shall be replaced before calibrating. The probe should be recalibrated throughout the day to account for the altitude of the site and the changes in air temperature. Calibration should be made in accordance with the instrument manufacturer's specifications and project or client-specific requirements. DO may be taken in monitoring wells using downhole measurements. If this process is used, the DO probe will be thoroughly decontaminated between wells. DO readings are collected after each well volume is removed. DO measurements may also be collected immediately after sample collection. Because most well purging techniques can allow aeration of collected groundwater samples, it is important to minimize potential aeration by using a low flow pump (i.e. peristaltic or redi-flow grundfos) to purge the well. DO measurements should be recorded in the field log book and reported to the nearest 0.1 mg/L.

1.1.4 Specific Conductivity

To field screen aqueous samples for specific conductivity, each conductivity meter shall be allowed to equilibrate to ambient temperatures. Calibration shall be in accordance with the manufacturer's specifications and project or client-specific requirements, and checked against a known conductivity standard. To field screen aqueous samples for specific conductivity, the meter will be immersed and the reading be allowed to equilibrate. The specific conductivity value will be read directly off the digital display and recorded in the field log book. Results should be expressed in milliSiemens per centimeter (mS/cm) or micromhos/centimeter (µmhos/cm) corrected to 25°C.

1.1.5 Turbidity

Turbidity will be measured using a nephelometric turbidity meter. Each turbidity meter shall be checked and calibrated to manufacturer's specifications and project or client-specific requirements before use. The calibration should be checked with secondary standards on a daily basis, and when mobilizing to a different site location. The meter should be calibrated to set standards prior to sample analysis. The sample volume will be shaken to ensure fully mixed conditions. The test vial will be completely filled with a water sample and the outside of the vial will be wiped until it is fully dry. No micro-bubbles should be present on the inside walls of the test vial. The vial will be placed in the turbidity meter and the turbidity reading will be allowed to equilibrate. The turbidity meter should equilibrate within 5 to 15 seconds. Equilibration periods longer than 15 seconds may result in low readings due to the settling of particles to the bottom of the test vial. Turbidity data will be recorded in the field log book in Nephelometric Turbidity Units (NTUs). Values which exceed 1,000 NTUs should be reported as >1,000 NTUs.

1.1.6 Oxidation Reduction Potential

To field screen aqueous samples for oxidation/reduction potential (ORP or redox), an ORP meter will be inspected to make sure the probe and meter are clean and undamaged. If dirty, the probe will be cleaned per the manufacturer's instructions (usually isopropanol will serve as a safe cleaning reagent). On the basis of the manufacturer's instructions and project or client-specific requirements, the meter will be calibrated using a redox solution standard. The probe will be placed in the water sample, and the probe slowly stirred through the sample. The readings will be allowed to equilibrate and the value will be read directly off the display. ORP data will be recorded in the field log book in millivolts (mV).

1.1.7 Salinity

To field screen aqueous samples for salinity, the salinity meter will be inspected for cracks and calibrated per the manufacturer's specifications. The probe should then be immersed in the sample and slowly stirred. The salinity reading will then be allowed to equilibrate. Units should be reported as a percentage.

1.1.8 Natural Attenuation Parameters

Groundwater or surface water concentrations of natural attenuation parameters will be field analyzed using a portable colorimeter. The colorimeter measures the amount of light, which passes through a vial of specially prepared water sample and reagent mixture. The reagent reacts with the constituent of concern in the sample, which causes coloring of the water. Light from a lamp in the colorimeter passes through the sample and a specific filter and is measured by a photo diode. The colorimeter can be used for screening for parameters, such as ferrous iron, nitrate, sulfate, and manganese, using different reagent mixtures.

General steps for using the colorimeter are as follows:

1. Install the correct filter module in the instrument.

2. Select the proper program number from the display.

3. Prepare the sample as indicated in the applicable test procedure. Be sure to use the correct reagent for the analysis (ferrous iron, nitrate, sulfate, etc…).

4. Place the sample vial with blank solution in the sample compartment.

5. Zero the instrument by pressing the ZERO key.

6. Place the sample vial with the prepared sample into the sample compartment.

7. Press the read key and read the results.

1.2 Soil Analysis

Soil screening instruments allow for immediate measurements of hydrocarbon levels contained in soils.

1.2.1 Soil Vapor Headspace

An Organic Vapor Analyzer (OVA) equipped with a Flame Ionization Detector (FID) or a Photoionization Detector (PID) will be used to assess the qualitative concentration of VOCs present in soil sample headspace vapors and in vadose zone soil vapors. The OVA will be calibrated by the manufacturer every 6 months. The instrument will also be calibrated daily (or according to project or client-specific requirements) using a methane gas standard. Refer to the manufacturer's instructions for specific calibration procedures.

Soil sample screening procedures will be conducted as described below:

1. Readings will be obtained at the site with the OVA in the survey mode.

2. Each soil sample for headspace analysis will be split into two half-filled, 16-ounce jars and covered with aluminum foil. For optimum results, the two samples should be brought to a temperature of between 20°C (68°F) and 32°C (90°F) and the readings should be obtained within approximately 5 minutes. Temperature of the soil samples can be controlled by heating the sample on the hood of a vehicle or within the vehicle, in front of a heater. To

obtain readings, the probe from the FID will be inserted through the aluminum foil into the headspace of the jar.

3. One of the readings will be obtained with the use of an activated charcoal filter unless the unfiltered reading is non-detected. A total corrected hydrocarbon measurement will be determined by subtracting the filtered reading from the unfiltered reading.

1.2.2 Immunoassay Kits

Soil screening and groundwater screening for parameters such as PCBs, PAHs, TPH, DDT, and BTEX can be accomplished using immunoassay kits manufactured by EnSys Inc., HACH, or their equivalent. The test kits for each project will be supplied with a customized standard equal to the proposed clean-up levels.

Detailed instructions are provided in the manuals supplied with the individual test kits.

1.2.3 Vadose Zone Soil Vapors – Organic Vapor Analyzer

Vadose zone soil vapors will be analyzed in the following manner with a calibrated OVA:

1. A sample of vadose zone vapors will be extracted from a monitoring point or well after proper well purging (two to three casing or tubing volumes).

2. If the sample is contained in a Tedlar bag, the OVA probe will be placed in the bag nozzle and the reading will be allowed to equilibrate. OVA monitoring will be conducted with and without an activated carbon filter for each sample taken.

3. If the vapor sample is extracted with a pump and sent through a moisture trap, the OVA probe will be placed in the vapor stream after the moisture trap and the reading will be allowed to equilibrate. OVA monitoring will be conducted with and without an activated carbon filter for each sample taken.

1.2.4 Pressure/Vacuum Monitoring

Air pressure during injection for the in situ respiration test will be measured with a pressure gauge with a minimum range of 0 to 30 psi. Changes in soil gas pressure during the air permeability test will be measured at monitoring points using Magnehelic™ or equivalent gauges. Tygon™ or equivalent tubing will be used to connect the pressure/vacuum gauge to the fitting on the top of each monitoring point. Pressure and vacuum gauges will be positioned before and after the blower unit to measure pressure/vacuum across the blower and at the head of the venting well. Pressure/vacuum gauges are available in a variety of pressure/vacuum ranges, and the same gauge can be used to measure either vacuum or pressure by simply switching inlet ports. Gauges are sealed and calibrated at the factory and will be re-zeroed before each test.

Monitoring of pressures will be performed as follows:

1. The piezometer wells will be capped with a secure polyvinyl chloride (PVC) end cap fitted with a barbed brass fitting. A 3-foot length of flexible tubing will be attached to the barbed fitting. The flexible tubing will be securely pinched at the end with a clothes-pin style clamp or equivalent fitting or valve in order to isolate the piezometer well from atmospheric pressure.

2. A portable vacuum gauge with the vacuum range anticipated for the piezometer well will be selected and flexible tubing will be securely attached to the vacuum gauge port.

3. The hose will be unclamped or valve opened and the vacuum reading allowed to stabilize. The vacuum for the well location will be recorded on the air sparge/SVE blower vacuum/pressure standardized log.

4. The hose will be reclamped or valve closed and the vacuum gauge removed. The PVC cap with barbed fitting and the flexible tubing should remain on the well throughout the pilot test.

2 MISCELLANEOUS EQUIPMENT

In addition to the instruments described above, a wide variety of field instruments and test kits can be used at project sites. These may include PIDs, radiation detection meters, etc. It is impractical to include descriptions of all types, brands, and calibration procedures of the instruments that may be used. Therefore, the manufacturer's recommendations and procedures for proper operation/calibration must be followed in every circumstance. Field-calibrated instruments will be calibrated once a day (at a minimum), and will be documented in the field log book.

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3 SEMI-ANNUAL MAINTENANCE

All analytical/test instruments and kits shall be inspected on a semi-annual basis, regardless of whether they have been used during the intervening period. The purpose of the semi-annual inspection is to maintain the equipment in a ready-to-use condition. This inspection shall consist of a general examination of the electrical system (including batteries) and a calibration against standards. Any expired reagents, broken glassware, or parts shall be replaced.

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4 SOURCES OF CHEMICALS AND STANDARDS

All chemicals used in test kits and with field analytical instruments as reagents, standards, and certified Ph buffer solutions shall be purchased from chemical suppliers (as opposed to being prepared in the field). All reagents and solutions shall have the received and expiration dates recorded on the reagent bottle and attached to the container. All out-of-date reagents, buffers, and chemical solutions shall be properly disposed of at their expiration date. All field reagents containers shall be identified with the chemical name, concentration, and date prepared.

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5 REFERENCES

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Environmental Protection Agency, Region IV, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1996.

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BSOP NO. 7

SURFACE WATER AND SEDIMENT SAMPLING

BHATE STANDARD OPERATING PROCEDURE NO. 7

SURFACE WATER AND SEDIMENT SAMPLING

The objective of Bhate Standard Operating Procedure (BSOP) No. 7 is to provide general procedures for obtaining data to be used in the determination of patterns of pollution, or baseline information, for the overall characterization of surface water and sediment systems.

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BSOP NO. 7

SURFACE WATER AND SEDIMENT SAMPLING

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1 SURFACE WATER SAMPLING

1.1 Objective

The objective of this section of the BSOP document is to present the basic techniques and general considerations to be followed for the collection of water-quality samples from rivers, streams, lakes, ponds, and bays. The specific details of actual sample collection are highly dependent upon local conditions, as well as the purpose of the water-quality study.

1.2 Procedure

Surface water bodies may be grouped into three types including:

1. Rivers, streams, and creeks

2. Lakes, ponds, and impoundments

3. Estuarine environment

The selection of the surface water sample locations will depend on the type of surface water body being sampled. Sampling locations where mixing is incomplete should be avoided if an average composition is required. Often, areas of poor lateral or vertical mixing can be visually identified. For example, color or turbidity differences may be apparent immediately below the confluence of a tributary and the main river or at a wastewater discharge point. Use of a field conductivity meter is recommended for determining the uniformity of the water composition across the width and depth of the water body. Once the sampling point has been selected, it must be fixed by detailed description, maps, or with the aid of stakes, buoys, or other landmarks so that subsequent visits to the site will allow the identification of the sampling point. When locating sampling points in a stream or river, the reference to the bank of the river will be from the vantage of looking upstream.

1.2.1 Shallow Stream Sampling

When sampling a shallow river, small stream, or creek (less than 20 feet wide and 3 feet deep), areas with relatively homogenous cross sectional channels will be sampled. The sampling site should be located immediately downstream from areas where turbulent flow exists to ensure vertical mixing of the water column has occurred. Unless otherwise specified in the project sampling program, samples should be collected at mid-depth in the mid-section or deepest flow channel of the stream. In addition, samples should be collected from the downgradient sample location to the upgradient location to prevent sediment disturbance and sample contamination.

When collecting samples from shallow surface waters, the following procedures will be followed:

1. Don personal protective clothing (for example, nitrile gloves and tyveks), as required.

2. Remove the sample bottles to be used at the site from the coolers. Fill in all information indicated on the bottle label with an indelible ink marker or permanent ink ball point pen in accordance with BSOP No. 4.

3. Do not rinse the sample containers.

4. Measure in-stream field parameters, such as pH, conductivity, turbidity, dissolved oxygen, and temperature and record data in the field log book.

5. Surface grab samples may be collected directly in the sample container. Reduce risk of sample contamination by sampling against the stream flow with the sampling personnel located in a downstream position from the sample bottle. If the sample jars are pre-preserved, a non-preserved laboratory clean jar can be used as the sampling device to transfer the sample from the stream to the actual jars. In addition, if it is not possible to wade within the stream, the sampling device can be strapped to a metal or wooden pole, which can be lowered into the stream from the stream bank or within a boat. The preferential order of sample collection is as follows:

   - Volatile organic compounds (VOCs)
   - Dissolved gases and total organic carbon (TOC)
   - Purgeable organic halogens (POX)
   - Total organic halogens (TOX)
   - Extractable (semi-volatile) organic compounds (SVOCs)
   - Total metals
   - Dissolved metals
   - Phenols
   - Cyanide
   - Sulfate and chloride
   - Turbidity
   - Nitrate and ammonia
   - Radionuclides

6. Replace cap and seal container tightly. Place the sample container in a sealed plastic bag.

7. Place sample in cooler immediately. Once the cooler is filled with samples, it will be secured in a sampling vehicle or other secure storage facility until the completion of the day's sampling activities. All samples will be packaged in a manner consistent with Sample Packaging procedures outlined in BSOP No. 4.

8. If no map of the sampling locations is available prior to sampling, a drawing of the site (not necessarily to scale) will be included in a left page of the field log book to provide an illustration of all sampling points. Care should be taken to reference distances to a sampling

point from a fixed, permanent location (for example, building corner or a road intersection). Refer to BSOP No. 3 for field documentation procedures.

9. Fill out sample chain-of-custody Form, in order to maintain an accurate record of sample collection, transport, analysis and disposal. Refer to BSOP No. 4 for chain-of-custody labeling procedures.

10. Decontaminate equipment after each sample is collected, as described in BSOP No. 13.

11. Discard contaminated personal protective clothing (e.g., latex gloves or tyvek) as required.

1.2.2 Deep (Stratified) River and Stream Sampling

In deep rivers or larger streams, use of a boat or raft will usually be required to obtain a representative sample. A vertical composite sample consisting of subsamples collected just below the surface, at mid-depth, and just above the bottom will be collected from the center of the channel. For large rivers, several vertical composites across the channel may be required to characterize the water quality. Generally, sample locations will be closer together towards the mid-channel where most flow occurs as opposed to the edges where less flow occurs.

Stratified/deep waters will be sampled using a Teflon, glass, and/or stainless steel Kemmerer bottle, Van Dorn, Bomb, or equivalent method as indicated below:

1. Don personal protective clothing (for example, nitrile gloves and a tyvek) as required by Site Safety and Health Plan (SSHP).

2. Decontaminate the sampling vessel between each vertical composite sampling location in accordance with BSOP No. 13.

3. Inspect vessel thoroughly to ensure that the sample drain valve is closed (if bottle is so equipped).

4. Measure with a weighted tape and then mark sample line at the desired sampling depth.

5. Open sampling vessel by lifting top stopper-trip head assembly.

6. Gradually lower bottle until desired level is reached.

7. Place messenger on sample line and release. This causes the stoppers to close the cylinder, trapping the discrete sample.

8. Retrieve sampler; hold sampler by center stem to prevent accidental opening of bottom stopper.

9. Rinse and wipe off exterior of sampler body (wear proper gloves and protective clothing).

10. Recover sample by grasping lower stopper and sampler body with one hand, and transfer sample by either (a) lifting top stopper with other hand and carefully pouring contents into sample bottles, or (b) holding drain valve (if present) over sample bottle and opening valve.

11. Allow sample to flow slowly down inside of sample bottle with minimal disturbance.

12. Preserve the sample as appropriate.

13. Check that a Teflon liner is present in the cap if required. Secure the cap tightly.

14. Immediately after the sample is collected, label the sample containers per the Sample Labeling procedures defined in BSOP No. 4.

15. Place sample in cooler immediately. Once the cooler is filled with samples, it will be secured in a sampling vehicle or other secure storage facility until the completion of the day's sampling activities. All samples will be packaged in a manner consistent with Sample Packaging procedures outlined in BSOP No. 4.

16. If no map of the sampling locations is available prior to sampling, a drawing of the site (not to scale) will be included in the field log book to provide an illustration of all sampling points. Refer to BSOP No. 2 for field documentation procedures.

17. Fill out sample chain-of-custody Form, in order to maintain an accurate record of sample collection, transport, analysis and disposal. Refer to BSOP No. 4 for chain-of-custody labeling procedures.

18. Decontaminate sampler and messenger in accordance with procedures outlined in BSOP No. 13.

19. Discard contaminated personal protective clothing (e.g., latex gloves, tyvek, etc.), as required.

1.2.3 Lakes, Ponds and Impoundments

Lakes, ponds, and impoundments are more likely to have stratified water columns than rivers and streams because of temperature differences. A single vertical composite surface water sample will be collected from the center of small ponds and impoundments. In lakes and large impoundments, several vertical composite subsamples may be collected along a transect or grid and combined to form a single composite sample. Sampling techniques used for lakes, ponds, and impoundments will be as outlined in Section 1.2.2.

1.2.4 Estuarine Environment

In an estuarine environment, samples will be collected at mid-depth in areas when the total depth is less than 10 feet. In deeper areas, samples will be collected 1 foot below the surface, at mid-depth, and 1 foot from the bottom. Sampling techniques used for estuarine environments will be as outlined in Section 1.2.2.

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2 SEDIMENT SAMPLING

2.1 Objective

This section presents the basic techniques and methods to be used to obtain representative sediment samples from lake and stream bottom sediments. Lake and stream bottom sediment sampling is performed to define the chemical, and in some cases physical or biological, composition of sediment. Sediment sampling is generally performed to delineate the extent of chemical contamination within benthic systems.

Sediment or benthic material may be obtained directly from small streams using stainless steel trowels or spoons. A dredge type sampler is used to collect sediment samples from lakes and ponds. In every case, all water sampling should be performed prior to disturbing the sediment.

2.2 Procedure

Sediment samples will be collected from the upper 6 inches of bottom sediment. Samples from small streams will be collected by a technician standing on the bank or wading into the stream, and will be collected from the stream bottom in depositional areas. Sediment samples from ponds, lakes or large rivers will be collected from a boat, and ideally, the position will be located with a Global Positioning System (GPS) as described in BSOP No. 11. At a minimum, the position will be established by triangulation with surface features and approximated distances.

Where sample collection using trowels or spoons is inappropriate, sediment samples may be collected using a core barrel/hand auger device for shallow water, and a Ponar© dredge, or gravity corer for deep water sampling. Samplers will be constructed of stainless steel.

2.1.1 Sampling with a Core Barrel/Hand Auger Device

The following procedures outline the collection of shallow water sediment samples using a core barrel/hand auger device.

1. Don personal protective clothing (for example, nitrile gloves and tyvek), and flotation as required by the SSHP.

2. Using a weighted measuring tape (if necessary), make detailed measurements of the sampling location and record in the field log book. Details should include the following:
   - Location references
   - Depth of water
   - Turbidity
   - Stream velocity estimates (stagnant, slow, moderate, or fast)
   - Bottom description

- Litter, vegetation, wildlife, and any other field observations that may be used to help interpret the data.

3. Wading into the stream, or from the bank, advance the core barrel/hand auger sampler into the stream bottom a distance of 6 to 12 inches. Use a smooth, continuous motion to advance the sampler.

4. If using a core sampler, close the air escape vent and retract the sampler from the stream bottom. To retrieve sampler, twist and remove smoothly.

5. Place sample onto a stainless steel or Teflon tray and remove the sediment contents with a pre-cleaned stainless steel lab spoon or equivalent. Immediately place sample into the appropriate containers.

6. Check for a Teflon liner in cap if required and secure cap tightly.

7. Immediately after the sample is collected, label the sample containers per the Sample Labeling procedures defined in BSOP No. 4.

8. Place sample in cooler immediately. Once the cooler is filled with samples, it will be secured in a sampling vehicle or other secure storage facility until the completion of the day's sampling activities. All samples will be packaged in a manner consistent with Sample Packaging procedures outlined in BSOP No. 4.

9. If no map of the sampling locations is available prior to sampling, a drawing of the site (not to scale) will be included in the field log book to provide an illustration of all sampling points. Refer to BSOP No. 3 for field documentation procedures.

10. Fill out sample chain-of-custody Form, in order to maintain an accurate record of sample collection, transport, analysis and disposal. Refer to BSOP No. 4 for chain-of-custody labeling procedures.

11. Decontaminate sampler in accordance with procedures outlined in BSOP No. 13.

12. Discard contaminated personal protective clothing (e.g., latex gloves, tyvek, etc.), as required.

2.1.2 Sampling with a Dredge Sampler

Sediment samples collected with the stainless steel Ponar© dredge sampler will be collected in the following manner:

1. Don personal protective clothing and flotation as required.

2. Using a weighted measuring tape (if necessary), make detailed measurements of the sampling location and record in the field log book. Details should include the following:

location references, depth of water, stream velocity estimates (e.g., stagnant, slow, moderate, fast), bottom description, litter, vegetation, wildlife, etc.

3. Place the jaws of the Ponar© dredge in the lock-open position. The Ponar© dredge should be used for the first sampling attempt at each point.

4. Secure a rope, cord, or cable to allow the dredge to reach from the sampling personnel to the sediment being sampled. When the interval to be sampled is greater than 3 feet below the water surface, the end of the cord or cable should be fixed to the boat or dock from which the sampler is being lowered.

5. Position the dredge directly above the point where the sample will be collected.

6. Check to be sure that the jaws of the dredge are open and that the connection cord or line is free to follow the dredge. Lower the dredge into the water and allow it to descend until it reaches the sample point.

7. When the dredge is in position to collect the sample, the connection cord should be tugged sharply three times. The dredge should be raised slowly at a constant rate by the sample collector. Care should be taken not to let the dredge bounce while being raised to the surface.

8. When the dredge has been raised, it should be placed in a clean stainless steel basin. Position the dredge on its side and slowly open the sample container.

9. Remove the sediment contents with a pre-cleaned stainless steel lab spoon or equivalent and place the sample into the appropriate container. If the dredge does not contain enough material or is empty, repeat steps one through seven until the sample has been obtained.

10. Immediately after the sample is collected, label the sample containers per the Sample Labeling procedures defined in BSOP No. 4.

11. Place sample in cooler immediately. Once the cooler is filled with samples, it will be secured in a sampling vehicle or other secure storage facility until the completion of the day's sampling activities. All samples will be packaged in a manner consistent with Sample Packaging procedures outlined in BSOP No. 4.

12. If no map of the sampling locations is available prior to sampling, a drawing of the site (not to scale) will be included in the field log book to provide an illustration of all sampling points. Refer to BSOP No. 3 for field documentation procedures.

13. Fill out sample chain-of-custody Form, in order to maintain an accurate record of sample collection, transport, analysis and disposal. Refer to BSOP No. 4 for chain-of-custody labeling procedures.

14. Decontaminate sampler and messenger in accordance with procedures outlined in BSOP No. 13.

15. Discard contaminated personal protective clothing (e.g., latex gloves, tyvek, etc.), as required.

2.1.3 Sampling with a Gravity Corer

Sediment samples collected with the stainless steel gravity corer sampler will be collected in the following manner:

1. Don personal protective clothing and flotation as required.

2. Using a weighted measuring tape (if necessary), make detailed measurements of the sampling location and record in the field log book. Details should include the following: location references, depth of water, stream velocity estimates (stagnant, slow, moderate, fast), bottom description, litter, vegetation, wildlife, and any other applicable field observations.

3. Secure a rope, cord, or cable to allow the corer to reach from the sampling personnel to the sediment being sampled. When the interval to be sampled is greater than 3 feet below the water surface, the end of the cord or cable should be fixed to the boat or dock from which the sampler is being lowered.

4. Insert a new acetate liner into the corer. Inspect the check valve on the top of the corer.

5. Position the dredge directly above the point where the sample will be collected.

6. Lower the dredge into the water and allow it to free-fall to the bottom.

7. Retrieve the sampler at a smooth, constant rate. Care should be taken not to let the corer bounce or bump while being raised to the surface.

8. When the corer has been raised, it should be placed in a clean stainless steel basin.

9. Release check valve, remove corer nosepiece, and extract sediment contents with a pre-cleaned stainless steel lab spoon or equivalent and place the sample into the appropriate container. If the corer does not contain enough material or is empty, repeat steps one through seven until the sample has been obtained. Additional weights may be added to the corer as needed.

10. Immediately after the sample is collected, label the sample containers per the Sample Labeling procedures defined in BSOP No. 4.

11. Place sample in cooler immediately. Once the cooler is filled with samples, it will be secured in a sampling vehicle or other secure storage facility until the completion of the day's

sampling activities. All samples will be packaged in a manner consistent with Sample Packaging procedures outlined in BSOP No. 4.

12. If no map of the sampling locations is available prior to sampling, a drawing of the site (not to scale) will be included in the field log book to provide an illustration of all sampling points. Refer to BSOP No. 3 for field documentation procedures.

13. Fill out sample chain-of-custody Form, in order to maintain an accurate record of sample collection, transport, analysis and disposal. Refer to BSOP No. 4 for chain-of-custody labeling procedures.

14. Decontaminate sampler and messenger in accordance with procedures outlined in BSOP No. 13.

15. Discard contaminated personal protective clothing (e.g., latex gloves, tyvek, etc.), as required.

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BSOP NO. 8

STANDARD FIELD PARAMETER MEASUREMENTS

BHATE STANDARD OPERATING PROCEDURE NO. 8

STANDARD FIELD PARAMETER MEASUREMENTS

The objective of Bhate Standard Operating Procedure (BSOP) No. 8 is to present general information regarding the collection of the field parameters associated with aqueous solutions (temperature, specific conductivity, pH, turbidity, oxidation/reduction potential, and dissolved oxygen), as well as field parameters specific to soil and sediment sampling.

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BSOP NO. 8

STANDARD FIELD PARAMETER MEASUREMENTS

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1 FIELD MEASUREMENT OF PARAMETERS IN WATER

Accurate measurement of field parameters is critical for the prediction and interpretation of the reactions and migration of dissolved species. Although numerous meters are commercially available, many are designed to measure more than one parameter. The set up and use of the meters should follow a basic format to assure a consistency of use. For instrument calibration procedures refer to BSOP No. 6. In addition, all meters should be properly maintained, calibrated, and operated in accordance with the manufacturer's specifications.

It is recommended that all groundwater measurements of field parameters be conducted using flow through cell or downhole techniques. A flow through cell is an enclosed device, which houses the probes of the water quality meter. Since the flow through is enclosed it protects the probes and groundwater from contact with the atmosphere or from unnecessary agitation, which can result in anomalous readings for field parameters. Groundwater that is being sampled typically enters the device through a port located at the bottom of the device. Water fills up the cell, submerging the water quality probes inside. When the device is full, water exits a port located at the top of the device and is diverted away from the well with a short piece of tubing attached to the port. Collecting water quality readings downhole is a lesser used method since cable extensions have to be used with the water quality instruments as well the instruments have to be introduced into the well, which increases the likelihood of contaminating the well. The instrument log book should be used to describe the type of instrument being used to collect the field parameters as well as the results of instrument calibrations performed prior to sample collection and throughout the sampling event.

1.1 Temperature

Temperature readings of liquids in the field are important for numerous applications. They are used in the measurement of oxidization-reduction potential (redox), pH, specific conductivity (SC), dissolved oxygen (DO); and in saturation and stability studies. It is important to know the temperature of surface waters and groundwater for the accurate geochemical evaluation of equilibrium thermodynamics. This method is applicable to groundwater, surface water, and saline waters, as well as domestic and industrial aqueous wastes. Temperature measurements may be made with a thermometer, single unit temperature meter or a multi-parameter unit. Temperature measurement should be recorded to the nearest 0.5 °C.

1.2 Specific Conductivity

Specific conductivity (SC) is a widely used indicator of water quality. It measures the ability of water to conduct or transmit an electrical current under specific conditions. This ability depends on the presence of ions, their total concentration, mobility, and temperature. Specific conductivity is a simple indicator of change within a system, and is used as an aid in evaluating whether a sample is representative of the water in the system.

Briefly, the specific conductivity of a sample is defined as the conductance of the sample between opposite sides of a cube, 1 centimeter (cm) in each direction. The following procedure describes the field measurement of the specific conductance of an aqueous sample.

This method is applicable to groundwater, surface water, and saline waters, as well as domestic and industrial aqueous wastes. The specific conductance of a sample is measured by use of a self-contained conductivity meter. Samples are preferably analyzed at 25 °C. If not, temperature corrections are made and results reported at 25 °C.

Specific conductivity measurements will be made with a single unit conductivity meter or a multi-parameter unit. The conductivity meter should be calibrated in accordance with BSOP No. 6. Measurements should be reported to the nearest 10 units for readings under 1,000 µmhos/cm and the nearest 100 units for readings over 1,000 µmhos/cm.

1.3 Concentration of Hydrogen Ions (pH)

This section contains the procedures for the measurement of pH in an aqueous solution. The pH is determined by using a glass hydrogen-ion electrode compared against a reference electrode of known potential by means of a pH meter. This method is applicable to groundwater, surface water, and saline waters, as well as domestic and industrial aqueous wastes.

The pH of a solution is defined as the negative logarithm to the base 10 of the hydrogen ion activity in moles per liter or grams equivalent per liter ($pH = -\log [H^+]$). Great care will be taken during pH measurements because pH is exponentially related to hydrogen ion concentration (activity).

The pH expresses both acidity and alkalinity on a scale, which ranges from 0 to 14. A value of 7.0 represents a neutral solution. Natural waters generally have pH values in the range of 4.0 to 9.0. The primary control over pH in natural waters is the carbonate system, including gaseous and dissolved carbon dioxide, bicarbonate, and carbonate ions. Temperature, atmospheric contamination, and ionic strength are factors that affect pH measurements. The pH measurement is relatively free from interference of color, turbidity, colloidal matter, oxidants, or reductants.

The pH measurements will be made with a single unit pH meter or a multi-parameter unit. The pH meter should be calibrated in accordance with BSOP No. 6. Report results to the nearest 0.1 pH unit.

1.4 Turbidity

Turbidity is a measure of the cloudiness in water due to suspended and colloidal organic and inorganic particles. Turbidity is an important parameter to measure during sampling, because a sample with elevated turbidity contains suspended matter that may affect the quality of analytical data. For instance, a total metals analysis of a turbid sample will detect the concentrations of both the dissolved metals and the metals adsorbed onto the particle surfaces.

A turbidity meter (nephelometer or turbidimeter) measures the turbidity of an aqueous sample by comparing the light absorption of the sample liquid and a control liquid. Turbidity is measured in nephelometric turbidity units (NTUs). An NTU is the standard reference for measuring turbidity of an aqueous solution. This method is applicable to ground and surface waters, as well as domestic and industrial aqueous wastes.

The turbidity meter should be calibrated in accordance with BSOP No. 6. Due to the wide variety of turbidity meters on the market today, the procedures for measuring the turbidity of a sample should follow the manufacturer’s specifications. Results for turbidity should be recorded in NTUs.

1.5 Dissolved Oxygen

The concentration of dissolved oxygen (DO) provides estimates of the amount oxygen that is dissolved in water, and hence measures the ability of the water to support aerobic life and/or biodegradation of hydrocarbon based contaminant plume. The rate of biodegradation will depend, in part, on the supply of oxygen to the contaminated area. At levels of dissolved oxygen (DO) below 1 to 2 mg/L in the groundwater, aerobic biodegradation rates are very slow. If background DO levels (upgradient of the contaminant source) equal or exceed 1 to 2 mg/L, the flow of groundwater will supply DO to the contaminated area, and aerobic degradation is possible.

Where aerobic biodegradation is occurring, an inverse relationship between DO concentration and constituent concentrations can be expected (i.e., DO levels increase as constituent levels decrease). Thus, if DO is significantly below background within the plume, aerobic biodegradation is probably occurring at the perimeter of the plume.

The following procedures describe the field measurement of DO content of an aqueous sample. DO is measured using a membrane electrode DO meter. Most DO meters utilize electrochemical reactions to determine DO concentrations. Under steady-state conditions, the electrical current or potential can be correlated with DO concentrations. A significant degree of interfacial turbulence is necessary when measuring this parameter because interfacial dynamics at the probe membrane and sample interface affect probe response.

This method is applicable to groundwater, surface water, and saline waters, as well as domestic and industrial aqueous wastes.

DO measurements will be made with a membrane electrode DO meter or a multi-parameter unit. Measurements for DO should be made as the water is moving across the membrane. The DO should be calibrated in accordance with BSOP No. 6. Due to the sensitivity of DO to the surrounding environment, measurements should be collected using closed cell flow through techniques and/or downhole monitoring. Record the results within the field log book and applicable field form to the nearest 0.1 mg/L.

1.6 Oxidation Reduction Potential (ORP)

The oxidation/reduction potential (ORP) of groundwater is a measure of electron activity and is an indicator of the relative tendency of a solution to accept or transfer electrons. Because ORP reactions in groundwater are biologically mediated, the rates of biodegradation both influence and depend on ORP. Many biological processes operate only within a prescribed range of ORP conditions. ORP also can be used as an indicator of certain geochemical activities (e.g., reduction of sulfate, nitrate, or iron). The ORP of groundwater generally ranges from 800 millivolts to about -400 millivolts. The lower the ORP potential, the more reducing and anaerobic the environment.

Measurement of ORP potential of groundwater also allows for approximate delineation of the extent of the contaminant plume. ORP potential values taken from within the contaminant plume will be lower than background (upgradient) ORP values and values from outside the plume. This is due in part to the anaerobic conditions that typically exist within the core of the dissolved hydrocarbon plume.

ORP measurements will be made with using a platinum electrode or a multi-parameter unit. Measurements for ORP should be made as the water is moving across the electrode. The ORP meter should be calibrated in accordance with BSOP No. 6. Due to the sensitivity of ORP to the surrounding environment measurements should be collected using closed cell flow through techniques and/or downhole monitoring. Record the results within the field log book and applicable field form to the nearest 1.0 millivolt.

1.7 Other Methods in Water

Additional field parameter measurements may be required for project specific investigations. It is not practical to list descriptions and methodologies for all methods potentially employed. In lieu of instrument-specific methodologies, all field measurements must be conducted in accordance with the published manufacturer’s operating manual or procedures. Also, all instruments that may be field-calibrated must be calibrated a minimum of once daily, or more often, as recommended by the manufacturer, and in accordance with BSOP No. 6. The type, model number, serial number (if available), vendor, and calibration frequency, of all field instruments must be recorded in the field log book. All entries, including calibration results and field measurements, must be entered chronologically on the right-hand side of the field log book (see BSOP No. 3).

2 SOIL AND SEDIMENT FIELD PARAMETERS

Soil and sediment field parameter measurements may be required for project specific investigations. Methods may include pH, alkalinity, acidity, redox, electrical conductance, and total organic carbon. Although it is not practical to list descriptions and methodologies for all methods potentially employed, specific methodologies will be documented within future task-specific Data Quality Objective (DQO) discussions or project scope of work (SOW), as required.

In lieu of instrument-specific methodologies, all field measurements will be conducted in accordance with published manufacturer's operating procedures.

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BSOP NO. 9
FIELD SCREENING TECHNIQUES

BHATE STANDARD OPERATING PROCEDURE NO. 9

FIELD SCREENING TECHNIQUES

This Bhate Standard Operating Procedure (BSOP) presents information regarding procedures employed to provide preliminary field screening of hydrogeologic and geochemical site parameters. The data provided by these methods are not considered of a quality sufficient to meet regulatory requirements regarding site characterization and/or closure, but are used for gross delineation of the extent of contamination, and to gain efficiency in the location of permanent monitoring wells and sampling locations. If possible, information from field screening samples should be used in conjunction with confirmation samples, which are analyzed by a certified laboratory to provide a point of reference. A list of field screening methodologies that may be utilized at federal installations is provided as Attachment 1-1.

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BSOP NO. 9

FIELD SCREENING TECHNIQUES

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Attachments

1 SOIL HEADSPACE (VOLATILE VAPORS) SCREENING

1.1 Objective

The objective of this section of the BSOP document is to provide information regarding procedures to be employed primarily for the screening of soil headspace (volatile vapors) in the field. Every soil sample collected will have headspace screening performed and the results recorded. The data provided by this method will be used for gross delineation of the extent of contamination, and to identify likely sampling locations. Additional matrices may also be screened utilizing the following procedures.

1.2 Procedure

Soil samples will be screened for volatile organic compounds (VOCs) in the field at the time of sample collection. Field screening shall utilize an organic vapor analyzer (OVA) equipped with either a photo-ionization detector (PID) or a flame-ionization detector (FID). Both, the PID and FID are instrument specific. If a high humidity condition exists during the time period when field activity is to be performed, the FID is recommended. The PID is not a completely reliable screening instrument under humid conditions. The ionization potential of the PID lamp shall be optimum for the contaminants of concern. Personnel shall perform field screening in accordance with the following procedures:

1. Immediately upon opening the split spoon (or other sample retrieval device) and after collecting the volatile organic sample (if required), a representative portion of the soil sample shall be collected and placed in a clean, contaminant-free 8-ounce jar, so that the jar is half to three-quarters full. If an 8-ounce soil jar is not available, new Zip-Lock™ bags can be used in the same manner. Samples placed in individual jars can also subsequently be utilized as the geotechnical soil sample (for sieve analysis) from that interval.

2. If the volume of sample recovered is insufficient for all analytical requirements, then the material used in the headspace readings could be utilized for any non-volatile sampling requirements (e.g., the headspace material could be used to fulfill the geotechnical requirements).

3. Seal each jar with at least one continuous sheet of aluminum foil, using the jar lid to secure the foil.

4. Vigorously agitate the sample jar for at least fifteen seconds and then allow a minimum of 15 minutes (or as the environmental conditions dictate) for the sample to adequately volatilize and equilibrate to ambient temperatures.

5. During cold weather, the samples shall be warmed to near room temperature (approximately 60 to 70^{o}F) prior to taking the headspace measurement.

6. Following the 15-minute period, re-shake the jar and remove the jar lid. The headspace is sampled, with a FID in survey mode, by piercing the aluminum foil cap and inserting the FID tip into the headspace with and without an activated charcoal filter. The activated charcoal filters off heavier VOCs allowing the instrument to record the naturally occurring, lighter, methane gas that may or may not be present. This methane value is then subtracted from the total unfiltered instrument reading to compute the VOC vapor concentrations associated with VOC contamination. Both readings (filtered and unfiltered) will be recorded. A PID may be used if the equivalent response of the PID is known. Manufacturer's operating procedures for the particular FIDs or PIDs will be followed.

These data will be recorded in the field log book or on the Headspace Analysis Log (Attachment 1-2). No background value corrections are made for these jarred headspace readings.

This procedure may also be utilized for other sample matrices (e.g., sediment, groundwater, and waste).

2 FIELD SCREENING TEST KITS

2.1 Objective

This section provides information regarding procedures to be employed for the proper operation of field screening chemical test kits. In general, each test kit will include specific instructions for the field analysis of particular compounds or classes of compounds.

2.2 Background

Field screening data provide investigators with information that can be used to make decisions regarding location and number of samples for off-site laboratory analyses, rather than making decisions based on random sampling grids or hypotheses. Data provided by field screening often allow investigators to reduce the number of samples required for off-site analysis by an analytical laboratory. Screening procedures allow sampling personnel on site to adjust their collection of samples in and around the areas of concern, that were identified in the field using the screening data, thus eliminating numerous background samples. Immunoassay kits are the primary types of screening kits, which may be employed.

Immunoassay kits have been developed to be selective to one type of chemical compound. The advantage of immunoassay is in its accuracy, usability, and selectivity to a specific class of compounds (e.g., fuels, chlorinated solvents, and PCBs) even when a mixture of these compounds is present. The disadvantages of immunoassay kits are that they will not detect contaminants in a sample that are not specific to the kit selected, as stated above. This type of kit is most effective at a location where the types of contamination have been narrowed down to a limited number.

2.3 Procedure

The immunoassay kits have analytical procedures provided with each kit to allow the technician to perform them accurately. The procedures required by each kit must be followed to produce correct and repeatable results. The manufacturer also provides training for its field screening kits. Therefore, it is recommended that individuals who use these test kits be trained by the manufacturer or by a manufacturer trained contractor representative. Additional quality control measures include the analysis of duplicate samples and split samples by a certified laboratory as recommended by the manufacturer or as required by the site plan.

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3 DIRECT PUSH TECHNOLOGY SCREENS

3.1 Objective

The objective of this section is to provide information and procedures relative to the conduct of Direct Push Technology (DPT) surveys and related sampling activities.

3.2 Procedure

DPT will be utilized to obtain geotechnical and hydrogeologic data and/or to collect representative groundwater and soil samples from selected intervals. Up to three instruments (a cone penetrometer known as a piezocone, a groundwater sampler known as a hydrocone, and a soil sampler known as a geocone) may be used depending on site-specific objectives. In addition, DPT may be used to install temporary piezometers. Each of these DPT components is discussed below. All DPT equipment will be decontaminated prior to use at each sampling location in accordance with the requirements described in BSOP No. 13.

For the investigation of aquifer units beneath a confining or semi-confining layer, surface casing will be installed using other drilling methods as discussed in BSOP No. 1. A surface casing may also be installed if the DPT groundwater sample is to be collected beneath a known zone of highly contaminated groundwater.

An example of the method by which protective surface casings will be installed follows:

- A borehole having a nominal diameter of 8 inches will be advanced using rotary drilling techniques to 3 to 5 feet into the top of the uppermost confining unit.

- 6-inch ID Schedule 80 PVC casing will be installed extending from the surface to the bottom of the borehole. Grout will be pumped into the annular space via tremie pipe from the bottom of the borehole to ground surface with cement/bentonite grout (Potable water, Portland Type I cement and 3% bentonite powder by weight).

After allowing a minimum of 24 hours for the grout to set, DPT sampling will be performed.

3.2.1 Cone Penetrometer Testing

The cone penetrometer or piezocone measures soil parameters and soil types using the static Dutch cone instrument (ASTM D 3441). An electronic cable connects the piezocone to a microcomputer. Testing proceeds by inserting the instrument into the soil in one-meter increments at a constant rate. The procedure is repeated until the target depth is reached. Three measurements (point stress, local sleeve friction, and pore pressure) are recorded every centimeter by various sensors. This information is relayed to a surface computer, which correlates the measurements to provide soil type and density and evaluates the pore saturation conditions. Soil types are computed following basic guidelines for use and interpretation of the electronic cone penetration test. When penetration is halted, the time required for the disturbed groundwater pressure to stabilize and the final equilibrium value provides a measure of relative soil permeability and piezometric pressure.

Lithologic logging will be conducted by advancing the piezocone tool from the uppermost confining unit to the bottom of exploration. The computer-monitored electric piezocone utilizes a hydraulic load frame, capable of exerting 50,000 pounds, to thrust the stainless steel sensing device into the ground. Soil types are computed following guidelines for use and interpretation of the electronic cone penetration test. Piezocone logs will be generated at each CPT location. The minimum operating procedures and data quantity and quality exceed the requirements of ASTM D 3441.

The standard operating procedure for the electric piezocone will be as follows:

1. Disassemble all elements within the downhole piezocone sampler. These elements will be all cleaned with deionized water, isopropyl alcohol and air-dried thoroughly.

2. Reassemble the downhole component of the piezocone and check for response (saturation). Proper response occurs when zero air voids are found within the piezocone element as determined by a cathode ray tube (CRT) readout based on the software package.

3. Thrusting of the piezocone will be carried out in accordance with the ASTM D 3441 with real time CRT display. Data obtained will be stored on floppy disks and used to develop plots.

3.2.2 Groundwater Sampling

Groundwater samples can be collected through the use of DPT methods. The DPT method hydraulically pushes a groundwater sampling tool to the target sampling depth sometimes with the assistance of a hydraulic hammer. Once the sampling device is at the target depth, the groundwater sample can be collected by two different methods, which are governed by sampling depth and site conditions. These DPT groundwater sampling methods include the use of a groundwater sampler and the Push-In/Bail Method. Each method is discussed below. All samples will be labeled, stored, and shipped (if applicable), in accordance to the procedures described in BSOP No. 4.

Groundwater samplers are generally comprised of a sampler body with a telescoping porous tip, an inert gas source, and a gas/electronic cable that connects the sampler body to a microcomputer. The sampler body is sealed as it is pushed to the selected sampling depth. The porous tip is then exposed, and a gas back pressure is used to regulate the rate at which the groundwater is collected. This allows for a controlled filling rate and reduced volatilization. Continuous measurements of the sample volume collected are relayed to the microcomputer, and presented in a time graphic display. After the sample is collected, it is secured by increasing the gas back pressure above hydrostatic pressure. The sampler body is then retracted from the subsurface. Sample collection rate and gas pressure are measured as a function of time, and allows for the calculation of the hydraulic conductivity of the interval where the sample was obtained according to methods developed by Bouwer and Rice (1976). Once the sampler is retrieved to ground surface, personnel wearing new laboratory grade gloves fill pre-labeled sample containers in accordance with the procedures described in BSOP No. 4. The samples are retrieved through a sample release valve, which regulates flow to reduce the chance of volatilization.

The Hydrocone HC-1 groundwater sampler or equivalent will be used if the above method is employed. The device has an OD of approximately 1.4 inches and an inside diameter (ID) of approximately 0.9 inches and a length of 2.0 meters. The maximum sample volume of the model HC-1 is 700 mL). The sampler is constructed of stainless steel and Teflon™ to ensure high-quality groundwater samples. The sampler is activated by argon gas, and the entire filling process is monitored in real time using a computer and CRT. The standard operating procedures for the Hydrocone HC-1 sampler are described below.

- The sampler is disassembled and properly cleaned. Disassembly consists of removing the retractable tip, lower unit valve mechanism, and upper unit sensor package.

- A new or decontaminated stainless steel filter is placed on the stainless steel mandrel. Filters can be constructed of various materials and for most studies will be 60 to 400 mesh stainless steel, 4.0 to 24.0 inches long.

- The lower valve unit is assembled, the mandrel and filter units are assembled, and the lower unit is retracted. In the retracted position, the stainless steel filter is contained within the sampler and is uncontaminated during thrusting to the sampling depth.

- The downhole sensor package is installed in the upper portion of the sampler.

- The assembled sampler operations are checked using the on-board computer system to ensure that argon gas pressure in the sampler is monitored properly. This check is determined by varying the argon gas pressure and monitoring the response on the CRT.

- The sampler is checked for leaks to ensure that the tip opens on pressurization. The sample tip is retracted inside the sampler.

- The sampler is hydraulically pushed to the required sampling depth using the hydraulic load frame.

- When the sampler is at the depth required for sampling, the argon gas pressure is activated to a pressure greater than the hydrostatic pressure in the aquifer. At this point, the hydraulic load frame pulls upward on the rods to enable exposure of the stainless steel filter. The sampler is now ready for filling.

- The argon gas pressure within the sampler is lowered to less than hydrostatic pressure, or a vacuum is applied, and water flows into the sampler with monitoring carried out in real time on the CRT.

- When sufficient sample volume has been obtained, as monitored on the CRT, the sample is repressurized to greater than hydrostatic pressure and withdrawn to the surface. During withdrawal, the rods are disassembled and decontaminated.

- The sampler is pulled to the surface and held vertically within the load frame. The tip is removed and disassembled for cleaning. The sampler is now ready for evacuation.

- The groundwater sample is removed from the sampler by utilization of a specifically designed sample release valve. The sample release valve enables the flow of water, from the sampler into the sample containers, to be regulated and to minimize aeration and subsequent volatilization.

Groundwater screening samples may also be collected utilizing the Push-In/Bail Method. The Push-In/Bail Method utilizes a stainless steel retractable screen, attached to 0.9-inch ID piezocone rods. The assembly is pushed into the subsurface using the hydraulic ram mounted in the cone penetrometer truck. Once the target depth is reached, the rod assembly is retracted 1 foot to expose the screened section to the surrounding groundwater. After allowing sufficient time for the groundwater to equilibrate and fill the push-in screen assembly, groundwater samples are collected using a small diameter stainless steel bailer and/or a peristaltic pump.

When collecting groundwater samples with the Geoprobe methodology, the groundwater sampling tool, consisting of a 1.75-inch OD stainless steel casing and stainless steel tip, is driven to the target depth by a hydraulic percussion hammer. The stainless steel casing is then retracted approximately 12 to 18 inches and a screen contained within the stainless steel casing is exposed. A stainless steel bailer or peristaltic pump is used to collect a groundwater sample from the stainless steel casing.

3.2.3 Soil Sampling

Soil samples can be collected with either the DPT method using a geocone or with a macro-core. One type of DPT soil sampler is known as a geocone consisting of a modified split spoon with a cone-shaped plug in the end that can be retracted when a soil sample is to be obtained. The sampler is first pushed to the target depth. After retracting the cone plug, the split spoon is pushed 18 to 24 inches. The spoon is then pulled to the surface and the sample is retrieved. Another type of DPT soil sampler is known as a macro-core consisting of a cutting shoe attached to a stainless steel sample tube into which a acetate, stainless steel, or plastic sample liner is inserted. The stainless steel sampler, with liner inside, is then driven to the target depth by a hydraulic percussion hammer. While being driven to the target sample depth, the plastic sample liner becomes filled with soil as the tool advances through the soil. The stainless steel cutting shoe, stainless steel casing, and filled sample liner are retracted to the surface. Soil samples are collected according to the procedures described in BSOP No. 1.

3.2.4 Temporary Piezometer Installation

Temporary piezometers may be installed using DPT to assess area-specific groundwater flow directions, and to obtain groundwater screening samples. Three DPT methods may be employed to install piezometers. The method selection will be based upon the total well depth and site conditions. Each method is discussed below.

The first method involves directly pushing a well point and riser to the target depth. Each well point will be constructed of 1.0-inch ID, flush thread, schedule 40 PVC. Well point screens will be a maximum of 10 feet in length with 0.010-inch machined slots.

Piezometers may also be installed by using an aluminum sacrificial (dummy) tip, held in place at the bottom of a 2.0-inch ID carbon steel rod. A length of 1-inch ID piezometer screen is placed inside the rod and threaded onto the dummy tip. The rod is then pushed directly into the subsurface, while successive joints of well materials and rods are alternately threaded on as the piezometer is advanced into the subsurface. Once the target depth is achieved, the rod is retracted, leaving the piezometer in place.

The third method involves the installation of 1.5-inch ID piezometer material. With this method, the dummy tip is larger in diameter than the piezometer materials, thereby reducing friction during installation. Piezocone rods (1.4-inch outside diameter (OD)) are used inside the piezometer material to push it into place. Once the temporary piezometer is pushed to the target depth, the piezocone rods are removed, leaving the piezometer in place.

All temporary piezometers will be secured such that tampering or removal of the cap may be identified. The following procedure or other means of securing the temporary piezometer may be used. A 2.0-inch PVC coupling may be attached to each installation at the surface. Following this, a locking cap will be used to secure each piezometer.

Installing temporary piezometers with material that is the same diameter as the soil boring commonly results in a relatively small annulus. Since the main purpose of a temporary piezometer is to accurately measure groundwater levels, the relatively fine screen slot size of 0.010 inch is specified to minimize the amount of suspended fine-grained materials that may enter a piezometer. In addition, an alternative method is to install a well with a “dual” screen with a pre-packed sand pack, usage of a pre-pack screen results in better data and water quality.

Temporary piezometers may also be installed using conventional hollow-stem augers and constructed of 2-inch PVC. This method of installation is discussed in BSOP No. 1.

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4 HYDROPUNCH

4.1 Objective

The objectives of this section includes providing a methodology to collect representative groundwater samples using the Hydropunch™ sampling tool.

4.2 Procedures

An evaluation of the usefulness of the Hydropunch™ at a particular site must be made prior to use. Decisions should be based upon an evaluation of previous water quality data, site hydrogeologic conditions, and the requirements of the project.

- The Hydropunch™ may be useful in the following situations:
  1. When groundwater quality data at a specific site is unavailable
  2. When the vertical or horizontal extent of a contaminant plume at a site has not been completely delineated
  3. When contaminant migration may be occurring in discrete geologic horizons
  4. As an aid in determining the most appropriate placement of monitoring wells and well screens.
- The Hydropunch™ is not suitable for evaluating water levels or head relationships between geologic units.

4.2.1 Decontamination Procedures For Sampling With Hydropunch

The Hydropunch™ must be completely disassembled, including the removal of the screen, the screen clamps and O-rings, before decontamination. This also pertains to the bottom discharge device assembly. Decontamination will be conducted in accordance with the procedures specified in BSOP No.13.

4.2.2 Assembly Procedures

Assembly of the Hydropunch™ may begin once the tool has completely dried from the decontamination procedure. A new polypropylene/stainless steel screen and set of screen clamps, and a new set of viton O-rings will be used each time the Hydropunch™ is decontaminated. The difference between use of stainless steel versus Teflon™ check balls is of little analytical significance, and will be left to the discretion of the field hydrogeologist. Assembly of the Hydropunch™ is illustrated in the "Hydropunch™ Operations Manual".

4.2.3 Hydropunch™ Use With Auger Drilling

- Advance borehole until the selected sample interval is encountered. Use a decontaminated water-level indicator probe to confirm that water has been encountered. At least 12 inches of water should be in the bottom of the borehole.

- The drill rods attached to the Hydropunch™ must be of small enough diameter to fit inside of the augers. It should be noted that heaved sands inside the augers create resistance to pushing or driving the Hydropunch™ to the sample interval. The heaved sands may also sandlock the Hydropunch™ inside the augers during removal of the tool from the sample interval.

- Attach the Hydropunch™ to an AW sub-size drill rod and attach the tool onto the selected drill rods. If AW rods are utilized, the Hydropunch™ may be directly attached to the rods. Visually inspect the drive point/sleeve alignment to ensure a proper O-ring seal. Lower the rods and Hydropunch™ to the bottom of the borehole. If a sudden jerk or slip occurs during the descent, the Hydropunch™ should be removed from the borehole to ensure that the screen did not prematurely open. If the Hydropunch™ does open prematurely, exposing the screen to water or mud, the contaminated unit must be disassembled and decontaminated once again before continuing.

- At the discretion of the technical oversight personnel, the tool shall be pushed hydraulically or driven with a 140 lb. hammer. This decision is dependent upon the density of the material to be penetrated. If the material is relatively soft, then pushing the tool is the preferred technique. If this is the case, connect the rods to the hydraulic drive head by means of an appropriate sub and push the Hydropunch™ into the formation to the desired depth with one continuous, relatively rapid stroke. The downward hydraulic pressure should not be allowed to exceed 1,000 psi to avoid damaging the Hydropunch™. If the formation is too hard to push the Hydropunch™ to the desired sampling interval, the Hydropunch™ may be driven into the subsurface using a 140 lb. hammer according to the same procedures used to drive a split spoon sampler (ASTM D 1586). A threaded cap on the upper check valve should be used when driving the tool with a hammer. Chalk marks should be made on the drill rods every 6 inches to aid in counting the blows. Never exceed 30 blow counts per 6 inches to avoid possible damage to the Hydropunch™. Discretion should be used whether pushing or driving the Hydropunch™ to minimize the potential for equipment damage (the stainless steel Hydropunch™ barrel is susceptible to bending).

- The Hydropunch™ should be pushed a minimum of 5.5 feet below the static water level. For samples where this is not of concern, the Hydropunch™ should generally be pushed 3 to 5 feet beyond the bottom of the borehole to ensure that the drive point will be sufficiently anchored to expose the screened interval.

- If the Hydropunch™ cannot be advanced using the techniques described above to the required sampling interval due to subsurface conditions (e.g., gravel content, lithified sediments, etc.), then the drill rods and Hydropunch™ should be removed from the borehole. Drilling equipment should be re-assembled and the borehole advanced 2 to 3 feet. Reassemble the rods and Hydropunch™ and attempt to push/drive the Hydropunch™ 3 to 3.5 feet. If this cannot be accomplished, the possibility of deleting the sample interval from the sampling plan should be considered. It is important not to force the Hydropunch™ into the subsurface since this may damage the tool.

- Once the Hydropunch™ is positioned at the desired sampling depth, the drill rods shall be pulled up 1.5 feet and subsequently secured. The initial upward movement may be described as a "short jerk". This step exposes the screened interval so that formation water may enter the sample chamber.

- With the rods properly secured, unscrew the top drill rod and lower a small diameter water level indicator down the inside of the drill rods. Using the water level tape, monitor the water level inside the rods. Initially, there may not be water inside the rods because the sample chamber is still filling, and the water has not risen above the top check valve and entered the drill rods.

- When water is detected inside the rods, indicating that water has risen above the top check valve, the sample chamber is full. In order to prevent additional water from entering the sample chamber while the Hydropunch™ is being removed from the borehole, the water inside the rods should be allowed to reach the static water level inside the augers or borehole. This procedure ensures that both check valves remain closed while the Hydropunch™ is stationary in the hole during removal of the drill rods, thus ensuring a representative sample.

- Once the Hydropunch™ is removed from the borehole, continue raising the rods until the tool is at eye level. Remove the drive point and insert the bottom discharge device assembly. Make certain that the discharge device is screwed on completely and that the stopcock on the discharge device is closed. If the threads contain sand or grit, rinse them with deionized water before attaching the discharge device. Unscrew the Hydropunch™ from the sub or rods and remove the upper check valve to break the suction.

- It is possible that excessive silt may enter the tool and plug the bottom discharge assembly or the upper and/or lower check valves. This usually occurs when the screen tears in the process of collecting the sample. If upon inspection of the upper check valve there is any indication that this valve was not sealed when the Hydropunch™ was retrieved, the sample should be discarded. If the lower check valve and/or bottom discharge assembly is plugged, try to clear the Teflon™ discharge tube by blowing it out (use of a smaller diameter piece of tubing may be helpful or rinsing the assembly with deionized water. If this does not clear the discharge path, unscrew the Hydropunch™ from the drill rods and pour the sample out of the top.

- If the bottom discharge device is not clogged, open the stopcock and drain the sample into the appropriate containers/vials. When the chamber is completely filled, approximately 500 mL of sample is collected.

- Appropriately labeled sample containers will be used at all times. All samples will be labeled, preserved, packaged, and handled according to the procedures specified in BSOP No. 4. Chain-of-custody control of the samples will be maintained in accordance with the procedures outlined in BSOP No. 4.

- When sampling is complete, the Hydropunch™ and Discharge Device assembly shall be decontaminated as specified in BSOP No. 13.

4.2.4 Hydropunch™ Use With Mud Rotary Drilling

Procedures for utilizing the Hydropunch™ in conjunction with mud rotary drilling are essentially the same as for auger drilling. Prior to installing the Hydropunch™ in the borehole, the drill rods must be removed if a wing bit or roller bit is being used. Before removing the Hydropunch™ from the borehole, the water level inside the drill rods must be at or above the level of drilling mud in the borehole outside the drill rods. This is frequently at or near ground surface. All other procedures regarding the assembly, placement, removal, and disassembly of the Hydropunch™ are identical to its usage with auger drilling.

5 PORTABLE GAS CHROMATOGRAPH

5.1 Objective

It is the objective of this section to provide procedures by which field portable gas chromatograph analyses are to be conducted. The section includes procedures for gas chromatograph operation, but focuses on the oversight of sample collection, handling, and analysis by subcontractors.

5.2 Background

A gas chromatograph (GC) is a self-contained unit, which provides for the separation, detection, and integration of the compounds detected in an air sample. The GC is equipped typically with a 10.6 electron volt lamp photometric detector. This lamp will ionize many target compounds reported in an EPA SW846 Method 8240 analysis. Equipment and supply requirements for the GC are included in the following section.

5.2.1 Equipment/Supplies

The following table describes the equipment needed and the purpose of each type of equipment.

Table 5-1. GC Equipment and Supplies

Material Required	Purpose
Ultra pure carrier air	Establish flow in capillary column
Organic chemicals/standards	Make standards of calculated concentration
System disks/RAM cards	Programming and storage for GC analyses
Syringes and glassware	Sample injection and sample preparation
Serial printer or computer	Report generation and data storage
Power 115V/BR2325 3-volt batteries	Charge GC battery/RAM card batteries
Wrenches/fittings/log book	Attach flow meter/hookups/records
Digital flow meter	Measure flow through column
Teflon™-Faced Silicon-Rubber Septa	Injection port seals

5.2.2 Ultra Pure Carrier Air

The GC should be charged with zero ultra air or other appropriate carrier gas by following the user's manual. The self-contained GC tank can be charged with a supply of air for one day's worth of analyses. High purity nitrogen (99.9999%) may be used instead of zero ultra pure air. Teflon tubing should be used to connect the air tank supply to the GC. Never use vinyl or rubber tubing, which will result in contamination of the GC column.

5.2.3 Standards

Organic standards shall be used to make calibration curves at three concentration ranges. This is both a qualitative and quantitative process, and requires a set of certified target compounds at known concentrations.

5.2.4 Syringes/Glassware

No liquids may be injected directly into the GC. Air-tight syringes will be used to collect a sample of air in equilibrium with the water sample being analyzed, which prevents the water sample from escaping from the syringe during injection. The air sample contains any volatile compounds from the water sample, if present, due to their vapor pressure. Non air-tight syringes may be used in preparation of aqueous standards.

5.2.5 Computer

The procedures for printing and connecting peripheral equipment to the GC will be followed as described in the user's manual. Alternatively, the chromatograms may be transferred to a computer using a peripheral connector and printed using the computer's printer.

5.2.6 Flow Meter/Indicator

The digital flow meter measures the flow of ultra pure air or nitrogen (carrier gas) as it passes through the column. The rate at which the compounds of interest pass through the GC detector is proportional to the rate of air flow. The GC uses a back flush flow of air to clean the column between analyses. The flow of air out of the detector and out of the back flush must be equal to maintain a stable baseline. Do not use any liquid solutions such as leak detection solution on any of the fittings.

5.2.7 Teflon®-Faced Silicone-Rubber Septa

Teflon®-Faced Silicon-Rubber septa enable the operator to inject the sample into the column via syringe without introducing ambient air. The rubber septa should be replaced after 40 (or fewer) injections. This will maintain the stability of the GC air flow.

5.3 Procedures

5.3.1 Sample Preparation

Groundwater samples must be collected in 40 mL vials with Teflon®-lined septa lids by filling the bottle, leaving no bubbles. Each sample should be collected in duplicate. Samples collected for laboratory verification analysis must be completely filled, with no bubbles and properly preserved. No preservative, such as hydrochloric acid, can be used when collecting the samples for field screening. Plastic materials should not be used during sample preparation or collection to prevent contamination of the GC. The following procedure should be used to prepare the sample prior to analysis:

1. Samples should be stored in a dark, cool place until ready to be processed for analysis. If the samples will be analyzed within a few hours, samples should be kept at room temperature. If samples will not be analyzed within 4 hours, samples should be kept cold (approximately 4°C). All samples should be analyzed within 24 hours of collection.

2. Remove 20 mL of water from each of the sample containers being prepared for analysis using a clean pipette with mL increments. Use a new pipette tip for each sample.

3. Shake the sample for 30 seconds to accelerate the equilibrium in the air space. Invert the samples so the air bubble is trapped in the bottom of each vial.

4. Place samples in a temperature controlled environment (30°C ± 5°C, to be verified by Fisher thermometer or equivalent) for 30 minutes prior to analysis. Samples may be kept at equilibrium temperatures prior to analysis for up to 4 hours. Record all temperatures in the GC log book.

5. Record all sample information from the sample vial into the computer note pad (if available) associated with that chromatogram as described in the GC user's manual.

5.3.2 Calibration

Standard mixtures shall be prepared in the fume hood on a daily basis. Measure 20 mL of organic-free water using a pipette. Place this water into a new 40 mL vial and cap the vial with Teflon®-faced septa and screw cap. For each aqueous standard desired, measure the required analytes-in-methanol volume using watertight syringes. Insert the needle of the syringe into the vial through the septa and inject the volume of standard into the organic-free water. A single ampule of the solvents-in-methanol standard solution purchased from the vendor shall be used for no more than one set of standards, due to the limited shelf life of the opened standard ampules.

Given constant carrier gas air flow, capillary column type, and isothermal column temperature, each chemical compound will pass from the injection port to the GC detector within a unique and reproducible amount of time. This is defined as the retention time (RT) value. RT values for each of the standards shall be identified and stored in the GC library. The RT is recorded in the GC printout and is used to identify the unknowns qualitatively against the standard RT values.

Once all of the RT values are known for the standard compounds, a mixture of all selected standards shall be prepared at three known concentrations. For compounds whose RT values are known, a quantitative determination of the target compounds can be made using the calibration points and the GC computer.

The following calibration procedure should be used:

1. Identify the RT values for each of the standards to be used in the calibration mixture. Record the RT values and the response in mV for each standard in the analyst log as well as the flow rate and GC column temperature.

2. Prepare a standard at concentrations slightly above the detection limit, at the median range, and above the range expected in the unknown samples. A standard prepared in the low parts per billion (ppb) range may be used to estimate the detection limit of the GC, approximately 1 to 5 ppb. If more than 20 samples will be run in a day, prepare a duplicate set of standards for later use as in continuing calibrations.

3. Allow the standards to equilibrate for at least 30 minutes under the same temperature conditions as the unknown samples.

4. Inject a predetermined volume (100 ìl) of sample headspace air from a standard into the GC in a uniform motion. Record the injected volume of headspace in the computer note pad and relate this volume to the volume used in the analysis of the unknown samples. Repeat this step for each of the standards and program the calibration as required.

5. Save all analyses and record the following information in the sample note pad. The following information should be provided:

   - Sample identification
   - Date analyzed
   - Time analyzed
   - Injection volume
   - Equilibrium temperature
   - GC analyst
   - Any other applicable notes

Note: If the above procedures differ from the manufacturer's instructions, the manufacturer's instructions should be followed.

5.3.3 Quality Assurance/Quality Control

The data quality objectives for field screening require several Quality Assurance/Quality Control (QA/QC) procedures, which include the use of instrument calibrations, instrument blanks, syringe blanks, organic free water blanks, replicate samples, and verification. The QA/QC samples defined in this section will monitor the analytical system and procedures for cross contamination, and will provide an estimation of the accuracy and precision in the analyses. QA/QC samples are assigned to each batch of up to twenty samples, and are performed at a rate based on either the percentage of the total number of samples analyzed or on professional judgment.

An analyst log shall be kept to record information for each sample analyzed and other events associated with the GC analyses. Calculations, volumes and all pertinent information used in the analysis of each analytical batch shall be noted and signed by the analyst on a daily basis. This log will be kept in the instrument trailer and is part of the QA/QC procedure.

Continuing Calibrations

Continuing calibration standards are performed each day of analysis or after every 20 samples to allow the analyst to determine if the sensitivity of the instrument has changed since the initial calibration. The areas of the peaks for each of the continuing calibration standard compounds should be within 25 percent of the initial calibration. Recalibration should be performed if continuing calibrations are not within these limits. Continuing calibration standards should be prepared with the initial calibration standards and stored (approximately 4°C).

Instrument Blanks

After the GC has reached a stable oven temperature, an instrument blank is performed at the beginning of each sample batch. An instrument blank consists of operating the GC in the sample analysis mode without making an injection with the loop purge tube in place. This allows the instrument to analyze carrier gas only. This is performed to determine if the GC is contaminated with organic compounds due to previous analyses or outside contamination. If any significant peaks are detected in the instrument blank, the column should be back flushed with air at the maximum GC temperature for several hours or until clean.

Syringe Blanks

Prior to using any syringe, make sure that the syringe needle is not plugged by injecting air through the needle into a glass of organic free water to see if bubbles appear. If bubbles do not readily appear, the needle is plugged and can be cleaned with a cleaning wire. Do not allow the needle to touch the aqueous standard solution because this will contaminate the GC injection syringe.

After the syringe has been tested, collect a sample of zero ultra air used for GC analyses and inject it into the GC. If any significant peaks are noted in the results, clean the syringe using methanol and allow it to air dry. Repeat until the syringe blank is clean or the source of syringe or ambient air contamination is detected.

Organic-Free Water Blanks

Prior to using organic-free water for standards, inject an air sample from the headspace in equilibrium with the organic-free water. Prepare the organic-free water blank in the same manner as the site samples are prepared. If no compounds are detected, this water may be used with standards. Perform this test at the beginning of each new calibration curve preparation. Store the organic free water in a glass container in a solvent free environment.

Replicate Analyses

Replicate analyses, also known as duplicate analyses, shall be performed at a rate of 10 percent. Peak areas for standards for replicate analyses should be within 50 percent of the initial calibration peak areas. If peak areas are outside these limits, recalibrate the GC and consider factors which have led to a loss in precision.

Verification Samples

Split samples will be sent to an off-site laboratory at a rate of 10 percent to evaluate the accuracy of the field GC results. Verification samples will be selected from field screening samples, which provide coverage of non-detect, low, medium, and high concentration ranges. Since the verification samples will be performed using an SW846 method, the results provided by the off-site laboratory will be Level III data rather than Level II from the field GC. Comparison of these results should be made within in 10 working days after receipt of validated analytical result. Level II results are expected to be within 50 percent of the off-site laboratory results. Additional verification samples may be submitted to the laboratory at the discretion of the contractor project manager on a site-specific basis.

5.3.4 Validation

Data generated by the GC will be validated with respect to the accuracy and precision by reviewing the QA/QC data. Prior to reporting the results of the analyses, the analyst should evaluate the control blanks, continuation calibrations, duplicates, and split sample results. Data may be issued prior to evaluation of the split samples if the other QA/QC samples are in control.

If peaks are observed in the chromatograms with known RT values, but are not integrated by the GC, the analyst may estimate the peak area and associated concentration, and issue a J flag with the result. The J flag indicates that the value is below the practical quantitation limit, but is above the method detection limit. The accuracy of the results is lower than the unqualified results but may indicate that the compound is present.

5.3.5 Records

All report results and documentation determined to be a QA Record will be maintained in the Bhate project file.

A checklist provided in the manufacturer's literature shall be completed at the beginning of each instrument batch or day's analyses. This form will cue the analyst to key items, and will provide documentation of correct operating procedures.

Data generated by the GC will be stored on permanent disk and printed out for use in a report either using a serial printer or a computer system. Data may be relayed to the field prior to final report generation if preliminary validation steps have been completed. All quantitative data will be tabulated into a summary table for evaluation.

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6 REFERENCES

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ATTACHMENT 1-1

FIELD SCREENING METHODOLOGIES

FIELD SCREENING METHODOLOGIES

Test Type	Test Name	EPA Draft Test Method Number	Manufacturer	Analytes Detected	Matrixes Testable	Kit Detection Limits* (soil) (ppm)	Kit Detection Limits* (wipe) (ppm)	Kit Detection Limits* (water) (ppb)	Testing Rate (Tests/hour)
Immunoassay	PCPs	EPA Method 4010A	Ensys	Pentachlorophenol	Soil	0.5	NA	5	5 samples/hour
Immunoassay	2,4-D	EPA Method 4015	EnviroGuard	2,4-Dichlorophenoxyacetic acid	Soil	0.5	NA	10	5 samples/hour
Immunoassay	PCBs	EPA Method 4020	Ensys	PCB 1260 PCB 1254 PCB 1248 PCB 1242	Soil/Wipe/Oils Soil/Wipe/Oils Soil/Wipe/Oils Soil/Wipe/Oils	0.4 0.4 1 2	4 4 10 20	Oils/5 Oils/5 Oils/5 Oils/5	4 samples/hour
Immunoassay	Hydrocarbons	EPA Method 4030	Ensys	Gasoline Diesel fuel Jet A fuel Jet fuel, JP-4 Kerosene Fuel Oil #2 Fuel Oil #6 Mineral Spirits	Soil/Water Soil/Water Soil/Water Soil/Water Soil/Water Soil/Water Soil Soil/Water	10 15 15 15 15 15 25 40	NA NA NA NA NA NA NA NA	165 245 280 185 215 210 NA 490	4 samples/hour
Immunoassay	PAHs	EPA Method 4035	Ensys	Polyaromatics	Soil	1	NA	NA	4 samples/hour
Immunoassay	Toxaphene	EPA Method 4040	EnviroGuard	Toxaphene	Soil	0.5	NA	NA	5 samples/hour
Immunoassay	Chlordane	EPA Method 4041	EnviroGuard	Chlordane	Soil	0.02	NA	NA	5 samples/hour
Immunoassay	DDT	EPA Method 4042	EnviroGuard	4,4'-DDT	Soil	0.2	NA	NA	5 samples/hour
Immunoassay	TNT	EPA Method 4050	D Tech	2,4,6-Trinitrotoluene	Soil	0.5	NA	NA	5 samples/hour
Immunoassay	RDX	EPA Method 4051	D Tech	Hexahydor-1,3,5-trinitro-1,3,5-triazine	Soil	0.5	NA	NA	5 samples/hour
Headspace/GC	VOCs	EPA Method 3810	Various	VOCs with a boiling point <125° C	Soil	1	NA	NA	4 samples/hour
Colorimetric	TNT	EPA Method 8515	Ensys	2,4,6-trinitrotuoluene	Soil	1	NA	NA	7 samples/hour
Immunoassay	Dioxins	NA		Dioxin (2,3,7,8-TCDD)	Soil/Water	Nanogram/kg	NA	Picogram/L	
Immunoassay	BTEX	NA	D Tech	Benzene Toluene Ethyl Benzene Xylenes	Soil/Water Soil/Water Soil/Water Soil/Water	5 5 5 5	NA NA NA NA	0.5-50 0.5-50 0.5-50 0.5-50	4 samples/hour
Hanby Method	Aromatics	NA	H-Nu	All aromatics	Soil/Water	0.5	NA	NA	6 samples/hour

*NOTE: DETECTION LIMITS PROVIDED ARE GUIDELINES ONLY. DETECTION LIMITS WILL BE SPECIFIC TO EACH KIT.

ATTACHMENT 1-2

HEADSPACE ANALYSIS LOG

HEADSPACE ANALYSIS LOG

Project Number/Name: ____ DQCR No.: ________

Location: ______________________ Date Sampled: ________________ Date Analyzed:________________

Analyst:______________________Instrument Used:____

SAMPLE NUMBER	SAMPLE DETPH (FT)	SAMPLE TYPE	BACKGROUND READING (PPM)[1]	WITHOUT CARBON FILTER	SAMPLE READING (PPM)[1]		REMARKS
					WITH CARBON FILTER	AMBIENT AIR TEMP. (^{o}F)	

NOTES: [1] PPM represents concentration of detectable volatile and gaseous compounds in parts per million of air.
NA = Not Applicable
NMT = No Measurement Taken
NIR = No Instrument Response

BSOP NO. 10
SUBSURFACE WATER INVESTIGATION

BHATE STANDARD OPERATING PROCEDURE NO. 10

SUBSURFACE WATER INVESTIGATION

The objective of this Bhate Standard Operating Procedure (BSOP) document is to describe Bhate's policies and procedural guidelines for the design, installation, and construction of piezometers and groundwater monitoring wells to be completed in unconsolidated portions of water-bearing geologic materials. This document also provides procedures for well development, groundwater sampling, and hydraulic testing. Site-specific procedures will depend on project objectives, geologic conditions, and appropriate State and Federal regulations and standards.

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BSOP NO. 10

SUBSURFACE WATER INVESTIGATION

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1 MONITORING WELL INVESTIGATION

1.1 Objective

It is the policy of Bhate to design, install, and construct monitoring wells in a manner that ensures that all wells installed meet the criteria of being 1) adequately sealed to prevent surface contamination or cross contamination between aquifers; 2) capable of yielding high quality groundwater samples representative of true water quality within the target unit; 3) adequately protected; and 4) in compliance with all applicable State and federal regulations. The procedures set forth in the section apply to all Bhate and contract personnel who are responsible, both directly and indirectly, for the design of monitoring well systems, for oversight of drilling and construction operations, and for evaluation of the suitability and reliability of monitoring wells and data and measurements obtained from monitoring wells.

1.2 Procedure

Monitoring wells are installed primarily to provide information on the hydrogeology of a site and to determine the extent of migration of contaminants, if any. Well permits will be obtained prior to initiating construction, repair, or abandonment of any monitoring well. The drilling subcontractor, who must be certified in the appropriate state, will obtain the permits. The certified well driller or his representative must be present at the site during all drilling operations. All drilling personnel must meet all applicable OSHA requirements. The supervising hydrogeologist must be fully knowledgeable and experienced with federal and state requirements/regulations for groundwater monitoring programs.

Site-specific work plans will specify drilling methods to be used, and will present proposed well design and construction details. The drilling methods, well design, and well construction will adhere to the criteria and methodologies presented in this document. The proposed well design will be based on existing subsurface and groundwater fluctuation data. The design will present these data with the grain size of the filter pack and a discussion of the procedure to be used in the field for determining screen placement. All equipment, well materials and tools that will enter the borehole must be steam cleaned with a high temperature pressure washer (water at 200°F and 1,500 psi) prior to installation. The cleaned materials will be wrapped in clean Visqueen plastic and protected from possible contaminants. If needed, they will be steam cleaned again immediately before installation. The specifications presented herein are to be adhered to unless a site-specific variance has been granted by the appropriate authorities.

1.2.1 Well Design Specifications

Well Screen

In general, the standard monitoring well screen installed at a site will consist of a 2-inch inside diameter Schedule 40 PVC screen with 0.010 inch slots. If site specific conditions warrant, well screen materials will be designed based on site specific data or selected depending upon the known or suspected chemical contaminants at the site, and so that the completed monitoring well provides data, which meet the project data quality objectives. Monitoring well screens will be sized to retain over 90% of the filter pack. Well screen materials will be of the same size and strength material as the well riser, and will be a non-contaminating, continuous wrap design. Factory-slotted screens will be acceptable for USACE projects as long as the suspected contaminants do not include those that have an affinity for sorbing onto soil particles (e.g., PCBs and PAHs) or metals. In such cases, continuous-wrapped screen will be required. No glues, adhesives, lead shot, or lead wool will be used to connect the riser sections or screen. No field-slotted screen will be permitted.

Filter Pack

The filter pack material will be clean, washed, well-rounded silica sand sized to perform as a filter between the formation material and the well screen. Proper documentation will be furnished concerning the composition, grain-size distribution, cleaning procedure, and chemical analysis. The filter pack gradation shall have a uniformity coefficient (C_u) of not more than 2.5, and shall be sized so that the slotted screen will retain 90 percent of the material.

The standard filter pack material used for monitoring wells will typically conform to the size appropriate for slot screen. The following table provides the appropriate sized filter pack material in accordance with ASTM D 5092-90 (ASTM, 1990).

Table 1-1. Grain Size Distribution Chart

Size of Screen Opening, mm (in.)	Slot No.	Sand Pack Mesh Size Names(s)	1% Passing Size (D-1), mm	Effective Size (D-10), mm	30% Passing Size (D-30), mm
0.125 (0.005)	5	100	0.09 to 0.12	0.14 to 0.17	0.17 to 0.21
0.25 (0.010)	10	20 to 40	0.25 to 0.35	0.4 to 0.5	0.5 to 0.6
0.50 (0.020)	20	10 to 20	0.7 to 0.9	1.0 to 1.2	1.2 to 1.5
0.75 (0.030)	30	10 to 20	0.7 to 0.9	1.0 to 1.2	1.2 to 1.5
1.0 (0.040)	40	8 to 12	1.2 to 1.4	1.6 to 1.8	1.7 to 2.0
1.5 (0.060)	60	6 to 9	1.5 to 1.8	2.3 to 2.8	2.5 to 3.0
2.0 (0.080)	80	4 to 8	2.0 to 2.4	2.4 to 3.0	2.6 to 3.1

In addition to the primary filter pack installed along the screened interval of the monitoring well, a secondary filter pack consisting of finer material will be installed to prevent bentonite pellets from commingling with the primary filter pack.

Well Riser

Well riser (casing) will consist of polyvinyl chloride (PVC) or stainless steel. PVC pipe will be new, threaded, flush-jointed, and as a minimum, conform to the requirements of ASTM F480-81/SDR 13.5 (Schedule 40). PVC pipe will bear markings identifying the material as that specified, and will carry the seal of the National Sanitation Foundation. Stainless steel pipe will consist of new, flush-jointed, and threaded, Type 304, corrosion-resistant steel. Unless noted in the site-specific work plans, monitoring wells will be 2-inch inside diameter (ID).

Bentonite Seal

The bentonite seal will be composed of commercially manufactured sodium bentonite pellets, which do not exceed 0.25-inch diameter. Clean, potable water will be used to hydrate the bentonite.

Annular Seal

The cement grout will consist of a mixture of Portland Cement (ASTM C 150-00) and water in the proportion of approximately 6 to 7 gallons of approved water per bag of cement (94 pounds). In addition, 3 to 5 percent by weight of sodium bentonite powder will be added. The minimum acceptable grout weight will be 14 pounds per gallon (lbs/gal). The cement grout weight will be determined using a mud balance. Water may be added to the mix in small amounts, at the discretion of the field geologist, to achieve pumpability.

1.2.2 Borehole Completion

Procedures for the drilling and advancement of soil borings are presented in BSOP No. 1, Section 4. Drilling techniques employed must minimize disturbance of subsurface samples and must not introduce contamination to the subsurface or allow contaminants, if any, in shallow hydrogeologic units to migrate to deeper units. A Monitoring Well Installation Detail Form (Attachment 1-1) will be completed for each monitoring well. This form includes a comprehensive list of pertinent drilling hydrogeologic and monitoring well construction information.

1.2.3 Well Construction

At all times during the progress of the work, precautions will be taken to prevent tampering with the well or the entrance of foreign material into it. Run-off will be prevented from entering the well during construction.

Depending on site conditions, consideration should be given to overdrill the borehole so that soils that have not been removed or that have fallen into the borehole during auguring or drill stem retrieval will fall to the bottom of the borehole below the depth of the filter pack and the screen. Normally 3 to 5 feet are sufficient for overdrilling. Once the desired depth of the borehole has been attained, the borehole will be prepared for installation of the well casing and screen. If drilling fluid was used, it must be flushed from the borehole with clean potable water to the extent possible without causing borehole collapse. The well casing/screen assembly will then be inserted into the borehole. For wells that are being installed beneath a confining or semi-confining unit, or are intended to monitor deep members or portions of an aquifer, the well casing/screen assembly will be installed within pre-set surface casing, to prevent cross-connections between different aquifer zones. If a well cannot be properly completed to prevent such an interchange of water between water-bearing zones or to prevent a loss of artesian pressure, the well will be abandoned and plugged.

The casing/screen assembly will be installed as follows:

1. Prior to installation of the casing and screen, the lengths and diameters of all components (including the bottom plug or cap) will be measured and recorded on the Casing/Well Screen Tally Form (Attachment 1-2). The casing riser and screen assembly will be installed round, plumb, and true to line.

2. A bottom plug will be attached to the bottom of the screened section.

3. The well screen will be connected to the riser sections of the casing assembly. For wells intended to monitor the upper surficial aquifer near the water table, the well screen will be installed so as to straddle the free water surface, extending both above and below the water table to accommodate seasonal or other variations in its elevation. In all cases, the top of the screen will be located at least 2 feet below the base of the down-hole seal. Screen slot size will be 0.10 inches, or the appropriate size based on grain-size distribution analyses and filter back design, as discussed above.

4. For wells installed to depths exceeding 50 feet, centralizers will be placed at locations just below the screen, just above the location of the bentonite seal, and at 50-foot intervals along the riser casing. Stabilizers will not be used if their installation prevents the placement of the annular materials.

5. Well risers will extend at least 2.5 feet above the ground surface, unless well casings must be completed at ground surface level as specified by the client or mandated by site conditions and planned use of the well. If a flush finish completion is conducted, the placement of annular materials will be done in such a way that the inside of the well casing is protected, i.e., the protective vault will be waterproof and strong enough to support anticipated loads.

6. The primary filter pack will be placed in the annulus between the well material and borehole using a tremie pipe, starting with the tremie at the bottom of the borehole and working the tremie upward as the filter pack is placed. When using hollow stem augers (HSAs), the augers will be raised incrementally during the installation of the filter pack. Attempts will be made to keep the bottom of the augers below the top of the filter pack during installation. The level of the top of the filter pack in the annulus will be continually verified by tag-line measurement during placement. The filter pack will extend at least 2 feet above the top of the screen. The volume of the installed filter pack will be compared with the annular volume

to verify proper placement of the filter pack. This material accounting will be recorded in the field book.

7. A secondary filter pack, at least 2 feet thick and consisting of material finer than the primary filter pack, but of similar composition, will be placed in the annulus between the primary filter pack and the overlaying bentonite seal. This secondary filter is intended to prevent movement of the seal or grout (or both) into the underlying primary filter pack.

8. A bentonite seal at least 2 feet thick will be placed in increments of four 6-inch lifts immediately above the filter pack. Pouring of the pellets is acceptable for boreholes less than 50 feet where the annular space is large enough to limit the potential for bridging and to allow measurements to ensure that the pellets have been placed at proper intervals. For depths greater than 50 feet, the bentonite pellets will be installed through a tremie pipe. The bentonite pellet seal will be hydrated either by pouring water or utilizing the tremie pipe with an approximately equal volume of clean, potable water, and allowed to hydrate a minimum of 30 minutes between lifts before proceeding. If water is used, its source and the volume used should be documented in the field book. After the placement of the final lift, the bentonite seal will be allowed to hydrate another 2 hours before grouting the remaining annulus. The level of the top of the bentonite seal will be verified by tag-line measurement prior to grouting. When using HSAs, the bottom of the augers will be left in the borehole as close as possible above the bentonite seal.

9. To grout the remaining annular space, a side-discharging tremie pipe will then be maintained 3 feet above the bentonite seal and will be used to slowly place the cement/bentonite grout mixture. When using HSAs, the augers will be pulled incrementally during the grouting procedures to limit borehole collapse. Grout will be pumped into the annulus through the tremie pipe until undiluted grout flows from the borehole at the ground surface. The grout will be allowed to cure for at least 24 hours prior to development.

1.2.4 Double Cased Wells

Surface casing will be installed in the borehole when drilling a monitoring well that will be installed at depths below relatively impermeable (confining) layers or below depths of known contamination. The purpose of the surface casing is to prevent cross-contamination between two aquifer zones and to prevent dragging contamination down to a greater depth during the drilling procedure.

A pilot borehole should be drilled and the surface casing installed to slightly below the known depth of contamination or a minimum of 2 feet into the confining layer. The diameter of the surface casing will be sufficient to contain the inner casing and a 2-inch annular space. The size of the borehole should be sufficient to maintain a 2-inch annular space between the borehole walls and the surface casing. The material of the surface casing may vary, but it will be chemically inert and able to withstand potential chemical degradation and any forces exerted on the casing during its installation and monitoring well construction.

The outer casing should be grouted by the tremie method from the bottom to within 2 feet of the ground surface. The grout should be pumped into the annular space between the outer casing and the borehole wall. This will be accomplished by either placing the tremie tube in the annular space and pumping the grout from the bottom of the borehole to the surface, or placing a grout shoe or plug inside the casing at the bottom of the borehole and pumping the grout through the bottom grout plug and up the annular space on the outside of the casing. If the casing is set into very tight clay, both of the above methods may have to be used, because the clay usually forms a tight seal in the bottom and around the outside of the casing preventing grout from flowing freely during grout injection. A minimum of 24 hours will be allowed for the grout seal to cure before attempting to drill through it. The grout mixture used to seal the outer annular space will be a neat cement mixture of one 94-lb bag of Type I Portland Cement per approximately 7 gallons of water and 3 to 5 percent bentonite powder by weight.

When drilling through the seal, care will be taken to avoid cracking, shattering, and/or washing out the seal. If caving conditions exist such that the outer casing cannot be sufficiently sealed by grouting, the out casing should be driven into place and a grout seal placed in the bottom of the casing. Removal of outer casings, which are sometimes called temporary surface casings, after the well screens and casings have been installed and grouted, is not acceptable. Trying to remove outer surface casings after the inner casings have been grouted could jeopardize the structural integrity of the well. The boring will be advanced through the surface casing to the target depth for monitoring well installation. The borehole beneath the surface casing will be of sufficient diameter to maintain a 2-inch annular space between the monitoring well and the borehole well.

1.2.5 Well Head Completion

Upon completion of the well, a suitable vented cap will be installed on the top of the well riser. The well riser will be surrounded by a larger diameter protective steel or PVC casing rising approximately 3 feet above ground level and set a minimum of 2 feet below the ground surface into the cement grout backfill. A drain hole at least 0.25 inches in diameter will be drilled at the base of the protective casing. The protective casing will be provided with a locking cap and a brass padlock or the well casing will be secured with a plastic expansion cap locked with a hexagonal key. All locks used at a particular site will be keyed alike. If wells are required to be finished flush with the grout or pavement, these will be fitted with a watertight, flush-mounted, traffic-rated steel cover at least 6 inches larger in diameter than the well riser. The well casing will be secured with a plastic expansion cap locked with a hexagonal key.

A minimum 3-foot by 3-foot by 4-inch thick concrete pad, sloped away from the well, will be constructed around the monitoring well with the top outer edge at the final ground elevation. At locations where vehicular traffic is likely, the concrete pad will be reinforced with reinforcement wire or rebar. Three or four 3-inch diameter or larger concrete-filled steel or PVC posts will be equally spaced around the well and cemented in place around the concrete pad. The base of these posts shall extend 2 feet bls and be appropriately 3 feet tall. Metal rebar may be installed inside the posts for additional stabilization. The concrete pad surface immediately surrounding the top of the well will be sloped away from the well. After the well is installed, the area will be cleaned and all discarded material will be properly disposed.

1.2.6 Documentation and Recording

In addition to providing standard field documentation procedures, a Monitoring Well Construction Form (Attachment 1-1) will be prepared to provide an accurate “as-built” diagram of each well and will include the following information:

- Project and site names, well number and the total depth of the completed well
- Depth of any grouting or sealing, and the amount of cement and/or bentonite used, and to the total borehole depth and elevation
- Depth, elevation, and type of well casing
- Installation date or dates, and name of the driller and the geologist installing the well
- All pertinent construction details of monitoring wells, such as depth to and description of all annular fill materials; gradation of filter packs; length, location (depth and elevation), diameter, slot size, material, and manufacturer of well casing and screen; position of centralizers; and location of any blank pipe or intermediate casing installed in the well
- Description of surface completion, including protective steel casing, protective pipes, and concrete surface seal
- Surveyed coordinates and elevation of top of ground and top of well riser. The accuracy of the survey points will be in accordance with BSOP No. 11.
- A brief stratigraphic log, showing depths to and descriptions of major lithologic changes encountered in the well borehole

A discussion of information to include in the boring logs is presented in BSOP No. 1. All original well record form, field report forms and geologist logs will be maintained in the project file.

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2 FLUID LEVEL MEASUREMENT AND RECORDING

2.1 Objective

This section presents procedures and guidelines for measuring groundwater and free product levels in monitoring wells. Consistent repeatable data should be obtained.

2.2 Procedure

Groundwater and product fluid levels are measured to determine the existence and nature of fluids in subsurface aquifer systems, and to evaluate fluid potential for hydraulic movement within and between hydrogeologic units during static and pumping conditions.

Water level measurements used to define the water table or a single potentiometric surface should be collected within a 24-hour period. Water level measurements should be taken within a shorter time interval if an aquifer is being significantly influenced by a recharging or discharging mechanism. Tides, river stages, impoundments, storm water drainages, and production pumping of irrigation and supply wells all can significantly affect the potentiometric surface over a brief period of time (U.S. EPA, 1992).

Water level measurement equipment will be constructed of materials that are chemically inert and which are not prone to sorption or desorption.

Before collecting water level measurements for potentiometric maps, the water levels in piezometers and wells should be allowed to recover for a minimum of 24 hours after installation/construction, well development, for purging. When collecting water levels at a site, measurements should be collected from wells in order of most contaminated to least contaminated, if known. This order typically follows collecting water levels from wells located in the most upgradient position to the most downgradient position. It is important to recheck water levels in all wells approximately 15 minutes after the initial measurement, to ensure the water levels have stabilized. If different readings are indicated, recheck the water levels until they have stabilized. Fluid level measurements will be recorded on Water Level Data Summary forms (Attachment 2-1).

2.2.1 Fluid Level Measuring Reference Point

Fluid level measurements are to be made from the top of the permanent well casing. The reference point will be marked near the north side of the casing using a permanent marker. All fluid levels are measured as depth from the reference point. This reference point must be surveyed for vertical elevation so that fluid level depths may be converted to elevations.

2.2.2 Electrical Tape Method

The use of an electrical tape to measure fluid levels is simple and convenient. The device consists of an electrode suspended by a pair of insulated wires. An ammeter, indicator light, or audible signal is used to indicate when the electrode touches the water surface. Batteries supply the current. This method is also known as the electric sounder method.

The procedures for this method are as follows:

1. Check batteries before going to the field and carry an ample supply of spares.

2. Turn power switch "ON".

3. Decontaminate tape and probe upon arrival to a site and between measurement in different wells or piezometers, as outlined in BSOP No. 13.

4. Lower probe into the well until a sharp deflection is noted on the meter, the indicator light is illuminated, or the audible tone is activated.

5. Verify that the electrode is functioning properly and is indicating the water surface with the same depth each time by moving the probe up and down several times.

6. Hold the probe cable at the measuring point location on the well pipe at the exact depth where the probe indicates the water surface to be. Record the reading to the nearest 0.01 foot.

7. Remove the probe from the well.

2.2.3 Continuous Recording

The measurement of groundwater elevations within pumping or monitoring wells can be accomplished by use of a mechanical or digital-analog, computerized, continuous recording system, and should be performed according to specifications given by the manufacturer of each unit. In general, when using either the mechanical or digital system, the pressure or electrical transducer is lowered into the well until it intersects the water surface. The actual fluid depth is then measured by the method described above, and is used to calibrate the continuous recorder. The field geologist is responsible for making proper adjustment. Proper maintenance of continuous recording devices during level monitoring should be performed by the field geologist so that continuous, permanent records are developed for the specified period of time. Records shall be sorted on mechanical graph paper or on a microprocessor. Frequent calibrations of equipment should also be made by the field geologist during monitoring periods of long duration. Calibration methods vary depending on the type of recording device used. Specific manufacturer's calibration procedures must be followed.

2.2.4 Interface Probe Methods

When opening wells that may contain non-aqueous phase liquids (NAPLs, a.k.a., free product), the air within the well head should be monitored to determine the potential for fire, explosion, and health and safety hazards. If light non-aqueous phase liquids (LNAPLs) are present, interface gauging will be used to differentiate between the water table and the surface of the immiscible layer.

For measurement of free product levels, a hydrocarbon interface probe gives different signals (e.g., constant versus intermittent) for the groundwater and free product surfaces. The procedures for this method are as follows:

1. Follow steps 1 through 3 of the electrical tape method.
2. Lower the probe into the well until an audible tone sounds, indicative of exposure to an organic liquid.
3. Hold the interface probe cable at the measuring point location on the well pipe at the exact depth where the probe indicates the organic liquid surface to be. Record the depth below top of casing to the organic liquid surface to the nearest 0.01 foot.
4. Slowly continue lowering the interface probe until the organic liquid/water interface is reached, indicated by the respective audible tone.
5. Move the interface probe slowly up and down to verify that it is functioning properly and is indicating the interface at the same depth each time.
6. Hold the probe cable at the measuring point location on the well pipe at the exact depth where the probe indicates the organic liquid/water interface to be. Record the depth below top of casing to the interface to the nearest 0.01 foot.

2.2.5 Data Reporting

All water level field data are to be entered in field log books or on an appropriate Water Level Data Summary form and will include the following information:

- Date (at top of page)
- Time recording is made
- Station location (monitoring well or piezometer identification)
- General comments about condition
- Measuring point, usually top of casing (TOC)

- Depth to product (if measured), to nearest 0.01 foot
- Depth to water, to nearest 0.01 foot

Field notes should also include the serial number of any measurement or recording device. If more than one device is used, indicate which device is used for each measurement.

2.2.6 Climatic Monitoring (Continuous/Non-Continuous)

The continuous and non-continuous monitoring of climatic conditions can be performed through the set-up and maintenance of a weather shed at the specified site. Specific instruments and measuring devices to be employed include, but are not limited to, rain gauges, hydrographs, barometers, thermometers, and any other site-specific instruments. Actual field monitoring of instruments should be performed according to methodologies described in NOAA (1972). It is the responsibility of the field geologist to maintain and preserve appropriate monitoring equipment throughout the specified monitoring interval and to retain all data for future use.

3 WELL DEVELOPMENT

Well development represents the attempts to restore the volume of aquifer material immediately surrounding the screened portion of the well to its indigenous condition by correcting damage done to the formation during the drilling process. Well development can be accomplished in many different ways. The effectiveness of the different methods are based on three primary factors:

1. The type of geologic material

2. The design and completion of the well

3. The type of drilling technology used in the borehole advancement and well installation

The discussion below presents the objectives of monitoring well development. It also describes the procedures that may be used to effectively develop a well. The actual procedures used will be dependent on site-specific, and possibly even well-specific, conditions. Personnel responsible for well development are encouraged to read U.S. EPA (1996), Aller (1989), and ASTM (1994) for more detailed discussions of well development philosophy, procedures, and criteria.

3.1 Objective

The primary objective of installing a monitoring well at a site is to collect a groundwater sample that is representative of the quality of groundwater surrounding the well. Well development is an important component of monitoring well completion. Monitoring wells should be sufficiently developed to ensure that they meet their intended objectives. The purposes of well development are the following:

- Assure that groundwater enters the well screen freely and at ambient velocities, thus yielding a representative groundwater sample and an accurate fluid level measurement.

- Remove all water and drilling additives that may have been introduced into the borehole and formation during drilling and installation activities.

- Remove fine-grained sediments entrained in the filter pack and within the well itself so that groundwater samples have a minimal turbidity and excessive silting of the well does not occur.

3.2 Procedure

Well development should ensue within 1 week after completion of the well, but no sooner than 24 hours after the grouting is completed. Well development can be performed using one or more of the following methods: bailing, surging, overpumping, or jetting. As noted above the method used will be based on site-specific conditions. It is anticipated that for the majority of the monitoring wells, the predominant development methods will be surging and overpumping. It is important to realize that effective development of a well requires the movement of fluids both into and out of the screen parts of the well and the surrounding filter pack. No dispersing agents, acids, or explosives will be utilized in well development activities. The water level and height of sediment in the well should be measured and recorded in the field log book prior to development, as discussed below. All development equipment inserted into the well will be decontaminated in accordance with BSOP No. 13.

In most cases the initial well development method will be hand bailing to remove accumulated sediment in the well. The bailer will be allowed to fall freely through the well past the water surface until it strikes the bottom of the well. The bailer will be raised to the surface vigorously to create a high action level of water movement. This free fall and rapid removal will provide some surging action to the filter pack and proximal formation material. To enhance the removal of sediment, the bailer should be intermittently agitated by rapid short upward strokes from the bottom of the well. Bailing should be continued until the water is free from suspended sand-sized sediment.

A surge block may be needed to create a stronger surging action than the bailer does. If this is the case, the surge block and the bailer should be used in conjunction with each other. After utilizing the surge block for a short period of time, the sediment that entered the well as a result of the surging should be removed with the bailer, as described in the previous paragraph. The surge block will be composed of inert material that will not affect the water quality in the well. The diameter of the surge block should be 0.125 to 0.25 inches smaller than the inside diameter of the well. Caution should be employed to ascertain that the block can move freely up and down the inside of the well without obstructions. The vertical action of the surge block will be accomplished either manually or mechanically with drill rods or wire line. Care should be taken in the length of the strokes, the velocity of the up and down movement, and the duration of each surge block cycle. If the surging action is too vigorous for the well construction and formation characteristics, then the activity can be detrimental to the well integrity. Detailed discussions are presented in Aller (1991) and ASTM (1994); responsible personnel should review these discussions before beginning well development with the surge block method.

Following the removal of suspended sand-sized sediment, the well development process should include overpumping the well with a submersible electric pump (e.g., Grundfos Redi-Flo2™). Commonly, the overpumping method will be employed in the latter stages of well development. In overpumping, the pump is operated at a capacity that substantially exceeds the yield of the formation (i.e., the capacity of the formation to deliver water to the well). This flow velocity well exceeds the flow velocity that will be induced during the purging process of well sampling.

If the monitoring well was installed using a mud rotary method, then it is recommended that water jetting be considered as a component of well development to break down the mud cake that may line the borehole walls. The particles of the mud cake can then be brought into and removed from the well by overpumping. The construction of the well should be considered when evaluating this process. For instance, the effectiveness of jetting is commonly reduced by the fine slot sizes (0.010 inch) of many monitoring wells. In addition, any sediment entrained in the jetting fluids may cause damage to a screen composed of PVC materials. As noted above, no dispersing agents will be utilized in the jetting of a well.

It is recommended that development with air (e.g., airlift pumping) not be employed, because the introduction of air to the formation could change the chemical environment of the aquifer (e.g., redox potential) and reduce the hydraulic conductivity of the formation.

During well development, the entire well cap and interior of the well casing above the water table should be washed using only water from that well. Water exiting the well will be contained and properly disposed of, as warranted, based on-site conditions. If the addition of water is required to facilitate surging and bailing, only formation water from that well will be used. For water jetting, the water quality must be verified prior to the introduction of any water from a source other than the well itself.

In some cases, such as the need to sample a well in a short time frame because of limited site access, preliminary well development is necessary. Preliminary well development may be conducted after installation of the well screen, casing and filter pack, but prior to installation of the bentonite seal and grout. Additional filter pack will be added, as needed, after completion of the preliminary well development to bring the filter pack up to the desired depth after settlement that may have occurred. Preliminary well development may consist simply of pumping fresh water for a brief interval (several minutes) through the well screen to flush drilling mud from the filter medium, or can include surging and pumping of the well.

All preliminary well development will be completed within 1 day after the screen, casing, and filter pack are installed. If soils above the screened aquifer are known or suspected to contain hazardous constituents, preliminary well development will be restricted to flushing the filter medium briefly through the screen. All other development efforts will then conducted after the bentonite seal and grout has been place and allowed to set.

Since preliminary well development is conducted prior to the installation of protective casings and surface pads, the borehole must be protected. Soil will be mounded around the base of the exposed well casing prior to development, in order to direct run-off away from the well annulus.

The person responsible for well development should inquire if any special circumstances apply to monitoring wells that contain free product. There may be instances where development of such wells results in the vertical spreading of contaminants through the aquifer matrix. In these cases, development may entail only the inward movement of water and materials toward the well.

3.2.1 Criteria and Well Development Documentation

Development criteria will include the stabilization of standard field parameters. These criteria will be refined, based on initial results at each site, with the objective of achieving minimum turbidity in all wells.

During the pumping stage of development pH, specific conductivity, dissolved oxygen, oxidation-reduction, temperature, and turbidity will be measured generally once every well volume removed. For wells that have a short water column (for instance, in wells screened across the water table), it may be more practical to measure the field parameters at greater intervals. In addition, due to the typically turbid nature of most groundwater monitoring wells, it is routinely necessary to remove significant volumes of purge water to obtain turbid free water. Therefore, in these cases it is more practical to measure the field parameters at greater intervals. The development of a well will be continued until the following conditions have been met:

- The duration of the well development has been at least 2 hours.
- The field parameters (pH, specific conductivity, oxidation-reduction, dissolved oxygen, and temperature) have stabilized for four consecutive measurement events (less than a change of 0.2 pH units and less than a 10 percent change for the other parameters between four consecutive readings).
- The turbidity has been significantly decreased. Attempts will be made to attain turbidity values of 5 nephelometric turbidity units (NTUs) or less for four consecutive measurement events. However, it should be recognized that the groundwater at some locations is naturally turbid because of organic or inorganic colloids. The meeting of these criteria will be evaluated by a senior geologist on a well-specific basis.
- The yield of the well is representative of the transmissivity of the aquifer. For wells that were installed with the mud rotary method, mud cake on the borehole the walls may reduce the yield of the well. If this occurs, development should continue until the mud cake is removed and the yield increases.

If field parameters stabilize, but the water remains turbid, the well, filter pack, and/or borehole walls may still contain construction materials, such as mud cake that has not been removed from the borehole walls. Excessive or thick drilling muds may not be efficiently flushed out of a borehole by purging only. In this case, surging or jetting methods may be needed to be applied.

Measurement of field parameters will documented on a Monitoring Well Development Log (Attachment 3-1) which will include the following information:

- Date and weather
- Summary of well construction

- Pre-development water level
- Measured height of sediment (if any) at bottom of well prior and after the development activities and the detected changes in this height during development
- Time of each measurement
- Cumulative total volume of water removed prior to each measurement
- Volume of water removed between measurements
- Pumping rate
- Method of development and duration employed
- Time and duration of cessation of development
- Results of field parameter measurements, and volume of suspended particles in water

Additional observations such as apparent yield of the well or detected odors should also be noted on the development log.

Eight-ounce clear glass jars will be used to collect samples of the pre-development water and the last water withdrawn from the well at the cessation of development. These samples will be labeled and photographed with a 35mm color photograph. The photograph should be taken following agitation of the jar contents by shaking, and prior to the settlement of fines in the jar. In addition, the photograph will be a suitably backlit close-up that shows water clarity. These photographs and samples will be stored throughout the duration of the project at an appropriate facility for later observation if needed. It should be noted that this procedure will be conducted on a site/client specific basis and may not apply to all projects.

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4 MONITORING WELL SAMPLING

4.1 Objective

The objective of this section is to provide procedures for the sampling of groundwater monitoring wells. These procedures were designed so that the groundwater samples will be of verifiable and legally defensible quality. To ensure that this goal is achieved, sampling protocols must be strictly followed and sample collection and handling must be properly documented in field log books, groundwater sampling logs, Chain-of-Custody forms, and project files. This procedure applies to all personnel who are responsible, both directly and indirectly, for groundwater sampling and the evaluation of analytical results from groundwater samples.

4.2 Procedure

This section presents procedures to be followed for collection of groundwater quality samples. All sampling personnel must be knowledgeable of groundwater sampling procedures and the established protocols. Adequate preparations for sampling trips will be made by responsible personnel to ensure that sampling will be performed as efficiently and cost effectively as possible. Proper sampling protocol will be followed to ensure that representative samples of groundwater are provided for analysis, and that the act of sampling and the specific equipment utilized to collect each specific sample.

It is recommended that a monitoring well not be sampled for at least 2 weeks after well development has been completed.

Procedures specified in the site-specific health and safety and sampling and analysis plans also must be reviewed to determine if more stringent procedures are required at a specific site.

4.2.1 Pre-Sampling Trip Preparation

The site team leader and the environmental technician or staff hydrogeologist performing the sampling are responsible for review of available information and preparation of equipment to ensure that the sampling trip is performed as efficiently as possible. Thorough preparation will reduce lost time during sampling episodes, and will ensure that the sampler has the proper equipment available on site to follow established protocols. The following pre-sampling activities are recommended.

During an appropriate time frame prior to the scheduled sampling date, a vehicle and all necessary equipment will be signed out and checked by the sampling personnel. The sampling equipment will be inspected to confirm proper calibration and good repair. Equipment failing to operate within manufacturer's recommended specifications, must be properly repaired, adjusted, and calibrated prior to utilization. Documentation of equipment maintenance must be recorded in the field log book and the specific equipment log. Expendable field supplies will be checked to determine whether adequate quantities of all supplies are available. Monitoring well construction logs and available water level data for all wells to be sampled should be reviewed to evaluate the conditions that will be encountered and the approximate volume of water to be evacuated.

Sample bottles must be ordered from the laboratory at least 2 to 3 days prior to the sampling date. When ordering sampling bottles, bottles for blanks and duplicates must be obtained, and the type of blanks to be obtained must be specified. Reagent grade water for equipment blanks must be provided by the laboratory or an appropriate vendor (e.g., Fisher Scientific).

The order of well sampling will be determined, such that the least contaminated wells at the site will be sampled first, progressing to the most contaminated wells last. Sample bottles obtained from the laboratory must be checked to ensure that all necessary sample bottles and associated preservatives have been provided.

On the day of sampling, on-site weather conditions will be evaluated to determine whether they are suitable for sample collection. Groundwater samples must not be collected in weather conditions that may affect the integrity of the samples (i.e., rain or high winds). Upon arrival at the site, the location and access to wells will be verified. Wells will be inspected to determine the condition of the surface casings, surface seals, well identification, and condition of the casing. The general condition of the wells and any abnormalities noted must be recorded in the field log book and the Field Data Information Log for Groundwater Sampling (Attachment 4-1).

4.2.2 Initial Activities

Prior to working at a particular well, plastic sheeting will be laid on the ground surface immediately surrounding the monitoring well.

It is recommended that immediately after opening the cap of the well, an OVA reading be collected at the well head. This may provide preliminary information on water quality and health and safety conditions.

The fluid levels will be measured in the well using the electric tape method. The presence of NAPLs should be reported to the project manager immediately, and may dictate the sampling method to be utilized.

The total depth of each well will be measured before sampling to ensure that silt or sand has not entered the well, which would indicate that the well screen has been damaged. The measurement will be used in the calculation of the volume of water standing in the well casing. The depth will be measured utilizing either an electric water level indicator, or, if contamination is known or suspected, a weighted, disposable line. A correction will be applied, as necessary, when using the electrical tape to account for the added length of the sensor located at the end of the tape.

4.2.3 Well Evacuation

All monitoring wells will be purged before collecting samples in order to remove stagnant water from the well casing and to assure that the groundwater sample submitted for laboratory analyses is representative of groundwater quality in the aquifer. During the purging process, the field parameters (pH, specific conductivity, dissolved oxygen, temperature, redox potential [Eh], and turbidity) will be measured at least once every well volume. To determine the volume of water standing in the well, the following formula may be used:

$$V = 0.041\ d^2h$$

Where: h = water column height (feet; well depth minus depth to water level)

d = diameter of well (inches)

V = volume of water standing in the well (gallons)

Well purging will continue until the following criteria have been met:

- A minimum of three to five well volumes have been evacuated from the well.
- Three consecutive measurements in which the field parameters have stabilized. Stabilization occurs when the pH measurements remain constant with 0.1 units, specific conductivity, redox potential, and dissolved oxygen vary by no more than 10 percent, and the temperature is constant. Utilizing low-flow purging and sampling techniques may require removal of a greater volume of water than three to five volumes.
- The turbidity is less than 5 NTUs.

All pertinent conditions of the sampling and the basis for field decisions should be documented in the Field Log Book and/or the Field Data Information Log for Groundwater Sampling.

It is strongly recommended that purging and sampling be conducted using low flow techniques, with an appropriate pumping mechanism, such as a Grundfos Redi-Flo2™ submersible pump. This method has been shown to cause a non-turbulent flow into the monitoring well screen (at a velocity closer to the “natural” flow). Hence, a relatively non-turbid sample, which is representative of the groundwater quality near the well, can be sampled. Purging may also be accomplished with a Teflon, PVC, or stainless steel bailer. It should be noted that bailing induces turbulent flow into the well, and hence tends to produce turbid samples with suspended particulate or colloidal matter which could lead to sampling artifacts (Barcelona and others, 1994). If groundwater is shallow enough (less than 30 feet bls) a peristaltic pump can be used for the purging and sampling of the well. The usage of a peristaltic is advantageous due to reducing equipment that needs to be decontaminated and likelihood of cross contamination between wells.

In preparation for groundwater sampling, an approximately 12-foot by 12-foot section of unused plastic sheeting will be secured on the ground surface surrounding the well. After measuring the pre-purging water level and total depth of the well, all of the pertinent equipment will be arranged and the pump and associated Teflon tubing will be inserted into the well. The pump intake will be installed to a depth in the central part of the screened interval of the well. After the pump assembly is secured, a water level probe will be lowered into the well to monitor the water level during the purging process.

The pump shall be turned on and the minimum flow rate possible shall be immediately attained. The objective is to have a flow rate low enough so that non-turbulent, rather than turbulent, flow is induced. Ideally, the flow rate should be close to the natural flow rate of groundwater moving through the well.

The field parameters noted above, as well as the water level in the well, will be measured and recorded immediately upon the commencement of purging and at least once every well volume thereafter. Attempts shall be made to limit the drawdown in the well to less than 0.25 feet. Drawdowns greater than this may indicate turbulent flow into the well.

In general, purging shall continue until the criteria listed above are met. Immediately after the groundwater sample and associated QA/QC samples have been collected, the field parameters will be measured and collected a final time. If the well exhibits a low yield, the flow rate will be reduced as much as possible to prevent the well from pumping dry. However, if the well does go dry, the well may be sampled following sufficient recovery, without the need for purging the minimum of three to five well volumes and documenting the stabilization of the field parameters. However, the field parameters should be measured and recorded as the measurements of record for the sampling event.

The low flow purging and sampling can be accomplished by pneumatic, peristaltic, or submersible pumps. A check valve will be installed along the intake purge line to minimize backwash of water. To minimize the possibility of contamination, all pumps and lines placed into the water will be manufactured of either Teflon or cleaned stainless steel.

If it is necessary to purge and sample the well with the bailer method, then Teflon or stainless steel bailers will be used. All bailers will be raised and lowered into the well using new nylon line, which will be disposed of between wells. The evacuation point should be just below the water surface when the screen is set near the bottom of the well.

All sampling personnel will wear a clean pair of new, disposable, latex or vinyl gloves while purging. After sampling, the hoses or bailers that come in contact with the groundwater will be decontaminated. The evacuated water will be discharged away from the well or will be containerized and properly disposed of if site conditions warrant this method of handling.

All field parameters and water level measurement will be recorded on the Field Data Information Log for Groundwater Sampling. Other information to be included on this log includes the following: a summary of the construction and apparent integrity of the monitoring well, calculation of the height of the standing water in the well, and any pertinent field observations.

4.2.4 Sample Collection

After stabilization of the required field parameters or as soon as sufficient recharge has occurred, the samples will be collected using the same system as that used for well purging. Sampling personnel will wear a clean pair of new, non-powdered, disposable latex gloves at each different sampling location. These gloves will be donned immediately prior to sampling and will never come in contact with the media being sampled.

Samples will be collected in the following order (as applicable):

- Volatile organic compounds (VOCs)
- Dissolved gases and total organic carbon (TOC)
- Purgeable organic compounds
- Purgeable organic halogens (POX)
- Total organic halogens (TOX)
- Extractable (semi-volatile) organic compounds (SVOCs)
- Total metals
- Dissolved metals
- Phenols
- Cyanide
- Sulfate and chloride
- Turbidity
- Nitrate and ammonia
- Radionuclides

4.2.5 Labeling and Handling Requirements

After each sample is collected, samples will be labeled and handled in accordance with procedures specified in BSOP No. 4.

4.2.6 Collection of Quality Control Samples

All Quality Assurance/Quality Control (QA/QC) sampling activities must comply with the requirements of the following documents:

1. The Installation Quality Assurance Program Plan (QAPP).

2. Bhate's approved Comprehensive Quality Assurance Plan (CompQAP).

3. The Site-Specific Quality Assurance Project Plan (QAPP).

In the case where these documents do not concur as to the number and type of QC samples to collect in any given situation, the most conservative number and type of QC samples will be collected (the number which provides the greatest ratio of QC samples to environmental samples and the types of QC samples which allow for a thorough evaluation of sampling and analytical method). Several types of QC samples can be collected, including equipment (rinsate) blanks, field blanks, material blanks, duplicates, matrix spike and matrix spike duplicates, and trip blanks.

Equipment blanks are taken in the field by pouring reagent grade water provided by the laboratory through the pump or other sampling device prior to sampling. The blank is immediately poured into the sample bottles, which are preserved as ordinary groundwater samples

Field blanks will be collected wherever ambient sources of contamination, such as heavy industrial traffic and chemical storage in tanks or holding ponds, exist. Such conditions may affect the quality of the samples collected.

Duplicate samples are collected to evaluate the accuracy and precision of the contract laboratory. Duplicate samples will be collected at the same time as the associated environmental samples.

All of the sample bottles for a particular analysis for both the duplicate and the environmental samples will be filled before filling the sample bottles for the next analysis.

Appropriate sample containers filled with analyte-free water will be sealed and provided by the laboratory. Trip blanks will accompany all sample shipments containing VOC samples. These samples will be kept in the storage and shipping containers during all stages of the sampling efforts.

4.2.7 Field Equipment Cleaning Procedure

Sampling and monitoring equipment, including electrical water level tapes, bailers, and pumps, will be decontaminated upon arrival on site and between each well. Field Decontamination procedures will be the same as the equipment decontamination procedures specified in BSOP No. 13. Sampling personnel should always sample the least contaminated wells first (if known), as an additional precaution against introducing contaminants into the wells and samples. If decontamination is performed in the field, all rinse water must be contained in a manner that prevents the introduction of contamination to surface water, boreholes, and adjacent areas. All rinsate should be collected in a compatible container and properly disposed of to prevent contamination of adjacent areas.

4.2.8 Field Documentation Procedure

A bound field log book must be maintained by sampling personnel to provide a daily record of sampling and events. The following information must be recorded into the log book using indelible, waterproof ink:

- Date
- Time
- Weather conditions
- Personnel present
- Signature of personnel making entry
- Well ID
- Total depth of well (if measured)
- Depth to water, measurement technique
- Well yield
- Purge volume and method
- Sample volume and method
- Sample withdrawal procedures
- Date and time of collection
- Well sampling sequence
- Field analyses performed
- Analyses requested
- Quality control activities

- Calibration procedures and results
- Problems encountered and corrective actions taken
- Sample distribution and transporter
- Field observations (e.g., unusual conditions, equipment malfunctions, and condition of monitoring well)

Pertinent data may be recorded on the Field Data Information Log for Groundwater Sampling for that specific sampling location. If the groundwater sampling log or its equivalent is used to record sampling data, then the field log book must be annotated by the personnel utilizing the form(s) such that the sample collection activities will be traceable through field records to the personnel sampling and the specific equipment utilized.

Additional documentation procedures are in BSOP No. 3. Shipping and handling of all samples will be accordance with the procedures specified in BSOP No. 4.

5 HYDRAULIC TESTING

5.1 Single-Well Aquifer (Pumping) Testing

5.1.1 Objective

The objective of this section is to provide procedures by which single-well aquifer (slug) tests are to be designed, conducted, and analyzed.

5.1.2 Procedure

5.1.2.1 Slug Test Design

Slug tests are utilized to obtain order-of-magnitude approximations of hydraulic conductivity in the portion of the aquifer immediately surrounding the well screens. Testing programs should be designed with consideration for potential aquifer heterogeneity, well construction variability, and ultimate use of results. Depending on a general understanding of the relative hydraulic conductivity of the aquifer to be tested (and thus the anticipated speed of the response to slug entry or removal), the depth to the water table, the types of contaminants, and well construction details, decisions can be made regarding slug test materials and data collection methodology. No water or other liquid shall be introduced into wells.

The time required for a slug test to be completed is a function of the volume of the slug, the transmissivity of the formation, and the well casing size. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. The length of the test may range from less than a minute to several hours.

Preparations for testing will include:

Office

- Review associated BSOP documents and information on the wells to be tested (depth to water, depth of well, screened interval, casing size).
- Coordinate schedules with sampling and other efforts.
- Review the operator manual provided with the electronic data logger, if appropriate.
- Check out and ensure the proper operation of all field equipment. Ensure that the electronics data logger is fully charged, if applicable. Test the electronic data logger and pressure transducers using a container of water (e.g., sink, bucket of water).

- Obtain appropriate sampling log book, and assemble a sufficient number of field form to complete the field assignment.

- Review appropriate sections of the Site Safety Plan.

Field

- Locate monitoring wells to be tested and appropriate decontamination areas.

- Assemble appropriate testing equipment.

- Decontaminate the transducers and cable as specified in BSOP No. 13.

- Collect initial water level measurement on the monitor well and record in the field log book.

- Before beginning the slug test, enter and record information in the electronic data logger. The type of information will vary depending on the model used. When using different models, consult the operator's manual for the proper data entry sequence to be used.

5.1.2.2 Slug Test Execution

The following general procedures will be used to collect and report slug test data. The procedures required for a particular slug test may vary slightly from those described, depending on site conditions. Modifications to the procedures shall be documented in the field log book.

A. When the slug test is performed using an electronic data logger and pressure transducer, most of the data will be electronically stored internally or on computer diskettes or tape. The information will be transferred directly to a computer and analyzed. A copy of field notes with supplemental information and a computer printout of the data shall be maintained in the files as documentation.

B. The field log book is used to record observations and supplemental information. At a minimum the following information shall be recorded for each test:

   - Site location: Brief description of the general location of the well.

   - Well or piezometer ID: Unique number assigned to each well or piezometer where measurements are taken.

   - Date of the test

   - Slug dimensions: Dimensions of the slug or displacement object in tenths of feet.

   - Personnel: Initials of personnel performing field measurements or collecting samples.

- Test type: The slug device is either inserted (falling head) or withdrawn (rising head) from the monitor well. Note the appropriate test type.

- Comments: Include appropriate observations or information concerning antecedent weather conditions, sequence of events, or work being conducted at the site.

- Elapsed time (min:sec): Cumulative time readings from beginning of test to end of test in minutes and seconds.

- Representative depth to water measurements: Depth to water levels should be recorded to hundredths of feet below the measuring point. Initial and final depth to water shall be measured using an electric tape. Test data may be recorded using a pressure transducer and electronic data logger.

C. Procedures for conducting a slug test.

1. Measure the pre-test water level in the well and record in the field log book and on the data sheet. The pint and time of measurement shall be noted in the field log book.
2. Cover sharp edges of the well casing with duct tape to protect the transducer cables.
3. Connect the transducer cable to the electronic data logger.
4. Slowly lower the transducer and cable down the well to a depth below the slug submergence for the test, but at least 6 inches from the bottom of the well. Be sure this depth of submergence is within the design range stamped on the transducer. Securely tape the transducer cable to a stationary object to keep the transducer at a constant depth.
5. Display the initial water level on the recording device according to manufacturer's instructions. Record the initial water level on the test data sheet.
6. Flag the slug/rope assembly so that easy identification can be made of how much rope must be left out to fully immerse the slug beneath the static water level, and how much rope to pull back to suspend the slug above the static water level.
7. Immediately after commencement of recording of data on the data logger, "instantaneously" introduce the slug and the rope to minimize slug movement. While results obtained from analysis of these "falling head" data may not be theoretically valid, continue to record and monitor head recovery until water returns to static levels. (Falling head tests are only valid for wells with the static water level above the top of the screen. Rising head tests will be utilized for wells that are screened across the water table. From a practical standpoint, data should be recorded until the displacement head has been reduced to 10 percent or less of maximum displacement, and monitoring should be continued until only 1 to 2 percent displacement remains.
8. If the head data are recorded manually, equate the moment of maximum head change to time zero, and measure and record the depth to water and the time at each reading. Depths should be measured to the nearest 0.01 foot. The number of depth-time measurements necessary to complete the test is variable. Measurements should be frequent enough so that the change in water level between two successive measurements is less than 5 percent of the initial change in water level. It is critical to make as many measurements as possible in the early part of the test.

9. After effective static water level has been reached, a second slug test may be performed on the well by instantaneously removing the slug from the water column. This type of slug test is referred to as a rising head slug test. If such a test is to be conducted, the slug should be withdrawn to the predetermined suspension level and the rope tied off to minimize slug interference with the transducer cable (if applicable), or the slug should be fully withdrawn to permit access for water level measurement.
10. Continue measuring and recording depth-time measurements until the water level return to within 10 percent of equilibrium conditions.

If the well is used as a monitoring well, precautions should be taken to prohibit contamination of the wells by material introduced into the well. Bailers, slug/rope assemblies, and measuring devices should be cleaned thoroughly before each test in accordance with BSOP No. 13. If tests are performed on more than one monitor well, care must betaken to avoid cross-contamination of the wells.

Slug tests must be conducted on relatively undisturbed wells. If a test is conducted on a well that has recently been pumped for water sampling purposes, the measured water level should be within 0.1 foot of the water level before sampling. At least 1 week should elapse between the drilling and development of a well and the performance of a slug test.

5.1.2.3 Post Operation

<u>Field</u>

- Decontaminate equipment and dispose of rope according to BSOP No. 13.
- If using an electronic data logger:
  1. Stop logging sequence.
  2. Save memory.

<u>Office</u>

- Inventory sampling equipment and supplies. Repair or replace all broken or damaged equipment.
- Replace expendable items.
- Return equipment to storage area, and report incidents of malfunctions or damage.
- Review field log book for completeness.
- Deliver original forms, logger data, and log books to supervising personnel with copies to file.

- Interpret slug test results. Analyze slug test using appropriate software packages or graphical solutions.

- Send data logger or pressure transducers to factory for recalibration, if needed.

5.2 Multiple-Well Aquifer (Pumping) Testing

5.2.1 Objective

This section presents general guidelines for performing multiple well aquifer pumping tests.

5.2.2 Procedure

5.2.2.1 Pumping Test Design

An aquifer test is a controlled field experiment designed to evaluate the performance characteristics of a well and the hydraulic properties of the associated aquifer(s). Such tests provide the best method for characterizing aquifer hydraulic properties when properly designed, performed, and conducted. They provide estimates for both transmissivity (T) and storage coefficient (S) over a large and representative volume of aquifer. Optimal performance of aquifer tests requires clear definition of three sets of requirements:

1. An understanding of the hydrogeological system being tested (i.e., confined or unconfined conditions and areal extent of aquifer).

2. The operational goals of the test (i.e., what information is needed from the test).

3. Identification of an analytical method that describes the aquifer conditions and can be used to reduce the data.

Aquifer tests are multifaceted, interdisciplinary efforts requiring coordination between technical personnel. Whereas, the more complex test are more difficult logistically and often more expensive, they generally yield much more information. Some essential hydrologic information, such as rates of leakage through confining layers can be obtained only by performing the more sophisticated aquifer tests.

Control Procedures of Aquifer Test Programs

The technical complexity of aquifer testing combined with the institutional concerns such as storage of contaminated water, requires procedures for general control of aquifer test programs. A 7-step control procedure is defined below. Detailed planning for, and supervision of, site-specific aquifer pumping tests must be conducted by an experienced hydrogeologist or groundwater hydrologist assigned to the project. The procedure presented here is primarily intended for project or task managers who require an aquifer test to be performed as part of a multi-discipline project.

1. Define test program requirements:

   a. Describe the hydrogeologic system to be tested (e.g., porous, heterogeneous aquifer).

   b. Define the operational goals and requirements for the test (e.g., transmissivity, confined or unconfined nature of aquifer, and/or leakage coefficients of aquitards).

   c. Identify a method by which the data may be interpreted, according to the known hydrogeologic conditions and operational requirements.

2. Evaluate operational constraints.

3. Design the test methods and develop an aquifer test plan.

4. Conduct pre-test activities.

5. Initiate test and collect data.

6. Interpret the data with the chosen model or appropriate analytical method.

7. Evaluate the need for further testing.

The following sections detail the information required for each step in the procedure.

Defining Test Program Requirements

Describe the Hydrogeologic System to be Tested: An aquifer test is interpreted by comparing field results with those expected from mathematical models. Therefore, the hydrogeology of the system to be tested should be defined as well as possible. Important factors include the following:

- Aquifer lithology and hydraulic characteristics (volume and nature of interstitial pores)
- Groundwater occurrence (confined, unconfined)
- Aquifer thickness, extent, and uniformity
- Boundary conditions (nearby streams, ponds, no-flow boundaries)
- Aquifer isotropy and homogeneity
- Well screen placement
- Anticipated flow rates and type of flow (transient, steady state)
- Potential for leakage form confining units

- Well characteristics (available drawdown, screen transmitting capacity, well efficiency)

Define Operational Goals of the Test: The information that is desired at the completion of the test should be well defined. Generally, the greater the accuracy and amount of information desired, the greater the complexity of the test. For example, the hydraulic conductivity of a test zone can be estimated on a local basis from a brief, inexpensive slug test (as described in Section 5.1.2), but the evaluation of leakage from confining units requires more complex aquifer pump testing. Common test goals include:

- Estimating aquifer yield for water supply needs
- Defining aquifer characteristics for groundwater assessment (usually driven by RCRA, CERCLA or other regulatory program)
- Defining aquifer characteristics for the siting of future waste disposal facilities
- Defining aquifer hydraulic characteristics for remedial action (extraction wells, hydraulic control, etc.)

Aquifer testing data needed for developing water supplies range from a single well performance test to a detailed aquifer characterization where a field of multiple wells is required. Where corrective or remedial actions are required, more detailed information is generally required. More complex aquifer tests are usually required to define this information. A relatively detailed conceptual model of the hydrogeologic system is needed to develop the optimal pumping strategy. The objectives of each project, the funding available, and other institutional concerns must be evaluated to develop the best aquifer testing approach.

Various types of aquifer test programs may be developed. The data generated vary according to the type of program. Some of the parameters which may be defined by an aquifer testing program are:

- Transmissivity (T)
- Storage coefficient/specific yield (S/Sy)
- Hydraulic conductivity (K)
- Vertical hydraulic conductivity of confining units (K_v)
- Groundwater yield from confining units
- Hydraulic resistance of confining units
- Specific capacity of a well

- Well losses and efficiency

The parameters defined during the aquifer test program must be selected based upon the objectives of the project, and the test methodology must be designed to yield the desired parameters. The desired areal extent of the test must also be considered when selecting the test method, discharge rate, and test duration.

Identify Testing and Data Reduction Methodology: Based on the criteria identified in the preceding two subsections, a method that fulfills the operational goals and adequately represents the hydrogeologic system must be identified. A large number of tests are available; may are summarized in Driscoll (1986) and Kruseman and DeRidder (1994).

Evaluate Operational Constraints

Once the technical basis of a program is established by the procedure described in the previous section, the plan must be expanded to address other site specific requirements, such as shutdown of water supply wells based on geologic and hydrologic conditions present at the site and 24-hour limited access to the site. In addition, environmental compliance requirements (notably requirements for discharge and disposal of any contaminated fluids) must be identified and fulfilled.

Define the Test Method and Testing Plan

An aquifer test plan should be prepared prior to testing. The plan should define all site-specific concerns such as site accessibility, water disposal, and 24-hour per day working conditions. The plan should also address specific technical concerns. Based upon the site hydrogeology, the chosen analytical method should be used to simulate the range of conditions expected to occur. This simulation should be used to determine observation well locations and screen settings, the length of time to run the test, and the effects of boundary conditions.

Conduct Pre-Test Activities

Prior to conducting the test, all activities scheduled for completion prior to test startup should be performed. These activities may include installation of additional observation wells, further defining the fluids management program, installation of pumping and monitoring devices such as flow meters and pressure transducers, and performing a sort term preliminary aquifer test. Specific pre-test activities for some pumping tests are defined in the following paragraphs. Pre-test activities may define needed modifications to the aquifer test plan.

Initiate Test and Collect Data

After completion of all previous procedures and pre-test activities, the aquifer test should be conducted according to the aquifer test plan (with modifications). Procedures for the most common tests are presented below.

Interpret Data with Chosen or Appropriate Analytical Method

After data are collected, they should be analyzed and interpreted with an appropriate analytical method or model. General data interpretation methods for curve-matching techniques are discussed below.

Evaluate the Need for Additional Testing

After data are compiled and interpreted, they should be evaluated to determine if additional testing is warranted. Events indicating the need for additional testing include evidence of interference from nearby pumping or special boundary conditions.

5.2.2.2 Test Site Selection

Selecting an appropriate test site will prevent difficulties often encountered during test data evaluation. In some cases, existing wells may be used or the hydrologic factors of a specific location may be of concern, thus predetermining the test site. However, the test site is usually dictated by the project needs and the test must be designed to accommodate site logistics.

Well field design and construction is dependent on the hydrogeology of the area and the hydrogeologic units of concern. Factors such as aquifer type, transmissivity and stratification should be taken into consideration by an experienced hydrogeologist when determining screen interval, number of wells, and well locations. Piezometers may be constructed in adjacent hydrogeologic units to determine any hydrologic connection these units have with the aquifer of concern.

5.2.2.3 General Testing Procedures

Water Level Measurements

The preferred method of collection aquifer test data is by the use of pressure transducers to ensure fast, accurate (at least to 1/100 of a foot), time-drawdown measurements. Other methods, as described in the references listed in Section 6, may be used to collect water level measurements when conducting multiple well, constant discharge tests. The same device should be used for measuring water levels in a particular well throughout the duration of a test. A reference point from which all water level measurements are made should be designated on the casing of each well. The reference point should be surveyed for vertical and horizontal location, in accordance with BSOP No. 11. The exact time all water level measurements are taken should be recorded on a military 24-hour time scale.

Decontamination

Any equipment used in production or monitoring wells must be thoroughly cleaned prior to use. Cleaning procedures are based upon site-specific conditions and the needs of the project. The actual cleaning procedure should be determined by the project manager and defined in the aquifer test data. Cleaning may consist of little or no cleaning (if the well is to be used on for aquifer testing), disinfection (if the well is a water supply well), steam cleaning, or more rigorous cleaning procedures, as described in BSOP No. 13.

5.2.2.4 Aquifer Pre-Test

Background

An aquifer pre-test will be conducted prior to conducting multiple well constant rate aquifer tests. The purpose of this test is to collect all available background information of the hydrogeologic system in question, ensure that all equipment is in good working order, and confirm that all pumping settings and water level measuring devices are prepared for the start of the actual test. This pre-test should be conducted far enough in advance of the start of the actual test to allow the water levels to recover and stabilize, and to collect sufficient pre-test trend data.

Often, the pre-test is a step drawdown test. This is done to observe aquifer responses at various flow rates. The following are five questions of concern that should be answered at the completion of the pretest are:

1. What is the maximum anticipated drawdown at various discharge rates?

2. What discharge rates occur in various pump speeds or valve settings?

3. What is the best method to measure yield?

4. Is the discharge pipe far enough from the radius of influence to avoid recharging the aquifers of concern?

5. Are the observation wells yielding usable drawdown data a various discharge rates?

The pre-test is also used to test equipment, and to finalize valve settings so that the discharge rates are established at the beginning of the constant rate aquifer test.

Field Method for Aquifer Pre-Test

1. Prepare test setup for duration of test.

2. Decontaminate all equipment to be inserted into the well, if required.

3. Measure and record the pre-test water levels and the exact time of each reading.

4. Setup pump and discharge lines. The pump or intake must be set below the anticipated drawdown and within the pump lifting capacity. Discharge must be directed outside of the radius of influence of the cone of depression. If pumping from contaminated area, all water must be discharged in a manner compliant with applicable or relevant and appropriate regulatory requirements.

5. Determine the best method to measure yield. Orifice weirs and totalizing flow meters are the most common methods. Specifications for constructing orifice weirs are presented in Driscoll (1986). All discharge measuring devices should be manually checked for accuracy, if possible, by filling a container of known volume and recording the time required to fill it.

6. Initiate pumping, record time, and immediately monitor water levels in the pumping well. For all aquifer tests involving pumping, it is important that the water level in the pumping well be monitored before, during, and after pumping. Water levels and the time of each measurement since pumping began should be recorded. Discharge rates should be monitored every 5 minutes. Monitor wells nearest the pumping well should be monitored early in the test to see when a response to pumping is observed. As the radius of influence expands, more distant monitoring wells should be monitored.

7. Semilog and arithmetic data plots of drawdown versus time should be developed in the field based on test results.

8. After water levels begin to stabilize, the discharge rate should be increased to approximately 25 percent of the maximum possible anticipated discharge.

9. Continue monitoring water levels and discharge rates in the systematic manner established at the beginning of the test.

10. Conduct the test at several pumping rates. Each pumping rate should be run until water levels stabilize. The final rate should be approximately equal to the maximum possible discharge rate at which total available drawdown is attained.

11. At the completion of the test, all pump valves should be at the settings desired for the actual test.

5.2.2.5 Step Drawdown Tests

Background

Step drawdown tests are used to evaluate the effects of pumping in a well at various discharge rates. Information gained from step drawdown tests include:

- Values of specific capacity at various discharge rates
- Optimum discharge rates for pumping well
- The amount of well loss attributable to laminar and turbulent flow components, respectively
- The effect of various discharge rates on turbulent flow

- Aquifer parameters such as transmissivity (T), hydraulic conductivity (K), and storage coefficient (S; if data is obtained from observation well); and projected future pumping costs

A properly conducted test will include steps of equal length and constant discharge.

Field Method for Step Drawdown Tests

1. Obtain water level data and the barometric pressure at the time of the reading for a minimum of 1 week prior to the start of the test.

2. Make sure that the outlet of the discharge is located far enough from the well to avoid recharging the aquifer being tested.

3. Conduct an aquifer pre-test as described above. At least four to five possible discharge rates in increasing order should be determined during the pre-test.

4. After allowing sufficient time for water levels to recover to pre-test levels, the test may be conducted.

5. Measure static water level and record the date and time of reading.

6. Measure the barometric pressure every 1/2 hour.

7. Insert transducers at a depth below the maximum anticipated drawdown and at least 1 foot above the bottom of the well.

8. Initiate pumping at the lowest discharge rate to be used. At the exact moment pumping begins, begin recording water levels in the pumping well and the exact time since pumping began. As many measurements as possible should be obtained during the first 5 minutes of the test. Water levels should then be obtained at increasing time intervals, beginning with 1 minute and increasing slowly to a maximum of 10 minutes. Intervals should never exceed the time required for water levels to change by 0.2 feet. Water levels should be measured in observation wells early enough to obtain initial drawdown data. Early drawdown data is especially critical in determining aquifer coefficients.

9. Measure and record discharge rates at the same frequency water level measurements are obtained. The entire test generally runs from 8 to 72 hours.

10. After running the initial step for 1 to 2 hours, and stabilization of water level, increase the discharge to the second desired rate. Measure the water levels and discharge rates at the same intervals as taken in the first step.

11. Continue the test through a minimum of two additional steps conducted in a manner similar to the first two.

12. Drawdown data should be plotted in the field to ensure stabilization of water levels during each step.

Data Analysis and Interpretation

The following information is required to analyze data and should be collected during the test:

1. Discharge rates of pumping well
2. A number of water level data during the course of the test (each record should specify water level and the exact time since pumping began)
3. Distance from pumping well to each observation well
4. Description and elevation of each measuring point
5. Total depth and screen interval of pumping and monitoring wells
6. Well materials and construction details of all wells
7. Barometric pressure at 30-minute intervals

Analysis of step drawdown pumping test shall be completed by an experienced hydrogeologist or groundwater hydrologist and reviewed by senior personnel. Drawdown data should be corrected for regional trends, barometric pressure, or any other influencing factors. Most common methods of analysis are described in Bear (1979), Bierschnenk (1964), and Rorabough (1953). However, appropriate methods of analysis are dependent on the type of aquifer being tested and well field construction and design.

5.2.2.6 Single and Multiple Well Constant Yield Tests

Background

Constant yield aquifer tests are conducted to estimate aquifer coefficients such as transmissivity and storativity (specific yield for unconfined aquifers), and hydraulic conductivity. Constant yield aquifer tests can also be used to predict:

1. The drawdowns in a well at future times and at varying discharge rates;
2. The effect of new withdrawals on existing wells;
3. The radius of the cone of influence for individual or multiple wells (multiple well tests);
4. The hydraulic characteristics of confining beds

5. The position and nature of aquifer boundaries; and

6. The degree of vertical and horizontal anisotropy.

A value for storage coefficient cannot be obtained from tests in which only the pumping well is monitored.

Field Method for Single or Multiple Well Constant Rate Tests

1. Obtain water level data for a minimum of 1 week prior to the start of the test.

2. Make sure that the outlet of the discharge is located far enough from well to avoid recharging of the aquifer being tested.

3. Conduct a pre-test as described above. A minimum of 2 days should be allowed for water to return to static conditions prior to starting the actual test.

4. Measure and record the static water level in all wells to be monitored and the exact time of each measurement.

5. Insert transducers below the depth of maximum anticipated drawdown and at least 1 foot from the bottom of the well.

6. Initiate pumping at a discharge rate determined during the pre-test. Record as many measurements as possible and the exact time since pumping began for each measurement during the first 5 minutes of the test. Measurements should then be obtained every 30 seconds to 10 minutes, then at increasing intervals beginning at 1 minute and increasing slowly to a maximum of 10 minutes, thereafter. Intervals should never exceed the time required for water levels to change by 0.2 feet.

7. Periodically record discharge rates throughout the test (every 5 minutes for the first hour and with each water level measurement thereafter).

8. Monitor barometric pressure every 15 minutes for the first 60 minutes of the test and every 30 minutes thereafter.

9. Measure and record any amounts of precipitation that occur during the test.

10. Develop Log-log and semilog plots of the test data in the field.

11. The test should last for at least 48 hours in an unconfined aquifer and 24 hours in a confined aquifer. Field data plots should be evaluated prior to termination of the test for variations in drawdown.

12. After pumping has ceased, the rate of the water level rise toward the static (pre-pumping) water level should be recorded, as described in Driscoll (1986, Chapter 9). This rate of

recovery provides a means for calculating the coefficient of transmissivity and storage, using information from the pumping well.

Data Analysis and Interpretation

The following information is required to analyze data and should be collected during the test:

1. Discharge rate of pumping well
2. Water level data during the course of the test (each record should specify water level, pumping or observation well ID, and the exact time since pumping began)
3. Distance from pumping well to each observation well
4. Description and elevation of each measuring point
5. Total depth and screen interval of pumping and observation wells
6. Well materials and construction details of all wells
7. Barometric pressure at 30-minute intervals

Analysis of aquifer pumping test shall be completed by an experienced hydrogeologist or groundwater hydrologist and reviewed by the Project or Task Manager. Drawdown data should be corrected for regional trends, barometric pressure, or any other influencing factors. Most common methods of analysis are described in Driscoll (1986), Lohman (1972), or Kruseman and DeRidder (1970). Several computerized solution techniques are also available. However, appropriate methods of analysis are dependent on the type of aquifer being tested and well field construction and design.

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6 REFERENCES

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ATTACHMENT 1-1

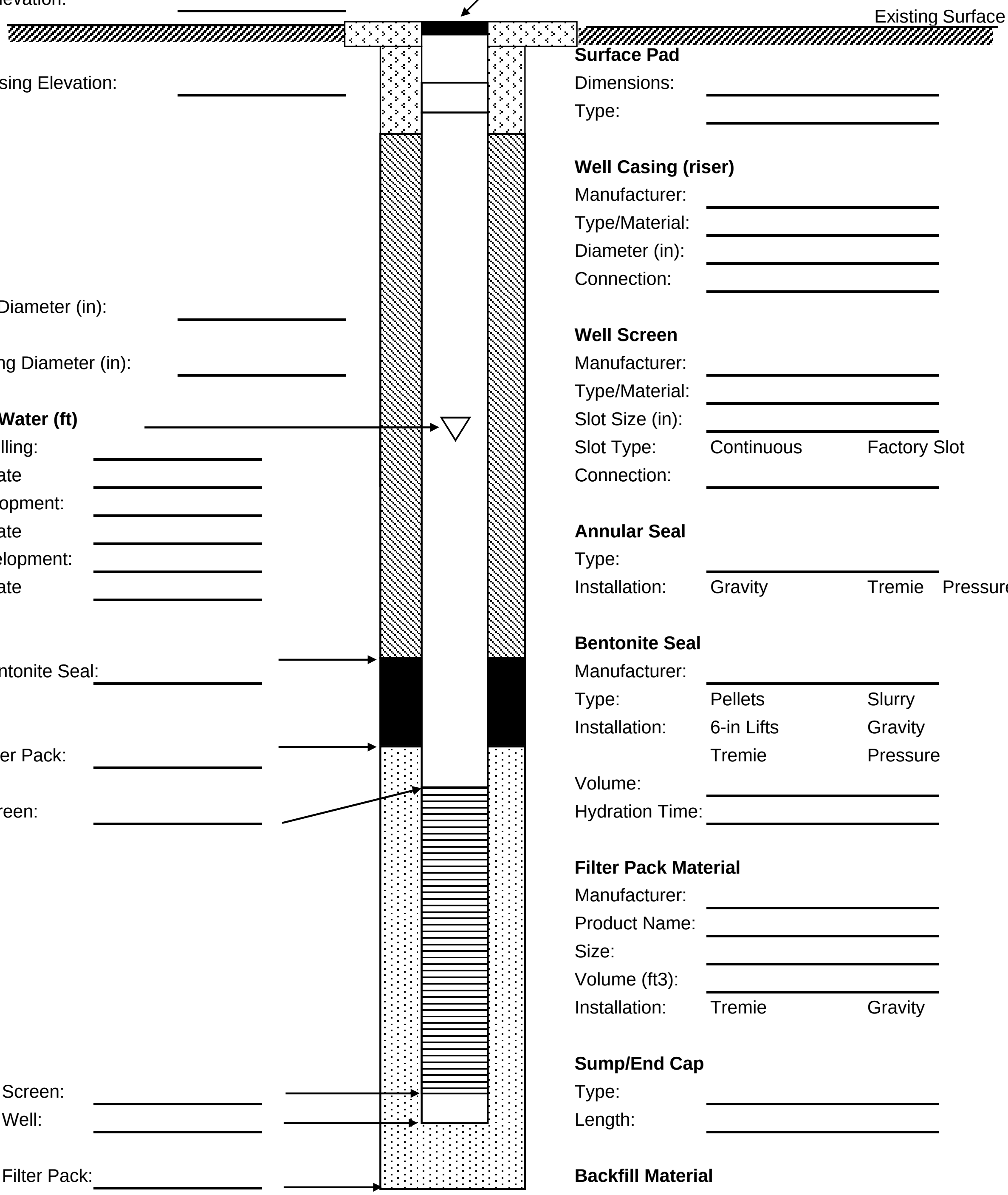
MONITORING WELL INSTALLATION DETAIL FORM

Bhate Environmental Associates **WELL CONSTRUCTION DIAGRAM (Flush Mount)**

Project/Phase: ____________________ Well/Boring No.: ____________________
Location: ____________________ Drilling Method: ____________________
Client: ____________________ Date(s): ____________________
Drilling Contractor: ____________________ Northing (NAD 83): ____________________
Driller: ____________________ Easting (NAD 83): ____________________
Geologist: ____________________ Bhate Project #: ____________________

NOT TO SCALE

Surface Elevation: ____________________



Top of Casing Elevation: ____________________

Borehole Diameter (in): ____________________

Well Casing Diameter (in): ____________________

Depth to Water (ft)
During Drilling: ____________________
Date ____________________
Pre Development: ____________________
Date ____________________
Post Development: ____________________
Date ____________________

Top of Bentonite Seal: ____________________

Top of Filter Pack: ____________________

Top of Screen: ____________________

Bottom of Screen: ____________________
Bottom of Well: ____________________

Bottom of Filter Pack: ____________________

Borehole Depth: ____________________

Protective Casing
Type: ____________________
Dimensions: ____________________
Length: ____________________

Surface Pad
Dimensions: ____________________
Type: ____________________

Well Casing (riser)
Manufacturer: ____________________
Type/Material: ____________________
Diameter (in): ____________________
Connection: ____________________

Well Screen
Manufacturer: ____________________
Type/Material: ____________________
Slot Size (in): ____________________
Slot Type: Continuous Factory Slot
Connection: ____________________

Annular Seal
Type: ____________________
Installation: Gravity Tremie Pressure

Bentonite Seal
Manufacturer: ____________________
Type: Pellets Slurry
Installation: 6-in Lifts Gravity
Tremie Pressure
Volume: ____________________
Hydration Time: ____________________

Filter Pack Material
Manufacturer: ____________________
Product Name: ____________________
Size: ____________________
Volume (ft3): ____________________
Installation: Tremie Gravity

Sump/End Cap
Type: ____________________
Length: ____________________

Backfill Material
Type: ____________________
Volume: ____________________

Comments:

Bhate Environmental Associates

WELL CONSTRUCTION DIAGRAM (Above Grade)

Project/Phase: ______________________

Location: ______________________

Client: ______________________

Drilling Contractor: ______________________

Driller: ______________________

Geologist: ______________________

Well/Boring No.: ______________________

Drilling Method: ______________________

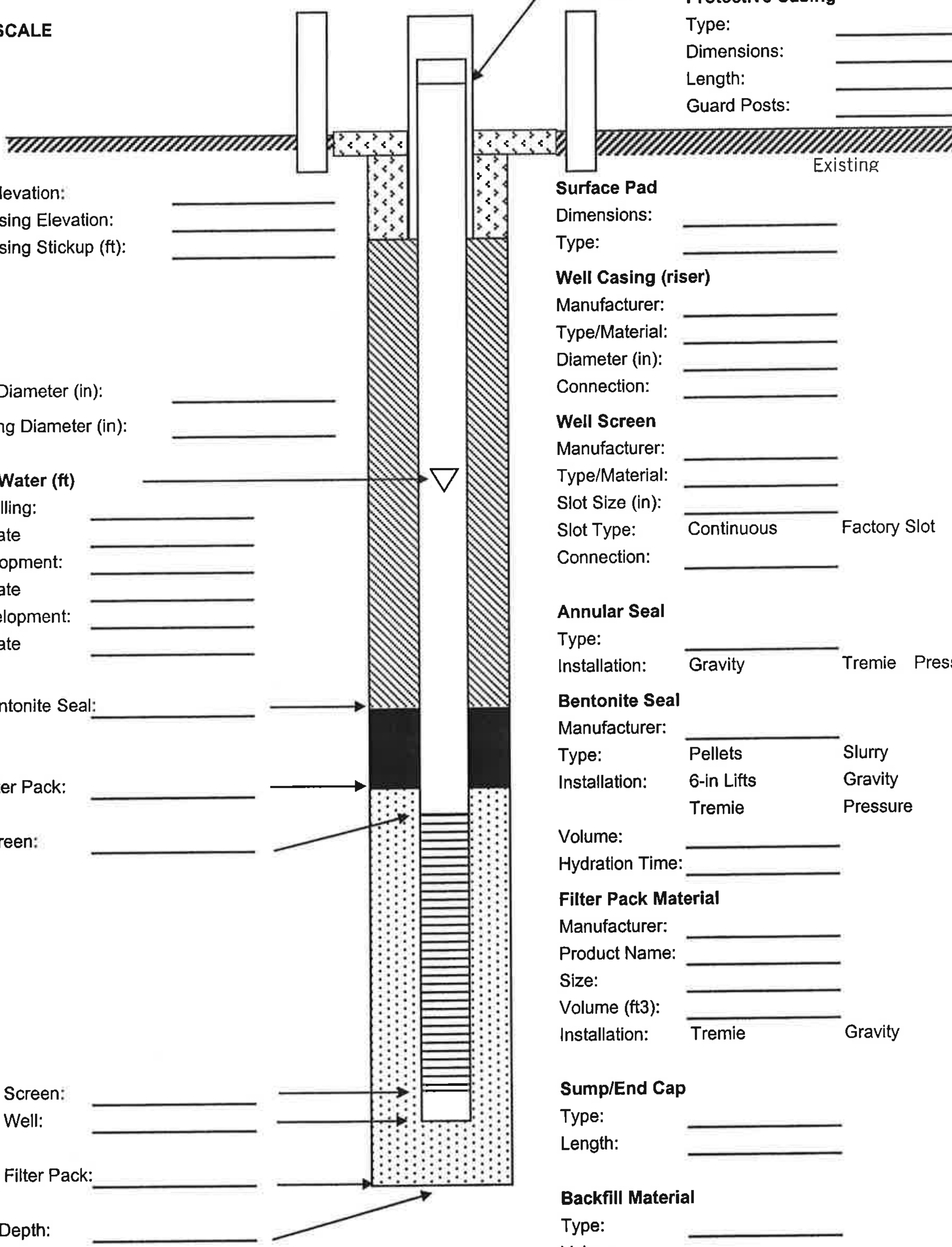
Date(s): ______________________

Northing (NAD 83): ______________________

Easting (NAD 83): ______________________

Bhate Project #: ______________________

NOT TO SCALE



Surface Elevation: ______________________

Top of Casing Elevation: ______________________

Top of Casing Stickup (ft): ______________________

Borehole Diameter (in): ______________________

Well Casing Diameter (in): ______________________

Depth to Water (ft)

During Drilling: ______________________

Date ______________________

Pre Development: ______________________

Date ______________________

Post Development: ______________________

Date ______________________

Top of Bentonite Seal: ______________________

Top of Filter Pack: ______________________

Top of Screen: ______________________

Bottom of Screen: ______________________

Bottom of Well: ______________________

Bottom of Filter Pack: ______________________

Borehole Depth: ______________________

Protective Casing

Type: ______________________

Dimensions: ______________________

Length: ______________________

Guard Posts: ______________________

Surface Pad

Dimensions: ______________________

Type: ______________________

Well Casing (riser)

Manufacturer: ______________________

Type/Material: ______________________

Diameter (in): ______________________

Connection: ______________________

Well Screen

Manufacturer: ______________________

Type/Material: ______________________

Slot Size (in): ______________________

Slot Type: Continuous Factory Slot

Connection: ______________________

Annular Seal

Type: ______________________

Installation: Gravity Tremie Pressure

Bentonite Seal

Manufacturer: ______________________

Type: Pellets Slurry

Installation: 6-in Lifts Gravity Tremie Pressure

Volume: ______________________

Hydration Time: ______________________

Filter Pack Material

Manufacturer: ______________________

Product Name: ______________________

Size: ______________________

Volume (ft3): ______________________

Installation: Tremie Gravity

Sump/End Cap

Type: ______________________

Length: ______________________

Backfill Material

Type: ______________________

Volume: ______________________

Comments:

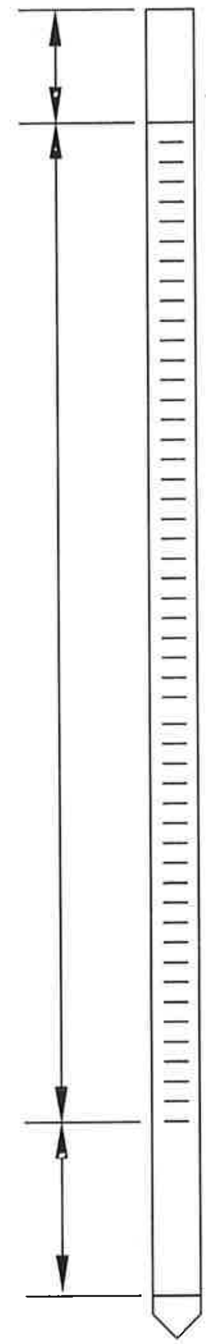
ATTACHMENT 1-2

CASING/WELL SCREEN TALLY FORM

BHATE
Environmental Engineers and Scientists

CASING TALLY

WELL NUMBER ______________________

ITEM NO.	DESCRIPTION	LENGTH (FEET)	SCREEN DIAGRAM
			

PROJECT NAME: ______________________ CLIENT: ______________________

PROJECT NUMBER/PHASE: ______________________ PROJECT LOCATION: ______________________

DRILLING MTHD: ______________________

DATE STARTED: __________ DATE FINISHED: __________ ENGINEER/GEOLOGIST: __________

ATTACHMENT 2-1

WATER LEVEL DATA SUMMARY FORM

WATER-LEVEL DATA SUMMARY

Project Name/Number	**Date**
	Field Personnel #1
Site Name	**Field Personnel #2**
Client	**Field Personnel #3**
Survey Datum (NGVD)	**Weather (previous 24 hours)**
Measuring Device	

Well Number	Time (hhmm)	Measuring Point		Depth to Water (ft, TOC)	Elevation of Water (ft, NGVD)
		Description	Elevation (ft, NGVD)		

Notes: NGVD = National Geodetic Vertical Datum
TOC = Top of Well Casing

Comments/Observations

ATTACHMENT 3-1

MONITORING WELL DEVELOPMENT LOG

Monitoring Well Development Log

Date Started (yr/mo/day) ____________Data Completed (yr/mo/day) _________

Field Personnel____

Project____

Site Name____

Job No. _________________________Well ID _#__________________________

____Upgradient _____Downgradient ______Sidegradient

Weather Conditions____

Air Temperature____°F

Total WellDepth (TWD)
From Top of Casing (TOC)=____________________________________1/100 ft

Depth to Ground Water (DGW)
From Top of Casing (TOC)=____________________________________1/100 ft

Length of Water Column (LWC) = TWD – DGW =_________________1/100 ft

1 Casing Volume (OCV) – LWC x ____ = ________________________gallons

5 Casing Volumes =____gallons

Method of Well Development____

____

Total Volume of Water Removed________________________________gallons

Date/Time	Discharge Rate (gpm)	Cumulative Volume Purged (gallons)	Water Temperature (°C)	pH	Eh	Specific Conductivity (umhos/cm)	Turbidity/Color (NTUs)	Dissolved Oxygen (mg/L)	Sand Content (%)	Remarks

COMMENTS/OBSERVATIONS:____

____

Monitoring Well Development Log (Continued)

Project____

Job No.____ Well ID No.____________________________

Date/Time	Discharge Rate (gpm)	Cumulative Volume Purged (gallons)	Water Temperature (^{o}C)	pH	Eh	Specific Conductivity (umhos/cm)	Turbidity/Color (NTUs)	Dissolved Oxygen (mg/L)	Sand Content (%)	Remarks

COMMENTS/OBSERVATIONS:____

____

____

____

ATTACHMENT 4-1

FIELD DATA INFORMATION LOG FOR GROUNDWATER SAMPLING

Field Data Information Log for Groundwater Sampling

Date Started (yr/mo/day) ______________________________
Field Personnel______________________________
Site Name______________________________
Job No. ______________________________
Well ID _#______________________________
____Upgradient _____Downgradient ______Sidegradient
Weather Conditions______________________________
Air Temperature______________________________°F
Total WellDepth (TWD) =______________________________1/100 ft
Depth to Ground Water (DGW) =______________________________1/100 ft
Length of Water Column (LWC) = TWD – DGW =________________1/100 ft
1 Casing Volume (OCV) – LWC x _____ = ______________________gallons
________________gal = Standard Evacuation Volume
Method of Well Evacuation______________________________
Method of Sample Collection______________________________
Total Volume of Water Removed______________________________gallons

Casing Diameter______________________________inches
Casing Material______________________________
Measuring Point Elevation______________________________1/100 ft
Height of Riser (above land surface)__________________________1/100 ft
Land Surface Elevation______________________________1/100 ft
Screened Interval______________________________1/100 ft
Dedictated Pump or Bailer YES___ NO____ Type____________________
Steel Guard Pipe Around Casing YES___ NO____
Locking Cap YES___ NO____
Protective Post/Abutment YES___ NO____
Well Integrity Satisfactory YES___ NO____
Well Yield LOW_____ MODERATE______ HIGH______
Comments/Observations______________________________
____
____
____

FIELD ANALYSES							
VOLUME PURGED (gallons)							
Pumping Rate (gpm)							
TIME (military)							
pH (S.U.)							
Specific Conductivity							
Water Temp (°C)							
Dissolved Oxygen (mg/L)							
Oxidation Reduction Potentail (ORP) (mV)							
Water Level (ft/TOC)							

COMMENTS/OBSERVATIONS:______________________________
____

Field Data Information Log for Groundwater Sampling (Continued)

Site Name____

Job No.______________________________ Well ID No.______________________

FIELD ANALYSES							
VOLUME PURGED (gallons)							
Pumping Rate (gpm)							
TIME (military)							
pH (S.U.)							
Specific Conductivity							
Water Temp (^oC)							
Dissolved Oxygen (mg/L)							
Oxidation Reduction Potentail (ORP) (mV)							
Water Level (ft/TOC)							

COMMENTS/OBSERVATIONS:____

____

FIELD ANALYSES							
VOLUME PURGED (gallons)							
Pumping Rate (gpm)							
TIME (military)							
pH (S.U.)							
Specific Conductivity							
Water Temp (^oC)							
Dissolved Oxygen (mg/L)							
Oxidation Reduction Potentail (ORP) (mV)							
Water Level (ft/TOC)							

COMMENTS/OBSERVATIONS:____

____

BSOP NO. 11
SURVEYING

BHATE STANDARD OPERATING PROCEDURE NO. 11

SURVEYING

This Bhate Standard Operating Procedure (BSOP) document identifies the standard procedures and techniques required by the Bhate for surveying or locating sample points or site features. In addition, this BSOP also discusses requirements for the use of global positioning systems (GPS) and professional surveying by a registered land surveyor (RLS).

Surveying conducted by Bhate personnel shall be restricted to sample point or grid line stakeout when precise horizontal or vertical point or line locations are not required, or when follow-on surveying of the sample point or grid line by GPS or RLS is planned.

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BSOP NO. 11

SURVEYING

TABLE OF CONTENTS

Attachments

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1 FIELD LEVEL SURVEYING

Projects may require preliminary horizontal and/or vertical stake-out surveying of sampling points or gridlines. The purpose of this Section is to describe minimum performance requirements for horizontal and vertical stake-out surveying.

1.1 Horizontal Surveying

1.1.1 Description

Horizontal control surveying pertains to the measurement of the relative difference in the horizontal location of two or more control points. Several field methods, from traditional or classical methods to Global Positioning System (GPS) techniques (discussed in the next section), may be used to horizontally locate sample points or various site features during site investigations. Regardless of the method(s) used, horizontal location surveys should be based on established control points.

Traditional traverse methods utilize horizontal angle or direction (azimuth/bearing) measurements and calculated horizontal distances from a starting point to a second point, and from the second to the third, and so forth to the last point. The last point in a traverse is usually a return to the starting point, thus making a closed loop. During a traverse for site control, sample points or site features may be located by employing various techniques at the traverse control points, i.e., by angle (azimuth or bearing) and distance measurements from a control point, by angular intersection from two control points, by perpendicular offset from a line between two control points, by angle from one control point and distance from another control point, etc.

When measuring horizontal angles, compensation should be made for the angle between true north and magnetic north. This angle is called the magnetic declination. Field surveying methods should be referenced to true north.

1.1.2 Requirements

The minimum requirements for horizontal field level surveying are as follows:

1. Use a topographic map or CAD map of the area as a base map, with magnetic and/or true north clearly indicated on the map.

2. Locate the reference point(s) clearly on the base map.

3. Use a magnetic sighting compass to make and record bearings. Assure that the compass is compensated for magnetic declination, otherwise include the declination when computing and recording bearings.

4. Use a surveyor's tape to make and record distances. Decimal distance graduations in tenths of a foot are preferred instead of inch graduations.

5. To the maximum extent possible, return to the reference point when surveying each point.

6. In remote locations, or when field level stakeout requirements of the site-specific sampling plan are not rigorous, distance may be measured by the technician's pace, and bearing may measured relative to map features, provided that minimum requirement #5 is satisfied. If minimum requirement #5 cannot be satisfied, then remote locations must be "flagged" from the reference point for subsequent GPS or RLS surveying.

7. At least one permanent structure (such as a building corner, culvert, monitoring well head) must be used as a reference point for all measurements. In remote locations, a temporary reference point may be used (such as a wooden or metal stake, or fencepost), provided that its approximate location is known relative to a permanent reference point, and a GPS or RLS survey of the temporary point will be subsequently conducted.

8. All measurements and reference points must be recorded in a field notebook.

9. A field sketch map of all measurements and reference points must be recorded in a field notebook or on a site map.

10. The accuracy of the field level surveying and notes must be to an accuracy such that a third party may use the notes and map to locate the survey points in the field to ± 5 feet, **or** to ½ the distance between sampling points when points are closer together than 5 feet. If such resolution cannot be obtained, then field level surveying for stakeout should be conducted using GPS or an RLS.

1.1.3 Procedure

Attachment 1-1 contains Sections 15.2.4 and 15.2.5 of the Environmental Protection Agency's (EPA) Standard Operating Procedures for Field Physical Measurements, which outline procedures for traversing and procedures for differential GPS, respectively. These procedures should be followed for horizontal surveying.

1.2 Vertical Surveying

1.2.1 Description

A vertical control survey is performed to relate a point or points of known elevation to a point or points for which a measure of elevation is desired. Vertical control is defined as a series of benchmarks or other points of known elevation established throughout an area. The procedure for relating a point of known elevation to another point or points of unknown elevation is called differential leveling. Differential leveling can be performed with a variety of survey instruments.

Differential leveling to establish vertical control for the top of a well casing, as an example, will be performed by Bhate field personnel using a survey level.

Frequently, a point of known elevation reasonably convenient to a project location is not readily ascertainable. It is therefore advised that locations that are the subject of the survey be related to a temporary benchmark that is reasonably convenient to those locations being surveyed. It is recommended that the temporary benchmark be a location that one can be reasonably certain will remain unchanged if, for instance, the site is undergoing redevelopment and other ground surface alterations. It is also possible to create a temporary benchmark by placing a wooden or metal stake in a relatively protected location on the site or by using a cold chisel to engrave a mark in a concrete surface. Such techniques are common in property boundary surveys but it is advised that before undertaking permanent alterations at the site, such plans be discussed with the project manager and/or property owner.

Once a temporary benchmark is chosen or created, an elevation is assigned to the point and then following the procedures performed during differential leveling, a vertical control survey is created for the points of interest.

1.2.2 Requirements

The minimum requirements for vertical field level surveying are as follows:

1. Use a topographic map or CAD map of the area as a base map, with magnetic or true north clearly indicated on the map.

2. Locate the reference point(s) clearly on the base map. Set up the level, or instrument, at a location not more than 250 feet from the benchmark and at a height above the benchmark and the next point(s). The level is ready for use when, after repeated rotations, the bubble in the horizontal level remains exactly in the center or middle of its housing.

3. Read where the horizontal cross-hair in the telescope of the level intersects the graduations on the rod.

4. Hold the rod on a point (called a turning point and denoted TP) of fixed but unknown elevation such as a nail in the ground, spike in a tree or telephone pole, or the top of a fire hydrant to take the second rod reading.

5. When practical, leveling should be conducted to form a closed circuit. That is, the level circuit or loop should close back in close agreement to a benchmark by within 0.02 foot of the original reading or third order accuracy whichever is greater.

6. If the level circuit does not close within these limits of accuracy, then the level circuit must be repeated until this accuracy is attained. Third order accuracy is defined by the formula: 0.05 foot × (_ number of miles run), which means for a one-mile level circuit, the closure should be within five hundredths of a foot.

1.2.3 Procedures

Attachment 1-2 contains Sections 15.3.4 and 15.3.5 of the EPA's Standard Operating Procedures for Field Physical Measurements, which outline procedures for differential and trigonometric leveling, respectively. These procedures should be followed for vertical surveying.

2 GLOBAL POSITIONING SYSTEM

2.1 Introduction

Use of GPS by Bhate personnel will be conducted to establish position to within plus or minus 1 meter of truth in the horizontal datum. If more precise horizontal or any vertical measurements are needed, a registered land surveyor will be subcontracted. All horizontal control will be surveyed to state plane coordinates and the vertical control will be surveyed to the National Geodetic Vertical Datum (NGVD).

2.2 Requirements

The minimum requirements for use of GPS by Bhate personnel are:

- Personnel must verify that a real-time beacon signal is serving the region. If a real-time beacon signal is not available, then use a community base station or set up a base station for the project.
- For "mapping grade" GPS work, horizontal resolution must be less than 1 meter. No vertical measurements are made for mapping grade GPS work.
- At least two known points shall be included in the GPS survey as quality control measurements.
- The "mapping grade" GPS deliverable shall be a tabulated list of survey points and coordinates, an electronic copy of the tabulated list (spreadsheet format), and an electronic copy of the points and coordinates in a GIS/CAD format suitable for import and use in the Base GIS and CAD systems.

2.3 Procedure

The manufacturer's instructions should be followed when using specific GPS equipment.

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3 PROFESSIONAL SURVEYING

For most projects, the horizontal and vertical locations of all sampling points as well as important site features will be surveyed by a RLS licensed in the appropriate state. For the monitoring wells, the elevations of both the marked top of the well casing (measuring point) and the ground surface will be surveyed. For the soil and other sampling locations, the elevations of the ground surface will be surveyed.

The RLS will perform surveys using equipment and procedures to assure the positional accuracy specified for each project and measurement activity in the contract.

3.1 Survey Requirements

The minimum requirements for professional surveying are:

- The surveyor must be a RLS, registered in the appropriate state.

- Both latitude and longitude coordinates, the state plane coordinates, and elevation will be calculated. Both of these coordinate systems are based on North American Datum (NAD) 1983 Geographic Coordinates. The vertical datum is the National Geodetic Vertical Datum (NGVD) of 1929.

- The horizontal control will be performed to the nearest tenth of a foot (0.1 ft.) and the vertical control will be performed to the nearest hundredth of a foot (0.01 ft.), unless specified differently in the site-specific sampling plan.

- At least two benchmarks shall be used in all surveys, unless specified differently in the site specific sampling plan.

- The minimum survey data deliverable shall be a tabulated list and electronic copy of point locations and elevations, a map showing the locations of the benchmarks, reference points and survey points, and a signed transmittal letter with the RLS stamp.

3.2 GPS Surveying Requirements

In addition to the survey requirements described above, additional requirements are imposed when surveying by GPS.

Additional minimum requirements for professional GPS surveying are:

- For “survey grade” GPS work, horizontal resolution must be less than 1/10 meter meter, and vertical resolution must be less than 1/10 meter meter.

- At least two known points shall be included in the GPS survey as quality control measurements of horizontal location and vertical elevation.
- The “survey grade” GPS deliverable shall be a tabulated list of survey points and coordinates, an electronic copy of the tabulated list (spreadsheet format), and an electronic copy of the points and coordinates in a GIS/CAD format suitable for import and use in the Base GIS and CAD systems.

4 REFERENCES

U.S. Environmental Protection Agency, Region 4, November 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*.

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ATTACHMENT 1-1

SECTIONS 15.2.4 AND 15.2.5 OF THE EPA STANDARD OPERATING PROCEDURES FOR FIELD PHYSICAL MEASUREMENTS

15.2.4 Procedures for Traversing

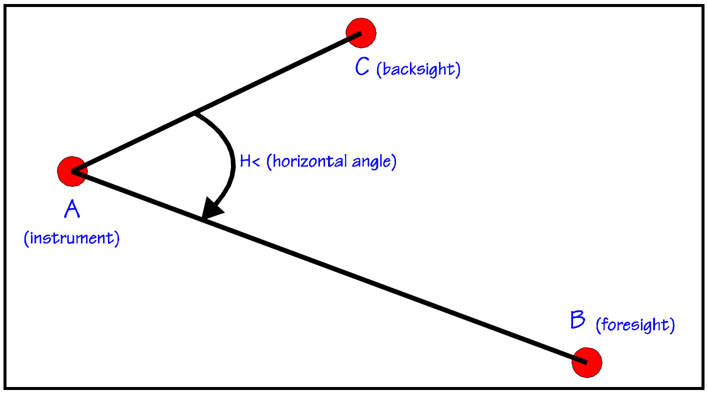
When traverse methods are used, at least two stations or control points of known horizontal location (expressed in terms of an arbitrary, local, State Plane or Universal Transverse Mercator coordinate system) must be in the site vicinity. These horizontal control points can usually be set for the specific site by a governmental agency or registered land surveyor.

The total station theodolite, often called the instrument, measures horizontal angles, vertical and/or zenith angles, and slope distances, is set up over an existing control point. The theodolite is attached to the plate of the tripod by a fastening screw and the bubble in the bullseye level is centered, or brought level by adjusting the three-screw leveling heads appropriately. Once the bulls eye bubble is centered, the theodolite is rotated 90 degrees at a time and the horizontal level bubble is checked and brought level using the three-screw leveling heads. The instrument is ready for use when, after repeated rotations, the bubble in the horizontal level remains exactly in the center or middle of its housing.

The rodman has either a range pole equipped with a reflector prism (single or triple) or a tripod with the reflector prism. The prism is used to reflect the signal from the electronic distance meter in the total station theodolite. While located over the point(s) whose location is desired, the rodman holds the range pole vertically by means of centering the bulls eye bubble, or sets up the tripod and reflector prism similarly as stated above. The instrument man sights through the telescope on the theodolite, lines up the horizontal and vertical cross-hairs on the center of the prism and records the horizontal angle (H∢), vertical angle (V∢) or zenith angle (Z∢), and the slope distance (Ds) to the prism. The difference in location between the point where the theodolite is set up and the point where the prism is held is determined trigonometrically. A compass and measuring tape could also be used to reference field measurements to a map or vice versa.

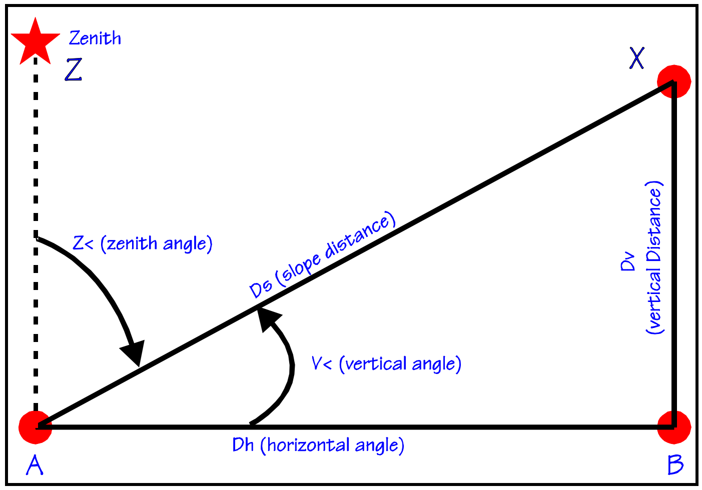
The following examples depict some of the field measurements that must be considered and accounted for, the calculations that must be performed, and the conversions that must be made when traverse methods are used to horizontally locate sampling points or other site features.

EXAMPLE 1, Horizontal Angles: Figure 15.2.1 illustrates that while the instrument is at point A (a control point), one reads the back sight angle (azimuth or bearing) to point C, then turns and measures the foresight angle (azimuth or bearing) to point B. The difference between the two angles is the interior angle included at the intersection of line AC and line AB, or the horizontal angle (H∢). The field notation for the measurement of the angle above would be represented as angle C-A-B. Typically, the first column to the left in the field book is labeled: (BS - ⍑ - FS), which stands for Backsight - Instrument - Foresight, or the column will simply be labeled Station and the second column is labeled H∢ (see Example 5, Field Notation).



Example 1: Figure 15.2.1. Map view showing horizontal angle C-A-B.

EXAMPLE 2, Vertical or Zenith Angles: After the horizontal angle is determined, the vertical angle (V∢) is measured, in Figure 15.2.2, from point B to point X to determine the angle between the line of sight AX and the horizontal line AB. The vertical angle is the included angle between a line connecting two points of different elevations and a line horizontal to the earths gravity. The vertical angle in Figure 15.2.2 is above the horizontal line AB and is also called an angle of elevation or positive angle and the field notation should be preceded by a + sign. If the vertical angle is below the horizontal line AB, it is called an angle of depression or negative angle and the field notation should be preceded by a - sign. Note that most theodolites measure the adjacent zenith angle instead of the vertical angle. A zenith angle is simply the included angle between a line connecting the point exactly overhead and the point in question. For example: a zenith angle of 90° is a horizontal line or right angle and the complimentary vertical angle would be 0°. The vertical angle can be obtained by subtracting the zenith angle from 90°.



Example 2: Figure 15.2.2. Side view showing vertical angle B-A-X and zenith angle Z-A-X.

To determine the height of the point X, measure the slope distance (Ds) with the electronic distance meter from A to X. Using the theodolite or transit, measure the vertical angle between line AX and AB or the zenith angle. The height of point X would be obtained by the appropriate trigonometric formula:

Dv = (sin V∢) Ds
or
Dv = (cos Z∢) Ds

The horizontal distance (Dh), which is the distance used when drawing the map, would be obtained by the appropriate formula:

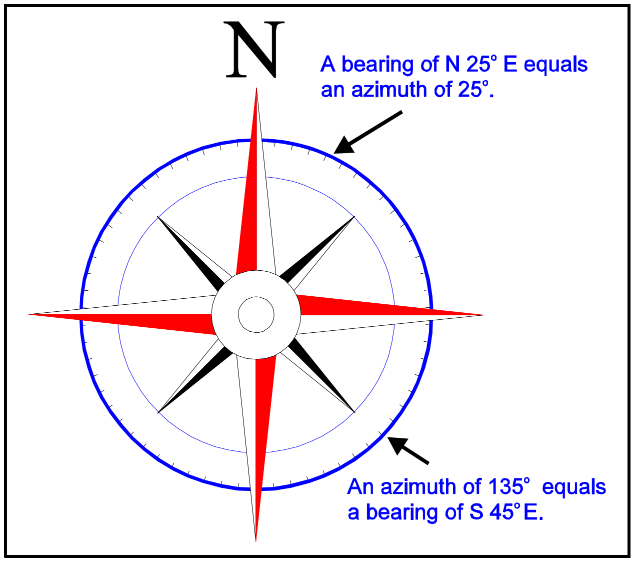
Dh = (cos V∢) Ds
or
Dh = (sin Z∢) Ds

If the vertical distance to be measured was to the top of a building, tank, or other point where the measurement of the slope distance is impractical, simply measure the horizontal distance and determine the height by:

Dv = (tan V∢) Dh

The field notation for the third column from the left in the field book is labeled: Z∢ or V∢ and the forth column is labeled Ds/Dh (see Example 5 Field Notation).

EXAMPLE 3, Azimuths and Bearings: When surveying, personnel should be able to convert bearings to azimuths or azimuths to bearings as shown in Figure 15.2.3. An azimuth is an angular direction based on the compass rose which divides a circle into 360°. The direction of northeast is expressed as an azimuth of 45°. Its reciprocal azimuth or the southwest azimuth direction is 225°. An azimuth is always turned clockwise from north or 0°. A bearing is the direction turned, either clockwise or counter-clockwise, with respect to north or south (whichever is closer) on a compass. As a bearing, the direction of northeast is expressed as North 45° East, while its reciprocal, or reverse bearing, is expressed as South 45° West.



Example 3: Figure 15.2.3. Compass rose showing conversion between azimuths and bearings.

The following are examples of conversions:

BEARING TO AZIMUTH		AZIMUTH TO BEARING	
N25°E	25°	135°	S45°E
S15°E	165°	280°	N80°W
N89°53'57"W	270°06'03"	353°06'49"	N06°53'11"W
S10°18'W	190°18'	06°35'	N06°35'E

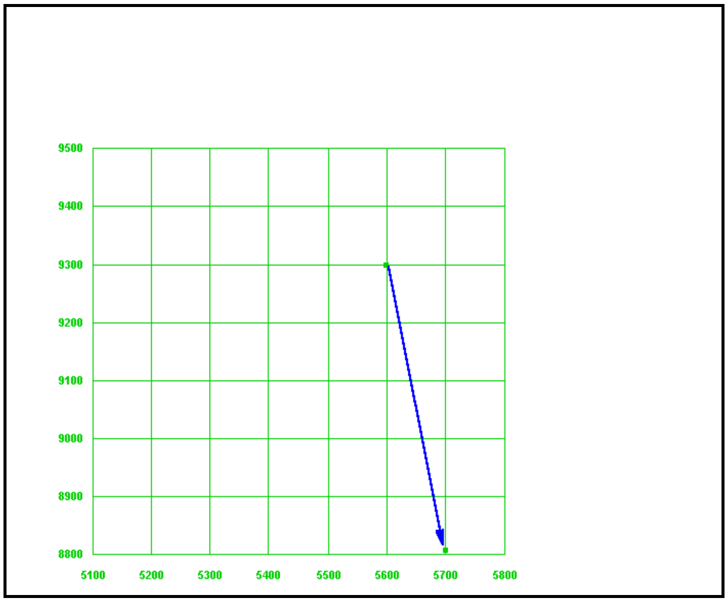
EXAMPLE 4, Coordinates: When the local State rectangular grid coordinate points near a particular site are obtained, personnel should be able to convert rectangular coordinates to polar coordinates. This is important since through this conversion, the azimuths and distances between each point can be obtained and then used as the starting control points for the site control traverse. Computers or simple programmable or non-programmable calculators are extremely useful in providing precise results from the field surveying measurements. The following is an example of manual conversion from rectangular to polar coordinates:

The instrument is set up at JORDAN88, and, given the rectangular coordinates:

Control Point	North (y)	East (x)
JORDAN88	9302.24	5605.23
SONIA93	8811.19	5706.13

The relative change in location between the north and east coordinates (from JORDAN88 to SONIA93), respectively, are:

$\Delta N = -491.05 \qquad \Delta E = 100.90$



Example 4: Figure 15.2.4. Map view showing change in direction from JORDAN88 to SONIA93.

The negative symbol for ΔN indicates the relative movement from JORDAN88 to SONIA93 downward (-) along the y axis (Figure 15.2.4.). The positive symbol for ΔE indicates relative movement from JORDAN88 to SONIA93 to the right (+) along the x axis. Solving for the formula (Pythagorean theorem):

$$c^2 = a^2 + b^2$$

The resulting distance between JORDAN88 and SONIA93 is c = 501.31'.

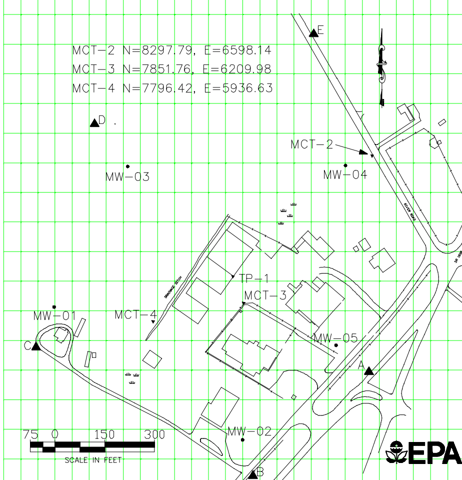
The azimuth is obtained by first computing the inverse tangent of the change in north divided by the change in east:

$$\tan^{-1} (\Delta N \div \Delta E) = -78.3886^\circ$$

This is the negative angle, expressed in decimal degrees, and is measured from the (x) axis into the southeast quadrant. The azimuth from JORDAN88 to SONIA93 is obtained, in this case, by changing the sign (- to +) and adding 90° which would give 168.3886 degrees. Converting to degrees, minutes, and seconds is the next task and the degrees are already done. Since there are 60 minutes in one degree, take the .3886 degrees and multiply by 60 and obtain 23.3160 minutes. Likewise there are 60 seconds in one minute, take the .3160 minutes and multiply by 60 and obtain 18.96 seconds. The resulting azimuth from JORDAN88 to SONIA93 is 168°23'19". **Note: The trigonometric formula above always gives the angle measured from the east-west (x) axis.** When using this procedure, it is wise to make a sketch, as shown above, (Figure 15.2.4.) that indicates the change in direction between the points relative to north. This will aid in visually and mentally seeing which geometric quadrant that the foresight angle falls in relation to the instrument. If the inverse tangent result was positive and pointed in the northeast quadrant direction, the azimuth would be subtracted from 90° and converted to degrees, minutes, and seconds. Likewise, when the inverse tangent result points in the southwest quadrant direction, the negative angle would be subtracted from 270° and a positive inverse tangent result pointing in the northwest quadrant would be added to 270° and then converted to degrees, minutes, and seconds.

EXAMPLE 5, Traverse Field Notation: The following is an example of the field notation for a traverse to horizontally locate sampling points. Figures 15.2.5 and 15.2.6 show the field notation, on the left hand side of the field log book and the physical features, sampling points, and traverse control points sketched on the right hand side of the field log book. The coordinates for each point are determined and usually entered in red ink after the traverse is finished.

02/01/96	Project 96E-0001 Region 4 Site Name City, State		Landis Surveyor - + Ben Chmark - ϕ Weather: Clear; 0-5 mph N	
Set traverse points around property to locate 5 monitoring wells				
Given:	TP1: MCT2: MCT3: TP1 to MCT3 :	N=7935.07 N= 3297.79 N=7851.76 ΔN=-83.32	E=6178.78 E=6598.14 E=6209.98 ΔE=31.21	
	[illegible]	[illegible]		
	[illegible]	[illegible]		
	∴ Azimuth TP1 to MCT3 = 159 27'54"			
(BS- + -FS) Station	H <	Z <	Ds / Dh	Coordinates
MCT3-TP1-	Set:H< = 159°27'54"	90° 45'24"	88.98' 88.97'	N=7935.07 E=6178.78
MCT3-TP1-A	125°26'18"	89° 44'06"	502.64' 502.635'	N=7643.63 E=6588.30
MCT3-TP1-MW5	124°09'12"	90° 07'21"	375.58' 375.58'	N=7724.22 E=6489.59
TP1-A-	Set:H< = 305° 26'18"	---------------		
TP1-A-B	228° 00'54"	90° 32'54"	470.94' 470.94'	N=7328.60 E=6238.24
A-B-	Set:H< = 48° 00'54"	---------------		
A-B-MW2	343° 55'21"	90° 21'54"	113.68' 113.68'	N=7437.83 E=6206.76
A-B-C	300° 46'27"	89° 59'54"	762.46' 762.46'	N=7718.72 E=5583.14
B-C-	Set H< = 120° 46'27"	---------------		
B-C-D	14° 40'24"	89° 49'39"	698.34' 698.34'	N=8394.28 E=5760.03
B-C-MW1	24° 11'21"	90° 21'12"	132.96' 132.96'	N=7840.01 E=5637.62
B-C-MW3	26° 50'36"	89° 44'45"	612.76' 612.754'	N=8265.45 E=5859.83



Example 5: Figure 15.2.5. Traverse field notation with site map showing traverse points used to locate monitoring wells.

02/01/96	Project 96E-0001 Region 4 Site Name City, State		Landis Surveyor - + Ben Chmark - ø Weather: Clear; 0-5 mph N	
(BS- + -FS) Station	H <	Z <	Ds / Dh	Coordinates
C-D-	Set:H <= 194°40'24"	---------------		
C-D-E	67°36'15"	90°03'48"	715.66' 715.66'	N=8666.95 E=6421.71
C-D-MW3	142°17'51"	89°45'03"	163.14' 163.14'	N=8265.20 E=5859.80
D-E-	Set:H <= 247°36'15"	---------------		
D-E- MCT2	154°27'09"	90°04'33"	409.08' 409.08'	N=8297.87 E=6598.13
E-MCT2-	Set:H <= 334°27'09"	---------------		(N=8297.79) (E=6598.14)
E-MCT2-A	180°51'42"	89°36'24"	654.28' 654.265'	N=7643.60 E=6588.30
E-MCT2-MW4	249°56'39"	88°32'48"	85.66' 85.63'	N=8268.42 E=6517.70
MCT2-A-	Set:H <= 360°51'42"	---------------		
MCT2-A-TP1	305°26'18"	---------------	-------- (502.635')	N=7935.04 E=6178.78
MCT2-A-MW5	309°13'33"	91°10'36"	127.50' 127.47'	N=7724.21 E=6489.55

Example 5 (continued): Figure 15.2.6. Second page of traverse field notation.

15.2.5 Procedures for Differential GPS

Differential GPS involves the use of two or more multichannel receivers. One or more are used as the rover receiver(s) and usually only one is used as the base station. The base station and the rover(s) should be within 200 to 300 miles of each other in order to increase the accuracy of the measurements (accuracy increases as separation between base and rover decreases) and have a clear view of the sky. The base is set up on a control point of known horizontal location (usually expressed in terms of latitude, longitude and elevation).

Trilaterated coordinate positions from the satellites are recorded at the base, which will be compared to the actual horizontal control point coordinates for the development of a correction factor to be applied to other roving GPS units. Since the base station receiver and the rover receiver(s) synchronize with the satellite's clocks, data must be recorded or logged by both receivers at the exact same time in order for the correction factor to be applicable. Often times, base station data will be obtained via modem, disk or internet after the field data collection by the rovers. It is therefore extremely important to coordinate the logistics and planning for using GPS techniques before leaving for the field (See Reference 4).

The procedures to follow when using GPS to locate horizontal positions of site features are quite simple and relatively easy to conduct. The GPS receiver/data logger is turned on and a predefined point, line or area feature to be mapped is selected from a data dictionary within the data logger. Once the feature is logged, the receiver/data logger user closes the feature, moves to the next feature for logging and so forth until all site features are logged. The data files are then downloaded, differentially corrected, if necessary, and exported to GIS applications for mapping and display of the features logged. Navigation to predefined points (called waypoints) is accomplished by selecting the waypoint from within the data logger, and proceeding in the direction displayed in the data logger until you arrive at the waypoint desired.

However, depending on which GPS receiver/data logger is used (Pathfinder Pro XR or Geoxplorer II), different types of GPS processing measurements can be made: Code Pseudorange or Carrier Phase. With these different processing measurements comes different accuracy. When code pseudorange is employed, the autonomous position measurements (without differential correction) will be within about 10 meters using either receiver/data logger listed above. When code pseudorange is used with differential GPS (this is either real time or post processed), the position measurements will be less than 1 meter for both the Pathfinder Pro XR or Geoexplorer II. Note: the Pathfinder Pro XR is capable of real time differential GPS (i.e., it has a beacon receiver built in), while the Geoexplorer II is not. When carrier phase is employed, both receiver/data loggers can obtain sub meter accuracy for points to be logged only (not waypoint navigation), and it is necessary to occupy each point feature a minimum of 5 minutes. So, although the basic procedures are simple and easy, some thought must be put into the planning of the data collection effort in order to define the features to be logged, capitalize on the accuracy and to meet the objectives of the project.

All professional staff and field technicians must be trained in the use of the GPS equipment by qualified staff before using this equipment. Specific procedures on the operation and setup of the GPS equipment are described in detail in the operations manuals for each of the instruments. All instruments will be used consistent with the instructions contained within these manuals. A copy of each of the manuals will be maintained by a designated person within the Region. The following templates list the methods and procedures to be considered and performed if differential GPS procedures will be used to data log GPS positions or horizontally locate sampling points or other site features (See Reference 5).

TEMPLATE 1. Planning To Capture GPS Data.

- ❑ Training in the use of GPS equipment is critical to the success of a field project.
- ❑ The objectives and accuracy requirements should be established and factors that might limit the use of the GPS equipment should be assessed.
- ❑ Check the availability of the GPS equipment and test it prior to going in the field in order to ensure that it works properly and meets the requirements of the field project.
- ❑ Decide what features (points, lines, or areas) and their attributes at a site that locational information will be captured with GPS equipment and create a Data Dictionary on the PC with Pathfinder Office software. Transfer the Data Dictionary to Asset Surveyor on the Data logger.
- ❑ Check the availability of horizontal control point data at or near the site for GPS equipment precision and accuracy check. If none exists, remember to log at least four points that surround the site and that can be seen in aerial photographs or topographic maps for checking and GIS georeferencing.
- ❑ Check the availability of base station coverage if the project is not dependant on collecting real time data.

TEMPLATE 2. Creating A New Data Dictionary.

- ❑ In Pathfinder Office software on the PC select *Data Dictionary Editor* from the *Utilities* menu.
- ❑ Select *New* to generate a new dictionary.
- ❑ Enter the name of the new data dictionary, and any comments (optional), then click *Ok.*
- ❑ Select *New Feature.* Enter the name of the feature and under *Feature Classification* choose *Point, Line* or *Area* depending on what the feature is on a map, then click *Ok.*
- ❑ Select *New Attribute.* Enter the type of attribute *Menu, Numeric, Text, Date, Time, File Name* or *Separator,* click *Ok* and fill in the requested *Attribute Name* information, click *Ok,* then click *Close* when finished with that attribute.
- ❑ Add more features and attributes as necessary. Many attributes can be listed for one feature. Attributes can be menus, numbers, character strings, dates or times. Numeric values require a minimum, maximum, and default value. Character strings require a maximum string length. Dates and times can be set for automatic generation in the field.
- ❑ Consider putting features that are most commonly used at the beginning of the dictionary and any existing GIS database that may require specific character string lengths. At the end of all data dictionaries that are created, a *generic point, line,* or *area* is also generated. This is in case while in the field, a feature not listed in the data dictionary may be tagged and identified. The following is an example of the data dictionary used by the region.

"COC_GIS", Dictionary, "Chain of Custody/GIS Data Dictionary"

"Surfsoil", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Subsoil", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Potwater", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Muniwsupply", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Indwell", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Waste", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Surfwater", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Sediment", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Groundwater", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Precipitation", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Other_unknown", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Other_biota", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Munipwater", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Indprocwater", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Wipesample", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"FIshsample", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Vegetation", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Macroinvertibrates", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Wastewater", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Sludgenonrcra", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Uicinjectionwells", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Petrotanks", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Ambair", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Indoorair", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Munieffwater", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Indeffwater", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Periphyton", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Tissue", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Lithology", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Fence", line
  "Type", text, 30

"Road", line
  "Name", text, 30

"Railroad", line
  "Name", text, 30

"Stream", line
  "Name", text, 30

"Structure", area
  "Type", text, 30

TEMPLATE 3. Data Dictionary Transfer To Data Logger or Geoexplorer II.

- ❏ Connect the GPS unit to the COM1 port of the PC using the appropriate cable that is attached to the COM1 port of the data logger or in the case of the Geoexplorer II attached to the input port.
- ❏ Select *File Transfer* in the data logger Asset Surveyor software main menu, or *Data Transfer* in the Geoexplorer II main menu.
- ❏ In Pathfinder Office software on the PC, select *Utilities*, then *Data Transfer*. Note: *Device* should be set to *GIS Data logger* and *Data Type* should be set to *Data Dictionary*. Under *Available Files,* highlight the data dictionary name and under *Selected Files,* choose *Add.* Under *Direction,* choose *Send.* Then click *Transfer.*
- ❏ Once the data dictionary has been transferred, *Close* the *Data Transfer* window and exit the data logger or Geoexplorer II.
- ❏ Note: Several data dictionaries can be uploaded to a data logger, but only one can be uploaded to a Geoexplorer II. Subsequent uploaded data dictionaries to the Geoexplorer II will delete previous ones.

TEMPLATE 4. Default Configuration Of The Data Logger And Geoexplorer II For Data Capture.

- ❑ In Asset Surveyor software on the data logger, choose *Config* or *Configuration* in the Geoexplorer II and set the following.

  Logging Intervals

Point Feature	1 second
Line and Area Feature	5 seconds
Not in Feature	All
Velocity	All
Minimum Positions (point feature)	20 (data logger) 120 (Geoexplorer II)
Position Mode	Overdet. 3D (data logger)ODS 3D (Geoexplorer II) Note: Manual 3D is the minimum for both.
Elevation Mask	15° (data logger and Geoexplorer II); 10° (base)
Signal-to-noise ratio mask	6 (data logger); 5 (Geoexplorer II)
PDOP mask and switch	6
Dynamics Code	Land (for terrestrial work), Sea or Air (for obvious reasons)

Template 5. Data Capture File Name Convention.

- ❑ Default file name convention is recommended.
- ❑ Assists with identifying files by time and date for matching up base station file if differential correction is needed.
- ❑ The following describes the parts of a file with the name: A021514A

GPS UNIT	MONTH	DATE	HOUR (UTC)	FILE LETTER
A	02	15	14	A

- ❑ When multiple GPS units are at the same site data logging, each unit will be given a different letter identification.
- ❑ UTC stands for Universal Time Coordinated, which used to be known as Greenwich Mean Time (GMT), i.e., the local time at the Greenwich meridian (zero degrees longitude). For the conversion between Eastern Standard Time (EST) or Eastern Daylight Time (EDT), use the following formula.

EST = UTC - 5 hours	(note that this is fall and winter)
EDT = UTC - 4 hours	(spring and summer)

Template 6. Data Capture Logging And Considerations.

- ❑ Choose *Data Capture* from the main menu.
- ❑ Select *Create rover file* in the data logger (choose *Open Rov. File* in the Geoexplorer II) or *Reopen rover file* when appending to a previous file.
- ❑ The *Create* file screen has three fields: *File, Data Dict.* and *Free Space.* Press Enter on the *Data Dict* field to choose your data dictionary.
- ❑ Press *Ok* to start the current file selected.
- ❑ Scroll through *Start feature* in the data logger or scroll to *Select Feature* in the Geoexplorer II and press Enter. A list of features in the data dictionary associated with the current file is displayed.

- ❑ Select the appropriate feature by pressing Enter. Then type the appropriate attribute value(s).
- ❑ After the minimum number of positions are attained (see Template 4 above), press *Ok* to accept and store the feature and all of its attributes values (in the Geoexplorer II, scroll to *Close Feature* to accept and store the feature and all of its attributes).
- ❑ Proceed to the next site feature and continue this operation for all site features. Note that while collecting positions for one feature, for example the positions along a road, you can *Nest* other features, for example wells or other sample points on one side of the road or the other, then press *Ok* to accept and store the wells or other sample points feature and attribute values and continue logging the road. When finished, press *Esc* to exit *Data Capture* and return to *Main Menu* (in the Geoexplorer II, scroll to *Close File* and select *Yes* to return to *Main Menu).*

CONSIDERATIONS

- ❑ Check the horizontal control point data at or near the site for GPS equipment precision and accuracy. To obtain a nearby National Geodetic Survey (NGS) control point, search the website www.ngs.noaa.gov and click "NGS Products and Services" then go into "Data Sheets" until "NGSmap" is found. This is an interactive NGS data sheet retrieval tool that will produce a map of up to 32 control points near the site. Use the data sheets to find the horizontal control point and record a separate point generic feature data file at the control point as a check of the manufacturers specifications for the GPS unit.

- ❑ When collecting GPS locational information, keep in mind the available maps or areal photographs of the site. Note: The GIS group has electronic georeferenced coverage of most of the region with USGS Topographical Maps or Aerial Photography. One of the best websites to obtain aerial photographs of a site is: http://rsori.rtpnc.epa.gov/ which is EPA's remote sensing home page. If only maps are available, collect enough site feature information to improve the existing maps. Collect at least four GPS points surrounding the site that can be seen in the field and on the existing maps and/or areal photographs (intersections of roads, manhole covers, etc.) so the existing maps and/or areal photographs can be georeferenced and rectified to the same coordinate system, datum, and projection back in the office with GIS techniques.

Template 7. Data Logger Files To PC.

- ❑ Connect the data logger to COM1 of the PC using the appropriate cable that is attached to the COM1 port of the data logger, or, in the case of the Geoexplorer II, attached to the input port.
- ❑ In Pathfinder Office software on the PC, select the appropriate project, then *Utilities,* then *Data Transfer.* Note: *Device* should be set to *GIS Data logger* and *Data Type* should be set to *Data.* Under *Available Files,* highlight the files to be downloaded and under *Selected Files,* choose *Add* or *Add All*
- ❑ Under *Direction* choose *Receive.* Then click *Transfer.* The data file(s) will be converted to files with a .ssf extension.
- ❑ Once the data files have been transferred, *Close* the *Data Transfer* window and exit the data logger.

Template 8. Differential Correction.

- ❑ If a real time GPS unit was used for data capture, the data file(s) must be checked to see if all positions were differential corrected through the real time broadcast signal. If any portion of a data file was not corrected with the real time broadcast signal, a base station file must be obtained in order for all positions in the file to be differentially corrected.

- ❑ In Pathfinder Office software on the PC, select *File* then *Open.* Select the data file(s) to look at then *Ok.* After a brief scan of the features, one by one, identify the features and file name(s) that need a base station file for differential correction then *Close* the file(s).
- ❑ Obtain base station file(s) from a base station as close to the site as possible and that match the month, date and UTC hour of the data file(s) exactly and place in the Base subdirectory of the Project directory in Pathfinder Office software on the PC (C:\Pfdata\(Project)\Base). These can be obtained through modem, internet, email, or disk via regular mail. As in Template 5 with data files, the base station files use a similar file naming convention and will identify the month, date, and UTC hour that the base station file was collected. The following is the base station file naming convention.

CITY	YEAR	MONTH	DATE	HOUR (UTC)
A	9	02	15	14

- ❑ These websites are good starting points for base station files and cover our entire region:

  http://www.ngs.noaa.gov/CORS/cors-data.html
  http://www.fs.fed.us/database/gps/clickmap/cbsmap.htm
  ftp://ftp.dep.state.fl.us/pub/

- ❑ Once base sation files are obtained that match the month, date, and UTC hour, in the data files as indicated above (and also in the same year), in Pathfinder Office software on the PC, select *Utilities* then *Differential Correction.*
- ❑ Select the rover file(s) (more than one may be selected) to be differentially corrected. If the base station files were placed in the Base subdirectory as mentioned above, select *Local Search* and the base station files that match the data files will be highlighted. Select *Ok.*
- ❑ The differentially corrected files will be placed in the Project directory with a .cor extension and the processing should be set to *Smart Code and Carrier Phase Processing.* After all of the above procedures are followed, select *Ok* to start the differential correction process.
- ❑ To view the corrected files, select *File* then *Open* and the corrected files should be highlighted. Select *Ok* to view then scan through the features to make sure all positions were differentially corrected.

Template 9. Export to ARC/INFO Arcview GIS.

- ❑ In Pathfinder Office software on the PC, select *Utilities*, then *Export.*
- ❑ Select the *Input Files* for export (highlighted).
- ❑ By default the *Output Folder* where files are exported is C:\Pfdata\(Project)\Export.
- ❑ In *Choose an Export Setup,* select *Sample Arcview Shapefile Setup* then click *Properties.*
- ❑ Data: Type of data to export: *Features - Positions and Attributes* and pulldown *Export All Features.*
- ❑ Position Filter: Filter by GPS Position Info; Minimum Satellites: *3d (4 or more Svs),* Maximum PDOP: *Any,* Check *Realtime Differential* and *Differential.*
- ❑ Output: Output Files *Combine all input files and output to the project export folder* and System File Format *DOS Files.*
- ❑ Coordinate System: Use export Coordinate System: *Latitude/Longitude,* Datum: *NAD 1927 (Conus).*
- ❑ Attributes: Export Menu Attributes As: *Attribute Value,* Generated Attributes: check *Feature Name.*
- ❑ Arcview Shapefile: Theme Options: Skip this screen.
- ❑ Units: Use Export Units: *Change,* then select the approprioate units (metric or english).
- ❑ Select *Ok* when finished with *Change Setup Options,* then *Ok* to export.

- ❑ Three types of files are generated. Each named feature, (where *feature* is one of the features listed in the Data Dictionary that was created in Template 2) will have the extensions: .dbf, .shp, and .shx.
- ❑ Transfer all of the *.dbf, .shp, and .shx* files to the appropriate directory on the R4ESD LAN G:\user\shared\ drive so they may be transfered by FTP or other means to the appropriate directory and work space in the GIS UNIX boxes. The GIS group (on their UNIX Boxes) or Project Leader (on the PC) will use these files in Arcview. Any conversions between coordinate systems and datums that may be necessary should be done by the GIS group.
- ❑ Open Arcview and add the coverages as themes.

Template 10. GIS to Realtime Differential GPS Waypoint Navigation.

- ❑ After the collection of site features, (i.e., wells, site structures, roads, etc), with GPS techniques, and/or after the site areal photographs or maps are georeferenced and rectified, specific samples locations can be picked out of the GIS coverages, and generated into waypoints. These waypoints can then be transferred back into the realtime GPS Data logger and used to layout a soil sampling grid or other locations of interest at the site.
- ❑ Waypoint files created in ARC/INFO must be in the following ASCII format for importing into Pathfinder Office software on the PC: xcoordinate,ycoordinate,zcoordinate,"waypointnameornumber" Note: the zcoordinate is optional and may be left blank with a space (i.e., x,y,,"waypoint").
- ❑ Once waypoint files are generated and in the proper format, in Pathfinder Office software on the PC, select *File, Waypoints,* then *ASCII Import.* Select the waypoint file to be imported and click *Ok.*
- ❑ Next, connect the GPS unit to the COM1 port of the PC using the appropriate cable that is attached to the COM1 port of the data logger.
- ❑ Select *File Transfer* in the data logger Asset Surveyor software main menu.
- ❑ In Pathfinder Office software on the PC, select *Utilities*, then *Data Transfer*. Note: *Device* should be set to *GIS Data logger* and *Data Type* should be set to *Waypoints.* Under *Available Files,* highlight the waypoint file name and under *Selected Files,* choose *Add.* Under *Direction,* choose *Send.* Then click *Transfer.*
- ❑ Once the waypoint file has been transferred, *Close* the *Data Transfer* window and exit the data logger.
- ❑ Upon returning to the site, select *Navigation* in the data logger Asset Surveyor software main menu. Move the curser to the waypoint listed and press Enter. Move in the direction indicated by the data logger until the waypoint is reached. Waypoints can also be edited on the fly and/or added to the list in the field and transferred back to Pathfinder Office software on the PC for updating and/or exporting back to GIS.

15.3 Vertical Location (Elevation) Surveys

15.3.1 Introduction

The field of surveying that pertains to measuring the relative differences in elevation of two or more points is called "running levels" or "Leveling". The two most commonly used methods are Differential Leveling and Trigonometric Leveling. Differential leveling is the most precise and easiest method because it utilizes "level" measurements with simple addition and subtraction. Trigonometric leveling is slightly less precise and more difficult as it uses vertical angle and distance measurements combined with the principles of trigonometry. Global Positioning System (GPS) equipment can obtain elevation measurements, however this new technology is less accurate than horizontal measurements and is not recommended for vertical locations. This subsection discusses the standard procedures and techniques used to obtain differences in elevation and are described in more detail in basic surveying and field geology textbooks (See References 1, 2, and 3).

ATTACHMENT 1-2

SECTIONS 15.3.4 AND 15.3.5 OF THE EPA STANDARD OPERATING PROCEDURES FOR FIELD PHYSICAL MEASUREMENTS

Trigonometric Leveling

- Topcon GTS-2, total station theodolite/electronic distance meter (EDM)
- tripod(s)
- reflector prism(s)
- prism pole
- cloth or steel tape
- compass

15.3.3 Specific Equipment Quality Control Procedures

Field surveying methods using this equipment should be made only by those personnel who have been trained to use them. All field investigators must be trained and checked out in surveying procedures by qualified staff before using this equipment.

Each piece of field equipment (as appropriate) should be numbered, and a log book should be kept containing all maintenance and calibrations made on the equipment. The specific maintenance and calibration procedures found in Section 15.2.3 should be used for all equipment listed above.

15.3.4 Procedures for Differential Leveling

The level, or instrument, is set up by the instrument man at a location not more than 250 feet from the benchmark and at a height above the benchmark and the next point(s). The level is attached to the plate of the tripod by a fastening screw and the bubble in the bullseye level is centered, or brought level by adjusting the three-screw leveling heads accordingly. Once the bullseye bubble is centered, the level is rotated 90 degrees at a time and the horizontal level bubble is checked and brought level using the three-screw leveling heads. The level is ready for use when, after repeated rotations, the bubble in the horizontal level remains exactly in the center or middle of its housing.

The rodman holds the rod as plumb (vertical) as possible on the benchmark so that the instrument man can read where the horizontal cross-hair in the telescope of the level intersects the graduations on the rod. The rodman "rocks" the rod in two planes, when instructed by the instrument man, to obtain a level reading. The rod is white with large red numbers which indicate the foot-marks and smaller black numbers which indicate the tenths of feet and has black graduations the entire length which indicate hundredths of feet. The instrument man sights through the telescope and takes the first rod reading which is called a backsight (denoted BS or + in the field log book). The backsight (+) reading added to the elevation of the benchmark gives the height of the level, or instrument, (denoted H.I. in the field log book). Next the rodman holds the rod on a point (called a turning point and denoted TP) of fixed but unknown elevation such as a nail in the ground, spike in a tree or telephone pole, or the top of a fire hydrant. The instrument man then takes his second rod reading which is called a foresight (denoted FS or - in the field log book). If the foresight (-) reading is subtracted from the H.I., the result is the elevation of the point. That is, the difference between the first reading obtained from the benchmark and the second reading obtained from the point is the difference in elevation between the point and the benchmark. Note that the distance between each sighted reading should not ordinarily exceed 250 feet with turning point backsight and foresight distances deviating no more than 50 feet from one another.

The instrument man then goes ahead of the rodman, sets the level up as stated before and takes a rod reading (backsight) from the previous turning point. The rodman then moves ahead of the instrument man for a new turning point rod reading (foresight) and so forth until the desired final point is located vertically. Once the final point is located, the instrument man breaks the set up of the level (i.e., changes the H.I.) and re-levels the level. The instrument man and rodman then run levels from the last or final point to the first point or benchmark. This is called making a closed circuit or closed level loop.

When practical, leveling should be conducted to form a closed circuit. That is, the level circuit or loop should close back in close agreement to a benchmark by within 0.02 foot of the original reading or third order accuracy whichever is greater. If the level circuit does not close within these limits of accuracy, then the level circuit must be repeated until this accuracy is attained. Third order accuracy is defined by the formula: 0.05 foot × (√number of miles run), which means for a one-mile level circuit, the closure should be within five hundredths of a foot. Figure 15.3.1 is an example of typical field notations for differential leveling.

06/01/01

Project 01-0001
Region 4 Site Name
City, State

Landis Surveyor - +
Ben Chmark - ø
Weather: Clear; 0-5 mph N, hot

Station/Point	+ or BS	H.I.	- or FS	Elevation	Remarks
B.M 523	6.13	25.69		19.560	Top of brass cap in concrete mon. marked B.M. 523 EL.=19.560'
TP01			6.11	19.58	Set nail in ground
					(Break setup)
TP01	2.24	21.82		19.58	Top of nail
TP02			10.30	11.52	RR spike in telephone pole NW corner Athens ST. and Georgia Ave.
MW01			12.13	9.69	Top of casing at MW01
GS01			14.84	6.98	Ground shot at MW01
WSCS			14.37	7.45	Water surface of cypress swamp
Weir 01			12.54	9.28	Invert of weir 01 south of plant
					(Break setup to run levels back)
TP02	7.89	19.41		11.52	RR spike in telephone pole NW corner Athens St. and Georgia Ave.
TBM 01			8.22	11.19	Set nail in 24" oak for temporary bench mark 01
					Break setup
TBM 01	9.59	20.78		11.19	Top of nail in 24" oak
B.M 523			1.23	19.55	Checked into BM 523 (off -0.01')
					Break setup - put instrument away

Example 1: Figure 15.3.1. Field notation for differential leveling.

15.3.5 Procedures for Trigonometric Leveling

The total station theodolite, or instrument, is usually set up above a benchmark and the elevation of the instrument (H.I.) must be obtained. The theodolite is attached to the plate of the tripod by a fastening screw and the bubble in the bullseye level is centered, or brought level by adjusting the three-screw leveling heads accordingly. Once the bullseye bubble is centered, the theodolite is rotated 90 degrees at a time and the horizontal level bubble is checked and brought level using the three-screw leveling heads. The instrument is ready for use when, after repeated rotations, the bubble in the horizontal level remains exactly in the center or middle of its housing.

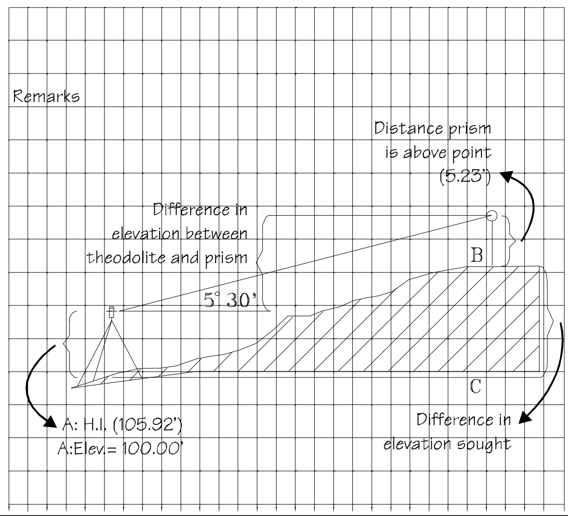
The rodman has either a range pole equipped with a reflector prism (single or triple) or a tripod with the reflector prism. The prism is used to reflect the signal from the electronic distance meter in the total station theodolite. While located over the point(s) whose elevation is desired, the rodman holds the range pole level by means of centering the bullseye bubble, or sets up the tripod by means of centering the bullseye bubble with the three-screw leveling heads. The instrument man sights through the telescope on the theodolite, lines up the horizontal and vertical cross-hairs on the center of the prism, and takes a reading of both the vertical angle (V◁) and the distance to the prism. The difference in elevation between the theodolite and the prism is determined trigonometrically. A compass with a clinometer and a measuring tape could also be used for field measurements or as a map reference.

The following three examples graphically depict the distances that must be considered and accounted for when using the trigonometric leveling method to compute the vertical changes in elevation. The field notation for trigonometric leveling follows each example.

Example 2: The elevation at point A in Figure 15.3.2 is 100.00 ft. The instrument is set up 5.92 ft. above point A which makes the height of the instrument (H.I.) 105.92 ft. Given a slope distance (Ds) shot to the prism (distance AB) of 323.88 ft. and a positive vertical angle (V∢CAB) of 5°30', the difference in elevation between point C and point B is computed using the trigonometric formula:

elevation difference = distance AB × sin(V∢)

02/01/96	Project 96E-0001 Region 4 Site Name City, State		Landis Surveyor - + Ben Chmark - ø Weather: Clear; 0-5 mph N	
Station/Point	+ or BS	H.I.	- or FS	Elevation
@A	5.92	105.92		100.00'
Distance A-B	323.88'			
Vertical <CAB			5°30'	
@B			5.23'	131.73'
	CB = AB x sin <CAB			
	= 323.88' x.0958			
	= 31.04'			
	B = 105.92' + 31.04' - 5.23' = 131.73'			



Example 2: Figure 15.3.2. Trigonometric level notation showing side view when elevation of point desired is above instrument.

The method described in Figure 15.3.2 only accounts for the relative difference in elevation between the theodolite (H.I.) and the center of the prism. The distance that the prism is held above the point in question must be subtracted from the resulting elevation of the prism to obtain the elevation of the point. Substituting in the trigonometric formula:

elevation difference = 323.88 ft. × sin(5°30') = 31.04 ft.

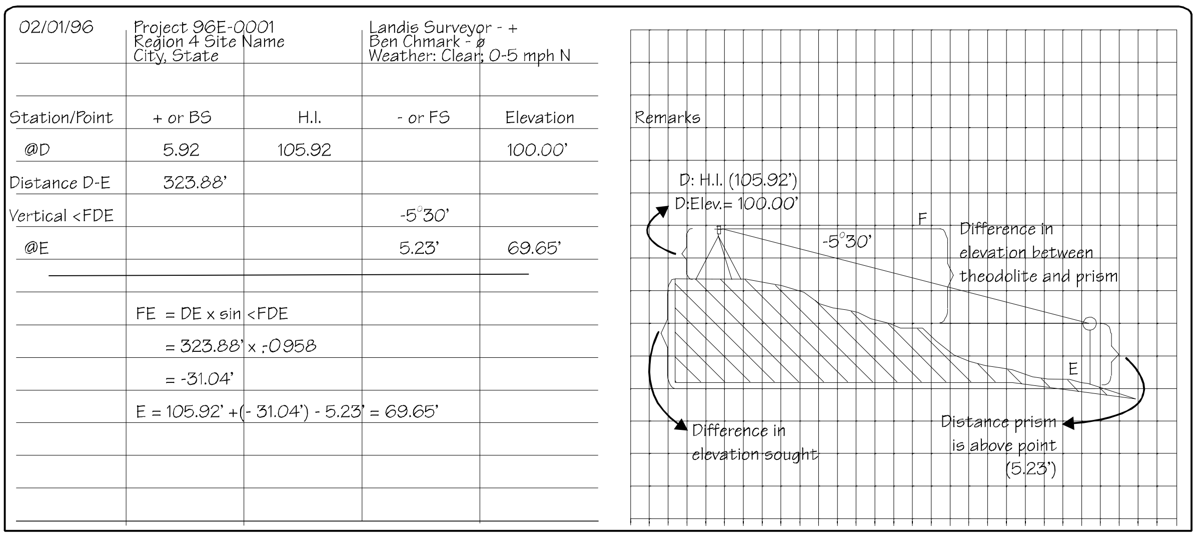
The elevation of point B is: 105.92 ft. + 31.04 ft. - 5.23 ft. = 131.73 ft.

Example 3: The elevation at point D in Figure 15.3.3 is 100.00 ft. The instrument is set up 5.92 ft. above point D which makes the height of the instrument (H.I.) 105.92 ft. Given a slope distance (Ds) shot to the prism (distance DE) of 323.88 ft. and a negative vertical angle (V∢FDE) of -5°30', the difference in elevation between point F and point E is computed by substituting in the trigonometric formula:

$$\text{elevation difference} = 323.88 \text{ ft.} \times \sin(-5°30') = -31.04 \text{ ft.}$$

The distance that the prism is held above the point in question must be subtracted from the resulting elevation of the prism to obtain the elevation of the point.

The elevation of point E is: 105.92 ft. + (-31.04 ft.) - 5.23 ft. = 69.65 ft.



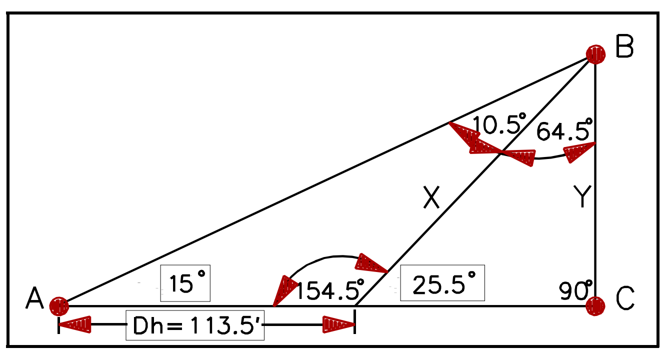
Example 3: Figure 15.3.3. Trigonometric level notation showing side view when elevation of point desired is below instrument.

Example 4: When the measurement of the slope distance is not possible, differences in elevation can be determined using the law of sines from trigonometry:

$$\frac{\sin \alpha}{a} = \frac{\sin \beta}{b} = \frac{\sin \gamma}{c}$$

or

$$\frac{a}{\sin \alpha} = \frac{b}{\sin \beta} = \frac{c}{\sin \gamma}$$



Example 4: Figure 15.3.4. Spot elevation differences using law of sines.

Spot elevation differences can be determined by taking only three measurements (shown enclosed in the boxes of Figure 15.3.4). The measurements can be obtained with the total station theodolite or by using a compass (equipped with a clinometer) and a measuring tape. In Figure 15.3.4 the vertical angle (V⊲) is measured at two locations (A and midway between A and C) and the horizontal distance (Dh) between those two measurements is also measured. Since the sum of the interior angles of each triangle should equal 180°, all the other interior angles are calculated. Substituting the measurements into the law of sines and solving for x and y shown in Figure 15.3.4:

$$\frac{x}{\sin 15°} = \frac{113.5'}{\sin 10.5°} \qquad \frac{y}{\sin 25.5°} = \frac{161.36'}{\sin 90°}$$

$$x = \frac{(\sin 15°)\,113.5'}{\sin 10.5°} \qquad y = \frac{(\sin 25.5°)\,161.36'}{1}$$

$$x = 161.36' \qquad y = 69.4'$$

Note that this method above only accounts for the relative difference in elevation between point A and the point in question, point B. If an instrument, such as a compass or theodolite, is used at point A, the H.I. at point A must be added to the resulting elevation of the point in question. The field notation would include the figure drawing, all field measurements, and all of the calculations.

15.4 Hydrological Studies

15.4.1 Scope and Applicability

Hydrological studies are an important component of virtually all Branch field studies and include activities such as time-of-travel studies, current/circulation studies, dye dilution surveys, flow measurement and stage/discharge relationship development. Time-of travel surveys are frequently required as part of water quality model calibration surveys or as a component of other activities such as reaeration measurements. Dye dilution studies are extremely useful for evaluating the mixing of effluents with receiving waters. Activities such as water quality enforcement studies, NPDES permit compliance monitoring, water quality survey monitoring, reconnaissance surveys, and research rely on accurate flow measurement. For example, NPDES permit limits often limit the mass loading of a particular pollutant that may be discharged. Stage measurement and the determination of stage-discharge relationships are also important hydrological data collected by the Branch. For example, stage-discharge studies are extremely useful for determining flow in conjunction with TMDL storm event sampling efforts. As much attention and care should be given to hydrological measurements in the design of a sampling program as to the collection of samples and subsequent laboratory analysis.

15.4.2 Methods

15.4.2.1 Surface Water Stage/Tape Down

Water level recorders provide a time series record of water levels. When necessary, these instruments should be referenced to National Geodetic Vertical Datum (NGVD). All water level tracings should be noted with beginning and ending date and time, site location, stage scale, and time scale and initialed by the field investigators. Standard USGS staff gages should be employed at each water level recorder site to provide a reference and check on the recorder trace. Water stage should be recorded to the nearest 0.01 foot where possible.

BSOP NO. 12

WELL AND BOREHOLE ABANDONMENT

BHATE STANDARD OPERATING PROCEDURE NO. 12

WELL AND BOREHOLE ABANDONMENT

Unplugged or improperly abandoned wells pose a potential threat to groundwater quality, because they may serve as a conduit for surface pollutants to migrate into the subsurface or allow mixing of groundwater through interconnecting isolated aquifers. The objective of this Bhate Standard Operating Procedure (BSOP) document is to provide the general procedures for the proper abandonment of boreholes and wells. The methods must comply with applicable federal, state, and local rules and regulations, and protect the groundwater resource from undue degradation.

When performing abandonment procedures, it is important to understand the objectives of the abandonment:

- Eliminate physical hazards
- Prevent groundwater contamination
- Conserve aquifer yield and hydrostatic head
- Prevent intermixing of groundwaters within separated aquifer systems

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BSOP NO. 12

WELL AND BOREHOLE ABANDONMENT

TABLE OF CONTENTS

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1 BOREHOLES

1.1 Objectives

The purpose of this section is to provide procedures for the abandonment of hand auger borings, soil borings, or test holes. The procedural standards are intended to include boreholes advanced manually or with a drill rig.

1.2 Procedure

All boreholes will be backfilled with grout or tamped cuttings in accordance with site specific requirements. The decision will be based in part on hydrogeologic considerations, as well as operational constraints. Shallow boreholes, advanced up to approximately 10 feet below land surface (bls) with a hand auger or drill rig can be backfilled with tamped cuttings, as long as no obvious sources of surficial contaminants which could enter the borehole are nearby. Any borehole advanced to a depth below the water table will be tremie-grouted from the borehole collapse depth to the ground surface.

The grout emplacement and mixture procedures will comply with specifications provided in BSOP No. 10 with regard to monitoring well annular seals. The boreholes will be backfilled as soon as practical after sampling is completed or data are collected, unless saturated conditions are encountered or a monitoring well is to be installed. For boreholes in which saturated conditions are encountered, attempts will be made to measure the groundwater level approximately 24 hours following completion of the borehole, prior to grouting the borehole. Boreholes left open overnight will be adequately covered to eliminate the potential for injury to personnel. In addition, the surrounding dirt or drill cuttings will be mounded around the borehole and the borehole will be covered with plastic sheeting to prevent surface drainage from entering the borehole.

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2 MONITORING WELLS

Monitoring wells represent a more complex conduit for potential groundwater contamination and intermixing, because they consist of a rigid well pipe structure within an annulus that may be filled with different material along its vertical dimension. Several methods are available for monitoring well abandonment, they include overdrilling, pulling the casing, and grouting the casing in place. With this in mind, it should be recognized that specific well abandonment methodologies will depend on several factors, including the following:

- Casing material, diameter, and condition
- Quality of the original seal within the annulus
- Total depth of the well
- Well plumbness
- Hydrogeologic conditions
- Level of contamination and the zone(s) where the contamination occurs

These factors should be considered when determining a specific abandonment procedure for a particular well. The appropriate water management district should be notified prior to abandonment activities for approval of the abandonment procedures.

2.1 Objectives

The purpose of this section is to provide procedures for the abandonment and plugging of monitoring wells.

2.2 Procedure

When a decision is made to abandon a monitoring well, the borehole will be sealed in such a manner that the well cannot act as a conduit for migration of contaminants from the ground surface to the water table or between aquifers. To properly abandon a well, the preferred method is to fill the well and porous annular space from the bottom of the structure to approximately 2 feet bls with a neat cement grout. The mixture of the grout will be in accordance with BSOP No. 10. For all well abandonment procedures, the top 2 feet will be backfilled with concrete to insure a secure surface seal (plug). If the area exhibits heavy vehicular traffic and/or the well location(s) needs to be permanently marked, then a protective surface pad(s) and/or steel or PVC bumper guards will be installed. The concrete surface plug can also be recessed below ground surface if the potential for construction activities exists.

A licensed water well contractor will be utilized for all well abandonment activities. This contractor will be responsible for managing the well abandonment permitting process. The water well contractor will plug any well drilled under his license, which is not completed or is not suitable for its intended use when work is completed.

In some cases, other well abandonment procedures may be more effective in accomplishing the objectives of preventing cross-contamination and intermixing of groundwater. One of these methods is to completely remove the well casing and screen from the borehole. This may be accomplished by overdrilling the well (for instance with hollow stem augers) over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. The well casing will then be removed from the hole with the drill rig. The clean borehole will then be tremie-grouted from bottom to top, as specified in BSOP No. 10 regarding annular well seals. The grout material will be placed into the borehole by pressure grouting with the positive displacement method (tremie method). The ground surface completion of the abandoned well will comply with the specifications presented in the previous paragraph.

This abandonment method can be accomplished on small diameter (1-inch to 4-inch) wells without too much difficulty. With wells having 6-inch or larger diameters, the use of hollow stem augers for casing removal is very difficult. Instead of trying to ream the borehole with a hollow stem auger, it may be more practical to force a drill stem with a tapered wedge assembly or a solid stem auger into the well casing and extract it out of the borehole. Wells with little or no grouted annular space can be removed in this manner. However, old wells with badly corroded casings and/or thickly grouted annular space have a tendency to twist and/or break-off in the borehole. When this occurs, the well will have to be grouted with the remaining casing left in the borehole. The preferred method in this case will be to pressure grout the borehole by placing the tremie tube at the bottom of the well casing, which will be the well screen or the bottom sump area below the well screen. The pressurized grout will be forced out through the well screen into the filter material and up the inside of the well casing sealing holes and breaks that are present. The tremie tube will be retracted slowly as the grout fills the casing to within 2 feet of the surface. The well casing will be cut off and the remaining space will be filled with concrete. If the casing has been broken off below the surface, the grout will be tremied to within 2 feet of the surface and then finished to the ground surface with concrete.

Well casings consisting of PVC material may be more difficult to remove from the borehole than metal casings because of the brittleness of PVC. If the PVC well casing breaks during removal, the borehole will be cleaned out by using a drag bit or roller cone bit with a rotary drill method to grind the casing into small cuttings that will be flushed out of the borehole by the selected drilling fluid. Another method is to use a solid-stem auger with a carbide auger head to grind the PVC casing into small cuttings that will be brought to the surface on the rotating flights. After the casing materials have been removed from the borehole, the borehole will be cleaned out and pressure grouted in accordance with BSOP No. 10. As previously stated, the borehole will be finished with a concrete surface plug and adequate surface protection, unless directed otherwise.

3 DOCUMENTATION

If required by state or local regulatory authorities, a permit to abandon a well will be obtained by the drilling contractor. The permits must be on-site during the well abandonment activities. The drilling contractor will be responsible for completely filling out and submitting a well abandonment completion report in an accurate and timely manner.

The contractor oversight will be responsible for fully documenting the well abandonment procedure. The following items will be documented in the field log book:

- Name of property owner
- Address of owner or property
- Well location
- Type of well installation method and date
- Type of well
- Construction of well, including total depth, diameter, depth of casing, type of well material, diameter of borehole, and material within annulus
- Depth to bedrock (if applicable)
- Depth to groundwater
- Formation material and characteristics
- Materials and quantities used to fill well, annulus
- Description of well abandonment procedures including drilling and placement of grout
- Description of drilling equipment
- Description and placement of well abandonment material
- Casing removed or filled in-place
- Drilling contractor

The contractor oversight will develop any logs or diagrams that may be helpful in documenting the abandonment process.

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4 REFERENCES

No references used.

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BSOP NO. 13

STANDARD CLEANING AND DECONTAMINATION PROCEDURES

BHATE STANDARD OPERATING PROCEDURE NO. 13

STANDARD CLEANING AND DECONTAMINATION PROCEDURES

The objective of this Bhate Standard Operating Procedure (BSOP) document is to provide the general procedures for the proper cleaning and decontamination of field equipment.

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BSOP NO. 13

STANDARD CLEANING AND DECONTAMINATION PROCEDURES

TABLE OF CONTENTS

1 INTRODUCTION

The cleaning procedures outlined in this BSOP represent standard decontamination procedures utilized by USEPA Region IV (EPA, 1997). If possible, sufficient clean equipment should be transported to the field so that an entire inspection or investigation can be conducted without the need for field cleaning of equipment. However, this will commonly be impracticable when using specialized field equipment. Field cleaning procedures are included in this Bhate Standard Operating Procedure (BSOP) document to cover these cases. Emergency field sample container cleaning procedures are also included in the last section of this BSOP document; however, they should not be used unless absolutely necessary. Specific cleaning procedures are presented in the following sections. Disposable sampling equipment will be used as much as possible to minimize the need for decontamination. In addition, sample containers for laboratory analyses will be provided by the laboratory and certified as clean. These sample containers will not be reused.

Sampling and field equipment cleaned in accordance with these procedures meet the minimum requirements for Data Quality Objectives (DQO) Level IV field work. Alternative field decontamination procedures must be documented in the approved study plan, field records, and investigative reports.

1.1 Procedure

1.1.1 Cleaning Materials

The cleaning materials referred to in this BSOP document are described in the following paragraphs.

The laboratory detergent will be a standard brand of phosphate-free laboratory detergent such as Liquinox®. The use of any other detergent must be justified, and documented in the field log books and inspection or investigative reports. This detergent must be kept in a clean plastic, metal, or glass container until used.

Nitric acid solution (ten percent) shall be made from reagent-grade nitric acid and deionized water. Nitric acid will be used only in areas with high metals contamination in the soil or groundwater. Nitric acid solution may be stored in clean plastic containers until used.

Tap water may be used from any municipal water treatment system. The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water must be stored in clean tanks, sprayers or squeeze bottles, or may be applied directly from a tap water source.

Deionized water is defined as tap water that has been treated by passing through a standard deionizing resin column. The deionized water should contain no heavy metals or other inorganic compounds (i.e., at or above analytical detection limits) as defined by a standard inductively coupled Argon Plasma Spectrophotometer (ICP) scan. Deionized water must be stored in clean glass, stainless steel, or plastic containers.

During cleaning operations, the substitution of a higher grade water (i.e., deionized or organic-free water for tap water) is permitted and need not be noted as a variation of this BSOP. However, the deionized water utilized must be subjected to the specific quality control procedures.

Nitric acid solution rinses may not be reused. The laboratory detergent and rinse water baths may be reused, but new solutions must be prepared periodically, depending on the amount of equipment requiring decontamination.

1.1.2 Marking and Segregation of Used Field Equipment

Field or sampling equipment that needs to be repaired will be identified with a tag. Any equipment problems and repair requirements shall be noted on this tag. Field equipment needing cleaning or repairs will not be stored with clean equipment, sample tubing, or sample containers.

1.1.3 Decontamination of Equipment Used to Collect Samples of Hazardous and Toxic Waste

Equipment that is used to collect samples of hazardous materials or toxic wastes or materials from hazardous waste sites, RCRA facilities, or in-process waste streams shall be decontaminated before it is returned from the field. At a minimum, this decontamination procedure shall consist of washing with laboratory detergent and rinsing with tap water. More stringent decontamination procedures may be required, depending on the waste sampled. If more stringent procedures are warranted, documentation of the decontamination method selection process and the supporting rationale must be provided to and approved by the Bhate Project Manager prior to implementation of the method in the field.

1.1.4 Proper Disposal of Cleaning Materials

The nitric acids used to rinse sampling equipment shall be collected and disposed of through an approved hazardous waste disposal contract. These procedures also apply to cleaning operations in the field.

1.1.5 Safety Procedures to be Utilized During Cleaning Operations

The materials used to implement the cleaning procedures outlined in this BSOP document can be dangerous if improperly handled. Due caution must be exercised by all personnel, and all applicable safety procedures shall be followed. At a minimum, the following precautions shall be taken in the washroom and in the field during these cleaning operations:

- Safety glasses with side shields or goggles, and nitrile or latex inner gloves, will be worn during all cleaning operations. When steam cleaning equipment, workers must wear tyveks and safety boots.

- All nitric acids rinsing operations will be conducted under a fume hood or outside. The operations shall never be performed in a closed room.

- No eating, smoking, drinking, chewing, or any hand to mouth contact shall be permitted during cleaning operations.

1.1.6 Storage of Field Equipment and Sample Containers

All field equipment and sample containers shall be stored in a contaminant free environment after being cleaned using the procedures outlined in this section. Equipment should be moved upwind of the decontamination area, and allowed to air dry. The dry equipment should then be wrapped in aluminum foil or plastic sheeting to prevent recontamination.

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2 SPECIFIC QUALITY CONTROL PROCEDURES FOR CLEANING OPERATIONS

This section establishes guidelines for specific quality control procedures to monitor the effectiveness of the sampling equipment cleaning procedures. All quality control procedures shall be recorded in a logbook.

2.1 Rinse Water

The quality of the laboratory, field deionized, or organic-free water shall be monitored by collecting samples once per quarter in standard pre-cleaned sample containers and submitting them for a standard ICP scan.

2.2 Cleaned Sampling Equipment

The effectiveness of the equipment cleaning procedures shall be monitored by rinsing cleaned equipment (equipment used to collect samples for trace organic compounds and metals analyses) with Milli-Q® or equivalent laboratory grade organic-free water and submitting the rinsate for low level analyses of extractable organic compounds including pesticides and a standard ICP scan.

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3 CLEANING REUSABLE EQUIPMENT

Efforts will be made to use disposable sampling equipment to minimize the potential for cross contamination. However, when equipment is reused, such as hand augers for soil sampling, the procedures outlined in this section shall be followed.

The following steps are to be utilized when cleaning Teflon™ or glass field sampling equipment:

1. Wash equipment thoroughly with laboratory detergent (e.g., Liquinox®) and water using a brush to remove any particulate matter or surface film.

2. Rinse equipment thoroughly with tap water.

3. Rinse equipment thoroughly with deionized water.

4. Allow equipment to air dry as much as possible.

5. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped equipment in plastic and date.

6. Rinse the Teflon™ or glass sampling equipment thoroughly with tap water in the field as soon as possible after use.

When cleaning stainless steel or metal sampling equipment, follow these steps:

1. Wash equipment thoroughly with laboratory detergent and water using a brush to remove any particulate matter or surface film.

2. Rinse equipment thoroughly with deionized water.

3. Allow equipment to air dry as much as possible.

4. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped equipment in plastic and date.

5. Rinse the stainless steel or metal sampling equipment thoroughly with tap water in the field as soon as possible after use.

In the cases where reusable sampling equipment (such as an oil-water interface probe) is used and contaminated with highly adhesive materials, additional decontamination procedures using special solvents may be required. If this is required, the special decontamination steps should be implemented between Steps 2 and 3.

If sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade isopropanol to remove the materials before proceeding with Step 1. In extreme cases, when equipment is painted, badly rusted, or coated with materials that are difficult to remove, it may be necessary to steam clean, wire brush, or sandblast equipment before proceeding with Step 1. Any metal sampling equipment that cannot be cleaned using these procedures should be discarded properly.

4 CLEANING PROCEDURE FOR SAMPLE TUBING

4.1 Silastic® Rubber Pump Tubing Used in Automatic Samplers and Other Peristaltic Pumps

The Silastic® rubber pump tubing need not be replaced in peristaltic pumps where the sample does not contact the tubing or where the pump is being used for purging purposes (i.e., not being used to collect samples).

The Silastic® tubing shall be pre-cleaned as follows:

1. Flush tubing with hot tap water and phosphate-free laboratory detergent.

2. Rinse tubing thoroughly with hot tap water.

3. Rinse tubing with deionized water.

4. Install tubing in automatic sampler or peristaltic pump.

5. Cap both ends of tubing with aluminum foil.

4.2 Teflon™ Sample Tubing

Manufacturer certified new, pre-cleaned Teflon™ tubing must be used for the collection of samples for laboratory analyses. The Teflon™ tubing will be discarded after use at one sampling location.

4.3 Stainless Steel Tubing

1. Wash with laboratory detergent and hot water using a long, narrow, bottle brush.

2. Proceed with Steps 2 through 5, as described in Section 4.1.

4.4 Glass Tubing

Use new glass tubing, pre-cleaned as follows:

1. Flush tubing with hot water and phosphate-free laboratory detergent.

2. Rinse thoroughly with deionized water.

3. Air dry for at least 24 hours.

4. Wrap tubing completely with aluminum foil and seal in plastic (one tube/pack) to prevent contamination during storage.

5. Discard tubing after use.

5 MISCELLANEOUS EQUIPMENT CLEANING PROCEDURES

5.1 Well Sounders or Tapes Used to Measure Groundwater Levels and Tag Lines

The following procedures apply to cleaning water level tapes and tag lines both in the field and at the shop. The procedures shall be followed for all sounding equipment upon arriving at a site and before leaving it. Personnel shall clean tag lines in accordance with these procedures between each well. However, just the probe on water level tapes may simply be rinsed with deionized water between wells, if gross contamination does not exist.

1. Wash with laboratory detergent and tap water.
2. Rinse with tap water.
3. Rinse with deionized water.
4. Allow to air dry overnight (doesn't apply to field cleaning).
5. Wrap equipment in aluminum foil (with tab for easy removal), seal in plastic, and date.

5.2 Submersible pumps and Hoses Used to Purge Groundwater Wells

5.2.1 Grundfos Pump Cleaning Procedure

CAUTION: To avoid damaging these pumps, the following precautions should be taken:

- Never run pumps under dry conditions.
- Never switch the Fultz pump directly from forward to reverse mode without pausing in the "OFF" position

Cleaning Procedure

1. Pump a sufficient amount of soapy water through the pump and associated hose to flush out any residual purge water.
2. Using a brush, scrub the exterior of the contaminated hose, electrical supply/control cables, and pump with hot soapy water. Rinse the soap from the outside of each with tap water. Next, rinse each with deionized water and recoil onto the spool.

3. Pump a sufficient amount of tap water through the pump and associated hose to flush out soapy water.

4. Pump or pour a sufficient amount of deionized water through the pump and hose to flush out the tap water.

5. Rinse the outside of the pump, hose, and electrical supply control cables with deionized water.

6. Place the equipment in a polyethylene bag or wrapped with polyethylene film to prevent contamination during storage or transit. Insure that a set of rotors, fuses, and cables are attached to each cleaned pump.

5.2.2 Goulds Pump Cleaning Procedure

CAUTION: During cleaning always disconnect the pump from the generator.

1. Using a brush, scrub the exterior of the contaminated hose and pump with soapy water.

2. Rinse the soap from the outside of pump and hose with tap water.

3. Rinse the tap water residue from the outside of pump and hose with deionized water.

4. Equipment should be placed in a polyethylene bag or wrapped with polyethylene film to prevent contamination during storage or transit.

5.3 Portable Power Augers

1. The engine and power head should be cleaned with a power washer, steam jenny, or hand washed with a brush using detergent (does not have to be laboratory detergent but should not be a degreaser) to remove oil, grease, and hydraulic fluid from the exterior of the unit. These units should be rinsed thoroughly with tap water.

2. All auger flights and bits shall be cleaned by a pressure washer (water at 200° and 1,500 psi) before borehole entry and will remain clean until installed in the borehole.

5.4 Large Soil Boring Equipment and Drilling Rigs

Large equipment such as drill rigs and drill tools (e.g., AW rods and HSAs) should be steam cleaned with high pressure hot water (200° F and at least 1,500 psi). Persistent particulate matter or surface films should be removed with tap water and phosphate-free detergent scrubbing and a tap water rinse. Drilling equipment that is steam cleaned should be placed on racks or saw horses at least 2 feet above the floor of the decontamination pad. Hollow stem augers or drill rods that are hollow or have holes that transmit water or drilling fluids should be cleaned on the inside with vigorous brushing.

After completion of decontamination the equipment should be removed from the decontamination pad and covered with clean unused plastic until the equipment is used again. If stored overnight, the plastic should be secured to ensure that it stays in place.

5.5 Miscellaneous Sampling and Flow Measuring Equipment

Miscellaneous flow measuring and sampling equipment shall be washed with laboratory detergent, rinsed with hot tap water, followed by a thorough deionized water rinse, and dried before being stored. This procedure is not used for any equipment utilized for the collection of samples for trace organic compounds or metals analyses.

5.6 ISCO Flow Meters, Field Analysis Equipment, and Other Field Instrumentation

The exterior of sealed, watertight equipment such as ISCO flow meters should be washed with a mild detergent (for example, liquid dishwashing detergent) and rinsed with tap water before storage. The interior of such equipment may be wiped with a damp cloth if necessary. Other field instrumentation should be wiped with a clean, damp cloth; pH meter probes, conductivity probes, DO meter probes, etc., and should be rinsed with deionized water before storage.

The desiccant in flow meters and other equipment should be checked and replaced if necessary each time the equipment is cleaned.

5.7 Ice Chests and Shipping Containers

All ice chests and reusable containers shall be washed with laboratory detergent (interior and exterior) and rinsed with tap water and air dried before storage. In the event that an ice chest becomes severely contaminated, in the opinion of the field investigator, with concentrated waste or other toxic material, it shall be cleaned as thoroughly as possible, rendered unusable, and properly disposed.

5.8 Portable Solvent Rinse System

1. Replace Teflon™ tubing if necessary. Wash nozzle and tubing fittings with hot, soapy water.

2. Rinse with deionized water.

3. Wrap nozzle and tubing ends with aluminum foil.

5.9 Preparation of Disposable Sample Containers

No disposable sample container may be reused. All disposable sample containers will be stored in their original packing containers. When packages of uncapped sample containers are opened, they will be placed in new plastic garbage bags and sealed to prevent contamination during storage.

5.10 Emergency Disposable Sample Container Cleaning

New one-pint or one-quart mason jars may be used to collect samples for analyses of organic compounds and metals in waste and soil samples in an emergency. These containers would also be acceptable on an emergency basis for the collection of water samples for extractable and pesticide organic analyses as well as metals analyses. These jars cannot be used for the collection of water samples for purgeable organic analyses (e.g., VOCs).

The rubber sealing ring should not be in contact with the jar and aluminum foil should be used, if possible, between the jar and the sealing ring. If possible, the jar and aluminum foil should be rinsed with pesticide-grade methanol (pesticide-grade petroleum ether or hexane may also be used) and allowed to air dry before use. Several empty bottles and lids should be submitted to the laboratory as blanks for quality control purposes.

6 REFERENCES

U.S. Environmental Protection Agency, Region IV, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, Environmental Services Division, March 1997, Revision 1.

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APPENDIX C
FIELD FORMS (PROVIDED ON CD)

bhate
ENVIRONMENTAL
CONSTRUCTION
ENERGY

1608 13th Avenue South, Suite 300
Birmingham Alabama 35205
Tel: 205-918-4000
Fax: 205-918-4050

Chain of Custody and Analytical Request

Page: ______ of ______

Project/Phase No: 9130156

COC Number(1): ______

LIMS Number: ______

Facility/Base I.D.:

Project/Site Name:

Client Name:

Collected by:

Field Sample ID (30 Characters Max)	ERPIMS LOCID (15 Characters Max)	Date Collected (dd-mmm-yyyy)	Time Collected (Military) (hhmm)	Sample Depth (beginning - ending)	SA Code (2)	Sample Number (3)	Sample Matrix (4)	Number of containers (Sample Analysis Requested (5))										Ambient Blank Lot Control Number (Quality Assurance Samples (6))	Equipment Blank Lot Control Number	Trip Blank Lot Control Number	Cooler ID
				-																	
				-																	
				-																	
				-																	
				-																	
				-																	
				-																	
				-																	
				-																	

COMMENTS: ______

Custody Transfers Prior to Receipt by Laboratory

Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time
1.______			1.______		
2.______			2.______		
3.______			3.______		

Sample Delivery Details / Laboratory Receipt

Delivered Directly to Lab: ______ Shipped No.: ______

Method of Shipment: Fed Ex Airbill Number: ______

Analytical Lab: Accutest Labs Delivery Location: ______

Lab Recipient: ______ Delivery Date/Time: ______

1.) Chain of Custody Number = date collected + custody number (e.g. 09-02-1999-01)

2.) Sample Type (SA) Codes: N = Normal Sample, TB = Trip Blank (-c) Sample, FD = Field Duplicate (-a) Samples, FR = Field Replicate (-b) Samples, EB = Equipment Blank (-d) Samples, MS = Matrix Spike, SD = Matrix Spike Duplicate, AB = Ambient Blank (-e)

3.) Sample Number: Unique sample number collected from a particular location per day. (e.g. Groundwater sample collected from MW-1 on 10/10/99 = 01, if sampled again on 10/10/99 = 02, etc.)

4.) Matrix Codes: GS = Soil Gas, WG = Groundwater, WS = Surface Water, SO = Soil, SE = Sediment, SL = Sludge, SS = Surface Soil Samples, WQ = Aqueous Blank Samples (trip, equipment, ambient, etc), SQ = Soil Blanks

5.) Sample Analysis Requested: Analytical method requested and number of containers provided for each.

6.) Quality assurance samples are assigned by date (ddmmyy) and the sample number associated with the sample (01, 02, etc) (e.g. Equipment blank collected in association with MW-1 on 10/10/99 will be designated 10109901 in the Equipment Blank Lot Control

DAILY QUALITY CONTROL REPORT

Project Number/Name: ____ DQCR No.: ________

Date ___/___/___ Time On-Site: ______________ Time Off-Site: _____________ Site Name: __ __________

Weather: ____ Temperature: __________ Wind: ___________

Contractor Personnel On-Site: ____

____

____

Visitors On-Site:____

____

Summary of Work Performed:____

____

____

____

____

____

Level of Health & Safety Protection: ____

____

Equipment Used: ____

____

Calibration(s) Performed: ____

____

Equipment Problem(s)/Remedies:____

____

Samples Collected*____

____

Sample Collection Method(s):____

Quality Control:____

Proposed Schedule for Tomorrow:____

Additional Remarks:____

Signature:____Job Title:__ ___

*Indicates sample media: groundwater, surface water, soil or sediment; sample type: composite, grab, split, duplicate, rinsate, and sample I.D. numbers

bhate ENVIRONMENT INFRASTRUCTURE

Daily Tailgate Safety Meeting

Project Name: ______________________ **Date:** ____________

Project/Phase: ______________________ **Time:** ____________

Meeting Conducted by: ______________________

Print Name *Signature*

1. AWARENESS (e.g., special EHS concerns, pollution prevention, recent incidents, etc.):

2. OTHER ISSUES (HASP changes, new AHAs, attendee comments, etc.):

3. DISCUSSION OF DAILY ACTIVITIES/TASKS AND SAFETY MEASURES TO BE USED:

4. ATTENDEES (Print Name):	
1)	2)
3)	4)
5)	6)
7)	8)
9)	10)
11)	12)
13)	14)

This Daily Tailgate Safety Meeting log documents the safety briefing conducted in accordance with 29 CFR 1910.120 *Hazardous Waste Operations and Emergency Response* as well as other applicable regulatory requirements. Personnel who perform work operations onsite are required to attend each safety briefing and acknowledge receipt of such briefings daily.

Headspace Monitoring Data Sheet
Page No. ________ of ________

Project Name: ______________________________ **Date:** ______________

Monitoring Equipment: PID / FID (Lamp eV, Calibration Gas Make, Model, Serial Number):

____

Task: ______________________________

Weather: ______________________________

Time	Sample ID	OVA (ppb/ppm) Filtered (if applicable)	OVA (ppb/ppm) Unfiltered	Comments:

bhate
ENVIRONMENT
INFRASTRUCTURE

Headspace Monitoring Data Sheet

Page No. _______ of _______

Time	Sample ID	OVA (ppb/ppm) Filtered (if applicable)	OVA (ppb/ppm) Unfiltered	Comments:

Comments:

HTW DRILLING LOG

1. COMPANY NAME	2. DRILLING CONTRACTOR	HOLE NO.
		SHEET OF SHEETS
3. PROJECT	4. LOCATION	
5. NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL	
7. SIZES & TYPES OF DRILLING & SAMPLING EQUIPMENT	8. HOLE LOCATION North East	
	9. SURFACE ELEVATION (ft. NGVD)	
	10. DATE STARTED	11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED	
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE REC %
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	Field Screening Results d	Geotech Sample or Core Box No. e	Analytical Sample No. f	Blow Counts g	REMARKS h
	0						
	1						
	2						
	3						
	4						
	5						

PROJECT	HOLE NO.

HTW DRILLING LOG

HOLE NO.

PROJECT	INSPECTOR	SHEET OF SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	Field Screening Results d	Geotech Sample or Core Box No. e	Analytical Sample No. f	Blow Counts g	REMARKS h

PROJECT HOLE NO.

HTW DRILLING LOG

HOLE NO.							
PROJECT				INSPECTOR		SHEET OF SHEETS	
ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	Field Screening Results d	Geotech Sample or Core Box No. e	Analytical Sample No. f	Blow Counts g	REMARKS h

PROJECT

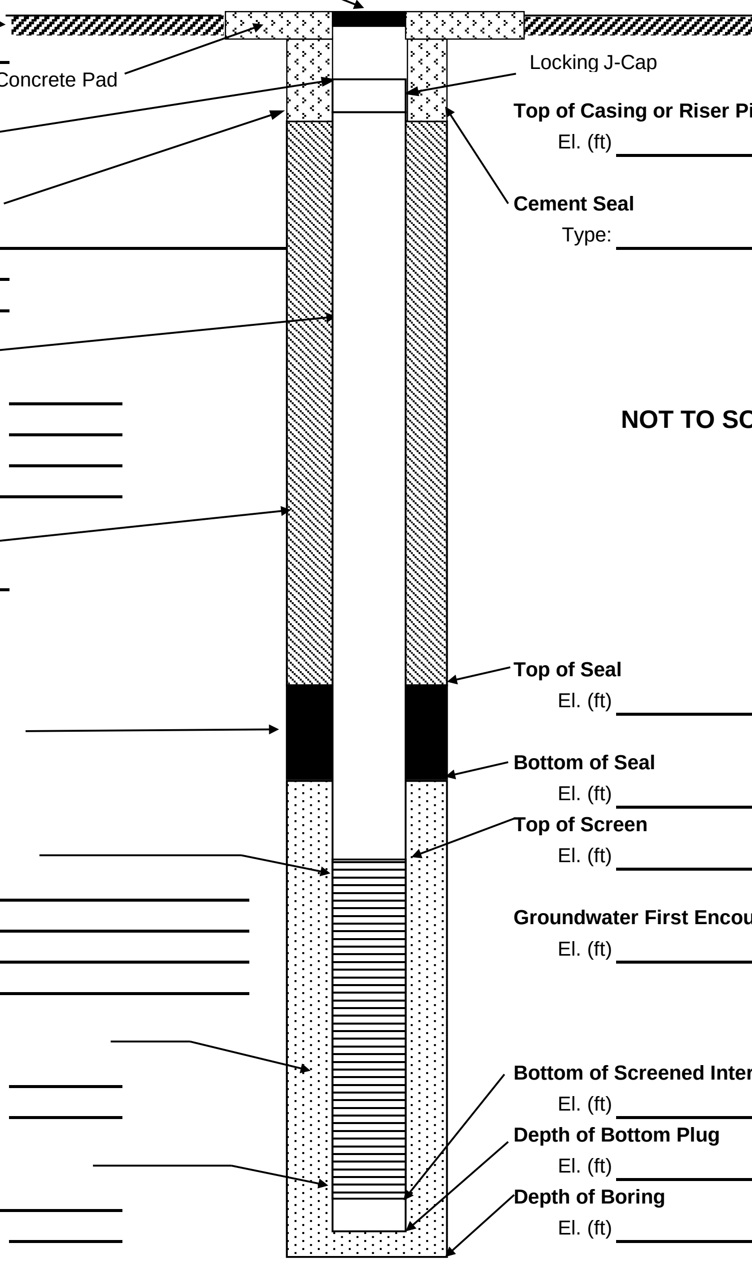
HOLE NO.

GROUNDWATER MONITORING WELL INSTALLATION DETAIL (FLUSH MOUNT)

Project: ______________________ Well/Boring No.: ______________________
Proj./Phase No.: ______________________ Geologist: ______________________
Boring Location: ______________________ Start Date: ______________________
Drilling Method: ______________________ End Date: ______________________
Driller Name: ______________________ Drilling Contractor: ______________________
Type of Installation: ______________________ Driller Certification No. ______________________

Survey Datum: NGVD Ground Surface Elevation (ft): ________

Protective Vault:
Inside Diameter: ________
Type of Surface Seal: ________
Thickness of Surface Seal: ________



Flush-Mounted Locking Cap

Existing Surface: ________

Concrete Pad

Locking J-Cap

Top of Casing below Existing Surface

Top of Casing or Riser Pipe
El. (ft) ________ Stickup (ft bls) ________

Grout Interval:
Material: ________
Top ________
Bottom ________

Cement Seal
Type: ________ Depth (ft): ________

Casing:
Diameter (in): ________
Length (ft): ________
Connections: ________
Material: ________

NOT TO SCALE

Borehole:
Diameter: ________

Top of Seal
El. (ft) ________ Depth (ft bls) ________

Bentonite Seal

Bottom of Seal
El. (ft) ________ Depth (ft bls) ________

Top of Screen
El. (ft) ________ Depth (ft bls) ________

Screen:
Slot Size: ________
Length: ________
Diameter: ________
Material: ________

Groundwater First Encountered
El. (ft) ________ Depth (ft bls) ________

Sand/Gravel
Size: ________
Material: ________

Bottom of Screened Interval
El. (ft) ________ Depth (ft bls) ________

Depth of Bottom Plug
El. (ft) ________ Depth (ft bls) ________

Bottom Plug
Material: ________
Connection: ________

Depth of Boring
El. (ft) ________ Depth (ft bls) ________

________ ft. + ________ ft. + ________ ft. = ________ ft.
Length of Riser Pipe + Length of Screen + Length of Cap/Plug = Total Well Depth

All elevations are referenced to National Geodetic Vertical Datum (NGVD). Bls = Below land surface

WELL DEVELOPMENT LOG

Sheet__________ of __________

PROJECT:			**WELL ID:**
Performed By:	**Signature:**	**Completion Date:**	**Development Data:**
Water Level **Initial:** **Final:**	**Develop Method:**		**Total Vol. Dev:**
Weather:	**Screen Interval:**	**Top:**	**Bottom:**
Wetted Volume: .016gal/ft 2' casing +.87 gal/ft sand pack for a borehole		**Total Depth:** **Initial:**	**Final:**

Time	Cum Volume (Liters)	Water Quality Parameters						Water Level (Feet)	Comments
		Temp (^{o}C)	pH	Cond (mS/cm)	Turb (NTU)	D.O. (mg/L)	Redox (mV)		

Remarks

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site:	Location ID:	Date:
	Project Name:	Project No./Phase:	Recorded By:
EQUIPMENT	Pump Type/ID#:	Water Quality Meter/ID#:	PID Type/ID#:
	Water Level Indicator Type/ID#:	Other Equipment/ID#:	Decon Method:
	Tubing Type/Diameter (in):	Other Equipment/ID#:	PPE:
WELL INFO	Casing Type / ID (in):	Unit Casing Volume (gal/lin ft) (A):	Initial Depth to Water (ft) (B):
	Total Well Depth (ft) (C):	Water Column Thickness (ft) (C-B):	Well Volume (gal) (A*(C-B)):
	Ambient PID (ppm):	Well Mouth PID (ppm):	System Volume (gal):
	Weather:	Well Condition:	Comments:

CASING INFO	Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
	Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)

Colorimeter Results					**No. Containers/Volume/Type**			**Preserv.**	**Filter (Y/N)**	**Method**	**Parameter(s)**
Time	**Analyte**	**Dilution**	**Result**	**Units**							
Conversions	**Stabilization Criteria**										
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%							
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%							
	Cond	+/- 10%	ORP	+/- 10	Sample ID:			Sample Time:			

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ENVIRONMENT
INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

Page ________ of ________

LOCATION	Site:	Location ID:	Date:
	Project Name:	Project No./Phase:	Recorded By:

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (gals)	Pumping Rate (mL/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)

UTILITY CLEARANCE CHECKLIST

Date:	Site Name:
Project/Phase Number:	Location:
SSHO:	Weather Conditions:
Other Personnel/Affiliations:	Team Members/Responsibilities:
Proposed Daily Activities:	

Activity	Date
1. Reviewed Work Plan with Project Manager	
2. Requested maps of aboveground and underground utilities	
3. Reviewed utility maps:	
• Water supply	
• Fire water supply	
• Sewer	
• Electric	
• Gas	
• Telephone	
• Cable	
• Other (navigational, process lines, etc.)	
4. Met with facility representative(s) to review utility locations and asked each representative the following questions:	
• Any underground utilities at work site location?	
• Any on-going construction that would affect field activities?	
• Any chemical releases associated with unit operations?	
• Any other hazards associated with operating units?	
• Any special requirements?	
5. Name of Utilities and their representatives:	

Utility	Name	Phone Number

6. Determine if any permits are required:	
7. Types of permits required:	
8. Requested MSDS for any on-site chemical expected in the subsurface:	

9. Comments

Drilling/Excavation Safety Sign-Off
(To be completed before drilling/excavation begins)

Field location of monitoring well/boring/excavation number ______________ has been evaluated for clearance of underground utilities (e.g., electrical, sewer, water, cable, etc.) as well a s a 10-foot clearance form overhead power lines. Additionally, clearance has been received from airport operations, the training officer, range control officer (if applicable), land management (hunting season checked), and other affected parties.

In addition, the Bhate Site Safety and Health Officer and the drilling/excavation foreman have familiarized themselves with any site safety and special considerations.

Title/Position	Printed Name	Signature	Date
Bhate Project Manager or Field Team Leader			
Bhate SSHO			
Airport Manager			
Land management			
Training Officer			
Drilling Foreman			

Drilling/excavation will commence after all affected/required parties have signed off.