Environmental Investigations at Former CCC/USDA Facilities: Master Work Plan

Environmental Science Division

United States Department of Agriculture

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Environmental Investigations at Former CCC/USDA Facilities: Master Work Plan

Volume 1: Main Text

by
Applied Geosciences and Environmental Management Section
Environmental Science Division, Argonne National Laboratory

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Notation

AGEM	Applied Geosciences and Environmental Management (Argonne)
ARAR	applicable or relevant and appropriate requirement
AS	air sparging
ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
BER	Bureau of Environmental Remediation (KDHE)
°C	degrees Celsius
CAA	Clean Air Act
CAS	corrective action study
CCC	Commodity Credit Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	U.S. Code of Federal Regulations (U.S.)
CLP	Contract Laboratory Program (EPA)
CPT	cone penetrometer
CSR	Code of State Regulations
CWA	Clean Water Act
dba	decibel(s)
DO	dissolved oxygen
DOE	U.S. Department of Energy
DQO	data quality objective
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESH	environmental, safety, and health
EUC	environmental use control
eV	electron volt(s)
EVS	Environmental Science Division (Argonne)
°F	degrees Fahrenheit

FFD	fitness for duty
FHSC	field health and safety coordinator (AGEM)
FR	Federal Register
FS	feasibility study
FSA	Farm Service Agency
ft	foot (feet)
gal	gallon(s)
GC-ECD	gas chromatography-electron capture detector
GC-MS	gas chromatography-mass spectrometry
GIS	geographic information system
gpm	gallon(s) per minute
HAP	hazardous air pollutant
HASP	health and safety plan
hr	hour(s)
IDW	investigation-derived waste
IGA	interagency agreement
ISM	Integrated Safety Management (Argonne)
JHQ	Job and Hazard Questionnaire (Argonne)
JSA	Job Safety Analysis (Argonne)
KAR	Kansas Administrative Regulations
KDHE	Kansas Department of Health and Environment
KSA	Kansas Statutes Annotated
LTM	long-term monitoring
LTO	long-term operation
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MCWC	Missouri Clean Water Commission
MDNR	Missouri Department of Natural Resources
mg/L	milligram(s) per liter

µg/L	microgram(s) per liter
mi	mile(s)
min	minute(s)
MOA	memorandum of agreement
MRBCA	Missouri Risk Based Corrective Action
NCP	National Contingency Plan (formally, the <u>National</u> Oil and Hazardous Substances Pollution <u>Contingency Plan</u>)
NDEE	Nebraska Department of Environment and Energy
NDEQ	Nebraska Department of Environmental Quality
NDNR	Nebraska Department of Natural Resources
NEPA	National Environmental Policy Act of 1969
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NSDWRs	National Secondary Drinking Water Regulations
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Organization
PEL	permissible exposure limit
PID	photoionization detector
PM	particulate matter
POTW	publicly owned treatment works
PPE	personal protective equipment
ppm	parts per million
QA/QC	quality assurance/quality control
RAP	remedial action plan
RAPMA	Remedial Action Plan Monitoring Act (Nebraska)
RBTL	Risk-Based Target Level
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
RMP	risk management plan
RSMo	Revised Statutes of Missouri

SARA	Superfund Amendments and Reauthorization Act of 1986
SDS	safety data sheet
SDWA	Safe Drinking Water Act
SMCL	secondary maximum contaminant level
SME	subject matter expert
SOP	standard operating procedure
SOW	statement of work
SVE	soil vapor extraction
TBC	to be considered
TSCA	Toxic Substances Control Act
USC	U.S. Code
USDA	U.S. Department of Agriculture
UST	underground storage tank
VCP	Voluntary Cleanup Program
VOC	volatile organic compound
WCD	work control document
WPC	work planning and control (Argonne application)
yr	year(s)

1 Introduction

The Commodity Credit Corporation (CCC) of the U.S. Department of Agriculture (USDA) has entered into an interagency agreement with the U.S. Department of Energy (DOE) under which Argonne National Laboratory provides the CCC/USDA with technical assistance for site characterization investigations and remediation efforts at its former grain storage facilities in Kansas, Nebraska, and Missouri (and possible other states), where carbon tetrachloride is the contaminant of primary concern. Argonne's environmental investigations at these facilities are based on an expedited approach to site characterization that Argonne developed, which became the basis for Standard D6235-98 (now Standard D62351-18; revised in 2004 and 2018) of the American Society for Testing and Materials (ASTM 2018).

The goal in Argonne's environmental site investigations is to produce a technically accurate data set that can fully support decision making about future needs at a site. Argonne's approach is as follows:

- Gather and integrate existing information before planning the field program.
- Develop a flexible site-specific work plan to accomplish the investigational goals established by the CCC/USDA and the state regulatory agency.
- Conduct an initial site visit to identify the most promising technological approaches for the specific site, as well as logistic and community constraints. Emphasize noninvasive and minimally invasive technologies to minimize risks.
- Throughout the field program, implement the broad requirements of the quality assurance/quality control (QA/QC) plan, community relations plan, and health and safety plan (HASP) presented in this volume, as well as site-specific procedures as needed.
- Throughout field implementation, communicate continually — with team members, the CCC/USDA project manager, and the regulating agency.
- Consult with the CCC/USDA and regulatory agency project managers if significant changes to the site-specific work plan are advisable.
- Include visiting CCC/USDA and regulatory agency project managers in field activity whenever possible; recover split samples to facilitate verification of analytical results.

The Argonne approach to environmental remediation, if necessary for a specific site, is as follows:

- Monitor groundwater flow and contaminant migration for a period adequate to define those aspects of the site.

- Review and select candidate remediation technologies appropriate to the site's groundwater flow and contaminant migration regime for review by the CCC/USDA and regulatory agency project managers.
- Design and implement a remediation program tailored to the needs for the specific site, with the assistance of contractors as needed.
- Design and implement a monitoring program to verify the effectiveness of the remediation, with the approval of the CCC/USDA and regulatory agency project managers.

This *Master Work Plan* describes the general investigation and remediation policies and procedures to be followed at former CCC/USDA facilities by Argonne's Applied Geosciences and Environmental Management (AGEM) program. Volume 1 of this plan describes the general procedures common to the field programs for all sites, as follows:

- Section 2 Regulatory framework
- Section 3 AGEM's technical program
- Section 4 QA/QC plan
- Section 5 Community relations plan
- Section 6 Health and safety plan
- Section 7 References

Volume 2 of this *Master Work Plan* contains the standard operating procedures (SOPs) that provide detailed direction for the AGEM program's field work.

In addition to the two volumes of this *Master Work Plan*, Argonne prepares for each site investigation a site-specific work plan that contains a description of the site geography and history, its geologic/hydrogeologic setting, specific community relations details, and the specific technical site program, as well as a site-specific HASP. For each site, therefore, the technical work plan will comprise a combination of the material presented in this *Master Work Plan* and the site-specific work plan.

The Argonne investigation program for any site may be divided into phases, or it may be targeted to focus on specific issues, with an initial stage and optional further stages of a single investigation. Results are reported at the conclusion of work in an investigation report, as outlined in the approved site-specific work plan.

When the investigation has been completed at a site, the CCC/USDA and regulatory agency project managers will determine whether extended monitoring and remediation are necessary. Related activities conducted by AGEM include risk assessment, selection of remedial approaches, and implementation of a remediation plan. Results are reported as determined by the CCC/USDA and regulatory agency project managers.

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2 Environmental Protection Controls and Performance Standards/Practices

This section provides a discussion of the environmental protection controls and performance standards/practices that, when applied to site investigation/characterization, remedial action, and long-term monitoring activities, will ensure that the activities do not adversely affect public health or the environment and that desired levels of environmental protection are attained. Section 2.1 addresses federal controls and performance standards/practices; Section 2.2 addresses those put forth by the states of Kansas, Nebraska, and Missouri.

This section addresses only environmental protection controls and standards. Standards for assuring the quality and accuracy of data gathered, and the protection of the health and safety of site workers and the general public, are discussed in Sections 4 and 6, respectively, of this *Master Work Plan*.

2.1 Regulatory Background

Former CCC/USDA facilities being addressed by the AGEM program under this *Master Work Plan* will be in one or more of the site work phases identified in an Intergovernmental Agreement (IGA) and/or other agreed-upon mechanisms used to identify and manage contaminant threats associated with former CCC/USDA grain storage sites in Kansas, Missouri, and Nebraska. Environmental controls and performance standards may be applicable to each of several phases with different nomenclature depending on the state, but which generally involve the following phases: (1) discovery, (2) site investigation/characterization, (3) evaluation of cleanup remedies, (4) remedy implementation, and (5) long-term monitoring. As noted in Section 2.2, each state follows a phased approach similar to that required by the federal *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended.

Section 121(d) of CERCLA requires that on-site remedial actions attain, upon completion of the remedial action (or waivers received for), federal environmental Applicable Relevant and Appropriate Requirements (ARARs) and more stringent state environmental ARARs, as well as follow all state facility-siting laws. Argonne relies on ARARs and state guidance documents during the site investigation/characterization phase to ensure that data collected can be used to satisfy remedial action-related ARARs. Federal ARARs provide cleanup goals and guide the remedy evaluation and implementation phases.

Federal ARARs are typically identified on a site-specific basis. Factors influencing ARARs and applicable state guidance include (1) the site characteristics, such as contaminants (chemicals) present, the site location, the site physical features; (2) the actions under consideration for investigation/characterization activities; (3) monitoring activities; and (4) the evaluation and implementation of corrective action (40 CFR 300).

The National Contingency Plan (NCP) explicitly requires the development and application of ARARs once the remedial investigation/feasibility study (RI/FS) phase is reached (40 CFR 300.430(d)). Typically, ARARs and state guidance are identified and documented in the FS; a corollary to the Corrective Action Study (CAS) in Kansas, the Voluntary Cleanup Program (VCP) in Nebraska, and the Risk Management Plan (RMP) in Missouri. However, as a matter of policy, the U.S. Environmental Protection Agency (EPA) has stated that even during the RI (a corollary to the Kansas, Missouri, and Nebraska investigation study phase), treatment or disposal of investigation-derived waste (IDW) must ensure protection of human health and the environment and must, to the extent possible, comply with (or waive) federal and state ARARs (EPA 1988a,b; 1989a, 1991, 1992).

2.2 Procedure for Identifying Controls and Standards

2.2.1 Site Investigation/Characterization Phase

Guidance for the determination of ARARs has been published by the EPA in numerous sources (e.g., EPA 1988a,b; 1989a, 1991, 1992,1997, 2017a). *Applicable* requirements are those that, as a matter of basic statutory or regulatory jurisdiction, would apply to an activity, whether or not that activity was conducted under the authority of CERCLA. The EPA guidance defines applicable requirements as “those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance present at a CERCLA site” (EPA 1989a).

Relevant and appropriate requirements are defined as “those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site” (EPA 1989a).

Additional standards and controls for site investigations/characterizations can be derived from non-promulgated guidance or advisories issued by federal or state agencies. Guidance and advisories are referred to as *To Be Considereds* (TBCs).

Environmental protection controls and standards are considered to be chemical-specific; action-specific; or location-specific. Chemical-specific ARARs/TBCs are health- or risk-based standards issued for specific chemicals (or chemical families). Action-specific ARARS/TBCs are applicable to the techniques used during a site investigation/characterization including, but not limited to:

- the form and content of investigation plan and investigation result reports;
- soil, groundwater and indoor air sampling methods;

- sample preservation, chain of custody, and transport;
- monitoring well installation methods; and
- methods for the management and disposal of IDW.

Some waste streams that are expected to result from the planned site investigation/characterization activities include (1) cuttings from soil borings and well installations, (2) well development fluids, (3) purge water recovered from sampling wells, (4) residuals and quality control duplicates from sample analyses performed both in the field and in off-site laboratories, (5) equipment decontamination rinsates, (6) soiled and potentially contaminated personal protective equipment, and (7) other miscellaneous wastes associated with well installation and sampling of various environmental media. Planned site investigation/characterization activities might also result in minimal releases of particulate matter or other air emissions from drilling equipment.

The anticipated chemical-specific ARARs/TBCs applicable to the generation, management, and ultimate disposal of site characterization wastes for the locations addressed in this *Master Work Plan* would be carbon tetrachloride and, at some locations, nitrates. (Even though the nitrate contamination that might be encountered is not attributable to CCC/USDA activities, the presence of such contamination in site characterization wastes will establish the applicability of nitrate-specific controls in the management and disposal of those wastes.)

Location-specific ARARs/TBCs are restrictions placed on concentrations of hazardous substances, or the conduct of activities involving those substances, solely because of the special or sensitive nature of the location within which the substances or activities are found. Site investigation/characterization activities also may involve location-specific aspects that are not necessarily requirements, but that Argonne is sensitive to because the attributes of a location can have a major impact on the way a characterization study is performed. Under this *Master Work Plan*, it is a standard practice to perform an initial site visit (reconnaissance survey) of each location to be investigated/characterized before site investigation activities begin. Such location-specific issues include, but are not limited to, the presence of:

- privately owned water supply wells;
- public water supply wells;
- faults displaced in Holocene time;
- 100-yr floodplains;
- salt dome formations;
- culturally significant properties;
- critical habitats upon which endangered or threatened species depend;

- wetlands, wilderness areas and wildlife refuges;
- areas immediately adjacent to streams or rivers;
- areas affecting national, wild, scenic, or recreational rivers;
- wellhead protection areas; and
- other sensitive areas as defined by the EPA or state authorities.

In addition, one of the goals of the initial site visit is to identify property boundaries and historic property ownership and all requirements imposed by local government entities (Section 3.1.1).

A listing of the federal environmental protection controls and performance standards that are applicable or relevant and appropriate (or considered to be relevant guidance) for planned site investigation/characterization work is provided in Table A.1, Appendix A.

2.2.2 Remedy Evaluation and Implementation Phases

The EPA relies on nine evaluation criteria for the analysis of the alternatives developed during the FS/remedial action phase. A key criterion is the identification of ARARs, the environmental controls and performance standards that are the subject of this chapter. The criteria are as follows:

1. Overall protection of human health and the environment.
2. Compliance with ARARs, which addresses the attainment of federal and state environmental requirements determined to be either applicable or relevant and appropriate to the alternative, on the basis of site-specific considerations. Potential federal ARARs and TBCs are listed in Table A.1, Appendix A.
3. Long-term effectiveness and permanence.
4. Reduction of contaminant toxicity, mobility, or volume.
5. Short-term effectiveness.
6. Implementability.
7. Cost.
8. State acceptance.
9. Community acceptance.

The nine evaluation criteria above are not given equal weight during the evaluation process. Any remedial alternative selected must meet ARARs and be protective of human health and the environment. ARARs and protectiveness are thus threshold criteria that must be met for a remedial alternative to survive the screening process and to be selected as the final remedy.

2.2.3 Long-Term Operations and Monitoring Phase

Some remedial actions will require long-term operations (LTO) and long-term monitoring (LTM); for example, the operation of equipment and periodic sampling and analysis of site monitoring wells for an agreed-upon remedial action time frame. Other remedial actions may involve monitoring only. In either case, there may be ARARs/TBCs that will need to be followed for the duration of the LTM/LTO.

2.2.4 Project Completion and Long-Term Stewardship

In some cases, a remedial action will result in the attainment of cleanup standards established by ARARs/TBC in which case the CCC/USDA's involvement with the site may cease. There may be state-specific ARARs/TBCs that dictate how the CCC/USDA's involvement with a site is completed. In other cases, where a cleanup level cannot be achieved, state-specific ARARs/TBCs may need to be followed to ensure that conditions at the site remain protective of human health and the environment.

2.3 Intergovernmental Agreements

2.3.1 Framework for Determining Regulations and Guidance that Apply

The AGEM program relies on a combination of mechanisms when working with the states of Kansas, Nebraska, and Missouri to evaluate former CCC/USDA grain storage facilities. Existing IGAs, or those under development, are the main vehicles that establish the framework for the relationship between CCC/USDA and the states. The IGAs require that actions undertaken to address former CCC/USDA grain storage facilities not be inconsistent with the NCP (40 CFR 300). This and other requirements in the IGAs are augmented by state-specific regulations and guidance. Figure 2.1 is based on highlight boxes excerpted from an EPA quick reference fact sheet (EPA 1989b); these highlights are used to assess the state laws, regulations, and guidance that could be considered ARARs and TBCs by the USDA.

Each IGA includes two appendices: Appendix A of the IGA lists the CCC/USDA sites requiring additional investigation, characterization, remediation, and/or other work at the time of its signing; Appendix B of the IGA lists sites that have been determined to require no further action. The goal of the work conducted under this *Master Work Plan* is to move sites from Appendix A to Appendix B of the IGA.

FIGURE 2.1 EPA highlight boxes (Source: EPA 1989b)

2.3.2 Kansas

The Kansas Department of Health and Environment (KDHE) is the principal agency implementing environmental protection programs in the state of Kansas. The internal KDHE bureaus responsible for administering regulations and/or guidance that could be ARARs or TBCs for CCC/USDA facilities evaluated by the AGEM program include the Bureau of Air, Bureau of Environmental Remediation (BER), Bureau of Waste Management, and Bureau of Water. In many cases, state regulations are analogous to federal standards or represent the state's exercise of authorities granted it under various federal statutes.

The KDHE guidance for preparing a corrective action study (CAS; KDHE 2001) lists "compliance with federal and state ARARs as one of the criteria that must be evaluated in the CAS process." The CAS guidance also refers to and adopts several regulations and guidance documents related to CERCLA. Section 121 of CERCLA and provisions of the NCP (40 CFR 300 and EPA 1990) require the EPA to ensure that cleanup actions implemented under CERCLA meet the specifications of ARARs.

During the development of a CAS in the state of Kansas, the AGEM program will identify ARARs and TBCs based on the nature of the contamination, the site location, and the proposed corrective (remedial) action activities.

The AGEM program relies on a phased approach to optimize the evaluation of agreed-upon former CCC/USDA sites listed in Appendix A of the IGA between the CCC/USDA and the state of Kansas. Results from each phase as well as input from the CCC/USDA and KDHE project managers inform the development of subsequent phases and support recommendations for further action, as described in the IGA. These include (1) no further action; (2) additional site investigation; (3) evaluation of remedial action technologies; and (4) implementation of a corrective (remedial) action. The guiding principles of the AGEM program in Kansas on behalf of the CCC/USDA are to:

- facilitate the investigation, characterization, remediation, and/or other agreed-upon actions or decisions relating to carbon tetrachloride and its associated degradation products, and/or any other identified contaminants that may be associated with certain former CCC/USDA grain storage sites in Kansas;¹
- ensure compliance with applicable state and federal laws and regulations of site-related work; and,
- not be inconsistent with the NCP (40 CFR 300).

¹ The term "investigation" in this case involves site inspections and the review of archival records; "characterization" means the development and implementation of a site investigation work plan involving the collection and analysis of environmental media samples.

In general, the guidance provided by the KDHE's policy BER-RS-015 entitled *Potential Applicable or Relevant and Appropriate Requirements* (KDHE 2005) and best practices used to identify ARARs in the federal CERLCA remedial investigation/feasibility study process are used to identify environmental controls and performance standards for site work phases in Kansas.

Numerous state of Kansas technical guidance documents also have relevance during the site investigation/characterization, corrective action, and monitoring phases of former CCC/USDA sites. Table A.2 (Appendix A) summarizes the state guidance/advisory documents authored by the KDHE's BER that are likely to be applicable or relevant and appropriate for the site investigation/characterization and subsequent site work phases. The Kansas state guidance/advisory documents relevant for the AGEM program are mutable; new documents are added and existing documents are rescinded or modified periodically. The current versions of these documents are used by the AGEM program during all phases of site work. Although they are not legally binding, such guidance and directives (often defined as TBC requirements in the formal ARAR process), have been reviewed for their usefulness in developing operating procedures or best management practices that ensure compliance with the IGA, as well as federal and state regulations, and protection of public health and the environment during all site work phases.

Table A.3 (Appendix A) summarizes the state of Kansas ARARs and TBCs acknowledged by the AGEM program.

2.3.3 Nebraska

The Nebraska Department of Environmental Quality (NDEQ)² is the principal agency implementing environmental protection programs in the state of Nebraska. The internal NDEQ divisions responsible for administering regulations and/or guidance that could be ARARs or TBCs for CCC/USDA facilities evaluated by the AGEM program include the Air Quality Division, the Water Division, and the Waste Division. In many cases, state regulations are analogous to federal standards or represent the state's exercise of authorities granted it under various federal statutes.

As part of its Memorandum of Agreement (MOA) with the NDEQ, the CCC/USDA has agreed to perform response actions in accordance with the Nebraska Environmental Protection Act. In order to move ("delist") sites from Appendix A to Appendix B, Condition 25 of the agreement states that all actions undertaken by the CCC/USDA must be in compliance with federal and state laws, regulations, and requirements. The MOA allows CCC/USDA to voluntarily conduct its response actions in accordance with the Nebraska Remedial Action Plan Monitoring Act (RAPMA; Neb. Rev. Stat. §§81-15,181–88) and to seek a determination from the NDEQ that no further response action is required at the sites.

² As of July 1, 2019, the NDEQ is known as the Nebraska Department of Environment and Energy (NDEE); however, many of the state's statutes, regulations, and guidance documents are still cited as NDEQ.

Guidance for implementing the RAPMA is provided in the document entitled *Nebraska Voluntary Cleanup Program Guidance* (NDEQ 2018). Some aspects of the VCP are different than traditional cleanup programs. However, it is similar to traditional cleanup programs in the following areas:

- Cleanup decisions are protective of human health and the environment
- A complete and thorough investigation is necessary
- All activities must be in compliance with all applicable state and federal laws and regulations
- Risk-based cleanup goals are within the acceptable risk range of federal cleanup programs

The VCP does not require a formal and extensive evaluation of numerous potential remediation technologies. However, in cases where a site is either a Brownfield site or a site funded by the federal superfund program, participants are required to perform a remedial alternatives evaluation of at least two remedial alternatives (other than the no action alternative) using the following criteria:

- Protect human health and the environment
- Comply with all ARARs
- Provide short-term and long-term effectiveness
- Implementability
- Cost
- Achieve community acceptance

The *VCP Guidance* provides a Remedial Action Plan (RAP) checklist to be used when preparing a RAP. Section 2.3.3 (Proposed Remedial Actions) of the guidance document includes “compliance with ARARs” as element-specific information to be included in the RAP. Given the call out of ARARs in the RAP checklist, the MOA condition not to be inconsistent with the NCP (40 CFR 300), and the need to ensure compliance with all federal and state laws, the CCC/USDA assumes that ARARs and TBCs may have some role in the VCP process.

Table A.4 (Appendix A) summarizes the state of Nebraska ARARs and TBCs acknowledged by the AGEM program.

2.3.4 Missouri

The Missouri Department of Natural Resources (MDNR), Division of Environmental Quality, is the principal agency implementing environmental protection programs in the state of Missouri. Environmental programs within the Division of Environmental Quality responsible for administering regulations and/or guidance that could be ARARs or TBCs for CCC/USDA facilities evaluated by the AGEM program include:

- Air Pollution Control Program
- Environmental Services Program
- Hazardous Waste Program (Federal Facilities Section)
- Soil and Water Conservation Program
- Solid Waste Management Program
- Water Protection Program
- Public Drinking Water Branch
- Water Pollution Control Branch
- Water and Wastewater

The Hazardous Waste Program, Federal Facilities Section, oversees response, characterization, risk assessment, and risk management under a variety of authorities at contaminated sites currently or previously owned federal agencies. The role of the Federal Facilities Section in providing oversight for Department of Defense and the Department of Energy sites is explicitly called out in the Missouri Risk Based Corrective Action (MRBCA) technical guidance document (MDNR 2008). The facilities formerly operated by the CCC/USDA in Missouri are presumed to fall into the federal facility category mentioned in the MRBCA.

The MRBCA process does not supersede applicable federal statutes and regulations. Rather, the MRBCA guidance establishes a framework that follows the step-wise approach used by many regulatory programs to address contaminated sites: response, characterization, risk assessment, and, if needed: risk management and long-term stewardship.

As described in the MRBCA guidance, the Federal Facilities Section operates under the authority of federal laws, cooperative agreements and federal facilities agreements. As noted in the MRBCA, in addition to the cooperative agreements, the Federal Facilities Section operates under the following authorities:

- Authorities for the RI/FS are pursuant to Sections 120 and 121 of CERCLA/SARA, 42 U.S.C §§ 9620 and 9621 and Sections 3006 and 6001 of RCRA, 42 U.S.C §§ 6901 et seq., as adopted in Section 260.350 et seq. and Title 10 CSR, Chapter 25 and Chapter 80.
- Authorities for Remedial Actions are pursuant to Sections 120 (f) and 121 (f) of CERCLA/SARA, 42 U.S.C §§ 9620 (f) and 9621 (f) and Sections 3006 of RCRA, 42 U.S.C §§ 6925 as adopted in Section 260.350 et seq. and Title 10 CSR, Chapter 25 and Chapter 80.

The CERCLA remedial action process typically involves identifying and evaluating multiple remedial actions for a given contaminated site before a final decision on remediating the site is made. The ARARs/TBCs for each remedial action alternative are identified and evaluated along with other criteria as part of the remedial action alternative selection process. The MRBCA guidance refers to risk management and long-term stewardship components, which are somewhat related to phases in the CERCLA remedial action process. The CERCLA FS, remedial action selection, long-term monitoring and operations are similar to the MRBCA-suggested risk management and long-term stewardship stages. However, rather than identifying several remedial alternatives in a FS stage, the MRBCA guides the regulated community to propose a single remedial alternative in the risk management plan for the site. In addition, while the CERCLA remedial action selection process results in the selection of a remedial action that can meet ARARs and TBCs, the MRBCA guidance does not include an explicit requirement to satisfy ARARs and TBCs. Nevertheless as noted above, the draft IGA (under development) establishes the requirement to not be inconsistent with the NCP (40 CFR 300).

For the purposes of this *Master Work Plan* and future investigation/risk management work to be performed by the AGEM program on behalf of the CCC/USDA in Missouri, it is assumed that the Federal Facilities Section of the MDNR will take the lead and that a CERCLA-like approach will be used for the development, evaluation, and selection of investigation and risk management aspects. It is also assumed that a single action for risk management will be proposed and the CCC/USDA will ensure that the action meets the requirements of all ARARs/TBCs.

Table A.5 (Appendix A) summarizes the state of Missouri ARARs and TBCs acknowledged by the AGEM program. Requirements established in the IGA between the CCC/USDA and the MDNR and/or interactions with the MDNR project manager for a given CCC/USDA site may result in modifications to this approach.

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3 Technical Aspects of the AGEM Program

This section presents the various technical aspects of the AGEM program. Section 3.1 describes the site investigation activities associated with the field program, including the initial site visit and document review, the sampling of environmental media, drilling and direct-push operations, the installation and completion (and abandonment) of monitoring wells and piezometers, the hydrogeological aspects of investigation, and the disposal of IDW. Section 3.2 identifies the laboratories used to analyze the field samples (including IDW) collected during the field program. Section 3.3 lists the technologies that could be used for remediation of former CCC/USDA facilities. Section 3.4 describes the AGEM program's management of data and records on behalf of the CCC/USDA.

Further details of site investigation activities described in this section, including methodologies and field team requirements, can be found in the SOPs in Volume 2 of this *Master Work Plan*. Table 3.1 provides a list the SOPs cited in this section.

3.1 Field Program

3.1.1 Initial Site Visit and Document Review

Early in the planning process, before the work plan for a new site investigation is prepared, AGEM team members, typically the AGEM program manager, project manager (technical lead), and other members of the AGEM field team, will visit the location of the former CCC/USDA grain storage site. The purpose of the initial site visit is to observe the lay of the land, and to meet with landowners and city officials. An important objective of the trip is to determine whether there are residents within one mile of the project site who are not served by the city public water supply or a rural water district (relying instead on a domestic well for their drinking water). The AGEM team members visit the project site and take note of its current land use, as well as any physical features (e.g., roads, waterways, wells, cell towers, and buildings/structures) on the property. One of the team members, usually the AGEM community relations representative, will prepare a trip report to document the findings of the site visit for the CCC/USDA; the report is also filed in the AGEM program archives.

The AGEM team also conducts a search for relevant deed and lease documents at the county courthouse to obtain the ownership history of the project site and adjacent properties, as well as any other relevant current and historic property documents (see Section 5.2.1). Gaining permission to access the project site, which invariably is on private, commercial, or public property, is critical before the site investigation can begin since a property owner's willingness to cooperate with the field program (and grant access) is completely voluntary. One of the AGEM team's main goals is to introduce the USDA/AGEM program and establish a good working relationship with the landowners who will be affected by the site investigation field activities.

TABLE 3.1 Standard operating procedures for the AGEM field program.^a

SOP No.	SOP Title
AGEM-01	Direct Push, Drilling, and Geologic Logging
AGEM-02	Monitoring Well Installation and Development
AGEM-03	Installation of Piezometers with Direct-Push Equipment
AGEM-04	Abandonment of Soil Borings, Monitoring Wells, and Piezometers
AGEM-05	Purge Groundwater Sampling
AGEM-06	Low-Flow Groundwater Sampling
AGEM-07	Measuring Water Levels in Wells
AGEM-08	Slug Tests
AGEM-09	Pumping Tests
AGEM-10	Soil Sampling
AGEM-11	Handling and Disposal of Investigation-Derived Waste
AGEM-12	Installation of Soil Gas Probes
AGEM-13	Soil Gas Sampling for Chemical Analysis
AGEM-14	Geoprobe [®] and Sub-Slab Gas Detection
AGEM-15	Sub-Slab Soil Vapor Sampling for Vapor Intrusion Applications
AGEM-16	Air Sampling for Chemical Analysis
AGEM-17	Surface Water Sampling
AGEM-18	Sediment Sampling (in Surface Water Bodies)
AGEM-19	Vegetation Sampling for Chemical Analysis
AGEM-20	Measurement of Sap Flow in Trees
AGEM-21	Calibration of Field Instrumentation and PID Operation
AGEM-22	Equipment Decontamination
AGEM-23	Handling, Packing, and Shipping of Samples in the Field
AGEM-24	Organic Analysis of Water Samples by the AGEM Laboratory
AGEM-25	Organic Analysis of Soil Samples by the AGEM Laboratory
AGEM-26	Organic Analysis of Vegetation Samples by the AGEM Laboratory
AGEM-27	Sample and Document Management

^a These SOPs are in Volume 2 of this *Master Work Plan*.

To prepare the site investigation work plan, the project manager and team members will review historical (legal) documents and previous studies to gain an understanding of the affected community's geography, population, and history, including the source of its public water supply. Historical and current satellite images of the project site are obtained to document changes in land use over time, with a focus on the grain storage structures and activities taking place when the CCC/USDA occupied the site. Previous investigations in the area are reviewed for information on the nature and extent of contamination at the site, and the regional and local topography and hydrogeological conditions. All of these findings are to be summarized in the draft work plan and considered as the technical objectives and scope (tasks) of the field program are defined. The AGEM team submits the draft work plan to the CCC/USDA for approval and forwarding to the appropriate state agency for its comment/review and approval.

3.1.2 Sampling of Environmental Media

Site-specific work plans will contain the details on sampling media, modes, intervals, and frequencies for each sampling event. The following sections describe the sampling and processing methodologies used in the AGEM program, with reference to SOPs (Volume 2), as appropriate.

3.1.2.1 Soil and Soil Gas

Various methods are used to recover soil samples for chemical analyses and geotechnical analyses (particle size, bulk density, or percent moisture). Recovery methods for soils at depth include drilling or direct-push technology, depending on the depth of sample, the soil type, and the type of analysis for which the soil sample is collected. The collection, handling, packing, shipping, and documentation of all soil samples will follow the procedures outlined in SOPs AGEM-10, -23, and -27. The field team must follow the procedures for decontaminating equipment outlined in SOP AGEM-22 to prevent cross-contamination between sampling locations and to minimize the transfer of hazardous substances from the work area to unaffected area.

The principal methodology consists of sonic drilling, used to reach the desired depth (Section 3.1.3.1; SOPs AGEM-01 and -10). The principal direct-push configuration consists of a Geoprobe® Dual Tube or Macro-Core® continuous soil sampler that is pushed hydraulically with a cone penetrometer (CPT) rig, Geoprobe®, or rotary sonic rig (Section 3.1.3.2; SOPs AGEM-01 and -10). Cores obtain by sonic drilling are sleeved in plastic; all cores (from sonic drilling and direct push) are placed in core boxes for preservation and long-term storage.

Near-surface soils may be recovered with hydraulic-push technology, a hand-driven coring device (such as an ESP™ sampler), a hand-pushed coring device, or hand tools such as shovels, as appropriate (SOP AGEM-10).

Subsurface soil gas may be collected for chemical analysis by actively withdrawing an aliquot of vapor with a direct-push sampling probe for laboratory analysis (SOP AGEM-13). Soil gas probes may be installed either temporarily or permanently/semi-permanently (SOP

AGEM-12). Soil gas may also be tested under pavements overlying soils or groundwater potentially contaminated with carbon tetrachloride or other VOCs. This method uses a Geoprobe[®]-powered rotary-percussion method to penetrate the pavement by a combination of hammer percussion and slow rotation of the drill bit, which progressively chips away small fragments of the hard surface (SOP AGEM-14). A portable photoionization detector (PID) is used to detect any soil gas accumulated under the pavement (though the results are not compound-specific) so that sampling may proceed in a safe manner (SOPs AGEM-14 and -21).

3.1.2.2 Groundwater and Groundwater Levels

Groundwater samples for chemical (organic and inorganic) analysis may be collected from private or public wells, existing monitoring wells, and open or temporarily screened boreholes using bailors or pumps (dedicated or introduced).

Private or public wells. Private (domestic) wells are not constructed or plumbed for chemical sampling and in-use wells often cannot be accessed. In addition, it is often the case that the well and water depths in these wells is unknown. For these reasons, domestic wells will be sampled as near to the well head as possible and upstream from water treatment installations following the sampling, handling, packing, shipping, and documentation methodologies outlined in SOPs AGEM-05, -23, and -27. Active public wells are to be sampled in a similar manner. The AGEM program manager (or designee) will contact the landowner or water district, as required, to make special arrangements to sample these wells.

Monitoring wells. Existing monitoring wells must be purged before sampling by removing at least three well volumes of water; if there is insufficient flow, water should be removed until the well is dry (unless low-flow is used). Groundwater level and well depth also must be measured before well sampling begins.

Low-flow groundwater sampling will use a bladder pump and appropriate field equipment to measure parameters of pH, temperature, specific conductivity oxidation-reduction potential (ORP), and dissolved oxygen (DO). These parameters will be used by the site hydrogeologist to determine when a representative sample of formation water can be collected. Static water levels will also be measured periodically to aid in this assessment (SOP AGEM-06).

Groundwater sampling should occur in a progression from the least contaminated well to the most contaminated well (SOPs AGEM-05 and -06). The field team must follow the procedures for decontaminating equipment outlined in SOP AGEM-22 to prevent cross-contamination between sampling locations and to minimize the transfer of hazardous substances from the work area to unaffected area (random samples of decontamination water are analyzed to ensure there is no cross-contamination). The collection, handling, packing, shipping, and documentation of all groundwater samples will follow the procedures outlined in SOPs AGEM-05, -06, -23, and -27.

Groundwater levels for established monitoring wells at AGEM project sites are measured by hand with a graduated electronic water sensor or automatically with a downhole recording device. These procedures are described in SOP AGEM-07.

Open or Temporarily Screened Boreholes. Groundwater in open or temporarily screened boreholes is typically recovered with a bailer following the sampling, handling, packing, shipping, and documentation methodologies outlined in SOPs AGEM-05, -23, and -27.

3.1.2.3 Surface Water and Sediment

Surface water. Surface water samples for chemical analysis may be collected from streams, rivers, lakes, and ponds at depths ranging from about 1 ft to the water's surface. It is important to note here for safety reasons that (1) sampling locations are only to be accessed by a field team member located on relatively firm (dry or slightly submerged) ground or other surfaces that present minimal physical risk; (2) the field team will not collect water samples at depths greater than 1 ft, or water from impoundments or lagoons; and (3) surface water sampling *is not to be conducted alone* by a field team member unless approved by the AGEM program manager and done while maintaining a cell phone connection to another field team member (see also SOP AGEM-17). Sampling of surface water at depths greater than 1 ft requires special equipment and collection methods that must be described in detail in the site-specific work plan and HASP, and approved by the EVS environment, safety, and health (ESH) coordinator.

The collection, handling, packing, shipping, and documentation of all surface water samples will follow the procedures outlined in SOPs AGEM-17, -23, and -27.

Sediment. Sediments include relatively undisturbed mineral or organic materials submerged beneath static or flowing water. Representative sediment samples for chemical analysis are to be collected using hand-operated devices in relatively shallow surface water environments, following the same safety precautions described for surface water sampling in the preceding paragraph. The collection, handling, packing, shipping, and documentation of all sediment samples will follow the procedures outlined in SOPs AGEM-18, -23, and -27.

3.1.2.4 Vegetation and Sap Flow in Trees

Vegetation. Because carbon tetrachloride moves through plants by transpiration, vegetation (grass, tree branches and leaves, and tree core tissues) sampling can help determine the presence of subsurface contamination and guide the selection of subsurface sampling locations. The collection, handling, packing, shipping, and documentation of all vegetation samples will follow the procedures outlined in SOPs AGEM-19, -23, and -27.

Measuring sap flow in trees. The AGEM program is interested in the uptake of contaminants in trees (indigenous or those planted by the program as a phytoremediation system) on some project sites (e.g., Murdock, Nebraska). Measuring sap flow rates in trees provides a measure of estimating water usage of a tree or tree stand, which can be used to estimate carbon tetrachloride removal rates of the system. The procedures and supplies for installing and removing thermal dissipation probes, and the methodologies for downloading and analyzing data logger output are provided in AGEM SOP-20.

3.1.2.5 Indoor Vapor Intrusion Testing

There are times when sub-slab (below foundation) vapor testing in buildings is warranted to evaluate the potential for indoor vapor intrusion in buildings at or near the project site. Sub-slab sampling involves drilling a small hole through the foundation and inserting a sampling gas probe and cementing it in place (see also SOP AGEM-15). After the cement has set, a vapor sample is collected in a stainless steel (Summa) canister or in a gas-tight syringe (for screening). Once the sample has been collected, the foundation surface is restored. A permanent probe may be installed (Section 5.2, SOP AGEM-15).

Sub-slab sampling will not be conducted in buildings with earthen-floor foundations or with radiant heating or other utilities; in such cases, discrete air samples will be collected from a crawl space or other indoor space (SOP AGEM-16). If sampling a crawl space is not possible, soil gas probes will be installed in the ground outside the building (either temporarily or permanently/semi-permanently) using Geoprobe[®] technology in accordance with SOPs AGEM-12 and -13.

3.1.3 Drilling and Direct-Push Operations

Drilling and direct-push operations are conducted primarily to collect soil, rock, and groundwater samples, and to install monitoring wells and piezometers, as needed. Equipment required for all AGEM drilling operations includes an appropriately sized and adequately equipped drill rig, drill support truck(s), a steam cleaner, steel drums or roll-off, plastic sheeting, and sorbent pads. It is important to note that when drilling occurs in a surficial (water-table) aquifer, drilling must be terminated before the basal aquitard is totally penetrated. The depth drilled into the aquitard is determined by the project hydrogeologist by observation in relation to the site-specific geology as the drilling progresses. Penetrations below the surficial aquifer are limited to avoid cross-contamination. If drilling must proceed into a lower aquifer, casing will be set to ensure that cross-contamination does not occur.

Drilling contractors must be licensed by the relevant state to drill and install monitoring wells; and all drilling permits and licenses requirement by the state must be obtained before field work begins. A hydrogeologist designated by the AGEM program manager must be on-site during all drilling operations.

3.1.3.1 Sonic Drilling

The preferred drilling method for the AGEM field program is sonic drilling (SOP AGEM-01). Other methods may be considered on a case-by-case basis, depending on site conditions, the required borehole depth and diameter, equipment availability, the location's accessibility, ease of sample collection, and identification of an interval suitable for screening, time, and cost. In sonic drilling, a dual line of drill pipe is oscillated through the subsurface. An outer pipe prevents collapse of the borehole and is used in the construction of monitoring wells and piezometers. An inner pipe contains a core bit; the inner pipe can function as a core barrel sampler.

3.1.3.2 Direct-Push Technologies

Direct-push technologies involve hydraulically driven probes or samplers that are pushed into the ground, rather than drilled, to obtain subsurface samples and data. These technologies are less costly and less invasive (producing little or no cuttings or fluids that need disposal) and are generally more rapid to use than drilling. They cannot penetrate as deeply as drilling (usually less than a depth of 120 ft), however, and they are not capable of penetrating well-consolidated or cemented strata.

The AGEM field program uses CPT and Geoprobe[®] Dual Tube and Macro-Core[®] technology to reach desired depth so that piezometers or wells points for the collection of soil samples and long-term water data can be installed (see also SOPs AGEM-01 and -03). The Geoprobe[®] is also used to install soil gas probes (SOP AGEM-12) and, in some cases, to penetrate foundations to facilitate the detection of sub-slab soil gas (SOP AGEM-14). Both CPT and Geoprobe[®] units are to be operated in accordance with the manufacturer's instructions, as provided in SOP AGEM-01, by field personnel with documented training and experience suitable for the task.

3.1.3.3 Geologic Logging and Documentation of Well Construction Details

The project geologist is responsible for overseeing all drilling operations, as well as logging boreholes and documenting the well construction details so they can be filed with the appropriate state agency. Geologic logs are recorded following the procedure outlined in SOP AGEM-01. The procedure for preparing a well construction diagram is provided in SOP AGEM-02.

3.1.4 Monitoring Well and Piezometer Installation, Registration, and Abandonment

3.1.4.1 Installation of Monitoring Wells and Piezometers

A significant part of the field program is the installation of monitoring wells and piezometers that provide permanent access for the monitoring of groundwater contamination and levels (SOP AGEM-02). Monitoring wells are installed using drilling or direct-push methods, depending on site conditions. Piezometers are installed using CPT or Geoprobe[®] devices (SOP AGEM-03). It is important to note that the installation and use of piezometers must adhere to all state regulations; e.g., in Nebraska, piezometers cannot be completed as permanent wells and must be abandoned within 90 days of installation. The procedures for installing and developing monitoring wells and piezometers, and the details of their construction, including materials used and surface completion (flush-mount or stick-up type and installation of concrete pad) are provided in SOPs AGEM-02 and -03, respectively.

Methods for establishing and documenting a measurement reference point (e.g., top of casing) for each new monitoring well or piezometer are provided in SOP AGEM-07.

3.1.4.2 Well Registration

All monitoring wells installed during the field program will be registered with the appropriate state agency following the registration requirements and using the registration forms provided on their websites (SOPs AGEM-02 and -03).

3.1.4.3 Abandonment of Boreholes, Monitoring Wells, and Piezometers

The abandonment/decommissioning of boreholes (soil borings), monitoring wells, and piezometers no longer used in the AGEM program (or in a state of disrepair) are to be conducted in accordance with state requirements to ensure they do not become conduits of contamination to the states' groundwater supplies. Abandonment procedures must conform to applicable state requirements for borehole abandonment, including those for completing abandonment/plugging forms (notices and records) and filing them with the appropriate state agencies, as specified in SOP AGEM-04.

3.1.5 Hydrogeological Testing

Hydrogeological testing is sometimes performed in the field to determine *in situ* hydraulic properties of aquifers (e.g., transmissivity, hydraulic conductivity, storativity, and radius of influence) and to define the overall hydrogeological regime at the project site. This aspect of the field program adds to the working conceptual site model and helps the project hydrogeologist predict the movement of contaminants in the subsurface. Test methods include slug tests or pumping tests, as described in SOPs AGEM-08 and -09, respectively. The selection of test method and test data analysis will be made by the project hydrogeologist.

3.1.6 Disposal of Investigation-Derived Wastes

When it comes to the waste generated during a site investigation, the AGEM field program is committed to the following objectives:

1. Leave the project site in a condition no worse than before the project began,
2. Minimize waste generation,
3. Comply with all federal and state regulations for wastes requiring permitted off-site disposal, and
4. Keep wastes on-site that do not require off-site disposal or extended above-ground containerization. The details of handling and disposing of IDW are provided in SOP AGEM-11.

The IDW at a project site can include cuttings from borings and well installations, development fluids, purge water, disposable sampling materials, and decontamination rinsates. Soil cores collected during sampling are not considered waste; therefore, they are placed in core boxes and transported to an Argonne facility for lithologic description, research, and storage. Waste soil from drilling activities are stored in 55-gal drums or a roll-off container and are to be staged in a way that minimizes public contact and considers landowner preferences. Wastewater suspected of being contaminated (including purge water) is stored in 55-gal drums or a portable polyethylene tank.

Representative samples of the IDW are collected for analysis in accordance with the applicable state and federal regulations and with the requirements of the waste-handling facility. These results are reported to the appropriate state agency for review/approval for the proper disposal method. Disposal receipts from the waste-handling facility are retained for the AGEM program archives.

Any non-hazardous wastes, including used personal protective equipment (PPE), are placed in plastic bags for later disposal in a sanitary landfill.

3.2 Analytical Laboratories

3.2.1 AGEM Laboratory

The AGEM Laboratory is located on the Argonne National Laboratory campus in Argonne, Illinois, about 40 mi west-southwest of Chicago. The laboratory is equipped to conduct rapid-turnaround VOCs analyses on water and soil samples using standard and modified EPA gas chromatograph-mass spectrometer (GC-MS) procedure (see also Sections 4.1.1 and 4.2.2; and SOPs AGEM-24 and -25). The laboratory is also able to analyze vegetation samples using headspace and analysis on a GC-electron capture detection (GC-ECD) system (Section 4.2.2; and SOP AGEM-26).

3.2.2 Other Laboratories

A minimum of 10% of all water and soil samples collected at a project site are sent to an EPA-certified laboratory for a second analysis, using EPA Contract Laboratory Program (CLP) methodology, to verify the results obtained by the AGEM Laboratory (Section 4.2.2.2). Currently, the AGEM program sends verification water and soil samples to TestAmerica, Inc., in Burlington, Vermont. Samples of IDW are sent to a certified laboratory for solid waste analysis. The verification and IDW analytical results are included in the supplemental material to the site investigation report that is submitted to the state agency for review. They are also filed in the AGEM program archives.

TABLE 3.2 Potential remediation technologies for use at former CCC/USDA grain storage facilities.

Technology	General Process(es) Involved	Implementation Options
<i>Potential Remedial Technologies for Vadose Zone Soils at Former CCC/USDA Facilities</i>		
Excavation	Contaminated soils are physically removed from the subsurface for <i>ex situ</i> treatment.	Use of conventional digging or trenching equipment. Soil removal via large-diameter boring. Treatment of excavated soil by land farming. Treatment of excavated soil by landfill/disposal.
Soil Vapor Extraction (SVE)	Vacuum is applied to pore space in soil to extract volatile contamination.	Conventional vertical, horizontal, or large-diameter boreholes.
SVE Plus Soil Heating	As above, with additional electrical-resistance heating of soils to enhance volatilization.	Generally applicable to relatively small areas/volumes only.
Multiphase Extraction (MPE)	Specialized form of vacuum extraction, in which high vacuum is applied to a specially constructed well to simultaneously extract vadose zone soil vapor and induce air lift pumping/sparging through an underlying saturated interval.	Configuration of each well can be adjusted, after installation, to preferentially address contamination in the vadose zone or saturated zone. Treatment of extracted water might be required.
Capping	Engineered barrier is placed over surface above contaminated soil, to reduce vertical moisture infiltration and hence reduce contaminant leaching to greater depth.	Capping alone, to control vertical leaching. Capping in combination with SVE, to restrict leaching and enhance horizontal vapor flow to SVE wells.
<i>In Situ</i> Chemical Reduction (ISCR)	Amendments are introduced into soils to create oxygen-depleted, chemically reducing conditions that promote reductive dechlorination.	Pressure injection via direct-push or conventional borings or wells. Passive placement in direct-push or conventional borings or wells.
<i>In Situ</i> Enhanced Bioremediation	Amendments of nutrients/electron acceptors and/or specialized microbial cultures are introduced into the soils to promote enhanced biodegradation of the target contaminant.	Amendments are introduced into soils to enhance the bioremediation activity of indigenous microorganisms capable of degrading contaminants. Specialized microorganisms (possibly with other amendments) are introduced to degrade target contaminants.

TABLE 3.2 (Cont.)

Technology	General Process(es) Involved	Implementation Options
<i>Potential Remedial Technologies for Soil Vapor Intrusion at Former CCC/USDA Facilities</i>		
Vapor Intrusion Barrier (VIB)	Synthetic sheets or sprayed-on coatings of high-density, low permeability material are placed below the foundation of a structure to prevent contaminant vapor intrusion.	Most amenable to new construction. Can be installed to permit active venting if needed.
Sub-Slab Vapor Extraction	Small-diameter vacuum points are installed through foundation floor to extract contaminant vapor from below a structure.	Can be employed in new or existing structures.
<i>Potential Remedial Technologies for Saturated Soils and Groundwater at Former CCC/USDA Facilities</i>		
Air Sparge (AS or AS-SVE)	Air is introduced into the saturated zone to strip volatile contaminants <i>in situ</i> .	Injection via conventional or horizontal wells. Resulting vapor may be released to atmosphere via natural permeability. Vapor may be captured below surface via coupled SVE.
In-Well Vapor Stripping	Form of air sparging in which stripping of volatiles occurs within a double-cased well.	
Groundwater Extraction (P+T)	Wells are used to produce contaminated groundwater for treatment at the surface.	Conventional (vertical) wells. Horizontal (bored) wells. Shallow horizontal (trenched) wells or French drains. Treatment by granular activated carbon (GAC). Treatment by shallow-tray air stripping. Treatment by spray irrigation. Treatment by cascade aeration.
Multiphase Extraction (MPE)	Specialized form of vacuum extraction, in which high vacuum is applied to a specially constructed well to simultaneously extract vadose zone soil vapor and induce air lift pumping/sparging through an underlying saturated interval.	Configuration of each well can be adjusted, after installation, to preferentially address contamination in the vadose zone or saturated zone. Treatment of extracted water might be required.

TABLE 3.2 (Cont.)

Technology	General Process(es) Involved	Implementation Options
<i>Potential Remedial Technologies for Saturated Soils and Groundwater at Former CCC/USDA Facilities (cont.)</i>		
Permeable Reactive Barrier (PRB)	A vertical wall of permeable, chemically, and/or biologically reactive material is constructed across the path of contaminated groundwater flow. Treatment occurs as flow passes through the wall.	Construction by conventional digging, trenching, or boring. Construction by injection at multiple overlapping points. Construction by deep soil mixing.
<i>In Situ</i> Chemical Reduction (ISCR)	Amendments are introduced into the saturated zone to create oxygen-depleted, chemically reducing conditions that promote reductive dechlorination.	Pressure injection via direct-push or conventional borings or wells. Passive placement in direct-push or conventional borings or wells.
<i>In Situ</i> Enhanced Bioremediation	Amendments of nutrients/electron acceptors and/or specialized microbial cultures are introduced into the saturated zone to promote enhanced biodegradation of the target contaminant.	Amendments are introduced into soils to enhance the bioremedial activity of indigenous microorganisms capable of degrading contaminants. Specialized microorganisms are introduced (possibly with other amendments) to degrade target contaminants.
Phytoremediation	Selective plantings of vegetation, most commonly trees or other deep-rooting species, are used to promote uptake of contaminated groundwater or surface water. Treatment may occur by evapotranspiration, in-plant degradation, degradation in the root zone, and/or sequestering.	Applicable to shallow groundwater and surface water.
Constructed Wetlands	Selective planting of hydrophilic vegetation species is used to promote uptake of shallow groundwater seepage or surface water. Treatment may occur by direct evaporation, evapotranspiration, in-plant degradation, degradation in the root zone, and/or sequestering.	Construction as in-stream wetlands along the natural surface water pathway. Construction as purpose-built treatment ponds. Can be coupled with phytoremediation or other processes as a polishing step prior to surface discharge.

3.3 Remediation Technologies

Table 3.2 identifies technologies that could be implemented at former CCC/USDA grain storage facilities if remedial action is determined to be required. The technologies can be considered either independently or in combinations. Technologies are grouped according to applicability to (1) vadose zone soils, (2) soil vapor intrusion, or (3) saturated soils and groundwater.

Before these technologies are assembled into remedial alternatives for detailed evaluation and consideration for a particular site, Argonne and the CCC/USDA will work with stakeholders to establish remedial action objectives and define a process for the evaluation of remedial alternatives.

3.4 Data and Records Management

The AGEM program retains records documenting all work funded by the CCC/USDA in the AGEM program archives. Maintaining the program archives facilitates full access by the CCC/USDA to these records per Argonne's contract with the agency. The CCC/USDA retains access to these records independently of whether or not a field study's proposal is currently in effect. The organizational structure of the program archives and the types of data and records it contains are shown in Figure 3.1. Environmental and sample data generated through the program's field activities are housed in an environmental data management system, while materials documenting how the program's technical, administrative, and regulatory activities are carried out on behalf of the CCC/USDA are housed in an electronic recordkeeping system (as outlined in SOP AGEM-27).

The environmental data management system has for many years utilized a proprietary database software. Environmental and sample data are distributed to the CCC/USDA as they are generated then incorporated into technical reports that are ultimately submitted to state regulators. To retain documentary materials, in 2016, the AGEM program moved from a paper-based recordkeeping system to an electronic recordkeeping system. For this reason, AGEM provides periodic technical assistance in transferring files from AGEM's electronic recordkeeping system to the CCC/USDA, as needed. The AGEM records manager also coordinates with the CCC/USDA regarding the occasional need to digitize select records from the paper-based recordkeeping system in support of the CCC/USDA's directive to comply with federal digital records requirements.

FIGURE 3.1 Organizational structure of the AGEM program archives.

4 Quality Assurance/Quality Control Plan

This section presents the QA/QC guidelines to be followed by all Argonne personnel and contractors participating in the AGEM field program. All activities affecting the quality of results were considered during the development of this plan. The main goal of the field program is to generate qualitative and quantitative data that reliably identify and characterize environmental problems at the project site. It is therefore vital that data generated be of known quality and scientifically accurate/defensible to support environmental decisions concerning the site.

This QA/QC plan is divided into four parts. Section 4.1 deals with the overarching data quality requirements inherent in the site investigation process, including data quality objectives (DQOs), data usage, and project personnel and their responsibilities. Section 4.2, developed on the basis of EPA guidance, describes QA/QC requirements for both sampling and analytical aspects of field work, including data reduction, validation, and reporting. Section 4.3 addresses other field activities, including geologic logging, hydrogeological investigations, and surveying of sampling locations. Section 4.4 describes the management and storage of field data records and files. Section 4.5 addresses the QA/QC plan and reporting of results for the QA/QC review for field investigations. These procedures are considered by Argonne to be minimum requirements to ensure the quality and integrity of all data generated as part of the AGEM field program.

4.1 Overarching Data Quality Requirements

4.1.1 Data Quality Objectives

The main purpose of a site investigation at a former CCC/USDA grain storage site is to characterize the nature and extent of carbon tetrachloride contamination in both soil and groundwater and, if present, to define the configuration and movement of carbon tetrachloride in groundwater at the site. Characterization requires an understanding of the geological and hydrogeological controls on groundwater movement, as well as the extent of any remaining source(s) of carbon tetrachloride and/or chloroform in soils. Argonne's technical approach integrates analytical data results with other data characterizing the site's geology, geochemistry, and hydrogeology. Field activities include sampling of environmental media (soil, soil vapor/air, vegetation, surface water, sediment, and groundwater), laboratory analysis of these media, and geologic logging of boreholes. If warranted, *in situ* aquifer tests (e.g., slug testing) may also be conducted.

The site investigation is typically separated into two phases. Phase I begins with a review of any previous investigations (including geological and hydrogeological studies) and research into the history of property ownership and lease records, as well as a review of any documentation on the usage, handling, and storage of fumigants at the former grain storage site by the CCC/USDA or other property occupants. This information guides the initial field study, which focuses on developing a conceptual site model and characterizing the extent of contamination in soil and groundwater. Phase II activities are dependent on the results of Phase I and targeted to

fill in the data gaps remaining after the completion of Phase I. Because the investigation is designed to meet all the requirements of an RI/FS, the development of DQOs follows the guidelines described in EPA (2006).

The results from the site investigation may be used for one or more purposes: (1) to justify site closure; (2) to conduct a risk assessment, (3) to evaluate alternatives for remedial action, or (4) to provide data for the development of an engineering (remedial) design. All of the data provided must be of an appropriate quality capable of supporting scientifically accurate and legally defensible decisions.

Analytical data are generated at several EPA-defined levels (Table 4.1). Groundwater samples are screened for parameters such as pH, conductivity, and temperature using field instrumentation (EPA Level I). Soil, soil vapor/air, and water samples are shipped to the AGEM Laboratory at Argonne for rapid-turnaround analysis for VOCs of interest, including carbon tetrachloride and chloroform, using standard EPA GC-MS procedures or modifications of the standard EPA purge-and-trap and GC-MS procedures (EPA Level V; see SOPs AGEM-24, -25, and -26). Chemical data generated at these two levels are used to develop and guide sample collection throughout the field program. In addition, a minimum of 10% of the total number of soil, soil vapor/air, and water samples collected are sent to a second analytical laboratory for verification analysis under the EPA's Contract Laboratory Program (CLP; EPA Level IV).

The EPA has assigned no data quality levels for the geological and hydrogeological data collected during a field investigation. However, the quality of data generated by these activities is as important to the entire program as is the quality of the analytical data. Only with a complete, accurate understanding of existing conditions at a project site can effective environmental decisions be made. Therefore, Section 4.3 describes quality controls and checks imposed on the geological and hydrogeological investigation activities to ensure that all data generated by Argonne meet the intended DQOs.

4.1.2 Data Usage

Analytical data obtained from field sampling events are used to define the general water quality at the project site and to establish the extent of VOC contamination in both soil and groundwater. All data generated during the field program are carefully integrated to provide a complete and accurate picture of environmental conditions at the project site. These data are ultimately used to support decisions about further action at the site, which may lead to additional sampling or monitoring, site closure, risk assessment, or remedial action.

Information about the underlying geological/hydrogeological conditions at the site is gathered throughout the field program. Existing information from previous geological investigations and well logs shapes the initial conceptual site model and hypotheses on major geological features to be investigated. During the site investigation, data for evaluating the local geological and hydrogeological conditions are collected using both drilling and direct-push (CPT) methodologies.

TABLE 4.1 Analytical levels appropriate to data uses.

Analytical Level	Data Uses	Type of Analysis	Limitations	Data Quality
I	Site characterization Monitoring during implementation	Total organic/inorganic vapor detection using portable instruments Field test kits	Instruments respond to naturally occurring compounds	With instruments calibrated and data interpreted correctly, can provide indication of contamination
II	Site characterization Evaluation of alternatives Engineering design Monitoring during implementation	Variety of organics by gas chromatography; inorganics by atomic absorption; x-ray fluorescence Tentative identification; analyte-specific Detection limits vary from low parts per million to low parts per billion	Tentative identification Techniques and instruments limited mostly to volatiles and metals	Depends on QA/QC steps used Data typically reported in concentration ranges
III	Risk assessment Determination of potentially responsible parties Site characterization Evaluation of alternatives Engineering design Monitoring during implementation	Organics and inorganics with EPA procedures other than CLP can be analyte specific RCRA characteristic tests	Tentative identification in some cases	Detection limits similar to CLP Less rigorous QA/QC than CLP Can provide data of same quality as Level IV
IV	Risk assessment Determination of potentially responsible parties Evaluation of alternatives Engineering design	Hazardous Substance List (HSL) organics and inorganics by gas chromatography-mass spectrometry; atomic absorption; inductively coupled plasma Detection limits in low parts per billion	Tentative identification of non-HSL parameters Sometimes required for validation of packages	Goal is data of known quality Rigorous QA/QC
V	Risk assessment Determination of potentially responsible parties Engineering design	Nonconventional parameters Method-specific detection limits Modifications of existing methods Appendix B (EPA 1987) parameters	Might require method development or modification Mechanism to obtain services requires special lead time	Method-specific ^a

^a As a performance-based quality standard, the AGEM Laboratory demonstrates that its modifications of Level III and Level IV methods meet or exceed the quality standards of the unmodified methods.

Source: EPA (1987)

The coordinates of each sample location are surveyed to provide the most accurate picture of surface and subsurface contaminant distribution and geology. Surveying the locations and elevations of existing wells (e.g., top of casing, ground surface, and depth to groundwater) is necessary to verify and support geological/hydrogeological interpretations.

4.1.3 Project Personnel and Their Responsibilities

The following lists key AGEM personnel and their responsibilities within the CCC/USDA field program:

- *AGEM program manager.* The AGEM program manager is responsible for defining the scope of work, assigning field roles and responsibilities, overseeing the field work (or delegating that responsibility to the project manager), identifying and controlling hazards in the field, communicating expectations to the field team, and ensuring that all field work is done safely. The AGEM program manager is also responsible for ensuring that the site-specific HASP is entered into Argonne's work planning and control (WPC) Aware application³ so it can be reviewed/approved by the EVS environmental safety and health (ESH) coordinator (see also Section 6).
- *Project manager.* A senior AGEM team member serves as the technical manager for all on-site activities. This person must have extensive training and experience in geology, hydrology, sampling, and analytical procedures and protocols. He/she is responsible for ensuring that all SOPs are followed and QA/QC requirements are met throughout each phase of the site investigation.
- *Field health and safety coordinator (FHSC).* A senior AGEM team member serves as the principal health and safety contact for all on-site activities. This person is responsible for preparing (or overseeing the preparation of) the site-specific HASP and verifies that field work is carried out accordingly (see also Section 6).
- *Project QA/QC coordinator.* An AGEM team member serves as the principal QA/QC coordinator for on-site activities. This person is also responsible for analytical data reduction/validation and assists the technical team in its interpretation of analytical results reported in the laboratory data packages.
- *EVS ESH coordinator.* The field work planned for any given CCC/USDA project site may involve multiple and diverse technical teams and contractors to perform media sampling, drilling/logging, and surveying. The EVS ESH coordinator has the proper Occupational Safety and Health Administration (OSHA) and industrial hygiene training required by Argonne and serves as the principal health and safety

³ Aware is an Argonne-wide application used by Argonne employees to implement the process of scoping, planning, and controlling work. Its purpose is to facilitate the identification and analysis of hazards and controls and ensure that work is performed within these controls to provide for the health and safety of all Argonne employees.

contact for all AGEM site investigation activities. The EVS ESH coordinator reviews and approves the site-specific HASP (see also Section 6).

- *AGEM records manager.* An AGEM team member ensures that records documenting all work funded by the CCC/USDA are retained in the program archives (see also Section 3.4).

4.2 Quality Assurance/Quality Control for Sampling and Analysis

Quality in sampling and analysis is ensured through documentation of field activities, performance audits, system audits, and periodic evaluations of QC procedures. The project QA/QC requirements include periodic and final reviews covering all aspects of sampling, field measurements, chemical analyses, data collection, data validation and reporting, periodic instrument calibrations, routine maintenance of analytical equipment, calibration of analytical instruments, and standardization procedures in analyses. In addition, technical review of the results ensures that the stated objectives of the project are met.

The identification, cause, and corrective action for conditions significantly adverse to quality are to be documented and reported to the project manager and QA/QC coordinator. Examples of conditions that are adverse to the intent of faithful implementation of QA/QC procedures are deficiencies in the use of procedures or instructions, failure to implement corrective actions in response to a nonconformance report, and unexpected loss of or damage to documentation. Corrective action is to be implemented in a timely manner. Actions taken to correct problems or deficiencies in the field (during sampling) and in laboratory analyses are to be documented and described in the QA portion of the sampling and analysis report.

4.2.1 Field Activities

4.2.1.1 Sample Collection

Two criteria that must be met in sampling are that (1) the samples must be a genuine representation of the conditions prevalent at the site, and (2) adequate numbers of samples must be available for a meaningful characterization of the site, in the judgment of the project manager. In some cases, it might not be possible to collect samples from an intended location because of access constraints. In such cases, alternate or additional samples may be collected, as appropriate, from more easily accessible areas without compromising the original objectives of the work. To contain costs, some samples collected in the sampling activity might not be analyzed. However, no fewer than 90% of the samples submitted for analysis are to be analyzed. If original samples submitted for analysis are accidentally lost, backup samples (if available) may serve as substitutes.

4.2.1.2 Field Instrument Calibration Procedures

The project manager, in conjunction with field team members, ensures that instruments used for field measurements are properly calibrated, reliable, and in proper working order (see SOP AGEM-21). Typical field measurements are temperature, pH, dissolved oxygen, oxidation-reduction potential, and electrical conductivity determinations of water samples. Calibration information documented in the sample logs for each instrument includes the instrument's name and model or serial number, the date of calibration and calibration method, and the signature of the person performing the calibration. Sample logs are to contain dated, signed entries for all field measurements.

4.2.1.3 Field Blanks, Field Rinsates, Field Replicates, and Trip Blanks

Quality control samples collected as part of a field sampling event include field blanks, rinsates, trip blanks, and field replicates/split samples. The nature and frequency of these types of samples are as follows:

- *Field blanks.* A field blank is prepared in the field using bottles and water from an outside source. Its purpose is to detect/identify any ambient contamination resulting from collecting, handling, and shipping samples in the field and is, therefore, a measure of the integrity of samples in a given sampling event. Field blanks are analyzed for VOCs.
- *Rinsates.* Some equipment (e.g., sampling bailers) is used repeatedly in sampling activities. It is essential to decontaminate this equipment after each use to ensure that repeated use does not result in cross-contamination of samples. A rinsate sample consists of water rinsed over a piece of sampling equipment after it has been cleaned and decontaminated. Rinsate samples are collected with a frequency of one sample per 20 pieces of equipment cleaned, with a minimum of one sample per cleaning session. Rinsate samples are analyzed for VOCs.
- *Trip blanks.* Trip blanks are prepared at the AGEM Laboratory or in another suitable uncontaminated area. The trip blank sample is shipped to the laboratory along with the field samples being analyzed for VOCs to demonstrate that contamination of samples has not occurred during shipment. The recommended frequency for trip blanks is one per ice chest shipped. Trip blanks are analyzed for VOCs.
- *Field replicates/split samples.* Field replicates of soil, water, and vegetation samples are used to verify consistency in the sampling methodology and the reproducibility of the analytical results. The frequency is one for every 10 samples collected.

4.2.2 Laboratory Analysis

4.2.2.1 Laboratory Duplicates

Section 4.2.1.3 describes the collection of field replicate samples during sampling activities. The field replicates serve, in part, to verify the reproducibility of the sampling procedures and analytical results. As a further verification of analytical reproducibility, the analytical laboratory selects some samples for duplicate analysis.

4.2.2.2 Volatile Organic Compound Analyses

Samples collected for VOC analyses are shipped to the AGEM Laboratory for immediate analysis with a GC-MS, using modifications of EPA procedures. Analysis of the samples is prioritized in consultation with the project manager so that the results can be used to optimize decision making in the field. Water samples are analyzed using modifications of EPA Methods 5030B and 524.2 (purge-and-trap method by GC-MS; SOP AGEM-24). Soil samples are analyzed using modifications of EPA Methods 5035 and 8010 (SOP AGEM-25). Vegetation samples are analyzed using a modification of EPA Method 5021-1, with separation and analysis on a GC-ECD system (SOP AGEM-26). Soil vapor/air samples are analyzed according to the AGEM Laboratory headspace method described in Section 4.3 (SOP AGEM-25).

In reviewing the analytical results, QA/QC procedures are verified in these laboratory-related areas: chain-of-custody records for samples, storage of samples, storage of sample extracts, temperature, holding times before analyses, calibration and maintenance of analytical instruments, performance standards of the instruments (reproducibility, standards, spike recoveries, etc.), and sample logs. The verification involves thorough evaluation of laboratory practices and procedures, audits of sample logs, and review of data packages (both original and reduced forms of data) by the project QA/QC coordinator. The results of this evaluation, in keeping with EPA national functional guidelines for organic methods (EPA 2017b), are presented in the QA portion of the sampling and analysis report.

A minimum of 10% of all water and soil samples collected at the project site are to be shipped to an EPA-certified laboratory for a second analysis to verify the results obtained by the AGEM Laboratory. Samples are selected for verification analysis on the basis of the AGEM Laboratory's results. The selected samples are to have a wide range of carbon tetrachloride values (from below the detection limit to high concentrations) to allow comparison of the analytical methods over the range of concentrations found. Water samples are analyzed by the second laboratory according to the EPA CLP analytical statement of work for organic superfund methods (EPA 2015). Soil samples are analyzed by EPA Method 8260B, as referenced in the EPA's *SW846 Compendium, Update V* (EPA 2014). Each sample subjected to verification analysis by the second laboratory is to be accompanied by complete CLP documentation (which generally appears in the supplemental material of an investigation report).

4.2.2.3 Other Analyses

Selected samples might be subjected to other analyses (unrelated to site contamination) to aid in development of the conceptual site (hydrogeological) model. For example, groundwater samples might be selected for inorganic or tritium analysis to aid in characterization of groundwater geochemistry. Soil samples might be selected for analysis of physical parameters such as particle size, bulk density, or percent moisture. These analyses are conducted by certified laboratories with established/accepted procedures. The analytical methodologies used and the results of a review of the QC procedures used for these analyses are presented in the sampling and analysis report as necessary.

4.2.3 Quality Assurance Records

Quality assurance records pertain to all activities related to the sampling and analysis work at each CCC/USDA project site. These records include soil boring logs, well completion logs, daily log entries, sample logs, sample labels, custody seals, and chain-of-custody records. All QA records must be assembled and maintained in the AGEM program archives. Records are to be legible, identifiable, and retrievable, and must be protected against damage, deterioration, or loss.

4.2.3.1 Field Notes

All field notes relating to the collection of samples are to be recorded in permanent ink on paper or provided to the QA/QC coordinator electronically. Field notes provide information on the sampling conditions and sample collection/handling methods. Minimal data to be recorded are the sample identification number, the date and time of sampling, the place of collection (with a simple hand-drawn location map), the weather conditions at the time of sampling, and any measurements made by field monitoring equipment. Each entry is to be signed by the sampler (see also SOP AGEM-27).

4.2.3.2 Sample Labels and Custody Seals

A sample label is affixed to each sample container to identify the sample. Custody seals are used to maintain the security of samples during shipment from the field to the laboratory. Sample labels and custody seals are discussed in SOP AGEM-27.

4.2.3.3 Chain-of-Custody Records

A chain-of-custody record is maintained to track the possession of the samples from the time of collection to the time of delivery to the analytical laboratory (SOP AGEM-27)

4.2.4 Analytical Data Reduction, Validation, and Reporting

4.2.4.1 Data Reduction

All notes, sample logs, and related records (for both sample collection/handling and sample analysis) completed during the conduct of the individual tasks are submitted to the QA/QC coordinator for storage in the program archives. The analytical results, with all pertinent information about sample locations and sampling conditions, are entered into the environmental data management system for integration with other activities and presentation in the final report.

4.2.4.2 Data Validation

If predefined QC limits are exceeded by the analytical laboratory, all data from the associated batch of samples must be thoroughly scrutinized. If no analytical problems are found, the data and out-of-control point are discussed in the QC section of the sampling and analysis report. If problems with the analytical data are found, the samples associated with the batch are to be reanalyzed, and the data from the reanalysis are reported. If holding times are exceeded, new samples should be collected and analyzed and the original data should not be reported.

The final sampling and analysis report presents all sample data along with detection limits and concentrations found.

4.2.4.3 Data Reporting

For all analyses, the laboratory report is to show, at a minimum, traceability to the sample analyzed. The laboratory report must contain the following information:

- Project identification
- Field sample number
- Laboratory sample number
- Sample matrix description
- Date of sample collection
- Date of sample receipt at the laboratory
- Analytical method description
- Individual parameter results
- Date of analysis (extraction, first runs, and subsequent runs)

- Quantitation limits achieved
- Dilution of concentration factors
- Corresponding QC report (to include method blanks, blanks/spikes, and continuing calibrations)
- Raw chromatogram data
- Chain-of-custody form
- Case narrative (where appropriate)

4.3 Quality Assurance/Quality Control for Other Field Activities

4.3.1 Geological Investigation

The approach to maintaining quality in defining the local geological and hydrogeological conditions at a project site is described here. The discussion includes the review of existing data, on-site drilling and CPT investigations, and soil boring logs. Primary responsibility for QA/QC in the geology investigation rests with the project manager.

4.3.1.1 Review of Existing Data

Available geologic logs for all wells, borings, and test holes within the immediate area of the CCC/USDA site (within at least a one-mile radius) are studied. These geologic logs normally include detailed state geological survey data and less detailed drillers' descriptions of formations. From these data, marker stratigraphic units are identified and geologic cross sections drawn. From the geologic logs and cross sections, an initial stratigraphic and hydrostratigraphic understanding of the area is interpreted by trained, experienced geologists on the field team.

4.3.1.2 Drilling and Electronic Cone Penetrometer Investigations

The initial (Phase I) field investigation focuses on confirming or modifying hypotheses about the stratigraphic sequence, as well as identifying the water-bearing units. The information is gathered by drilling a continuous core hole at or near the former CCC/USDA grain storage facility. The core is initially logged in detail by an Argonne geologist. The log records include all the information described in Section 4.3.1.3. The geologic logs are recorded daily and then turned over to the senior geologist for confirmation and evaluation against the existing data. The core is retained for the duration of the field activity. If the core needs to be retained longer, it is placed in core boxes for further examination and testing, and is properly catalogued and stored.

Aside from the drilling program, the CPT is used to collect additional data and information as needed. Maintenance and calibration of all CPT equipment is to be in conformance with SOP AGEM-01 for the specific equipment used.⁴ The CPT cone is calibrated using National Institute of Standards and Technology standards, and a log is kept of each calibration. Locally available driller's logs and investigation borehole geologic logs serve as controls for interpreting the CPT physical measurements and probe sensor data through comparison of the results with the known geologic stratigraphy. The geologic log is the initial control for the CPT logs, which might provide more detail on individual stratigraphic horizons than do the logs of visible geology. The additional data in the CPT logs are particularly important with respect to variations in clay, silt, and sand contents within a stratigraphic unit. Incorporation of all logging results into the conceptual site model furthers understanding of geological controls and establishes the geological and hydrostratigraphic sequence for subsequent investigations at a site.

During the subsurface sampling activity of each investigation, additional core drilling might be carried out where subsurface confirmation of the stratigraphic sequence is required. At some drill hole sites, a CPT boring is completed to compare downhole CPT responses with the core logging data. Variations in the details of the sequence are highlighted, and new geologic cross sections are drawn showing any lateral or vertical changes. On average, five or six core holes are drilled to collect soil and groundwater samples at depths beyond the capabilities of other subsurface sampling equipment at each investigation site. Electronic CPT logging is typically performed adjacent to these core holes. A CPT boring is usually completed at a minimum of two of the core hole sites. The data generated during the CPT push are sent to a data acquisition system on the CPT truck for processing and storage. Hardcopies and digital backups of the data for each location are provided to the site geologist and retained as part of the investigation record (in the program archives) for future reference.

4.3.1.3 Soil Boring Logs

Soil and rock materials encountered during drilling activities are recorded at the time of drilling by the project geologist. Soils are classified by using the modified Wentworth-Udden grain size scale and Burmeister's descriptive terms for soil, combined with regular sampling of sandy materials for grain-size analysis. All necessary information is recorded on the boring logs. Standard borehole log forms are used (see SOP AGEM-01).

4.3.2 Hydrogeological Investigation

This section addresses all hydrogeological operations involved in an environmental site investigation, including construction of monitoring or aquifer pumping wells, water level monitoring, and *in situ* aquifer testing. The quality objective of the hydrogeology program is to design and conduct effective and appropriate hydrogeological measurements. Primary

⁴ After prolonged use, exposure to extremely difficult pushing conditions, or questionable data, CPT cones are sent to the manufacturer (a.p. van den Berg, Inc., Netherlands) for inspection and formal recalibration.

responsibility for QA in the hydrogeology investigation rests with the AGEM program and site project managers.

4.3.2.1 Selection of Contractors and Instrumentation

Before field operations begin, the project manager defines the nature and extent of hydrogeologic data required to satisfy the site characterization objectives.

To participate in the hydrogeology investigation, the AGEM program and project managers identify contractors having verifiable records demonstrating reliability and appropriate expertise in their disciplines.

All drilling contractors must be licensed by the relevant state to drill and install monitoring and drinking water wells. The AGEM program manager verifies that all necessary drilling permits and licenses are obtained before field work begins.

The project manager identifies the equipment needed to meet the objectives of the site-specific work plan and is responsible for proper preparations before the field operations begin, including details about the equipment selection, the prescribed calibration procedures to be followed in the field, and procedures for contacting the equipment manufacturer in case problems arise in the field.

4.3.2.2 Data Acquisition

During the field operations, the quality of the data acquired is assured by rigorous monitoring of the selection of locations to be surveyed, the calibration of instruments and equipment, and the recording of data.

- *Selection of Locations.* The project manager, in conjunction with the site hydrogeologist and the site geologist, selects locations for investigation that will provide information useful for the overall program. The project manager (or designee) ensures that (1) selected locations are correctly identified and flagged for coordinates surveying, (2) the surveyors are made aware of all hydrogeological investigation locations to be surveyed, (3) selected locations are properly recorded, and (4) the data are disseminated to the appropriate AGEM personnel (QA/QC coordinator, Geographic Information Systems [GIS]/graphics specialist, and records manager).
- *Calibration of Instruments and Equipment.* The site hydrogeologist ensures that each instrument is maintained within the calibration limits specified by the manufacturer. The water level measuring, pressure sensing, and data recording devices employed for environmental site investigations cannot be calibrated in the field; special equipment available only to the instrument manufacturer is required. The project manager, in conjunction with the site hydrogeologist, therefore must

ensure that instrument checks, as outlined in SOP AGEM-21, are performed in the field to verify that all instruments are in proper working order at the time of use. The hydrogeologist is to record the date, time, and results of the instrument checks.

- *Recording of Data.* The project manager, in coordination with the site hydrogeologist, ensures that data are collected according to the SOPs described in Volume 2 of this *Master Work Plan*. The hydrogeologist records the date and time at which field data are acquired, the model number and serial number of the equipment used to collect the data, and the personnel operating the equipment. The hydrogeologist further certifies that the SOP for the particular method used was followed. Variances from the SOP are to be noted and explained.

Water level records are accompanied by all necessary supporting data. The supporting data include the following:

- Project identification
- Monitoring point identification
- Time of measurement
- Date of measurement
- Type of measurement or test
- Description of reference datum
- Recorder's name
- Weather conditions at the site

4.3.2.3 Well Construction

The project manager and consulting drilling engineer ensures that well (and piezometer) construction is completed in accordance with state and federal requirements, as described in SOPs AGEM-02 and -03.

4.3.2.4 In Situ Aquifer Testing

The project manager, in conjunction with the site hydrogeologist, identifies the most appropriate aquifer tests for achieving the investigation's objectives and on this basis determines equipment and logistic requirements. Information on hydrogeological testing is in SOPs AGEM-08 and -09.

4.3.3 Surveying Procedures

Spatial control is maintained by integrating in-house resources and professional coordinates survey data. When characterization efforts are complete, the surveyor formally surveys locations targeted by the Argonne project manager. The Argonne project manager (or designee) normally visits each location with a representative of the survey crew. The locations are otherwise to be described in sufficient detail for the surveyors to identify the positions easily. The following items are also made available to provide a means of detecting gross errors in the coordinates list (such as misnaming of a location) through comparison with investigation maps, measures, and other field records:

- A scaled plot of surveyed points;
- A base map marked with field-sketched approximate locations of all surveyed points; and
- A description of the approximate locations of surveyed points, consisting, where appropriate, of horizontal ties of sampling points to features on the base map.

After the field effort, the coordinates of data collection points provided by the surveyor are reviewed for accuracy by the Argonne project manager and QA/QC coordinator prior to inclusion in the project's GIS files and program archives.

4.4 Quality Assurance/Quality Control for Field Data Records and Files

The QA/QC coordinator is responsible for verifying that field data and records are assembled and maintained according to the QA/QC standards defined in this section. Field data and records contain either data acquired from the field in the course of site characterization or the results of processing and interpreting these data (as such, they may be digitally recorded or scanned). The primary quality objective with regard to field data and records is to maintain the security and integrity of characterization data, from initial acquisition through final archival, while providing AGEM's technical team members and the CCC/USDA ready access to information contained in the records.

Each team member who is involved in acquiring field data is responsible for recording data in accordance with the procedures defined in this section and for making these records available to the QA/QC coordinator and AGEM GIS/graphics specialist (and others) in the prescribed formats. The QA/QC coordinator will verify the field data records and notify field team members if there are quality issues to be addressed so they can be resolved in a timely manner.

4.4.1 Field Data

The following are requirements for field records that are generated, stored, or transferred in an electronic format. This includes both data recorded directly by means of computer systems (i.e., original records), e.g., electronic logs or water level data, and data transferred to computer

systems for analysis and/or storage (i.e., transcribed data) such as field notes, sample logs, survey information, geological well logs, and some chemical analysis data.

4.4.1.1 Original Records

The primary QA concern with regard to original field data is that accurate, secure copies of all data are preserved and that no data are lost or altered as a result of mishandling or computer system failure.

Any original records that are entered directly onto an electronic file, such as automatic recording of water levels on a transducer, are to be provided to the QA/QC coordinator for retention in the program archives. The originals are to be considered the master files, and all further processing of the data is to be done with working copies made from these master files.

4.4.1.2 Transcribed Data

Field data that are transcribed from written form into electronic files, such as information in sample logs, chains-of-custody, survey coordinates, or geologic logs are to be checked and verified for accuracy at the time of transcription by the QA/QC coordinator. Following verification, a copy of the electronic file is to be retained in the program archives as a master file. Copies of paper records from which the master files were transcribed do not require retention.

4.4.1.3 Master Data Files

Master data files (either original records or transcriptions of field data as described above) are to be retained in the program archives, separate from working copies of these files. Copies of supporting paperwork, such as field notes, laboratory reports, observer reports, and paper logs, are to be maintained with the master data files in the program archives as digital files (either scanned from paper or in an original electronic format such as a spreadsheet or other data file). Master data files are to be labeled in a manner that includes the site location.

If corrections are made to original paperwork that has been used to generate a master file, the team member initiating the change is responsible for informing the QA/QC coordinator, who alone makes the correction in the master file.

4.4.2 Data Processing

To ensure that master data files are not altered or damaged, all processing of field data is performed by using duplicate copies of master files for input, not the master data files. Quality assurance of processed data consists of ensuring that (1) processing is conducted with approved methods for preserving data integrity throughout the processing sequence, and (2) processed data are quickly made available to technical team members for review and verification. The QA procedures are discussed in the following sections.

4.4.2.1 Testing of Hardware and Software

All hardware, software, and processing sequences to be used in processing field data are to be tested before field operations begin. Testing of any new system, program, or sequence of programs involves processing benchmark datasets and verifying that the new results are consistent with results obtained through established methods. If no comparable results have been produced previously, the new processing results are to be verified through review by the technical team member(s) designated by the project manager.

4.4.2.2 Data Processing Standards

Data are to be processed by technical or GIS/graphics group personnel using benchmark-tested software and systems. Documentation of software used in processing is to be maintained and available for reference. Each technical and GIS/graphics team member is responsible for keeping track of software and upgrades that meet quality standards and for providing documentation of software.

Field data are initially preprocessed into a common format that can be imported into an Excel spreadsheet. Data are then imported by the AGEM GIS/graphics specialist to data visualization programs such as LogPlot and MapInfo to produce graphic displays (e.g., well/borehole logs, stratigraphic columns and cross sections, and maps) of field results. These images are submitted to technical team members for validation and approval.

During all stages of data processing, records are to be backed up daily on a storage medium that is independent of the computer on which the processing takes place, such as the AGEM program server (a program-shared EVS network drive); Argonne's Box (secure cloud-based file storage) system, an external hard drive, or a removable disk/thumb drive.

4.4.2.3 Review and Correction of Errors

To minimize errors in processed field data, processing results are circulated for review by project team members (often in graphic format to facilitate review and detection of errors). Maps are created and distributed by the AGEM GIS/graphics specialist showing the results of field activities, such as sample locations, water levels, and analytical results. Analytical results are often also presented in tabular format. Subsurface geological and hydrological data are displayed in the form of well logs and cross sections. These displays may be made from interim or temporary processing results, provided that all displays indicate the version and/or date of the processing file from which the display was generated.

Team members are responsible for notifying the AGEM GIS/graphics specialist immediately of any erroneous or inconsistent results in graphic displays. Corrections to master data files, if needed, are to be documented and approved by the AGEM GIS/graphics specialist and QA/QC coordinator, according to the procedures in Section 4.4.1.

4.4.2.4 Final Data Processing Results

Whenever final results of data processing are reported in a form other than listings of raw field data, the digital files that generated these results are to be saved with appropriate labeling to indicate a final result. This includes files that generate graphic displays, database files, spreadsheet listings, and MapInfo maps, for example.

4.4.3 Quality Control Tracking

At various stages in the acquisition, processing, and reporting sequence, data files are to be processed into database formats for compilation and display. Processing of data is to be coordinated by the AGEM GIS/graphics specialist to ensure that only accurate data are included.

4.4.4 Data Archival

All project master data files, files of final results, files of significant intermediate or auxiliary results, and copies of analytical databases are to be archived in the program archives, together with electronic copies of supporting paperwork and documents. The program archives are maintained on a divisional network drive that is backed up on a regular schedule according to EVS data management procedures.

4.5 Reporting Results of QA/QC Review for Field Investigations

Section 4 of this *Master Work Plan* serves as the QA/QC plan for all field work conducted under the site-specific work plans prepared for AGEM field (site) investigations. The findings of the QA/QC review are to be summarized in the field investigation report, which also provides the data and findings of each field event. The QA/QC review generally consists of verification that (1) all QA/QC procedures were followed through each phase of sampling and analysis (e.g., proper sample documentation, and use of chain-of-custody forms and custody seals); (2) QC samples were collected (to monitoring sample-handling activities) and found to be clean of contaminants of concern; (3) laboratory method blanks were free of contaminants of concern; (4) consistency between samples analyzed by AGEM Laboratory and the contract laboratory(ies) was within a relative percent difference of $\pm 20\%$. The detailed QA/QC review also identifies any exceptions (outliers) found.

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5 Community Relations Plan

This section provides a brief description of the community outreach efforts employed by the AGEM team at sites where environmental activities, ranging from site investigation (characterization) to the implementation of a corrective action (cleanup), are conducted on behalf of the CCC/USDA. All of the former CCC/USDA grain storage sites and adjacent lands are owned by private citizens, commercial entities, and/or local municipalities. The AGEM team's outreach efforts serve two main purposes: (1) to obtain property access at locations where environmental field work is needed; and (2) to support the CCC/USDA's and state's efforts to inform and involve responsible stewards, including local government officials, landowners, and private citizens.

5.1 Obtaining Property Access Where Field Work is Needed

Most former CCC/USDA grain storage sites are located within or adjacent to the municipal boundaries of small, rural communities. Community road rights-of-way and other municipal properties, e.g., parks, city common areas, and schools, are frequently needed by the AGEM field team for access to conduct its field work. Project sites tend also to be located on or adjacent to private and commercial properties that are devoted to agricultural use (farming operations and agricultural cooperatives, respectively). Many of these property owners lease or rent their properties to others, potentially increasing the number of individuals who may need to be involved in access discussions. The CCC/USDA and the regulating state agency rely on AGEM's ability to convince property owners and lessors/renters to voluntarily allow access to their properties.

The importance of the AGEM team's outreach efforts cannot be overstated as site investigation activities cannot proceed without the property owner's cooperation and property access approval. It is important to note that neither the state regulators nor the CCC/USDA has attempted to force a property owner to provide access when they have refused to do so. Property access is completely voluntary.

5.1.1 Identifying Property Owners

When the CCC/USDA directs AGEM to initiate environmental work at a former grain storage site, one of its first tasks is to identify all property owners where access may be needed. An AGEM team representative accomplishes this by:

- Contacting and working with the applicable county courthouse to obtain all relevant property documents (e.g., deeds and leases) for the former CCC/USDA site property, as well as all other adjacent properties where access may be required. The county Register of Deeds office maintains current and historical property documents. Argonne works closely with the county officials to obtain current ownership records in addition to historical property documentation, such as the ownership history of the properties to be investigated.

- Contacting and working with the applicable city offices to confirm property ownership and obtain contact information for the owners. Also, because access is frequently needed to city properties, particularly road rights-of-way, AGEM contacts and works with city officials so they are made aware of the site work to be conducted in their communities.

5.1.2 Meeting with Community Officials and Affected Landowners

Once the AGEM team has identified and contacted community officials and affected landowners, it makes arrangements to travel and meet with them in person. When meeting with community officials, affected landowners, or other interested residents during the initial site reconnaissance visit, AGEM's community relations representative implements the following protocol:

- Introduces the AGEM field team;
- Provides a point of contact who will serve as liaison throughout the project;
- Explains the CCC/USDA's proposed investigation plans, locations, and schedule;
- Walks the property with the affected landowners to locate the specific locations where access is needed. This task enables Argonne and landowners to identify physical constraints that may need to be taken into account, including utility lines, buildings, trees, farm land, and business traffic, so that proposed access locations can be modified, as needed; and
- Learns of any relevant issues that may be of concern to landowners and/or community officials.

In addition, when meeting exclusively with community officials, the AGEM field team will:

- Confirm that the community is served by a public water supply that provides a safe and ample source of domestic water for all residents;
- Confirm the locations of all current and former public water supply wells;
- Confirm the existence and locations of any current and/or former private wells located both inside and outside of the city's boundaries and determine if they are or have been used as a drinking water source; and
- Obtain all historical data the city may have on file that may be relevant to the development of the site investigation work plan. This includes data regarding public and private well sampling, well construction specifications, and any other information regarding local groundwater issues, both historical and current.

5.1.3 Achieving Land Access

Requesting property owners/lessors to voluntarily provide access to their properties is a significant challenge. Making this challenge even more difficult is that AGEM's access requests:

- Often call for the property owner(s) to allow heavy equipment (drilling rigs, etc.) to be brought on to the property, which can cause considerable, temporary disturbances to the property. Argonne assures the property owners that once the site work is completed, the property will be restored to its original state (to the extent practicable). The properties are subsequently restored to the property owners' satisfaction.
- Are very candid with property owners, by explaining to them that access is not typically a "one-time" or short-term event. In many instances, property access is required for many years due to state regulatory directives, such as for the installation of monitoring wells and subsequent long-term sampling of monitoring wells (which may take place over a period of some years). Also, at sites where state regulators have approved cleanup actions, long-term access is required to construct and then operate remedial system components and the required system performance monitoring.
- Provide no assurance to the property owners regarding liability for any contamination identified on the property.

For over twenty years, the AGEM field team has been able to persuade property owners/lessors and city officials at dozens of former CCC/USDA grain storage sites across the Midwest to allow access to their properties in order for environmental site work to be conducted. The sites where access was not obtained is limited to a small handful. This ongoing record of accomplishment of obtaining landowner access and gaining local community support is due to the following:

- Small, rural communities take pride in their towns and readily provide the assistance needed by Argonne to conduct site investigation work. Communities want to know the extent of any contamination in their local area and be informed of and involved in any proposed remedial solutions.
- The CCC/USDA has always been committed to ensuring that affected communities and residents are informed of and supportive of all aspects of the site work, through the entirety of its projects' life-cycle.
- Per CCC/USDA's directive, the AGEM field team invests heavily from the outset of field work at a given site, in developing positive working relationships with the local community. Since the AGEM field team may need to maintain a presence for many years at a project site, it regularly communicates and works with affected entities to integrate field activities into the community setting in a manner that limits intrusiveness to residents.

5.2 Supporting the Involvement of Responsible Stewards

Per the IGA, the lead state agency⁵ exercises regulatory oversight for all environmental activities at the former CCC/USDA grain storage sites listed in Appendix A (of the IGA). As lead agency, the state is responsible for ensuring that its public information and involvement requirements are fully satisfied throughout the “life-cycle” of site investigation and remediation activities. AGEM’s community relations objective is to support the state in this role by providing relevant information and accessibility throughout each project phase. Specific community relations activities are described in the following sections.

5.2.1 Activities Before Field Work Begins

On behalf of the CCC/USDA, AGEM’s community relations representative makes arrangements with the city clerk to have Argonne placed on the city council’s regular monthly meeting agenda. Once scheduled, AGEM informs the CCC/USDA of the meeting date so it can inform the regulating state agency. When they are able, the CCC/USDA and states have representatives attend these meetings.

At these council meetings, the AGEM community relations representative:

- Introduces the AGEM field team;
- Provides a point of contact who will serve as liaison throughout the project;
- Explains the CCC/USDA’s proposed investigation plans, locations, and schedules;
- Requests from the city council access to any city properties where field work may need to be conducted. The AGEM team’s requests are typically formally approved by the city council during the meeting;
- Provides fact sheets and other handouts that describe the field work to be conducted. The fact sheets provide the names and contact information for state regulatory officials, CCC/USDA officials, and the Argonne technical lead and field team members;
- Makes note of any relevant issues that are of concern to the city council and interested citizens in attendance. Argonne considers project modifications (if needed) to address or accommodate any concerns raised at the meeting;
- Requests of those in attendance whether they know of the existence/locations of any current and/or former private wells located both inside and outside of city boundaries and if they are or have ever been used as a drinking water source. Argonne explains that the first priority of the CCC/USDA and state regulators is to

⁵ The lead state agency for Kansas is the KDHE; for Nebraska, the NDEE (formerly the NDEQ); and for Missouri, the MDNR.

confirm that all local residents both inside and outside of city boundaries have access to safe drinking water;

- Informs attendees that the results of the investigation and the next steps to be taken at the site will be included in a technical summary report. Once the report is approved by the CCC/USDA and state, Argonne will provide it to the city, affected property owners, and interested residents;
- Informs attendees that any residents' concerns/inquiries expressed to Argonne at the meeting (or at any time during the project) will be forwarded to the CCC/USDA and state regulator; and
- Invites interested parties to stop by the project site once work commences to learn more about the field investigation. Argonne adds that site visits must be conducted in a manner that adheres to all safety and health requirements.

5.2.2 Activities During Field Work

Once the environmental site activities begin, local residents may become more aware and curious about the work being conducted by Argonne and its contractors. Therefore, the AGEM team continues to communicate with the city, property owners, and interested residents, both in person and by telephone/computer, to keep interested parties informed of the project's activities. Fact sheets are kept on site for distribution to interested parties during the field work. The fact sheets provide the names and contact information for the state regulators, the CCC/USDA, and Argonne. Copies are typically provided to city offices, affected property owners, interested citizens, and local newspapers. Fact sheets are also distributed to public places like coffee shops, libraries, restaurants, and the post office. Meetings with interested parties are conducted when needed.

Argonne immediately forwards to the CCC/USDA and state regulator all community concerns and inquiries that arise during the field work so they can be addressed in a timely fashion.

5.2.3 Activities After Field Work is Completed

Once the field work is completed, AGEM continues to maintain close contact with the city, property owners, and interested residents, both in person and by telephone/computer. Argonne provides periodic updates to interested parties regarding the overall status of the project.

After Argonne evaluates the data collected during the field investigation, it develops a technical report that summarizes its findings as well as the next steps to be taken at the site. Argonne submits the report to the CCC/USDA and, once approved, it is sent to the state regulator. Once the state has accepted/approved the report, Argonne provides a copy to the city on behalf of the CCC/USDA. The Argonne community outreach representative also makes arrangements with the city clerk to attend the city council's next monthly meeting so it can present the report

and its findings, and answer questions regarding the status of the project (following a similar protocol to that described in Section 5.1.1).

5.2.4 Ongoing Community Outreach Activities

At many sites where Argonne has conducted field investigations, the regulating state agency requires long-term monitoring programs to routinely sample numerous groundwater wells, both on and near the site, for a period of years. Wells to be sampled include monitoring wells (installed during the site investigation), as well as public and private wells. Irrigation, commercial, and livestock wells can also be part of a long-term monitoring program. Argonne maintains communication with property owners where such wells are located so it can have continued access to these wells. Sampling results are provided to the CCC/USDA, the state, and the well owners.

At sites where remedial actions are in place, Argonne will regularly communicate with the city, affected property owners, and other interested residents to provide updates regarding the remedial system and its performance. Periodic briefings of the city council are also arranged, as needed. Fact sheets with status updates may also be distributed throughout the community.

5.3 Preparation of the Site-Specific Community Relations Plan

The site-specific community relations plan usually comprises a section in the site-specific work plan and tiers off the information provided in Section 5 of this *Master Work Plan*. It also includes site-specific information such as (1) the community's concerns related to the CCC/USDA's history at the site or the planned field work; (2) a description of the community (e.g., the mayor and city council activities) and its water supply; (3) a history of the community's involvement in issues concerning groundwater contamination and related issues; (4) the AGEM team's community relations objectives and planned activities (e.g., public meetings); and (5) a contact list of key officials, including local officials, CCC/USDA officials, state agency officials, and AGEM contacts.

6 Health and Safety Plan

This section presents the general HASP for the AGEM field program. The plan outlined here contains the information required to protect AGEM field personnel at former CCC/USDA facilities during normal field operations. The main purpose of this plan is to provide field team members with the information, procedures, regulations, and guidelines needed to conduct their work with minimal risk to their own health and safety and the health and safety of the surrounding public and the environment. The primary intent is to document the responsibility of all workers to conduct their operations safely and to provide them with the means to do so, in keeping with the policy of the CCC/USDA and Argonne that health and safety are foremost considerations in conducting the field investigation.

Secondary purposes are to (1) demonstrate to the CCC/USDA, OSHA, EPA, and state and local regulatory agencies that health and safety have been given adequate consideration in the planning and execution of the field work; (2) show that applicable regulatory requirements are being met; and (3) show that relevant policy and procedural requirements of Argonne and its EVS Division are being satisfied.

The outline of this section follows that recommended by Argonne's EVS Division, and meets the requirements of the *EVS Work Planning and Control Manual* (Rev. 0, dated February 1, 2019). Members of the AGEM field team must become familiar with the procedures in both volumes of this *Master Work Plan*, as well as those outlined in the site-specific work plan and site-specific HASP.

6.1 Field Program

6.1.1 General Description

The AGEM field program encompasses activities associated with site investigation and remediation (cleanup) work. Site investigation or characterization work typically involves sonic or auger (rare) drilling, push operations (CPT or GeoProbe®), soil sampling, groundwater sampling, vegetation sampling (trees and natural vegetation), surface water and sediment sampling, soil gas and/or air sampling, and the installation of temporary and/or permanent wells. Remediation work might include the installation of an extraction well and treatment system, well development and sampling, and testing/maintenance of vapor mitigation systems.

6.1.2 Work Control Documents

Work control documents (WCDs) for the AGEM field program will include both volumes of this *Master Work Plan*, which together outline the program's overarching policies and procedures, as well as the site-specific work plan, which defines the scope of work for the field event. A site-specific HASP will also be prepared to document those aspects of health and safety that are unique to the CCC/USDA project site under investigation. Together, these documents meet the

requirements of Argonne's work planning process, which also satisfies many of the elements within the core functions of the Integrated Safety Management (ISM) system (see Section 6.2).

The HASP presented here focuses on the field program; the HASP for the analytical work conducted in the AGEM Laboratory is based on Argonne's WCDs for onsite laboratories; therefore, it is not presented here.

6.1.3 Key Field Personnel

Key field personnel include the AGEM program manager, the field project manager, the FHSC, the AGEM field team, and the EVS ESH coordinator (who may visit the site, but is not present for the entire field event). The AGEM field program often relies on contractors to assist in the drilling and sampling work, as well as installation of remediation systems.

6.2 Integrated Safety Management

The DOE requires that the principles of ISM be implemented for all Argonne activities. All AGEM program and contractor personnel are to incorporate the basic ISM core functions during their field work activities. The following sections outline the safety-related responsibilities of the AGEM program field team based on the ISM system.

6.2.1 AGEM Program Manager Responsibilities

The AGEM program manager is responsible for ensuring that the five ISM core functions are carried out properly. The five ISM core functions are as follows:

1. *Defining the scope of work.* Define the work, roles, and responsibilities. Allocate resources to ensure that programmatic and research goals are balanced with safe work practices.
2. *Identifying and analyzing hazards associated with the work.* Identify and analyze the hazards through environment, safety, health, and quality evaluations; consultation with subject matter experts (SMEs); and use of safety data sheet (SDS) information, lessons learned by other project managers and staff, and other resources.
3. *Developing and implementing hazard controls.* Actions and tools include training to optimize engineering controls and procedural approaches; job-specific hazard communication training; job pre-briefings; compliance-based and project-specific training; environment, safety, and health permits; and protective equipment.
4. *Performing work activities within these controls to assure that work is done safely.* Communicate expectations to project staff. Ensure that the controls identified in both volumes of this *Master Work Plan*, and the site-specific work plan and HASP,

are carried out. Provide opportunities for procedure modification in response to unanticipated situations. Ensure that employees feel empowered to stop work if imminent danger exists.

5. *Providing feedback on the adequacy of the controls to continue improving safety management.* Solicit feedback from project staff regarding environment, safety, health, and quality issues, and act on that input. Communicate concerns to and seek help from supervisors and EVS environment, safety, and health personnel. Reallocate resources to address issues that arise, and ensure that safety meetings are held and site briefings are performed.

The AGEM program manager is also responsible for ensuring that both volumes of this *Master Work Plan*, the site-specific work plan, and the site-specific HASP are entered into Argonne's WPC Aware application, as specified in the *EVS Work Planning and Control Manual* (Rev. 0; dated February 1, 2019). Together, these reports become the WCDs that will be evaluated by the EVS review team (consisting of the EVS Division director, the EVS ESH coordinator, and SMEs, if needed). These reports must include the following elements:

- A description of the field work planned, how it will be done, and where it will occur;
- An analysis of the possible hazards that could be encountered; and
- A discussion of the controls that will mitigate possible hazards and reduce field worker risk to an acceptable level.

The WCDs must be approved before any fieldwork can begin. Approval by the EVS review team authorizes the AGEM program manager to commence fieldwork activities.

6.2.2 Field Health and Safety Coordinator Responsibilities

The FHSC prepares (or oversees the preparation of) the site-specific HASP, determines whether the field team members are adequately trained and training is current, and arranges for additional training where necessary. Names and telephone numbers of field team members and contractors are recorded in the site-specific HASP for each field event. The FHSC provides the required health and safety information to the field project manager. The FHSC also conducts oversight inspections to ensure that the contents of both the general and site-specific HASPs are followed.

Before field work begins, the FHSC will conduct a pre-job brief to provide a thorough review of the site-specific HASP (in accordance with the *EVS Work and Control Manual* (Rev. 0; dated February 1, 2019). Other field responsibilities include:

- Verifying that the work is carried out according to the approved and authorized WCD.
- Leading the pre-job and post-job briefs (and daily tailgates).

- Confirming that all field team members read and understand both volumes of the *Master Work Plan* and the site-specific HASP.
- Providing safety oversight for the field team during field work.
- Responding to questions about how to complete work safely.
- STOPPING or PAUSING work and involving the proper SMEs and management for unexpected or unsafe conditions that arise.
- Providing feedback to the work planner who prepared the site-specific HASP.

6.2.3 Field Project Manager Responsibilities

The field project manager is available on the project site at all times when investigation activities, sampling, remedial activities, and associated work are conducted. The field project manager ensures that team members follow the applicable procedures in both volumes of the *Master Work Plan*, the site-specific work plan, and the site-specific HASP. The responsibilities of the field project manager include the following:

- Providing the required health and safety information to team members and contractor personnel.
- Ensuring that all personnel are aware of the potential hazards at the site and of the proper procedures for handling those hazards, including the health and safety provisions in the general and site-specific HASPs.
- Assuring that required PPE is available and used properly by all site personnel, in accordance with provisions of the general and site-specific HASPs.
- Implementing the general and the site-specific HASPs. This responsibility includes monitoring the safety performance of personnel to ensure that mandatory health and safety procedures are adequate and correcting any aspects that do not comply with the general or site-specific HASP.
- Conducting monitoring as required to ensure that the existing hazards are characterized adequately and that the level of PPE is appropriate.
- Monitoring personnel for signs of temperature stress or exposure to hazards.
- Ensuring that field crews observe the appropriate work practices and decontamination procedures.

6.2.4 Field Team Responsibilities

The members of the AGEM field team are responsible for knowing and following the ISM principles described in Section 6.2.1. The responsibilities of the field team include:

- Demonstrating that they've read and agree to follow the guidelines and procedures in the general and site-specific HASPs by signing the Acknowledgement and Agreement form provided in the site-specific HASP.
- Actively participating in the identification of hazards before work begins.
- Ensuring that potential work hazards have been evaluated by SMEs and are accounted for in all work practices.
- Ensuring that safety measures are incorporated into all activities.
- Performing only those tasks that can be done safely.
- Taking all reasonable precautions to prevent injury to themselves and their fellow field workers.
- Following all directives in both volumes of this *Master Work Plan* and the site-specific HASP, as well as all EVS and Argonne safety procedures (and required training).
- Suspending work if unexpected concerns arise (resuming field work only when concerns are addressed and authorization to restart is given).
- Keeping the field project manager or FHSC informed of all issues, problems, and concerns regarding all aspects of the field work.
- Reporting any changes in conditions that may affect safety and health to the field project manager or FHSC.
- Immediately notifying the field project manager or FHSC of symptoms or signs of exposure related to any chemical, physical, or biological hazards at the site.
- Immediately reporting any accidents, injuries, and/or unsafe conditions to the field project manager or FHSC.

It is important that everyone on the field team know that *anyone may initiate STOP work and PAUSE work*. Argonne's process for actions following a STOP work or PAUSE work includes placing the work in a safe condition at the direction of the AGEM program manager. For all work stoppage, the AGEM program manager will notify the EVS ESH coordinator and EVS Division director to identify a path forward. *Only the EVS Division director can authorize work to restart.*

6.2.5 Contractor Responsibilities

Contractors assisting the AGEM field team are subject to Argonne's health and safety rules and regulations, including the authority of the AGEM program manager, field project manager, the FHSC, and the EVS ESH coordinator, as well as to their company's HASP in instances where it is more stringent than Argonne's requirements. Contractors performing field activities must submit a Job Safety Analysis (JSA) to the FHSC or the EVS ESH coordinator (or both) for approval before work may begin at each job location (see Appendix B for the JSA form). The JSA forms specific to risk levels (low, moderate, and high) must be completed by contractors and filed with Argonne before they can begin field work.

Contractors are directly and solely responsible for ensuring that their own employees have been provided with appropriate PPE and have been adequately instructed with respect to the requirements of the general and the site-specific HASPs, as well as for ensuring that their employees conduct themselves in full conformance with the provisions of both plans at all times.

Contractors are responsible for the health and safety training of their employees.

6.3 Assessment of Potential Hazards

This section provides a summary of the potential hazards present at AGEM project sites. Implementation of controls to mitigate these hazards in the field is presented in Section 6.4. The sections in Section 6.4 addressing each hazard are provided at the end of each bullet for reference.

Physical hazards:

- Trip/fall hazard (due to uneven terrain, site clutter, or wet conditions); Section 6.4.1.
- Mechanical hazards (pinch points, rotating parts, tall derricks/rods, and heavy support equipment) associated with drill rigs, CPTs, or earth-moving equipment; Section 6.4.2.
- Fire hazard due to dry grass, especially if higher than the ground clearance of a vehicle; Section 6.4.3.
- Noise (from drill rigs, CPTs, or other heavy equipment); Sections 6.4.2 and 6.4.4.
- Confined space entry (potentially toxic, explosive, or oxygen-deficient atmosphere); Section 6.4.5.
- Poor lighting (when sun starts to set); Section 6.4.6.
- Vehicle traffic; Sections 6.4.7 and 6.4.8.

Chemical hazards:

- Exposure to site contaminants (carbon tetrachloride, chloroform) via contaminated media such as soil, water, or vapors (including those conveyed through the borehole to the surface); Sections 6.4.8, 6.4.9, and 6.4.11.
- Exposure to sulfuric and hydrochloric acids (small quantities used in sample preservation); Sections 6.4.8 and 6.4.9.
- Exposure to dry ice (used to preserve and ship soil samples); Sections 6.4.8 and 6.4.10.
- Exposure to hazardous volatiles released from soil as a result of the air stripping effect of rotary drilling with air (vapors can be relatively concentrated at the wellhead); Sections 6.4.8 and 6.4.11.
- Exposure to fuels and fuel vapors (containerized gasoline, diesel fuel, and motor oil); Sections 6.4.8 and 6.4.11.

Electrical hazards:

- Encountering overhead power lines or underground utilities; Section 6.4.12.
- Improper grounding of electrical equipment; Section 6.4.13.
- Energized electrical circuits; Section 6.4.13.

Biological hazards:

- Vector-borne diseases (illnesses caused by viruses and bacteria transmitted by mosquitos, ticks, etc.); Section 6.4.8.
- Poisonous plants (e.g., poison ivy); Section 6.4.8.
- Rodents and snakes (bites); Section 6.4.8.

Weather-related hazards:

- Tornadoes; Section 6.4.14.
- Extreme heat (or cold) stress; humidity; Sections 6.4.14 and 6.4.18.
- Lightning related to storms; Section 6.4.14.

Human factors/conduct:

- Improper or inadequate training for tools, equipment, or procedures; or new and/or unfamiliar equipment; Sections 6.4.15 and 6.4.16.
- Improper clothing or PPE; Sections 6.4.8, 6.4.15, and 6.4.16).
- Fatigue from long shifts, odd hours, jet lag, or stress; Section 6.4.15.
- Ingestion of contaminants (eating, drinking, or smoking at the work site); Section 6.4.15.
- Distraction (illness, fatigue, wildlife, or stress); Section 6.4.15.
- New/inexperienced team members; Sections 6.4.15 and 6.4.16.
- Unclear task assignment; Section 6.4.15.

6.4 Implementation of Hazards Control

The AGEM field program adheres to all applicable rules and regulations of 29 CFR 1926 (OSHA Construction Standards) and 29 CFR 1910 (OSHA General Industry Standards). It also follows all applicable health and safety policies and procedures of EVS Division, Argonne, and DOE, as well as those established by the states of Kansas, Nebraska, and Missouri. The following sections describe the controls in place to mitigate the potential hazards identified in Section 6.3.

6.4.1 Controlling Work Areas at Project Sites

Work areas will be designated using cones, flags, signs, or a combination of these. All field workers are responsible for keeping work areas organized and neat to avoid trip/fall hazards. Access to work areas will be controlled by the field project manager or FHSC; no unauthorized persons will be allowed access to the work areas.

Visitors seeking access to the work area(s) must receive a safety briefing by the field project manager or FHSC. The safety briefing will identify restricted area(s), provide site evacuation procedures and emergency shelters, and cover other relevant topics (such as how to protect oneself from biological or weather-related hazards). Visitors to the project site must wear appropriate PPE (issued by the FHSC) and remain with an escort at all times. Visitors without the OSHA 40-hour training will not be allowed access to restricted areas.

6.4.2 Working Safely around Drilling and CPT Equipment

Sonic drilling operations at AGEM project sites are performed by contractors that have their own HASPs. However, AGEM field workers are to know and observe the contractors' safety rules and procedures, especially with regard to the defined exclusion zone and safety equipment

requirements. *Field workers who do not need to be in the exclusion zone should stay clear of the area.*

AGEM field workers should always wear appropriate PPE and exercise caution around drilling and CPT equipment, keeping the following directives in mind:

- Backup alarms and spotters are to be assigned to heavy equipment.
- Do not touch or go near moving parts (to avoid pinch point injuries). If close observation is required to complete an inspection, minimize exposure time. Always get authorization to proceed from the driller.
- Know the location of the emergency shut off switches. These switches must be checked for proper operation before drilling, pushing, or sampling begins and during the daily maintenance check. All malfunctions must be repaired before the work may proceed.
- Do not smoke or use spark-producing equipment around drilling operations, because flammable gases may be released from the subsurface environment.
- Use proper lifting procedures and ask for help, as needed.
- Always wear noise protection.
- Pay attention to weather conditions (noise protection and low visibility in the enclosed units can limit awareness of weather).
- *Do not work or stand around the drilling equipment during a thunderstorm because lightning could strike the rig. If you can see lightning, you are already in danger.*
- Drilling activities may be monitored for explosive or hazardous gases, if warranted. The AGEM field project manager will enter into the field logbook the location of the measurement, the time taken, the instrument used, the person taking the reading, and the results. If an explosive or high-risk atmosphere exists, STOP work, and develop an action plan to proceed. Work may not be restarted until the unsafe condition has been abated. Follow the procedure in Section 6.2.4 to authorize a restart.

6.4.3 Controlling Fire Hazards

Several multipurpose (A:B:C) dry-chemical fire extinguishers are to be available on the work site. One fire extinguisher will be on the inside wall of each CPT vehicle, and the others will be distributed among support vehicles. All personnel using fire extinguishers must be properly trained.

Workers must avoid driving over dry grass that is higher than the ground clearance of a vehicle. Catalytic converters on the undercarriages of vehicles are sufficiently hot to ignite dry grass. A vehicle with a warm undercarriage must never be allowed to sit in a stationary location over dry grass or other combustible materials.

Before the drilling rig moves onto an area with dry grass, the area must be cleared sufficiently to mitigate any potential for fire.

6.4.4 Working Safely around Noise

Drilling operations generate high noise levels near the rig. Hearing protection is required when personal noise exposure levels are in excess of 85 dBA as a time-weighted average over an 8-hr shift. Guidelines for determining the allowable duration of continuous noise exposure are:

Guidelines for Continuous Noise Exposure	
Hours per Day	Sound Level (dBA)
8	85
4	88
2	91
1	94
1/2	97
1/4	100
1/8	115

Hearing protection must have a manufacturer noise reduction rating sufficient to reduce noise exposure levels to 85 dBA or less. Hearing protection is to be worn in the proper manner to assure that the noise reduction rating is effective. As a general rule, hearing protection is required if workers must shout to be heard at a distance of 3 ft in continuous noise or when load impact noise is expected. The field project manager or FHSC is to use calibrated equipment to measure noise levels. Field personnel are to be properly trained. All work areas are to be monitored at the initial start-up time by using a sound level meter. Monitoring records are to be kept for the program archives.

6.4.5 Confined Space Entry

For the purpose of this general HASP, a confined space is defined as any area having limited space for entry and exit and the potential for the presence of a toxic, explosive, or oxygen-deficient atmosphere. This definition includes manholes, certain trenches (particularly those through waste disposal areas), and all test pits more than 4 ft deep in potentially contaminated soil.

The following procedures and requirements apply to entry into any confined space:

- Before any confined space entry occurs, a Confined Space Entry Permit (Argonne's form ANL-614) must be completed by the field project manager or FHSC and approved by the AGEM program manager, as well as by the EVS ESH coordinator. The permit specifies additional entry requirements. *This is to be done during the project planning phase (and not in the field).*
- No worker may enter any test pit or trench more than 4 ft deep unless the sides are shored or laid back to a stable slope.
- No worker may enter a confined space unless another worker is present.
- When a worker must enter a pit or trench 4 ft deep or more, an adequate means of entry and exit, such as a slope of at least 2:1 to the bottom of the pit or a secure ladder or steps, must be provided.
- Before a worker enters any confined space, including any test pit or any trench that might have the potential for the accumulation of toxic gases or vapors, the atmosphere must be tested. Any worker entering a confined space must have been trained in confined space entry and must be equipped with an appropriate level of respiratory protection. However, *no worker may enter a confined space if that confined space requires the use of OSHA Level B or Level A protection.*

6.4.6 Lighting

All field activities are expected to be performed during daylight hours. All operations on the site will cease at sunset unless the work area is adequately illuminated (to at least 5 foot candles) with artificial lighting.

6.4.7 Working Safely around Vehicle Traffic

Field workers should be aware of and avoid vehicle traffic (cars, trucks, drill rigs, farm equipment, etc.) both on the project work site and on streets and roads at all times. Workers working within 6 ft of a street or road that is open to traffic will wear a reflective vest.

6.4.8 Personal Protective Equipment

AGEM field work does not typically require OSHA Level B or Level A protection, which require respiratory protection and/or a totally encapsulated chemical- and vapor-protective suit. The PPE discussed in this section, therefore, pertains only to OSHA Levels D and C protection.

6.4.8.1 OSHA Level D Protection

Level D protection is generally appropriate for most field work at AGEM project sites. Level D PPE will comply with the OSHA requirements detailed in Appendix B of 29 CFR 1910.120 and includes the following:

- Work clothing appropriate for the weather.
- Safety shoes that come above the ankle (no loafers or sport shoes) or boots.
- Safety glasses.
- Chemical goggles and a full-face shield, when indicated.
- Hard hat.
- Leather or other work gloves when contact with contaminated soils or water is not anticipated.
- No loose-fitting clothing or jewelry; long hair constrained.

In some situations, as noted below, additional PPE may be required:

- Minimum PPE for drill operators, crew, and persons in the vicinity will include gloves, hard hat, safety glasses, safety shoes, and hearing protection.
- Field workers working within 6 ft of a street or road that is open to traffic will wear a reflective vest.
- Field workers in contact with potentially contaminated soils or water will wear chemical-resistant gloves (nitrile, neoprene, or natural rubber) and coveralls.
- Field workers who potentially could be exposed to hazardous vapors or contaminated cuttings and fluids will wear appropriate respiratory and dermal protection.

Field workers should also be prepared to protect themselves from sunburn with hats, long-sleeved shirts, and sunscreen. Protection from poisonous plants (e.g., poison ivy), insects (e.g., mosquitos and ticks), and biting animals (e.g. snakes) includes pest repellent, long-sleeved shirts, and pants long enough to tuck into boots.

6.4.8.2 OSHA Level C Protection

Level C protection is selected when the type of hazardous airborne substance is known, its concentration has been measured, criteria for using air-purifying respirators are met, and skin or eye exposure is unlikely. The field project manager or FHSC will monitor the air to comply with

OSHA regulations and to ensure respirator effectiveness. Level C PPE will comply with the OSHA requirements detailed in Appendix B of 29 CFR 1910.120 and includes the following:

- Air-purifying respirator (as directed by the Mine Safety and Health Act and approved by the National Institute for Occupational Safety and Health), equipped with an organic vapor cartridge. Cartridges must be changed daily or more often if indicated.
- Chemical-resistant clothing. A polyethylene coating is recommended for protection against liquid chemicals. Acceptable clothing includes one-piece coveralls; hooded, two-piece chemical splash suits; chemical-resistant hoods and aprons; and disposable chemical-resistant coveralls.
- Chemical-resistant inner and outer gloves. Viton or polyvinyl alcohol is recommended for handling liquids.
- Boots with safety toe and shank, chemical resistant.
- Disposable chemical-resistant outer boots, optional.
- Two-way radio communications (intrinsically safe), optional.
- Hard hat (near mechanical or overhead hazards).
- Escape mask (respirator), optional.

6.4.8.3 Guidelines for the Use of Personal Protective Equipment

Guidelines for the use of PPE are as follows:

- Avoid direct contact with contaminated materials unless contact is necessary for sample collection or observation. Wear PPE at all times.
- Do not handle contaminated soil, waste samples, or any other potentially contaminated items without appropriate chemical-resistant, impermeable gloves.
- Always use the appropriate level of PPE indicated in the site-specific procedures. Inadequate levels of protection can allow otherwise preventable exposure; excessive levels of protection can impair efficiency and increase the potential for accidents.
- Establish hand signals or other means of emergency communication for personnel wearing respiratory equipment before work begins. Some PPE can seriously impair communication by speaking/hearing.

- Nonparticipating visitors to the site, such as nearby property owners and community residents, are to be escorted when they are near site investigation activities. Visitors to the site are to be evaluated with regard to (1) the reason for the visit, (2) the length of the visit, and (3) the level of participation in site activities. Appropriate health and safety actions taken on this basis include participation in daily safety review meetings and the use of safety goggles, hearing protection, and other PPE.

6.4.9 Working Safely with Chemical Hazards

6.4.9.1 Carbon Tetrachloride

Carbon tetrachloride is a noncombustible, colorless liquid with a sweet, aromatic, ether-like odor. Prolonged exposure to high concentrations can cause loss of consciousness and death due to respiratory failure. Exposure to low concentrations can cause severe gastrointestinal upset progressing to serious kidney and liver damage. Carbon tetrachloride as a vapor or liquid is also an eye irritant, causing burning and tearing. The EPA considers carbon tetrachloride to be a probable human carcinogen. The odor threshold for carbon tetrachloride in air is 50 ppm.

The OSHA maximum concentration limit for carbon tetrachloride for work area breathing zone air is 10 ppm for an 8-hour workday (time-weighted average) over a 40-hour work week, with a ceiling concentration of 25 ppm that may not be exceeded during an 8-hour workday, except for one 5-minute period every four hours. The acceptable maximum peak during this 5-minute period is 200 ppm (see 29 CFR 1910.1000, Table Z-2).

6.4.9.2 Chloroform

Chloroform is a noncombustible, colorless liquid with a pleasant, sweet odor. This compound is classified as moderately toxic when exposure occurs orally. Potential health effects resulting from acute exposure include dizziness, mental dullness, nausea, headache, and fatigue. Chloroform is a well-known anesthetic. Inhalation can initially induce a warm feeling on the face and body that is followed by irritation of the mucous membranes and skin. Prolonged inhalation can cause paralysis accompanied by respiratory failure and eventually death. The EPA recognizes chloroform as a probable human carcinogen. OSHA cites odor threshold concentrations in air of 85-307 ppm. OSHA has established a permissible exposure limit (PEL) for chloroform of 50 ppm as a non-exceedable ceiling value in workplace breathing zone air (see 29 CFR 1910.1000, Table Z-1).

6.4.9.3 Safety Data Sheets

Safety precautions and first aid measures for exposures to carbon tetrachloride and chloroform are detailed in SDSs for these chemicals (ThermoFisher 2018a; 2019a). These SDSs,

as well as those for any other chemicals of concern (such as hydrochloric and sulfuric acid, used in sample preservation; see ThermoFisher 2019b; 2018b), will be attached to the site-specific HASP.

6.4.10 Working Safely with Dry Ice

Dry ice is solid carbon dioxide at a temperature of -78.5°C (-109.3°F); in the AGEM field program, it is used to hold and ship soil samples. Safety precautions and first aid measures for dry ice exposure are detailed in SDS P-4575 (Praxair 2019); the SDS must be attached to the site-specific HASP if it is used in the field. Site workers must be aware of the hazards of dry ice to work safely. These include:

- Dry ice in contact with skin can cause cryogenic burns (severe frostbite).
- Carbon dioxide changes directly from a solid to a gas (sublimes) at temperatures above -78.5°C . Gaseous carbon dioxide generated in a closed space from dry ice can cause asphyxia by displacing oxygen. Concentrations of carbon dioxide in excess of 1.5% can cause death.
- Excess carbon dioxide gas from dry ice in aircraft can asphyxiate pilots and cause a crash.
- Gas pressure generated in a tightly closed space can cause an explosion.

The following are basic protective measures to be taken to reduce the risk of dry ice exposure:

- Protect skin and eyes.
- Properly label holding coolers that contain dry ice.
- Ventilate storage areas.
- Open a window when transporting coolers of samples with dry ice in an enclosed vehicle. If climate control is in use in the vehicle, set the controls to draw outdoor air rather than to recirculate. Any exception to this procedure must be approved by the AGEM program manager or FHSC.
- Transport large quantities of dry ice in open-bed vehicles.
- Observe packaging instructions in SOP AGEM-23 (*Master Work Plan*, Volume 2). Perforate plastic bags containing dry ice to relieve pressure and prevent explosive build-up of gas.
- To protect any drivers and pilots who transport shipping containers to the laboratory, follow shipping regulations, and use proper labeling.

6.4.11 Site Monitoring

All necessary monitoring equipment and supplies are to be available before site work begins. The field project manager is to ensure that ambient air monitoring is conducted for hazardous materials whenever appropriate. The following types of equipment are to be available for monitoring exposures:

- A field PID, such as HNu P1-101, OVM 580, or Mini Rae P10. Lamp selections will include 11.7-eV types (carbon tetrachloride has 90% sensitivity; chloroform has 60% sensitivity).
- Carbon dioxide monitor.
- Oxygen meter.
- Sound level meter.
- Combustible gas indicator.
- Draeger pump and detector tubes for carbon tetrachloride (#8101021) and chloroform (#6728861).

The field project manager will ensure that monitoring is conducted for hazardous materials and noise whenever appropriate. Calibration and air monitoring results must be documented.

Air monitoring for hazardous vapors in the work zone will be performed according to SOP AGEM-21 (*Master Work Plan*, Volume 2). Additional monitoring methods, if required, will be detailed in the site-specific HASP.

6.4.12 Working Safely Around Power Lines and Underground Utilities

Field workers should always take note of the locations of overhead utilities (electric lines, telephone lines, etc.). The driller is to inspect the area when drilling occurs in the vicinity of overhead electrical lines. All lines are to be considered live and dangerous. Determine the minimum distance from any point on the drilling equipment to the location of the nearest power line when the mast is raised or is being raised. *Do not operate the drill rig if the minimum distance is less than 20 ft.* Similar offset distances are required for drilling and CPT operations.

Underground utilities are to be surveyed, marked, and avoided. Before the ground is penetrated in investigation activities, the field project manager or FHSC will contact the appropriate utilities surveyor to determine the locations of utilities. Contact information for the utilities surveyor will be provided in the site-specific HASP. Contact utility location services as follows:

- In Kansas, call 811 (Kansas 811).
- In Nebraska, call 800-331-5666 (or 811).

- In Missouri, call 800-DIG-RITE (800-344-7483; or 811).

In the event that an underground utility is hit or drilling/pushing operations hit questionable material, the field project manager or FHSC is to immediately STOP work and leave the area. The field project manager will contact the AGEM program manager and the EVS ESH coordinator for direction on how to proceed. Once resolved, the EVS Division director can give authorization to restart work.

6.4.13 Working Safety Around Electrical Hazards

All electrical equipment to be used during field activities must be properly grounded. Before any 120-V, single-phase, 15- or 20-A receptacle outlet is used, a ground fault circuit interrupter approved by an accredited testing laboratory must be installed. Only qualified persons may work on electrical equipment, and all equipment must be maintained in safe condition. Underground electrical utilities must be located before drilling or excavation begins.

Work is not to be performed on any energized electrical circuits. Before work is done, the circuit must be de-energized and tested to make sure that no voltage is present. A lockout/tagout procedure must then be implemented, and an attempt must be made to operate the equipment to ensure that it has been de-energized. Only then may work on the circuit begin. Only qualified persons may implement lockout/tagout procedures; the procedures must be performed in accordance with OSHA's performance requirements for controlling hazardous energy, as specified in 29 CFR 1910.147.

6.4.14 Extreme Weather Events

Tornado procedures will be established at the beginning of the field event. Storm warning radios or devices will be available in the field. Keep a close watch on weather conditions when weather is unsettled in the region. There are several weather apps (e.g., RadarScope, Weather Channel, and Dark Sky) that can be downloaded to cell phones for free (or a nominal fee) to facilitate local weather monitoring. The Dark Sky app also predicts lightning strikes. If thunder is heard or lightning is observed (or predicted), field workers will terminate all field work immediately and retreat to a safe (shelter) location. Field workers should wait at least 30 min after the last lightning occurrence before restarting work.

All field workers should be familiar with the *Severe Weather Preparedness Guide* (IEMA 2019), which is available in the AGEM program archives. The guide provides important information of the terms of extreme weather events (for tornadoes, thunderstorms, and floods) and guidance on what to do both during and after such a threat hits.

Field workers also must be aware that rain or snow can increase the risk of sliding and falling, decrease visibility, and make equipment more hazardous to operate. Extra caution is required in these conditions.

6.4.15 Field Team Conduct

For their health and safety, field workers should consistently conduct themselves as follows:

- Stay alert and avoid fatigue.
- Use common sense.
- Be informed about and follow procedures.
- Ask questions as needed about anything that is unclear.
- Cease all field activities at sunset (because of poor lighting).
- Refrain from using cell phones or hands-free devices while driving (Argonne policy LMS-POL-6, Rev. 11).
- Implement STOP work authority, if needed.

AGEM field workers are not to work alone. There should be at least one other AGEM field team member or contractor present at all times. In addition, field workers will not work more than 14 consecutive days at a time.

Eating, drinking, and smoking are prohibited at the work site during sampling activities. All employees are to wash their hands (and faces, if necessary) thoroughly before they eat, drink, smoke, or chew gum, in order to avoid hand-to-mouth contamination. A wash station will be available on the site during all investigations and remedial action activities

Most project sites do not have drinking water available. The FHSC, therefore, will ensure that adequate water and ice to last the day are provided (field workers may also bring their own supply). Most sites do not have restrooms. Field workers, therefore, should identify a place in town with available restrooms. For extended field activities (and remote sites), a portable facility may be provided.

6.4.16 AGEM Field Team Training

All Argonne personnel are required to complete individual- and Division-specific training courses based on their job responsibilities (as documented in their Job and Hazard Questionnaire [JHQ]). These may include some or all of the following:

- Fitness for Duty – Field Exam (FFD)
- Supervising at Argonne (HR265)
- Human Factors – A Team Approach (WPC203)

- Work Planning and Execution – EVS Specific (WPC303)

“Onboarding” training required by EVS is dependent on individual staff job requirements. Those relevant to the AGEM field team include location-specific hazard awareness, emergency response, and equipment-specific training. Team members must meet all their training requirements as documented in Argonne’s JHQ system to be eligible to work in the field. Authorization to work will not be granted by the AGEM program manager until all training requirements are met.

The AGEM field team and contractor personnel must also complete OSHA’s 40-hour Hazardous Waste Operations and Emergency Response Standards training course that meets the requirements of 29 CFR 1926.65(e). The training is to be documented with a certificate signed by the course director. Training also includes an additional 24 hours of field or operations training under supervision. Field supervisors are required to complete an additional 8 hours of training. All field team members (and contractors) are required to complete the 8-hour refresher course annually.

Only personnel who have completed U.S. Department of Transportation hazardous material training will be authorized by the AGEM program manager (or FHSC) to ship packages containing dry ice, if shipment is to be by air or water.

6.4.17 Medical Monitoring

6.4.17.1 Heat Stress

In the field, a worker’s heat tolerance is reduced when impermeable clothing is worn, and his/her physical condition should be observed closely. The table below summarizes the basic symptoms field team workers should recognize for heat-stress-related illnesses, along with appropriate treatments.

Symptoms and treatments for heat-stress-related illnesses		
Category	Symptom	Treatment
Heat stroke	Hot, dry skin; temperature high and rising; mental confusion, loss of consciousness, coma	Immediately and rapidly cool by immersing in cool water; wrap in wet sheets and fan with cool, dry air.
Heat exhaustion	Fatigue, nausea, headache, giddiness; clammy, moist skin; faint, rapid pulse	Remove to cooler environment; administer electrolyte replacement fluids; allow to rest.
Heat cramps	Painful spasms of muscles used during work	Administer electrolyte replacement fluids; allow to rest.
Sunburn	Redness and possible blistering of the exposed skin	Remove victim from the sun; apply sun block lotions and lip balm often to prevent burning.

If heat stress occurs, the field worker is to leave the work area, rest in a shaded or air-conditioned area, cool off, and drink plenty of cool water. The field worker is to notify the field project manager or FHSC, and medical assistance is to be obtained if necessary. Personnel wearing protective clothing are to be observed by the FHSC for signs and symptoms of heat-stress-related illnesses when the ambient temperature is 70°F or above. The frequency of observation and assessment are to increase as the ambient temperature increases and as the use of protective clothing increases.

To protect workers from heat stress, the following evaluation and control measures are to be used when appropriate:

- *Environmental Monitoring.* The air temperature or adjusted dry-bulb temperature will be used as an index for expressing environmental heat load.
- *Work-Rest Regimen.* An appropriate work-rest regimen will be developed on the basis of environmental heat load, work load, and level of PPE.
- *Physiological Response Monitoring.* Physiological response to heat load (e.g., increase in heart rate, body temperature, skin temperature, and sweat production) will be evaluated as appropriate.
- *Providing Adequate Water and Electrolyte Supplements.* An adequate supply of cool water is to be maintained at the work site, and electrolyte supplements are to be available as needed. Salt tablets are NOT recommended.

6.4.17.2 Cold Stress

Sustained field exposure to low temperatures, especially accompanied by wind or wet clothing, can cause various degrees of cold stress. The table below summarizes the basic symptoms field team workers should be able to recognize for cold-stress-related illnesses, with appropriate treatments.

Symptoms and treatments for cold-stress-related illnesses		
Category	Symptom	Treatment
Hypothermia	Initial signs: exhaustion, reluctance to move, trembling and shivering, false feeling of well-being, clumsiness, and loss of judgment	Stop and immediately get to shelter; attempt to slowly rewarm the victim (add layers of clothes or blankets); attempt to get hot, sweet food or drink into the victim; seek medical attention.
Frostbite	Sudden blanching of the skin; tingling, stinging, or dull ache in affected area, followed by numbness	Place frozen area in warm place immediately. Do not rub frostbitten area. Seek medical attention.

If cold stress occurs, the field worker is to contact the field project manager or FHSC so they can obtain medical assistance, if necessary.

To protect workers from cold stress, appropriate insulating clothing is to be worn. The following evaluation and control measures are to be used when appropriate:

- *Environmental Monitoring.* When the temperature falls below 32°F, evaluate the dry-bulb temperature and wind speed every 4 hours and use them as an index for expressing environmental cold stress. Check personnel routinely for signs of frostbite.
- *Work-Rest Regimen.* Develop an appropriate work-rest regimen that is based on environmental monitoring, work load, and protective clothing.
- *Providing Adequate Fluid Replacement.* Dehydration can occur insidiously in the cold environment. Therefore, make fluids available during breaks.

6.4.18 Emergency Notifications

All accidents and/or injuries must be reported to the AGEM field project manager and FHSC as soon as possible after the occurrence. In the event of an emergency, the best course of action for the AGEM field team will be determined by the FHSC. The general emergency response procedures are as follows:

- First, protect yourself from harm.
- If needed, determine the most rapid method of contacting emergency personnel (phone, radio, or messenger), and initiate contact procedures.
- Attend continuously to the victim to the extent possible, until help arrives.
- Supply first aid assistance to the victim, consistent with your training level, and take other action, as appropriate, to stabilize the situation until professional help arrives. Incidents that appear likely to cause injury or property damage must be reported to the AGEM program manager.
- In the event of an injury, illness, or accident, the FHSC will make the following notifications as soon as practical (preferably within one hour) after immediate care is provided: (1) the EVS ESH coordinator; (2) the injured/ill party's supervisor or the EVS Division director; and (3) Argonne's Incident Reporting Hotline (630-252-1911). Alternately, if phone reporting is not convenient, the supervisor should send an electronic mail message to safety@anl.gov to report the incident (Argonne procedure LMS-PROC-157, Rev. 15).

- Use the Incident Description Form (Argonne's form ANL-239), provided in Appendix B, to collect and record information needed for reporting. The following information is needed:
 - Name and badge number
 - Division (EVS)
 - Date and time of incident
 - Location of incident
 - Type of incident (e.g., injury)
 - Brief description of the incident

These procedures will be provided in Section 3 of the site-specific HASP (Figure 6.1). All accidents or injuries requiring first aid or medical treatment will be investigated by the FHSC and the EVS ESH coordinator.

6.4.19 New (Unplanned) Activity

The field project manager will provide or obtain the needed information for any unusual or new activity that has not been evaluated for its health and safety potential. Such activity should be evaluated and approved, as necessary, by the EVS review team (see Section 6.2.1). A short written report (Site Safety Review Form; Appendix B) of the EVS review team's findings will be prepared by the AGEM program manager, in consultation with the EVS ESH coordinator, and filed with the site-specific HASP in the program archives.

6.5 Determination of Risk

Each site-specific HASP will provide a determination of risk level (low, moderate, high) based on the hazards assessment for the project scope of work. Risk determination will use the EVS risk assessment matrix that plots likelihood of risk (not likely, possible, probable) against a scale of severity (acceptable, tolerable, generally unacceptable). Based on the hazards identified in Section 6.3, the overall risk level for the AGEM field program is typically LOW to MODERATE.

6.6 Post-Field Event Review

During the field program, task-specific hazards (and feedback from field workers) will be reviewed daily at "tailgate" meetings. *Field team attendance at tailgate meetings is mandatory.* The purpose of the tailgate discussion is to provide feedback to the field project manager and FHSC (and other field workers) that may result in real-time work modifications to lessen worker risk. Meeting notes taken by the field project manager or FHSC and workers in attendance (by

signature) will be documented on the tailgate forms provided as attachments to the site-specific HASP (see also Appendix B). These will be reviewed by the AGEM program manager so that work instructions for future field events can be modified/improved (as needed) and forwarded to the records manager for the program archives.

6.7 Safe Handling of Investigation-Derived Wastes

The types of potential wastes generated during a site investigation include soil cuttings, soil cores, drilling mud, purge water, decontamination fluids, sampling expendables, PPE, and general refuse. The field team will use screening techniques and laboratory analyses (if warranted) to evaluate representative samples of accumulated waste to characterize the waste and determine the proper method of disposal. Waste disposal will be in accordance with state and federal guidelines.

Potentially contaminated IDW is to be segregated, contained, characterized, and disposed of in a manner protective of worker health and the environment. Containers approved by the U.S. Department of Transportation will be used, with appropriate labels. Such containers include steel drums, covered roll-offs, or bulk liquid containers.

Waste container contents are to be identified by weather-resistant labels indicating the status of the waste (e.g., "Waste Awaiting Characterization"). Information including project name, origin of waste, date containerized, container identification number, and the nature of the waste is to be written on each label with indelible ink. The information is to be initialed by the labeler. Containers are to be re-labeled if the status of the waste changes.

Waste containers are to be staged to minimize public contact while meeting project-specific needs and conditions, including landowner preferences. On-site handling will be consistent with the "as low as reasonably achievable" concept to the extent practicable. Small quantities of environmental media or solid waste may be contained in steel or plastic carboys or plastic bags. Best professional judgment will be used to determine whether management options are protective and compliant in a site-specific context. Waste will be moved off-site only in compliance with applicable laws.

6.7.1 Purge Water

Purge water from any source suspected of being contaminated must be containerized, without exception.

6.7.2 Field Assay Kits

Field assay kits may contain small volumes of spent reagents or contaminated disposables. Kit wastes of concern are to be segregated and accumulated during the field event

in secure, labeled containers (e.g., plastic bottles or sealable plastic bags). Kit wastes are to be disposed of appropriately at the end of the field activity.

6.7.3 Non-Hazardous Refuse

Non-hazardous refuse is to be bagged for later disposal in a sanitary landfill. Because of the volatility and low concentrations of the contaminants of concern (carbon tetrachloride and chloroform), Level D PPE is normally appropriate. Contact of environmental media with PPE does not result in risk-level contamination. Used PPE and expendables may be combined with general refuse for disposal.

6.8 Preparation of the Site-Specific Health and Safety Plan

The site-specific HASP will be prepared by the FHSC (or work planner designee) for each field event conducted by the AGEM program. The site-specific HASP will incorporate the information presented in this section of the *Master Work Plan* by reference, as it applies, and focus on information (such as hospital route) specific to the planned scope of work and project site location. The site-specific HASP will follow the outline of the EVS HASP template provided in Appendix B.

Once the site-specific HASP has been reviewed and approved by the AGEM program and field managers, it will be uploaded with this *Master Work Plan* to Argonne's WPC Aware application for review by Argonne's EVS Division director and the EVS ESH coordinator. Once these documents are approved, the EVS Division director will authorize field work to begin.

The field project manager will forward signed and dated copies of the AGEM Field Program Acknowledgement and Acceptance and daily Tailgate Safety Meeting forms to the records manager for the program archives. In the event of a safety incident or (planned) confined space entry, the field project manager will also complete Argonne forms ANL-239 (Incident Description) and ANL-614 (Confined Space Entry Permit) and forward them to the AGEM records manager for the program archives. All of these forms will be provided as attachments to the site-specific HASP (see Appendix B for forms to attach) and uploaded as WCDs to Argonne's WPC Aware application.

7 References Cited or Consulted

ASTM, 2018, *Standard Practice for Expedited Site Characterization of Vadose Zone and Groundwater Contamination at Hazardous Waste Contaminated Sites*, Standard D6235-18 (revised), American Society for Testing and Materials, West Conshohocken, Pennsylvania. (For this and other ASTM standards, go to <https://compass.astm.org>)

EPA, 1987, *Data Quality Objectives for Remedial Response Activities, Development Process*, EPA/540/G87/003, OSWER Directive 9355.0-7B, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, and Office of Solid Waste and Emergency Response, Washington D.C., March.

EPA, 1988a, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, EPA/540/G-89/004, OSWER Directive 9355.3-01, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington D.C., October. (For this and other EPA guidance and documents on ARARs, go to <https://www.epa.gov/superfund/applicable-or-relevant-and-appropriate-requirements-arars>)

EPA 1988b, *CERCLA Compliance with Other Laws Manuals: Interim Final, Part 1*, EPA/540/G-89/006, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C., August. (For this and other EPA guidance and documents on ARARs, go to <https://www.epa.gov/superfund/applicable-or-relevant-and-appropriate-requirements-arars>)

EPA, 1989a, *CERCLA Compliance with Other Laws Manuals: Part II. Clean Air Act and Other Environmental Statutes and State Requirements*, EPA 540/G-89/009, OSWER Directive 9234.1-02, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington D.C., August. (For this and other EPA guidance and documents on ARARs, go to <https://www.epa.gov/superfund/applicable-or-relevant-and-appropriate-requirements-arars>)

EPA, 1989b, *CERCLA Compliance with Other Laws Manual, Compliance with State Requirements*, Quick Reference Fact Sheet, EPA Publication 9234.2-05/FS, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington D.C., December. (For this and other EPA guidance and documents on ARARs, go to <https://www.epa.gov/superfund/applicable-or-relevant-and-appropriate-requirements-arars>)

EPA, 1990, *National Oil and Hazardous Substances Contingency Plan: Final Rule (40 CFR Part 300)*, U.S. Environmental Protection Agency, Washington D.C., revised in 1994 to reflect the oil spill provisions of the Oil Pollution Act of 1990. (For an overview of the NCP go to <https://www.epa.gov/emergency-response/national-oil-and-hazardous-substances-pollution-contingency-plan-ncp-overview>)

EPA, 1991, *Compendium of CERCLA ARARs Fact Sheets and Directives*, EPA Publication 9347.3-15; CERCLA-005/1091, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C., and U.S. Department of Energy, Office of Environmental Guidance, October. (For this and other EPA guidance and documents on ARARs, go to <https://www.epa.gov/superfund/applicable-or-relevant-and-appropriate-requirements-arars>)

EPA, 1992, *CERCLA/SUPERFUND, Orientation Manual*, EPA/542/R-92/005, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Technology Innovation Office, Washington D.C., October. (For this and other EPA guidance and documents on ARARs, go to <https://www.epa.gov/superfund/applicable-or-relevant-and-appropriate-requirements-arars>)

EPA, 1997, *Clarification of the Role of ARARs in Establishing Preliminary Remediation Goals under CERCLA*, EPA/540F-97/008, OSWER 9200.4-23; memorandum by Timothy J. Fields, Acting Assistant Administrator, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington D.C., August. (For this and other EPA guidance and documents on ARARs, go to <https://www.epa.gov/superfund/applicable-or-relevant-and-appropriate-requirements-arars>)

EPA, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, EPA/240/B-06/001, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C., February.

EPA, 2014, *Hazardous Waste Test Methods: SW846 Compendium, Update V (Revision 8)*, U.S. Environmental Protection Agency, Washington, D.C., July. (For updates and a searchable table of all methods in the compendium, go to <https://www.epa.gov/hw-sw846/sw-846-compendium>)

EPA, 2015, *EPA Contract Laboratory Program Statement of Work for Organic Superfund Methods, Multi-Media, Multi-Concentration*, SOM02.3, September.

EPA, 2016, *Superfund Community Involvement Handbook*, U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation, Washington D.C., January.

EPA, 2017a, *Best Practice Process for Identifying and Determining State Applicable or Relevant and Appropriate Requirements Status Pilot*, OLEM Directive 9200.2-187; memorandum by James E. Woolford, Director, U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation, Washington D.C., October. (For this and other EPA guidance and documents on ARARs, go to <https://www.epa.gov/superfund/applicable-or-relevant-and-appropriate-requirements-arars>)

EPA 2017b, *National Functional Guidelines for Organic Superfund Methods Data Review*, EPA/540/R-2017/002, OLEM 9355.0-136, U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation, Washington D.C., January.

IEMA, 2019, *Severe Weather Preparedness Guide*, Illinois Emergency Management Agency, Springfield, Illinois, March.

KDHE, 2001, *Scope of Work (SOW) for a Corrective Action Study*, BER Policy #BER-RS-019, guidance published by the Kansas Department of Health and Environment, Bureau of Environmental Remediation/Remedial Section in 1991, revised March 2001. (For this and other KDHE BER policies, go to <http://www.kdheks.gov/ber/policies.htm>)

KDHE, 2005, *Potential Applicable or Relevant and Appropriate Requirements (ARARs)*, BER Policy #BER-RS-015, guidance published by the Kansas Department of Health and Environment, Bureau of Environmental Remediation/Remedial Section in 1995, revised December 2005. (For this and other KDHE BER policies, go to <http://www.kdheks.gov/ber/policies.htm>)

MDNR, 2008, *Missouri Risk-Based Corrective Action Technical Guidance*, guidance published by the Missouri Department of Natural Resources, April 2006, revised June 2008. (Note that future changes to this document are documented at <https://dnr.mo.gov/env/hwp/mrbcaupdate.htm>)

NDEQ, 2018, *Nebraska Voluntary Cleanup Program Guidance Document*, guidance published by the Nebraska Department of Environmental Quality, Lincoln, Nebraska, September.

Praxair, 2019, *Safety Data Sheet (P-4574): Carbon Dioxide, Solid or Dry Ice*, on January 1, 1997; revised February 2, 2019.

ThermoFisher Scientific, 2018a, *Safety Data Sheet: Carbon Tetrachloride*, issued on November 24, 2010; revised on January 18, 2018.

ThermoFisher Scientific, 2018b, *Safety Data Sheet: Sulfuric Acid (Certified ACS Plus)*, issued on November 12, 2010; revised on July 6, 2018.

ThermoFisher Scientific, 2019a, *Safety Data Sheet: Chloroform*, issued on October 20, 2009; revised on April 25, 2019.

ThermoFisher Scientific, 2019b, *Safety Data Sheet: Hydrochloric Acid*, issued on August 24, 2009; revised on April 25, 2019.

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Appendix A:

Federal and State Applicable or Relevant and Appropriate Requirements

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TABLE A.1 Potential federal ARARs and TBC guidance for former CCC/USDA grain storage facilities.

Title	Citation ^a	Description	Comment	Type ^b
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	42 USC 9601 <i>et seq.</i>			A
National Oil and Hazardous Substances Pollution Contingency Plan (NCP)	40 CFR Part 300	Provides the federal government's blueprint for responding to both oil spills and hazardous substance releases.	Applicable to releases into the environment of hazardous substances and pollutants or contaminants that may present an imminent and substantial danger to public health or the national welfare.	A
Off-Site Rule	40 CFR 300.440	Establishes procedures for planning and implementing off-site response actions.	Applicable to response actions involving off-site transfers of hazardous substances, pollutants, or contaminants.	A
Emergency Planning and Community Right-to-Know Regulations	49 CFR 350, 355 and 372	Allows state and local planning for chemical emergencies, provides for notification of emergency releases of chemicals, and addresses communities' right to information about toxic and hazardous chemicals.	Applicable if hazardous chemicals are stored or otherwise used as part of the corrective action.	A
Safe Drinking Water Act (SDWA) (Public Health Service Act)	42 USC 300(f) <i>et seq.</i>			A
National Primary Drinking Water Standards	40 CFR Part 141, Subparts B and G	Establishes maximum contaminant levels (MCLs), which are health-based standards for public water systems. The MCL for carbon tetrachloride is 5 µg/L. The MCL for chloroform (total trihalomethanes) is 80 µg/L.	Applicable at the tap to organic groundwater contamination in a sole-source aquifer.	
National Secondary Drinking Water Regulations (NSDWRs)	40 CFR Part 143	Establishes secondary maximum contaminant levels (SMCLs) for public water systems to protect the aesthetic quality of the water. The SMCLs are not federally enforceable but are intended as guidelines for the states.	Applicable if groundwater is a source of drinking water and if the NSDWRs have been adopted as enforceable standards by the state.	A, C
Maximum Contaminant Level Goals (MCLGs)	40 CFR Part 141, Subpart F	Establishes non-enforceable drinking water quality goals at levels of no known or anticipated adverse health effects, with an adequate margin of safety. The MCLG for carbon tetrachloride is zero.	May be relevant and appropriate if a more stringent standard is required to protect human health and the environment.	C

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Standards for Owners and Operators of Public Water Supply Systems	40 CFR Part 141	Provides treatment requirements for public water supply systems (i.e., systems that serve at least 25 people or have at least 15 connections).	Relevant and appropriate in the establishment of cleanup goals for groundwater contamination.	A
Underground Injection Control Regulations	40 CFR Parts 144-148	Provides for protection of underground sources of drinking water.	Applicable if a response alternative involves underground injection.	A
Sole-Source Aquifers	40 CFR Part 149	Prohibits activities, including drilling, in an area designated a sole-source aquifer without special permission of the EPA.	Applicable if the aquifer in the area is a sole-source aquifer.	A, L
Clean Water Act (CWA) (Federal Water Pollution Control Act)	33 USC 1251 <i>et seq.</i>			A, C
Ambient Water Quality Criteria	40 CFR Part 131	Establishes ambient water quality criteria (AWQCs) reflecting "the latest scientific knowledge . . . on the kind and extent of all identifiable effects on health and welfare including, but not limited to, plankton, fish, shellfish, wildlife, plant life . . . which may be expected from the presence of pollutants in any body of water. . . ." Water quality criteria are based solely on data and scientific judgments on the relationship between pollutant concentrations and environmental and human health effects. These recommended criteria provide guidance for states and tribes in adopting water quality standards under Section 303(c) of the CWA [33 USC 1313(c)].	Developed for some organic constituents in groundwater; may be relevant and appropriate.	C
National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122-125	Establishes NPDES permit procedures, criteria, and standards governing the discharge of pollutants from any point source into U.S. waters [Sections 318, 402, and 405 of the CWA (33 USC 1328, 1342, 1345)]. Most storm water discharges require coverage by an NPDES permit.	Discharge limits will be established if effluent is discharged to a surface water body. No permit is required for on-site response actions under CERCLA, but the substantive requirements apply if a response alternative involves discharge into a creek or other surface water on-site. A permit is required if the discharge is to a creek or other surface water off-site.	A, C

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Storm Water Discharge Requirements	40 CFR 122.26	Establishes requirements to obtain a permit to discharge storm water under the NPDES program.	Applicable to surface water discharges of storm water.	A
Water Quality Standards	40 CFR Part 131	Defines goals for a water body by designating the water body's uses, setting criteria to protect those uses, and establishing provisions to protect water bodies from pollutants. Forms the foundation of the water-quality-based pollution control program mandated by the CWA.	Applicable to surface water discharges.	C
National Pretreatment Standards	40 CFR Part 403	Provides general pretreatment standards and regulations for existing and new sources of pollution; establishes standards to control pollutants that pass through or interfere with treatment processes in publicly owned treatment works (POTWs) or that may contaminate sewage sludge.	Applicable if a response alternative involves discharge to POTWs.	A, C
Dredge or Fill Requirements	40 CFR Parts 230-233 [40 CFR Part 6.302(a)]	Requires permits for discharge of dredged or fill material into navigable waters.	Applicable if a response alternative requires discharge of dredged or fill material into navigable waters.	A
Executive Order (EO) on Protection of Wetlands	EO 11990 [40 CFR Part 6.302(a)]	Requires federal agencies to avoid, to the extent possible, adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists.	Applicable if a response alternative has a negative effect on wetlands.	A, L
Rivers and Harbors Act of 1899	33 USC 401 <i>et seq.</i>			A
Section 10 Permit	33 USC 403 33 CFR Parts 320-330 [40 CFR Part 6.302(a)]	Requires a permit for structures for work in or affecting navigable waters.	Applicable if a response alternative affects a navigable waterway.	A, L
Executive Order on Floodplain Management	EO 11988 [40 CFR Part 6.302(b)]	Requires federal agencies to evaluate the potential effects of actions in a floodplain to avoid, to the extent possible, the adverse impacts associated with direct and indirect development of a floodplain.	Applicable if activities are located in a 100-yr floodplain.	A, L

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
National Environmental Policy Act of 1969 (NEPA)	42 USC 4321-4370(c)	Requires federal agencies to consider significant environmental impacts arising from projects under agency jurisdiction and to establish a procedure giving members of the public an opportunity for meaningful participation in consideration of the proposed action.	Applicable for major federal actions. The CERCLA-like procedures in the CAS process — including public participation, the development of corrective action alternatives, and the corrective action alternative evaluation process — are equivalent to the NEPA process.	A
Clean Air Act (CAA)	42 USC 7401 <i>et seq.</i>			A
Standards of Performance for New Stationary Sources	40 CFR 60	Describes standards for the performance of new stationary sources of air emissions.	Applicable if emissions thresholds are exceeded.	A, C
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Establishes national primary and secondary ambient air quality standards under Section 109 of the Clean Air Act (42 USC 7409) to protect public health and welfare.	Applicable if contaminants are discharged to the air during treatment.	A, C
National Emissions Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR Parts 61 and 63	Implements the federal control program for hazardous air pollutants (HAPs). Identifies emission standards for HAPs that originate from specific categories of sources, including site remediation. NESHAPs are technology based and are issued to limit the release of specified HAPs from specific industrial sectors. <i>Federal Register</i> notices published for carbon tetrachloride [50 FR 32621 (August 13, 1985)] and chloroform [50 FR 39626 (September 27, 1985)] included consideration of serious health effects, such as cancer, due to ambient exposures.	Applicable if the identified HAPs are emitted from a specific source category at amounts regulated by the program (for example, if on-site treatment units with emissions are part of response actions).	A, C
Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA), the Hazardous and Solid Waste Amendments of 1984, the Federal Facility Compliance Act of 1992, and the Land Disposal Program Flexibility Act of 1996	40 USC 6901 <i>et seq.</i>	Regulates the characterization, generation, transportation, treatment, storage, and disposal of hazardous waste and establishes a framework for the management of nonhazardous waste.		A

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	<p>Establishes classification criteria for sanitary landfills and prohibits open dumps. At a minimum, facilities meet the sanitary landfill classification “only if there is no reasonable probability of adverse effects on health or the environment . . .” [Section 4004(a) of RCRA (42 USC 6944(a))].</p> <p>Provides for protection of surface water and groundwater at solid waste disposal facilities (40 CFR 257.3-3 and -4).</p>	<p>Applicable if a response alternative involves land disposal of solid waste on-site.</p> <p>Applicable if a response action includes provisions for an on-site landfill.</p>	A
Criteria for Municipal Solid Waste Landfills	40 CFR Part 258	Establishes minimum national criteria for municipal solid waste landfill units.	Applicable if municipal solid waste is placed in a municipal solid waste landfill.	A
Identification and Listing of Hazardous Wastes	40 CFR Part 261	Identifies solid wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 124, 262-265, 268, 270, and 271.	Applicable if a material at the site is defined as a solid and hazardous waste; requires handling as a hazardous waste.	A, C
Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262	Establishes standards for generators of hazardous waste.	Applicable if hazardous wastes are generated as a result of on-site activities.	A
Standards Applicable to Transporters of Hazardous Waste	40 CFR Part 263	Establishes standards that apply to transporters of hazardous waste within the United States if the transportation requires a manifest under 40 CFR Part 262.	Applicable if a response alternative involves off-site transportation of hazardous wastes.	A
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR Part 264	<p>Establishes minimum national standards that define the acceptable management of hazardous wastes for owners and operators of facilities that treat, store, or dispose of hazardous waste.</p> <p>Provides for groundwater protection standards, general monitoring requirements, corrective action requirements, and technical requirements.</p>	<p>Applicable or relevant and appropriate if hazardous waste is disposed of on-site.</p> <p>RCRA standards can be relevant and appropriate for groundwater at a site if an on-site landfill is constructed.</p>	A

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Standards for Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities	40 CFR Part 266	Establishes requirements that apply to recyclable materials.	No substances are expected to be present at CCC/USDA sites in quantities to warrant recycling.	A
Land Disposal Restrictions	40 CFR Part 268	Identifies hazardous wastes that are restricted from land disposal; defines limited circumstances under which an otherwise prohibited waste may continue to be land disposed.	Applicable or relevant and appropriate if hazardous waste is disposed of on-site.	A, C
Hazardous Waste Permit Program	40 CFR Part 270	Establishes provisions covering basic EPA permitting requirements.	No permit is required for on-site CERCLA response actions. Substantive requirements are addressed in 40 CFR Part 264.	A
Universal Wastes	40 CFR Part 273	Establishes requirements governing universal wastes (hazardous waste batteries, hazardous waste pesticides that are either recalled or collected in waste pesticide collection programs, hazardous waste thermostats, and hazardous waste lamps).	Applicable if universal wastes are generated or managed on-site in the course of investigation or response operations.	A
Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks	40 CFR Part 280	Establishes regulations related to underground storage tanks.	Applicable if a response alternative involves use of underground storage tanks.	A
Occupational Safety and Health Act (OSHA)	29 USC 651 <i>et seq.</i>			A
Occupational Safety and Health Standards	29 CFR Part 1910	Establishes safety and health standards for workers. OSHA has set a limit of 10 ppm for carbon tetrachloride in workplace air for an 8-hr time-weighted average (29 CFR 1910.1000 Table Z-2).	Under 40 CFR Section 300.150, response actions under the NCP will comply with OSHA requirements for the safety and health of response action workers.	A
Regulations for Construction	29 CFR 1926	Provides standards for work practices, safety equipment, fall protection, equipment operation, excavation, use of power tools, and other activities related to construction.	Applicable if construction activities are required for a corrective action.	A
Noise Control Act of 1972	42 USC Sect. 4901 <i>et seq.</i>	Prohibits federal activities resulting in noise that would jeopardize the health or welfare of the public.	Applicable for activities such as drilling near a public access point.	A

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Hazardous Materials Transportation Act	49 USC 5101 <i>et seq.</i>			A
Hazardous Materials Transportation Regulations	49 CFR Parts 106-180	Protects against the risks to life and property inherent in the transportation of hazardous material by listing the materials deemed hazardous and describing required labeling, placarding, and training. Hazardous materials are chemicals that the U.S. Department of Transportation has determined pose unreasonable risks to health, safety, and property during transportation activities.	Applicable if an alternative involves transportation of hazardous materials. Does not apply to on-site response operations.	A
National Historic Preservation Act of 1966	16 USC 470 <i>et seq.</i>	Establishes criteria for the creation and management of a National Registry of Historic Places composed of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture.	Applicable if an alternative involves a site on the National Registry of Historic Places.	L
Protection of Historic Properties	36 CFR Parts 800 [40 CFR 6.301(b)]	Defines the way federal agencies meet the statutory responsibilities. Requires federal agencies to consider the effects of any federally assisted undertaking (including those carried out with federal financial assistance and those requiring a federal permit, license, or approval) on any district, site, building, structure, or object that is listed in the National Register of Historic Places or eligible for such listing; requires agencies to give the Advisory Council on Historic Preservation a reasonable opportunity to comment on those undertakings.	Applicable if a district, site, building, structure, or object listed on or eligible for the National Register is on or adjacent to the site.	A, L
Executive Order on Protection and Enhancement of Cultural Environments	EO 11593	Requires federal agencies to preserve, restore, and maintain the nation's historic and cultural environment in their activities.	Applicable if an alternative involves the disturbance of significant cultural resources.	A, L
Executive Order on Preserve America	EO 13287	Formulates policy to promote intergovernmental cooperation and partnerships for the preservation and use of historic properties.	Applicable if an alternative involves a historic property.	A, L

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Historic Sites, Buildings and Antiquities Act (Historic Sites Act) and Regulations	16 USC 461 <i>et seq.</i> [40 CFR 6.301(a)]	Establishes a national policy to preserve historic sites and objects of national significance, including those located on refuges. Provides procedures for designation, acquisition, administration, and protection of such sites. Requires federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks and avoid undesirable impacts to such landmarks.	Applicable if an entity on the National Register of National Landmarks is on or adjacent to the site.	A, L
Archaeological and Historic Preservation Act of 1974 and Regulations	16 USC 469 <i>et seq.</i> [40 CFR 6.301(c)]	Carries out policy established by the Historic Sites Act. Establishes procedures for preservation of historical and archaeological data that might be lost or destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program. Directs federal agencies to notify the Secretary of the Interior whenever they find that a federal or federally assisted, licensed, or permitted project may cause loss or destruction of significant scientific, prehistoric, or archaeological data.	Applicable if historical or archaeological data are on or adjacent to the site and if construction projects or alteration of terrain at the site could destroy historical or archaeological materials.	A, L
Antiquities Act	16 USC 431 <i>et seq.</i>	Authorizes the President to designate as national monuments objects or areas of historic or scientific interest on lands owned or controlled by the United States. Requires a permit for examination of ruins, excavation of archaeological sites, and the gathering of objects of antiquity on lands under the jurisdiction of the Secretaries of Interior, Agriculture, and Army. Provides penalties for violations.	Applicable if an alternative involves the gathering of objects of antiquity on lands under the jurisdiction of the federal agencies noted.	A, L
Preservation of American Antiquities	43 CFR 3 [40 CFR Sect. 6.301(b)] EO 11593	Protects all historic and prehistoric sites on federal lands and prohibits excavation or destruction of such antiquities without the permission (Antiquities Permit) of the secretary of the department that has the jurisdiction over those lands; authorizes the President to declare areas of public lands as national monuments and to reserve or accept private lands for that purpose.	Applicable if site operations affect antiquities on federal lands.	A, L

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Archaeological Resources Protection Act	16 USC 470aa <i>et seq.</i>	Supplements the provisions of the Antiquities Act of 1906. Establishes detailed requirements for issuance of permits for any excavation or for removal of archaeological resources from federal or Indian lands. Also establishes civil and criminal penalties for the unauthorized excavation, removal, or damage of such resources.		A, L
Protection of Archaeological Resources	43 CFR Part 7, 36 CFR Part 296 [40 CFR 6.301(b)]	Establishes uniform definitions, standards, and procedures to be followed by all federal land managers in providing protection for archaeological resources located on public or Indian lands.	Applicable if site operations affect archaeological resources on public or Indian lands.	A, L
American Indian Religious Freedom Act	42 USC 1996 <i>et seq.</i>	Protects and preserves the right of American Indians to have access to their sacred places; directs federal agencies to consult with Indian religious practitioners if a place of religious importance to American Indians may be affected by an undertaking.	Applicable if site operations affect access to sacred Indian sites.	A, L
Executive Order on Indian Sacred Sites	EO 13007	Requires agencies managing federal lands to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of such sacred sites; also requires agencies to develop procedures for reasonable notification of proposed actions.	Applicable if site operations affect access to sacred Indian sites.	A, L
Native American Grave Protection and Repatriation Act	25 USC 3001 <i>et seq.</i>	Establishes the priority for ownership or control of Native American cultural items excavated or discovered on federal or tribal lands after 1990 and the procedures for repatriation of items in federal possession; allows the intentional removal or excavation of Native American cultural items from federal or tribal lands only with a permit or upon consultation with the appropriate tribe.	Applicable if site operations involve excavation or discovery of Native American cultural items on federal or tribal lands.	A, L

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Native American Graves Protection and Repatriation Regulations	43 CFR Part 10	Develops a systematic process for determining the rights of linear descendants and Indian tribes to certain Native American human remains, funerary objects, sacred objects, or objects of cultural patrimony. Defines items included under the Native American Grave Protection and Repatriation Act. Describes the consultation procedure applicable to intentional excavation or inadvertent discovery of remains or objects covered.	Applicable if actions involve intentional excavation or inadvertent discovery of remains or objects subject to the regulations.	A, L
Endangered Species Act	16 USC 1531 <i>et seq.</i>	Provides for the conservation of threatened and endangered plants and animals and the habitats in which they are found.	Applicable if actions involve threatened and endangered species.	A
Interagency Cooperation	50 CFR Part 402 [40 CFR 6.302(h)]	Requires action to conserve threatened and endangered species within critical habits upon which endangered species depend, including consultation and conferencing with the Department of the Interior (U.S. Fisheries and Wildlife Service or U.S. National Marine Fisheries Service).	Applicable if threatened or endangered species or critical habitats are identified at the site.	A
Migratory Bird Treaty Act	16 USC 703 <i>et seq.</i>			A
Migratory Bird Permits	50 CFR Parts 10 and 21	Requires a permit from the U.S. Fisheries and Wildlife Service for the taking of protected migratory birds.	Applicable if a response alternative will affect a migratory pathway.	A
Executive Order on Responsibilities of Federal Agencies to Protect Migratory Birds	EO 13186	Directs federal agencies taking actions having or likely to have a negative effect on migratory bird populations to work with the U.S. Fisheries and Wildlife Service to develop an agreement to conserve those birds.		A
Bald and Golden Eagle Protection Act	16 USC 668 <i>et seq.</i>			A
Eagle Permits	50 CFR Parts 10 and 22	Requires a permit from the U.S. Fisheries and Wildlife Service to move nests because of construction or operation of project facilities.	Applicable if project activities affect bald and golden eagle populations, including construction or operation of facilities that call for the moving of nests.	A, L

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Fish and Wildlife Conservation Act	16 USC 2901 <i>et seq.</i>	Encourages states to develop conservation plans for nongame fish and wildlife of ecological, educational, aesthetic, cultural, recreational, economic, or scientific value.	Applicable if significant populations are present at a site or are affected by site response activities.	A
Fish and Wildlife Coordination Act	16 USC 661 <i>et seq.</i> [40 CFR 6.302(g)]	Requires consultation with the U.S. Fish and Wildlife Service when a federal department or agency proposes, authorizes, permits, or licenses any modification of any stream or other water body. Requires adequate provision for protection of fish and wildlife resources.	Applicable if a response alternative will cause damage to or loss of wildlife by modifying a stream or body of water.	A
Wilderness Act	16 USC 1311 <i>et seq.</i>			A
Wilderness Preservation and Management	50 CFR Part 35	Describes the activities allowed and banned in wilderness areas and uses requiring authorization.	Applicable if a wilderness area exists on-site or adjacent to the site.	A
Management of Designated Wilderness Areas	43 CFR Part 6300		Applicable if actions involve a Designated Wilderness Area.	A
National Wildlife Refuge System Administration Act	16 USC 668dd		Applicable if actions involve a National Wildlife Refuge.	A
Executive Order on Management and General Public Use of the National Wildlife Refuge System	EO 12996	Directs preservation of a national network of lands and waters for the conservation and management of fish, wildlife, and plant resources for the benefit of present and future generations. Recognizes compatible uses, while ensuring maintenance of biological integrity and environmental health.	Applicable if a wildlife refuge area exists on-site or adjacent to the site.	A, L
Wild and Scenic Rivers Act	16 USC 1271 <i>et seq.</i>	States that a federal agency may not assist, through grant, loan, license, or otherwise, the construction of a water resources project that would have a direct and adverse effect on the values for which a river in the National Wild and Scenic Rivers System or a study river on the National Rivers Inventory was established.		A, L

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Wild and Scenic Rivers	36 CFR Part 297 (40 CFR 6.302(e))	Requires a notification process for federally assisted water resource projects in any portion of a designated river.	Applicable to on-site water resource projects located within, above, below, or outside a wild and scenic river or study river.	A, L
Federal Insecticide, Fungicide and Rodenticide Act of 1972	16 USC 2901-2911	Establishes a pesticide regulatory program.		A
Pesticide Management Program Regulations	40 CFR 150-189	Creates a federal program for the registration, control, distribution, and use of pesticides.	Applicable if pesticides will be used as part of corrective action activities.	A
Toxic Substances Control Act (TSCA) of 1976	15 USC 2601	Authorizes the EPA to track, screen, and require reporting or testing of chemicals that might pose an environmental or human health risk.	Applicable if site activities involve substances regulated under TSCA, such as polychlorinated biphenyls.	A
Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, EPA 540-G-89-004, October 1988		Describes the procedures used to characterize the nature and extent of contamination and risk posed by the release of chemical constituents at a site. Also describes the procedures for evaluating potential remedial alternatives.		TBC
Office of Solid Waste and Emergency Response Technical guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (Subsurface Vapor Intrusion)	OSWER 9200.2-154 (June 2015)	Provides technical recommendations based on current understanding of vapor intrusion into indoor air from subsurface vapor sources. For sites with a complete pathway, guidance is provided to evaluate whether the pathway poses a potential significant risk to human health.	Suggested for use at NPL and Superfund Alternative Sites.	TBC
Guidance for Quality Assurance Project Plans, EPA 240-R-02-009, December 2002		Describes the form and content of a Quality Assurance Project Plan.		TBC
Use of Monitored Natural Attenuation Remedies for VOCs in Groundwater, April 2004		Describes the procedures for performing and evaluating monitored natural attenuation (MNA).		TBC
Technical Protocol for Evaluating Chlorinated Solvents in Groundwater, October 1998		Describes protocols that can be used to evaluate whether MNA is occurring in groundwater.		TBC

TABLE A.1 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Guide to Discharging CERCLA Aqueous Wastes to Publicly Owned Treatment Works, EPA OSWER Directive 9330.2-13 FS, March 1991		Describes the process of discharging CERCLA wastes to a publicly owned treatment works (POTW).	Applicable to the discharge of CERCLA wastes to a POTW.	TBC

^a Abbreviations for citations: USC, U.S. code; CFR, code of federal regulations; EO, executive order; OSWER, Office of Solid Waste and Emergency Response.

^b Types: A, action-specific; C, chemical-specific; L, location-specific; TBC, to-be-considered.

TABLE A.2 Environmental remediation policies of the Kansas Department of Health and Environment, Bureau of Environmental Remediation.

KDHE BER Policy No.	KDHE BER Policy Title	Site Work Phase ^a	
		Investigation	Post-Investigation
BER-041	Total Petroleum Hydrocarbons (TPH) and Light Non-Aqueous Phase Liquid(LNAPL) Characterization, Remediation, and Management	x	
BER-049	Contaminated Groundwater and Surface Water Intersection	x	x
BER-RS-001	Guidelines for Ranking Contaminated Sites		
BER-RS-002	Public Information Program	x	x
BER-RS-003	KDHE Recommended Procedures for Characterization and Disposal of Soil Cuttings	x	
BER-RS-004	Collection of EPA's Past Costs		
BER-RS-005	Evaluating Future Land Use	x	x
BER-RS-006	Final Guidance for Verification Sampling of Non-Hazardous Industrial Wastewater Ponds		
BER-RS-007	Minimum Standards for Model Use	x	
BER-RS-009	State Cooperative Program Decision Document Development		
BER-RS-011	Utilization of Funding Through the State Water Plan		
BER-RS-013A	Investigation and Remediation of Salt (Chloride)-Impacted Soil and Groundwater		
BER-RS-015	Potential Applicable or Relevant and Appropriate Requirements ARARs	x	x
BER-RS-017	Scope of Work (SOW) for a Preliminary Investigation	x	
BER-RS-018	Scope of Work (SOW) for a Comprehensive Investigation	x	
BER-RS-019	Scope of Work (SOW) for a Corrective Action Study	x	x
BER-RS-020	Scope of Work (SOW) for a Comprehensive Investigation (CI)/Corrective Action Study (CAS)	x	x
BER-RS-023	Scope of Work (SOW) for a Corrective Action Plan (CAP)/Corrective Action (CA)	x	x
BER-RS-024	Site Closure in the State Cooperative Program		
BER-RS-025	Scope of Work (SOW) for a Remedial Investigation (RI)/Feasibility Study (FS)	x	x
BER-RS-026	Scope of Work (SOW) for a Remedial Design (RD)/Remedial Action (RA)	x	x
BER-RS-027	Reimbursement of Costs for Use of KDHE Direct-Push and Mobile Laboratory		
BER-RS-028	Consideration for Hydraulic Containment	x	x

TABLE A.2 (Cont).

KDHE BER Policy No.	KDHE BER Policy Title	Site Work Phase ^a	
		Investigation	Post- Investigation
BER-RS-029	Policy and Scope of Work (SOW) for Interim Measures (2006)	x	x
BER-RS-031	Removal Site Evaluation (RSE)/Removal Action Design (RAD)/Removal Action (RA)	x	
BER-RS-032	Guidelines for Obtaining an Alternative Public Drinking Water Source		
BER-RS-033	Considerations for Remedial Standards	x	x
BER-RS-034	Mercury Contamination Characterization at Gas Pipeline Sites		
BER-RS-035	Mercury Contamination Remediation at Gas Pipeline Sites		
BER-RS-036	Scope of Work (SOW) for Site Monitoring		x
BER-RS-038	Determining Background Levels for Chemicals of Concern	x	
BER-RS-039	Scope of Work (SOW) for a Qualitative Risk Assessment	x	x
BER-RS-042	Monitored Natural Attenuation of Volatile Organic Compounds in Groundwater	x	x
BER-RS-045	Considerations for Groundwater Potability and Use Determinations	x	x
BER-RS-046	Filtering Water Samples Collected for Metal Analysis	x	
BER-RS-047	Presumptive Remedy Policy: Investigation and Cleanup of Nitrogen at Agriculture Related Sites	x	x
BER-RS-048	Consideration and Selection of Borrow Sites		
BER-RS-052	Procedures Regarding Ability to Pay Analysis		
BER-RS-053	Considerations for Operations, Maintenance, and Monitoring of Residential Active Subslab Depressurization Systems		x
BER-RS-054	Design Guidance for Encapsulation Cells		
BER-RS-055	Developing a Soil-Waste Management Plan		
BER-RS-056	Considerations for Performing Water Well Receptor Surveys Near Contaminated Sites	x	
BER-RS-057	Risk Management Program Guidance	x	
BER-RS-058	Environmental Liability Release Program Guidance		x
BER-ARS-044	Natural Resource Damage Assessments	x	
BER-ARS-045	Sediment Policy	x	
BER-ARS-047	Transformer Oil Spill Cleanup		

TABLE A.2 (Cont).

KDHE BER Policy No.	KDHE BER Policy Title	Site Work Phase ^a	
		Investigation	Post- Investigation
BER-VCP-001	VCPRP Initial Deposits for Properties		
BER-RS-VCP-002	Eligibility Determinations Concerning Public or Private Drinking Water Well Situations	x	
BER-RS-VCP-003	Standards for Property Identification for Issuance of NFA Determinations	x	x
BER-VCP-005	Process for Notification of Termination from the Voluntary Cleanup and Property Redevelopment Program		
BER-RS-BF-001	Property Eligibility for Assessments Conducted by the Brownfields Program		
–	<i>Kansas Vapor Intrusion Guidance – Chemical Vapor Intrusion and Residential Indoor Air</i> , Remedial Section, Bureau of Environmental Remediation, Kansas Department of Health and Environment, Topeka, Kansas, June 22.	x	x

^a An “x” in the column denotes that the policy is relevant as an environmental control or performance standard in the noted site work phase(s).

TABLE A.3 Potential state ARARs and TBC guidance for former CCC/USDA facilities in Kansas.

Title	Citation ^a	Description	Comment	Type ^b
Radiation	KAR 28-35-1 to 28-35-363	Addresses the registration of radiation-producing devices and the licensing of sources of radiation.	Applicable if radiation-producing devices are used as part of a corrective action.	A, C
Spill Reporting	KAR 28-48-1 to 28-48-2	Addresses reporting requirements for the accidental releases of unpermitted discharges.	Applicable if an unpermitted discharge occurs during the performance of a corrective action.	A, C
Emergency Planning and Right-to-Know Regulations	KAR 28-65-1 to 28-65-4	Requires facilities storing hazardous substances above threshold quantities to report the presence of the materials and any releases of the materials. Creates emergency planning and response procedures.	Applicable if regulated hazardous chemicals are stored as part of the corrective action.	A, C, L
Kansas Air Quality Control Act; Kansas Air Quality Regulations	KSA, Chapter 65, Article 30; KAR, Title 28, Article 19	<p>Requires permitting and preconstruction notices for air contaminant sources. Provides for reporting and inspections. Establishes state emission standards for listed hazardous air pollutants (HAPs) and state air quality standards. HAPs include carbon tetrachloride and chloroform emitted above a threshold (e.g., 10 tons/yr of a single HAP or 25 tons/yr of any combination of HAPs).</p> <p>Specifically requires the following:</p> <p>For emissions above threshold amounts, (1) construction permits (e.g., for 25 tons/yr of particulate matter [PM], 15 tons/yr of PM 10, 100 tons/yr of carbon monoxide, 40 tons/yr of volatile organic compounds [VOCs]) or (2) preconstruction approval (e.g., for 5 lb/hr of PM, 2 lb/hr of PM 10, 50 lb of carbon monoxide per 24-hr period, or 50 lb of VOCs per 24-hr period — alternatively, in a nonattainment area, either 15 lb per 24-hr period or 3 lb/hr) (KAR 28-19-300).</p> <p>Operating permits for certain stationary sources (28-19-500 <i>et seq.</i>).</p> <p>Prohibits open burning (28-19-645 <i>et seq.</i>).</p> <p>Establishes emission standards for major source HAPs (28-19-750 <i>et seq.</i>).</p>	Applicable if any listed pollutants are discharged to the air during investigation or response through air stripping, thermal destruction, handling of contaminated soil, gaseous waste treatment, aeration, or disposal in a municipal solid waste landfill.	A

TABLE A.3 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Underground Storage, Disposal Wells and Surface Ponds	KSA, Chapter 65, Article 1; KAR, Title 28, Article 13	Regulates the construction and use of underground storage reservoirs, disposal wells, and surface ponds for the confinement, storage, and disposal of industrial fluids. Establishes approval and permitting requirements.	Applicable if a response alternative involves the need for underground storage reservoirs, disposal wells, or surface ponds.	L, A
Drinking Water Regulations	KSA, Chapter 65, Article 33; KAR, Title 28, Article 15	Establishes maximum contaminant levels (MCLs) pertaining to public water supplies. The MCLs for carbon tetrachloride, total trihalomethanes (including chloroform), nitrate, and nitrite are 0.005 mg/L, 0.1 mg/L, 10 mg/L, and 1 mg/L, respectively (KAR 28-15a-61 and 28-15a-62).	Applicable if waste derived from an investigation or response enters a public water system. Not applicable to investigative wells, as such, that are not used for drinking water supply; however, relevant for establishing sampling and analysis parameters and analytical detection limits during investigation activities.	C
Water Pollution Control Regulations	KSA, Chapter 65, Article 33; KAR, Title 28, Article 16	<p>Protects public health and welfare and the use of surface water for aquatic life; for agricultural, domestic, and industrial water supply; and for recreation. Controls surface water use designation. Establishes surface water quality standards (KAR 28-16-28 <i>et seq.</i>). MCL is defined as “any of the enforceable standards for finished drinking water promulgated by the U.S. Environmental Protection Agency [KAR 28-16-28b(hh)].”</p> <p>When the KDHE finds that these criteria are underprotective or overprotective for a given surface water segment, the KDHE may, in accordance with KAR 28-16-28f(f), make appropriate site-specific determinations [KAR 28-16-28e(a)]. Surface water must be free from the harmful effects of substances that produce any public health hazard; hazardous substances must not occur in surface water at concentrations that jeopardize public health and other protected life [KAR 28-16-28e(b)].</p>	Applicable if contaminated effluent from investigative or response operations is discharged into surface water; also possibly applicable to alluvial aquifers demonstrated to be hydraulically connected to surface water bodies.	C

TABLE A.3 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Water Pollution Control Regulations (Cont.)		<p>Provides numeric criteria by use category for different parameters [KAR 28-16-28e(d)]. For chloroform the values are 28,900 µg/L for aquatic life-acute, 1,240 µg/L for aquatic life-chronic, 470 µg/L for public health-food procurement, and 100 µg/L for public health-domestic water supply. (No values are specified for agriculture-livestock and agriculture-irrigation.) For carbon tetrachloride the values are 35,200 µg/L for aquatic life-acute, 6.94 µg/L for public health-food procurement, and 5 µg/L for public health-domestic water supply. (No values are specified for aquatic life-chronic, agriculture-livestock, and agriculture-irrigation.) The State's overall water quality program also implements an anti-degradation policy to limit discharges and other activities that will negatively impact water quality.</p> <p>Establishes procedures relating to the discharge of wastewaters under the NPDES program (KAR 28-16-57 <i>et seq.</i>). National effluent standards are adopted by reference.</p> <p>Provides for the establishment and administration of critical water quality management areas (KAR 28-16-69 <i>et seq.</i>).</p> <p>Limits the types of wastes that can be discharged to publicly owned treatment works (POTWs) and governs pollutants from nondomestic sources that are subject to one or more pretreatment standards and that are indirectly discharged into POTWs or are otherwise introduced by any means (KAR 28-16-83 <i>et seq.</i>).</p>	<p>Applicable if the following result from an investigation or response:</p> <p>Discharges into "waters of the state."</p> <p>Discharges into a designated critical water quality management area.</p> <p>Discharges of contaminated groundwater to POTWs.</p> <p>Discharges into a designated critical water quality management area.</p>	C
Groundwater Management Districts	KSA, Chapter 82a, Article 10	Establishes requirements for the creation of special districts for the proper management of the groundwater resources of the state.		L
Kansas Drycleaner Environmental Response Act	KSA 65-34, 141	Authorizes creation of a drycleaner site management program; funds assessment and corrective action activities at former and existing drycleaner facilities.		L

TABLE A.3 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Kansas Drycleaner Environmental Response Regulations	KAR 28-68-1 to 28-68-9	Regulations created pursuant to the Kansas Drycleaner Environmental Response Act.	May be applicable if a drycleaner operated at the site of the former CCC/USDA facility.	A, C
Kansas Environmental Use Controls	KSA, chapter 65-1221 to 65-1235	Defines the Environmental Use Control (EUC) as a legal mechanism for applying restrictions, prohibitions, and conditions on land use for a property that has environmental contamination at levels prohibiting unrestricted use (i.e., exceeding residential standards). An EUC can be voluntarily applied to a property by the landowner as part of a corrective action to assure adequate protection of public health and the environment from contamination on the subject property. The protection offered by an EUC can provide a landowner relief from environmental liability concerns, making property more attractive for redevelopment or to prospective buyers.	Applicable if corrective action includes an EUC.	L
Kansas Water Well Contractor's License Regulations; Water Well Construction and Abandonment Regulations	KSA, Chapter 82a, Article 12; KAR, Title 28, Article 30	Establishes requirements for licensing of well drillers and standards for construction, operation, and abandonment of wells (KAR 28-30-3 <i>et seq.</i>).	Applicable if investigation or response involves drilling and installing wells that intercept the water table.	A
Underground Injection Control Regulations	KSA, Chapter 65, Article 1; KAR, Title 28, Article 46	Governs discharges into underground injection wells (KAR 28-46-1 <i>et seq.</i>). In general, federal Safe Drinking Water Act regulations are adopted by reference.	Applicable if investigative or response wastes are introduced into wells for discharge or disposal.	A, C
Solid Waste Act and Regulations	KSA, Chapter 65, Article 34; KAR, Title 28, Article 29	Establishes standards for management activities and facilities relative to solid wastes (KAR 28-29-1 <i>et seq.</i>).	Applicable if nonhazardous materials discarded as a result of an investigation or response are landfilled on-site.	A, C, L
		Establishes location restrictions, design standards, operating standards, groundwater monitoring, corrective action, and financial assurance for municipal solid waste landfill units, during and after closure (KAR 28-29-100 <i>et seq.</i>).	Applicable if a municipal solid waste landfill is used.	

TABLE A.3 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Hazardous Waste Management Standards and Regulations	KSA, Chapter 65, Article 34; KAR, Title 28, Article 31	Requires generators of solid waste to make a hazardous waste determination. For a waste that is not excluded from hazardous waste regulations and not listed as a hazardous waste, the determination is generally made through testing by a laboratory certified for such analyses by the KDHE [KAR 28-31-4(b)].	Applicable if investigation or response operations generate solid wastes.	A, C
		Establishes standards for hazardous waste generators and transporters and for facilities that treat, store, or dispose of hazardous waste (KAR 28-31-4 <i>et seq.</i>).	Applicable to response-generated wastes that are determined to be hazardous and that are managed on-site through treatment, storage, and disposal or are transported.	
		Adopts by reference federal regulations governing universal wastes (KAR 28-31-15).	Applicable if universal wastes are generated or managed on-site in the course of an investigation or response operation.	
Kansas Board of Technical Professions	KAR 66-6-1 through 66-14-12	Establishes requirements for the licensing of surveyors, geologists, and architects.	Applicable if these professionals are required for implementation of the selected corrective action.	A
Kansas Storage Tanks Act	KSA Chapter 65, Article 34	Establishes standards for the registration and permitting of nonexempt aboveground tanks used to store a regulated substance (KAR 28-44-29).	Applicable if a response alternative involves use of storage tanks to contain an accumulation of regulated substances, associated piping and ancillary equipment, and a containment system.	A, L
Petroleum Products Storage Tanks	KAR 28-44-1 to 28-44-29	Provides requirements for permitting, installing and testing underground storage tanks and for licensing installation contractors.		A, L
Kansas Water Appropriations Act	KSA 82a-701 <i>et seq.</i>	Addresses the appropriation and distribution of water.		A, L
Kansas Water Appropriations Act Rules and Regulations	KAR 5-1-1 through 5-10-6 and KAR 5-50-1 through 5-50-8	Establishes a framework for the control, conservation, regulation, allotment, and distribution of water resources.	Applicable if water appropriations are required for a corrective action.	A, L

TABLE A.3 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Kansas Nongame and Endangered Species Conservation Act; Kansas Nongame and Endangered Species Conservation Regulations	KSA, Chapter 32, Article 9; KAR, Title 115, Article 15	Designates endangered and threatened species, as well as nongame species in need of conservation. Requires consultation with the Kansas Department of Wildlife and Parks pertaining to actions that might affect listed species and their critical habitats. Projects that affect listed species or their habitats and that are publicly funded, state or federally assisted, or require a permit from another state or federal agency require review and action permits (KSA 32-957 through -963, 32-1009 through 32-1012, and 32-1033; KAR 115-15-1, -2, -3, and -4).	Applicable if threatened or endangered species are identified at or near the site.	A
Kansas Levee Law and Regulations	KSA, Chapter 24, Article 1; KAR, Title 5, Article 45	Requires prior approval of chief engineer before construction of floodplain fills and levees (KSA 24-126). "Floodplain fill" means material, usually soil, rock, or rubble, placed in a floodplain to an average height of more than 1 ft above the existing ground, which has the effect of diverting, restricting, or raising the level of floodwaters on a stream (KAR 5-45-1).	Applicable if site activities involve construction of floodplain fills.	A
Kansas Historic Preservation Act and Regulations	KSA, Chapter 75, Article 27; KAR, Title 118, Article 3	Provides for protection and preservation of sites and buildings listed on state or federal historic registries (KSA 75-2715 through 75-2726; KAR 118-3-1 through 118-3-16).	Applicable if the investigation or response site is a listed state or federal historic site or is adjacent to such a site and if activities requiring permitting are initiated at the site.	A
Kansas Unmarked Burial Sites Preservation Act	KSA Chapter 75, Article 27; KAR Title 126, Article 1	Establishes the Burial Sites Preservation Board; prohibits unauthorized disturbance; requires permits for excavation of any unmarked burial site, registered or unregistered (KSA 75-2741 through 75-2754; KAR 126-1-1 through 126-1-2).	Applicable if investigation or remediation activities encounter a burial site.	L, A
Agricultural and Specialty Remediation Act	KSA Chapter 2, Article 37; KAR Title 124, Article 1	Provides for the reimbursement of corrective action costs resulting from an incident involving a rupture, leak, spill, emission, discharge, disposal, or any other event that releases an agricultural or specialty chemical accidentally or otherwise into the environment. Releases resulting from the normal use of a product or practice in accordance with the law are not covered.	Applicable if remediation activities involve the release of an agricultural or specialty chemical. Costs to the federal government are considered ineligible.	C, A

TABLE A.3 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Guidelines for Obtaining an Alternative Public Drinking Water Source	BER-032		Formerly BER-RS-032; 2005	TBC
Kansas Vapor Intrusion Guidance Chemical Vapor Intrusion and Residential Indoor Air			No number provided; 2007	TBC
Public Information Program	BER-RS-002		Adopted 1993	TBC
Characterization and Management of Contaminated Soil Cuttings	BER-RS-003		Revised 1996	TBC
Cost Recovery of EPA's Past Costs	BER-RS-004		Revised 2005	TBC
Evaluating Future Land Use	BER-RS-005		Revised 2005	TBC
Final Guidance for Verification Sampling of Non-Hazardous Industrial Wastewater Ponds	BER-RS-006		Revised 1996	TBC
Minimum Standards for Model Use	BER-RS-007		Revised 2005	TBC
Development of Draft CADs	BER-RS-009		Revised 2005	TBC
Utilization of Funding Through the State Water Plan	BER-RS-011		Revised 2001	TBC
Recommended Remedial Levels for Nitrate and Ammonia in Soils	BER-RS-012		Revised 2002	TBC
Investigation and Remediation of Salt (Chloride)-Impacted Soil and Groundwater	BER-RS-013A		Revised 2005	TBC

TABLE A.3 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Potential Applicable or Relevant and Appropriate Requirements ARARs	BER-RS-015		Revised 2005	TBC
Scope of Work (SOW) for a Preliminary Investigation	BER-RS-017		Revised 2005	TBC
SOW for a Comprehensive Investigation	BER-RS-018		Revised 2005	TBC
SOW for a Corrective Action Study	BER-RS-019		Revised 3-29-01	TBC
SOW for a Comprehensive Investigation/ Corrective Action Study	BER-RS-020		Revised 2005	TBC
SOW for a Corrective Action Plan/Corrective Action	BER-RS-023		Revised 2005	TBC
Reclassification Plan	BER-RS-024		Revised 2001	TBC
SOW for a Remedial Investigation/Feasibility Study	BER-RS-025		Revised 2005	TBC
SOW for a Remedial Design/Remedial Action	BER-RS-026		Revised 2005	TBC
Reimbursement of Costs for use of KDHE Direct-Push and Mobile Laboratory	BER-RS-027		Revised 2005	TBC
Consideration for Hydraulic Containment	BER-RS-028		Revised 2005	TBC
Removal Site Evaluation/ Removal Action Design /Removal Action (RA)	BER-RS-031		Revised 1996	TBC

TABLE A.3 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Guidelines for Obtaining an Alternative Public Drinking Water Source (changed to BER-032, 2005)	BER-RS-032		Adopted 1995	TBC
Considerations for Remedial Standards	BER-RS-033		Revised 2005	TBC
Mercury Contamination Characterization at Gas Pipeline Sites	BER-RS-034		Revised 2005	TBC
Mercury Contamination Remediation at Gas Pipeline Sites	BER-RS-035		Revised 2005	TBC
Scope of Work for Site Monitoring	BER-RS-036		Revised 2005	TBC
State Cooperative Program	BER-RS-037		Adopted 2005	TBC
Scope of Work for a Qualitative Risk Assessment	BER-RS-039		Revised 2005	TBC
Clean-up Levels for Total Petroleum Hydrocarbons	BER-RS-041		Adopted 2000	TBC
Addendum	BER-RS-041		Adopted 2001	TBC
Monitored Natural Attenuation	BER-RS-042		Revised 2005	TBC
Considerations for Groundwater Use and Applying RSK Standards to Contaminated Groundwater	BER-RS-045		Adopted 2004	TBC
Filtering Water Samples Collected for Metal Analysis	BER-RS-046		Adopted 2006	TBC
SOW for a Nitrate Presumptive Remedy	BER-RS-047		Adopted 2003	TBC

TABLE A.3 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Consideration and Selection of Borrow Sites	BER-RS-048		Adopted 2007	TBC
Cost Recovery Guidance for KDHE/BER Activities at Sites Determined to have Responsible Parties	BER-RS-049		Adopted 2007	TBC
Remediating Soil From Agricultural Chemical Incidents by Excavation & Land Applications Interim Measures	BER-RS-050		Adopted 2007	TBC
VCPRP Initial Deposits For Grouped Properties	BER-RS-VCP-001		Adopted 2004	TBC
Eligibility Determinations Concerning Public or Private Drinking Water Well Situations	BER-RS-VCP-002		Adopted 2000	TBC
Standards for Property Identification For Issuance of NFA Determinations	BER-RS-VCP-003		Adopted 2002	TBC
Transfer of Contaminated Sites From the State Cooperative Program to the Voluntary Cleanup and Property Redevelopment Program	BER-RS-VCP-004		Adopted 2003	TBC
Property Eligibility for Assessments Conducted by the Brownfields Program	BER-RS-BF-001		Adopted 2004	TBC
Natural Resource Damage Assessments	BER-ARS-044		Adopted 2002	TBC
Sediment Policy	BER-ARS-045		Adopted 2004	TBC

TABLE A.3 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Kansas Petroleum Storage Tank Release Trust Fund Policy and Procedures Manual				TBC
Kansas Storage Tank Program Aboveground Storage Tank Overview				TBC
Updated Policy and Procedures Manual for the Preventative/UST Unit Storage Tank Section				TBC
Kansas Geological Survey Public Information Circular 23 — Drilling a Water Well on Your Land; What You Should Know	Suchy et al. 2011	Includes a primer on groundwater systems; describes how to evaluate the potential for a water well; advises that a yield of 4-5 gpm is considered the minimum amount necessary for domestic household use; references the need to select a reputable and responsible driller, and points out the need to check with local and state regulatory agencies for permitting and construction regulations.	Adopted in 2005; amended in 2011	TBC
Presumptive Remedy Policy Investigation and Cleanup of Nitrogen at Agriculture-Related Sites in Kansas	BER-RS-047, 2014	KDHE guidance on the investigation and remediation of nitrate and ammonium contamination at agriculture and bulk distribution-related sites that include the use, manufacture, transportation and/or distribution of chemicals resulting in nitrogen contamination		TBC
Guidelines for Investigating and Remediating Nitrate/Ammonia Contamination from Agricultural Chemical Releases	BER-RS-050, June 2010	Addresses nitrate contamination in soil and groundwater		

^a Abbreviations for citations: KAR, Kansas Administrative Regulations; KSA, Kansas Statutes Annotated.

^b Types: A, action-specific; C, chemical-specific; L, location-specific; TBC, to-be-considered.

TABLE A.4 Potential state ARARs and TBC guidance for former CCC/USDA facilities in Nebraska.

Title	Citation	Description	Comment	Type ^a
Regulations Governing Water Well Construction, Pump Installation and Water Well Abandonment	Neb. Rev. Stat. §46-602, Title 178, Chapter 10, and Title 456, Chapter 12	Groundwater wells must be registered with the Department of Natural Resources. Wells located in a groundwater management area must be permitted by the Natural Resources District if the well pumps more than 50 gpm.	May be an ARAR is remedy involves installation of wells	L, A
Regulations Governing Water Well Construction, Pump Installation and Water Well Abandonment Standards	Neb. Rev. Stat. §46-602 and Title 178, Chapter 10	Establishes regulations and certification requirements for well drillers, pump installation contractors, well drilling supervisors, pump installation supervisors, groundwater technicians.	May be an ARAR is remedy involves installation of wells	A
Water Well Standards and Contractor's Practice Act	Neb. Rev. Stat. §46-1201 to §46-1241, Title 178, Chapter 10, and Title 456, Chapter 9	Provides for the protection of groundwater resources through licensing, regulation and certification requirements. The following disciplines are regulated: well and pump installation contractors; well drilling and pump installation supervisors; well monitoring technicians. The Statute also protects the health and welfare of citizenry by protecting resources from potential through proper well siting and construction methods.	May be an ARAR is remedy involves installation of wells	A, L
Well Spacing Requirements	Neb. Rev. Stat. §46-651 to §46-655	Well spacing requirements.	May be an ARAR if remedy involves installation of wells	A
The Industrial Ground Water Regulatory Act	Neb. Rev. Stat. §46-675 through 46-690 and Title 456, Chapters 4 and 7	A permit is required for the extraction and transfer of groundwater. A permit required before well construction. The permit program is administered by the NDNR.	Could be an ARAR if groundwater is extracted as part of a remedy	A
Municipal and Rural Domestic Groundwater Transfers Permit Act	Neb. Rev. Stat. §46-638 to §46-650	Establishes permitting requirements to protect public water supplies.	May be an ARAR is remedy involves groundwater extraction.	A, L

TABLE A.4 (Cont.)

Title	Citation	Description	Comment	Typea
Institutional Controls Nebraska Hazardous Waste Regulations, Title 128, Chapter 21 and 22; Integrated Solid Waste Management Regulations, Title 132, Chapter 3; and Nebraska Uniform Covenants Act, Neb. Rev. Stat. §76-2601 to 76-2613		<p>If hazardous wastes remains on site after closure in accordance with 40 CFR 264.119 and 265.119 and Title 128 , then under– Nebraska Hazardous Waste Regulations, Chapter 21 and 22 a deed notice is required.</p> <p>A deed notice is required for closed solid waste disposal areas in accordance with Title 132 – Integrated Solid Waste Management Regulations, Chapter 3.</p> <p>Environmental Covenant</p> <p>1. An environmental covenant pursuant to the Nebraska Uniform Covenants Act Neb. Rev. Stat. §76-2601 to 76-2613 may be used for a site, that upon completion of the clean-up action, is not suitable for unrestricted land use.</p>	Could be an ARAR in the event that hazardous substances are going to remain on a former CCC/USDA facility site	A, L
Air Quality Regulations	Title 129 Chapter 17, Section 001	A pre-construction review and permit may be required if a remediation system has the potential to emit pollutants (criteria pollutants or toxic/hazardous pollutants). Emissions greater than or equal to 1.5 tones/year of hazardous air pollutants triggers the need to use Best Available Control Technology. In some cases, annual emissions must be reported.	Could be an ARAR if a remediation system discharges emissions in excess of the noted threshold.	C, A, L
Disposal of Activated Carbon Used as Air Emission Control	Title 128, Chapter 2	In some cases, spent carbon must be handled as a hazardous waste.	If emissions from a remediation system are treated using activated carbon, this regulation could be an ARAR	C, A
Integrated Solid Waste Management Regulations	Title 132, Chapter 13	Some wastes resulting from the treatment of contaminants may be considered special waste that has to be disposed of pursuant to requirements	Could be an ARAR isf special wastes are generated.	C, A
Excavation of Contaminated Soil	Title 128, Chapter 4	In some cases soil excavated with the intent of soil disposal may meet the definition of solid waste in Title 138 chapter 4 requirements	Could be an ARAR if contaminated soil is excavated as part of a remedy	A

TABLE A.4 (Cont.)

Title	Citation	Description	Comment	Typea
Generation, treatment storage and Disposal of Hazardous Waste	Title 128, Chapter 4	Generators of solid waste must determine whether or not the waste is a hazardous waste. Hazardous waste must be treated, stored and disposed according to requirements in Title 128 Chapters 8, 9, 10 and 11.	Could be an ARAR if hazardous waste is generated, treated, stored or disposed of as part of a remedy	C, A, L
Disposal of Nonhazardous Waste	Title 132, Chapter 1	Some non-hazardous waste must be handled as a special waste as defined in Title 132 chapter 1. Such waste can only be disposed in a licensed landfill.	Could be an ARAR if waste is generated, treated, stored or disposed of as part of a remedy	A
Rules and Regulations for Underground Injection and Mineral Production Wells	Title 122	A State Underground Injection Control Program establishes requirements for situations where extracted groundwater is going to be reinjected.	Could be an ARAR if a remediation system involves the injection treated groundwater into the subsurface	A
Nebraska Pollutant Discharge Elimination System	Title 119 - Rules and Regulations Pertaining to the Issuance of Discharge Elimination System Permits, Title 121 - Effluent Guidelines and Standards, Title 117 – Nebraska Surface Water Quality Standards	Discharge of contaminated water to surface water would be regulated under the Nebraska Pollutant Discharge elimination System	Could be an ARAR if a remediation system involves the discharge of treated effluent into waters of the State.	C
Nebraska Surface Water Quality Standards	Title 117	Establishes water quality standards to be met in surface waters in the State of Nebraska. Required for protection of surface water features such as wetlands, streams and lakes.	Could be an ARAR is treated effluent is discharged to surface waters.	C
Groundwater Quality Standards Title 118	Title 118	Establishes standards for contaminants in groundwater. Provides that groundwater quality must be maintained. Establishes that the State may choose, after public notice and public hearing to allow water quality that does not meet the standards within an established geographical zone.	Could be an ARAR	C, A

TABLE A.4 (Cont.)

Title	Citation	Description	Comment	Type ^a
Flood Plain Management	The Flood Plain Management Act, Neb. Rev. Stat. §31-1001 to §31-1031, and Title 258	Governs activities within floodplains.	Could be an ARAR is a remedy involves construction in a floodplain that is regulated.	L, A
Endangered and Threatened Species	The Nebraska Nongame and Endangered Species Act, Neb. Rev. Stat. §37-801 to §37-811 (recodified in 1998), and Title 163, Chapter 4, 012,	Requires consultation with the Nebraska Game and Parks Commission if actions may affect threatened or endangered species or their critical habitat.	Could be an ARAR is remediation activities involve the disturbance of TE species or critical habitat.	L, A
Human Health Risk Assessment Report		Provides a framework for evaluating the baseline health risk due to current site exposure.	Could be a To Be Considered (TBC)	TBC
Nebraska Voluntary Cleanup program Guidance	Nebraska Voluntary Cleanup Program Guidance, NDEQ, October 2008	Establishes remediation goals for sites remediated under the Voluntary Cleanup program	Could be a To Be Considered (TBC)	TBC

^a Types: A, action-specific; C, chemical-specific; L, location-specific; TBC, to-be-considered.

TABLE A.5 Potential state ARARs and TBC guidance for former CCC/USDA facilities in Missouri.

Title	Citation ^a	Description	Comment	Type ^b
Sanitary Landfill Regulations	CSR Title 10, Division 80, Chapter 3, 3.010 and 3.011	Solid wastes must be tested to determine disposal requirements.	May be an ARAR since some investigation derived materials or wastes generated as part of the installation of a remedy would be covered under these regulations.	A
Air Quality Standards, Definitions, Sampling and Reference Methods, and Air Pollution Control Regulations for the Entire State of Missouri	CSR, Title 10, Division 10, Chapter 6	<p>Provides long-range goals for ambient air quality throughout Missouri (10 CSR 10-6.010).</p> <p>Designates carbon tetrachloride and chloroform as HAPs (10 CSR 10-6.020, Table 3).</p> <p>Requires construction permits for major sources of HAPs (emitting or having the potential to emit 10 tons per year of any HAP or 25 tons year of any combination of HAPs; 10 CSR 6.060(9)). Exempts insignificant emissions (not exceeding more than 0.5 pounds per hour or the hazardous emission threshold established by the regulator, whichever is less; 10 CSR 6.061(3)(A)3). Establishes construction permits by rule (10 CSR 10-6.062).</p> <p>Requires operating permits for certain installations (10 CSR 10-6.065).</p> <p>Establishes emissions control technology, performance criteria, and work practices to achieve emissions standards for sources that emit or have the potential to emit HAPs (10 CSR 10-6.075).</p> <p>Establishes emissions standards and performance criteria for new or modified sources emitting HAPs (10 CSR 10-6.080).</p>	<p>Division 10 offers area-specific regulations for the Kansas City metropolitan area (Chapter 2), the out-state Missouri area (Chapter 3), the Springfield-Greene County area (Chapter 4), and the St. Louis metropolitan area (Chapter 5).</p> <p>Applicable if listed pollutants.</p>	C

TABLE A.5 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Air Quality Standards, Definitions, Sampling and Reference Methods, and Air Pollution Control Regulations for the Entire State of Missouri (cont.)		<p>Restricts the emission of particulate matter to the ambient air beyond the premises of origins, including handling, transporting, or storing of any material; construction, repair, cleaning, or demolition of a building or its appurtenances; construction or use of a road, driveway, or open area; or operation of a commercial or industrial installation (10 CSR 10-6.170).</p> <p>Specifies the maximum allowable opacity of visible air contaminant emissions, unless specifically exempt or regulated by 10 CSR 10-6.070; requires the use of continuous opacity monitor systems on certain air contaminant sources (10 CSR 10-6.220).</p> <p>Restricts emissions from municipal solid waste landfills (10 CSR 10-6.310).</p>		A
Missouri Wildlife Code, Endangered Species	3 CSR Division 10, Chapter, 4, 4.110.	The regulation establishes action to manage wildlife including a prohibition against causing any deleterious substance to drain into waters of the State.	May be an ARAR if investigation or remedial activities cause a deleterious substance to discharge into waters of the State.	A
Missouri Clean Water Commission (MCWC) Permitting	10 CSR Division 20, Chapter 6	A permit is required for injection into the subsurface. Although a permit is typically not required for a CERCLA-like action.	May be an ARAR if the remedial action involves the injection of <i>in situ</i> treatments or contaminated water (post treatment) into groundwater.	A,
MCWC Water Quality	10 CSR Part 20-7	Limits for pollutants which are discharged to subsurface and surface waters of the state have been established.	May be an ARAR if the remedial action involves the injection of <i>in situ</i> treatments or contaminated water (post treatment) into groundwater. May be applicable for the discharged of treated water to surface water	A, C

TABLE A.5 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Clean Water Permits	CSR, Title 10, Division 20, Chapter 6	Requires construction and operating permits for all persons who build, erect, alter, replace, operate, use, or maintain existing point-sources, or who intend these actions for proposed point sources or water contaminant sources (10 CSR 20-6.010). Establishes requirements governing the application process and terms and conditions for the permits (10 CSR 20-6.010).	Applicable if investigation or remediation operations involve a point-source structure.	A
		Provides requirements and an application process for non-discharging facility permits, as well as the terms and conditions for authorization (10 CSR 20-6.015).	Applicable if investigation or remediation operations involve building, erecting, altering, replacing, operating, using, or maintaining water contaminant sources or point-source facilities for water treatment. Also includes permit requirements for injection wells used to handle treated wastewater.	
		Establishes the procedure and time limitations governing the issuance of water quality certifications (10 CSR 20-6.060).	Applicable if a response alternative requires discharge of dredged or fill material into navigable waters.	
		Establishes storm water permit regulations (10 CSR 20-6.200).	Applicable if investigation or remediation operations result in a storm water discharge.	
Effluent Regulations and Water Quality Standards	CSR, Title 10, Division 20, Chapter 7	Establishes effluent limits for various pollutants that are discharged to waters of the state (10 CSR 20-7.015).	Applicable if pollutants are released into rivers, lakes, losing streams, metropolitan no-discharge streams, special streams, or subsurface waters during investigation and response operations.	A
		Identifies beneficial uses of waters of the state, sets criteria to protect those uses, and defines an anti-degradation policy (10 CSR 20-7.031).		
		Table A (Criteria for Designated Uses) specifies 5 µg/L of carbon tetrachloride for human health protection (fish consumption), drinking water supply, and groundwater. For chloroform, Table A specifies 470 µg/L for human health protection (fish consumption) and 5.7 µg/L for drinking water supply and groundwater.		

TABLE A.5 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Underground Storage Tanks—Technical Regulations	CSR, Title 10, Division 20, Chapter 10	Contains the technical standards for underground storage tanks (USTs). The rules include performance standards for new UST systems (10 CSR 20-10.020), upgrading of existing UST systems (10 CSR 20-10.021), notification requirements (10 CSR 20-10.022), spill and overfill control (10 CSR 20-10.030), operation and maintenance of corrosion protection (10 CSR 20-10.031), reporting and recordkeeping (10 CSR 20-10.034), general requirements for release detection for all UST systems (10 CSR 20-10.040), methods of release detection for tanks (10 CSR 20-10.043), methods of release detection for piping (10 CSR 20-10.044), and release detection recordkeeping (10 CSR 20-10.045). Regulations also address requirements for reporting, investigating and remediating releases; risk-based cleanup levels and closure requirements (10 CSR 20-10.050 to 10.074).	May be applicable if an investigation or response alternative involves USTs.	A
Aboveground Storage Tanks — Release Response	CSR, Title 10, Division 20, Chapter 15	Specifies which aboveground storage tanks must comply with technical requirements governing release reporting and initial release response measures (10 CSR 20-15.020), as well as site characterization and corrective action (10 CSR 20-15.030).	Applicable if a response alternative involves the use of aboveground storage tanks	
Missouri Water Resources Law	RSMo 640.400	MDNR is required to ensure that the quality and quantity of the water resources of the state are maintained at the highest level practicable to support present and future beneficial uses. The department shall inventory, monitor and protect the available water resources in order to maintain water quality, protect the public health, safety and general and economic welfare. Under 640.418 the Department may establish water quality protection areas if surface water or groundwater exceeds water quality standards.	May be an ARAR if a remedy involves water resources being monitored	A

TABLE A.5 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Well Drillers and Pump Installers Permitting, Well Construction Code, Monitoring Well Construction Code, Test Hole Construction and Plugging Code	CSR, Title 10, Division 23, Chapters 1, 2, 3, 4, 6	<p>Covers the construction of new wells; installation of pumps and pumping equipment; repair and maintenance of wells, pumps, and equipment; proper plugging of wells; and proper isolation of possible sources of contamination from existing wells to protect groundwater aquifers.</p> <p>Requires a permit for constructing or repairing a well in the state (10 CSR 23-1.090). Provides requirements for qualification of permit applicants (10 CSR 23-1.050), procedures for filing a permit application (10 CSR 23-1.060), and registration procedures for well drilling and pump installation machines 10 CSR 23-3.155).</p> <p>Establishes a fee structure (10 CSR 23-2.010).</p> <p>Establishes requirements governing location of wells (10 CSR 23-3.010), standards for construction of wells (10 CSR 23-3.030), well casing seals and connections (10 CSR 23-3.040), pump installation (10 CSR 23-3.050), certification and registration reports (10 CSR 23-3.060), plastic well casing (10 CSR 23-3.070), liners (10 CSR 23-3.080), sensitive areas (10 CSR 23-3.100), and plugging of wells (10 CSR 23-3.110)</p> <p>Requires monitoring wells to comply with all applicable standards for certification and registration (10 CSR 23-4.020), location (10 CSR 23-4.030), drilling methods (10 CSR 23-4.040), construction (10 CSR 23-4.060), development (10 CSR 23-4.070), and plugging (10 CSR 23-4.080).</p> <p>Establishes regulations governing test holes (drilled for geologic data), including standards for location (10 CSR 23-6.030), construction (10 CSR 23-6.040), and plugging (10 CSR 23-6.050).</p>	Applicable if investigation or response involves drilling of monitoring wells, test holes, and other wells.	

TABLE A.5 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Missouri Board of Geological Registration	CSR Title 20 Division 145	Activities requiring the interpretation of geology must comply with these regulations.	This regulation would likely be an ARAR since the interpretation of subsurface geology is fundamental to former USDA facility investigations.	A
Hazardous Waste Management	CSR, Title 10, Division 25, Chapters 4, 5, 6, 7, 16	<p>Sets forth methods for identifying hazardous wastes (10 CSR 25-4.261). Establishes standards for generators of hazardous waste (10 CSR 25-5.262), transporters of hazardous waste (10 CSR 25-6.263), and owners/operators of hazardous waste storage, treatment, and disposal facilities (10 CSR 25-7.264). Also establishes standards for the management of specific hazardous wastes and specific types of hazardous waste management facilities (10 CSR 25-7.266), as well as land disposal restrictions (10 CSR 25-7.268).</p> <p>In addition to incorporating the federal regulations at 40 CFR Part 270 by reference, provides additional state requirements (10 CSR 25-7.270).</p> <p>Establishes standards for universal waste management (10 CSR 25-16.273).</p>	Applicable if hazardous waste is generated on-site.	A
Contaminant Levels and Monitoring	CSR, Title 10, Division 60, Chapter 4	<p>Establishes maximum volatile organic contaminant levels and monitoring requirements (10 CSR 60-4.100), as well as maximum inorganic chemical contaminant levels, action levels, and monitoring requirements (10 CSR 60-4.030); also requires special monitoring for unregulated chemicals (10 CSR 60-4.110).</p> <p>The MCL value for the volatile organic chemical carbon tetrachloride is 0.005 mg/L (10 CSR 60-4.100). No MCL has been established for chloroform. The MCL values for inorganic chemicals are 10 mg/L for nitrate (as nitrogen); 1 mg/L for nitrite (as nitrogen); and 10 mg/L for total nitrate and nitrite (as nitrogen) (10 CSR 60-4.030).</p>	Applicable if universal waste is generated on-site.	C

TABLE A.5 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Solid Waste Management	CSR, Title 10, Division 80, Chapters 2, 3	Requires detailed geologic and hydrologic investigations to be conducted and reported at a proposed solid waste disposal area (10 CSR 80-2.015); compliance with all applicable permitting standards and procedures for solid waste disposal areas and processing facilities (10 CSR 80-2.020, -2.021); closure, post-closure care, corrective action planning, and financial assurance (10 CSR 80-2.030); and solid waste tonnage fees (10 CSR 80-2.080).	Applicable if on-site solid waste disposal areas are used.	A
		Establishes rules governing the design and operation of a sanitary landfill, including detection monitoring for nitrate/nitrite, carbon tetrachloride, and chloroform (10 CSR 80-3.010).	Applicable if on-site sanitary landfills are used.	
Historic Preservation	CSR, Title 10, Division 90, Chapter 3	Section 106 of the National Historic Preservation Act (see federal ARARs) is implemented by the State Historic Preservation Office (SHPO) of the MDNR. This office reviews federally funded or federally assisted projects to ensure compliance with federal preservation legislation. The office also assesses the significance of properties within project areas, studies the impacts of projects to significant resources, and consults with agencies regarding ways to avoid or mitigate damage to the resources.	Applicable if a district, site, building, structure, or object listed on or eligible for the National Register is on or adjacent to the site	L
Unmarked Human Burial Sites	RSMo Title XII, Chapter 194, Sects. 194.400 et seq.	Requires immediate notification of either the state historic preservation officer or the local law enforcement agency (Sect. 194.406), if an individual knows or has reason to know that an unmarked human burial or human skeletal remains are being disturbed, destroyed, removed, excavated, or exposed. Provides that construction activities must cease and not resume without specific authorization from the state historic preservation officer or the local law enforcement agency (Sect. 194.406).	Applicable if investigation or remediation activities encounter a burial site.	L

TABLE A.5 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Registry of Confirmed Abandoned or Uncontrolled Hazardous Waste Disposal Sites in Missouri	Title XVI Conservation, Resources and Development chapter 260 260.445	This section of the Revised Missouri Statutes directs the Missouri DNR to conduct investigations of potential abandoned or uncontrolled hazardous waste disposal sites and identify those sites that should be placed on a Registry. Owners or operators of the site are notified. Owner or operators of the site can appeal its proposed addition to the Registry.	USDA site could already be on the Registry or could be placed on the Registry as a result of investigation activities pursuant to the MOU between Missouri and USDA	A
Wildlife Code: Permits	CSR Title 3, Division 10, Chapters 4, 5	<p>Defines the Wildlife Code (3 CSR 10-4.105). Prohibits the pursuit, taking, possession, or use of wildlife except as provided in the Wildlife Code (3 CSR 10-4.110). Extends special protection to endangered wildlife, and lists species considered to be threatened with extinction (3 CSR 10-4.111).</p> <p>Requires that any person who takes or uses wildlife in any manner must obtain a permit or be exempted (3 CSR 10-5.205).</p>	Applicable if investigation or remediation operations involve taking wildlife.	A
Updated Monthly https://dnr.mo.gov/pubs/pub2616.htm	PUB 337, July 1, 2012 to June 30, 2013	Missouri Registry Annual Report: Registry of Confirmed or Abandoned or Uncontrolled Hazardous Waste Disposal Sites in Missouri.		
Missouri Department of Health and Senior Services, Departmental Missouri Risk Based Corrective Action Technical guidance	State Bill 901 (May 2004)	The guidance applies to contaminated or potentially contaminated sites. It provides a methodology to conduct site-specific characterization, calculate risk-based levels, implement risk management and provide long term stewardship.	The guidance does not supersede federal statutes and regulations. The Department has the authority to used risk-based decision making at sites so this guidance could be a TBC.	TBC

TABLE A.5 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Risk-Based Corrective Action Guidance	CSR Title 10 Division 25 Chapter 18	<p>Risk-Based Corrective Action (MRBCA) provides a framework that facilitates the constructive use of contaminated sites in the context of current and reasonably anticipated future site use. This rule does not change federally mandated, program-specific administrative, technical, and notification requirements. The rule is applicable to newly discovered sites, new releases discovered at previously closed sites, on-going cleanups and site reviews where different uses are being contemplated. Process is summarized below:</p> <p>Imminent threats are to be mitigated immediately. Site Characterization and development and validation of conceptual site model must be performed. If maximum levels do not exceed default target levels, one can request a letter of completion. Alternatively, one can proceed to the Tiered Risk Assessment using representative concentrations.</p> <p>Representative contaminant concentrations are compared to Risk Based Target Levels (RBTLs) calculated in Tier 1, Tier 2 or Tier 3 Risk Assessments. At each Tier one can either request a letter of completion, (because RBTLs are not exceeded) submit a Risk Mgnt. Plan (RMP) or perform the risk assessment in the next Tier. RBTLs are more site-specific in Tier 3 than in Tier 2. Tier 1 RBTLs lack any site-specific modifications and are conservatively safe for all exposure scenarios.</p> <p>RMPs must be approved by Missouri DNR. Where residuals remain above cleanup levels an Activity Use Limitation and an Environmental Covenant linked to the land title must be established.</p>		TBC

TABLE A.5 (Cont.)

Title	Citation ^a	Description	Comment	Type ^b
Environmental Covenants	RSMo 260.1000 to 1039.	<p>The Missouri Environmental Covenants Act, or MoECA, found in the Missouri Revised Statutes at sections 260.1000 to 260.1039, RSMo., creates a uniform standard for environmental covenants and directs the Missouri Department of Natural Resources to create a public database of properties that have restrictions provided for by this law. The law provides standards for and increases the reliability of covenants used as part of the cleanup of contaminated sites. Covenants are used to remediate a site to some restricted use condition and can be used to limit the liability of some parties.</p> <p>The act specifies the following:</p> <ul style="list-style-type: none">• Which environmental projects may use the act covenants• The specific elements the covenants must contain.• The obligations of the department and other holders of interest in a property• How the covenant is to be recorded• Who receives a copy of the covenant• How the database is to be structured• The conditions under which a covenant may be amended or removed• The actions required to transfer a covenant to a new holder• The environmental covenant runs with the land		

^a Abbreviations for citations: CSR, Code of State Regulations; RSMo, Revised Statutes of Missouri.

^b Types: A, action-specific; C, chemical-specific; L, location-specific; TBC, to-be-considered.

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Appendix B:
Site-Specific Health and Safety Plan Template and Forms

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ENVIRONMENTAL SCIENCE DIVISION (EVS)

Health and Safety Plan (HASP) for

Project Title: [Name]

LOCATION: [XXX]

COST CODE: [XXX]

PROJECT SPONSOR: [NAME/ORGANIZATION]

DATE: [XXX]

REVISION: [XXX]

RESPONSIBLE INDIVIDUAL/PRINCIPAL INVESTIGATOR: [NAME]

WORK PLANNER: [NAME]

PERSON IN CHARGE/FIELD ESH (FESH): [NAME]

WORK PLANNING & CONTROL NO. (WCD NO.): [INSERT #]

Project Title: [Name]

Date: [XXX]

Revision: [XXX]

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Date: [XXX]

Revision: [XXX]

WORK SCOPE

This HASP template coincides with the EVS Work Planning and Control Manual: [LINK: EVS WPC Manual](#) please reference when developing your HASP.

HASP (Health and Safety Plans) —place HASPs in the [Box folder EVS HASP Health and Safety Plans](#). Use the following naming convention: hasp_project title_mm/dd/yyyy_rev # (where mm=two-digit month, dd=two-digit day, and yyyy=four-digit year).

- 1) Concise summary of What, Where, How
- 2) Can be understood by all stakeholders
- 3) List key activities that can be broken down into tasks (document details in the Task scope and limits)
- 4) Avoid being verbose...scope is not a dissertation!
- 5) Avoid paragraphs, use short sentences or bulleted lists
- 6) Avoid acronyms (unless known)
- 7) Use simple, common vocabulary and grammar everyone understands (consider language barriers)
- 8) Place warnings, precautions, critical work steps, controls where applicable (of significant importance to safety)
- 9) Action / worker oriented

WORK SCOPE LIMITS

- 1) Put boundaries around your work scope.
 - a) Scope limits should list the conditions at which the activity or task is to be conducted.
 - b) Research work requires bounding statements with flexibility to vary experimental parameters
 - c) Do not document in paragraph form – use bulleted list for quick reference
 - d) Avoid ambiguous statements like “includes, but is not limited to...”, “approximate”, etc.
 - e) Consequences of deviation from the operating limits should be addressed.
 - f) Consider possible actions that can be taken safely to correct/avoid deviations from limits.
 - g) Review work instructions when necessary to verify current operating practice (i.e., changes with process chemicals, technology, and equipment)
- 2) Examples of types of limits / boundary conditions:
 - a) “Excavate only where underground utilities have been marked”
 - b) “Soil sampling/Excavating are only allowed within marked areas”
 - c) “Only use provided PPE; Nitrile gloves selected due to its excellent “break-through” properties”
 - d) “Do not leave contaminated area without going through decontamination area”
 - e) Such as excavations no more than 4 ft.

PLANNING THE WORK

- 1) Project Team Members & Responsibilities
 - a) List your team members that will be a part of the planning process.
 - i) RI/Procedure Owner/PI
 - ii) PIC/Field ESH Coordinator
 - iii) Work Planner
 - iv) SME(s)
 - v) DD
 - vi) Project Mgr
 - vii) ECR
 - viii) Division ESH
- 2) Scheduled Planning Reviews (Tabletop or Walk-downs)
 - a) State which type of planning review you will conduct with you Project Team listed above.
 - b) Once the review is complete, record the date, time and attendees in this HASP

IDENTIFYING THE HAZARDS

- 1) Physical
- 2) Line of Fire - Line of fire injuries occur when the path of a moving object intersects with an individual's body.
 - a) Struck by or Crush by
 - b) Caught in or between
 - c) Released energy
 - d) Rotating Parts
- 3) Fall Potential
 - a) Holes, Pits, Shafts
 - b) Uneven surfaces
 - c) Elevated work
- 4) Electrical
 - a) Overhead lines
 - b) Buried lines
- 5) Unguarded Machinery
 - a) Rotating parts
 - b) Nip points
- 6) Fire/Flammables/Combustibles – Hot Work
- 7) Excessive Force
- 8) Flying particles, chips or sparks
- 9) Hazardous Energy (LOTO)
 - a) Electrical
 - b) Pneumatic
 - c) Hydraulic
 - d) Mechanical

Project Title: [Name]

Date: [XXX]

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- e) Chemical
- 10) Sharp Objects
- 11) Improper tool/equipment use/inspections
- 12) Right tool for the job
- 13) Confined Spaces
- 14) Rigging
- 15) Heat & Cold Stress
- 16) Noise
- 17) Chemical
 - a) List all the chemicals (Gas, Dusts, Fumes, Vapors, Liquids) and attach SDS to this HASP or upload separately into your WCD. SDS may be found in [CORAL](#)
 - b) Determine Chemical Safety Levels if performing laboratory work
- 18) Biological
 - a) List any health hazards associated with your travel.
 - b) Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by mosquitoes, sandflies, triatomine bugs, blackflies, ticks, tsetse flies, mites, snails and lice. ...
 - c) Poisonous plants
 - d) Bird droppings
- 19) Radiological
 - a) Radiofrequency
 - b) Sealed source
- 20) Ergonomic
 - a) Vibration
 - b) Repetitive tasks
 - c) Unnatural/awkward body positioning
 - d) Heavy or awkward lifting
- 21) Behavioral or Human Errors
 - a) Improper or inadequate training for tools, equipment or procedures
 - b) Fatigue: Long shifts, odd hours, jet lag, stress
 - c) Is the facility, device, procedure, etc. Unusual, antique, or new to you?
 - d) Are you distracted by illness, fatigue, or unusual stressors?
 - e) Does the job lead you to multitask?
 - f) Are there unpredictable distractions like pedestrians, wildlife, etc.?
 - g) Is the job assignment or task vague or confusing?
 - h) Are you under unreasonable time pressure?
 - i) Did you team recently add any new members?
 - j) Have you done this task 10+ times in a row with the same team/partner?
 - k) Could errors on irreversible steps cause injury, damage, or death?

CONTROLLING THE HAZARDS

In order to provide maximum benefit and ease of use, EVS will utilize a tried and true method of controlling hazards, the Job Hazard Analysis (JHA). The JHA is a simple

Project Title: [Name]

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technique that focuses on job steps, the associated hazards and controls that are implemented to reduce the risk.

Please see separate JHA document attached to WCD No. XXXX

AUTHORIZING WORKERS

- 1) [List all workers here and verify this list matches the WCD list of Authorized Workers]
- 2) Has the training of each staff member on this project in compliance with Section 8 of the EVS Work Planning & Control Manual? Yes/No

DETERMINING THE RISK

- 1) Looking at your hazards in Section 1.04, check Section 4.2 of EVS Work Planning & Control Manual: Determining Risk. Will your workers be involved with any of this work? Yes/No
- 2) If you have a high hazard that is not listed in Section 4.2 of the EVS WPC Manual. Please include it in this HASP and alert your EVS ESH Coordinator as the EVS WPC Manual may need to be updated. This is a function of Feedback in the Laboratory's Integrated Safety Management System. So, Thank you!
- 3) Use the Risk Matrix below to determine the hazard level for the entire project/WCD. Think of each High Hazard you listed and the controls put into place in Section 1.05 and pick what you think is the highest hazard and assign it a Hazard Level as defined in the Risk Assessment Matrix (upper left hand).
- 4) If you do not have any High Hazard associated with your project. Use the Risk Matrix below and assign a Hazard Level using the next highest hazard level you or your coworkers would be potentially exposed to (Low, Moderate, High) for your WCD.

Project Title: [Name]

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EVS RISK ASSESSMENT MATRIX

HAZARD LEVEL FOR WCD NO.		SCALE OF SEVERITY		
		ACCEPTABLE	TOLERABLE	GENERALLY UNACCEPTABLE
HIGH				
MODERATE				
LOW				
(CIRCLE ONE)		LITTLE TO NO EFFECT ON EVENT	EFFECTS ARE FELT, BUT NOT CRITICAL TO OUTCOME	SERIOUS IMPACT TO THE COURSE OF ACTION AND OUTCOME
SCALE OF LIKELIHOOD	NOT LIKELY MAY ASSUME EXPOSURE WILL NOT HAPPEN	LOW	MODERATE	MODERATE
	POSSIBLE LIKELY TO OCCUR SOMETIME	LOW	MODERATE	HIGH
	PROBABLE LIKELY TO OCCUR SEVERAL TIMES	MODERATE	HIGH	HIGH
RISK RATING KEY		LOW	MODERATE	HIGH
		ACCEPTABLE	ALARP - AS LOW AS REASONABLY PRACTICABLE	GENERALLY UNACCEPTABLE
		OK TO PROCEED	TAKE MITIGATION EFFORTS	SEEK SUPPORT

Severity:

Acceptable: Risks that bring no real negative consequences, or pose no significant threat to the organization or project.

Moderate: Risks that could potentially bring negative consequences, posing a moderate threat to the project or organization.

Generally Unacceptable: Risks with substantial negative consequences that will seriously impact the success of the organization or project.

Likelihood:

Not Likely: Extremely rare risks, with almost no probability of occurring.

Possible: Risks that are more typical, with about a 50/50 chance of taking place.

Probable: Risks that are highly likely to occur.

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Date: [XXX]

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- 5) It has been determined that the Hazard Level for this WCD is: **LOW – MODERATE – HIGH** [circle one]. Use Table 1 below to determine who you should involve in your planning team and when to conduct a Pre or Post-Job brief.

Table 1 - Communication Methods Used in the Work Planning and Control Process

Category	Involve	Required?
Planning work	Workers, subject matter experts (SME), ESH coordinator, person in charge (PIC) authorizer (procedure owner), environmental compliance representative (ECR)	Low hazard: Suggested
Table-top review of HASP		Moderate hazard: Recommended High hazard: Required
Pre-job briefing	Workers, PIC, RI	Low hazard: Suggested
Post-job briefing	Suggested SME, ESH coordinator	Moderate hazard: Recommended High hazard: Required

EXECUTING THE WORK

- 1) I [name of PIC/Field ESH] have reviewed the list of Authorized Workers for this project as recorded in WCD No. [XXX] and have conducted a Pre-Job brief as outlined in Section 5 of the EVS Work Planning & Control Manual on [insert date].
- 2) A Pre-Job Brief should consist of a review of this HASP at job start and the items below should be addressed before the start of work each day.
 - a) What is the activity being performed today?
 - b) Lessons learned from previous day and any field changes to HASP
 - c) Does everyone understand their scope of work?
 - d) What are the hazards, controls, and hold points?
 - e) What could go wrong and has it been controlled to a reasonable risk level?
 - f) What are the emergency procedures for today?
 - i) Tornado shelter
 - ii) Fire
 - iii) Inclement weather
 - iv) Eye wash

FEEDBACK – POST-JOB REVIEW

The PIC or FESH collects daily feedback from workers for review and possible reporting to management. The RI collects weekly feedback at routine group meetings

Include changes in the work procedure in either the HASP in use for that scope of work or in a revision of the work instructions in a WCD-EZ form. Lessons learned from the work

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Date: [XXX]

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process are forwarded at any time in the lifetime of the project to the EVS point of contact for lessons learned which is the EVS ESH Coordinator.

You may hand write in your feedback notes here:

EMERGENCY INFORMATION & PREPAREDNESS

The general emergency response procedures to be followed by EVS personnel are:

- 1) If needed, determine the most rapid method of contacting emergency personnel (phone, radio, or in-reach satellite communicator, available from Bobby Herrera) and initiate contact procedures. **See Table 2 for list of emergency contacts.**
- 2) Attend continuously to the victim to the extent possible until help arrives.
- 3) Supply first aid assistance to the victim, consistent with training level, and take other action, as appropriate, to stabilize the situation until professional help arrives.
Incidents that appear likely to cause injury or property damage should be reported to the FHSC. If needed, the HASP will be modified to address unanticipated situations.
- 4) In the event of injuries, illness, or property and equipment damage, the involved Argonne employee or the Argonne FESH must make the following notifications as soon as practical after immediate care is provided: (1) the injured/ill employee's supervisor or next available senior supervisor and (2) one of the EVS/CELS personnel listed in Table 1
- 5) All incidents must be reported to the EVS Environment, Safety, and Health (ESH) coordinator and Division office as soon as possible after the occurrence regardless of day or time.
- 6) A full report must be submitted to the EVS ESH Coordinator within 48 hours. All incidents must be reported to [insert name of CLS DSM] (CLS Directorate Safety

Manger DSM) immediately so that she may determine if the incident is reportable to the Department of Energy via the Occurrence Reporting and Processing System or ORPS.

- 7) If the EVS ESH coordinator cannot be reached, the following order of contact will be followed:
 - a) EVS Division Director Cristina Negri (or Denise Fals in the Division office)
 - b) CLS DSM [insert CLS DSM name].

See additional details on any site-specific information in the following paragraphs.

[insert any details on the project locations emergency information such as locations of shelters, phone numbers or special lifesaving protocols such as life flight.]

Project Title: [Name]

Date: [XXX]

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Table 2
Emergency Contacts for [insert project name]

Name	Contact Information
<i>Survey Team</i>	
<i>EVS</i>	
Sean Erlenbeck (EVS EHS)	630-252-2453 (work) 815-254-1962 (home) 815-679-8157 (mobile)
[insert name] (CLS DSM)	630-252-1617 (work) 630-484-4783 (mobile)
Cristina Negri (EVS Division Director)	630-252-9662 (work) 773-343-3925 (mobile)
Denise Fals (Administrative Assistant to Negri)	630-252-3753 (work)
<i>Project Specific Contacts of Importance</i>	
<i>On Location Medical and Fire Emergency</i>	
Emergency Services	911
Hospital: [Location]	
Occupational Clinic 24Hr.	
Occupational Clinic non-24Hr.	
Fire Department	
Security	
Police	

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Name	Contact Information
<i>On Location Transportation and Evacuation</i>	
Airline	
Taxi	
Coast Guard National Response Center	
U.S. Coast Guard Search and Rescue	
<i>Argonne</i>	
Incident Reporting Hotline (staffed 24/7)	
<i>Hotels</i>	

If none of these personnel can be reached, reporting requirements will be met by submitting an email notification to safety@anl.gov. Include the following information in the email:

- Your name and badge number
- Division
- Date and time of incident
- Location of incident
- Type of incident (e.g., injury)
- Brief description of incident (may describe injury or illness but do not include other personal medical information)

Complete and submit the Argonne Incident Description Form (ANL-239) (Attachment A) within one hour of stabilizing the injury/illness, regardless of the day or time, or as soon as practicable. If computer access is not readily available, the incident reporting hotline at 630-252-1811 should be called to report the incident. The hotline is staffed from 7:00 a.m. to 7:00 p.m., Monday through Friday; after hours, follow the voice mail instructions.

HASP ATTACHMENT A

INCIDENT DESCRIPTION FORM
(ANL-239 Form)

INCIDENT DESCRIPTION

Name: _____ Badge No. _____

Signature: _____ Phone No.: _____

Time and Date of Statement: _____ Work Location: _____

Time and Date of Incident: _____ Incident Location: _____

Brief description of incident:

Your role in the incident:

1. Fully describe what happened, in sequence, listing times as accurately as possible. Include the conditions that you observed and your response to those conditions. Use additional paper as needed.

2. Note anything unusual you observed prior to or during the incident (odors, sounds, sights, etc.).

Name: _____ Badge No. _____ Statement Date: _____ Work Location: _____

3. What conditions influenced the incident (weather, equipment malfunction, time of day, stress, etc.)?

4. What caused the incident?

5. Please list other people who may have pertinent information concerning the incident.

6. Additional comments/observations.

Job Safety Analysis Environmental Science (EVS) Division

Note: This form is to be completed by the Contractor and submitted to the Field Safety Coordinator for approval prior to work commencement. In addition, this form is to be maintained at the site where work is being performed.

Job Title _____

Contract No. _____ Building/Area _____

Contractor		EVS Division	
Company Name _____		Field Manager _____	Project _____
Project Manager _____		Phone _____	
Phone _____	Pager _____		
Superintendent _____		ESH Rep _____	
Phone _____	Pager _____	Phone _____	Pager _____
ESH Rep _____			
Phone _____	Pager _____		
Designated Competent Person			
Excavation _____		☐	Approved
(29CFR:1926.650)		☐	Approved as Noted
Confined Space _____			
(29CFR:1936.21)			
		EVS Safety Coordinator _____	
		Date _____	

- The Contractor ESH Representative must hold an Orientation with all employees prior to work identifying the hazards related to their Scope of Work and have each person sign the Signature Sheet attached.
- Identify location of **Emergency Telephones** and designated **Tornado Shelters** in relationship to the work site and provide phone numbers:
Sheriff _____
Fire _____
Ambulance _____
Hospital _____
- Emphasize compliance with **OSHA 29CFR:1926**.
- Utilizing the format on attached pages, identify hazards and safety precautions/procedures to mitigate hazards.

cc: Project Manager
Div. Safety Coordinator
Procurement
Field Safety Coordinator
Contractor

Phase of Work	Safety Hazard	Precautions/Safety Procedures

Safety Data Sheets (SDSs)

Hazardous materials used on this site are:

1. _____	3. _____	5. _____
2. _____	4. _____	6. _____

Location of SDSs for listed hazardous materials:

Review of Emergency Routes to Hospitals, Assembly Points, Tornado Shelters, and Emergency Response Procedures

Basic Information*

*Use separate sheets as necessary.

Basic Safety Rule Reminders

1. Safety hat and safety glasses with side shields, long pants, shirts with short sleeves, and sturdy work boots are required as a minimum. Safety shoes, hearing protection, and gloves are required as needed.
2. Inspect all tools and equipment for OSHA compliance before use.
3. Fall protection required when working heights above 6 feet when handrail or other fall protection is not provided. A Class III full-body harness with shock-absorbing lanyard is required for fall arrest protection.
4. Flag work areas and post warning signs.
5. Ground fault circuit interrupters (GFCIs) are required on all 110 and 120 volt receptacles including portable generators. Extension cords shall be heavy duty rated and shall be grounded; lengths shall not exceed 100 feet.
6. Stairways, passageways, and accessways must be kept free of materials and equipment.
7. Orderly housekeeping shall be maintained.
8. Report all injuries/illnesses and near misses to the Field Project Manager as soon as possible.
9. Metal ladders are prohibited.
10. No dumping of any kind shall be performed on site without use of a qualified and competent spotter. After dumping their loads, all trucks must lower their beds before driving away.

Contractor _____	Building/Area _____
Contract No. _____	Job Title _____
Superintendent _____	Company (not ANL) ESH Rep. _____

[illegible]

Note: Contractor representative will provide a copy of this sheet with initial signatures and all added signatures to the Project Manager and/or to the EVS ESH Coordinator at the completion of the job.

Site Safety Review Form

Documentation of Changes in Site Health and Safety Plan

Was the health and safety plan followed as presented? Yes: _____ No: _____

Describe, in detail, any changes to the health and safety plan:

Reason for changes: _____

Follow-up, review, and evaluation prepared by: _____ Date: _____

Discipline:

Approved by:

AGEM Program Manager _____ Date: _____

Field Safety Coordinator _____ Date: _____

EVS ESH Coordinator _____ Date: _____

Site Safety Review Form (Cont.)

Evaluation of Site Health and Safety Plan

Was the health and safety plan adequate? Yes: _____ No: _____

What changes would you recommend?

AGEM Field Program Acknowledgement and Acceptance

I, the undersigned, have read and understand the contents of the attached site-specific health and safety plan. I agree to perform my work in accordance with this plan.

[illegible]

TAILGATE SAFETY MEETING

Division _____ Facility _____
Date _____ Time _____
Customer _____ Address _____
Specific Location/Address _____
Type of Work _____
Chemicals Used _____

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment _____
Chemical Hazards _____
Physical Hazards _____
Emergency Procedures _____
Hospital/Clinic _____
Hospital Address _____
Special Equipment _____
Other _____

ATTENDEES

Name Printed	Signature	Name Printed	Signature
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
Meeting conducted by:	Signature	_____	_____
_____	Signature	_____	_____
Supervisor	_____	Manager	_____

INCIDENT DESCRIPTION

Name: _____ Badge No. _____

Signature: _____ Phone No.: _____

Time and Date of Statement: _____ Work Location: _____

Time and Date of Incident: _____ Incident Location: _____

Brief description of incident:

Your role in the incident:

1. Fully describe what happened, in sequence, listing times as accurately as possible. Include the conditions that you observed and your response to those conditions. Use additional paper as needed.

2. Note anything unusual you observed prior to or during the incident (odors, sounds, sights, etc.).

INCIDENT DESCRIPTION

Name: _____ Badge No. _____ Statement Date: _____ Work Location: _____

3. What conditions influenced the incident (weather, equipment malfunction, time of day, stress, etc.)?

4. What caused the incident?

5. Please list other people who may have pertinent information concerning the incident.

6. Additional comments/observations.

Confined Space Entry Permit

This permit must be cancelled by the supervisor immediately after the work is completed or within an 8-hour shift, whichever is sooner.

1. Date: _____
2. Confined Space (CS) ID No.: _____
3. Location: _____
4. Division: _____
5. Nature of the work: ☐ Inspection ☐ Repair ☐ Cleaning ☐ Other
6. Description of Work (approved procedure must be attached): _____
7. Other Permits Required? ☐ Yes ☐ No If yes, list other permits: _____
8. List PPE required: _____
9. List method of attendant-entrant communication: _____
10. Method of emergency communication with the Fire Department: _____
11. Check the correct answer to all questions:

	Yes	No	N/A
a. Are all lines isolated and/or disconnected?	☐	☐	☐
b. Are all valves locked and tagged?	☐	☐	☐
c. Are all motors and electrical switches in the CS locked and tagged?	☐	☐	☐
d. Has the CS been decontaminated and purged?	☐	☐	☐
e. Is forced supply/exhaust ventilation operating?	☐	☐	☐
f. Is oxygen at least 19.5% and less than 23.5% by volume?	☐	☐	
g. Are combustible gases/vapors less than 10% LEL?	☐	☐	
h. Are toxic gas concentrations acceptable?	☐	☐	
i. Has adequate illumination been provided?	☐	☐	
j. Is the procedure for this entry attached?	☐	☐	
k. Is the procedure up-to-date (less than 12 months old)?	☐	☐	
l. Has a briefing been held with all crew members to explain the job?	☐	☐	
m. Has the Fire Department been contacted?	☐	☐	

12. Explain any "no" answers _____

13. I understand the potential hazards associated with this job and have read and been briefed on the procedure on how to perform this work in a safe and efficient manner.

Crew Member: _____ Date: _____

Crew Member: _____ Date: _____

Crew Member: _____ Date: _____

Crew Member: _____ Date: _____

Crew Member: _____ Date: _____

Crew Member: _____ Date: _____

Crew Member: _____ Date: _____

Crew Member: _____ Date: _____

Crew Member: _____ Date: _____

Crew Member: _____ Date: _____

Print Name

Signature

14. I have examined the above and attest that entry requirements and precautions have been satisfactorily achieved in accordance with the attached procedures.

Entry Supervisor: _____ Date: _____

Print Name

Signature

15. Post-job observations/crew feedback:

16. **Permit Canceled** _____ Date: _____

Print Name

Signature

Keep at worksite. Record air monitoring data on the log below. Once canceled, maintain in the division filing system for 75 years; send copy to ESQ-Industrial Hygiene, Bldg 200.

Confined Space Entry Log

Confined Space ID No. _____

Instrument (make/model): _____

Serial Number: _____

Calibration due date: _____

☐ Bump test OK? Date: _____

Time**	Measured Concentration*					Surveyed by (print name & initial)	Level OK?
	O ₂ (%)	COMB (%LEL)	H ₂ S (PPM)	CO (PPM)	Other		

*Allowable levels and order of testing:

O₂ = 19.5-23.5%

Combustible = <10%LEL

H₂S = <10 PPM

CO = <25 PPM

**Record data and time for each entry, after breaks or as directed by ESQ-IH.

Continuous monitoring was performed ☐ Yes ☐ No

Name/Badge (Print)	Function (Checkmark)		Attendant's Log of Time In & Out (Put actual time in or out)					
	Entrant	Attendant	Time In	Time Out	Time In	Time Out	Time In	Time Out

Each entrant and attendant shall review this permit, enter their names above and check their assigned function.

Instructions for Confined Space Entry Permit, ANL-614

1. This permit must be filled out by the supervisor in charge of the entry.
2. This permit must be filled out in ink (no pencils are to be used).
3. Each item/question must be filled in or checked off **individually** (e.g., no lines through all "yes" answers), and **completely** (no blank spaces).
4. This permit must be completed and available at the confined space site during the entry.
5. The atmospheric monitoring results must be recorded every time the confined space is entered (i.e., the first entry and after every extended break). Check the appropriate box to show if continuous monitoring was performed.
6. The entrants name and time in and out shall be recorded every time an entrant enters or leaves the space. If the attendant is changed, this, too, must be recorded.
7. Any feedback from the work crew or supervisor on issues encountered or suggestions for work improvements must be documented on the permit by the entry supervisor. Line management must also consider further documentation and reporting requirements (e.g., ORPS, PAAA), if the issues encountered are significant.
8. This permit must be cancelled by the supervisor immediately after the work is completed or within an 8-hour shift, whichever is sooner.
9. The original completed permit and procedure must be maintained in the division filing system with copies of the completed permit sent to ESQ-IH, building 200.

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Environmental Investigations at Former CCC/USDA Facilities: Master Work Plan

Volume 2: Standard Operating Procedures

by
Applied Geosciences and Environmental Management Section
Environmental Science Division, Argonne National Laboratory

November 2019

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Master Work Plan, Volume 2:

Introduction

This report presents Volume 2, Standard Operating Procedures, of the Applied Geosciences and Environmental Management (AGEM) program's *Master Work Plan*. This volume is a compilation of the 27 standard operating procedures (SOPs) used in the field program, which is mainly focused on site investigation/characterization fieldwork. The SOPs and all references cited or consulted are filed in the AGEM program archives and are available upon request.

Both volumes of the *Master Work Plan*, including the SOPs presented here, will be reviewed on an annual basis and updated (or expanded), as needed.

The SOPs herein have been reviewed and approved by the AGEM program manager, Lorraine LaFreniere, Ph.D., with concurrence from the AGEM technical team.

A handwritten signature in black ink, appearing to read 'Lorraine LaFreniere', is written over a horizontal line.

Lorraine LaFreniere, Ph.D.
AGEM Program Manager

November 29, 2019

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**Environmental Investigations at
Former CCC/USDA Facilities: Master Work Plan**

Volume 2: Standard Operating Procedures

AGEM-01:

Direct Push, Drilling, and Geologic Logging

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AGEM-01:

Direct Push, Drilling, and Geologic Logging

1 Scope and Applicability

This SOP describes the methods used for direct push (CPT and Geoprobe[®]) and drilling operations, and geologic logging of borings. These methods are conducted primarily to collect soil, rock, and groundwater samples, and to install monitoring wells, observation wells, and piezometers, as needed. Drilling contractors must be licensed by the state to drill and install monitoring wells; and all drilling permits and licenses required by the state must be obtained before field work begins. A geologist designated by the AGEM program manager must be on-site during all drilling operations.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
CPT	cone penetrometer
ft	foot (feet)
gal	gallon(s)
HASP	health and safety plan
PID	photoionization detector
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure
VOC	volatile organic compound

3 Responsibilities

The AGEM program manager and the field project manager are responsible for the following:

- Selecting the investigation locations.
- Selecting the optimal method for each investigated location, on the basis of subsurface conditions, the depth to be achieved, surface features, and other considerations.

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel operating the CPT, Geoprobe[®], and drill rigs have the appropriate training and experience and are licensed as required.
- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Verifying that the work is performed as directed by the AGEM program manager.
- Verifying that the driller has the appropriate license and that the required permits are obtained before field work begins.
- Verifying that an Argonne representative and a geologist are on-site and available to monitor direct push and/or drilling operations.
- Ensuring that the *Master Work Plan*, the site-specific work plan, and the site-specific HASP are available at the field site.
- Ensuring that the necessary equipment and materials are at the field site.
- Ensuring that all drilling equipment is devoid of gross contamination when it arrives at the site and also is steam cleaned both when it arrives and between borings/wells.
- Acquiring the necessary utilities surveys.
- Delineating and controlling work areas at the site (*Master Work Plan, Volume 1, Section 6.5*).

The on-site geologist is responsible for the following:

- Monitoring all direct push and drilling operations.
- Ensuring that drilling in a surficial aquifer is performed as indicated in Section 5.3 of this SOP.
- Recording the geologic logging information specified in Section 5.8 of this SOP.

All personnel conducting the field work are responsible for the following:

- Implementing this SOP and related procedures, as directed.

- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

Direct push methods used by the AGEM program employ the use of a CPT or Geoprobe[®] (hydraulically-powered) machine with either a DualTube or Macro-Core[®] continuous soil sampling system.

The preferred drilling method for the AGEM program is sonic drilling. Other methods may be considered on a case-by-case basis, depending on site conditions, the required borehole depth and diameter, equipment availability, the location's accessibility, ease of sample collection, and identification of an interval suitable for screening, time, and cost.

Monitoring well installation is discussed in AGEM-02; the installation of piezometers is discussed in AGEM-03. Abandonment of borings is addressed in AGEM-04.

5 Procedures

5.1 Equipment and Supplies Needed

- CPT and/or Geoprobe[®] unit, appropriately sized and equipped (as needed)
- Drill rig, appropriately sized and equipped (as needed)
- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Steam cleaner and other decontamination supplies (AGEM-22)
- Steel drums/rolloff, plastic sheeting, absorbent pads
- Logbooks and other documentation material
- Field meters and monitoring equipment

5.2 Preparations before Work Begins

1. Put on the approved level of PPE.
2. Inspect all equipment as it arrives at the site to verify that the equipment is devoid — both inside and outside — of gross contamination such as asphaltic, bituminous, or other encrusting or coating material, grease, grout, or soil. Clean, as necessary.
3. Place a temporary berm around the drilling location. Lay plastic sheeting over the work location and the berm to contain any discharged fluids.
4. Calibrate field meters (e.g., PID; see AGEM-21).
5. Initiate air (PID) monitoring for hazardous materials, as appropriate.
6. Clean all drilling equipment in a designated laydown area before leaving the site (at the driller's and project geologist's discretion).

5.3 Preventing Cross-Contamination

When drilling occurs in a surficial aquifer, the following procedures will apply:

- Drilling must be terminated before the confining layer below the aquifer is fully penetrated.
- The on-site geologist will determine the depth drilled into the confining layer on the basis of the site-specific geology.
- If drilling must proceed into a lower aquifer, casing must be set to prevent cross-contamination.

5.4 Direct Push Operations

The CPT and Geoprobe[®] Dual Tube and Macro-Core[®] soil samplers are direct push methods used to install piezometers or well points (AGEM-03) for the collection of soil samples (AGEM-10) and long-term water level data (AGEM-07).

The CPT is to be operated in accordance with the manufacturer's instructions by field personnel with documented training and experience suitable for the task (e.g., Applied Research Associates, Inc. 1996). The manufacturer's SOP is available from the AGEM records manager; a hardcopy can also be found in the AGEM field trailer.

The Geoprobe[®] is to be operated in accordance with the manufacturer's instructions by personnel with documented training and experience suitable for the task. Operational instructions and sampling protocols for the Geoprobe[®] devices are detailed in Geoprobe[®] (2011) and Geoprobe[®] (2013), which are available through the manufacturer (online) or from the AGEM records manager. A hardcopy of these SOPs can also be found in the AGEM field trailer.

5.5 Sonic Drilling

Currently, sonic drilling is the AGEM program's preferred method for all well installation and core recovery. In sonic drilling, a dual line of drill pipe is oscillated through the subsurface. An outer pipe prevents collapse of the borehole and is used in the construction of monitoring wells and piezometers. An inner pipe contains a core bit; the inner pipe can function as a core barrel sampler.

Recover core as follows:

1. Advance the inner drill pipe and core bit approximately 6-30 ft into the subsurface.
2. Advance the outer drill pipe over the inner pipe to hold the boring open.
3. Use the drill head to lift the inner pipe to the surface for core recovery.
4. Vibrate the core out of the inner drill pipe and into a plastic sheath or stainless steel tray.
5. Advance the inner barrel to the next sampling interval.
6. If no well will be installed in a boring, withdraw all equipment from the hole. Abandon the hole as indicated in AGEM-04.
7. Clean all drilling equipment as required, at the driller's and site geologist's discretion.

5.6 Geologic Logging

The on-site geologist is responsible for logging each boring. Information to be recorded includes the following:

- Boring number and location (GPS coordinates in decimal degrees)
- Drilling method and borehole diameter
- Lithologic descriptions
- Core recoveries

- Evidence of obvious contamination
- Weather conditions
- Groundwater levels (depth encountered and static)
- Materials placed by humans
- Sample depths and identification numbers

An example of a borehole log is in Exhibit 01.1.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 6.5 (PPE; work area designation and site control; utilities survey)
- *Master Work Plan, Volume 2:*
 - AGEM-02: Monitoring Well Installation and Development
 - AGEM-03: Installation of Piezometers with Direct Push Equipment
 - AGEM-04: Abandonment of Soil Borings, Monitoring Wells, and Piezometers
 - AGEM-05: Purge Groundwater Sampling
 - AGEM-10: Soil Sampling
 - AGEM-21: Calibration of Field Instrumentation and PID Operation
 - AGEM-22: Equipment Decontamination
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

Applied Research Associates, Inc. *CPT Operator's Training Manual*, June 10.

Argonne National Laboratory, 2004, *Argonne Patent: CPT air delivery system*, 14 claims, granted July 10, 2004 (#6,763,901 B1).

California EPA, 1995, *Drilling, Coring, Sampling and Logging at Hazardous Substance Release Sites, Guidance Manual for Ground Water Investigations*, July.

Geoprobe[®], 2011, *Geoprobe[®] Macro-Core[®] MC5, 1.25-Inch Light-Weight Center Rod Soil Sampling System, Standard Operating Procedure*, Technical Bulletin No. MK3139, January. (The SOP for this and other Geoprobe[®] instruments can be downloaded from the Geoprobe[®] literature web page at <https://geoprobe.com/literature>.)

Geoprobe[®], 2013, *Geoprobe[®] DT22 Dual Tube Soil Sampling System, Continuous Core Soil Sampler, Standard Operating Procedure*, Technical Bulletin No. MK3140, January (originally prepared in November 2006). (The SOP for this and other Geoprobe[®] instruments can be downloaded from the Geoprobe[®] literature web page at <https://geoprobe.com/literature>.)

KDHE, 2011, *KDHE Geoprobe Operations*, SOP BER-07, in "Quality Assurance Management Plan (QMP), Part II, Appendix A," Kansas Department of Health and Environment, Division of Environment, Bureau of Environmental Remediation, Topeka, Kansas (SOP BER-07 was originally published on August 14, 2000), January 1. (For links to the various sections and appendices of the QMP [Revision 6], including SOPs, dated February 21, 2019, go to <http://www.kdheks.gov/environment/qmp/qmp.htm>)

Lunne, T., Robertson, P.K., and J.J.M. Powell, 1997, *Cone Penetration Testing in Geotechnical Practice*, Routledge, New York, New York.

MDNR, 2019, *Well Installation: Monitoring Well Construction Code*, Missouri Code of State Regulations (CSR), 10 CSR 23-4, prepared by the Missouri Department of Natural Resources, January 29.

NDHHS, 2014, *Water Well Standards: Water Well Construction, Pump Installation, and Water Well Decommissioning Standards*, prepared by the Nebraska Department of Health and Human Services, Nebraska Administrative Code [178 NAC 12], August 26.

Project Name:		Drilling Method:		Date/Time Start:	
Borehole Number:		Location:		Date/Time Finish:	
Geologist:		First Water:		Date/Time:	
Surface Elevation: (ft AMSL)		Static Depth GW:		Date/Time:	

Depth (ft)	% Recovery	Interval Desc.	Description (Major Texture: %sand, %granules, %gravel; sorting, rounding; plasticity; carbonates; Fe/Mn; sedimentary structure and other significant features; color; moisture)	Blow Count	Sample Id	Remarks

EXHIBIT 01.1 Sample borehole log.

**Environmental Investigations at
Former CCC/USDA Facilities: Master Work Plan**

Volume 2: Standard Operating Procedures

AGEM-02:

Monitoring Well Installation and Development

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AGEM-02:

Monitoring Well Installation and Development

1 Scope and Applicability

This SOP describes the methods for installing groundwater monitoring wells in order to establish permanent access for collecting groundwater samples and/or monitoring water levels. Monitoring well installation must follow the guidelines in *Handbook of Suggested Practices for the Design and Installation of Ground Water Monitoring Wells* (National Groundwater Association 1989) and the requirements of the respective state regulatory agency. Direct-push and drilling operations will be conducted in accord with AGEM-01 (Direct Push, Drilling, and Geologic Logging).

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
ft	foot (feet)
HASP	health and safety plan
hr	hour(s)
in.	inche(s)
lb	pound(s)
mL	milliliter(s)
min	minutes(s)
PPE	personal protective equipment
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
SOP	standard operating procedure

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel operating the CPT, Geoprobe[®], and drill rigs have the appropriate training and experience and are licensed as required.
- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.

- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Verifying that the work is performed as directed by the AGEM program manager.
- Ensuring that the necessary equipment and materials are at the field site.
- Ensuring that all direct push and/or drilling equipment is devoid of gross contamination when it arrives at the site and also is cleaned when it arrives, as needed
- Acquiring the necessary utilities surveys (48 hr before work is to be done and refresh every 10 days).
- Delineating and controlling work areas at the site (*Master Work Plan, Volume 1, Section 6.5*).

Personnel conducting the field work are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

Monitoring wells may be installed using direct-push methods (CPT or Geoprobe[®]) or drilling methods, as appropriate for site conditions.

Direct-push and sonic drilling operations are discussed in AGEM-01. Abandonment of borings, wells, and piezometers is discussed in AGEM-04.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Decontamination supplies (AGEM-22)

- Logbooks and other documentation material
- Field meters and monitoring equipment

5.2 Preparations before Work Begins

1. Put on the approved level of PPE.
2. Lay plastic sheeting around the work location to minimize the likelihood of cross-contamination.
3. Inspect drilling or direct-push equipment to verify that the equipment is devoid of gross contamination.
4. Clean all drilling or direct-push equipment with approved water when the equipment arrives at the site. To the extent possible, perform this cleaning in an area that is off the investigation site.
5. Calibrate field meters.
6. Initiate air monitoring for hazardous materials, as appropriate.

5.3 Step-by-Step Implementation

1. Drill or push the boring according to AGEM-01
2. When drilling or pushing is complete, measure the bottom of the borehole with a tape to verify its depth.
3. If the interval selected for screening is not at the bottom of the hole, backfill the hole with bentonite to within approximately 1 ft of the bottom of the selected interval. Allow the bentonite to hydrate for at least 30 min. Then place a 1-ft layer of filter sand over the bentonite.
4. Assemble the monitoring well screen, end plug, casing, top cap, and centralizers (if required). Lower the well assembly until it rests on the layer of filter sand.
5. Withdraw the drill pipe or direct-push rod in increments of 5 ft while adding filter pack sand. Take repeated depth soundings of the bottom of the hole to monitor the level of the sand and detect any bridging of sand.
6. Allow sufficient time for the filter pack to settle through the water column before continuing withdrawal of the pipe or rod.
7. Extend the filter pack sand to approximately 2 ft above the top of the well screen.

8. For installations in Missouri, install a secondary filter pack of 100-mesh sand, at least 1 ft thick, on top of the primary filter pack to prevent infiltration of grout or bentonite slurry into the primary filter pack.
9. Place a seal of bentonite chips or pellets at least 3 ft thick above the filter pack. Tremie the bentonite slurry or pellets (in wells more than 30 ft deep), or pour the slurry or pellets into the annular space. Allow the slurry or pellets to set for approximately 30 min before grouting begins.
10. While the drill pipes or push rods are being removed, tremie cement/bentonite grout into the annulus above the bentonite seal. Top off the grout level periodically during this process.
11. After 24 hr, install the concrete pad and protective well cap.

5.4 Construction Details and Materials

5.4.1 Well Casing

Well casings typically consist of threaded, flush-joint, 2- or 4-in. inner diameter, schedule 40 or schedule 80 PVC pipe. Use only casings cleaned and prepackaged by the manufacturer. Extend the casing from the top of the well screen to approximately 3 ft above ground level, and attach a sanitary seal with casing vent. Do not use solvents, cements, or adhesive tapes to join sections of casing.

5.4.2 Well Screens

Well screen lengths are not to exceed 10 ft unless special conditions warrant a longer screen. Use only well screens cleaned and prepackaged by the manufacturer. The screens are to be flush-joint, 1/2- or 4-in. inner diameter, schedule 40 (for depths < 100 ft) or schedule 80 PVC (for depths > 100 ft) pipe with factory-machined continuous slots of appropriate slot size as determined by a sieve analysis (see Section 5.4.4 of this SOP). Well screens are to have PVC bottom plugs. Do not use solvents, cements, or adhesive tapes to join the screen to the casing.

5.4.3 Centralizers

Use stainless steel or PVC centralizers on wells built with “open” holes (for depths > 100 ft) to center the well in the borehole and maintain its alignment during grouting. Locate centralizers at the top and bottom of the screen and at 20-ft intervals on the casing. Do not use cements or adhesive tapes to affix the centralizers.

5.4.4 Filter Pack

Fill the annular space between the well screen and the borehole wall with clean filter pack. Extend the filter pack from approximately 1 ft below the well screen to approximately 2-3 ft above the top of the well screen. Unless otherwise stipulated, the filter pack grain size is to be based on formation grain size analysis. Use the value of the D30 (70% retained) sieve size, multiplied by a factor not less than 3 or greater than 6, to determine the appropriate grain size of the filter pack.

5.4.5 Bentonite/Expanding Cement Seal

Install a 2-ft bentonite pellet seal above the filter pack if the sealed interval is below the water table. If the sealed interval is above the water table, use expanding cement instead of bentonite.

5.4.6 Cement/Bentonite Grout

Tremie grout into the annular space between the well casing and the borehole wall from the top of the bentonite seal to the ground surface. Make the grout mixture with Portland cement (and/or bentonite in Nebraska) and potable water. If adding bentonite, prepare the grout by first thoroughly mixing the bentonite and water and then mixing in the Portland cement. Lower the tremie line to within 5 ft of the bottom of the zone to be grouted. Withdraw the tremie line as the annulus fills with grout, taking care to ensure that the discharge end of the tremie line remains submerged by a minimum of 5 ft in the grout during cement placement.

5.5 Monitoring Well Completions

5.5.1 Flush-Mount Completions

Certain sites require a variance request for flush-mount surface completion for a well (Exhibit 02.1). All installations are to conform to individual state requirements.

Dig a hole large enough to contain the steel flush-mount housing around the casing, so that the cover plate is at or slightly above the surrounding surface. Set the attached steel or PVC skirt or shroud in cement to preclude migration of water into or around the well. Upon installation of the housing, terminate the well casing as high in the flush-mount housing as possible. Unless otherwise stipulated, install a concrete pad (Section 5.5.3 of this SOP). Finally, install a waterproof cover plate, such as a Morrison Bros. Co. Model 418XA (see Morrison Bros. Co. [2019] for specification sheet).

5.5.2 Stick-Up Completions

Under certain conditions, a stick-up surface completion is appropriate (Exhibit 02.2). The subsurface well construction is the same as for the flush-mount completion (Section 5.5.1 of this SOP), except that the PVC casing extends approximately 3 ft above the ground surface and is enclosed in an 8- to 12-in. protective PVC shroud with a lockable cap. Install a manufactured square well guard (stick-up) with a lockable steel cap and padlock over the well casing. Embed the protective cap in the cement/bentonite grout before it has set. If needed (e.g., in high traffic areas), drive three or four steel pickets evenly around the well at a distance of 4 ft.

5.5.3 Concrete Pad

For both flush-mount and stick-up installations, install a concrete pad (Sakrete, Quikrete, or equivalent) at least 8 in. thick and 8 in. beyond the installation's edge, with a 12:1 or 12:2 slope to prevent pooling of surface water.

5.6 Well Construction Diagram

Record the construction of each well on a well construction diagram in the field (see Exhibit 02.3) and attach the diagram to the boring log (Exhibit 01.1 in AGEM-01). Graphically denote at least the following information:

- Total depth of hole
- Screen location and length
- Filter pack interval
- Bentonite seal interval
- Grout interval
- Centralizer locations
- Height of riser
- Casing/screen size(s) and slot size
- Protective casing detail

5.7 Well Development

After well construction is complete, develop the well until a consistent yield of clean water is produced. Use a surge block and bailer or a surge block and submersible pump for development. Decontaminate any equipment entering a well on the site before inserting it.

Employ two well development techniques, over-pumping and surging, in tandem. Initially pump the well at a rate higher than recharge. Then surge the well by using a plunger to force water back and forth through the well screen, filter pack, and formation. Any water introduced to facilitate development must be approved in advance by an Argonne representative or designee. Containerize or discard water produced from well development as determined by local environmental regulators. Record the following information before and during development:

- Date and method of development
- Static water level before and after development
- Development water volumes (in gallons)
- Volume and source of water added (if any)
- Final water clarity

5.8 State Certifications

The licensed driller must submit all required well completion/certification forms (including apprentice permit application forms and variance requests) within the time indicated by the appropriate state agency.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control; utilities survey)
- *Master Work Plan, Volume 2:*
 - AGEM-01: Direct Push, Drilling, and Geologic Logging
 - AGEM-04: Abandonment of Soil Borings, Monitoring Wells, and Piezometers
 - AGEM-05: Purge Groundwater Sampling

- AGEM-06: Low-Flow Groundwater Sampling
- AGEM-07: Measuring Water Levels in Wells
- AGEM-11: Handling and Disposal of Investigation-Derived Waste
- AGEM-22: Equipment Decontamination
- AGEM-23: Handling, Packing, and Shipping of Samples in the Field
- AGEM-27: Sample and Document Management

7 References Cited or Consulted

Delta Environmental Services, 2000, *Flush Mount Well Construction Detail*, prepared by D. Surgnier, proprietor, Delta Environmental Services, June 23.

Delta Environmental Services, 2001, *Field Record Form*, Form 120601, prepared by D. Surgnier, proprietor, Delta Environmental Services.

Delta Environmental Services, 2002, *Stick-Up Well Construction*, prepared by D. Surgnier, proprietor, Delta Environmental Services, January 22.

EPA, 2018, *Groundwater Monitoring Well Installation*, SOP#2048, U.S. Environmental Protection Agency, Environmental Response Team, Emergency Division, Office of Emergency and Remedial Response, Washington D.C., May 10. (The most current versions of this and other EPA ERT SOPs are available online at: <https://response.epa.gov>; click on the link “ERT Standard Operating Procedures.”)

EPA, 2013, *Design and Installation of Monitoring Wells*, SESDGUID-101-R1, Region 4, January 29.

KDHE, 2011, *Installation of Monitoring Wells*, SOP BER-06, in “Quality Assurance Management Plan (QMP), Part II, Appendix A,” Kansas Department of Health and Environment, Division of Environment, Bureau of Environmental Remediation, Topeka, Kansas (SOP BER-06 was originally published on August 14, 2000), January 1. (For links to the various sections and appendices of the QMP [Revision 6], including SOPs, dated February 21, 2019, go to <http://www.kdheks.gov/environment/qmp/qmp.htm>)

Morrison Bros. Co., 2015, *Specification Sheet: Model 418 Series Limited Access Test Well Manhole*, Dubuque, Iowa, July. (For link to various specification sheets by Morrison Bros. Co., go to the literature downloads page at <http://www.morbros.com>)

NGWA, 1989, *Handbook of Suggested Practices for the Design and Installation of Ground Water Monitoring Wells*, published by the National Ground Water Association.

EXHIBIT 02.1 Details of flush-mount well construction. Source: Delta Environmental Services (2000)

EXHIBIT 02.2 Details of stick-up well construction. Source: Delta Environmental Services (2002)

Field Record

<i>Well Schematic</i>	Site Name: _____, State _____, Well Number: _____ T.D. _____
	Date: _____ Prepared By: _____
	Location: _____ 1/4 _____ 1/4 _____ 1/4 of Sec. _____, Twp. _____ N/S, Rge. _____ E/W, County _____
	GPS Location: Latitude (i.e. 40.1234): _____ Longitude (i.e. - 102.8923): _____
	Owner: _____ Address _____
	Unit operator: _____ Helper: _____
	Use: Observation _____, Water Sampling _____, Soil Sampling _____, Electronics Data _____, Other: _____
	Geologist: _____, Registration Number: _____, State: _____
	CPT Unit: 680A (40 Ton) _____, 680B (GeoProbe) _____, 680C (22 Ton Crawler) _____
	Status: Depth (s) Groundwater Encountered: 1. _____ to _____, 2. _____ to _____, 3. _____ to _____, SWL: _____
	Hole Size: _____ in. to _____ ft. & _____ in. to _____ ft. & _____ in. to _____ ft.
	Casing height above ground level: _____ inches / Flush Mount / Stick-up, Size _____
	Well casing material: PVC _____, Steel _____, Fiberglass _____, Other (specify) _____
	Screen Dia.: _____ O.D. X I.D. _____, Length: _____, Slot size: _____, Type slot: _____, Mfg. By: _____
	Prepack Well Screen : Yes/No, From: _____ ft. to _____ ft. & _____ ft. to _____ ft. Sand Grade _____
	Bentonite Seal Above Screen: Yes / No, From: _____ ft. to: _____ ft. and From: _____ ft. to: _____ ft.
	J-Plug Well Seal: Yes / No Well Head Properly Vented: Yes / No.
	Is well Locked: Yes / No. Lock Number: _____, Key Number: _____, Lock mfg. _____
	Was Hole Plugged: Yes / No. Was Well Chlorinated: Yes / No. Static Water Level: _____
	Grouted: Yes / No with: neat cement _____, cement grout _____, bentonite grout _____, other _____
Grout: _____ lbs/gal., Trimmed in Hole: Yes / No, Total of _____ gals. of slurry pumped.	
Field Supervisor: _____, Helper: _____	
Nearest pollution/ contamination source: _____	
Direction and distance: _____	
Comments: _____ _____ _____ _____ (Use back if needed for additional comments)	
Well Schematic Explanation: _____ _____ _____	

EXHIBIT 02.3 Field record of well construction. Source: Delta Environmental Services (2001)

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**Environmental Investigations at
Former CCC/USDA Facilities: Master Work Plan
Volume 2: Standard Operating Procedures**

**AGEM-03:
Installation of Piezometers with Direct Push Equipment**

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Exhibits

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AGEM 03:

Installation of Piezometers with Direct Push Equipment¹

1 Scope and Applicability

This SOP describes the use of CPT or Geoprobe[®] devices to install piezometers or well points to collect long-term water level data. The installation and use of piezometers must be conducted in accordance with the regulations of the state in which the installation is taking place.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
cm ²	square centimeter(s)
CPT	cone penetrometer
ft	foot (feet)
gal	gallon
HASP	health and safety plan
in.	inche(s)
mm	millimeter(s)
PID	photoionization detector
PPE	personal protective equipment
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
SOP	standard operating procedure

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.

¹ Note that in Nebraska, piezometers cannot be completed as permanent wells; they are to be abandoned within 90 days of installation.

- Ensuring that the necessary equipment and materials are at the field site.
- Delineating and controlling work areas at the site (*Master Work Plan, Volume 1, Section 6.5*).

Personnel conducting the field activities are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting field notes related to waste management to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

Direct push methods used by the AGEM program employ the use of a CPT or Geoprobe[®] (hydraulically-powered) machine with either a DualTube or Macro-Core[®] continuous soil sampling system.

5 Procedures

5.1 Equipment and Supplies Needed

- CPT or Geoprobe[®]
- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Decontamination supplies (AGEM-22)
- Plastic sheeting, absorbent pads
- Logbooks and other documentation material
- Field meters and monitoring equipment

5.2 Preparations before Work Begins

1. Put on the approved level of PPE.
2. Place a temporary berm around the drilling location. Lay plastic sheeting over the work location and the berm to contain any discharged fluids.
3. Calibrate field meters (e.g., PID; see AGEM-21).
4. Initiate air (PID) monitoring for hazardous materials, as appropriate.

5.3 Flush-Mount Piezometer Installation

To install a flush-mount piezometer, well point, or sand point well, use the following procedure:

- Push a Geoprobe® rod or a non-instrumented CPT cone to depth as specified in Surgnier (2001a), Exhibit 03.1.
- Pull the rod/cone back to the surface.
- For Missouri, attach a 3.25-in.-diameter expendable tip to a 0.5-in. to 1 in.-diameter PVC screen. Attach the rod to the expendable tip and push to the desired depth. The maximum screen length for sampling a discrete interval is 5 ft.
- For Kansas, the hole must be 4 in. in diameter from the ground surface to a depth of 20 ft.
- Use push rods to advance the assembly to the base of the desired sampling interval. The size of the push rods should be 15 cm² for 0.5-in. screen or 2.25 in. (60 mm) for 1-in. screen.
- Withdraw the rods enough to expose the 5-ft screen.
- Withdraw a water sample if desired.
- To install a piezometer, sand point well, or well point, lower 0.5- to 1-in.-diameter schedule 40 PVC riser pipe into the hole through the rods. Attach the pipe to the top of the screen and withdraw the rods, 2.5-5 ft at a time, while using a tremie to fill the hole with silica sand or filter pack to a level 2-3 ft above the top of the screen.
- Unless otherwise stipulated, base the filter pack grain size on a formation grain size analysis. Use the value of the D30 (70% retained) sieve size, multiplied by a factor not less than 3 or greater than 6, to determine the appropriate grain size.

- Use a water level meter or other measuring device to determine the location of the top of the sand and ensure that sufficient sand is in place.
- Install 1-2 ft of secondary filter pack on top of the primary filter pack (Missouri).
- Pour bentonite pellets into the hole (to a thickness of 2-3 ft) with some water. Allow the pellets to hydrate for at least 20 min to form an effective seal between the screened interval and the section above.
- Mix grout and tremie it into the hole from the top of the bentonite seal to a depth of 3 ft below ground level. Mix bentonite grout to a minimum density of 9.4 lb/gal.
- For the surface installation, dig out an area 28 in. in diameter and 26 in. deep around the borehole and riser pipe. Place a 6-in.-deep layer of bentonite pellets on top of the grout.
- Set a 12-in. O.D. by 12-in. flush mount. See Exhibit 03.1 for construction details.
- Fill the surface hole outside the flush mount with grout or QuickCrete, and finish to a smooth surface with a 12:1 or 12:2 slope. The concrete pad must be a minimum of 8 in. thick and must extend at least 8 in. beyond the flush mount (28 in. minimum).
- Cut the riser pipe to the appropriate height. For wellhead protection, install a 12-in. Morrison Bros. Co. Model 418XA Flush Mount Cover or similar cover (Morrison Bros. Co. 2015). Fit the top of the casing with a Morrison Bros. Co. "J" Plug Model 678XA or equivalent (Morrison Bros. Co. 2013) and a screened vent with a locking pipe plug and padlock.
- Complete a piezometer installation form (Exhibit 03.2), and give the completed form to the licensed water well contractor so that the installation can be registered with the state regulatory agencies.

5.4 Stick-Up Piezometer Installation

If a stick-up piezometer installation is more appropriate than a flush-mount installation, follow the procedure above (Flush-Mount Piezometer Installation) for all aspects of the subsurface installation. See Exhibit 03.3 for the surface completion details.

Complete a piezometer installation form (Exhibit 03.2), and give the completed form to the licensed water well contractor so that the installation can be registered with the state regulatory agencies.

5.5 State Certifications

The licensed driller must submit all required well completion/certification forms (including apprentice permit application forms and variance requests) within the time indicated by the appropriate state agency.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 6.5 (PPE; work area designation and site control; utilities survey)
- *Master Work Plan, Volume 2:*
 - AGEM-04: Abandonment of Soil Borings, Monitoring Wells, and Piezometers
 - AGEM-05: Purge Groundwater Sampling
 - AGEM-06: Low-Flow Groundwater Sampling
 - AGEM-10: Soil Sampling
 - AGEM-21: Calibration of Field Instrumentation and PID Operation
 - AGEM-22: Equipment Decontamination
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

Delta Environmental Services, 2001, *Field Record Form*, Form 120601, prepared by D. Surgnier, proprietor, Delta Environmental Services.

Geoprobe[®], 2011, *Geoprobe[®] Macro-Core[®] MC5, 1.25-Inch Light-Weight Center Rod Soil Sampling System, Standard Operating Procedure*, Technical Bulletin No. MK3139, January. (The SOP for this and other Geoprobe[®] instruments can be downloaded from the Geoprobe[®] literature web page at <https://geoprobe.com/literature>.)

Geoprobe[®], 2013, *Geoprobe[®] DT22 Dual Tube Soil Sampling System, Continuous Core Soil Sampler, Standard Operating Procedure*, Technical Bulletin No. MK3140, January (originally prepared in November 2006). (The SOP for this and other Geoprobe[®] instruments can be downloaded from the Geoprobe[®] literature web page at <https://geoprobe.com/literature>.)

KDHE, 2011a, *KDHE Geoprobe Operations*, SOP BER-07, in “Quality Assurance Management Plan (QMP), Part II, Appendix A,” Kansas Department of Health and Environment, Division of

Environment, Bureau of Environmental Remediation, Topeka, Kansas (SOP BER-07 was originally published on August 14, 2000), January 1. (For links to the various sections and appendices of the QMP [Revision 6], including SOPs, dated February 21, 2019, go to <http://www.kdheks.gov/environment/qmp/qmp.htm>)

KDHE, 2011b, *Installation of Direct Push Monitoring Wells*, SOP BER-29, in “Quality Assurance Management Plan (QMP), Part II, Appendix A,” Kansas Department of Health and Environment, Division of Environment, Bureau of Environmental Remediation, Topeka, Kansas (SOP BER-29 was originally published on August 14, 2000), January 1. (For links to the various sections and appendices of the QMP [Revision 6], including SOPs, dated February 21, 2019, go to <http://www.kdheks.gov/environment/qmp/qmp.htm>)

Morrison Bros. Co., 2013, *Specification Sheet: Model 678XA Test Well Plug*, Dubuque, Iowa, March. (For link to various specification sheets by Morrison Bros. Co., go to the literature downloads page at <http://www.morbros.com>)

Morrison Bros. Co., 2015, *Specification Sheet: Model 418 Series Limited Access Test Well Manhole*, Dubuque, Iowa, July. (For link to various specification sheets by Morrison Bros. Co., go to the literature downloads page at <http://www.morbros.com>)

X 1/4 of X 1/4 of X 1/4 of Section X, Twp. X North / South, Rge. X East / West
X County, State of Kansas

Date: XX/XX/XX

12" Morrison Brothers, Co. Model 418XA flush mount cover.
Top of casing fitted with a (J-Plug) Morrison Brothers, Co.
Model 678XA and a padlock.

8" thick and extends 8" larger than the flush mount (28" minimum). Sloped to prevent pooling of water and vegetation around well and to allow for placement of a surveyor pin.

The well is grouted with cement grout as required, mixed with clean fresh water.

Well casing is terminated as high as possible inside the flush mount and is capped with a (J-Plug) Morrison Brothers, Co. Model 678XA locking plug and padlock.

4" PVC Sch 40, threaded casing and PVC, Mill Slot (0.020") well screen.

The hole is X" in diameter from the surface to (XX') T.D. and grouted from the top of the sand pack to the base of the flush mount.

Gravel/sand pack is designed to stabilize the aquifer material and permit the fine fraction to move into the well during development. Gravel/sand pack extends to at least 2' above screen.

The well was constructed under the direction of a licensed water well contractor as specified under the Kansas Department of Health and Environment regulation.

The well was registered with the Kansas Department of Health and Environment on form WWC-5.

Field Record

<i>Well Schematic</i>	Site Name: _____, State _____, Well Number: _____ T.D. _____
	Date: _____ Prepared By: _____
	Location: _____ 1/4 _____ 1/4 _____ 1/4 of Sec. _____ Twp. _____ N/S, Rge. _____ E/W, County _____
	GPS Location: Latitude (i.e. 40.1234): _____ Longitude (i.e. - 102.8923): _____
	Owner: _____ Address _____
	Unit operator: _____ Helper: _____
	Use: Observation _____, Water Sampling _____, Soil Sampling _____, Electronics Data _____, Other: _____
	Geologist: _____, Registration Number: _____, State: _____
	CPT Unit: 680A (40 Ton) _____, 680B (GeoProbe) _____, 680C (22 Ton Crawler) _____
	Status:
	Depth (s) Groundwater Encountered: 1. _____ to _____, 2. _____ to _____, 3. _____ to _____, SWL: _____
	Hole Size: _____ in. to _____ ft. & _____ in. to _____ ft. & _____ in. to _____ ft.
	Casing height above ground level: _____ inches / Flush Mount / Stick-up, Size _____
	Well casing material: PVC _____, Steel _____, Fiberglass _____, Other (specify) _____
	Screen Dia.: _____ O.D. X I.D. _____, Length: _____, Slot size: _____, Type slot: _____, Mfg. By: _____
Prepack Well Screen : Yes/No, From: _____ ft. to _____ ft. & _____ ft. to _____ ft. Sand Grade _____	
Bentonite Seal Above Screen: Yes / No, From: _____ ft. to: _____ ft. and From: _____ ft. to: _____ ft.	
J-Plug Well Seal: Yes / No Well Head Properly Vented: Yes / No.	
Is well Locked: Yes / No. Lock Number: _____, Key Number: _____, Lock mfg. _____	
Was Hole Plugged: Yes / No. Was Well Chlorinated: Yes / No. Static Water Level: _____	
Grouted: Yes / No with: neat cement _____, cement grout _____, bentonite grout _____, other _____	
Grout: _____ lbs/gal., Trimmed in Hole: Yes / No, Total of _____ gals. of slurry pumped.	
Field Supervisor: _____, Helper: _____	
Nearest pollution/ contamination source: _____	
Direction and distance: _____	
Comments: _____	

<i>(Use back if needed for additional comments)</i>	
Well Schematic Explanation: _____	

EXHIBIT 03.2 Field record of well construction. Source: Delta Environmental Services (2001)

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**Environmental Investigations at
Former CCC/USDA Facilities: Master Work Plan**

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AGEM-04:

Abandonment of Soil Borings, Monitoring Wells, and Piezometers

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AGEM 04:

Abandonment of Soil Borings, Monitoring Wells, and Piezometers

1 Scope and Applicability

This SOP describes the methods used to abandon soil borings, monitoring wells, and piezometers. These methods must be conducted in accordance with the regulations of the state in which the abandonment is taking place.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
ft	foot (feet)
gal	gallon(s)
HASP	health and safety plan
in.	inch(es)
PPE	personal protective equipment
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
SOP	standard operating procedure

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and all decommissioning guidelines for the state and are capable of implementing it correctly.
- Ensuring that the necessary equipment and materials are at the field site.
- Delineating and controlling work areas at the site (*Master Work Plan, Volume 1, Section 6.5*).

Personnel conducting the field activities are responsible for the following:

- Implementing this SOP and related procedures, as directed.

- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting field notes related to waste management to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

The abandonment/decommissioning of soil borings, monitoring wells, and piezometers no longer used in the AGEM program (or in a state of disrepair) are to be conducted in accordance with state requirements to ensure they do not become conduits of contamination to the states' groundwater supplies.

5 Procedures

5.1 Plugging and Sealing Decommissioned Borings, Wells, and Piezometers

Procedures for plugging and sealing borings, monitoring wells, and piezometers must conform to applicable state requirements for borehole abandonment (see references in Section 7 of this SOP), including those for completing abandonment/plugging forms (notices and records) and filing them with the appropriate state agencies. The following general guidelines also apply:

- Fill open holes with a bentonite slurry or neat cement. If the hole is deeper than 10 ft, emplace the bentonite or cement grout with a tremie pipe from the bottom of the hole up, until the grout/bentonite displaces all water in the hole and flows onto the ground surface. Shallow holes less than 3 ft deep may be backfilled with native soil or grouted to the surface.
- Abandon wells by removing as much of the casing as possible. Then proceed as for open holes.
- Abandon piezometers by first grouting with a tremie pipe. Then remove the top 3 ft or more of casing. Install a 1-ft-thick cement plug, and backfill to the surface with native soil or grout.
- Fill out abandonment/plugging forms and file with the appropriate state regulators

5.2 Plugging and Sealing Hand Dug Wells

- Remove pumps and clean out debris and ensure they are properly disposed of.
- Disinfect water wells with chorine (at a rate of 1 gal of 5% solution per 500 gal of water in well).
- Slowly knock off about 5 ft of rock lining into the well, alternately filling with rock then sand (to fill the voids).
- Fill with clean sand/gravel to the static water level.
- Keep water in the well pumped down to the static water level.
- Backfill the well with compacted clay (bentonite) to within 5 ft of the surface and seal it with a 6-in. layer of cement or bentonite.
- Fill the remaining 4.5 ft or so with compacted top soil.
- Create a mound at the ground surface to drain water runoff away from the well.
- Fill out abandonment/plugging forms and file with the appropriate state regulators.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 6.5 (PPE)
- *Master Work Plan, Volume 2:*
 - AGEM-21: Calibration of Field Instrumentation and PID Operation
 - AGEM-22: Equipment Decontamination
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

KDHE, 2018a, *Procedure for Plugging a Groundwater Monitoring Well*, Procedure #WWP-10, prepared by the Bureau of Water, Geology and Well Technology Section, Kansas Department of Health and Environment, January.

KDHE, 2018b, *Plugging Abandoned Wells*, prepared by the Bureau of Water, Geology and Well Technology Section, Kansas Department of Health and Environment, April.

MDNR, 2019, *Plugging of Monitoring Wells*, Missouri Code of State Regulations (CSR), 10 CSR 23-4.080, prepared by the Missouri Department of Natural Resources, January 29.

MDNR, 2014, *Plugging Your Abandoned Well*, Publication 2281, prepared by the Missouri Department of Natural Resources, May.

NDHHS, 2014, *Water Well Standards: Water Well Construction, Pump Installation, and Water Well Decommissioning Standards*, prepared by the Nebraska Department of Health and Human Services, Nebraska Administrative Code (NAC), Title 178, Chapter 12 [178 NAC 12], August 26.

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AGEM-05:

Purge Groundwater Sampling

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AGEM-05:

Purge Groundwater Sampling

1 Scope and Applicability

This SOP establishes a method for purging and collecting representative groundwater samples for chemical analysis (including analysis for VOCs) from the saturated zone of the subsurface. Monitoring wells are purged before sampling because groundwater in the well casing is not considered representative of formation water in the aquifer.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
°C	degree(s) Celsius
CPT	cone penetrometer
ft	foot (feet)
ft ²	square foot (feet)
gal	gallon
HASP	health and safety plan
hr	hour(s)
IDW	investigation-derived waste
in.	inche(es)
min	minute(s)
PID	photoionization detector
PPE	personal protective equipment
QA/QC	quality assurance/quality control
sec	second(s)
SOP	standard operating procedure
VOC	volatile organic compound

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.

- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment (including sample containers; AGEM-23) and materials are at the field site.

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting the field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

This procedure describes methods for collecting groundwater samples from existing private or public wells, temporarily screened wells, or pushed or bored holes by using existing pumps, introduced pumps, or bailers. Wells must be purged before sampling, by using either (1) a bailer or pump to remove at least three well volumes of water, or if there is insufficient flow, until dry, or (2) when the aquifer is low-yielding, the low-flow procedure in AGEM-06. Sampling should occur in a progression from the least contaminated well to the most contaminated well.

Related procedures are listed in Section 6 of this SOP. Extensive information about pumps and other equipment used in sampling is in the references cited in Section 7; use all equipment according to the manufacturer's instructions.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Decontamination supplies (AGEM-22)
- Logbooks and other documentation material
- Sampling device(s) and monitoring instruments
- Sample containers, ice, and cooler(s)

5.2 Preparations before Sampling

1. Lay plastic sheeting around the well to minimize the likelihood of contamination, if needed.
2. Put on the approved level of PPE.
3. Calibrate field meters and prepare to monitor conductivity, pH, and temperature of the samples.
4. Prepare ice-filled coolers to hold the groundwater samples collected for VOCs analysis immediately after collection.
5. Initiate air monitoring for hazardous materials, as appropriate.

5.3 Measuring Water Levels, Purging Wells, and Recovering Samples from Wells

5.3.1 Monitoring Wells

1. Remove the locking well cap. Note the location, time, and date in the sampling logbook. Remove the well casing cap.
2. Measure the depth to the water surface (AGEM-07) and the total depth of the well.
3. For the three-well-volume purging method, calculate the purge volume and purge the well as follows:
 - a. For wells of common diameters, use the table below to determine one well volume per foot of water column (gal/ft), then multiply that value by the height of the water column (ft) and by 3 to obtain the purge volume:

<u>Well Diameter (in.)</u>	<u>Volume (gal/ft)</u>
0.5	
1.0	
2.0	0.1632
3.0	0.3672
4.0	0.6528
6.0	1.4688

- b. For wells of other diameters, calculate one well volume (v in gal/ft) as

$$v = 7.48 \cdot \pi \cdot r^2$$

($\pi = 3.1416$; r = well radius [ft]; conversion factor [7.48] units are gal/ft²)

- c. Use a bailer or pump to purge the calculated volume of water from the well, monitoring pH and conductivity. Measure the volume of purged water removed by using a flow meter or a container of known volume (such as a 5-gal bucket). Containerize the purged water (IDW) for analysis before disposal (see AGEM-11).
 - d. Sample after the well has recharged and field parameters are stable (within 24 hr of purge). (If there is insufficient [slow] well volume recovery, collect a grab sample, purge a second time, and collect another grab sample once some of the well volume has recovered.)
 - e. Decrease the pumping rate, and collect samples through a Teflon-lined sampling hose. Alternatively, recover samples with a bailer.
4. To sample a monitoring well with the low-flow method, follow AGEM-06 for purging and sample collection.
 5. Decontaminate reusable equipment before proceeding to the next location.

5.3.2 Domestic or Lawn-and-Garden Wells

1. Turn on a faucet (preferably outdoors) on the well side of any water conditioning device or screen.
2. Allow the well to discharge for 5-10 min, monitoring pH and conductivity.
3. Sample after the well has recharged and field parameters are stable (within 24 hr of purge).
4. Collect the sample directly from the faucet (not through a garden hose).

5.3.3 Active Public Wells

To sample active public wells, use a spigot near the wellhead to collect a sample while the pump is in production mode and the water is routed into the normal system.

5.4 Recovering Samples from Open or Temporarily Screened Boreholes

1. In general, use a bailer to recover groundwater samples from open or temporarily screened boreholes. Use other means of recovery if the situation requires.
2. To recover groundwater samples from boreholes made with the CPT or other direct-push device, push a tip-and-screen system to 3 ft below the desired sampling depth. Pull back to release the tip and expose the screen. Monitor the

water level (AGEM-07) until it becomes stable. Then use a clean string and bailer for sampling.

3. Decontaminate reusable equipment before proceeding to the next location (AGEM-22).

5.5 Handling Samples for VOCs Analyses

Sample volumes and preservation methods are specified in AGEM-23. To minimize disturbance of groundwater samples collected for VOCs analyses and thus avoid loss of volatiles, treat these samples as follows:

1. Open the sample vial, set the cap in a clean place, and collect the sample in midstream as the water flows from the sampling device. Collect duplicates at the same time as primary samples.
2. Fill the sample vial until it just overflows, and a meniscus forms on the top. Do not rinse the vial or allow overflowing to continue.
3. Verify that the cap is clean and dry, and then place it directly over the top of the vial. Screw the cap down firmly, but do not over-tighten.
4. Invert the vial, and tap it gently. Observe for at least 10 sec. If an air bubble appears, discard the sample, and begin again. Trapped air will result in loss of volatiles.
5. Immediately place the vial into a protective foam sleeve and then on its side in an ice-filled cooler (4°C).
6. Ship the samples to the laboratory as soon as possible. Maintain the samples at 4°C until the time of analysis. Do not allow them to freeze. Holding time before VOCs analysis is ten days.
7. Follow AGEM-23 for further handling, packing, and shipping.

5.6 Handling Samples for Other Analyses

Sample volumes are specified in AGEM-23.

1. Maintain samples for tritium, nitrate, and hydrogen analyses at ambient temperature.
2. Acidify samples for total nitrate analysis to pH < 2 with sulfuric acid (H₂SO₄), and maintain at ambient temperature.

3. Follow AGEM-23 for handling, packing, and shipping.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control; utilities survey)
- *Master Work Plan, Volume 2:*
 - AGEM-01: Direct Push, Drilling, and Geologic Logging
 - AGEM-04: Abandonment of Soil Borings, Monitoring Wells, and Piezometers
 - AGEM-11: Handling and Disposal of Investigation-Derived Waste
 - AGEM-21: Calibration of Field Instrumentation and PID Operation
 - AGEM-22: Equipment Decontamination
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

EPA, 2001, *Groundwater Well Sampling*, SOP#2007, U.S. Environmental Protection Agency, Environmental Response Team, Emergency Division, Office of Emergency and Remedial Response, Washington D.C., April 16. (The most current versions of this and other EPA ERT SOPs are available online at: <https://response.epa.gov>; click on the link “ERT Standard Operating Procedures.”)

KDHE, 2011, *Collection of Groundwater Samples at Known or Suspected Groundwater Contamination Sites*, SOP BER-01, in “Quality Assurance Management Plan (QMP), Part II, Appendix A,” Kansas Department of Health and Environment, Division of Environment, Bureau of Environmental Remediation, Topeka, Kansas (SOP BER-01 was originally published on August 14, 2000), January 1. (For links to the various sections and appendices of the QMP [Revision 6], including SOPs, dated February 21, 2019, go to <http://www.kdheks.gov/environment/qmp/qmp.htm>)

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**AGEM-06:
Low-Flow Groundwater Sampling**

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Exhibit

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AGEM-06:

Low-Flow Groundwater Sampling

1 Scope and Applicability

This SOP establishes a method for low-flow purging and collecting representative groundwater samples for chemical analysis (including analysis for VOCs) from the saturated zone of the subsurface.

Monitoring wells are purged before sampling because groundwater in the well casing is not considered representative of formation water in the aquifer. The low-flow purging method in this SOP minimizes stress to the monitoring well by keeping the pumping rate consistent with the natural flow rate of groundwater in the low-yielding aquifers or water bearing zones. This procedure also minimizes the generation of potentially contaminated wastewater.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
°C	degree(s) Celsius
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
HASP	health and safety plan
ORP	oxidation-reduction potential
mg/L	milligram(s)/liter
min	minute(s)
mV	millivolt(s)
PPE	personal protective equipment
QA/QC	quality assurance/quality control
sec	second(s)
SOP	standard operating procedure
SVOC	Semi-volatile organic compound
VOC	volatile organic compound

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Recording all pertinent data on the AGEM Low-Flow Groundwater Purging and Sampling Record (Exhibit 06.1).
- Submitting the field data to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

The groundwater level and the well depth must be measured before well sampling begins. In accordance with EPA guidance, this procedure for low-flow groundwater sampling will use a bladder pump and appropriate field equipment to determine when representative formation water is entering the well casing during pumping (Puls and Barcelona 1996; Yeskis and Zavala 2002). Static water levels should be measured periodically, and the parameters of pH, temperature, specific conductivity, ORP, and DO should also be monitored to determine when a sample representative of formation water can be collected.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Decontamination supplies (AGEM-22)
- Electronic water level indicator and weighted tape with marked intervals of 0.01 ft for measuring the depth to water
- Submersible or bladder pump with adjustable rate control

- Generator and extension cord
- Polyethylene tubing
- Multi-parameter meter with flow-through cell, graduated container, stop watch, and calculator for measuring flow
- AGEM Low-Flow Groundwater Purging and Sampling Record (Exhibit 06-1) and an indelible pen
- Sample containers, sample labels, chain-of-custody forms, and custody seals
- Disposable gloves, resealable bags, and garbage bags
- Shipping container and ice packs
- Drum or container for purged water
- Well keys
- Map of well locations and summary of well construction details

5.2 Preparations before Sampling

1. Put on the approved level of PPE.
2. Assemble equipment and supplies; ensure that they are clean and in working order. Calibrate field meters.
3. Prepare and organize sample containers for each well site.
4. Place plastic sheeting on the ground around the well to keep the sampling equipment clean, as needed.
5. Position sampling equipment and field instruments.
6. Check the condition of the well for damage or evidence of tampering. Unlock the wellhead. Record location, time, date, and other appropriate information (Exhibit 06-1).
7. Check the known well construction data to determine the screen interval and calculate the volume of water in the well casing.

5.3 Purging and Sampling

1. Measure the static water level in the well with an electronic water level meter (AGEM-07).
2. Measure the total depth of the well (AGEM-07).
3. Slowly insert the bladder pump into the well to a depth midway between the top and bottom of the screen. Keep the pump above the bottom of the casing to minimize disturbance of the solids that are typically present at the bottom of a well. If the water depth in a well is inadequate to cover the screen interval, then the AGEM program manager will determine a suitable depth for the bladder pump intake.
4. Set the pumping rate for the bladder pump to minimize drawdown during pumping. Monitor the rate by measuring the static water level periodically throughout pumping.
5. Use polyethylene tubing to connect the bladder pump to an in-line flow cell that continuously measures formation parameters including pH, temperature, specific conductivity, ORP, and DO during pumping. Record measurements every 4 min, until three successive measurements for each parameter are within a range indicating that the formation water is stable. The ranges are as follows:
 - a. pH, within 0.1
 - b. Temperature, within 3%
 - c. Specific conductivity, within 3%
 - d. ORP, within ± 10 mV
 - e. DO, within ± 0.3 mg/L
6. After stabilization of the formation water parameters occurs, disconnect the polyethylene tubing from the in-line flow cell, and pump the groundwater sample through the tubing and into laboratory-approved containers (AGEM-23).
7. Keep the polyethylene tubing for each well and dedicate it for reuse at that well. Record pumping rate data for each well as a reference for subsequent sampling events.

5.4 Field Quality Control

1. Begin sampling at well locations with the least contamination; proceed systematically to the wells with the most contamination.

2. Fill the sample containers for VOCs analysis first. Visually check these containers to ensure that no bubbles are present.
3. Fill sample containers for additional analytes, as required by the site-specific sampling plan, in the following order:
 - a. Methane
 - b. SVOCs
 - c. Inorganics and water quality parameters
4. Temporarily place all samples in a cooler with ice immediately after collection. Verify that all sample types required for the well have been collected.
5. Verify that all field records are complete and that the well is locked and secured, before proceeding to the next well location.
6. Decontaminate sampling equipment between wells.
7. Collect QA/QC samples as appropriate, including field blank, equipment rinsates, trip blanks, replicates, and verification samples.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control)
- *Master Work Plan, Volume 2:*
 - AGEM-05: Purge Groundwater Sampling
 - AGEM-08: Measuring Water Levels in Wells
 - AGEM-11: Investigation-Derived Waste Handling and Disposal
 - AGEM-13: Soil Gas Sampling for Chemical Analysis
 - AGEM-21: Calibration of Field Instrumentation and PID Operation
 - AGEM-22: Equipment Decontamination
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field

- AGEM-27: Sample and Document Management

7 References Cited or Consulted

Puls, R.W., and M.J. Barcelona, 1996, "Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures," EPA/540/S-95/504, in *Ground Water Issue*, Superfund Technology Support Center for Ground Water, National Risk Management Research Laboratory, U.S. Environmental Protection Agency, Ada, Oklahoma, April.

Yeskis, D., and B. Zavala, 2002, *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers: Ground Water Forum Issue Paper*, EPA 542-S-02-001, Technology Innovative Office, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C., May.

Sampler's Initials:

Site	Date	Sample Time	Well ID#	Casing Size	Pump Type	Pump Intake	Water Level	Well Depth
						ft	ft	ft

Screen Interval	Water in Well	Well Volume	Start Pump Time	1-Vol. Purge Time	Start Meter	Sec per cycle	1-Vol. per cycle	Total Purged
ft to ft	ft	3x L					mL	L

Conversion Table:	Casing Size:	0.5 in.	1.0 in.	2.0 in.	4.0 in.	6.0 in.
1 gal = 3.7854 L	Liters of Volume per ft:	0.039	0.154	0.618	2.470	5.565

[illegible]

Notes:

☐ 4 x 20 mL for VOCs to AGEM Lab ☐ 4 x 20 mL for VOCs to TestAmerica
☐ _____ x _____ mL for _____ to _____
☐ _____ x _____ mL for _____ to _____
☐ _____ x _____ mL for _____ to _____

EXHIBIT 06.1 AGEN Low-Flow Groundwater Purging and Sampling Record

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AGEM-07:

Measuring Water Levels in Wells

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AGEM-07:

Measuring Water Levels in Wells

1 Scope and Applicability

This SOP describes standardized methods for establishing monitoring points, measuring groundwater levels in monitoring wells (either manually or automatically), retaining water level data in the program archives, and using water level recorder software.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
HASP	health and safety plan
hr	hour(s)
PPE	personal protective equipment
psi	pounds per square inch
QA/QC	quality assurance/quality control
SOP	standard operating procedure

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.

Personnel conducting the field activities are responsible for:

- Implementing this SOP and related procedures, as directed.

- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Completing the specified records.
- Submitting the field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

After a well has been developed and surface construction completed, water levels can be measured relative to an accurately surveyed reference point. The resulting water level measurements are considered part of the water level dataset for a site. The procedures outlined here ensure consistency of such measurements and minimize random measurement error.

Water levels measured after establishment of the reference point for a well must be entered in the environmental data management system for that site. Water levels measured during drilling and/or in wells prior to their final completion and survey are not considered to be part of the water level dataset for that site and are retained separately in the program archives. See Section 5.5.1 of this SOP for further information.

Related procedures are listed in Section 6 of this SOP.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan*, Volume 1, Section 6.5)
- Decontamination supplies (AGEM-22)
- Logbooks and other documentation material
- Field meters and monitoring equipment
- Saw/knife and permanent marker for marking reference point
- Graduated electronic water sensor measuring tape (water level meter) or automatic recording device
- Calibration device for water level meter
- Distilled water and disposable paper towels for decontamination of water level meter

- Portable computer (for downloading automatically recorded data)
- Previous water level data for the site

5.2 Establishing a Water Level Monitoring Point

Take the following steps to establish a water level monitoring point:

1. Establish and identify a measurement reference point. The preferred point is the top of the well casing. Make a permanent mark at the reference point, preferably a physical mark such as a saw or knife cut, in addition to a mark drawn with a permanent marker. This is normally only done once for any given well, following its final completion. A reference point must be re-defined, however, if any modifications subsequently occur to the well casing (such as cutting or extension to accommodate a revised surface completion) that might affect the position of the original reference point. *Note that if there is no mark in the well, the high point of the well casing on the north side is used as the reference point.*
2. Near the measurement reference point, clearly mark the well identification number or the name of the measurement location.
3. Record well identification details in the logbook. Note the measuring reference point position precisely.
4. Measure and record the depth to the groundwater in the well as described in Section 5.3 of this SOP.
5. Measure and record the depth of the well by using a weighted tape. Lower the tape into the well until the tape goes slack. Record the depth of the well below both the ground surface and the reference point, and confirm that the well is clear across the screen interval by comparing the measured depth with the well construction log.

5.3 Measuring Water Levels by Hand

Use a graduated electronic water sensor measuring tape (water level meter) to measure water levels by hand, as follow:

1. At the beginning of a new project or sampling program, check the depth interval markings on the tape by using an accurate measuring device. Check more frequently during periods of heavy use or if the cable might have been stretched.
2. Check for proper operation of the water level meter by immersing the sensor tip in water.

3. Clean and dry the sensor tip.
4. Measure the water level in the well or borehole by slowly lowering the cable until the sensor indicates contact with water.
5. Fine-tune the measurement by raising and lowering the cable in gradually smaller increments until the most precise reading is obtained.
6. Read the depth to the water from the measurement reference point, and record the value (see Section 5.5.1 of this SOP). Include the date and time (on the 24-hr clock) of the reading, and note the prevailing weather conditions.
7. Compare the water level with any previous data for the site. If the water level measurement is inconsistent with previous values, take a second reading for confirmation while the water level measuring device is still in place.
8. Before moving to the next well, decontaminate the portion of the tape and sensor that was immersed. Spray the cable and sensor with distilled water, and dry the tip with a paper towel or allow to air-dry.

5.4 Measuring Water Levels Automatically

Each water level recording system requires a specific set of protocols to ensure good system operation. For details on operating individual water level recording systems, refer to the manufacturers' instructions and manuals. Manufacturer's operating manuals for all of the water level monitoring devices used by AGEM are kept with the equipment.

Install all systems according to the general procedures in the following sections.

5.4.1 Test Setup

These instructions are applicable to the use of either conventional pressure transducers (which require a separate data logging unit at the surface) or self-contained downhole recording devices equipped with a vented cable that passively corrects the sensor for changes in atmospheric pressure. For simplicity, the term *pressure sensor* is used to indicate either type of device.

Set up the water level recording system for a test and begin the test as follows:

1. Measure and record the water level and the depth of the well by using the manual procedures in Section 5.3 of this SOP.
2. Select a depth of installation for the pressure sensor. This depth must be within the specified pressure operating range and must allow for the maximum anticipated water level variation. The operating range is normally specified by the manufacturer as pressure in psi units. Multiply the value in psi by 2.30667 to

convert the value to a water level range. *Do not immerse the pressure sensor beyond its operating depth. Doing so could cause permanent damage.*

3. Place a non-permanent mark on the pressure sensor cable at the selected installation depth. This can conveniently be accomplished by wrapping a small piece of electrical tape around the cable.
4. Lower the pressure sensor into the borehole to the required installation depth. Attach the pressure sensor cable securely to the well, avoiding sharp edges that might kink or cut the cable. *Do not bend the cable in curves of radius less than 1 in. Doing so could obstruct the vent tube in the cable.* If necessary, excess cable may be coiled or otherwise placed inside the well completion housing, or within the well casing if insufficient space exists in the completion housing.
5. Protect the wellhead and data recorder against disturbance or damage due to severe weather, vandalism, curious residents, and traffic. For extended-duration sensor installations, a standard well “J-plug” that has been modified (by drilling or cutting a small hole near the plug edge) to allow passage of the sensor cable through the plug, can be inserted in the top of the casing to protect the well bore.
6. Connect the transducer (if applicable) to the data recorder.
7. Enter the required setup parameters, pressure sensor calibration information, and details of the desired monitoring schedule. The setup data required will vary for different pressure sensor and data recorder systems (as specified by individual equipment manuals); however, program all tests according to the following guidelines:
 - Set data recorders to log water level measurements as depth to water from the established physical reference point (usually the top of the casing).
 - If a recorder reference level (an arbitrary value relative to which all pressure measurements are reported) is required, set this level at the hand-measured water level determined in step 10 (below). For recorders that allow a delayed test start (programmed test start), select the option to set the reference level immediately (when the hand water level measurement is made), not at the start of data recording.
 - Check the date and time setting of each data recorder internal clock, and adjust to local time. If multiple recorders are being installed, synchronize all internal clocks, most simply by synchronizing each recorder to the internal clock of the portable computer being used to program the data recorders.
 - A 4-hr measurement interval, with measurements at 0000, 0400, 0800, 1200, 1600, and 2000 hr, is the standard for long-term water level

monitoring (one week or longer). Shorter intervals (usually ≤ 2 hr) are sometimes required to generate detailed data on the effects of well pumping.

- Record and double-check the identity of the pressure sensor measuring each borehole, as well as the recorder channel to which each sensor is connected if a multichannel data recorder is being used.
 - If permitted by the operating programs, assign each pressure sensor and recorder a unique name to appear in the water level data file. Assigned device names should include (if possible) the instrument serial number, the investigation site name, and the designation of the well being monitored.
8. Check the pressure sensor response by raising the sensor in the water column a known amount (the more the better) and taking a new pressure reading. (Most pressure sensing devices can be interrogated for a reading without starting to record a test.) The indicated water level change should agree with the change in pressure sensor height to within 1% or 0.1 ft per 10 ft of water level change. Depending on the results, do the following:
- If the error exceeds 1%, check all calibration settings. If the error is confirmed, check the response again by raising the pressure sensor a known distance. Allow extra time for water levels to re-equilibrate to the change in depth of the sensor.
 - If the calibration is accurate, return the pressure sensor to its original position.
 - If the response test continues to indicate equipment problems, replace the pressure sensor, and arrange for repair of the faulty equipment.

Note that this test is valid only for boreholes that are approximately vertical. If a pressure sensor is to be used in a borehole that deviates significantly from vertical, test the sensor in an alternate, vertical borehole before installation in the deviated hole.

9. After completion of the response test and return of the pressure sensor to its original position, allow water levels to re-equilibrate before proceeding.
10. Hand measure and record the water level again as accurately and precisely as possible.
11. Set the recording device's reference water level reading to the water level just measured by hand.
12. Activate the test to begin recording data per the required measurement schedule.

13. Confirm that the test has started and that data are being collected successfully by the recorder.
14. Ensure that all cable connectors and weatherproof caps are properly in place. Close and secure the well cover and any additional enclosure if an external data recorder is used. These actions prepare the system to run unattended.
15. Record all test setup information, including pressure sensor and recorder model and serial numbers, sensor installation depth, and measurement interval for each test.

5.4.2 Data Downloading

Download data as follows:

1. Upon return to the site, check for signs of damage or disturbance of the well or recording device since the previous visit. In particular, verify that the pressure sensor is still set at its original reference position.
2. Take a current pressure sensor reading by interrogating the sensor directly.
3. Take a hand water level reading (see Section 5.3 of this SOP) as soon as possible *after* the pressure sensor reading; in doing so, minimize any actions that might potentially disturb the position of the sensor or the static groundwater level. Record the result in the logbook. Taking the pressure sensor reading first ensures that the sensor reading is not affected by immersion of the water level meter.
4. Compare the change in water levels (since the previous readings) for both the pressure sensor and the hand measurements. When the automatic water level recorders are functioning properly, the pressure sensor and hand readings should agree to within 0.05 ft; at most sites, however, agreement of the readings to within 0.1ft is usually acceptable for interpretation of the local groundwater level relationships. If the difference is greater, check both the pressure sensor and hand measurements again. If the difference is confirmed, check the calibration of the pressure sensor as in step 8 of Section 5.4.1 of this SOP. If the calibration is still accurate, return the pressure sensor to its original position for continued data recording or the start of a new test. Aside from the pressure sensor, possible sources of calibration error in the recorded water level data are
 - Battery failure,
 - Severe temperature changes (verifiable by checking weather records),
 - Severe electrical interference from nearby external sources (for example, lightning strikes),

- Previous inaccurate hand water level measurements (corrected by accurate readings in the future), and
 - An inaccurate hand water level meter (documented by checking the calibration of the meter against a reliable measure).
5. Download the data for the current test before stopping the test (if necessary). For some recording devices, a name derived from the programmed test information is automatically assigned to the downloaded file. If this is not the case for a particular recording device, name the file manually. To name downloaded data files, create a code representing the
- Site name (two letters) and,
 - Well identification (letters, numbers, and/or special characters as appropriate).

A three-letter suffix is automatically added to the above file name by the programming and download software systems currently in use by AGEM, the nature of which may be software-specific. An example file name would be YKDL1-A.a4d, for data recovered from a Seametrics PT2X downhole sensor logger installed at well DL1-A in York, Nebraska, and downloaded by using the proprietary Aqua4Plus software associated with this type of unit.

6. When the download is complete, convert the data file (if necessary) into a format (e.g., Excel spreadsheet) suitable for quick scanning of the data, or review the data by directly using the functions included in the programming and download software. Scan the data to verify that the full data record is in the file and that the equipment appears to be functioning properly.
7. Stop or continue the current test as required. For some recorders, starting a new test will reduce the size of the file to be downloaded the next time. It might also increase the available recorder memory. Some recording systems permit the internal storage of data sets from multiple tests in nonvolatile memory. In other systems, all preexisting data in memory must be deleted before a new test can be programmed. *Never delete any files from the recording device until downloaded data have been checked and backed up.*
8. If data collection is to be continued, ensure that all cable connectors and weatherproof caps are properly in place. Close and secure the well cover and any additional enclosure if an external data recorder is used. These actions prepare the system to run unattended.
9. At the end of the day, make a backup copy of all downloaded files.

5.5 Archiving Groundwater Level Data

5.5.1 Distinguishing Measurements in Completed Wells from Measurements during Drilling

Water levels measured after establishment of the reference point for a well must be entered in a dedicated water level record for the investigation site. This record is to be included in the program archives.

Water levels measured prior to well completion and the designation of a permanent reference point are not considered to be part of the water level dataset for a site and are retained separately in the program archives from water level data collected after well completion. Prior to designation of a permanent reference point, water levels are normally taken relative to ground surface or a temporary top of casing (or other temporary reference) and recorded in a drilling log or water sampling logbook.

5.5.2 Hand-Measured Water Levels

All field records containing water level data must be included in the program archives. Original field data may be recorded manually in a site-specific water level logbook, or recorded electronically if a portable computer is used for this purpose in the field. Data recorded manually should be transcribed to an electronic format, and the original document scanned to create a digital image. Both formats are to be retained in the program archives.

All data files containing records of manually measured groundwater levels must be retained in the program archives. These files must be clearly identified by a file name reflecting the site and date at which the manual measurements were obtained.

5.5.3 Automatically Recorded Water Levels

All data files downloaded from automatic water level recording equipment must be retained in the program archives. All files must be clearly identified by using the naming protocols described in Section 5.4.2 of this SOP. For data downloaded in binary format, a copy of the original binary file plus a version of the same file in readable format (text, Excel, or similar) should be retained. The choice of electronic storage medium is at the discretion of the AGEM program manager.

5.6 Use of Water Level Recorder Software

Many different water level sensing and recording devices are currently available. Interrogation of the pressure sensor and programming or downloading of the data recorder is typically accomplished by using device-specific software installed on a portable computer connected to the recorder in the field by using an interface cable. For other systems, programming is

accomplished by using a keypad integral to the recording unit. All software necessary for the operation of water level recorders must be used in accord with the manufacturer's instructions and with the procedures specified in Section 5.4.2 of this SOP. All personnel required to use these programs and equipment must be trained to an appropriate level of proficiency.

Both the portable computer software and operating firmware installed in the data recorders must be maintained at the most recent revision level that is compatible with each specific device type.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control; utilities survey)
- *Master Work Plan, Volume 2:*
 - AGEM-05: Purge Groundwater Sampling
 - AGEM-06: Low-Flow Groundwater Sampling
 - AGEM-08: Slug Tests
 - AGEM-09: Pumping Tests
 - AGEM-21: Calibration of Field Instrumentation and PID Operation
 - AGEM-22: Equipment Decontamination
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field
 - AGEM-27: Sample and Document Management

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AGEM-08:

Slug Tests

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Photos

PHOTO 08.1	Pneumatic slug testing equipment used by the AGEM program (Photo credit: Argonne National Laboratory).....	08-11
PHOTO 08.2	Physical slugs of varying size used by the AGEM program (Photo credit: Argonne National Laboratory).....	08-12

Exhibit

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AGEM-08:

Slug Tests

1 Scope and Applicability

This SOP describes the procedure for performing slug tests for monitoring wells in the AGEM field program.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
ASTM	American Society for Testing and Materials
ft	foot (feet)
hr	hour(s)
K_h	hydraulic conductivity
S	storativity (storage coefficient)

3 Method Summary

Well response-or “slug” tests are performed in a single well by causing a rapid change (either rise or fall) in water level within the well casing, then recording the subsequent recovery of the water column to its predisturbance level. Perturbation of the casing water level is performed by either (1) introducing (or removing) a solid physical rod or slug into the casing, or (2) using air pressure to depress, then quickly release, the water level in the casing as described by Prosser (1981) and Kelly (1991). The objective is to determine the horizontal hydraulic conductivity (K_h) of a geologic horizon under *in situ* conditions. This is an important parameter for evaluating the flow of groundwater in an aquifer.

Slug testing provides a convenient and relatively rapid method for obtaining estimates of the local K_h of the subsurface materials near a boring. By conducting slug tests at multiple observation points, information on the spatial variability of K_h across a site can be obtained. The K_h of small, discrete portions of an aquifer can also sometimes be estimated (e.g., sand layers within a clay) *in situ*, thereby avoiding errors incurred in laboratory testing of disturbed soil samples. Slug tests can be performed on conventional wells, as well as observation points installed by direct-push techniques. The tests can be performed quickly at relatively low cost, because groundwater pumping and observation wells are not required.

Slug testing presents certain limitations, as follows:

- The slug test estimates the Kh of the materials within a limited radius surrounding the well; this might not be representative of the average hydraulic conductivity over a wider area.
- The storage coefficient (S) usually cannot be determined by this method.
- Both slug-in and slug-out tests may be performed for observation points in which the screened and sand-packed intervals (if present) remain fully saturated throughout the test procedure. To obtain readily interpretable results, slug-out testing only is required for observation points in which the screened interval (and/or sand pack) intersects the water table.

Water level responses resulting from the slug test procedure normally follow a characteristic pattern, in which the recovery to static conditions is initially rapid, and then progressively slows with time. For coarse-grained formations having high Kh , the entire recovery can be very rapid (in seconds to minutes); for finer-grained units, the recovery may be prolonged (taking hours to days). To efficiently record these changes, water levels during a test are monitored by AGEM using automatic, programmable data loggers together with water level (pressure) sensors.

If coarser-grained intervals are to be tested (particularly in larger diameter casings), use of the air-pressurization (pneumatic) slug test method often facilitates more rapid test implementation, and superior data quality. Under these conditions, the use of a very large physical slug might be required to obtain a reasonable initial offset of the static water level, while air pressurization can more easily induce a comparable response. If relatively long recovery times are anticipated, however, based on observed lithologic characteristics, the use of solid slugs for offsetting the static water level is normally more efficient. For low- Kh intervals, the equilibration time required for pneumatic testing, prior to release of the pressure to initiate data collection, can be similar in duration to the actual test response.

The AGEM program has assembled a purpose-built manifold for use in pneumatic slug testing (Photo 08.1; see description in Prosser 1981; Kelly 1991), as well as a range of physical slugs of varying sizes (Photo 08.2). AGEM also has available several types of downhole sensors and recording equipment (single-channel Seametrics PT2X self-contained sensor/logger units; *in-situ* 2-channel and 8-channel Hermit recorders with separate downhole pressure transducers). The selection of the appropriate test approach and recording equipment for each slug test program is determined on a well- and site-specific basis.

4 Procedures

4.1 Quality Control Procedure

- Check the calibration of all instrumentation before use, per manufacturer's recommendations. If field calibrations are implemented, record these factors as part of the slug test record.

- Operate all instrumentation in accordance with the manufacturer's instructions. Manufacturer's operating manuals for all of the water level monitoring devices used by AGEM are kept with the equipment.

4.2 Field Procedure

1. Ensure that any downhole equipment introduced to the well is decontaminated before (and after) use.
2. Determine the static water level in the well, before any downhole equipment is installed, by measuring the depth to water (to the nearest 0.01 ft) over several minutes using a manual water level probe-tape measure.
3. Install the transducer (or self-contained sensor/logger) and cable in the well to a depth below the target drawdown estimated for the test, but at least 2 ft from the bottom of the well if possible. Verify that the placement depth is within the specified pressure range of the sensor. Temporarily tape or otherwise physically anchor the sensor cable at the surface, to keep the sensor at a constant depth.
4. Following installation of the sensor, repeat the manual measurements of water level in the well as described in (2) above, to verify that the level has returned to static and to identify any short-term trends in the water level that might affect the test procedure. In formations having low Kh , installation of the sensor may in itself incur a "slug" response, and subsequent delay in the return to static conditions.
5. Program all required information into the data logger, per manufacturer's instructions, to define the parameters of the test. Minimum essential data for all tests include a unique identifier for the well being tested, test designation, and the time schedule for collection of the water level readings during the test. Example time schedules suitable for slug tests in several types of sediments are in Table 08.1. (Other equipment-specific parameters and/or time schedules may be required, depending on the logger type being used).
6. To initiate the slug test, the water level in the casing should be perturbed from the static position as rapidly as possible, but with minimal splashing. If a solid slug is employed, it should be quickly and smoothly lowered (to a point below the static position) into or withdrawn from the water column; the slug should not be allowed to free-fall. If pneumatic testing is being performed, air pressure is first introduced into the casing to depress the water level; following stabilization, the pressure is quickly released to initiate the test (see Prosser 1981; Kelly 1991; and Photo 01.1).

TABLE 08.1 Example slug test data collection schedules.

For Seametrics PT2X downhole sensor/loggers

Reading Interval	Number of Readings	Period ^a
1 sec ^b	61 ^b	First min
12 sec	45	1-10 min
2 min	45	10-100 min
20 min	45	100-1,000 min
3 hr	45	1,000-9,100 min

For use with the Hermit data loggers^c

Reading Interval	Number of Readings	Period ^a
0.2 sec	101	First 20 sec
1 sec	40	20 sec-1 min
12 sec	45	1-10 min
2 min	45	10-100 min
20 min	45	100-1,000 min
3 hr	45	1,000-9,100 min

^a Total program runs for 6.3 days.

^b Set rate for initial minute based on maximum supported by the current device firmware.

^c "Logarithmic" schedule pre-programmed in Hermit data loggers.

- Data collection by the automatic logger must be initiated at the exact time that the water level is offset at the beginning of the test. To accomplish this, it is often most convenient to pre-program a start time for the data collection into the logger, and then physically initiate the test at that time.
- The slug test is completed, and data collection may be terminated, when the water level in the well returns to the original position identified prior to initiation of the test, or reaches a stable level very near this position. In some cases, particularly if the recovery is slow, exact return of the water level to the original static position may not be observed, due to subtle changes in site conditions as a result of "background" water level changes, or the influence of fluctuations in barometric pressure. As the recovery progresses, the recorded water level data should periodically be reviewed to determine when the level has returned to a stable position in the casing.

9. To evaluate the precision of the test procedure, each well should be slug tested at least three consecutive times; if the recovery is extremely slow, however, repeated testing may not be logistically possible. If a solid slug is employed and the site-specific well conditions permit, both slug-in and slug-out tests should be performed. The pneumatic test procedure can only be used to generate a rising water level response in the casing, equivalent to a slug-out test.

4.3 Documentation Procedure

Documentation of a slug test should include the following information, at a minimum:

- Site identification
- Well identification
- Date
- Name of individual conducting the test
- Testing procedure employed (solid slug or pneumatic)
- Description of the solid slug used (as appropriate)
- Serial number of the data logger and transducer (or sensor/logger) used
- Unique identifier, and associated file name, for each test data set
- Electronic copies of the data logger measurement files for all individual tests performed on the well.
- Initial and final (post-testing), manually measured water levels.

A template for field documentation of the slug testing information is shown as Exhibit 08.1. The slug test documentation will become part of the permanent program archives.

5 Related Procedures (for Data Interpretation)

Interpretation of the slug test data is performed using documented procedures appropriate to the specific conditions of each test, as many alternative methods have been developed to address varying well construction and aquifer characteristics. Analytical methods for test evaluation are described in ASTM standards D4104, D4105, and D4106 (available from the ASTM at <http://www.astm.org>), as well as in standard texts and publications (e.g., Freeze and Cherry 1979; Kruseman and deRidder 1991; Kawecki 1993).

Commercially available well test analysis packages, such as AQTESOLV (Geraghty and Miller Software, Reston, Virginia) and AquiferTest (Waterloo Hydrogeologic, Inc., Waterloo, Ontario, Canada) incorporate many of the available procedures, and provide menu-driven systems which simplify processing and interpretation of the test data. The specific analysis procedure(s) appropriate for the evaluation of any given test dataset is selected, however, on a case-by-case basis.

Related internal procedures from the *Master Work Plan, Volume 2*, include:

- AGEM-05: Purge Groundwater Sampling
- AGEM-07: Measuring Water Levels in Wells
- AGEM-09: Pumping Tests

6 References Cited or Consulted

Freeze, R.A., and J.A. Cherry, 1979, *Groundwater*, Prentice Hall, Englewood Cliffs, New Jersey.

Kawecki, M., 1993, "Recovery Analysis from Pumping Tests with Stepped Discharge," *Ground Water* 31(4):585-592.

Kelly, D., 1991, Collection and Interpretation of Pneumatic Slug Test Data in a Highly Permeable Aquifer, M.S. Thesis, University of Illinois, Urbana, Illinois.

Kruseman, G., and N. deRidder, 1991, *Analysis and Evaluation of Pumping Test Data*, International Institute for Land Reclamation and Improvement, The Netherlands.

Prosser, D., 1981, "A Method of Performing Response Tests on Highly Permeable Aquifers," *Ground Water* 19(6):588-592.

PHOTO 08.1 Pneumatic slug testing equipment used by the AGEM program
(Photo credit: Argonne National Laboratory)

PHOTO 08.2 Physical slugs of varying size used by the AGEM program
(Photo credit: Argonne National Laboratory)

Slug Testing Data Log Sheet			
SITE: _____	DATE: _____		
WELL: _____			
Static WL, TOC: _____	TD, TOC: _____		
Screen, BGL: _____	Screen, TOC: _____		
WL above Screen: _____	WL above TD: _____		
METHOD: _____			
SLUG USED: _____			
RECORDER: _____			
<u>TESTS</u>			
Name: _____			
File: _____	_____	_____	_____
Start: _____	_____	_____	_____
End: _____	_____	_____	_____
Rdgs: _____	_____	_____	_____
Rdgs: _____	_____	_____	_____
Rdgs: _____	_____	_____	_____
Rdgs: _____	_____	_____	_____
Rdgs: _____	_____	_____	_____
Rdgs: _____	_____	_____	_____
Rdgs: _____	_____	_____	_____
Rdgs: _____	_____	_____	_____
Rdgs: _____	_____	_____	_____
Rdgs: _____	_____	_____	_____
Rdgs: _____	_____	_____	_____
Test Personnel: _____			

EXHIBIT 08.1 Slug Testing Data Log Sheet

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**Environmental Investigations at
Former CCC/USDA Facilities: Master Work Plan**

Volume 2: Standard Operating Procedures

AGEM-09:

Pumping Tests

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AGEM-09:

Pumping Tests

1 Scope and Applicability

This SOP describes the procedure for performing pumping tests for monitoring wells in the AGEM field program.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
ASTM	American Society for Testing and Materials
hr	hour(s)
K_h	hydraulic conductivity
S	Storativity (storage coefficient)
T	transmissivity

3 Method Summary

3.1 Aquifer Pump Testing (Constant-Discharge Testing)

An aquifer or constant-discharge pumping test is typically carried out by using a centrally located extraction well and one or more nearby groundwater level observation wells. The extraction well is pumped at a constant rate, to induce “drawdown” and the development of a cone-of-depression in the aquifer surrounding the pumping location. By recording the rate and degree of drawdown generated at the monitoring point(s), the results of the test can usually be interpreted to provide quantitative information on the basic nature of the aquifer (unconfined, confined, “leaky” confined, etc.) as well as the hydraulic conductivity (K_h), transmissivity (T), and storativity (S) of the pumped interval, and (in some cases) selected parameter data for adjacent confining layers.

Constant-rate pumping can also be employed in a more operational context, to evaluate the anticipated long-term production capacity of an aquifer and/or extraction well(s). Such “production” tests may not require the monitoring of adjacent observation points.

The duration of a constant-rate test must be determined on the basis of:

- The technical objectives of the pumping event,

- The site specific hydrogeologic conditions, and
- The characteristics of the groundwater level responses observed as the test proceeds.

Tests for the determination of aquifer hydraulic parameters are typically conducted, however, for 12-72 hr.

3.2 Step Testing (Variable-Discharge Testing)

A step test or variable-discharge test is carried out by monitoring the water level response, usually in a single well, as it is pumped at successively higher rates in a series of three to four stages or steps. The duration of each step is variable, but it typically ranges from 1 to 3 hr. Step test drawdown data are usually used to estimate the specific capacity (incremental flow rate per incremental unit of drawdown) of the pumping well and its efficiency or degree of development (Kruseman and deRidder 1991). Water level recovery data recorded upon termination of pumping can also give an estimate of aquifer transmissivity (Kawecki 1993).

4 Procedures

4.1 Quality Control Procedure

- Check the calibration of all instrumentation before use, per manufacturer's recommendations. If field calibrations are implemented, record these factors as part of the pump testing record.
- Operate all instrumentation in accordance with the manufacturer's instructions. Manufacturer's operating manuals for all of the water level monitoring devices used by AGEM are kept with the equipment.

4.2 Field Procedure

The design and implementation of a constant-discharge or variable-discharge test are influenced by a wide variety of site-specific technical, logistic, and operational concerns that must be evaluated on a case-by-case basis; detailed guidance for assessing these factors is provided by Kruseman and deRidder (1991). General procedures to be followed during pumping tests include the following:

- Selection (or the installation) of a well for pumping should be based on both its location and construction. Ideally, the extraction well should be uniquely screened in the aquifer (or interval) of interest, and be of sufficient diameter to accept a pump

capable of producing significant drawdown in the well and a resulting cone-of-depression in the surrounding aquifer.

- The pumping well should not be influenced by other sources of transient drawdown or groundwater level change during the duration of the planned test.
- At least one observation well should be employed for constant-rate tests; however, three or more observation points are preferable. The observation points should, ideally, also be screened uniquely in the aquifer interval(s) of interest, and located at varying distances and directions from the pumping well. In this way, it may be possible to obtain insights regarding possible aquifer heterogeneity surrounding the pumping location. (Suitable offset distances for the monitoring points should be estimated on the basis of the anticipated aquifer characteristics, but actual observation points frequently must be selected from available existing monitoring well locations.)
- Logistic requirements include the provision of a continuous power supply to the pumping well for the planned duration of the test, and provisions for handling/storage/disposal of the produced groundwater, subject to local regulatory requirements. Produced groundwater should not be allowed to re-infiltrate to the interval being pumped during the test.
- Facilities must be put in place to maintain and measure the flow from the pumping well at a stable rate. Flow controls typically employed by the AGEM program (depending on the type of pump) include multi-turn valve(s) placed along the pump discharge piping, or the use of an adjustable pump drive/control unit (variable frequency drive, etc.). Depending on the anticipated rate of discharge, AGEM has available a circular orifice weir, as well as mechanical and digital meters/totalizers in various sizes that can be used for flow measurement. For relatively low flows, periodically recording the time required to fill a container of known volume from the discharge is also acceptable.
- Flow rates should be measured and recorded frequently (typically every several minutes) following the start of a constant-rate test (or the start of each step in a variable-discharge test), and the flow rate adjusted as/if necessary to compensate for head changes in the pumping well. As time progresses and flow rates typically become more stable, the frequency of measurements can be decreased. At minimum, however, flow rate should be measured and recorded at least once per hour during the later stages of a (12 hr or longer) constant-rate test.
- Water level responses should be measured and recorded in both the pumping and observation wells. At any given location, drawdown resulting from the pumping procedure normally follows a characteristic pattern, in which the decline from static conditions is typically more rapid initially, and then progressively slows with time (although this can vary depending on the aquifer conditions). To efficiently record

these changes, water levels during a test are monitored by AGEM using automatic, programmable data loggers together with water level (pressure) sensors.

- AGEM has available several types of downhole sensors and recording equipment (single-channel Seametrics PT2X self-contained sensor/logger units; *in-situ* 2-channel and 8-channel Hermit recorders with separate downhole pressure transducers). The selection of the appropriate equipment for each test program must be determined on a well- and site-specific basis. The sensors and data loggers selected should be calibrated and operated in accord with the manufacturer's instructions.
- Groundwater levels at each well should be periodically measured and recorded (to the nearest 0.01 ft) by using a manual water level probe-tape measure, and compared to coincident readings obtained from the data loggers to confirm that the sensor/loggers are performing correctly throughout the course of the pumping event.
- Water levels in the pumping and observation wells should be recorded for several days before the aquifer test, and record local variations in barometric pressure and precipitation both before and during the test to permit correction of the test data for possible background trends in water level variations, aquifer barometric efficiency, or both.
- Water level recovery should be monitored for a similar period following the termination of pumping.

4.3 Documentation Procedure

Documentation of a pumping test should include the following information, at a minimum:

- Date of testing
- Name of individuals conducting the test
- Site identification
- Identification of the pumping and observations wells
- Construction data for the pumping and observation wells
- Measured offset distance(s) and direction(s) of the monitoring well(s) from the pumping well
- Serial number of the data logger and transducer (or sensor/logger) used for each well

- Unique identifier, and associated file name, for each test data set from each well
- Electronic copies of the sensor/logger measurement files for all wells.
- All manually measured water levels, including date and time of measurement.

The pumping test documentation will become part of the AGEM program's permanent file.

5 Related Procedures (Analysis of Aquifer and Well Test Data)

Interpretation of the aquifer and well test data must be performed by using documented procedures that are appropriate to the specific conditions of each test. Many alternative methods have been developed to address varying well construction and aquifer characteristics. Analytical methods for test evaluation are described in ASTM standards D4104, D4105, and D4106 (available from the ASTM at the Internet location <http://www.astm.org>), as well as in standard texts and publications (e.g., Freeze and Cherry 1979; Kruseman and deRidder 1992; Kawecki 1993).

Commercially available well test analysis packages, such as AQTESOLV (Geraghty and Miller Software, Reston, Virginia) and AquiferTest (Waterloo Hydrogeologic, Inc., Waterloo, Ontario, Canada) incorporate many of the available procedures, and provide menu-driven systems which simplify processing and interpretation of the test data; however, the specific analysis procedure(s) appropriate for the evaluation of any given test data set must be selected on a case-by-case basis.

Related internal procedures from the *Master Work Plan, Volume 2*, include:

- AGEM-08: Measuring Water Levels in Wells
- AGEM-10: Purge Groundwater Sampling
- AGEM-24: Slug Tests

6 References Cited or Consulted

Freeze, R.A. and J.A. Cherry, 1979, *Groundwater*, Prentice Hall, Englewood Cliffs, New Jersey.

Kawecki, M., 1993, "Recovery Analysis from Pumping Tests with Stepped Discharge," *Ground Water* 31(4):585-592.

Kruseman, G. and N. deRidder, 1991, *Analysis and Evaluation of Pumping Test Data*, International Institute for Land Reclamation and Improvement, The Netherlands.

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**Environmental Investigations at
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Volume 2: Standard Operating Procedures

AGEM-10:

Soil Sampling

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AGEM-10:

Soil Sampling

1 Scope and Applicability

This SOP describes the methods used to collect representative soil samples for chemical analyses (usually for VOCs) and geotechnical analyses. Various methods are used to recover soil samples, depending on the depth of the desired sample, the soil type, and the type of analysis for which the soil sample is collected. Site-specific work plans contain details about sampling media, modes, intervals, and frequencies for each sampling event.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
CPT	cone penetrometer
HASP	health and safety plan
hr	hour(s)
ID	sample identification
in.	inche(s)
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure
VOC	volatile organic compound

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.
- Acquiring the necessary utilities surveys.

- Delineating and controlling work areas at the site (*Master Work Plan, Volume 1, Section 6.5*).
- Ensuring that monitoring for hazardous materials and noise is conducted as appropriate.
- Documenting the results of instrument calibration and air monitoring.

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

Various methods are used to recover soil samples for geotechnical and chemical analyses. The principal methodology consists of sonic drilling, used to reach depth. The principal direct push configuration consists of a Geoprobe[®] Dual Tube or Macro-Core[®] continuous soil sampler that is pushed hydraulically with a CPT rig, Geoprobe[®], or rotary sonic rig. Push cores are normally sleeved in plastic.

Hydraulic-push technology, a hand-driven coring device such as an ESP[™] sampler, a hand-pushed coring device, or hand tools such as shovels, can be used to recover near-surface soil, as appropriate. All equipment is to be used in accordance with the manufacturer's directions.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Decontamination supplies (AGEM-22)
- Logbooks and other documentation material
- Field meters and monitoring equipment

- Sampling device(s)
- Sample containers, dry ice, and cooler(s) (AGEM-23)

5.2 Preparations before Sampling

1. Delineate and control field work areas.
2. Secure a utilities survey (48 hr before drilling, with a 10-day refresh).
3. Calibrate field instruments and initiate air monitoring for hazardous materials, as appropriate.
4. Put on the approved level of PPE.
5. Lay plastic sheeting around the work location to minimize the likelihood of cross-contamination.
6. For soil samples collected for VOCs analysis, fill the cooler with dry ice for immediate preservation to cryogenically lock in VOCs.

5.3 Collecting and Handling Soil Samples for VOCs Analyses

5.3.1 Handling Soil Samples for VOCs Analyses

1. Place the soil sample in a jar. Secure the cap tightly, label the jar (with the sample ID), and immediately place the jar on dry ice in a cooler.
2. Maintain cryogenic conditions until the samples are removed for analysis in the laboratory.
3. Ship the samples to the laboratory via an overnight delivery service.
4. Consult AGEM-23 for details on handling, packing, and shipping.

5.3.2 Soil Sampling near the Ground Surface by Hand

The following procedure can be used in most soil types to collect soil samples near the ground surface:

1. Carefully remove the top layer of soil or debris to the desired sample depth with a clean spade or trowel.

2. Immediately use a clean spoon or scoop to collect and transfer the sample directly into a labeled sample container.
3. Decontaminate reusable equipment before proceeding to the next location.

5.3.3 Soil Sampling at Shallow Depth with Augers and Thin-Wall Tube Samplers

Use a sampling system consisting of an auger or a thin-wall tube sampler, a series of extensions, and a T handle as follows:

1. Attach the auger bit to a drill rod extension, and attach the T handle to the drill rod.
2. Clear the area to be sampled of surface debris (twigs, rocks, litter). If appropriate, remove the first 3-6 in. of near-surface soil in over a radius of approximately 6 in. around the drilling location.
3. Begin advancing the auger. Periodically remove accumulated soils and deposit them onto a plastic sheet spread near the hole to prevent loose material from falling back into the borehole.
4. At the desired sampling depth, slowly and carefully remove the auger from the hole.
5. Use a clean laboratory spoon or scoop to transfer soil from the auger directly into the labeled sample container.
6. To collect another sample at greater depth in the same hole, continue advancing the auger with additional extensions, and repeat step 5.
7. Abandon the shallow hole by backfilling with removed soil material.
8. Decontaminate reusable equipment before proceeding to the next location.

5.3.4 Soil Sampling at Depth with the Geoprobe® Dual Tube and Macro-Core® Soil Sampling Systems

1. The Geoprobe® Dual Tube soil sampler is a direct push system used to collect continuous core samples of unconsolidated material (soil) from within a sealed casing of Geoprobe® 2.25-in. outside diameter probe rods. Operational instructions and sampling protocols for this device are detailed in the *Geoprobe® DT22 Dual Tube Standard Operating Procedure, Technical Bulletin No. MK3140* (Geoprobe 2013), which is available through the manufacturer (online) or from the AGEM records manager. A hardcopy of the SOP can also be found in the AGEM field trailer.

2. The Geoprobe[®] Macro-Core[®] soil sampler is a solid barrel, direct push device used to collect continuous core samples of unconsolidated material (soil) at depth. Sample tubes come in lengths of 48 in. and 60 in. with an outside diameter of 2.25 in. Soil samples are collected inside a removable liner. Operational instructions and sampling protocols for this device are detailed in the *Geoprobe[®] Macro-Core[®] Standard Operating Procedure, Technical Bulletin No. MK3139* (Geoprobe 2011), which is available through the manufacturer (online) or from the AGEM records manager. A hardcopy of the SOP can also be found in the AGEM field trailer.

5.4 Collecting Soil Samples for Geotechnical Analysis

Soil samples for geotechnical analysis are collected as described in Sections 5.3.2 through 5.3.4 of this SOP; however, the methods for packaging and preservation are as follows:

1. If the analytical parameters include moisture, seal the ends of the sample in a tube with a nonpenetrating, nonshrinking wax and store in a cool, dark location until shipped.
2. Place soil samples for geotechnical analyses such as grain size in labeled bags or jars and store in a cool, dark location until shipped.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control; utilities survey)
- *Master Work Plan, Volume 2:*
 - AGEM-01: Direct Push, Drilling, and Geologic Logging
 - AGEM-04: Abandonment of Soil Borings, Monitoring Wells, and Piezometers
 - AGEM-11: Handling and Disposal of Investigation-Derived Waste
 - AGEM-22: Equipment Decontamination
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

EPA, 2001, *Soil Sampling*, SOP#2012, U.S. Environmental Protection Agency, Environmental Response Team, Emergency Division, Office of Emergency and Remedial Response, Washington D.C., July 11. (The most current versions of this and other EPA ERT SOPs are available online at: <https://response.epa.gov>; click on the link “ERT Standard Operating Procedures.”)

Geoprobe[®], 2011, *Geoprobe[®] Macro-Core[®] MC5, 1.25-Inch Light-Weight Center Rod Soil Sampling System, Standard Operating Procedure*, Technical Bulletin No. MK3139, January. (The SOP for this and other Geoprobe[®] instruments can be downloaded from the Geoprobe[®] literature web page at <https://geoprobe.com/literature>.)

Geoprobe[®], 2013, *Geoprobe[®] DT22 Dual Tube Soil Sampling System, Continuous Core Soil Sampler, Standard Operating Procedure*, Technical Bulletin No. MK3140, January (originally prepared in November 2006). (The SOP for this and other Geoprobe[®] instruments can be downloaded from the Geoprobe[®] literature web page at <https://geoprobe.com/literature>.)

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**AGEM-11:
Handling and Disposal of Investigation-Derived Waste**

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AGEM-11:

Handling and Disposal of Investigation-Derived Waste

1 Scope and Applicability

This SOP describes the management of the small amounts of wastes generated in the field by AGEM investigations. These wastes include cuttings from borings and well installation, well development fluids, purge water, disposable sampling materials, and decontamination rinsates.

Soil cores collected during sampling are not considered waste; they are placed in core boxes and transported to an Argonne facility for lithologic description, research, and storage.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
gal	gallon
HASP	health and safety plan
IDW	investigation-derived waste
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.
- Delineating and controlling work areas at the site (*Master Work Plan, Volume 1, Section 6.5*).

Personnel conducting the field activities are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting field notes related to waste management to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

The general approach to management of IDW involves (1) leaving the site in a condition no worse than before the project began, (2) minimizing waste generation, (3) complying with federal and state regulations for wastes requiring permitted off-site disposal, and (4) keeping wastes on-site that do not require off-site disposal or extended aboveground containerization.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Decontamination supplies (AGEM-22)
- Logbooks and other documentation material
- Field meters and monitoring equipment
- 55-gal drums, roll-off container(s), and/or polyethylene tank(s)
- Steel or plastic containers or plastic bags for small volumes of solids
- Labeling materials

5.2 Preparations before Work Begins

1. Lay plastic sheeting around the work location to minimize the likelihood of cross-contamination, as needed.
2. Put on the approved level of PPE.

3. Calibrate field meters.
4. Initiate air monitoring for hazardous materials, as appropriate.

5.3 Handling Waste Soil

1. Store waste soil from drilling activities on-site in 55-gal drums or a roll-off container.
2. Remove or destroy old labels on the containers.
3. Label the top and side of each container with a weather-resistant label and indelible ink. Include the following information:
 - f. A general description of the contents, such as "Waste Awaiting Characterization"
 - g. Project name
 - h. Origin of the material
 - i. Container identification number
 - j. Initials of the labeler
4. Re-label the container if the status of the IDW changes.
5. Stage waste containers in a way that minimizes public contact while meeting project needs, and that also considers landowner preferences.
6. Collect a representative sample of the IDW for analysis in accordance with applicable state and federal regulations and with requirements of the waste-handling facility.
7. If the analytical data indicate that the IDW may be placed in a permitted landfill, propose this method.
8. If the analytical data preclude placing the IDW in a permitted landfill, propose alternative disposal methods.
9. Submit the proposed disposal action to the state regulatory agency for approval and a permit where necessary.
10. Following approval (and permitting where necessary), obtain a disposal receipt from the permitted landfill and retain the record in the program archives.

5.4 Handling Wastewater

1. Place all wastewater suspected of being contaminated (including purge water) in 55-gal drums or a portable polyethylene tank.
2. Label and stage the containers on-site as in steps 2-5 of Section 5.3 of this SOP.
3. Aerate the wastewater, if acceptable to the state regulatory agency.
4. Collect a representative sample of the wastewater for analysis in accordance with applicable state and federal regulations.
5. If the analytical data indicate contaminant concentrations below applicable regulatory levels, propose discharge of the wastewater on-site, away from known sensitive receptors.
6. If the analytical data indicate concentrations above applicable regulatory levels, propose transport of the wastewater to a treatment facility approved by the state regulatory agency.
7. Submit the proposed disposal action to the state regulatory agency for approval.
8. Following approval, obtain a disposal receipt from the treatment facility and retain the record in the program archives.

5.5 Non-Hazardous Trash

1. Place non-hazardous trash in plastic bags for later disposal in a sanitary landfill.
2. Include used PPE and expendables with the non-hazardous trash.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Sections 2.1 and 2.2 (regulations and performance standards)
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control)

- *Master Work Plan, Volume 2:*
 - AGEM-27: Sample and Document Management
 - AGEM-10: Soil Sampling
 - AGEM-05: Purge Groundwater Sampling
 - AGEM-22: Equipment Decontamination
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field

7 References Cited or Consulted

BBL, Inc., 2006, "Standard Operating Procedure: Investigation Derived Waste Handling and Storage," in *McGuire's Ranch Sampling and Analysis Plan*, prepared for Regional Water Quality Control Board, North Coast Region, Santa Rosa, California, by Blasland, Bouck, and Lee, Inc., Petaluma, California.

EPA, 2014, *Management of Investigation Derived Waste*, SESDPROC-307-R3, prepared by the U.S. Environmental Protection Agency, Region 4, May 14.

KDHE, 2011, *Characterization and Disposal of Investigation-Derived Waste*, SOP BER-08, in "Quality Assurance Management Plan (QMP), Part II, Appendix A," Kansas Department of Health and Environment, Division of Environment, Bureau of Environmental Remediation, Topeka, Kansas (SOP BER-08 was originally published on August 14, 2000), January 1. (For links to the various sections and appendices of the QMP [Revision 6], including SOPs, dated February 21, 2019, go to <http://www.kdheks.gov/environment/qmp/qmp.htm>)

NDEQ, 2016, *Investigation-Derived Waste (IDW) & Remediation Waste Considerations*, 05-161, Nebraska Department of Environmental Quality, Lincoln, Nebraska, December.

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**AGEM-12:
Installation of Soil Gas Probes**

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AGEM-12:

Installation of Soil Gas Probes

1 Scope and Applicability

This SOP describes the techniques used to install probes in the unsaturated zone of the subsurface for the collection of soil gas samples.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
HASP	health and safety plan
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.
- Acquiring the necessary utilities surveys.
- Delineating and controlling work areas at the site (*Master Work Plan, Volume 1, Section 6.5*).

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.

- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

Soil gas probes can be installed either temporarily or permanently/semi-permanently. Collection of soil gas samples is discussed in AGEM-13. Operation of the Geoprobe[®] is discussed in AGEM-01 and AGEM-14.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Decontamination supplies (AGEM-22)
- Logbooks and other documentation material
- Field meters and monitoring equipment
- Soil gas probes
- Bentonite
- Carbon dioxide (CO₂) cylinder, regulator, and tubing

5.2 Preparations before Installation

1. Lay plastic sheeting around the work location to minimize the likelihood of cross-contamination, as needed.
2. Put on the approved level of PPE.
3. Calibrate field meters.
4. Initiate air monitoring for hazardous materials, as appropriate.

5.3 Steps for Installing Soil Gas Probes

5.3.1 Installing Temporary Probes

Install temporary soil gas probes by using the Geoprobe[®] or other direct push technology (AGEM-01, -14), as follows:

1. Advance the probe to the predetermined target depth.
2. Pull back to expose the inlets of the probe. It may be necessary to use a rod down the center of the probe rods while retracting them to verify that the expendable tip was disconnected from the holder.
3. Use hydrated bentonite to form a seal around the drive rod at the ground surface to prevent intrusion of ambient air (note: this step is dependent on how deep the probe was advanced into the soil).
4. Ensure that the inner soil gas pathway from the probe tip to the surface is continuously sealed (e.g., by attaching a sampling tube to a screw adapter fitted with an O-ring and connected to the probe tip [post-run tubing method]). Flood rods with CO₂ to displace ambient air.
5. After sample collection, remove both the tubing and then the drive rod.
6. Decontaminate drive rods and other reusable components before moving to another location by steam cleaning or by washing with non-phosphate detergent, rinsing with tap water, and rinsing with distilled water.

5.3.2 Installing Permanent or Semi-Permanent Soil Gas Probes

Use direct push methods to install permanent or semi-permanent soil gas probes. Mud rotary drilling is not acceptable. Air rotary and rotosonic drilling can adversely affect soil gas during and after drilling and necessitate extensive equilibration time; these methods are also not recommended.

Install the probes as follows:

1. Place the probe tip midway in a sand pack at least 1 ft long. Use sand of size no smaller than the grain size of the surrounding formation. Install the sand pack to minimize disruption of air flow to the sampling tip.
2. Place at least 1 ft of dry granular bentonite on top of each sand pack to prevent infiltration of hydrated bentonite grout.
3. Grout the borehole to the surface with hydrated bentonite.

4. If deep probes are constructed with multiple probe depths, grout the borehole between probes, and place 1 ft of dry granular bentonite between the filter pack and the grout at each probe location.
5. Decontaminate drive rods and other reusable components before moving to another location by steam cleaning or by washing with non-phosphate detergent, rinsing with tap water, and rinsing with distilled water.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 6.5 (PPE; work area designation and site control; ambient air monitoring; utilities survey)
- *Master Work Plan, Volume 2:*
 - AGEM-01: Direct Push, Drilling, and Geologic Logging
 - AGEM-13: Soil Gas Sampling for Chemical Analysis
 - AGEM 14: Geoprobe[®] and Sub-Slab Gas Detection
 - AGEM-22: Equipment Decontamination

7 References Cited or Consulted

California EPA, 2012, *Advisory — Active Soil Gas Investigations*, prepared by the California EPA in coordination with the Department of Toxic Substances Control, the San Francisco Bay Regional Water Quality Control Board, and the Los Angeles Regional Water Quality Control Board, April 30.

EPA, 2014, *Soil Gas Sampling*, SESDPROC-307-R3, prepared by the U.S. Environmental Protection Agency, Region 4, May 14.

EPA, 2001, *Soil Gas Sampling*, SOP#2042 in “Compendium of ERT Soil Sampling Procedures, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington D.C., April 18 (originally published in June 1996).

Geoprobe[®] Systems, Inc., 2006, *Direct Push Installation of Devices for Active Soil Gas Sampling and Monitoring (Manual)*, Tech. Bull. MK3098, May.

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AGEM-13:

Soil Gas Sampling for Chemical Analysis

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Exhibit

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AGEM-13:

Soil Gas Sampling for Chemical Analysis

1 Scope and Applicability

This SOP describes the techniques used to collect, from the unsaturated zone of the subsurface, representative soil gas samples of known quality for chemical analysis.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
EPA	U.S. Environmental Protection Agency
FID	flame ionization detector
ft	foot (feet)
HASP	health and safety plan
hr	hour(s)
in.	inche(s)
min	minutes(s)
mL	milliliter
PID	photoionization detector
PPE	personal protective equipment
PRT	post running tube
SOP	standard operating procedure

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.
- Acquiring the necessary utilities surveys.

- Delineating and controlling work areas at the site (*Master Work Plan, Volume 1, Section 6.5*).

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting the field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

A soil gas sample is collected by actively withdrawing an aliquot of vapor from the subsurface, typically with a sampling probe. The sample is then analyzed as desired.

Soil gas probes can be installed either temporarily or permanently/semi-permanently. Installation of soil gas probes is discussed in AGEM-12.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Decontamination supplies (AGEM-22)
- Logbooks and other documentation material
- Field meters and monitoring equipment
- Vacuum pump and gauge
- Leak check compound
- Sampling device(s) and monitoring instruments
- Sample containers: Summa canisters, Tedlar bags, or sorbent (Tenax) tubes
- Carbon dioxide (CO₂) cylinder, regulator, and tubing

5.2 Preparations before Sampling

1. Lay plastic sheeting around the sampling location to minimize the likelihood of contamination, as needed.
2. Put on the approved level of PPE.
3. Calibrate field meters.
4. Prepare to protect the soil gas samples from heat, light, and physical damage.
5. Initiate air monitoring for hazardous materials, as appropriate.

5.3 Steps for Collecting Soil Gas Samples

5.3.1 Equilibration

During installation of a soil gas probe, unavoidable disturbance of subsurface conditions occurs. Allow the soil gas profile to equilibrate after probe installation and before soil gas collection, as follows:

1. For probes installed by a direct-push method, equilibration for at least 20 min if the drive rod remains in the ground and at least 30 min if the drive rod is withdrawn is normally sufficient; however, up to 2 hr (or longer) may be required under certain subsurface conditions.
2. If necessary, verification that equilibrium has been re-established can be obtained by collecting time-series data. Soil gas samples, along with oxygen and carbon dioxide measurements, should be collected shortly after installation, and periodically thereafter, to demonstrate the equilibration time needed to recover representative samples. A field instrument (PID, FID, etc., as appropriate) may be used to screen the soil gas samples for this purpose. For multiple sampling points in a relatively homogeneous lithology, evaluation of one monitoring point may be sufficient.

5.3.2 Shut-In Test

Before purging and sampling, a shut-in test should be performed to check for leaks in the above-ground sampling apparatus. The required tubing, valves, and fitting to be used in connecting the soil vapor probe to the sample container should be assembled, and include a pressure/vacuum gauge. A vacuum is applied to the sampling train (using a suitable pump or gas-tight syringe) and then the system is isolated. Components of the sampling train should be adjusted, if necessary,

so that no loss of vacuum is observed from the system over a minimum period of 1-30 min or longer (to be determined based on the anticipated duration of each sample collection event).

If temporary, direct-push soil gas sampling points are installed by using the post-run tubing PRT method, the shut-in test as described above can be performed on the entire above-and below-ground sampling system after connection of the post-run tubing to the expendable point holder and above ground sampling train, but *prior to retraction of the rod string and release of the O-ring sealed expendable drive point* from point holder.

5.3.3 Determining the Purging and Sampling Rate

Flow rates and applied vacuum levels must be kept low to limit stripping and reduce the probability of leakage. An initial flow rate of 100-200 mL/min and vacuums less than 100-in. water should ideally be employed. A flow rate greater than 200 mL/min may be used to reduce purging times under certain conditions (for example, when purging deep locations using large-diameter tubing; however, a vacuum level of 100-in. water should generally not be exceeded. A vacuum gauge should be used to confirm the applied levels. Record vacuum and flow rate measurements in the sampling log.

If soil gas permeability is too low to sustain a reasonable flow rate at less than or equal to 100-in. water applied vacuum, alternative purging and sampling methods, as outlined in Appendix D of the *Advisory – Active Soil Gas Investigations* report (California EPA 2012), may be used to obtain representative samples.

5.3.4 Purging

Soil gas probes must be purged before sampling to ensure that stagnant or ambient air is removed from the system and that the samples collected are representative of subsurface conditions. Purge the system as follows:

1. Calculate the volume of the sampling system as the sum of:
 - a. The volume of the probe's screened or open void interval accounting for the porosity of sand pack, if installed)
 - b. The volume of tubing from the probe tip to the ground surface
 - c. The volume of above-ground tubing connecting the soil probe to the sample collection device
2. Withdraw at least three volumes of the full sampling system, at flow rates and vacuum conditions similar to those used for sample collection (see Section 5.3.3 of this SOP). For small required purge volumes, a large gas-tight syringe may be used for purging (within the vacuum limits noted above) in lieu of a vacuum pump.

5.3.5 Leak Testing

A leak test must be conducted each time a soil gas sample is collected to demonstrate that the sample is not diluted or contaminated as a result of leakage. The leak test must use a tracer compound, such as CO₂, isopropanol, pentane, isobutane, propane, or butane, that is not otherwise associated with the site. The preferred tracer for the AGEM program is CO₂. Conduct the leak test as follows:

1. Immediately before sampling, place the tracer compound at each location where ambient air could be entering the sampling system or cross-contamination could occur. For liquid tracer compounds (e.g., isopropanol), wet a paper towel with the compound, and place the paper towel over each location to be tested. For gaseous tracer compounds, a suitable enclosure must be placed around the sampling train and sampling probe head, and flooded with the tracer throughout the sample collection process. Areas to be tested include the base of the probe at the ground surface, the connection from the probe to the sampling line, and connections in the sampling line.
2. Analyze the samples for the tracer compound, in addition to other analytes of significance to the investigation. If field analysis methods are available, test samples should be collected and analyzed, and any identified system leaks corrected, prior to the collection of representative soil gas samples.

5.3.6 Collecting the Samples

Collect soil gas samples after purging as follows:

1. If samples are to be analyzed off-site, collect the samples in gas-tight containers such as Summa canisters, Tedlar bags, or sorbent tubes.
 - a. When certified clean, pre-evacuated Summa canisters are used, place a flow regulator and pressure/vacuum gauge (often supplied with canisters as a single unit) between the probe and the container to ensure that the flow rate is maintained as indicated in Section 5.3.4 of this SOP. Measure and record the canister vacuum upon initial opening of the inlet valve, and upon completion of sample collection, and the time and duration of sampling (using the soil gas sampling log shown in Exhibit 11.1).
 - b. When a vacuum pump is used with sorbent tubes, collect the samples on the intake side of the pump. Handle, fill, and store the sorbent tubes in accord with the tube manufacturer's instructions.
 - c. If Tedlar bags are used, samples may be (1) collected from the sampling train and injected into the bags using gas-tight syringes, or (2) by directly connecting the bag to the sampling train, placing the bag in a suitable

enclosure (vacuum box), and applying an external vacuum to inflate the bag. Filled bags should be placed in an empty cooler at ambient temperature (not chilled) to maintain an ambient temperature and minimize exposure to light.

2. If samples are to be analyzed promptly on-site, collect the samples by using gas-tight syringes.
 - a. Syringes should be checked for leaks before each use by closing the inlet valve and attempting to draw (or expel) ambient air through the needle. Gas-tight glass syringes with Teflon seals are preferred.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control; ambient air monitoring; utilities survey)
- *Master Work Plan, Volume 2:*
 - AGEM-12: Installation of Soil Gas Probes
 - AGEM-22: Equipment Decontamination
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

California EPA, 2012, *Advisory — Active Soil Gas Investigations*, prepared by the California EPA in coordination with the Department of Toxic Substances Control, the San Francisco Bay Regional Water Quality Control Board, and the Los Angeles Regional Water Quality Control Board, April 30.

EPA, 2014, *Soil Gas Sampling*, SESDPROC-307-R3, prepared by the U.S. Environmental Protection Agency, Region 4, May 14.

Geoprobe[®] Systems, Inc., 2006, *Direct Push Installation of Devices for Active Soil Gas Sampling and Monitoring (Manual)*, Tech. Bull. MK3098, May.

Hartman Environmental Geoscience, 2015, *The Vapor Intrusion Risk Pathway: A Practical Guide*, May.

Soil Gas Log Sheet				
Date:			Site:	
Well ID:			Sample ID:	
Beginning Gauge Reading:				
CO2 Flood Start:		:	Stop:	:
11 Liter GeoProbe Vacuum Pump Storage Tank Gauge Readings				
1 st Tank Volume	Start		Hg psi at	: hour
	Stop		Hg psi at	: hour
2 nd Tank Volume	Start		Hg psi at	: hour
	Stop		Hg psi at	: hour
3 rd Tank Volume	Start		Hg psi at	: hour
	Stop		Hg psi at	: hour
4 th Tank Volume	Start		Hg psi at	: hour
	Stop		Hg psi at	: hour
Sample Can #		Flow Control #:		
Can starting at		Hg psi at	: hour	
		Hg psi at	: hour	
Can stopping at				
Sampler's Initials:				

EXHIBIT 13.1 Soil Gas Log Sheet

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AGEM-14:

Geoprobe® and Sub-Slab Gas Detection

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AGEM-14:

Geoprobe® and Sub-Slab Gas Detection

1 Scope and Applicability

This SOP describes a method for the penetration of hard paved surfaces (including concrete foundations, roadways, and walkways) for the purpose of sampling materials (soils, soil gases, groundwater, etc.) underlying them. The specific procedure outlined here is designed for the use of direct push technology, including (1) Argonne's 540B portable Geoprobe® (with power unit), equipped with a GH40 rotary-percussion hydraulic hammer, and (2) the standard Geoprobe® drill bits and related components. While the key elements of this procedure are fairly generic, they are sufficient to permit adaptation to the use of other (similar) direct push equipment, whether from Geoprobe® or other manufacturers.

If the pavements being investigated are known or suspected to overlie soils or groundwater contaminated with carbon tetrachloride (or other VOCs), the potential may exist for local accumulation of gases or vapors in the soils beneath the (relatively impermeable) paved surfaces. This SOP, therefore, includes a method for the detection and preliminary (non-compound-specific) quantitation of possible sub-pavement gases that might be encountered upon breaching of the surface being drilled. The detection method relies on the use of a PID (see AGEM-21 for procedures on PID operations).

This SOP does not present instructions for routine operation of the Geoprobe® equipment; this equipment is to be used in accord with the operation, maintenance, and safety requirements specified by the manufacturer's SOPs (Geoprobe® 2011, on file), as well as AGEM-01, which covers direct push technology.

This SOP differs from AGEM-15 (Sub-Slab Soil Vapor Sampling for Vapor Intrusion Applications) in that AGEM-15 focuses on indoor work culminating in the collection of soil vapor samples for VOCs analysis to evaluate the potential for intrusion of volatile soil contaminants into residential living spaces.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
eV	electronvolt(s)
ft	foot (feet)
HASP	health and safety plan
in.	inche(s)
min	minute(s)
PID	photoionization detector
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure
VOC	volatile organic compound

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Acquiring the necessary utilities surveys (*Master Work Plan, Volume 1, Section 6.5*).
- Delineating and restricting access to the work zone (*Master Work Plan, Volume 1, Section 6.5*).
- Assuring that a *minimum field party of two equipment operators, plus one observer/safety monitor is present for all Geoprobe[®] operations conducted under this SOP.*

Personnel conducting the field sampling are responsible for:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

This procedure describes the use of a Geoprobe[®]-powered rotary-percussion method to advance a roughly circular hole into and through a paved surface. Penetration of the surface is achieved by a combination of hammer percussion and slow rotation of the drill bit, which progressively chip

away small fragments of the hard surface. This method permits penetration without (1) the generation of excessive heat or (2) a requirement for the use of water or other coolants that might adversely affect the physical or chemical properties of the sub-pavement materials targeted for investigation or sampling.

Because of the potential for local accumulation of gases or vapors in soils beneath paved surfaces, this SOP requires the use of a portable PID for the detection and preliminary (non-compound-specific) quantitation of possible sub-pavement gases that might be encountered upon breaching of the surface being drilled.

5 Procedures

5.1 Supplies Needed

The field equipment and materials needed for pavement drilling may include the following:

- Model 540B Geoprobe® with hydraulic hammer and power unit (or similar)
- Drill steels (lengths 24 in. to 48 in., as required)
- Anvil retainer cap assembly
- Carbide-tipped drill bits (diameters 1.5 in. to 2.5 in., as required)
- Traffic cones, warning signs, caution tape (or other suitable equipment to delineate and restrict access to the drilling location)
- Logbook and record-keeping supplies
- Decontamination supplies

The field equipment and materials needed for preliminary detection and measurement of possible sub-slab gases may include the following:

- Hand-held PID equipped with 11.7-eV lamp (required for detection of carbon tetrachloride)
- Calibration gas, gas regulator, and related supplies
- Teflon or Teflon-lined PID inlet probe extension tubing
- Logbook and record-keeping supplies
- Decontamination supplies

5.2 Preparations before Drilling

1. Record in the project logbook all project data, including the site name, date and time, and names of field party personnel.
2. Determine the thickness of the pavement to be drilled at its edge, if possible, by probing or digging to obtain an estimate of the penetration depth required at the chosen drilling location within the pavement. Record this thickness in the project logbook.
3. Select a boring location, preferably away from obvious fractures or as required to meet program needs. Record the specific drilling location in the project logbook.
4. Assemble a clean drill steel (of sufficient length), carbide-tipped bit (of sufficient diameter), and anvil retainer cap per manufacturer instructions; confirm that all threaded connections are tight. Record in the project logbook the size and type of drill steel and bit used.
5. Prepare the Geoprobe[®], power unit, and hydraulic hammer; test for proper operation.
6. Position the Geoprobe[®] mast over the intended drilling location.
7. Position traffic cones, caution tape, etc. to identify the drilling area; restrict access to this area to required personnel only.
8. Calibrate the PID instrument by using isobutylene or another recommended gas per the manufacturer's instructions.
9. Enter the appropriate correction factor(s) on the calibrated PID, for the most probable contaminant species expected at the site.
10. Attach Teflon or Teflon-lined extension tubing to the PID inlet port in sufficient length to permit gas sampling from a level immediately above the exposed soil surface at the bottom of the completed pavement boring.
11. Check the PID response. Unstable zero readings or a response to moisture or movement of the instrument may indicate a need to clean the lamp.
12. Obtain a "clean air" reading daily, before testing for possible contamination at the target drilling location(s).
13. Record, in the project logbook and in the dedicated equipment logs (if available), all relevant drilling equipment and PID information, including calibration results and descriptions of required maintenance activities.

5.3 Drilling and PID Measurement of Sub-Pavement Vapor Concentrations

1. Install the drill steel and bit assembly on the hydraulic hammer.
2. Set the hammer/rotation selector on the drilling unit to provide the slowest counterclockwise rotation speed possible in the hammer mode. (Excessive rotation speed will lead to premature bit wear.)
3. Lower the hammer until static weight is just barely applied to the drill steel and bit. Then raise the hammer approximately 1-2 in. to allow the drill steel to move freely within the drive unit while still maintaining contact with the pavement surface. With the drive controls disengaged, check for adequate travel by manually raising and lowering the drill steel.
4. Activate the hydraulic hammer, with rotation.
5. Slowly lower the hammer to obtain the optimum amount of downward force on the drill steel. A defined “thudding” sound and a metallic “pinging” will be noted when the correct amount of force is applied; under this condition, the bit is quickly striking and then rebounding from the pavement while the drill steel vibrates freely within the hammer drive. Muffled “thumping” with possible stoppage of the bit rotation or excessive “clanging” sounds with sporadic hammer contact indicate, respectively, that too much or too little static weight is being applied.
6. Adjust the position of the hammer up or down in small increments, as necessary, to maintain the proper drilling force as the bit advances into the pavement.
7. If unacceptable heating of the surface or drilling equipment is noted, temporarily discontinue drilling until temperatures return to appropriate levels. Retract the drill bit with rotation to help prevent binding of the bit in the hole.
8. If penetration is impeded because of the presence of rebar or other obstacles within the pavement, retract the drill bit with rotation. Reposition the Geoprobe[®] approximately 1 ft from the original drilling location, and repeat the preceding steps to initiate drilling at the new location.
9. Upon penetration of the surface, retract the drill bit with rotation. Measure and record the actual drilled depth in the project logbook.
10. Immediately following the withdrawal of the drilling bit from the completed pavement boring, insert the inlet extension tubing of the PID meter to a level just above the surface of the soil exposed at the bottom of the boring.
11. Operate the PID inlet sampling pump for a sufficient period (based on the calculated volume of the inlet extension tubing) to completely flush the inlet tubing.

12. Continue to operate the PID inlet pump for 1 min. Record the highest concentration value observed in the project logbook.
13. Conduct soil gas sampling pursuant to AGEM-13.

5.4 Decontamination

1. Decontaminate or remove and replace the PID inlet extension tubing if the instrument is to be used for readings at additional locations.
2. Disassemble the drill steel and bit assembly, and decontaminate as necessary if the equipment is to be used for the drilling of additional locations.
3. Install the drill steel and bit assembly on the hydraulic hammer before repeating the steps in Section 5.3 (of this SOP) at additional locations.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 6.5 (PPE; site monitoring)
- *Master Work Plan, Volume 2:*
 - AGEM-01: Direct Push, Drilling, and Geologic Logging
 - AGEM-05: Purge Groundwater Sampling
 - AGEM-10: Soil Sampling
 - AGEM-11: Handling and Disposal of Investigation-Derived Waste
 - AGEM-13: Soil Gas Sampling for Chemical Analysis
 - AGEM-15: Sub-Slab Soil Vapor Sampling for Vapor Intrusion Applications
 - AGEM-21: Calibration of Field Instrumentation and PID Operation
 - AGEM-22: Equipment Decontamination
 - AGEM-23: Handling, Packing, and Shipment of Samples in the Field
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

Geoprobe[®], 2011, Geoprobe[®] Macro-Core[®] MC5, 1.25-Inch Light-Weight Center Rod Soil Sampling System, Standard Operating Procedure, Technical Bulletin No. MK3139, January.

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AGEM-15:

Sub-Slab Soil Vapor Sampling for Vapor Intrusion Applications

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AGEM-15:

Sub-Slab Soil Vapor Sampling for Vapor Intrusion Applications

1 Scope and Applicability

This SOP defines a process for boring through a building foundation and collecting a representative sample of soil gas directly beneath the foundation for the purpose of vapor intrusion evaluation.

Sub-slab sampling is *not appropriate in buildings with earthen-floor foundations or with radiant floor heating or other utilities that cannot be avoided*. In these cases, gas samples should be collected from crawl spaces (AGEM-16) or by drilling into the ground outside the building (AGEM-12 and -13).

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
HASP	health and safety plan
in.	inche(s)
L	liter(s)
mL	milliliter(s)
min	minutes(s)
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.

- Acquiring the necessary utilities surveys (*Master Work Plan, Volume 1, Section 6.5*).
- Delineating and controlling work areas at the site (*Master Work Plan, Volume 1, Section 6.5*).

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting the field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

The first step in sub-slab vapor sampling is drilling a small hole through the foundation. Next, a sampling probe is inserted into the foundation and cemented into place. After the cement has set, the vapor sample is collected in a stainless steel (Summa) canister — typically over an interval of 3-20 min — or in a gas-tight syringe. The surface is then restored.

Because samples are collected from very shallow depths (typically 2-6 in. below the surface), minimal purge volumes and small samples are preferred to minimize potential breakthrough from the surface. A leak check gas is needed to detect leaks and verify that breakthrough has not occurred.

Related procedures on sample handling are listed in Section 6 of this SOP.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Hearing protection (*Master Work Plan, Volume 1, Section 6.5*)
- Decontamination supplies (AGEM-22)
- Logbooks and other documentation material
- Field meters and monitoring equipment

- Rotary hammer drill with spline bit
- Quick-drying portland cement and surface plugs
- Sample containers (stainless steel [Summa] canisters or gas-tight syringes)
- Teflon bags for shipping to laboratory, if using gas tight syringes
- For probes: stainless steel tubing (1/8 in. or 1/4 in. outer diameter); stainless steel, ceramic, or plastic tips (if needed); Swagelok fittings or two-way valve
- For sampling: nylon or Teflon tubing (1/8 in. or 1/4 in. outer diameter), plastic three-way valve, vacuum gauge, sampling train
- Leak check compound
- 60-mL plastic syringes for purging

5.2 Drilling through the Foundation and Installing the Probe

1. Put on the approved level of PPE.
2. Mark utility locations.
3. Use the drill and masonry bit (suitable for the surface) to make a hole (outer diameter 0.5-1.0 in.) through the slab. Use the larger size for a flush or recessed surface termination. If necessary to control dust, cover the location with a towel having a pre-cut hole to accommodate the drill.
4. Measure the thickness of the slab.
5. Cut tubing the length needed to reach the base of the slab and accommodate the appropriate surface termination (flush, recessed, or protruding).
6. Insert the tubing into the hole. Add sand to cover the tip by about 1 in.
7. Grout to the surface with bentonite (for a temporary installation) or cement (for a permanent installation).
8. Allow 15-30 min for the bentonite to set.
9. Decontaminate reusable equipment before proceeding to the next location.

5.3 Sample Collection in Stainless Steel Canisters with Valves

1. Use a three-way valve to connect a 60-mL plastic syringe to the sampling train. Purge by removing 250 mL or four dead volumes of the sampling train, whichever is larger. Leave the syringe in place.
2. Flush any flow chokes and filters to be used.
3. Check the canister vacuum immediately before use.
4. Connect the canister to the sampling train or the connecting tubing. Ensure that fittings and connections are tight.
5. Place the leak check compound around the implant at the ground surface and at connections in the sampling train, as follows:
 - For liquid compounds, wet a paper towel with the compound and wrap it around each test location.
 - For gaseous compounds, use a shroud to hold the compound in place.
 - Analyze samples for the leak check compound in addition to the analytes of interest in the investigation.
6. Open the three-way valve, and open the valve on the canister to collect the sample.
7. For canisters greater than 1 L, maintain sample flow rates at 500 mL/min or less.
8. Make any desired measurements with field meters.
9. Flush any flow chokes and filters being reused before proceeding to the next location.

5.4 Sample Collection in Syringes for Immediate On-Site Analysis

1. Use the three-way valve to connect a plastic 60-mL syringe to the sampling train. Purge by removing 250 mL or four dead volumes of the sampling train, whichever is larger. Replace the plastic purging syringe with a gas-tight sampling syringe; leave the gas-right syringe in place.
2. Place the leak check compound around the implant at the ground surface and at connections in the sampling train.
 - For liquid compounds, wet a paper towel with the compound and wrap it around each location.

- For gaseous compounds, use a shroud to hold the compound in place.
 - Analyze samples for the leak check compound in addition to the analytes of interest in the investigation.
3. Open the three-way valve, and collect the soil gas sample with the gas-tight syringe.
 4. Make any desired measurements with field meters.
 5. Decontaminate any reusable equipment before proceeding to the next location.

5.5 Restoring the Surface

1. Cap the probe.
2. Clean the area.
3. Reseal the foundation with cement.
4. Repair the surface covering.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control; utilities survey)
- *Master Work Plan, Volume 2:*
 - AGEM-12, Installation of Soil Gas Probes
 - AGEM-16, Air Sampling for Chemical Analysis
 - AGEM-22, Equipment Decontamination
 - AGEM-23, Handling, Packing, and Shipping of Samples in the Field
 - AGEM-27, Sample and Document Management

7 References Cited or Consulted

ADEC, 2012, *Vapor Intrusion Guidance for Contaminated Sites*, State of Alaska Department of Environmental Conservation, Division of Spill Prevention and Response (SPAR) Contaminated Sites Program, October.

California EPA, 2012, *Advisory — Active Soil Gas Investigations*, prepared by the California EPA in coordination with the Department of Toxic Substances Control, the San Francisco Bay Regional Water Quality Control Board, and the Los Angeles Regional Water Quality Control Board, April 30.

EPA, 2001, *Soil Gas Sampling*, SOP#2042, U.S. Environmental Protection Agency, Environmental Response Team, Emergency Division, Office of Emergency and Remedial Response, Washington D.C., April 18. (The most current version of this and other EPA ERT SOPs are available online at: <https://response.epa.gov>; click on the link “ERT Standard Operating Procedures.”)

Hartman Environmental Geoscience, 2015, *The Vapor Intrusion Risk Pathway: A Practical Guide*, May.

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AGEM-16:

Air Sampling for Chemical Analysis

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AGEM-16

Air Sampling for Chemical Analysis

1 Scope and Applicability

This SOP describes the techniques used to collect discrete “grab” air samples or time-integrated air samples in crawl spaces, indoor spaces, or outdoors, for analysis of VOCs.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
BER	Bureau of Environmental Remediation (KDHE)
ft	foot (feet)
HASP	health and safety plan
Hg	mercury
hr	hour(s)
HVAC	heating, ventilation, and air conditioning unit
KDHE	Kansas Department of Health and Environment
L	liter(s)
PPE	personal protective equipment
SOP	standard operating procedure
VOC	volatile organic compound

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting the field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

Air samples must be collected in pre-evacuated, certified-cleaned, polished, stainless steel Summa canisters. Time-integrated samples are collected in canisters up to 6 L in volume, fitted with calibrated flow controllers. Discrete grab samples can be collected in smaller containers.

Canisters, flow controllers, and inlet filters (if required) as described above are specialized, reusable equipment that is obtained, as needed, from outside vendor-laboratories that have been evaluated and approved by AGEM. Preparation and certification of all sample canisters flow controllers, and filters as clean is required from the vendor prior to equipment delivery, and is performed by AGEM. Similarly, calibration of flow controllers is required from the vendor and is not performed by AGEM.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan*, Volume 1, Section 6.5)
- Logbooks and other documentation material
- Certified-clean and pre-evacuated Summa canisters and calibrated flow controllers (for time-integrated samples)

5.2 Preparations before Installation

1. Put on the approved level of PPE.
2. Calibrate field meters.
3. Initiate air monitoring for hazardous materials, as appropriate.

5.3 Air Sampling in Crawl Spaces, Indoor Spaces, and Outdoors

5.3.1 Sampling in Crawl Spaces

1. Before sampling, evaluate a crawl space to determine whether it meets the criteria of a confined space. If so, follow the established confined space entry procedure (see *Master Work Plan, Volume 1, Section 6.5*).
2. Select a sampling location at a distance from external vents.
3. Collect a 24-hr time-integrated sample for a residential building. For a commercial building, collect an 8-hr time-integrated sample.
4. Collect an outdoor ambient air sample simultaneously with the crawl space sample.

5.3.2 Sampling in Indoor Spaces

1. Schedule sampling at the convenience of the building occupants.
2. Conduct a pre-sampling interview, as follows:
 - a. Complete a building survey form pursuant to state requirements; e.g., KDHE SOP BER-33, Attachment 1 (KDHE 2011).
 - b. Document the sampling location and surrounding area, in particular noting chemical storage areas, garages, doorways, stairways, basement sumps, plumbing, electrical conduits, elevator shafts, compass directions, and other relevant information.
3. Select a sampling location that is representative of the building's normal use. Avoid locations near windows, external doors, and HVAC and other utility equipment and outlets.
4. Place the sampling equipment in the normal breathing zone (2-5 ft above the floor). Conduct sampling in the basement (if present) and ground floor living space.
5. Collect 24-hr time-integrated sample(s) in a residential building. In a commercial building, collect 8-hr time-integrated sample(s).
6. Collect an outdoor ambient air sample simultaneously with the indoor air sample.
7. Respect the right of occupants to keep results confidential, subject to relevant regulatory agency requirements for reporting and disclosure.

5.3.3 Sampling Outdoor Ambient Air

1. Select a sampling location that is upwind from the building being sampled.
2. Select location for the sampling equipment that minimizes potential contamination from exogenous sources (e.g., gasoline stations, automobiles or other gasoline-powered engines, oil storage tanks, industrial facilities), in a position that is not shielded from the wind by trees or bushes.
3. Place the sampling device's intake close to the breathing zone (approximately 5 ft above the ground surface) and 5-15 ft away from the building of interest.

5.4 Step-by-Step Sample Collection

5.4.1 Collecting Grab Samples

1. Remove the inlet cap and connect a particulate filter and pressure/vacuum gauge (nomally combined as one unit supplied by vendor) to the canister inlet, in accord with vendor's instructions.
2. Open the canister valve slightly to allow air to enter the canister; note and record the canister pressure/vacuum level at opening. Leave the valve open to allow the canister pressure to reach ambient pressure (~ 0-in. Hg).
3. Verify and record the final pressure with the gauge and close the valve.
4. Remove the inlet assembly and replace the inlet cap per vendor's instructions.

5.4.2 Collecting Time-Integrated Samples

1. Remove the inlet cap and connect a particulate filter, pressure/vacuum gauge, and flow controller (nomally combined as one unit supplied by vendor) to the canister inlet, in accord with vendor's instructions.
2. Open the canister bellows valve, and record the start time and initial canister vacuum level. The initial vacuum level should be at or very near the vacuum gauge maximum (normally ~ 30-in. Hg); if a lower vacuum is indicated, the integrity of the canister may have been compromised and it should not be used.
3. At the end of the sampling period, check and record the time and final vacuum level. A low residual vacuum (~ 1 to 5-in. Hg) is normally observed, indicating that the canister has continued to recover air throughout the targeted timed interval. If a very low residual vacuum is observed, or if the canister has reached atmospheric

pressure, the flow controller may have malfunctioned during the collection period, compromising the time-integrated aspect of the sampling.

4. Close the canister bellows valve, and record the final time.
5. Remove the inlet assembly and replace the inlet cap per vendor's instructions.

6 Related Internal Procedures

- Master Work Plan, Volume 1:
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control)
- *Master Work Plan, Volume 2:*
 - AGEM-13: Soil Gas Sampling for Chemical Analysis
 - AGEM-15: Sub-Slab Soil Vapor Sampling for Vapor Intrusion Applications
 - AGEM-22: Equipment Decontamination
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field
 - AGEM-15: Sub-Slab Soil Vapor Sampling for Vapor Intrusion Applications
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

KDHE, 2011, *Procedures for Sampling and Analysis of Indoor Air Samples*, SOP BER-33, in "Quality Assurance Management Plan (QMP), Part II, Appendix A," Kansas Department of Health and Environment, Division of Environment, Bureau of Environmental Remediation, Topeka, Kansas (SOP BER-33 was originally published on August 14, 2000), January 1. (For links to the various sections and appendices of the QMP [Revision 6], including SOPs, dated February 21, 2019, go to <http://www.kdheks.gov/environment/qmp/qmp.htm>).

Massachusetts DEP, 2005, "Chapter 1, Indoor Air Quality Evaluation Methods," in *Indoor Air Quality Manual and Appendices*, prepared by the Commonwealth of Massachusetts, Department of Environmental Protection, September. (Available online by searching "air quality manual" at Mass.gov).

EPA, 1992, *Summa Canister Sampling*, SOP#1704 (Chapter 2.0), in “Compendium of ERT Air Sampling Procedures, OSWER Directive 9360.4-05, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington D.C., May.

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**AGEM-17:
Surface Water Sampling**

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AGEM-17

Surface Water Sampling

1 Scope and Applicability

This SOP describes the procedures used to collect representative surface water samples for chemical analyses.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
°C	degree(s) Celsius
EVS	Environmental Science Division (at Argonne)
ft	foot (feet)
HASP	health and safety plan
HSC	health and safety coordinator
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure

3 Responsibilities

The field project manager, or another designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.
- Ensuring that surface water sampling *is not conducted alone by a field team member unless approved by the AGEM program manager and done while maintaining a cell phone connection to another field team member.*

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting the field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

This procedure applies to surface water samples collected from streams, rivers, lakes, and ponds at depths ranging from about 1 ft to the water's surface. *This procedure is not intended for collecting discrete samples at depths greater than 1 ft, or from water in impoundments or lagoons;* rather, it is to be used for sampling locations that can be accessed by personnel located on relatively firm (dry or slightly submerged) ground or other surfaces that present minimal physical risk.

If project objectives require the discrete sampling of surface water at depths greater than 1 ft, appropriate sampling equipment and collection methods must be described in detail in the site-specific work plan and HASP, and approved by the EVS HSC (see Sections 4.1.3 and 6.2).

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Decontamination supplies (AGEM-22)
- Logbooks and other documentation material
- Sample containers, scoops or other transfer containers, ice, and cooler(s)

5.2 Preparations before Sampling

1. Put on the approved level of PPE.
2. Decontaminate any reusable transfer containers or other equipment required for sample collection.

3. Prepare a cooler with ice to hold the surface water samples at 4°C immediately after collection.
4. Use stakes, flags, or buoys as necessary to identify and mark the sampling locations.

5.3 Direct Collection of Surface Water with a Sample Container

1. From a position downstream of the sampling location, place the sample container under the water's surface, with the opening pointing upstream.
2. Allow the container to fill completely, taking care to minimize aeration.
3. Seal the sample container and place on ice at 4°C.
4. Handle samples according to AGEM-23.

5.4 Collection of Surface Water with a Scoop or Transfer Container

1. From a position downstream of the sampling location, place a scoop or other suitable transfer container (glass or plastic beaker, bottle, etc.) under the water's surface. If necessary for safety or other reasons, the transfer container may be connected to a collapsible pole or extended handle to provide greater reach.
2. Transfer the sample to a sample container.
3. Allow the sample container to fill completely, taking care to minimize aeration.
4. Seal the sample container and place on ice at 4°C.
5. Handle samples according to AGEM-23.
6. Decontaminate all reusable equipment before proceeding to another location.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control)

- *Master Work Plan, Volume 2:*
 - AGEM-22: Equipment Decontamination
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

EPA, 2016, *Surface Water Sampling*, SOP#2013, U.S. Environmental Protection Agency, Environmental Response Team, Emergency Division, Office of Emergency and Remedial Response, Washington D.C., July 31. (The most current versions of this and other EPA ERT SOPs are available online at: <https://response.epa.gov>; click on the link “ERT Standard Operating Procedures.”)

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Former CCC/USDA Facilities: Master Work Plan**

Volume 2: Standard Operating Procedures

AGEM-18:

Sediment Sampling (in Surface Water Bodies)

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AGEM-18

Sediment Sampling (in Surface Water Bodies)

1 Scope and Applicability

This SOP addresses the collection of representative sediment samples (i.e., samples of any eroded mineral or organic materials that are submerged beneath static or flowing water) for chemical analyses. The methods described are for direct sampling with hand-operated collection devices in relatively shallow surface water environments, where the sampling can be performed by personnel located on relatively firm, dry ground.

If project objectives require the sampling of sediments submerged below more than 2 ft of water or deeply buried sediment horizons, appropriate sampling equipment, and collection methods must be described in detail in the site-specific work plan and HASP, and approved by the EVS HSC.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
EVS	Environmental Science Division (at Argonne)
ft	foot (feet)
HASP	health and safety plan
HSC	health and safety coordinator
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure
VOC	volatile organic compound

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.

- Ensuring that the necessary equipment and materials are at the field site.
- Ensuring that sediment sampling *is not conducted alone by a field team member unless approved by the AGEM program manager and done while maintaining a cell phone connection to another field team member.*

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting the field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

This procedure describes direct methods for scooping near-surface sediments (at depths of 0 to about 0.5 ft below the sediment-water interface) into a sample container, either directly or by transfer with a beaker, trowel, shovel, or similar implement.

This procedure also describes methods for recovering relatively undisturbed samples of near-surface or deeper sediments that reflect the depositional profile with depth (to approximately 2 ft below the sediment-water interface), through use of a bucket, tube auger, or a hand coring device.

If project objectives require the sampling of sediments submerged below more than 2 ft of water or deeply buried sediment horizons, safety considerations must be described in detail as part of the site-specific work plan and HASP.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan*, Volume 1, Section 6.5)
- Decontamination supplies (AGEM-22)
- Logbooks and other documentation material
- Tools for digging, as appropriate: scoop, spatula, trowel, spade/shovel, post-hole digger, auger, hand-corer, extension rods/poles, T-handle

- Sample containers for chemical analyses: glass wide-mouth jars or vials with Teflon lids or cap liners
- Sample containers for mineralogic, particle size distribution, and/or bulk physical property analyses: glass or plastic containers with lids or sealable plastic bags
- Scoops, dry ice, and cooler(s)

5.2 Preparations before Sampling

1. Put on the approved level of PPE.
2. Walk through the sampling area to accomplish the following:
 - a. Identify site boundaries.
 - b. Determine the general conditions of stream flow and depth or pond size and depth.
 - c. Identify any anthropogenic features that could affect the sampling plan or analysis results.
3. Prepare a cooler with dry ice for immediate preservation of sediment samples collected for chemical analyses.
4. Record the location and depth of each sampling point in sufficient detail to permit consistent resampling from the same point. Sketch the location and record descriptive information, with reference to any permanent nearby landmarks.
5. If conditions permit, install a permanent or semi-permanent location marker (i.e., a labeled ground stake, a marked washer nailed to an adjacent tree, flagging, etc.) at the sampling point, or as close to it as possible.
6. Record any additional conditions or features of the sampling location that might be required or useful during the interpretation of sample data (weather conditions at the time of sampling, water depth and flow conditions, the presence of nearby discharges, etc.).
7. Rinse the sampling device in the overlying water near the intended sediment sampling location, but at a sufficient distance *downstream* from the sampling point to prevent disturbance of the sediment.

5.3 Sediment Recovery Methods

5.3.1 Direct Recovery

Use the following methods for direct recovery of relatively soft to semi-consolidated, near-surface sediments (0 to 0.5 ft below the sediment-water interface) from water depths no greater than about 2 ft. Avoid excessive washing of fine materials from the sample during its withdrawal through the overlying water column.

1. Fill a sample container with sediment directly as follows:
 - a. Remove the lid from the sample jar or vial.
 - b. Slowly submerge the container to the sediment surface.
 - c. Collect material by scraping the container into the sediments to the desired depth.
2. Alternatively, collect sediment with a scoop, trowel, shovel, or similar implement (with collapsible pole or extended handle if appropriate) by excavating the required thickness and volume of sediment from the target location the least possible agitation or mixing/washing of the sample.
3. Handle samples for chemical analyses as follows:
 - a. Place the sediment directly into the sample jar or vial. Alternatively, transfer the material to a temporary intermediate container (pan, bowl, foil sheet, etc.); quickly select the desired material, and place it in the sample jar or vial by using the original collection implement or a suitable spoon, spatula, etc.
 - b. Collect multiple “grabs” of sediment if required to provide sufficient material for the selected analyses. Do not homogenize samples for chemical analyses.
 - c. Wipe or rinse excess material from the container opening (which would prevent complete sealing) and tightly close the container.
 - d. Clean and dry the exterior of each sample container, apply the sample label, and place the container in a marked sealable plastic bag.
 - e. Place the bagged sample in a holding cooler (on dry ice for VOCs samples).
 - f. Ship the samples to the laboratory as soon as possible (AGEM-23). Maintain them cryogenically until the time of analysis.

- g. Decontaminate reusable sampling equipment before proceeding to the next location.

5.3.2 Recovery with Less Disturbance

Use the following methods to recover less disturbed, near-surface or deeper sediment samples (to about 2 ft below the sediment-water interface) retaining some or all of the original sedimentary structure.

1. Collect relatively undisturbed sediment with a bucket or tube auger as follows:
 - Assemble the auger and handle, with extensions if necessary, per the manufacturer's instructions.
 - Slowly lower the auger through the water column to the sediment surface, and push the auger into the sediments to the required depth at an angle of no more than 20° from vertical.
 - Rotate the auger to break the contained sediment core free from the underlying materials.
 - Slowly withdraw the auger and cored sample. If using a tube auger, ensure that the open slotted side of the auger is facing upward.
 - Handle samples for chemical analyses according to Step 3 in Section 5.3.1 of this SOP.
 - Decontaminate reusable sampling equipment before proceeding to the next location.
2. Collect relatively undisturbed sediment with a hand coring device as follows:
 - Assemble the corer and handle, with extensions if necessary, per the manufacturer's instructions. If the device is designed for the use of a liner inside the core barrel, use a new liner for each sample collected.
 - Insert the corer into the sediment with a smooth, continuous motion.
 - Rotate the corer to break the sediment core free, and withdraw the corer in a single smooth motion.
 - Carefully remove the nosepiece and sediment catcher (if installed) from the lower end of the coring barrel.

- If no core barrel liner is used, quickly transfer the required sediment from the core barrel to the sample jar or vial, or to a temporary intermediate container (pan, bowl, foil sheet, etc.) by using a suitable spoon, spatula, etc.
- If a barrel liner is used, remove the liner and the contained sediment core.
- If whole cores (or core segments) are to be retained for later geologic or other analyses, mark and seal both the upper and lower ends of the barrel liner with dedicated caps, aluminum foil and tape, or other means that are suitable for the required analyses. Store the material in an upright position under appropriate preservation conditions. Barrel liners may be carefully cut into vertical segments (if necessary) by using a clean hack saw.
- If immediate sampling or examination of the cored sediment is required, quickly transfer the collected material from the core barrel liner to the sample container, or to a temporary intermediate container (pan, bowl, foil sheet, etc.). Depending on the consistency of the cored material, it may be possible to remove it from the liner by simple “pouring” or extrusion. Barrel liners may carefully be split lengthwise (if necessary) by using a clean razor knife. Quickly select the desired material from the temporary container, and place it in the sample jar or vial by using a suitable spoon, spatula, etc.
- Handle samples for chemical analyses according to Step 3 in Section 5.3.1 of this SOP.
- Decontaminate reusable sampling equipment before proceeding to the next location.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control)
- *Master Work Plan, Volume 2:*
 - AGEM-22: Equipment Decontamination
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

EPA, 2016, *Sediment Sampling*, SOP#2016, U.S. Environmental Protection Agency, Environmental Response Team, Emergency Division, Office of Emergency and Remedial Response, Washington D.C., July 31. (The most current versions of this and other EPA ERT SOPs are available online at: <https://response.epa.gov>; click on the link “ERT Standard Operating Procedures.”)

KDHE, 2004, *Sediment Policy*, Policy BER-ARS-045, Assessment and Restoration Section, Bureau of Environmental Remediation, Kansas Department of Health and Environment, January 9.

KDHE, 2011, *Collection of Sediment Samples*, SOP BER-04, in “Quality Assurance Management Plan (QMP), Part II, Appendix A,” Kansas Department of Health and Environment, Division of Environment, Bureau of Environmental Remediation, Topeka, Kansas (SOP BER-04 was originally published on February 15, 2000), January 1. (For links to the various sections and appendices of the QMP [Revision 6], including SOPs, dated February 21, 2019, go to <http://www.kdheks.gov/environment/qmp/qmp.htm>)

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**Environmental Investigations at
Former CCC/USDA Facilities: Master Work Plan**

Volume 2: Standard Operating Procedures

AGEM-19:

Vegetation Sampling for Chemical Analysis

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AGEM-19

Vegetation Sampling for Chemical Analysis

1 Scope and Applicability

This SOP describes the methods used to collect samples of viable vegetation for VOCs analysis.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
COC	chain-of-custody
ft	foot (feet)
g	gram(s)
GPS	global positioning system
HASP	health and safety plan
ID	identification
mL	milliliter(s)
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.

- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

For each selected tree in each sampling event, collect one sample of leaves and/or one sample of the branch on which the sampled leaves were growing. To maintain consistency, collect leaf and branch samples that are similar in size, aspect, and location on each tree.

Various plant species and tissue types may be sampled when viable vegetation is available. Above ground portions of available grasses (often brome or foxtail) are preferred.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan*, Volume 1, Section 6.5)
- Decontamination supplies (AGEM-22)
- Logbooks and other documentation material
- Distinct sample number labels to be affixed to sample vials
- Field meters and monitoring equipment, as appropriate
- Vegetation sampling record forms (Exhibit 19.1)
- 40-mL screw-cap glass vials
- Sharp, clean pruning shears
- Sharp, clean scissors
- Measuring tape
- Cooler with dry ice
- Small diameter, hand-operated tree corer (incremental borer)

5.2 Preparations before Sampling

1. Put on the approved level of PPE.
2. Calibrate field meters.
3. Initiate air monitoring for hazardous materials, as appropriate.
4. Prepare coolers containing dry ice for sample preservation.

5.3 Sample Collection

5.3.1 General Vegetation Sampling Guidelines

The following sampling guidelines are illustrated in Photos 19.1 through 19.5:

- Do not sample wet leaves/branches; wait until dew or rain has dissipated.
- Avoid diseased, discolored, dry, or defoliated specimens.
- Sample weights should be approximately 25 g to allow for replicate analyses.
- Measure and record diameter of the tree trunk circumference and include the measurement in the field logbook.
- Collect one sample per tree, either leaf, branch or core, with statistical replicates for QA/QC purposes.
- Tightly close and label each sample vial as it is filled, affix the identifying label and place the sample on dry ice immediately after collection.
- Triplicate sample labels (3) are pre-printed or hand labeled with a unique number in order to differentiate each sample as it is received in the laboratory and analyzed. One sample label is affixed to the sample vial, another to the log book and a third remains on the label page for use if needed.
- Field replicates are assigned a unique sample ID number and the above process of sample identification is repeated.
- The established codes to be recorded on the unique sample label are as follows:
 - GA-green ash
 - WN-Niobe willow

- EC-eastern cottonwood
 - BC-bald cypress
 - BW-black willow
 - NC- northern catalpa
 - PREE-pre-existing designation
 - Additional codes will be added, as needed, as new tree species are encountered at various investigation sites
- Clean all sampling equipment before proceeding to the next location (AGEM-22)
 - All samples are to be recorded on a chain-of custody form to accompany the sample shipment preserved in coolers on dry ice (AGEM-23).
 - Samples are packed on dry ice and shipped for overnight delivery to the AGEM Laboratory for analysis. A COC form will accompany each cooler shipped.

5.3.2 Sampling Procedures for Branches and Leaves

Branches: unless otherwise specified, sample branches as follows:

- Select branches for sampling as follows:
 - Lowest possible branch of the desired diameter available, preferably from the south side of the tree immediately above the end of the black (or yellow) protective tube in very young trees (if present); see Photo 19.1. If this protection is not available or the trees have grown to sufficient size to no longer need this protection, sample the lowest branch accessible.
 - Record the vertical distance between the branch insertion point and the ground surface in the sample record.
 - Record the actual branch insertion orientation (N, S, E, or W)
 - Sample a primary branch growing directly out of the tree trunk, preferentially.
 - Use a sharp, clean pruning shears to make the cut near the branch point of insertion into the trunk. Use care not to damage the trunk.
 - Remove all petiole and bud residue from the branch. Select a 12-in. long piece of relatively constant diameter. Cut this piece of branch into 2 to

3-in. long segments and place the sample directly into a 40-mL vial and close tightly immediately (Photos 19.2 through 19.5). To avoid analyte loss, do not grind or crush the branch tissue

- Woody branches of similar diameter (ideally 0.25 in. or 0.5 cm) are to be selected to fit into the 40-ml sample vial.
- The previous year's branch growth, recognizable because it is not green, is to be selected.
- Branches with mature (full size), healthy, green leaves.
- Place sample immediately on dry ice and record the unique sample number and information in the logbook.

Leaves: unless otherwise specified, sample leaves as follows:

- Depending on species, collect 2-20 leaves per sample.
- Cut leaves across their bases with scissors, so that no petiole (stem) is attached (see Photos 19.2 through 19.5).
 - Place sample in 40-mL vial and tightly close, label, and preserve each sample on dry ice immediately after collection.
 - Carefully clean all sampling equipment before proceeding to the next location, as needed.
 - Ship the samples (on dry ice) to the AGEM Laboratory by overnight delivery (AGEM-23).
 - Experience at Murdock, Nebraska, has shown limited VOC recovery from leaf samples. As a consequence, if taking a leaf sample, also take a branch sample, cutting it as close as possible to the recovered leaf sample.

5.3.3 Sampling Procedure for tree cores

- In some instances it is more appropriate to acquire a representative sample by actually retrieving a small core of tissue from the tree trunk if the tree is of sufficient size and diameter.
- A small section of the bark should be removed from the tree (Photo 19.6) for ease of insertion of the incremental borer and to assist in accessing the underlying tissue.

- The sample should be taken at a height of about 1 to 2 ft (*preferably 2 ft*) from the ground surface and the cardinal point (N, S, E, or W) and height of the core should be recorded. *Note that the south side of the tree is preferred for core sampling.*
- Insert a small diameter corer (incremental borer) into the trunk of the tree turning and advancing by hand (Photo 19.7).
- Insert the sampling spoon into the center of the incremental borer (Photo 19.8). Extreme care should be taken when removing and handling the delicate tree tissue samples. Once the sampling spoon has been inserted, twist and pull it to loosen the core sample from the borer (Photo 19.9)
- Place the extracted tissue sample directly into a 40-mL vial, cap tightly, label and place on dry ice immediately (Photo 19.10)
- Enter all appropriate information and comments into the record for each sample (Exhibit 19.1). Include any comments on the general condition of the tree.
- Carefully clean all sampling equipment before proceeding to the next tree to prevent cross contamination and disease transmittal.

5.3.4 Sampling Procedure for Grasses

1. Pull or dig up the grass by the roots.
2. Knock off any soil, remove dead material, and snip off roots with pruning shears.
3. Insert the cut grasses as a loose bunch into a 40-mL sample vial.
4. Trim the vegetation to fit in the sample vial, tightly cap and affix the label.
5. Place the sample on dry ice immediately for preservation and shipment.
6. Complete the vegetation sampling record (Exhibit 19.1) making all appropriate notes including a GPS location for the sample, if possible.
7. Clean sampling equipment before proceeding to the next location.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)

- Section 6.5 (PPE)
- *Master Work Plan, Volume 2:*
 - AGEM-22: Equipment Decontamination
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field
 - AGEM-27: Sample and Document Management

PHOTO 19.1 Sampling guidelines, as illustrated for willow branches

PHOTO 19.2 Cutting lines (red) for black willow (and for Niobe willow). Exclude petioles, and avoid discolored leaves

PHOTO 19.3 Cutting lines (red) for eastern cottonwood. Exclude petioles, and avoid discolored or wet leaves

PHOTO 19.4 Cutting lines (red) for composite green ash, excluding petioles. Sample each leaflet of a few composite leaves.

PHOTO 19.5 Cutting line (red) for catalpa leaf, excluding petiole. One or two leaves should be sufficient. Branch sample may be shorter and larger in diameter.

PHOTO 19.6 Select a small section of bark for removal

PHOTO 19.7 Insert a small diameter corer (incremental borer) into trunk of the tree

PHOTO 19.8 Insert sampling spoon into the incremental borer

PHOTO 19.9 Twist and pull sampling spoon to extract tree tissue

PHOTO 19.10 Place extracted tissue sample into a 40-mL via

Vegetation Sampling Record

Collection date and time	Collected by	Location ID + Tree ID	Tissue sampled	Laboratory ID (paste label)	Field observations
			Leaf ☐ Branch ☐ Core ☐		
Height of branch insertion point from gravel: _____ cm				SOP followed: yes ☐ no ☐	If SOP not followed, specify deviations:
Branch insertion orientation: N ☐ S ☐ E ☐ W ☐				Recorded by (Signature)	
Collection date and time	Collected by	Location ID + Tree ID	Tissue sampled	Lab ID (paste label)	Field observations
			Leaf ☐ Branch ☐ Core ☐		
Height of branch insertion point from gravel: _____ cm				SOP followed: yes ☐ no ☐	If SOP not followed, specify deviations:
Branch insertion orientation: N ☐ S ☐ E ☐ W ☐				Recorded by (Signature)	

EXHIBIT 19.1 Vegetation sampling record (for leaves, branches, and core samples)

**Environmental Investigations at
Former CCC/USDA Facilities: Master Work Plan**

Volume 2: Standard Operating Procedures

AGEM-20:

Measuring Sap Flow in Trees

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AGEM-20:

Measuring Sap Flow in Trees

1 Scope and Applicability

This SOP describes the techniques used to measure sap flow in trees. The technique is an application of the heat dissipation method of Grainer (1985), which is based on principles of convective heat transfer. Continuous data from commercially available thermal dissipation probes are stored by a data logger and downloaded onto a laptop computer. The data are imported into a spreadsheet table to calculate the rate of water use.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
cm	centimeter(s)
HASP	health and safety plan
hr	hour(s)
K	flow index
mm	millimeter(s)
PPE	personal protective equipment
QA/QC	quality assurance/quality control
sec	second(s)
SOP	standard operating procedure
TDP	thermal dissipation probe
ΔT	temperature difference

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.

- Delineating and controlling work areas at the site (*Master Work Plan, Volume 1, Section 6.5*).

Personnel conducting the work described here are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting field notes and data to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

The techniques described here for measuring sap flow require the installation of thermal dissipation probes (e.g., the Dynamax, Inc., TDP-30) in the hydroactive sapwood (the outer 30-40 cm) of tree trunks. Two probes per tree are placed radially, one above the other. The upper probe contains a heater element and a (hot) thermocouple junction that is referenced to a (cold) junction at ambient temperature in the lower probe. Application of constant power to the heater sets up a temperature difference (ΔT) between the two probes that is dependent on the sap flow rate. As sap flow increases, heat is lost from the heated probe more rapidly, and ΔT increases.

The thermocouples produce a small-voltage signal, proportional to ΔT , that is sent to a data logger (e.g., Campbell Scientific CR10X) for storage. Adding a relay multiplexer (e.g., Campbell Scientific AM416) to the system increases the number of sensors that can be scanned by the data logger.

The data are downloaded to a laptop computer and imported into a spreadsheet table. A series of calculations yields an estimate of the volume of water transpired by the tree per unit time.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Logbooks and other documentation material
- Steel wool, bleach solution (10%), and hydrogen peroxide solution (3%)
- Electrical insulating compound
- Flexible porous foam, reflective insulation, and duct tape

- Parafilm or static-cling plastic wrap
- System components as described by the manufacturer

5.2 Installation of Thermal Dissipation Probes

1. Put on the approved level of PPE.
2. Select trees > 30 mm in diameter and within the manufacturer-specified distance of the data logger and/or multiplexer.
3. Run cables to connect the trees to the data logger.
4. Measure and record the diameter of each tree in its N-S and E-W aspects; average these numbers to obtain a tree diameter value for use in determining cross-sectional area.
5. Select a uniform installation height at 15-30 cm above the ground surface. Remove lateral branches below the selected height to reduce artifacts in measurements.
6. Rinse a drill bit (#55 bit, 1.32 mm) with 10% bleach solution.
7. Drill two holes (#55 bit, 1.32 mm) into the first tree, approximately 30 mm deep and separated vertically by 40 mm.
8. Rinse the interiors of the holes with 3% hydrogen peroxide solution delivered with a syringe.
9. Clean the probe needles with 10% bleach solution, coat them with electrical insulating compound, and insert them into the holes (heated probe in the top hole). The electrical insulating compound facilitates insertion of the needles and effectively seals the holes to help keep out microbes and moisture.
10. If insertion of the needles is difficult, use a slightly larger bit (#54 bit, 1.4 mm) to enlarge the hole. Repeat steps 7-8.
11. Wrap flexible porous foam at least 5 cm thick around the probes. Wrap a reflective insulation blanket around the entire apparatus to minimize the influence of thermal and solar radiation on the probes.
12. Seal the probe-cable connection with Parafilm or static-cling plastic wrap. Double up the end of the probe that is connected to the cable and place the connection under the insulation for further protection from moisture.
13. Use duct tape to secure the foam and insulation blanket. Wrap the insulation tightly enough at the top to keep precipitation out but not so tightly that it restricts growth.

14. Clean the drill bit(s) with steel wool, and rinse with 10% bleach solution before continuing to the next tree.
15. Repeat steps 6-13 for each successive tree.
16. Connect wires as directed by the data logger and multiplexer manufacturer(s). Label each wire. Ensure contact by pulling each wire gently after making the connection. Use cable ties to bundle the wires neatly together.

5.3 Downloading Data

1. Load the software provided by the manufacturer onto a laptop computer.
2. Open the software program, and proceed with the download as directed in the software documentation.

5.4 Removing Thermal Dissipation Probes at the End of the Monitoring Period

1. Remove the insulation from the probes.
2. Carefully grasp a needle by the probe, near the insertion point into the tree.
3. If possible, slowly pull the needle out by hand, as straight as possible. Bending a needle can damage the thermocouple, which cannot be repaired.
4. If necessary, use a small pry bar (provided with the probes) with a fulcrum to keep the needle as straight as possible.
5. Remove any residue from the needle, and clean the connections thoroughly.
6. Wind up extension cables, remove wires from the multiplexer, and store the probes and cables in a dry location. Undamaged probes can be reused.

5.5 Data Analysis

Use a spreadsheet to analyze data logger output (ΔT values) according to manufacturer guidelines, in the following general steps:

1. Calculate a dimensionless flow index K for each 24-hr period from the relationship $K = [\Delta T_{max} - \Delta T] \div \Delta T$, where ΔT_{max} is the largest ΔT value in the 24-hr period.
2. Calculate sap velocity V (cm/sec), according to an empirical relationship of Granier (1985), as $V = 0.0119 \times K^{1.231}$.

3. Calculate the cross-sectional area A_s (cm^2) of the tree at the location of the probe from the average diameter measurement (cm) (Section 5.2, step 3).
4. Calculate the rate of sap flow F_s (cm^3/hr) by multiplying sap velocity V (cm/sec) by the cross-sectional area A_s (cm^2) of the tree at the location of the probe, according to the relationship $F_s = A_s \times V \times 3600 \text{ sec/hr}$.

5.6 Potential Sources of Error

1. This method can underestimate the sap flow velocity if a portion of a heat dissipation probe is in contact with nonconducting xylem or bark. For this reason, avoid probes longer than the depth of conducting sapwood. For younger poplar and willow trees, the entire area can be assumed to be conducting (hydroactive). In older trees, hydroactive sapwood occupies the outer part of the trunk to a depth of 30-40 mm.
2. Other potential problems with the measurement system — including damaged probes, faulty cable connections, interrupted power supply, or faulty computer program — will appear as obvious data anomalies. Immediately investigate such observations and take corrective actions.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 6.5 (PPE; work designation and site control)
- *Master Work Plan, Volume 2:*
 - AGEM-22: Equipment Decontamination

7 References Cited or Consulted

Granier, A., 1985, "Une nouvelle méthode pour la mesure du flux de sève brute dans le tronc des arbres," *Annales des Sciences Forestières* 42(2):193-200.

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Volume 2: Standard Operating Procedures

AGEM-21:

Calibration of Field Instrumentation and PID Operation

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Exhibit

EXHIBIT 21.1	PID Calibration Record	21-10
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AGEM-21:

Calibration of Field Instrumentation and PID Operation

1 Scope and Applicability

This SOP describes the general techniques used for calibrating, maintaining, and operating field meters, with greater detail on the operation of the PID for ambient air monitoring when hazardous materials might be present. Other equipment used for safety-related field (air) monitoring is listed in the *Master Work Plan, Volume 1*, Section 6.5. Note that *all meters must be operated in accordance with the manufacturer's instructions*.

Field parameters measured during groundwater sampling and surface water sampling include temperature, pH, electrical conductivity, dissolved oxygen, and oxidation-reduction potential. Additional information about the use of field meters for these applications is in AGEM-05, AGEM-06, and AGEM-17. Techniques and equipment for measuring groundwater levels are described in AGEM-07 and are not included here.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
EPA	U.S. Environmental Protection Agency
HASP	health and safety plan
PID	photoionization detector
PPE	personal protective equipment
ppm	part(s) per million
sec	second(s)
SOP	standard operating procedure
QA/QC	quality assurance/quality control
UV	ultraviolet
VOC	volatile organic compound

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.

- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.
- Establishing calibration standards and frequencies for field instruments.
- Designating responsibilities for calibration and maintenance of field instruments.

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Calibration and Maintenance of Field Instruments

Field instruments that measure a quantity or must meet defined performance criteria require calibration and preventive maintenance and are therefore subject to the following provisions:

1. For each field instrument, determine the following:
 - a. The standard to which the instrument is to be calibrated. This depends on the equipment's stability, the required accuracy and precision, and the potential effects of measurement error.
 - b. The frequency of calibration. This depends on the equipment's stability, manufacturer's recommendations, the intended use, and the potential effects of measurement error.
2. Designate an individual to be responsible for overseeing the care and maintenance of each field instrument.
3. Establish the unique identity of each instrument by using the manufacturer's serial number or another identifier that is permanently attached to the instrument.
4. Attach a label to each instrument (except those used for groundwater field parameters) indicating when the next calibration is due.
5. Calibrate field equipment used for groundwater measurements before each use, by using fresh calibration standards and following the manufacturer's instructions.

6. Establish a calibration log for each instrument; store the log with the instrument. Include the following information:
 - a. Unique instrument identifier, type, model, and serial number
 - b. Date and time of calibration
 - c. Individual and organization performing the calibration
 - d. Reference equipment or standards used in calibration
 - e. Instrument reading with respect to each calibration standard
 - f. Certificates or statements of calibration provided by manufacturers or outside organizations
 - g. Comments regarding instrument performance
 - h. Maintenance and repair records
7. If an instrument does not meet calibration requirements, take it out of service until acceptable performance can be verified through maintenance or recalibration by the manufacturer.
8. Maintain an inventory of spare parts.
9. As required, establish a program of periodic operational checks in addition to formal calibration, to be implemented in conjunction with data acquisition.
10. Establish an organized program of preventive maintenance including equipment cleaning, lubrication, reconditioning, adjustment, and/or testing, in order to maintain proper performance, prevent equipment failure during use, and maintain the equipment according to the owner's manual.
11. Designate a temperature-controlled storage space for each instrument, in accordance with the manufacturer's instructions.
12. Clean equipment probes and electrodes before storage.

5 PID Operation Procedures

Operate PIDs in the field as follows:

5.1 Field Calibration

1. Use pre-calibrated, leased PID, specific to the contaminants of concern.
2. Conduct and record field calibration according to the PID manufacturer specifications (see Exhibit 21.1).
3. Obtain a “clean air” reading daily, before testing for possible contamination at the target drilling location(s).

5.2 Operation

1. Refer to EPA's SOP #2114 (EPA 1994) for information on interferences and potential problems with PID operation.
2. When the start-up procedure is complete, set the function switch to the appropriate range. If the concentration of gases or vapors is unknown, set the function switch to the 0-20 ppm range. Adjust if necessary.
3. Monitor the work activity as specified in the *Master Work Plan* and the site-specific health and safety plan. Avoid exposing the PID to excessive moisture, dirt, or contamination.
4. Position the probe assembly close to the area being monitored. Slowly sweep the probe from side to side. The instrument readout has a delay of 3-5 sec, depending on sensitivity to the contaminant.
5. During drilling, perform PID monitoring at regular intervals downhole, at the headspace, and in the breathing zone. In addition, where elevated organic vapor levels are encountered, monitor the breathing zone during actual drilling.
6. For activities other than drilling, emphasize monitoring of the breathing zone.
7. As needed, wrap the instrument (except for the probe's inlet and exhaust) in clear plastic to protect it from contamination or to keep it dry in the event of precipitation.
8. At the end of the monitoring period, clean the outside of the instrument with a damp disposable towel to remove visible dirt.

5.3 Care after Operation

1. Turn the function switch to the OFF position.
2. Complete logbook entries or download (Section 4, item 6, of this SOP).
3. Recharge the PID batteries on the docking station, located in a secure area.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 6.5 (PPE; air monitoring)
- *Master Work Plan, Volume 2:*
 - AGEM-05: Purge Groundwater Sampling
 - AGEM-06: Low-Flow Groundwater Sampling
 - AGEM-07: Measuring Water Levels in Wells
 - AGEM-14: Geoprobe and Sub-Slab Gas Detection
 - AGEM-17: Surface Water Sampling
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

EPA, 1994, *Photoionization Detector (PID) HNU*, SOP#2114, U.S. Environmental Protection Agency, Environmental Response Team, Emergency Division, Office of Emergency and Remedial Response, Washington D.C., October 6. (The most current versions of this and other EPA ERT SOPs are available online at: <https://response.epa.gov>; click on the link “ERT Standard Operating Procedures.”)

BBL, Inc., 2006, “Calibration and Maintenance Procedures,” Section B.5 in *McGuire’s Ranch Sampling and Analysis Plan*, prepared for Regional Water Quality Control Board, North Coast Region, Santa Rosa, California, by Blasland, Bouck, and Lee, Inc., Petaluma, California.

Date:		Calibrated By:	
Equipment Manufacturer:			
Model:		Serial Number:	
Lamp Intensity (eV):			
Battery Fully Charged:		Yes	No
Temperature (°F):		Relative Humidity (%):	
Calibration Location:			
Fresh or Zero Air Calibration:		Yes	No

CALIBRATION GASES		
Manufacturer (if applicable)	Calibration/Span Gas	Shelf-Life Specified on Cylinder (if applicable)

[illegible]

* Specify "self-adjusts" when the equipment sets its own sensitivity to the calibration gas.

Comments:

EXHIBIT 21.1 PID Calibration Record

**Environmental Investigations at
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**AGEM-22:
Equipment Decontamination**

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AGEM-22:

Equipment Decontamination

1 Scope and Applicability

This SOP defines a consistent process for decontaminating field equipment to prevent cross-contamination between sampling locations and minimize the transfer of hazardous substances from the work area to unaffected areas. This procedure does not address decontamination of personnel.

Sample containers are certified clean by the analytical laboratory or a supplier before they arrive in the field.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
BER	Bureau of Environmental Remediation (KDHE)
EPA	U.S. Environmental Protection Agency
HASP	health and safety plan
KDHE	Kansas Department of Health and Environment
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Ensuring that the necessary equipment and materials are at the field site.
- Delineating and controlling decontamination areas at the site (*Master Work Plan, Volume 1, Section 6.5*).

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting the field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

To minimize the potential for contamination, select work practices that minimize contact with hazardous substances, use appropriate PPE (*Master Work Plan, Volume 1, Section 6.5*) when handling contaminated equipment, and use disposable sampling equipment as appropriate.

The location(s) of decontamination station(s) will be determined by the field project manager. Work area designation is discussed in the *Master Work Plan, Volume 1, Section 6.5*.

Gross contamination can be removed initially by using brushes. Washes with various cleaning agents and rinses follow. Tap water from any municipal or industrial water treatment system is acceptable for use in initial washing and rinsing of sampling equipment. Commercially available distilled is acceptable for final rinsing. Collection of field blank samples is discussed in the *Master Work Plan, Volume 1, Section 4.2.1*.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Large containers for decontamination water
- Source of tap water (designated for decontamination only)
- Distilled water
- Soft- and stiff-bristled brushes with long handles
- Detergent (solid or liquid)
- Spray bottles for rinsing
- Paper towels or other disposable cleaning cloths
- Plastic garbage bags for disposal of solid/hazardous wastes

- Hand pump sprayer
- Plastic drop cloth

5.2 Preparations before Decontamination Begins

1. Lay plastic sheeting around the decontamination area to minimize the likelihood of cross-contamination, as needed.
2. Put on the approved level of PPE.

5.3 Daily Decontamination of Reusable Sampling Equipment

Decontaminate reusable sampling equipment (pumps and bailers) after each monitoring well is sampled and at the end of each working day, as follows.

1. Scrape the equipment and wipe it clean of any mud, grease, or oil.
2. Rinse the equipment with distilled water.
3. Retrieve a grab (rinsate) sample as needed.
4. Dispose of contaminated materials as indicated in AGEM-11.

5.4 End of Event Decontamination of Reusable Sampling Equipment

Decontaminate reusable sampling equipment such as pumps, bailers, vegetation tools, and direct push tooling according to the following procedure:

1. Scrape and wipe the equipment clean of any mud, grease, or oil.
2. Wash and scrub the equipment thoroughly with nonionic detergent and water.
3. Rinse with tap water.
4. Rinse with distilled water.
5. Repeat steps 2-4, if necessary.
6. Air dry.
7. Dispose of contaminated materials as indicated in AGEM-11.

5.5 Replacing Plastic Tubing in Sampling Equipment

For sampling equipment that uses plastic tubing, disassemble the equipment and install clean tubing between sample locations.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control)
- *Master Work Plan, Volume 2:*
 - AGEM-11: Handling and Disposal of Investigation-Derived Waste

7 References Cited or Consulted

EPA, 1994, *Sampling Equipment Decontamination*, SOP#2006, in “Compendium of ERT Waste Sampling Procedures,” EPA/540/P-91/008, OSWER Directive 9360.4-07, U.S. Environmental Protection Agency, Environmental Response Team, Emergency Division, Office of Emergency and Remedial Response, Washington D.C. (originally published in January 1991), August 11.

KDHE, 2011, *Decontamination of Equipment*, SOP BER-05, in “Quality Assurance Management Plan (QMP), Part II, Appendix A,” Kansas Department of Health and Environment, Division of Environment, Bureau of Environmental Remediation, Topeka, Kansas (SOP BER-05 was originally published August 14, 2000), January 1. (For links to the various sections and appendices of the QMP (Revision 6), including SOPs, dated February 21, 2019, go to <http://www.kdheks.gov/environment/qmp/qmp.htm>)

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AGEM-23:

Handling, Packing, and Shipping of Samples in the Field

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AGEM-23:

Handling, Packing, and Shipping of Samples in the Field

1 Scope and Applicability

This SOP defines AGEM's process for ensuring consistency and reliability in the preparation of field samples for shipment to a laboratory for analysis.

2 Definitions

The following is a list of the acronyms and abbreviations used in this SOP.

AGEM	Applied Geosciences and Environmental Management
ASAP	as soon as possible
°C	degrees Celsius
CFR	Code of Federal Regulations
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
g	gram(s)
mL	milliliter(s)
mm	millimeter(s)
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure
VOC	volatile organic compound

3 Responsibilities

The field project manager, or other designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Ensuring that the necessary equipment and materials are at the field site.
- Delineating and controlling work areas at the site (*Master Work Plan, Volume 1, Section 6.5*).

Personnel conducting the field sampling are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Shipping verification samples to a reference laboratory as directed in the *Master Work Plan, Volume 1*, Sections 3.2.2 and 4.2.2.
- Following additional procedures in both volumes of the *Master Work Plan* and the site-specific work plan and HASP.
- Submitting the field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Method Summary

This procedure describes the containers, preservatives, and holding times needed for various sample media and analyses, as well as the methods for using those materials to ensure sample integrity. Sample documentation requirements are specified in AGEM-27.

5 Procedures

5.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1*, Section 6.5)
- Logbooks and other documentation material
- Disposable non-talc gloves
- Shipping supplies (e.g., tape, markers, sealable plastic bags, bubble wrap, trash bags, coolers)
- Preservatives (e.g., ice, dry ice, sulfuric acid), as appropriate
- Sample containers, labels, appropriate forms, and custody seals

5.2 Sample Containers

Use sampling containers that are certified to have been cleaned to EPA specifications, either in the analytical laboratory or by a supplier. Sample size, container specifications, and preservation requirements for various media and analyses are summarized in Table 23.1.

TABLE 23.1 AGEM Program sampling containers, preservation requirements, and holding times.

Parameter	Sample Matrix	Shipping Destination	Holding Time	Preferred Sample Container and Size	Preservative	Minimum Volume ^a
Volatile Organics	Water (primary)	AGEM	10 days	4 x 20-mL vial, Teflon-lined cap	Ice, 4°C	40 mL
	Water (confirmation; 10% of samples)	TestAmerica-Burlington	10 days	2 x 40-mL vial, Teflon-lined cap	Ice, 4°C	80 mL
	Sediment/Soil (primary)	AGEM	–	Glass jar	Dry ice	50 g
	Soil (confirmation; 10% of samples)	AGEM	–	Prepared at AGEM for analysis by TestAmerica	Methanol	–
	Air	TestAmerica-Burlington	30 days	Canister from TestAmerica ^b	None	–
Cations	Water	TestAmerica-Burlington	180 days	Plastic (1 x 500 mL)	Ice, 4°C	100 mL
Anions	Water	TestAmerica-Chicago	28 days	Plastic (1 x 500 mL)	Ice, 4°C	100 mL
Ammonia	Water	TestAmerica-Chicago	28 days	Plastic (1 x 500 mL)	Ice, 4°C	100 mL
Nitrate (Total)	Water	TestAmerica-Chicago	28 days	Plastic (2 x 500 mL)	pH < 2, H ₂ SO ₄	200 mL
Nitrate	Water	TestAmerica-Chicago	48 hr	Plastic (2 x 250 mL)	None	100 mL
Tritium	Water	Miami	6-12 mo	Plastic (1000 mL)	None	1 L
Isotopes	Water	Kruger	14 days	Plastic (2 x 40 mL)	Ice, 4°C	80 mL
Total Organic Carbon	Soil	TestAmerica-Burlington	14 days	Glass jar	Ice, 4°C	20 g
	Water	TestAmerica-Burlington	28 days	2 x 40-mL vial	pH < 2, H ₂ SO ₄	80 mL
Methane, Ethane, Ethene	Water	TestAmerica-Burlington	14 days	2 x 40-mL vial	Ice, 4°C	80 mL
Sulfide	Water	TestAmerica-Burlington	30 days	Plastic (1 x 250 mL) from TestAmerica ^b	NaOH/Zn	250 mL
Hydrogen	Water	Microseeps	ASAP	Sampling tube from Microseeps ^b	None	–

^a If the indicated minimum volume is less than the preferred volume, the analysis is possible with the smaller volume, but the results will be subject to quality limitations.

^b Allow 7 days for the laboratory to provide the container.

5.3 Preparations before Sample Handling Begins

1. Create a clean and safe working environment for sample handling.
2. Put on the approved level of PPE.

5.4 Packing Samples for Shipment

1. Place the containers constituting each individual sample in a sealable plastic bag and then in a sturdy cooler double-lined with unscented plastic trash bags.
2. Preserve analytical samples with specific holding temperatures as indicated in Section 5.5 of this SOP.

5.5 Preserving Samples

5.5.1 Water Samples

For tritium analysis: Prevent the sample from freezing.

- *For total nitrate-nitrite analysis:* Preserve with sulfuric acid, pH < 2. Because calcareous solids react with acid, attempts to adjust the pH of turbid water can result in the use of excessive acid (enough to affect results via dilution), foaming, container pressurization with consequent leakage, and a sample pH outside the preservation range. Handle turbid sample as follows:
 - Remove solids before acidification by placing the sample in a settling container.
 - Wait for the water to become clear.
 - Decant the clarified water into a sample bottle, and adjust the pH.
- *For other chemical analyses, including VOCs:* old and ship at 4°C, as follows:
 - Layer the sample containers with crushed conventional (water) ice inside the trash bag.
 - Include a water trip blank.
 - Close and seal the outer trash bag.
 - Take care to prevent the samples from freezing in transit to the laboratory.

5.5.2 Soil and Sediment Samples for VOCs Analyses

1. Place the sample containers with chunks of dry ice inside the trash bag in the cooler.
2. Include a soil trip blank.
3. Close the trash bag, and then *cut ventilation slits in its top to prevent a buildup of gas pressure.*

5.5.3 Vegetation Samples for VOCs Analyses

1. Place the sample containers with chunks of dry ice inside the trash bag in the cooler.
2. No trip blank is used.
3. Close the trash bag, and then *cut ventilation slits in its top to prevent a buildup of gas pressure.*

5.5.4 Air Samples for VOCs Analyses

To return cannisters to the laboratory, package and ship them according to vendor's instructions (see also AGEM-16).

5.6 Shipping Samples

1. Complete a chain-of-custody record (AGEM-27) inventorying the contents of the cooler. Place the record inside a clearly marked plastic bag or pouch, and affix the bag or pouch to the inside lid of the cooler.
2. Tape the cooler securely with fiber filament (or equivalent strength) tape.
3. Affix two custody seals (AGEM-27), signed and dated by the shipping coordinator, to the outside of the cooler so that the cooler cannot be opened without breaking the seal.
4. Complete a standard Federal Express or equivalent airbill. Retain a copy of the airbill until receipt of the shipment is verified.
5. If the package contains dry ice, indicate that in the "Special Handling" section of the Federal Express airbill. For air shipment, the package must comply with the International Air Transport Association's Dangerous Goods Regulations. Attach the required Class 9 shipping label (shown in Exhibit 23.1).

6. Select priority overnight delivery for samples to be analyzed for VOCs.

5.7 U.S. Department of Transportation Regulations

Samples of substances listed in the DOT's hazardous materials table (see 49 CFR, Regulation 172.101) must be identified, packaged, marked, labeled, documented, and shipped according to the regulations listed for that substance. A letter of understanding between the EPA and DOT states that preservatives in water samples are exempt if the reagents do not exceed the concentrations specified in Table 23.2.

TABLE 23.2 Maximum concentrations of hazardous materials used as preservatives in water samples that are exempt from DOT hazardous materials regulations

Preservative	Concentration
Hydrochloric acid (HCl)	0.4% by weight
Mercuric chloride (HgCl ₂)	0.004% by weight
Nitric acid (HNO ₃)	0.15% by weight
Sulfuric acid (H ₂ SO ₄)	0.35% by weight
Sodium Hydroxide (NaOH)	0.08% by weight
Phosphoric acid (H ₃ PO ₄)	pH between 4 and 2

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; hazardous materials shipment training; work area designation and site control)
- *Master Work Plan, Volume 2:*
 - AGEM-11: Handling and Disposal of Investigation-Derived Waste
 - AGEM-22: Equipment Decontamination
 - AGEM-27: Sample and Document Management

7 References Cited or Consulted

BBL, Inc., 2006, "Attachment B: Standard Operating Procedures — Sampling Handling and Shipping," in *Supplemental Sediment Investigation Work Plan for Brownfield Cleanup Agreement-West Parcel, Former General Motors Assembly Plant Site, Sleepy Hollow, New York*, prepared for General Motors Corporation, Detroit, Michigan, by Blasland, Boucek, and Lee, Inc., Syracuse, New York, September.

California EPA, 1995, *Representative Sampling of Groundwater for Hazardous Substances: Guidance Manual for Groundwater Investigations*, prepared by the California EPA in coordination with the Department of Toxic Substances Control, Sacramento, California, July (revised February 2008).

<p>Shipper's Declaration not Required.</p> <p>Part B is required</p> <p>Dry ice amount must be in kilograms.</p> <p>Note 2 lbs = 1 kg.</p>		<p>Airwaysbills/airbills must have the following:</p> <ol style="list-style-type: none">1. "Dangerous Goods - Shipper's Declaration not required".2. Dry ice; 9; UN18453. $\frac{\text{Number}}{\text{(Number pgs.)}} \times \frac{\text{wt.}}{\text{(wt.)}} \text{ Kg III}$
<p>DRY ICE, _____ kg.</p> <p>Shipper's Name and Address</p> <p>_____ _____ _____</p>		<p>UN1845</p> <p>Consignee Name and Address</p> <p>_____ _____ _____</p>

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EXHIBIT 23.1 Dry ice label for shipping

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**AGEM-24:
Organic Analysis of Water Samples by the AGEM Laboratory**

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AGEM-24:

Organic Analysis of Groundwater by the AGEM Laboratory

1 Scope and Applicability

This SOP describes the analysis of water samples for VOCs, including carbon tetrachloride and chloroform, at the AGEM Laboratory. The analyses are performed at EPA Analytical Level V (*Master Work Plan, Volume 1*, Section 4.1.1, Table 4.1) by using modifications of purge-and-trap and GC-MS procedures. All QA/QC requirements of the standard procedures are met. The method detection limits are 1.0 µg/L or 0.1 µg/L, depending on the procedure used.

Water samples shipped for verification purposes to an outside laboratory are analyzed for VOCs of interest (including carbon tetrachloride and chloroform) according to rigorous analytical methods such as EPA Contract Laboratory Program SOW SOM01.2-trace (EPA 2007), which has a method detection limit of 5.0 µg/L. These analyses are not described in this SOP.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
°C	degree(s) Celsius
EPA	U.S. Environmental Protection Agency
GC-MS	gas chromatograph-mass spectrometer
L	liter(s)
min	minute(s)
mL	milliliter(s)
mm	millimeter(s)
m	meter(s)
PPE	personal protective equipment
QA/QC	quality assurance/quality control
µg	microgram(s)
RSD	relative standard deviation
SOP	standard operating procedure
SOW	statement of work
VOC	volatile organic compound

3 Method Summary

Water samples are prepared for analysis by the purge-and-trap procedure, using EPA Method 5030B (EPA 2014).

To achieve the low detection limits required for analysis of well water and drinking water samples, the AGEM Laboratory has developed a modification of the EPA Method 524.2 (EPA 1995). This modification is used preferentially by the AGEM Laboratory for all water samples, because most of the water samples analyzed are well water or drinking water. EPA Method 524.2 is equivalent to EPA Method 8260B, except that it is more restrictive in terms of detection limits and QA/QC standards. Instrumental detection limits for EPA Method 524.2 are 0.04 µg/L for carbon tetrachloride and 0.02 µg/L for chloroform. Method detection limits are estimated at 0.1 µg/L for both components, and the quantitation limits are 1.0 µg/L. The analysis of each sample takes approximately 40 min (including purging and separation/detection time). The total analytical capacity of the laboratory is approximately 28 samples per day.

4 Procedures

4.1 Supplies Needed

- PPE (Master Work Plan, Volume 1, Section 6.5)
- Logbooks and other documentation material
- Reagents, materials, and equipment as specified in the analytical methods

4.2 Purge-and-Trap Sample Preparation — EPA Method 5030B

Sample preparation EPA Method 5030B is implemented as directed (EPA 2014), with the following parameters:

Trap:	Tenax-silica gel-charcoal
Desorb temperature:	-10°C (dry ice cryogenic trap)
Purge time:	11 min
Desorb temperature:	220°C
Desorb time:	4 min

4.3 Analysis of Volatile Organic Compounds in Water — EPA Methods 524.2 and 8260B

EPA Methods 524.2 and 8260B are implemented as directed (EPA 1995, 2014) and as described below, except for the modifications noted in Section 5.3 of this SOP.

4.3.1 Water Analysis Modifications

1. Sample size is 10 mL instead of the 5 mL recommended.
2. A Tenax-silica gel-charcoal trap is used in conjunction with a dry ice cryogenic interface.
3. The dry ice cryogenic trap is at -10°C.
4. The desorption temperature is increased from 180°C to 220°C.
5. The Supelco DB-624 capillary column used is 30 m long and 0.25 mm in diameter.
6. Fluorobenzene, 1,2-dichlorobenzene, and bromofluorobenzene are used as internal standard and surrogates.

4.3.2 Calibration for Water Analysis

Calibrate the instrument as follows:

1. Prepare standard samples with concentrations ranging from 0.1 µg/L to 100 µg/L.
2. Analyze the samples.
3. Prepare a calibration plot.
4. Perform calibration checks regularly.
5. The system is presently calibrated for the following compounds:

benzene	1,1-dichloroethene
bromodichloromethane	1,2-dichloropropane
4-bromofluorobenzene	Fluorobenzene
carbon tetrachloride	Methylene chloride
chlorobenzene	tetrachloroethene
chloroform	1,1,2,2-tetrachloroethane
dibromochloromethane	toluene
1,2-dichlorobenzene-d4	1,1,1-trichloroethane
1,1-dichloroethane	1,1,2-trichloroethane
1,2-dichloroethane	trichloroethene

4.3.3 Step-by Step Procedure for Water Analysis

The analysis procedure is as follows:

1. For sample analysis, place 10-mL samples into purge tubes. Add 10 μ L each of fluorobenzene (internal standard), 1,2-dichlorobenzene (surrogate), and bromofluorobenzene (surrogate) to each sample, and place the sample in the autosampler.
2. Bubble an inert gas through the sample to extract (purge) the VOCs from the sample matrix.
3. Trap the purged components in a sorbent tube.
4. Heat the sorbent tube.
5. Backflush the tube with an inert gas to desorb the components into the GC-MS system.
6. Identify the compounds eluting from the GC column by retention time and by comparison with reference library spectra.
7. Analysis parameters are as follows:

Line temperature:	100°C
Column:	0.25-mm $\times$ 30-m DB-624 (Supelco)
Carrier flow:	1 mL/min (helium)
Oven profile:	35°C (6 min) to 200°C (2.5 min) at 10°C/min
Detector:	mass spectrometer

8. Calculate the concentration of each compound through comparison of the MS response for the quantitation ion to corresponding calibration curves or results for internal standards.

4.3.4 Quality Assurance/Quality Control for EPA Method 524.2

The QA/QC requirements for each data set are as follows:

1. Laboratory blanks (minimum of 10% of the samples)
2. Calibration curves (minimum of six points)
3. Duplicate samples (minimum of 10% of the samples)
4. Calibration checks (RSD less than $\pm 20\%$)

5. Instrument calibration (autotune and 4-bromofluorobenzene tune)
6. Surrogate spike recoveries (RSD less than $\pm 20\%$).

5 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.1 (data quality objectives)
 - Section 4.2 (QA/QC for sampling)
- *Master Work Plan, Volume 2:*
 - AGEM-05: Purge Groundwater Sampling
 - AGEM-06: Low-Flow Groundwater Sampling
 - AGEM-17: Surface Water Sampling
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field
 - AGEM-25: Organic Analysis of Soil Samples by the AGEM Laboratory
 - AGEM-26: Organic Analysis of Vegetation Samples by the AGEM Laboratory
 - AGEM-27: Sample and Document Management

6 References Cited or Consulted

EPA, 1987, *Data Quality Objectives for Remedial Response Activities: Development Process*, EPA/540/G-87/003, OSWER Directive 9355.0-7B, March.

EPA, 1995, *Method 524.2: Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, Revision 4.1*, edited by J.W. Munch, National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio.

EPA, 2007, "Exhibit D — Analytical Methods: Analytical Method for the Analysis of Trace Concentrations of Volatile Organic Compounds," in *Multi-Media, Multi-Concentration Organics Analysis, SOM01.2*, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 2014, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, in “The SW846 Compendium,” Update V, U.S. Environmental Protection Agency, July (see <https://www.epa.gov/hw-sw846/sw-846-compendium> for searchable table of methods and notices regarding updates).

**Environmental Investigations at
Former CCC/USDA Facilities: Master Work Plan**

Volume 2: Standard Operating Procedures

AGEM-25:

Organic Analysis of Soil Samples by the AGEM Laboratory

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AGEM-25:

Organic Analysis of Soil Samples by the AGEM Laboratory

1 Scope and Applicability

This SOP describes the handling of soil samples at the AGEM Laboratory and their analysis for VOCs including carbon tetrachloride and chloroform. The analyses are performed at EPA Analytical Level V (*Master Work Plan, Volume 1, Section 4.1.1, Table 4.1*) by standard EPA GC-MS procedures or modifications of the standard procedures. All QA/QC requirements of the standard procedures are met. The method quantitation limits for carbon tetrachloride in soil are 10 µg/kg or lower.

The use of methanol as a combined preservative and extractant in field sample collection is *not* appropriate for the low-concentration soil analysis procedure used by the AGEM Laboratory.

Soil samples shipped for verification purposes to an outside laboratory are analyzed for VOCs of interest (including carbon tetrachloride and chloroform) according to procedures, including EPA Methods 5035 and 8010 (EPA 2014), with method detection limits for medium-level soils as high as 60 µg/kg. The verification analyses are not described in this SOP.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
°C	degree(s) Celsius
EPA	U.S. Environmental Protection Agency
GC-MS	gas chromatograph-mass spectrometer
g	gram(s)
hr	hour(s)
kg	kilogram(s)
L	liter(s)
min	minute(s)
mL	milliliter(s)
mm	millimeter(s)
m	meter(s)
PPE	personal protective equipment
QA/QC	quality assurance/quality control
µg	microgram(s)
RSD	relative standard deviation
SOP	standard operating procedure

SOW	statement of work
VOC	volatile organic compounds

3 Method Summary

Soil samples preserved in the field and transported on dry ice (-78°C) rather than on water ice at 4°C, per the method of Alvarado and Rose (2004). Sample handling is described in SOP AGEM-23.

The two analysis schemes used by the AGEM Laboratory for low-level VOCs analyses of soil samples are as follows:

1. Headspace method

- Headspace analysis is conducted by an AGEM Laboratory modification (Alvarado and Rose 2004) of EPA Method 5021-1 (EPA 2014), with separation and analysis on a gas chromatograph and an electron capture detector.
- In the equilibrium headspace sample preparation procedure (EPA Method 5021-1), VOCs in the soil sample matrix are allowed to volatilize, with heating and agitation, into the headspace of a sample vial. The vapor in the headspace is subsequently analyzed.
- The highly sensitive AGEM Laboratory headspace method gives qualitative results that are used as a guide in the selection of field investigation locations.
- Typical reporting limits are 0.5 µg/kg for carbon tetrachloride and 0.75 µg/kg for chloroform. (The frequent presence of chloroform in the methanol solvent used prevents accurate preparation of chloroform standards at lower concentrations.)
- Analysis time is approximately 15 min per sample, after equilibration for 60 min. The total analytical capacity of the AGEM Laboratory is approximately 36 samples per day, with a sampler that allows the equilibration of multiple samples to be started during the analysis of previous samples.

2. Purge-and-trap method

- The purge-and-trap method involves methanol extraction by a modification of EPA Method 5035, with sample preparation by purge-and-trap EPA Method 5030B and analysis by GC-MS EPA Method 8260B (EPA 2014).
- In this method, the VOCs are purged from the methanol extract of the sample by bubbling an inert gas through the extract. The purged components are

trapped in a sorbent tube, which is subsequently heated and backflushed with an inert gas to desorb the components into the GC-MS system for analysis.

- This method is quantitative and gives results suitable for determination of risk.
- The instrument detection limit is 0.05 µg/kg, the method detection limit is 1.0 µg/kg, and the method quantitation limit is 10 µg/kg.
- Analysis time is approximately 40 min per sample (including purging and separation/detection time). The total analytical capacity of the AGEM Laboratory with this method is approximately 14 samples per day.

4 Procedures

4.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Logbooks and other documentation material
- Reagents, materials, and equipment as specified in the analytical methods

4.2 Soil Sample Handling in the Laboratory

Store soil samples in the laboratory in a sub-zero freezer at -78°C.

Split each soil sample received at the AGEM Laboratory, as follows:

1. Seal one portion (0.5-1 g) in a weighed headspace vial with a high-temperature Teflon-faced septum seal for immediate analysis with EPA Method 5021-1 (Section 4.3 of this SOP).
2. Place a second portion (approximately 10 g) in a VOCs analysis vial (Section 4.4.1 of this SOP). Add methanol to an approximate sample to methanol ratio of 1:1. Analyze according to the purge-and-trap method (Section 4.4 of this SOP).

4.3 Headspace Method

4.3.1 Features of the AGEM Laboratory Method

Features of the AGEM Laboratory headspace method (Alvarado and Rose 2004) that achieve low detection limits are as follows:

- Sample preservation is on dry ice at -78°C rather than at 4°C.
- The analysis relies on external calibration.

4.3.2 Standard Preparation and Instrument Calibration for the Headspace Method

The system is presently calibrated for the VOCs carbon tetrachloride, chloroform, and tetrachloroethene.

Before each analysis run, calibrate the analytical system as follows:

- Prepare standards by injecting known quantities of dilute standards containing carbon tetrachloride, tetrachloroethene, and chloroform into a headspace vial.
- With each set of samples, analyze standards to generate a calibration curve with a minimum of six points, based on the mass of each compound present in the vial.
- Determine VOCs concentrations in the samples by comparison of analytical results for the samples with the calibration curves.

4.3.3 Gas Chromatograph Parameters for the Headspace Method

The GC parameters for headspace soil analysis are as follows:

Sampler:	headspace
Oven temperature:	90°C
Equilibration hold time:	60 min
Vial pressurization time:	0.30 min
Loop fill time:	0.40 min
Loop equilibrium time:	0.10 min
Sample injection time:	1.00 min
Oven stabilization time:	1.00 min
Agitation:	high
Oven step:	no
Equilibration step increase:	no

4.3.4 Implementation of the Headspace Method

To implement the headspace method, proceed as follows:

- Weigh a 20-mL headspace vial to 0.001-g accuracy.
- Seal 0.5-1 g of sample in the weighed headspace vial.

- Weigh the vial and sample to 0.001-g accuracy. Subtract to obtain the sample weight.
- Continue with EPA Method 5021-1 as directed (EPA 2014).

4.3.5 Quality Assurance/Quality Control Requirements for the Headspace Method

Overall reproducibility is 5-15%. With each set of samples, perform the following analyses and checks:

- Calibration standards
- Laboratory blanks
- Field blanks
- A sample duplicate

4.4 Purge-and-Trap Method

4.4.1 Sample Preparation for the Purge-and-Trap Method

Prepare soil samples for purge-and-trap analysis as follows:

- Place approximately 10 g of soil in a VOCs analysis vial.
- Add an equal volume (10 mL) of pure methanol.
- Shake the vial.
- Allow the contents to equilibrate for approximately 24 hr.

4.4.2 Standard Preparation and Instrument Calibration for the Purge-and-Trap Method

The system is presently calibrated for the following compounds:

benzene	1,1-dichloroethene	tetrachloroethane
bromodichloromethane	1,2-dichlorobenzene-d4	1,1,2,2-tetrachloroethane
4-bromofluorobenzene	1,1-dichloroethane	toluene
carbon tetrachloride	1,2-dichloroethane	1,1,1-trichloroethane
chlorobenzene	1,2-dichloropropane	1,1,2-trichloroethane
chloroform	fluorobenzene	trichloroethene
dibromochloromethane	methylene chloride	

Before each analysis run, calibrate the system as follows:

1. Prepare standard samples with concentrations of the above compounds ranging from 1.0 µg/L to 100 µg/L.
2. Analyze the standards, and prepare calibration plots.
3. Perform regular calibration checks.

4.4.3 Implementation of the Purge-and-Trap Method

Implement EPA Methods 5035, 5030B, and 8260B as directed (EPA 2014). Briefly, the analysis procedure is as follows:

1. Into purge tubes, place 10-mL samples consisting of 9 mL of water and 1 mL of the methanol extract after 24-hr equilibration.
2. To each sample, add 10 µL of each of the following:
 - Fluorobenzene (internal standard)
 - 1,2-Dichlorobenzene-d4 (surrogate)
 - Bromofluorobenzene (surrogate)
3. Place the sample in the autosampler.
4. Analysis parameters are as follows:

Trap:	Tenax-silica gel-charcoal
Desorb temperature:	-10°C (dry ice cryogenic trap)
Purge time:	11 min
Desorb temperature:	220°C
Desorb time:	4 min
Line temperature:	100°C
Column:	0.31 mm x 30 m DB-624
Carrier flow:	1 mL/min (helium)
Oven profile:	35°C (6 min) to 200°C (2.5 min) at 10°C/min
Detector:	mass spectrometer

5. Identify compounds eluting from the GC column by retention time and by comparison of the MS response for the quantitation ion to corresponding calibration curves or internal standards.

6. Calculate the concentration of each compound by comparison of the MS response for the quantitation ion to the corresponding calibration curve or results for an internal standard.

4.4.4 Quality Assurance/Quality Control Requirements for the Purge-and-Trap Method

All QA/QC requirements in EPA Methods 5030B and 8260B must be met. With each set of samples, perform the following analyses or checks:

- Laboratory blanks
- Calibration curves (at least eight points)
- Duplicate samples
- Calibration checks (RSD less than $\pm 20\%$)
- Instrument calibration (autotune and 4-bromofluorobenzene tune)
- Surrogate spike recoveries (RSD less than $\pm 20\%$)

5 Related Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.1 (data quality objectives)
 - Section 4.2 (QA/QC for sampling)
- *Master Work Plan, Volume 2:*
 - AGEM-10: Soil Sampling
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field
 - AGEM-24: Organic Analysis of Water Samples by the AGEM Laboratory
 - AGEM-26: Organic Analysis of Vegetation Samples by the AGEM Laboratory
 - AGEM-27: Sample and Document Management

6 References Cited or Consulted

Alvarado, J.S., and C. Rose, 2004, "Static Headspace Analysis of Volatile Organic Compounds in Soil and Vegetation Samples for Site Characterization," *Talanta* 62:17-23.

EPA, 1987, *Data Quality Objectives for Remedial Response Activities: Development Process*, EPA/540/G-87/003, OSWER Directive 9355.0-7B, March.

EPA, 1989, *U.S. EPA Contract Laboratory Program, Statement of Work for Organic Analysis: Multi-Media, Multi-Concentration*, U.S. Environmental Protection Agency SOW No. 2/88, including revisions 9/88 and 4/89.

EPA, 2014, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, in "The SW846 Compendium," Update V, U.S. Environmental Protection Agency, July (see <https://www.epa.gov/hw-sw846/sw-846-compendium> for searchable table of methods and notices regarding updates).

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AGEM-26:

Organic Analysis of Vegetation Samples by the AGEM Laboratory

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AGEM 26:

Organic Analysis of Vegetation Samples by the AGEM Laboratory

1 Scope and Applicability

This SOP describes the handling of vegetation samples at the AGEM Laboratory and their analysis for VOCs, including carbon tetrachloride and chloroform. The analyses are performed at EPA Analytical Level V (*Master Work Plan, Volume 1, Section 4.1.1, Table 4.1*) by a headspace GC-ECD procedure that is a published modification of a standard EPA procedure.

Vegetation samples are not submitted for verification analysis by an outside laboratory.

2 Definitions

The following is a list of the acronyms and abbreviations (including units of measure) used in this SOP.

AGEM	Applied Geosciences and Environmental Management
°C	degree(s) Celsius
EPA	U.S. Environmental Protection Agency
GC-ECD	gas chromatograph-electron capture detector
g	gram(s)
min	minute(s)
mL	milliliter(s)
PPE	personal protective equipment
QA/QC	quality assurance/quality control
µg	microgram(s)
SOP	standard operating procedure
VOC	volatile organic compound

3 Method Summary

Vegetation samples preserved in the field and transported on dry ice (-78°C) rather than on water ice at 4°C, per the method of Alvarado and Rose (2004). Sample handling is described in SOP AGEM-23.

The headspace method used by the AGEM Laboratory for low-level VOCs analysis of vegetation samples is similar to the headspace soil analysis method described in SOP AGEM-25. Briefly, the vegetation headspace method is as follows:

- Headspace analysis is conducted by an AGEM Laboratory modification (Alvarado and Rose 2004) of EPA Method 5021-1 (EPA 2014), with separation and analysis on a GC-ECD system.
- In the equilibrium headspace sample preparation procedure (EPA Method 5021-1), VOCs in the vegetation sample matrix are allowed to volatilize, with heating and agitation, into the headspace of a sample vial. The vapor in the headspace is subsequently analyzed.
- Typical detection limits are 0.5 µg/kg for carbon tetrachloride and 0.75 µg/kg for chloroform. (The frequent presence of chloroform in the methanol solvent used prevents accurate preparation of chloroform standards at lower concentrations.)
- Blank samples are analyzed between investigative samples to preclude cross-contamination.

4 Procedures

4.1 Supplies Needed

- PPE (*Master Work Plan, Volume 1, Section 6.5*)
- Logbooks and other documentation material
- Reagents, materials, and equipment as specified in the analytical methods

4.2 Vegetation Sample Handling in the Laboratory

Store vegetation samples until analysis in a sub-zero freezer at -78°C. Immediately before analysis, prepare the samples as follows:

1. Cut or grind the frozen plant tissues to increase surface area.
2. Seal 0.5-1 g of the frozen tissue in a weighed headspace vial with a high-temperature Teflon-faced septum seal for immediate analysis with EPA Method 5021-1.

4.3 Vegetation Analysis with the Headspace Method

4.3.1 Features of the AGEM Laboratory Method

Features of the AGEM Laboratory headspace method (Alvarado and Rose 2004) that achieve low detection limits are as follows:

- Sample preservation is on dry ice at -78°C rather than at 4°C.
- Oven temperature is increased to 90°C for 120 min to ensure complete evaporation of the VOCs of interest from the tissue matrix.
- The analysis relies on external calibration.
- No surrogate spikes are added to the samples.
- No GC injector is used. A sub-loop is used for direct injection onto the capillary column.

4.3.2 Standard Preparation and Instrument Calibration for the Headspace Method

The system is presently calibrated for the VOCs carbon tetrachloride, chloroform, tetrachloroethene.

Before each analysis run, calibrate the analytical system as follows:

- Prepare standards by injecting known quantities of dilute standards containing carbon tetrachloride, tetrachloroethene, and chloroform into a headspace vial.
- With each set of samples, analyze standards to generate a calibration curve with a minimum of six points, based on the mass of each compound present in the vial.
- Determine VOCs concentrations in the samples by comparison of analytical results for the samples with the calibration curves.

4.3.3 Gas Chromatograph Parameters for the Headspace Method

The GC parameters for headspace vegetation analysis are as follows:

Sampler:	headspace
Oven temperature:	90°C
Equilibration hold time:	120 min
Vial pressurization time:	0.20 min
Loop fill time:	0.20 min
Loop equilibrium time:	0.05 min
Sample injection time:	1.00 min
Oven stabilization time:	1.00 min
Agitation:	high
Oven step:	no
Equilibration step increase:	no

4.3.4 Implementation of the Headspace Method

To implement the headspace method, proceed as follows:

- Weigh a 20-mL headspace vial to 0.01-g accuracy.
- Seal 0.5-1.0 g of sample in the weighed headspace vial.
- Weigh the vial and sample to 0.01-g accuracy. Subtract to obtain the sample weight.
- Except for the modifications noted in Section 4.3.3 of this SOP, implement EPA Method 5021-1 as directed (EPA 2014).

4.3.5 Quality Assurance/Quality Control Requirements for the Headspace Method

Overall reproducibility is 5-15%. With each set of samples, perform the following analyses and checks:

- Calibration standards
- Laboratory blanks
- A sample duplicate

5 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.1 (data quality objectives)
 - Section 4.2 (QA/QC for sampling)
- *Master Work Plan, Volume 2:*
 - AGEM-23: Handling, Packing, and Shipping of Samples in the Field
 - AGEM-24: Organic Analysis of Water Samples by the AGEM Laboratory
 - AGEM-25: Organic Analysis of Soil Samples by the AGEM Laboratory
 - AGEM-27: Sample and Document Management

6 References Cited or Consulted

Alvarado, J.S., and C. Rose, 2004, "Static Headspace Analysis of Volatile Organic Compounds in Soil and Vegetation Samples for Site Characterization, *Talanta* 62:17-23.

EPA, 1987, *Data Quality Objectives for Remedial Response Activities: Development Process*, EPA/540/G-87/003, OSWER Directive 9355.0-7B, March.

EPA, 2014, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, in "The SW846 Compendium," Update V, U.S. Environmental Protection Agency, July (see <https://www.epa.gov/hw-sw846/sw-846-compendium> for searchable table of methods and notices regarding updates).

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**AGEM 27:
Sample and Document Management**

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AGEM 27:

Sample and Document Management

1 Scope and Applicability

This procedure provides a framework and specific guidance for maintaining control of samples and documentation. These procedures are needed to (1) establish the authenticity of information generated, (2) facilitate interpretation of sampling and analysis results, and (3) maintain the program archives to objectively demonstrate the research, administrative, and operational activities of AGEM.

2 Definitions

The following is a list of the acronyms and abbreviations used in this SOP.

AGEM	Applied Geosciences and Environmental Management
BER	Bureau of Remediation (KDHE)
COC	chain-of-custody (form)
DOE	U.S. Department of Energy
EVS	Environmental Sciences (Division at Argonne National Laboratory)
hr	hour(s)
ID	identification
KDHE	Kansas Department of Health and the Environment
PPE	personal protective equipment
QA/QC	quality assurance/quality control
SOP	standard operating procedure
VOC	volatile organic compound

3 Responsibilities

3.1 AGEM Program Manager

The AGEM program manager is responsible for the following:

- Delegating responsibility for sample and document management to accomplish the tasks indicated in this SOP.
- Determining when samples and other physical evidence or project information may be discarded.

3.2 Field Project Manager

The field project manager, or another designee of the AGEM program manager, is responsible for the following:

- Verifying that the personnel implementing this SOP understand the procedure and are capable of implementing it correctly.
- Verifying that the personnel implementing this SOP understand the specific work planned for each field event.
- Gathering the sample labels, logbooks, and other forms needed for the field project and transporting them to the work site.
- Verifying that quality checks are performed on sample labels and other sampling records.
- Verifying that COC records have been reviewed and are properly signed before sample shipment.
- Verifying that the original signed COC record is shipped with samples to the laboratory in a prominently labeled plastic pouch in the shipping container and that a copy is retained in a temporary field file until the original reaches the laboratory.
- Verifying that the custody seals are signed and dated.
- Verifying that custody seals are affixed to sample shipping containers in a way that can demonstrate the integrity of the samples when the shipment arrives at the analytical chemistry laboratory.
- Maintaining an inventory of all project documents, including the *Master Work Plan* and site-specific work plan, field records, sample labels, COC records, shipping forms, correspondence, notes, legal documents, illustrations, software programs, and analytical data.
- Verifying that all required field records are completed and made available for review by the AGEM QA/QC coordinator.

3.3 Field Personnel

Personnel conducting the field program are responsible for the following:

- Implementing this SOP and related procedures, as directed.
- Completing field records as described in this procedure.

- Recording water level measurements as directed in Section 4.8 of this SOP.
- Following additional procedures in the *Master Work Plan* and the site-specific work plan.
- Submitting field notes to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

Personnel handling samples in the field are responsible for the following:

- Completing sampling records (Section 4.4 of this SOP).
- Labeling samples so that they can be easily identified and distinguished from other similar samples, from collection to analysis (Section 4.5 of this SOP).
- Assigning sample identification codes in accordance with Section 4.3 of this SOP.
- Shipping verification samples to a reference laboratory as directed in the *Master Work Plan, Volume 1*, Section 4.1.1.
- Initialing COC records (Section 4.6 of this SOP).
- Placing the original COC record in the shipping container with the samples sent to the laboratory, in a prominently labeled plastic pouch, and making a copy of the COC record for the temporary field file.

3.4 Records Coordinator and QA/QC Coordinator

The AGEM records coordinator is responsible for the following:

- Maintaining the environmental data management system of field, laboratory, and other data.
- Logging in samples and entering sample information into the environmental data management system.
- Identifying documents comprising records from among information generated or received by the program consistent with Argonne and DOE policy.
- Placing field and program records in the electronic recordkeeping system in accord with the established organizational hierarchy.
- Preserving the reliability, authenticity, integrity, usability, content, context and structure of archived field and program records, objectives articulated in federal records management policy.

- Coordinate with the division records coordinator to retain and dispose of records on schedules defined by Argonne and DOE policy.

The AGEM QA/QC coordinator is responsible for the following:

- Verifying the completeness and accuracy of recorded information by performing a cross-check of sample documentation in the field sampling records, reported on the COC record, and included in the environmental data management system.
- Resolving discrepancies in project documentation and recording the outcome.

3.5 Analytical Laboratory Personnel

Analytical laboratory personnel are responsible for the following:

- Recording the condition of samples and documentation received in the laboratory.
- Conducting analyses as prioritized by the AGEM project manager or designee and within holding times.
- Maintaining documentation to demonstrate that analyses were conducted according to QA/QC protocols.
- Submitting documentation to the AGEM QA/QC coordinator for review and to the AGEM records coordinator for retention in the program archives.

4 Documentation of Field Activities

4.1 Supplies Needed for Field Documentation

- Pens with waterproof ink
- Pencils
- Forms, serialized sample labels, logbooks, COC forms, custody seals

4.2 Procedures for Completing Documentation

- Use waterproof ink unless weather conditions prohibit the use of ink. In that case, use a pencil and note the reason.

- If an error is made on any field document, make a correction by drawing a single line through the error and entering the correct information. Initial and date all corrections.
- If a field document is damaged, lost, or destroyed, record the serial number of the document and the nature of the problem. Keep voided documents so that they can be maintained in the files for accountability.

4.3 Assigning Sample Identification Codes

Assign each sample collected for analysis a unique five-digit number selected from a continuous number series, plus encoded information, to create an alphanumeric identifier (sample ID). The encoded information must identify the work site and sample matrix. Additional information normally specifies the sample location designation (for environmental samples) or the sample type (for QC samples).

The general system is as follows:

Sample ID:	AABBB-C-DDDDD
A	Site name (two letters)
B	Additional information (letters, numbers, or both; variable number of characters)
-C-	Sample medium (one letter)
D	Unique serial number (five digits)

Though the serial number alone distinguishes the sample uniquely, the additional information facilitates sample handling and data processing and provides a safeguard against transcriptional errors. In practice, the AGEM records coordinator (before mobilization to the field) assigns a block of numbers from a continuous series to an event at a site. A preprinted label carrying a number from this series is assigned to each sample at the time of sampling.

Examples are as follows:

Sample ID:	MRSB01-S-10445
MR	Morrill, Kansas
SB01	Soil boring number 01, a formally named and mapped location
-S-	Soil
10445	Unique number assigned from continuous series

Sample ID:	MRQCTB-W-10446
MR	Morrill, Kansas
QC	Quality control sample
TB	Trip blank
-W-	Water
10446	Unique number assigned from continuous series

4.4 Documenting Sample Collection

For all sampling activities, field personnel are responsible for recording (1) the sequence of activities (for later reconstruction of the sampling event) and (2) the location and size of each sample collected. Record the following information on a suitable form:

- The unique sample ID (Section 4.3).
- Sample medium.
- Size and type of sample container.
- Analysis to be performed.
- Type and volume of preservative(s) added (if applicable) and the preservation conditions.
- Day, month, and year of sample collection.
- Time (based on the 24-hr clock) of sample collection.
- Site name.
- General location of the sampled area.
- Exact point where the sample was collected.
- Depth below the ground surface level where the sample was collected.
- Visual or other observations relevant to the sampling area, the waste source, or the sample itself, such as the following:
 - Soil — color, texture, moisture, cohesiveness, odor

- Sediment — exposed or lying under water, texture, color, cohesiveness, viscosity
- Water — turbidity, water level, flow, flow rate
- Drum — container type, size, shape, markings, volume of contents, viscosity
- Sampling site — terrain, topography, landforms
- Results of quantitative field measurements of the site or the sample (e.g., pH, conductivity).
- Type of sample (e.g., waste, quality control, branch, leaf, surface water).
- Deviations from procedures specified in the *Master Work Plan, Volumes 1 and 2* (main text and SOPs) or in the site-specific work plan.
- Signature to verify recording of the entries on the form.
- Signature to verify performance of the QA check on the completed form.

4.5 Sample Label

To maintain sample identity, beginning at the time of sample collection, use self-adhesive labels preprinted with the site identifier and unique five-digit numbers incorporated into sample IDs (Section 2.3 of this SOP). Add other portions of the sample identification code indicated in Section 2.3. If more sample aliquots are collected for analysis than preprinted labels are available, use standard commercially available sample labels.

The sample label must be completed by the person collecting the sample. After a review of the sample documentation by the AGEM QA/QC coordinator, the AGEM records coordinator enters the label information into the environmental data management system during sample log-in. An example of a sample label is shown in Exhibit 27.1.

4.6 Chain-of-Custody Record

The purpose of the serialized COC record (Exhibit 27.2) is to document, as evidence admissible in a court of law, transfers in the possession and custody of samples. Properly completed, the COC record demonstrates that, from sample collection to laboratory analysis, the sample was continuously under custody. The COC record unequivocally links samples collected in the field with the data reported by the analytical laboratory. Responsibilities are summarized in the main text of this volume.

The process for initiating and handling the COC record is as follows:

- The sampler initially completes the COC record; individuals accepting or relinquishing custody of the sample subsequently review and sign the COC record.
- The field project manager or designee reviews and signs the COC record.
- The original signed COC record is placed, with the samples, in a prominently labeled plastic pouch inside the shipping container for transfer to the primary laboratory.
- Analytical laboratory personnel review and sign the original COC record and send it to the AGEM records coordinator.
- The AGEM records coordinator enters the COC information in the environmental data management system, scans the original signed COC record to an electronic format, and retains a copy in the electronic recordkeeping system.
- The field project manager keeps a copy of the COC record until the original is received at the laboratory.

The serialized COC record form must contain the following information:

- The medium (soil/sediment or groundwater) sampled.
- The name of the laboratory to which the sample is being sent.
- The identifying number or physical description of the shipping container.
- Carrier airbill number or other pertinent shipping detail.
- The name and telephone number of an individual who can provide information about the sample(s).
- The name of the site where the sample was collected.
- The signature(s) of individual(s) who physically collected the sample.

- The day, month, and year of sample collection.
- The ID number(s) of the sample(s).
- The total number of containers used for each respective sample.
- The analysis to be performed on the sample(s).
- Comments about the individual sample(s), such as “Sample container was broken and discarded.”
- The names of the individual who relinquished custody of the sample(s) and the individual who accepted custody, together with the date and time of transfer. The first person to relinquish the sample(s) must be one of the sample collectors.
- Comments about all of the samples inventoried on the COC record, such as, “High-priority sample. Please analyze first and fax preliminary results to field project manager.”
- Verification by analytical laboratory personnel that the custody seal and sample containers were intact when they were received; that the shipment was at the required temperature; and that the sample labels, tags, and COC record agree.

4.7 Custody Seal

During shipment from the field to the analytical chemistry laboratory, samples pass through the hands of unidentified individuals. The purpose of the custody seal (Exhibit 27.3) is to maintain the security of the samples during this period, so that signatures of the unidentified intermediate handlers are not required on the COC record. The custody seal must be affixed to the shipping container in a way that can demonstrate, upon arrival at the analytical laboratory, that the samples were secure during shipment. The custody seal must be signed and dated when the container is prepared for shipping from the field site. Responsibilities are defined in the main text of this volume.

4.8 Recording Water Level Measurements

Water levels measured *during drilling and construction* are not entered into the environmental data management system and are recorded separately from that system. Measure pre-completion water levels relative to the ground surface level; enter the results in field records for drilling, sampling, or both if relevant.

Once a well has been completed, measure all water levels relative to the accurately surveyed reference point for each well. Water levels measured in this way are entered into the environmental data management system for a site. During the sampling of newly completed and

developed wells, enter the measurements in the field sampling record initially, and then transcribe the data to the environmental data management system, when appropriate. For long-term water level monitoring programs, incorporate water level measurements into the environmental data management system.

4.9 Discarding Samples

A sample and its container may be discarded only as authorized by the AGEM program manager, in writing, in response to a written request.

5 Documentation of Program Activities

Procedures for managing program records include:

- Identifying documents comprising records from among information generated or received by the program that are required to be retained consistent with applicable Argonne and DOE policy.
- Classifying the record within the hierarchy of the established filing scheme and retaining it in the electronic recordkeeping system.
- Saving each record's metadata to document the provenance and contextual information of the record. Types of metadata include the purpose; method of creation; date of creation; creator or author; standards used in creation; origin location; and retention location of the record.
- Observing retention periods specified in applicable Argonne and DOE policy to manage each record throughout its entire lifecycle, from receipt or generation of information, to disposition at the end of its lifecycle.

6 Related Internal Procedures

- *Master Work Plan, Volume 1:*
 - Section 4.2 (QA/QC for sampling)
 - Section 6.5 (PPE; work area designation and site control)
- *Master Work Plan, Volume 2:*
 - AGEM-05: Purge Groundwater Sampling
 - AGEM-06: Low-Flow Groundwater Sampling

- AGEM-07: Measuring Water Levels in Wells
- AGEM-10: Soil Sampling
- AGEM-11: Handling and Disposal of Investigation-Derived Waste
- AGEM-13: Soil Gas Sampling for Chemical Analysis
- AGEM-15: Sub-Slab Soil Vapor Sampling for Vapor Intrusion Applications
- AGEM-16: Air Sampling for Chemical Analysis
- AGEM-17: Surface Water Sampling
- AGEM-18: Sediment Sampling
- AGEM-19: Vegetation Sampling for Chemical Analysis
- AGEM-21: Calibration of Field Instrumentation and PID Operation
- AGEM-22: Equipment Decontamination
- AGEM-23: Handling, Packing, and Shipping of Samples in the Field
- Other:
 - Argonne National Laboratory: *Guidelines to Policies and Practices, Project Records Management*, EVS Division.
 - Argonne National Laboratory: *Records Management and Control*, Laboratory-Wide Argonne Procedure, Laboratory Management System PROC-2.
 - DOE, 2013: *Records Management Program, Attachment 1: Contractor Requirements Document*, U.S. Department of Energy Order DOE O 243.1B, March 11.

7 References Cited or Consulted

KDHE, 2011, *Chain of Custody*, SOP BER-19, in “Quality Assurance Management Plan (QMP), Part II, Appendix A,” Kansas Department of Health and Environment, Division of Environment, Bureau of Environmental Remediation, Topeka, Kansas (SOP BER-19 was originally published on October 15, 2000), January 1. (For links to the various sections and appendices of the QMP [Revision 6], including SOPs, dated February 21, 2019, go to <http://www.kdheks.gov/environment/qmp/qmp.htm>)

EPA, 2002, *Standard Operating Procedure for Chain of Custody of Samples*, prepared by the Office of Environmental Measurement and Evaluation, EPA New England, Region 1, North Chelmsford, Massachusetts, March 25.

Thermo SCIENTIFIC		90003 0512
CLIENT/SOURCE	☐ GRAB ☐ COMPOSITE	
SITE NAME	DATE/TIME	
SAMPLE #	PRESERVATIVE	
ANALYSIS	COLL. BY	

EXHIBIT 27.1 Sample Label

7393

MATRIX:			ARGONNE NATIONAL LABORATORY CHAIN OF CUSTODY RECORD*										Shipping Container:							
RECEIVING LAB:													Shipping Info:							
PROJECT/SITE:													Field Contact (Name & Temporary Phone):							
SAMPLER(S) (Signature)			Number of con- tainers	ANALYSIS										REMARKS						
DATE OF COLLECTION	SAMPLE ID NUMBER(S)																			
Relinquished by (Signature)		Date	Time	Received by (Signature)		Relinquished by (Signature)		Date	Time	Received by (Signature)										
Relinquished by (Signature)		Date	Time	Received by (Signature)		Date	Time	Remarks												
Y	N	FOR LAB USE ONLY				*A sample is under custody if: 1. It is in your possession; or, 2. It is in your view, after having been in your possession; or, 3. It was in your possession and you locked it up; or, 4. It is in a designated secure area.														
		Custody seal was intact when shipment received.																		
		Sample containers were intact when received.																		
		Shipment was at required temperature when received.																		
		Sample labels, Tags and COC agree.																		
Argonne National Laboratory, Applied Geosciences & Environmental Mgt. Group, Environmental Science Division, 9700 S. Cass Avenue, Argonne, IL 60439																				

EVS-160 (6-07)

EXHIBIT 27.2 Chain-of-Custody Form

CUSTODY SEAL
_____ Date
_____ Signature

EXHIBIT 27.3 Example Custody Seal

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AGEM Team at Argonne

AGEM Staff Member	AGEM Role
Lorraine M. LaFreniere, Ph.D. Principal Geological Engineer	Program Manager
Jorge S. Alvarado, Ph.D. Chemist	Laboratory Manager and Analyst
Esther E. Bowen, M.S. Data Management Specialist	Quality Assurance/Quality Control and Records Manager
Laurel A. Culbert, B.A. Graphic Artist/Designer	Report Graphics and Maps (including GIS)
James Hansen, B.A. Program Coordinator/Manager	Site Reconnaissance and Community Relations
Louis E. Martino, M.S. Environmental Systems Engineer/Program Manager	Technical Lead/Remediation Specialist (Cost Engineering)
Terri Patton, M.S. Principal Geologist	Technical Editor
Robert A. Sedivy, M.S. Hydrogeologist	Technical Lead/Hydrogeologist
Eugene Y. Yan, Ph.D. Earth Scientist	Technical Lead/Hydrogeologist

Environmental Science Division

Argonne National Laboratory
9700 South Cass Avenue, Bldg. 203
Lemont, IL 60439-4843

www.anl.gov

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