DRAFT FINAL (REVISION 1)

VOLUME 2B

QUALITY ASSURANCE PROJECT PLAN

SITE WIDE GROUNDWATER (OPERABLE UNIT 03)

WEST LAKE LANDFILL SITE

BRIDGETON, MISSOURI

April 22, 2020

Project #: 63N-001-002

SUBMITTED BY: Trihydro Corporation

1252 Commerce Drive, Laramie, WY 82070

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QUALITY ASSURANCE PROJECT PLAN
SITE WIDE GROUNDWATER (OPERABLE UNIT 03)
WEST LAKE LANDFILL SITE, BRIDGETON, MISSOURI
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List of Acronyms

°C	degrees Celsius
φ_{MR}	relative standard deviation at any concentration greater than UBGR
A2LA	American Association of Laboratory Accreditation
abs	Absolute value
AD	Deep Alluvium
AI	Intermediate Alluvium
ALS	ALS Environmental Laboratories (ALS)
ALS-S	ALS Environmental Laboratories (Simi Valley, CA)
ALS-W	ALS Environmental Laboratories (Winnipeg, Canada)
AMO	AMO Environmental Decisions, Inc.
ANS	American Nuclear Society
ANSI	American National Standards Institute
APM	Assistant Project Manager
AS	Shallow Alluvium
ASAOC	Administrative Settlement Agreement/Order on Consent
BRAWP	Baseline Risk Assessment Work Plan
BTV	Background Threshold Values
C_1	Concentration of Parent Sample
C_2	Concentration of Duplicate Sample
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
C_n	Nominal Concentration of Spiked Aliquot

List of Acronyms (cont.)

CoC	Chain-of-Custody
COPCs	Constituents of Potential Concern
C_s	Measured Concentration of the Spiked Sample Aliquot
CSM	Conceptual Site Model
CSU_s	Combined Standard Uncertainty of the First Sample
CSU_d	Combined Standard Uncertainty of the Second Sample
C_u	Measured Concentration of the Unspiked Sample Aliquot
%D	Percent Difference
DER	Duplicate Error Ratio
DOE	Department of Energy
DOECAP	Department of Energy Consolidated Audit Program
DOD	Department of Defense
DQO	Data Quality Objective
EDD	Electronic Data Deliverable
EDR	Environmental Data Resources
EMSL	EMSL Analytical, Inc.
EMSI	Engineering Management Support, Inc.
FSP	Field Sampling Plan
FTL	Field Team Leader
GC	Geospatial Coordinator
GC/MS	Gas Chromatography/Mass Spectrometry
GIS	Geographical Information System
GNSS	Grade Global Navigation Satellite Systems

List of Acronyms (cont.)

GPS	Global Positioning System
HASP	Health and Safety Plan
HQ	Hazard Quotient
ICV	Initial Calibration Verification
IDW	Investigation Derived Waste
KS	Keokuk
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
LOD	Limit of Detection
LOQ	Limit of Quantitation
MARLAP	Multi-Agency Radiological Laboratory Analytical Protocols Manual
MCL	Maximum Contaminant Level
MCLInc	Materials and Chemistry Laboratory, Inc.
MDC	Minimum Detectable Concentration
MDL	Method Detection Limit
MDNR	Missouri Department of Natural Resources
mg/L	milligrams per Liter
mg/kg	milligrams per kilogram
µg/L	micrograms per Liter
µg/m^3	micrograms per cubic meter
MRL	Method Reporting Limit
MS	Matrix Spike

List of Acronyms (cont.)

MSD	Matrix Spike Duplicate
MSW	Municipal Solid Waste
NAD83	North American Datum 1983
NELAC	National Environmental Laboratories Accreditation Conference
ND	Non-detected
NGDP	National Geospatial Data Policy
OSWER	Office of Solid Waste and Emergency Response
OU-1	Operable Unit 1
OU-2	Operable Unit 2
OU-3	Operable Unit 3
Pace	Pace Analytical Services, LLC.
Pace-E	Pace Analytical Energy Services, LLC in Pittsburgh, Pennsylvania
Pace-I	Pace Analytical Services, LLC in Indianapolis, Indiana
Pace-P	Pace Analytical Services, LLC in Pittsburgh, Pennsylvania
Pace-K	Pace Analytical Services, LLC in Lenexa, Kansas
Pace-N	Pace Analytical National Center for Testing and Innovation in Mt. Juliet, Tennessee
pCi/g	picocuries per gram
pCi/L	picocuries per Liter
PID	Photoionization Detector
PM	Project Manager
ppm	parts per million
PRG	Preliminary Remediation Goal
PSQ	Principal Study Question

List of Acronyms (cont.)

QA	Quality Assurance
QAD	Quality Assurance Director
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QAM	Quality Assurance Manual
QC	Quality Control
RCS	Radiological Control Supervisor
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RIM	Radiological Impacted Material
RPD	Relative Percent Difference
RSL	Regional Screening Level
RSO	Radiation Safety Officer
SA	Spiked Activity or Concentration Added
SAP	Sampling and Analyses Plan
SD	Salem Formation bedrock zone
SEM-EDS	Scanning Electron Microscope with Energy Dispersive X-ray Spectroscopy
SHSO	Site Health and Safety Officer
SOP	Standard Operating Procedure
SOW	Scope of Work
SQCO	Site Quality Control Officer
SR	Unspiked Sample Result

List of Acronyms (cont.)

SS	Salem Formation bedrock zone
SSR	Spiked Sample Result
TOC	Total Organic Carbon
TOV	Total Organic Vapor
TPH	Total Petroleum Hydrocarbon
Trihydro	Trihydro Corporation
UBGR	Upper Bound Gray Region
UPL	Upper Prediction Limits
UTL	Upper Tolerance Limits
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compound
XRD	X-Ray Diffraction
WLL	West Lake Landfill

1.0 INTRODUCTION

Trihydro Corporation (Trihydro) prepared this quality assurance project plan (QAPP) on behalf of Bridgeton Landfill, LLC, Cotter Corporation, N.S.L., and the United States Department of Energy (DOE) (collectively Operable Unit 3 [OU-3] Respondents), for site-wide groundwater (OU-3) at the West Lake Landfill (WLL) site (site) located at 13570 St. Charles Rock Road in Bridgeton, Missouri. This QAPP contains the procedures that will be used to help ensure that data collected during OU-3 Remedial Investigation and Feasibility Study (RI/FS) related sampling activities are sufficiently precise, accurate, complete, representative, comparable, and sensitive enough to meet the established data quality objectives (DQOs). The QAPP presents the management organization, project and quality assurance (QA) objectives, and QA/Quality Control (QA/QC) activities for the sampling program to complete assessment activities. It describes the specific protocols that will be followed for sampling, sample handling and storage, chain-of-custody (CoC), field analyses, and laboratory analyses per the prescribed QA/QC. In addition, this QAPP covers general procedures for ensuring quality of geospatial data collected. The QA/QC procedures are structured in accordance with applicable technical standards, United States Environmental Protection Agency (USEPA) requirements, regulations, guidance, and technical standards. The OU-3 RI/FS Work Plan is comprised of three volumes, the Work Plan (Volume 1), a Sampling and Analysis Plan which includes the Field Sampling Plan (FSP) as Volume 2a and this QAPP as Volume 2b, and a Health and Safety Plan (HASP) as Volume 3. The OU-3 RI/FS Work Plan Volume 1 includes a description of the site history, a summary of previous investigations, the preliminary conceptual site model (CSM), and proposed data collection activities. The OU-3 FSP describes the general approach and methods that will be used for collection of groundwater, leachate, solid matrices (alluvium and bedrock), vapor (indoor air), and other applicable samples as outlined in the OU-3 RI/FS Work Plan.

This QAPP has been prepared in general accordance with the following guidance documents:

- *American Nuclear Society Verification and Validation of Radiological Data for use in Waste Management and Environmental Remediation* (ANS 2018)
- *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination* (USEPA 1997)
- *Guidance for Data Quality Assessment: Practical Methods for Data Assessment QA/G-9* (USEPA 2000a) https://www.epa.gov/sites/production/files/2015-06/documents/g9-final.pdf
- *USEPA Data Quality Objectives Process for Hazardous Waste Site Investigations* (USEPA 2000b), https://www.epa.gov/sites/production/files/2015-07/documents/g4hw-final.pdf
- *USEPA Requirements for Quality Assurance Project Plans QA/R-5* (USEPA 2001), https://www.epa.gov/sites/production/files/2016-06/documents/r5-final_0.pdf

- *USEPA Guidance for Quality Assurance Project Plans for Modeling QA/G-5M* (USEPA 2002a), https://www.epa.gov/sites/production/files/2015-06/documents/g5m-final.pdf
- *USEPA Guidance for Quality Assurance Project Plans QA/G-5* (USEPA 2002b), https://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf
- *USEPA Guidance on Systematic Planning Using the Data Quality Objectives Process QA/G-4* (USEPA 2006a), https://www.epa.gov/sites/production/files/2015-06/documents/g4-final.pdf
- *Guidance for Data Usability in Risk Assessment*, Office of Solid Waste and Emergency Response (OSWER) (USEPA 1992a) https://semspub.epa.gov/work/05/424356.pdf
- *Data Quality Assessment: A Reviewer's Guide QA/G-9R* (USEPA 2006b), https://www.epa.gov/sites/production/files/2015-08/documents/g9s-final.pdf
- *Data Quality Assessment: Statistical Methods for Practitioners QA/G-9S* (USEPA 2006c), https://www.epa.gov/sites/production/files/2015-08/documents/g9s-final.pdf
- *USEPA Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP)* (USEPA 2004a), https://www.epa.gov/radiation/marlap-manual-and-supporting-documents
- *USEPA QA Field Activities Procedure CIO 2105-P-02.0* (USEPA 2014), https://www.epa.gov/sites/production/files/2015-03/documents/2105-p-02.pdf
- *USEPA OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA 2015a), https://www.epa.gov/sites/production/files/2015-09/documents/oswer-vapor-intrusion-technical-guide-final.pdf
- *USEPA* New England Environmental Data Review Supplement for Region 1 Data Review Elements *and Superfund Specific Guidance/Procedures* (USEPA 2018), https://www.epa.gov/sites/production/files/2018-06/documents/r1-dr-supplement-june-2018.pdf
- *USEPA Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A)* (USEPA 1989), https://www.epa.gov/sites/production/files/2015-09/documents/rags_a.pdf
- *USEPA National Functional Guidelines for Inorganic Superfund Methods Data Review (ISM02.4)* (USEPA 2017a), https://www.epa.gov/sites/production/files/2017-01/documents/national_functional_guidelines_for_inorganic_superfund_methods_data_review_01302017.pdf
- *USEPA National Functional Guidelines for Organic Superfund Methods Data Review (SOM02.4)* (USEPA 2017b), https://www.epa.gov/sites/production/files/201701/documents/national_functional_guidelines_for_organic_superfund_methods_data_review_013072017.pdf

Geospatial Guidance:

- *USEPA Guidance for Geospatial Data Quality Assurance Project Plans QA/G-5G* (USEPA 2003), https://www.epa.gov/sites/production/files/2015-06/documents/g5g-final.pdf
- *USEPA National Geospatial Data Policy (NGDP)*(USEPA 2005), https://www.epa.gov/sites/production/files/2014-08/documents/national_geospatial_data_policy_0.pdf
- United States Geological Survey (*USGS) Methods of Practice and Guidelines for Using Survey-Grade Global Navigation Satellite Systems (GNSS) to Establish Vertical Datum in the United States Geological: Techniques and Methods 11-D1* (USGS 2012), https://pubs.usgs.gov/tm/11d1/tm11-D1.pdf
- *USGS The National Map Seamless Digital Elevation Model Specifications: Techniques and Methods 11-B9* (USGS 2017a), https://pubs.usgs.gov/tm/11b9/tm11B9.pdf
- *US Army Corps of Engineers Standards and Procedures for Referencing Project Elevation Grades to Nationwide Vertical Datums (EM 1110-2-6056)* (United States Army Corp of Engineers [USACE 2010]), https://www.publications.usace.army.mil/LinkClick.aspx?fileticket=ZdUNOaOWxkI%3d&tabid=16439&portalid=76&mid=43544

1.1 DOCUMENT ORGANIZATION

This QAPP for the WLL OU-3 RI/FS is organized as follows:

Section 2.0 – Project Management and Organization – This section describes the project management and organization of the project team.

Section 3.0 – Data Quality Objectives – This section addresses specific quality procedures used in developing DQOs, the DQOs, performance indicators, training and documentation.

Section 4.0 – Data Quality Assessment – This section explains data usability and statistics to be applied to existing and newly collected data.

Section 5.0 – Data Generation and Acquisition – This section specifies sample handling, analytical methods, quality control (QC) for data generation, and data management. Specifics on field and laboratory generation are also included in the FSP Standard Operating Procedures (SOPs) and the laboratory SOPs.

Section 6.0 – Audits and Oversight – This section addresses how quality will be audited and verified (audits and reporting).

Section 7.0 – Data Validation and Usability – This section specifies data validation and usability standards that will be employed for field and laboratory data.

Section 8.0 – References – This section lists references used in preparation of the QAPP.

1.2 ALIGNMENT WITH OU-3 RI/FS WORK PLAN

The OU-3 RI/FS Work Plan (Volume 1) provides a description of what data will be collected and the rationale for the RI/FS, including a project description, a summary of site historical information, site setting overview, and general technical approach. The FSP (Volume 2a) outlines how the data will be collected, including detailed field methodology descriptions. This QAPP outlines the DQOs for the project along with the supporting QC requirements that will be used to ensure the data collected during the RI/FS program are of acceptable and known quality.

As noted in Section 5.4 of the OU-3 RI/FS Work Plan, the following tasks will be completed during the RI/FS:

- Preparatory activities
- Site reconnaissance
- Well inventory, repair, replacement, and abandonment
- HPT pilot test
- Drill rig selection
- Continuous coring and field logging
- Alluvium and bedrock aquifer matrix sampling
- Borehole geophysical logging
- Packer testing
- Monitoring well installation
- Monitoring well development
- Slug testing
- Aquifer pumping test
- Groundwater monitoring
- Staff gauge installation
- Leachate collection system sampling
- Vapor intrusion assessment
- Ecological survey

- Surveying and mapping of the investigation areas
- Investigation Derived Waste (IDW) management

This information will be used to refine the CSM, address principal study questions (PSQs) associated with the DQOs, and inform decision-making for the Feasibility Study. For consistency across the documents, a document directory has been included as Table 1-1, which maps where each major topic or task is addressed within each document.

2.0 PROJECT MANAGEMENT AND ORGANIZATION

This project will be managed as outlined in the expanded project Organization Chart, included as Figure 2-1. In general, the OU-3 Respondents will direct this project. Trihydro and its subcontractors will perform the field investigation, analyze data, prepare reports, and perform any subsequent studies. An overview of critical roles and responsibilities for regulators, OU-3 Respondents, Trihydro personnel, and laboratory personnel are included below. Additional responsibilities for each of these personnel may be required, as specified in associated guidance documents.

2.1 OU-3 RESPONDENTS RESPONSIBILITIES

The OU-3 Respondents have the responsibility to review reports and verify that they meet the requirements of the OU-3 RI/FS Work Plan. The OU-3 Respondents will review and propose modifications to the OU-3 RI/FS Work Plan (as needed).

Additionally, the OU-3 Respondents' responsibilities for the project may include:

- Review reports for submittal to the USEPA
- Review project schedule
- Review and analyze overall task performance with respect to planned requirements and authorizations

The OU-3 Respondents will be involved with communication with the USEPA Region 7, Missouri Department of Natural Resources (MDNR), and the USGS.

2.2 OU-3 PROJECT COORDINATOR RESPONSIBILITIES

The OU-3 Project Coordinator has the responsibility for overall project completion and communication between the regulators, the OU-3 Respondents and contractors. Additionally, the OU-3 Project Coordinator's responsibilities for the project may include:

- Review and transmit reports (deliverables)
- Prepare OU-3 monthly status reports for submittal to USEPA by the 11th of each month
- Manage overall schedule for the site

- Coordinate OU-3 activities, scope and schedule with the Operable Unit 1 (OU-1) and, Operable Unit 2 (OU-2) activities, scope, and schedule
- Notify USEPA and MDNR of field schedules

2.3 TRIHYDRO RESPONSIBILITIES

Trihydro will function as the primary contractor, with Ameriphysics and Feezor Engineering providing radiation safety and field support roles. Together, these companies will be responsible for the proper implementation and management of the OU-3 RI/FS Work Plan, sample collection, and preparation of reports. Relevant roles outlined below include Trihydro Project Principal, Project Manager (PM) and Assistant Project Manager (APM), Trihydro Field Team Leader (FTL), Trihydro Field Team Members, Trihydro Site Quality Control Officer (SQCO), Trihydro Quality Assurance Director (QAD), Trihydro Site Health and Safety Officer (SHSO), Radiation Safety Officer (RSO), Radiological Control Supervisor (RCS), and Trihydro Geospatial Coordinator (GC).

Trihydro Project Principal

The Project Principal maintains overall oversight and his responsibilities include the following:

- Coordinate and communicate with the project coordinator
- Review and approve final reports (deliverables) before their submission to the OU-3 Respondents
- Establish project procedures to address the specific needs of the project as a whole
- Review and analyze overall task performance with respect to planned requirements and authorizations
- Identify and insure commitment by both contractor and subcontractor resources

Trihydro Project Manager (PM) and Assistant Project Manager (APM)

The Trihydro PM and Trihydro APM have the overall responsibility for the investigation with oversight by the OU-3 Respondents. The Trihydro PM and APM are responsible for implementing the project and have the authority to commit the resources necessary to meet project objectives and requirements. The Trihydro PM and APM's primary function is to ensure that regulatory, technical, financial, and scheduling objectives are achieved successfully. The Trihydro PM and APM will:

- Coordinate and communicate with the Trihydro Project Principal
- Select, coordinate, and schedule staff for the work assignments
- Manage budgets and schedules

- Prepare progress reports for OU-3 Project Coordinator and Respondents
- Maintain and distribute the official approved QAPP
- Monitor and direct subcontractors engaged in implementing the OU-3 RI/FS Work Plan
- Implement QA measures and any corrective action requirements
- Attend review meetings
- Interface with USEPA
- Perform final data assessment
- Monitor and direct the field leaders
- Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product
- Review the work performed on each task to ensure its quality, responsiveness, and timeliness
- Prepare and assure quality of interim and final reports
- Conduct initial site safety training for project team personnel
- Ensure Trihydro and subcontractor field team personnel have read and understand the HASP
- Ensure that work performed by Trihydro is conducted in accordance with safe practices outlined in this plan
- Define project objectives and develop a detailed OU-3 RI/FS Work Plan schedule
- Acquire and apply technical and corporate resources as needed to ensure performance within budget and schedule constraints
- Orient field leaders and support staff concerning the project's special considerations
- Review the work performed on each task to ensure its quality, responsiveness, and timeliness
- Assist with preparation of monthly progress reports to the USEPA
- Interface and provide project status updates to the OU-3 Respondents and OU-3 Project Coordinator
- Direct the organization of the data and final evidence file

The Trihydro PM and APM have responsibility for ensuring that the project meets the project required objectives and quality standards (outlined in the OU-3 RI/FS Work Plan, FSP, and Section 1.0 of this QAPP). The Trihydro PM and APM will communicate the schedule of field events with the OU-3 Respondents. The Trihydro PM and APM will report directly to the OU-3 Project Coordinator and are responsible for technical QC and project oversight. The Trihydro PM and APM may communicate directly with the USEPA, MDNR, USGS, and other stakeholders at the request of the OU-3 Project Coordinator to communicate field events, schedule, and other related project communication.

Trihydro Field Team Leader (FTL)

The Trihydro FTL will conduct oversight of field activities. The Trihydro FTL will also be responsible for team supervision upon implementation of field activities, which will be in accordance with procedures in the associated EPA-approved FSP and this QAPP. The Trihydro FTL has the overall responsibility for the investigation in the field with oversight by the Trihydro PM and APM. The Trihydro FTL's primary function is to oversee the subsurface investigation and site assessment activities. The Trihydro FTL will:

- Select, coordinate, and schedule staff for the work assignments
- Plan and oversee field assessment activities
- Manage field subcontractors engaged in implementing the OU-3 RI/FS Work Plan
- Manage the field sample collection team
- Evaluate shallow subsurface geology/hydrology and impacts
- Prepare progress reports to the Trihydro PM
- Ensure that field staff conduct work in accordance with the site HASP and FSP

The Trihydro FTL has the responsibility for ensuring that the field activities meet the guidelines identified in the FSP and OU-3 RI/FS Work Plan. The Trihydro FTL will report directly to the Trihydro PM and APM.

Trihydro Field Team Members

Field team members will be responsible for conducting site reconnaissance; sampling; performing an ecological assessment; conducting a well inventory; overseeing borehole advancement, borehole geophysical logging, packer testing, monitoring well installation, monitoring well development, surveying, and monitoring well abandonment; collecting solid matrix (alluvium and bedrock) samples; collecting groundwater/leachate samples; collecting vapor samples (indoor air); conducting aquifer testing; and installing and monitoring staff gauges and pressure transducers. In addition, they are responsible for collection field QC samples in the type and frequency described in this QAPP; calibrating field equipment in accordance with Section 4.0 of the FSP, and field calibration checks and documentation. Decontamination of sampling equipment will be accomplished by the field team under the direction of the Trihydro FTL. Field team members will complete, and file personal daily time logs and complete field documentation forms, as indicated in Section 3.21 of the FSP. Field team members will submit field documentation forms to Trihydro and will relinquish custody of field samples to the contracted laboratory as outlined in the QAPP. Field team members will perform sample packaging and shipping. Field team members will comply with the provisions of the site-specific HASP, including the responsibility to stop work. Anyone involved with the project has "stop work authority", which can include stopping work for quality or safety concerns.

Trihydro Site Quality Control Officer (SQCO)

The site SQCO will check the completion of CoC forms, packaging and shipment of samples, and sample logbook entries. The SQCO will check the daily time logs and field data forms for accuracy and compliance with the QAPP and FSP. The SQCO is responsible for maintaining field instrument calibration logs for field instruments. After review of documentation, the SQCO is responsible for storing and forwarding the documentation for filing in accordance with appropriate document control and security measures. The SQCO will vary depending on the phase of work and will be a member of the field team and report to the Trihydro FTL.

Trihydro Quality Assurance Director (QAD)

The Trihydro QAD will have direct access to contact the laboratories with QA/QC questions. The Trihydro QAD is responsible for auditing the implementation of the QA program in conformance with the demands of specific investigations under USEPA Superfund and Trihydro policies. The Trihydro QAD has the authority to stop work on the investigation as deemed necessary in the event of serious QA/QC issues. Specific functions and duties are to:

- Audit field memoranda prepared by field personnel to ensure that the procedures for sample collection and sample custody are strictly adhered to
- Review laboratory reports to ensure that adequate QA/QC procedures are imposed on the laboratory analytical results
- Review and approve QA plans and procedures
- Provide QA technical assistance to project staff
- Provide independent QA review of analytical data as part of the data validation process
- Report on the adequacy, status, and effectiveness of the QA program on a regular basis to the Trihydro PM and APM
- Distribute and re-distribute quality documents initially and upon revision

The Trihydro QAD reports directly to the Trihydro PM and will be responsible for ensuring that procedures for this project are followed. In addition, the Trihydro QAD will be responsible for organizing technical staff to complete Trihydro level validation including: Tier I validation/data verification, and/or Tier II, Tier III, or Tier IV data validations of sample results from the analytical laboratory. The data validation team and QA team will report directly to the Trihydro QAD. The specific definition of levels is included as Table 2-1 and validation levels are specified in Section 7.1.

Trihydro Site Health and Safety Officer (SHSO)

The SHSO will be present on-site during field operations and will be responsible for health and safety activities and delegation of duties to the health and safety staff in the field. The SHSO duties may be conducted by the Trihydro FTL or other on-site personnel, depending on the duties being performed and the ability to perform the role completely without compromising other duties. The SHSO will work with Ameriphysics' RSO to verify that radiological control and safety programs are administered. The SHSO will be responsible for implementing the HASP. The SHSO will be responsible for assisting with any stop-work authority, which can be executed by any on-site personnel upon his/her determination of an imminent safety hazard, emergency condition, or other potentially dangerous situations, such as detrimental weather conditions. Authorization to proceed with work will be issued by the SHSO in conjunction with the PM and RSO as needed after such action. The SHSO will initiate and execute contact with support facilities and personnel when this action is appropriate. The SHSO will vary depending on the phase of work and will report to the Trihydro PM and APM and will work in coordination with the Trihydro FTL.

Radiation Safety Officer (RSO)

The RSO is responsible for executive-level administration of the radiological control and safety program in accordance with prevailing procedures and industry practices. Specific responsibilities include the following:

- Establishing standards and guidelines for radiological operations
- Limiting occupational radiation exposures to levels that are as low as reasonably achievable
- Suspending any operation that presents a radiological or safety threat to employees, the environment, or the general public
- Ensuring the quality of protective equipment for personnel and prescribing usage standards
- Establishing procedures for radiological protection and monitoring
- Overall responsibility for the radiation protection training program

Radiological Control Supervisor (RCS)

The RSO will assign a designated RCS to the project. The RCS reports to the RSO and is responsible for field implementation of the radiological control and safety program at the field level. The RCS has the authority to and shall order any operations suspended when such operations present an imminent radiological or safety threat or hazard to employees, the environment, or the public. The RCS will be present onsite at any time work is conducted in Area 1 or Area 2. If the RCS must be away from the site, his or her responsibilities will be designated to an appropriately experienced Health-Physics Technician such that continuity of radiological supervision is maintained.

Trihydro Geospatial Coordinator (GC)

The Trihydro GC will conduct oversight of collection and use of geospatial data from external or internal sources. The Trihydro GC will also be responsible for communication between survey teams, Geographical Information System (GIS) analysts, the groundwater modeling team, and the Trihydro PM/APM, which will be in accordance with tasks in the associated OU-3 RI/FS Work Plan and described in the FSP. The Trihydro GC has the overall responsibility for collection and use of geospatial data with oversight by the Trihydro PM and APM. The Trihydro GC will:

- Verify that resolution and accuracy of data collection sources as per the NGDP (USEPA 2005) Tier 2 Level Accuracy and Precision of 1-5 meter
- Verify the best available data are used in preparation of figures and models
- Verify that mapping and digitizing meet quality requirements
- Manage geospatial data collection
- Review and verify geospatial points or coordinates

The Trihydro GC has the responsibility for ensuring that the field activities meet the guidelines identified in the FSP and OU-3 RI/FS Work Plan. The Trihydro GC will report directly to the Trihydro PM and Trihydro APM.

2.4 SUBCONTRACTOR RESPONSIBILITIES

The proposed SOW will require subcontractors for drilling, surveying, sampling, laboratory services, and health and safety. In addition to the Trihydro personnel roles and responsibilities, second tier contractors may be required. These subcontractors were selected based on qualifications and experience related to the task at hand, quality of work, proximity to project site, health and safety record, cost effectiveness, and client approval. These subcontractors will be given the planning documents to review and will be required to commit to the quality and safety requirements referenced in these documents. The Trihydro PM will ensure that the activities of Trihydro's subcontractors will be carefully monitored and coordinated to comply with the safety and quality guidelines outlined in the QAPP and HASP.

2.5 LABORATORY RESPONSIBILITIES

Laboratory services will include groundwater, solid matrix (alluvium and bedrock), leachate, and vapor analysis. Due to the range of analytical methods and specialty methods, no one laboratory can perform all of the tests. Therefore, five laboratory firms will be used as part of the OU-3 RI/FS Work Plan activities, including Pace Analytical Services, LLC (Pace), Materials and Chemistry Laboratory, Inc. (MCLInc), Advanced Terra Testing, ALS Environmental Laboratories (ALS), and EMSL Analytical, Inc (EMSL). Pace Analytical Services, LLC in Indianapolis, Indiana (Pace-I) will be the primary lab for the groundwater, solid matrix (alluvial and bedrock) and leachate samples for non-radionuclide analyses and will manage submitting samples to the other Pace laboratories and EMSL. Some specialty samples and vapor samples will be directly shipped to Advanced Terra Testing, MCLInc, and ALS. The laboratory Quality Assurance Manuals (QAM) and certifications (Section 3.10.2) are included in Appendix A. These laboratories will analyze groundwater, solid matrix (alluvium and bedrock), leachate, and vapor samples as follows:

1. Four additional Pace laboratories will be used:
   a. Pace Analytical Services, LLC in Pittsburgh, Pennsylvania (Pace-P) will provide radiochemistry analytical services.
   b. Pace Analytical Energy Services, LLC in Pittsburgh, Pennsylvania (Pace-E) will provide the dissolved gas analyses in groundwater/leachate samples.
   c. Pace Energy Services, LLC in Lenexa, Kansas (Pace-K) will provide analyses of Cation Exchange Capacity.
   d. Pace Analytical National Center for Testing and Innovation in Mt. Juliet, Tennessee (Pace-N) will provide analyses of Total Organic Carbon (TOC) and Total Petroleum Hydrocarbon (TPH).
2. Advanced Terra Testing, Lakewood, Colorado will provide geotechnical sample analysis.
3. MCLInc, Oak Ridge, Tennessee: MCLInc is a specialty laboratory that will be performing analyses that are not able to be covered by Pace or ALS (large commercial laboratories). Due to the nature of these specialty analyses, the QA/QC procedures may slightly vary or be modified from the procedures discussed for other methods in the QAPP. MCLInc will be performing: sequential extraction analysis (as defined in Section 5.1.2.2). Any other specific QA/QC procedures that are modified or developed for the work to be performed by MCLInc will be submitted to USEPA for review and approval prior to the new modified or new procedure being implemented on site samples or used in support of project studies.
4. Two ALS laboratories will be used:
   a. ALS Environmental (ALS-S) Simi Valley, California will analyze vapor samples for volatile organic compounds (VOCs), fixed gases, helium, and methane.

    b. ALS Environmental (ALS-W) Winnipeg, Canada will analyze vapor samples for radon.

5. EMSL Analytical, Inc. Cinnaminson, New Jersey: EMSL will analyze aquifer matrix materials (alluvium and bedrock) by X-Ray Diffraction (XRD) and Scanning Electron Microscope with Energy Dispersive X-Ray Spectroscopy (SEM-EDS).

The Table 2-2 series tables provides the primary laboratory for each analytical method, preservation, and holding time requirements by media type. The Table 2-3 series tables provides a list of each method with the associated analytes along with screening limits and detection limit goals by media type. Table 2-3a-i includes the USEPA Maximum Contaminant Levels (MCL) the current USEPA Regional Screening Levels (RSL), the MDNR groundwater protection standards, the method detection limits (MDL), and the method reporting limits (MRL) for each groundwater and leachate analyte. For radiochemistry (Table 2-3a-ii), the USEPA MCL, and the USEPA Preliminary Remediation Goal (PRG) are shown, along with the limit of quantitation (LOQ), limit of detection (LOD; aka the Minimum Detectable Concentration [MDC]), the radiological action level, and variables discussed in Section 3.8. Table 2-3b includes alluvium and bedrock analyses and reporting limits. Vapor target analytes, MRLs, MDLs, indoor air removal management levels, screening levels, and RSLs are included in Table 2-3c. Field parameters, equipment, and accuracy measurements are provided in Table 2-3d.

The laboratory organization structures and internal responsibilities for each of the laboratories are described in detail in the QAMs located in Appendix A. These documents outline specific training and organizational procedures that will be followed by each laboratory. The documents in Appendix B provide the general data validation procedures that will be provided for each analyses and media and as described in Section 7.0. The provided laboratory QA standards for each media and method (where standards apply) are provided in Appendix C. Lastly, the location of laboratory, and associated laboratory analytical method SOPs are included in Appendix D.

Laboratory Project Managers

The Laboratory PMs will report directly to the Trihydro PM/APM and will be responsible for the oversight of production and final review of the analytical reports and the case narratives to verify that any data quality issues are thoroughly explained and the requirements of this QAPP have been met. The Trihydro QAD will serve as liaison between the laboratory and the Trihydro PM, APM, and FTL, as needed. They will communicate any special project instructions that affect the way that analyses are to be performed, the data evaluated, sample turnaround time, or the results reported. The laboratory operations managers or designees will inform the Laboratory PMs of samples status and will:

- Coordinate laboratory analyses
- Supervise in-house CoC
- Schedule sample analyses
- Oversee data review
- Oversee preparation of analytical reports
- Compare bottle orders (if applicable for the analyses) against bottle sets for accuracy and to ensure proper chemical preservation of bottle sets before they are shipped to the site
- Approve final analytical reports prior to submission to Trihydro
- Sign the title page of the QAPP

Laboratory Quality Assurance Officers

The Laboratory Quality Assurance Officers (QAOs) have the overall responsibility for data after samples arrive at the laboratory, during analyses, and during reporting. In addition, the Laboratory QAOs (or designees) will be responsible for the following tasks:

- Oversee laboratory QA
- Determine compliance with the laboratory certifications
- Oversee QA/QC documentation
- Conduct detailed data review per laboratory requirements
- Determine whether to implement laboratory corrective actions, if required
- Define appropriate laboratory QA procedures
- Prepare and review laboratory SOPs
- Sign the title page of the QAPP
- Verify that instrument controls are in place
- Verify radiological labeling and safety procedures are followed

The Laboratory PMs, prior to release of data, will verify that the laboratory is in accordance with state and federal regulatory requirements and the terms of their accreditations.

Laboratory Sample Custodians

The Laboratory Sample Custodians will report to the Laboratory PMs and the position will be staffed by laboratory personnel. Responsibilities of the Laboratory Sample Custodians are:

- Receiving and inspection of incoming sample containers
- Recording the condition of the incoming sample containers
- Signing appropriate documents
- Verifying CoC documentation
- Notifying the laboratory PM of sample receipt and inspection
- Assigning a unique identification number and customer number, and entering each into the sample receiving log
- Notifying the Trihydro PM/APM when samples are received indicating the sample names, sample condition, and sample parameters to be analyzed
- With the help of the laboratory PM, initiating transfer of the samples to appropriate lab sections
- Controlling and monitoring access/storage/disposal of samples and extracts
- Verifying that radiological samples are stored in a restricted area and accessible only to authorized personnel

The Laboratory technical staff will be responsible for sample analysis and identification of corrective actions. The staff will report directly to the laboratory PM and QAO or designee.

3.0 DATA QUALITY OBJECTIVES

DQOs are quantitative statements used to clarify the study objectives, define the appropriate type of data to collect, determine the appropriate conditions from which to collect the data, determine the quality of the data used to support decisions at the site, and specify tolerable limits on decision errors. Preparation of these DQOs generally followed the USEPA *Guidance on Systematic Planning Using the Data Quality Objectives Process (USEPA QA/G-4)* (USEPA 2006a). Site-specific DQOs have been prepared in collaboration with the USEPA Region 7 project team based on the following seven DQO steps:

1. State the Problem
    1.1. Description of the Problem
    1.2. Conceptual Model of the Environmental Hazard
    1.3. Project Resources - Budget, Personnel, and Schedule
2. Identify the Goal of the Study
    2.1. Identify Principal Study Questions
    2.2. Decision Statements / Estimation Statements
    2.3. Alternative Outcomes
3. Identify Information Inputs
    3.1. Identify the Types of Information Needed
    3.2. Identify the Source of Information
    3.3. Identify Appropriate Sampling and Analysis Methods
4. Define the Boundaries of the Study
    4.1. Target Population
    4.2. Spatial and Temporal Boundaries
    4.3. Practical Constraints
    4.4. Scale of Inference

5. Develop the Analytical Approach
    5.1. Population Parameters
    5.2. Decision Problem/Action Level
6. Specify Performance or Acceptance Criteria
7. Develop the Detailed Plan for Obtaining Data
    7.1. Sampling Design
    7.2. Key Assumptions

Detailed site-specific DQOs are documented in Table 3-1. The DQO table has been prepared in conjunction with the OU-3 RI/FS Work Plan, QAPP, and FSP; references to applicable text, tables, figures, and appendices within these documents have been included to the DQO table for consistency between the documents and brevity. In addition to Trihydro and the Respondents, the USEPA, USGS, and MDNR have also provided input in the development of the DQOs. An overview of each step is included below. The data quality process is iterative and flexible as specified in the QA/G-4 guidance. Therefore, these DQOs will be refined as the RI process progresses throughout the phases of work as discussed in Work Plan Section 4.3.

3.1 STEP 1 – STATE THE PROBLEM

Step one in the DQO process is to specify the problem based on the reason for the study. As part of this process, the problem description, the site conceptual model, project team, and schedule are determined and specified (USEPA 2006a).

3.1.1 DESCRIPTION OF THE PROBLEM

The problem definition is a description of the conditions which led to the initiation of the RI/FS process. For the OU-3 RI/FS, the Administrative Settlement Agreement/Order on Consent (ASAOC) was issued to address, the need identified by USEPA for “additional data needed to determine the nature, extent, and source of groundwater contamination at the site, the potential for such contamination to migrate beyond site boundaries into critical exposure pathways, the mechanisms of contaminant migration and attendant risks posed to human health and the environment” (USEPA 2019). This statement forms the basis for the problem definition:

> Petroleum hydrocarbons, VOCs, trace metals, trace anions, and various radionuclides have been detected in groundwater at the site. The nature and extent of site-related impacts to groundwater, indoor air, and groundwater-related impacts to surface water and sediment are unknown. An

improved understanding of the nature, extent, and source(s) of groundwater contamination at the site, and the mechanisms of contaminant migration, will be used to:

1. Assess the potential for site-related contamination to migrate beyond site boundaries into critical exposure pathways,
2. Determine the current and predicted future risks posed to human health and the environment, and
3. Develop potential groundwater remedies as necessary.

3.1.2 CONCEPTUAL MODEL OF THE HAZARD

At this time, there is no off-site monitoring well network for evaluation of groundwater conditions available for use in the development of the OU-3 RI/FS Work Plan and associated documents. However, based on the evaluation of existing information, described in the OU-3 RI/FS Work Plan, the general framework of a CSM has been developed. A CSM of the potential current and future hazards for OU-3 groundwater conditions is anticipated to include the following elements:

1. Constituents of potential concern (COPCs) are present in onsite groundwater related to the former on-site landfills (OU-1/OU-2). The impacted groundwater may extend off-site vertically and laterally, but the extent is unknown.
2. COPCs may also be present in groundwater due to up-gradient sources, including both naturally-occurring and anthropogenic sources.
3. Groundwater may be used as a water supply source, which may pose a risk to human health and/or ecological health.
4. Groundwater may be hydraulically connected to surface water bodies including the Missouri River and nearby ponds, which may also pose a risk to human and/or ecological health.
5. Groundwater may contain vapor-forming COPCs, which may pose a risk to human health from the volatilization into indoor air. Vapor migration into the vadose zone from the waste units may also be occurring.
6. Further refinement of the CSM is necessary as additional data are obtained related to aquifer properties, hydraulic gradients, flow directions, background groundwater quality, up-gradient groundwater quality, geochemistry, future COPC concentrations, effects of infrastructure, and temporal and spatial variations in flow directions.

3.1.3 PROJECT RESOURCES – BUDGET, PERSONNEL, AND SCHEDULE

The project resources include the budget for the work, the availability of personnel, and the anticipated project schedule. The current budget estimate for the completion of the OU-3 Remedial Investigation (RI) scope of work

(SOW) is $19 million through 2023 exclusive of long-term monitoring and agency fees. Trihydro has identified specific project personnel and subcontractors to complete the OU-3 RI/FS SOW. The OU-3 RI/FS project team is shown on Figure 2-1. Roles for individuals are referenced in Section 2.0. The project team will include:

- OU-3 Respondents: Representatives of Bridgeton Landfill, LLC, Cotter Corporation, N.S.L., and DOE
- OU-3 Project Coordinator: Paul Rosasco (Engineering Management Support, Inc. [EMSI])
- Stakeholders: USEPA Region 7, MDNR, and USGS
- Technical Advisor: Ralph Golia (AMO Environmental Decisions, Inc. [AMO])
- Trihydro: Gary Risse (Project Principal), Allison Riffel (PM), Michael Sweetenham (APM), Dan Gravelding (Technical Director), Wilson Clayton, PhD (Modeling Technical Lead), Craig Carlson (Radiation Technical Lead), Andrew Pawlisz (Risk Assessment Technical Lead), Justin Pruis (Vapor Intrusion Technical Lead), and Todd Forry (Health and Safety)
- Subcontractors: Ameriphysics (Radiation Safety, Health Physicist); Chad Drummond (Geochemical/Radionuclide Modeling); Feezor Engineering (Radiation Safety, Field support); Laboratories: Pace; MCLInc (specialty); Advanced Terra Testing (geotechnical), ALS (vapor), and EMSL (specialty); and Driller: To Be Determined

A detailed project schedule is included as Figure 10-2 in the RI/FS OU-3 Work Plan. The following schedule assumes the OU-3 RI/FS Work Plan documents are approved by July 1, 2020:

- Initial Tasks (Well Inventory, Staff Gauge Installation, Access Agreements, Permitting, Fluid Level Monitoring) – Spring 2020 pending USEPA approval to expedite tasks
- Well Inventory Summary Report – Summer 2020
- Interim Groundwater Sampling – Summer 2020 and Early 2021
- Quarterly Groundwater Sampling – Spring 2021 through Summer 2022
- Phase I and II Well Installation – Summer 2020 – Spring 2021
- Addendum to RI Work Plan – Late 2020
- Additional RI Well Installation – Spring 2021
- Groundwater Modeling Work Plan – Late 2021
- Groundwater Modeling Report – Early 2023
- Baseline Risk Assessment Work Plan – Fall 2022

- RI Report – Late 2023
- Baseline Risk Assessment Report – Late 2023
- Feasibility Study – Spring 2025

In correspondence dated April 8, 2020, the Respondents requested permission to begin initial tasks to expedite the OU-3 RI schedule (Trihydro 2020). These preparatory activities, including completion of an on-site well inventory, installation and monitoring of staff gauges, completing access agreements for third-party property access, well permitting, and an off-site records search, would be commenced prior to approval of the OU-3 RI/FS Work Plan documents pending USEPA concurrence.

3.2 STEP 2 – IDENTIFY THE GOAL OF THE STUDY

Step 2 involves identifying the PSQs for the OU-3 RI/FS. The goal of the PSQs is to focus the search for information that will address the study problem. For each question, a range of possible alternative outcomes are identified and used to create a decision statement or estimation statement. The OU-3 RI/FS Work Plan (Section 4.0) identified five initial PSQs that are applied to the seven-step DQO process herein, plus three additional PSQs that will be applied to the DQO process as initial data are evaluated. The five initial PSQs that have been developed, including the alternative actions and associated estimation/decision statements are shown below and in Table 3-1:

Principal Study Questions (PSQs)
PSQ-1: Are COPCs present in groundwater above screening levels?
PSQ-2: What is the vertical and horizontal spatial distribution of COPCs above screening levels in groundwater?
PSQ-3: Are the COPCs site-related?
PSQ-4: What are the sources of site-related COPCs in groundwater?
PSQ-5: Where will COPCs migrate in the future?

Note: For PSQ-1 the COPC and screening levels are listed in Table 2-3a-i and Table 2-3a-ii.

Estimation/Decision Statements (referenced to PSQ Number)	
PSQ-1:	Determine if the concentrations/activity levels of COPCs in groundwater are above screening levels.
PSQ-2:	A: Estimate the horizontal distribution and spatial variability of COPCs above applicable screening levels in groundwater. B: Estimate the vertical distribution and spatial variability of COPCs in groundwater above applicable screening levels in the different geologic units. C: Estimate the temporal variability in COPC groundwater concentrations, if present.
PSQ-3:	Determine if any COPCs present in groundwater above screening levels are not related to the site.
PSQ-4:	A and B: Determine which of the site-specific sources are contributing COPCs to groundwater.

Estimation/Decision Statements (referenced to PSQ Number)
C: Determine whether Radiologically impacted material (RIM) is providing a source of radionuclides to groundwater. D: Determine whether Municipal solid waste (MSW) is providing a source of COPCs to groundwater. E, F, and G: Determine whether the geochemistry of landfill leachate, the subsurface reaction, and/or landfill gases are resulting in the release of COPCs from naturally occurring aquifer materials into groundwater, including naturally-occurring radium.
PSQ-5: A, B, and C: Estimate the lateral and vertical gradients and flow within the groundwater system, including any spatial and temporal variability thereof. D: Estimate the attenuation parameters. E: Determine the effect of and hydraulic interactions with various features and stresses on the hydrogeologic system, including recharge and discharge. Determine the water balance for the system.

Alternative Outcomes
PSQ-1: A. If groundwater COPCs are present at levels equal to or above screening levels, evaluate if further action is appropriate. B. If groundwater COPCs are not present above screening levels, evaluate if no further action is appropriate.
PSQ-2: A. COPCs are present in groundwater above applicable screening levels onsite/nearsite, or offsite, or both onsite and offsite. B. COPCs may or may not be present above applicable screening levels within one or more of the alluvial zones (shallow alluvium [AS], intermediate alluvium [AI], deep alluvium [AD]), the upper Salem/St. Louis Formation (SS), Salem Formation bedrock zone (SD), and/or the Keokuk (KS) bedrock zone. C. COPCs are present above applicable screening levels consistently throughout the year, or concentrations vary seasonally.
PSQ-3: A. An individual COPC at a specific location is site-related, or is not-site-related, or a combination of both.
PSQ-4: A. Site-specific sources (e.g., individual landfill cells or other units, e.g., Underground Storage Tanks) may be distinguishable, including potentially Area 1, Area 2, Former Inactive Sanitary Landfill, and Bridgeton Landfill. B. Alternately, the individual sources may be indistinguishable, so the site will be treated as a source as a whole. C. RIM is a source of radionuclides to groundwater, so the areas with RIM will be managed as a source (OU-1). D. MSW is a primary source of COPCs to groundwater, so MSW areas will be managed as a source. Alternative outcomes include: - MSW from the Inactive Sanitary Landfill is a source, - MSW from the Bridgeton Landfill is a source, - MSW from Area 1 is a source, - MSW from Area 2 is a source, - MSW from the former C&D landfill is a source, - Both landfills are sources, or - Neither landfill is a source.

Alternative Outcomes
E. Landfill leachate is resulting in the release of COPCs to groundwater due to changes in pH, redox, and other geochemical processes, so that areas with landfill leachate are identified as contributing sources of COPCs to groundwater, or not. F. The subsurface reaction is resulting in the release of COPCs into groundwater due to elevated pressures, elevated temperatures, reducing conditions, and landfill mass matrix destruction, or not. G. Landfill gas from the site is resulting in changes to the pH, redox, and other geochemical processes, so that areas with landfill gases are identified as contributing sources of COPCs to groundwater, or not.
PSQ-5: A. Spatial distribution of gradients and flow within the groundwater system integrates and builds upon existing CSM framework. B. Spatial distribution of gradients and flow within the groundwater system is inconsistent with CSM, and CSM has to be reconsidered. C. Groundwater flow has temporal variability (e.g. seasonal variation) or is consistent throughout the year. D. COPCs are attenuated and do not migrate offsite, or may be somewhat attenuated, or are not attenuated. E. Site features, pumping, leachate extraction, and stresses influence current and future COPC migration, or do not.

Notes:
Onsite Wells – Wells installed within the WLL Superfund Site boundary as shown on OU-3 RI/FS Work Plan Figure 1-2.
Nearsite Wells – Wells installed outside of the WLL Superfund Site boundary within 350 ft of the site as shown on OU-3 RI/FS Work Plan Figure 1-2.
Offsite Wells – Wells installed approximately 350 ft outside of the WLL Superfund Site boundary as shown on OU-3 RI/FS Work Plan Figure 1-2.
COPCs – See Table 2-3a-i and 2-3a-ii.

The initial PSQs 1-5 will be investigated based on the work to be completed during Phases I and II of the OU-3 RI/FS. Additional PSQs 6-8 have been identified that will be evaluated during subsequent phases of work, including:

- PSQ-6: Are exposure pathways complete or will they be complete in the future?
- PSQ-7: What are the current and predicted future exposure point concentrations?
- PSQ-8: Is a remedy warranted?

Several studies may be performed based on the results of the initial field investigations and/or results obtained from OU-1 and OU-2, including vapor intrusion, and potential sediment pore water/sediment/surface water studies. DQOs for these studies will be prepared as part of future addenda to this OU-3 RI/FS QAPP. Note, indoor air sampling is proposed to be conducted prior to finalization of a vapor intrusion addendum; however, the precision, accuracy, method completeness, compliance, sensitivity, and completeness are included in Section 3.8 of the QAPP. This iterative approach is consistent with the USEPA QA/G-4 guidance (USEPA 2006a). PSQs 1-8 address the data gaps identified in the ASAOC as modified in OU-3 RI/FS Work Plan Section 2.4.17, including:

1. Adequacy, usability, and status of existing and abandoned on-site and near-site monitoring wells
2. Aquifer properties, including recharge/discharge rates and hydraulic conductivities
3. Regional and localized hydraulic gradients and flow directions between alluvial and shallow bedrock aquifers
4. Background groundwater quality of alluvial and shallow bedrock aquifers near the site
5. Occurrence and extent of groundwater contamination and landfill gas migration in groundwater
6. Groundwater geochemistry parameters, redox couples, and organic content
7. Effects of the Bridgeton Landfill, related infrastructure, and hydraulic characteristics of landfill material on the groundwater system
8. Vapor intrusion
9. Temporal variability in groundwater levels and flow direction
10. Temporal and spatial water elevation effects from relevant surface water features (Missouri River, streams, and surface water bodies) and storm events

Several evaluations will be performed once initial data are available to support the DQO process, including groundwater modeling, the screening level ecological risk evaluation, and the baseline risk assessment.

3.3 STEP 3 – IDENTIFY INFORMATION INPUTS

In Step 3, the types and sources of information needed to investigate the decision/estimation statements above are identified, including whether new data collection is necessary, the information basis for establishing the analytic approach and performance or acceptance criteria, and whether a methodology exists for sampling and/or analysis for the proposed task. See Table 3-1 for details on Step 3 for each of the PSQs.

3.4 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

In Step 4, the boundaries of the study are defined, including the target population, the spatial and temporal boundaries, practical constraints, and the scale of inference (i.e., decision unit or scale of estimation). The target populations were determined to be the individual samples or data to be collected at this time. The target populations, spatial boundaries, and temporal boundaries may change as the initial data are evaluated and the quality of the data are established. See Table 3-1 for details on Step 4 for each of the PSQs.

Note, spatial and temporal boundaries listed in Table 3-1 have been identified based on the current CSM (Work Plan Section 3.0). Changes to the spatial boundary of the study may be developed in subsequent revisions to the DQOs after the RI/FS data are collected, depending on the results that are obtained.

3.5 STEP 5 – DEVELOP THE ANALYTICAL APPROACH

In Step 5, the analytic approach is identified, which will be used during analysis of the study results and how conclusions will be drawn from the data. This includes identifying the population parameters and action level/decision rules. In Step 5, how the data will be compared and analyzed are specified. Potentially applicable statistical approaches have been specified in each PSQ; details on the statistical methods listed in Table 3-1 are included in Section 4.2. The proposed analytical approach may be revised as the amount and quality of the data are determined. See Table 3-1 for details on Step 5 for each of the PSQs.

3.6 STEP 6 – SPECIFY PERFORMANCE / ACCEPTANCE CRITERIA

In Step 6, the decision rules are established and the potential consequences of making incorrect decisions are discussed. Tolerable levels of decision error are identified for Type I (false negative) and Type II (false positive) decision errors. The baseline condition/null and alternative hypotheses are identified. For estimation problems related to the study, a range of values is identified and summary of the acceptable limits on estimation uncertainty are specified. Performance indicators as specified in Section 3.8 will be used to verify that MQOs are met. For radiological COPCs, the upper boundary, lower boundary, and gray region are specified. See Table 3-1 for details on Step 6 for each of the PSQs.

3.7 STEP 7 – DEVELOP THE DETAILED PLAN FOR OBTAINING DATA

The last DQO step involves the development of a resource-effective sample design for collection and compilation of the data needed to complete the study in a manner that is sufficient to fulfill the study objectives and maximizes the amount of data collected within a fixed budget in accordance with the performance or acceptance criteria. Key assumptions associated with the sample design are identified. The sample designs are based on the study objectives, outputs from DQO Steps 1 through 6, and current understanding of the preliminary CSM. The proposed sample design is a judgmental sampling program using available information from existing wells onsite. Due to the lack of initial data for the off-site areas at this time, a statistical approach to the offsite groundwater investigation sample design was not able to be utilized as this process requires an understanding of the variability in the data. However, the adequacy of the sampling design will be evaluated on an ongoing basis during the RI process using statistics as specified in Section 4.0. If additional sampling is required to meet statistical criteria associated with the DQOs, this will be identified, and work scope changes will be developed and presented to USEPA for review and approval as described in the OU-3 RI/FS Work Plan (Section 4.0). See the FSP for details on data collection procedures associated with the proposed sample design. The lateral and vertical distribution of sampling locations in the sample design, or sample representativeness, is based on the historical data set and on the data collection needs identified (OU-3 RI/FS Work Plan Section 2.0). See Table 3-1 for details on Step 7 for each of the PSQs.

3.8 CRITERIA FOR MEASUREMENT DATA

Six quantitative/qualitative measures of quality will be employed during site activities:

- Precision
- Accuracy
- Completeness
- Representativeness
- Comparability
- Sensitivity

The QA objectives for these criteria and procedures to compare calculated values to the objectives are described in greater detail below. QA requirements for the frequency and type of QC samples analyzed may vary due to method-specific requirements.

3.8.1 ANALYTICAL PRECISION

Precision is the degree of agreement between the numerical values of a set of replicate samples performed in an identical fashion. Field precision is assessed by the collection of blind duplicates at a rate of 1 duplicate for every 10 field samples to measure the Relative Percent Difference (RPD). Field duplicate samples will be taken concurrently with the parent sample. Laboratory precision will be assessed through calculation of the RPD for replicate analyses of samples including matrix spikes (MS), matrix spike duplicates (MSD), laboratory control samples (LCS), and laboratory control samples duplicates (LCSD). LCSDs are not part of all routine analyses for the laboratories but may be prepared when the MS is prepared from another client's sample or not prepared at all. LCS and/or MS pairs shall be prepared on a 5% basis or at least one per analytical batch (unless otherwise specified in the method-specific SOP). For solid matrix (alluvium and bedrock) samples, the MS pairs may not provide good accuracy measurement since solid matrix samples are inherently nonhomogeneous. LCSDs are not part of all routine analyses for the laboratories but may be prepared when the MS is prepared from another client's sample or not prepared at all. If a laboratory is unable to prepare an MS/MSD pair, an LCS and LCSD is required for the analyses. MS samples are not required for air sample analyses and an LCSD may be prepared to account for laboratory precision.

3.8.1.1 PRECISION FOR ANALYTICAL DATA REPLICATE ANALYSES

Precision will be based on the analytical data from the laboratory and field replicate analyses (radiological analyses are addressed below). Precision analyses may be reported as RPD as expressed by the following formula:

$$\%\mathrm{RPD} = \frac{abs\ (\mathrm{C}_1 - \mathrm{C}_2)}{\frac{(\mathrm{C}_1 + \mathrm{C}_2)}{2}} \mathrm{X}100$$

Where:

abs=Absolute value

C_1 = Concentration of the parent sample

C_2 = Concentration of the duplicate sample

A summary of laboratory acceptance criteria for precision analyses is included in Appendix C and also in accordance with the method-specific SOPs located in Appendix D. Third-party data validation review of duplicates will be conducted according to the *USEPA New England Environmental Data Review Supplement for Region 1 Data Review Elements and Superfund Specific Guidance/Procedures* (USEPA 2018). For third-party data validation, the RPD for water matrix (groundwater and leachate) field duplicate constituents must be less than 30%, the RPD for solid matrix (alluvium and bedrock) field duplicates must be less than 50%, and the RPD for vapor samples must be less than 25%.

3.8.1.2 PRECISION FOR RADIOLOGICAL ANALYSES

Laboratory and field replicate samples may be analyzed during the analytical processes. The objective is to measure precision of the analyses regardless of matrix interference or other outside factors. Precision analyses may be reported as percent RPD as expressed by the following formula:

$$\%\text{RPD} = \frac{abs(\text{C}_1 - \text{C}_2)}{\frac{(\text{C}_1 + \text{C}_2)}{2}} \text{x } 100$$

Where:

abs=Absolute value

C_1=Concentration of the parent sample

C_2=Concentration of the duplicate sample

Laboratory control limits will be calculated according to statistical analysis of data. Procedures may vary based on method-specific requirements and as defined in the laboratory SOPs; however, laboratory procedures shall be at least as conservative as those noted in this QAPP. These laboratory limits may be calculated using the following formula identified in Appendix C of the MARLAP guidelines (USEPA 2004a) as a guide:

Percent RPD Control limit determined by the laboratory=4.24 $\varphi_{MR} \times 100$ %

Where:

φ_{MR}=relative standard deviation at any concentration greater than upper bound gray region (UBGR) see Table 2-3a-ii

If the %RPD is not within laboratory-defined limits, the duplicate error ratio (DER) is calculated. The DER will be expressed using the following formula:

$$\text{DER} = \frac{abs(\text{C}_1 - \text{C}_2)}{\sqrt{(\text{CSU}_\text{S})^2 + (\text{CSU}_\text{d})^2}}$$

Where:

abs = Absolute value

C_1 = Concentration of the parent sample

C_2 = Concentration of the duplicate sample

CSU_s = the first sample combined standard uncertainty reported by the laboratory

CSU_d = the second sample combined standard uncertainty reported by the laboratory

DER = Duplicate Error Ratio

Data validation control limits for DER are defined in Appendix B-2. The control limits are provided using the *American Nuclear Society (ANS) Standard 41.5-2012* (ANS 2018) guidelines.

A summary of laboratory acceptance criteria for precision analyses is included in Appendix C, which is in accordance with the method-specific radiochemical SOPs (Appendix D). Third-party data validation for radiochemical data will be performed using the criteria defined in the *ANS Standard 41.5-2012* (ANS 2018) and with reference to *Chapter 8 of the USEPA MARLAP, document number USEPA 402-B-04-001A* (USEPA 2004a).

For third-party data validation, the RPD for water matrix (groundwater and leachate) field duplicate constituents must be less than 30% and the RPD for solid matrix (alluvium and bedrock) field duplicates must be less than 50%.

For third-party data validation and laboratory duplicates, if laboratory data are not sufficient to calculate control limits, the following criteria will be used:

1. If the measured concentrations are less than 5*LOD/MDC, then RPD must be 100% or less.
2. If the measured concentrations are greater than 5*LOD/MDC, then RPD must be less than 20% or DER must be less than or equal to 3.

3.8.2 ANALYTICAL ACCURACY

Accuracy is the measure of agreement of a result to the accepted (or true) value. Errors may arise from personnel, instrumental, or method factors. Accuracy in the field is assessed through use of field, equipment, and trip blanks and adherence to sample handling procedures, preservation methods, and holding times (see the Table 2-2 series tables). Field, equipment, and trip blanks will be collected as documented in Section 5.1.3.1.

For analytical data, LCS and/or MS pairs shall be prepared on a 5% basis or at least one per analytical batch (unless otherwise specified in the method-specific SOP). For solid matrix samples, the MS pairs may not provide a good accuracy measurement because of probable sample inhomogeneity and the results may not be useable. Therefore, if a laboratory is unable to prepare an MS, at least an LCS is required for the analyses in order to have some measure of accuracy. MS samples are not required for air sample analyses and an LCS will be prepared to account for laboratory accuracy.

3.8.2.1 ACCURACY FOR ANALYTICAL DATA

For field and laboratory accuracy using blank samples, the analytical data will be assessed based on the methods recommended by the USEPA Contract Laboratory Program (CLP) for common laboratory contaminants (radiological analyses are addressed in 3.8.2.2). The following procedures for third-party data validation will be used to assess blanks collected in the field and analyzed in the laboratory. If a contaminant is detected in an equipment blank, field blank, trip blank, or laboratory blank (as prepared to assess possible laboratory contamination), the detected concentrations of that contaminant in any associated environmental sample will be qualified as follows. If the contaminant concentration in the environmental sample is found to be within 10 times the contaminant concentration of the blank, the associated environmental sample concentration will be 'JB' qualified and considered an estimated value due to possible cross-contamination. As noted in the data validation variance documents (Appendix B), Trihydro uses a "10 times" rule for possible contaminants identified in the blank samples. However, if contaminants are detected in environmental samples at values below the original blank detection or the associated MRL, the contaminants will be qualified with a "U" and considered non-detect (ND) at the MRL.

Laboratory accuracy is assessed by evaluating LCS, LCSD, MS, MSD, and organic system monitoring compounds (surrogate) percent recoveries. Analytical accuracy is estimated from the recovery of spiked analytes from the matrix of interest. Laboratory performance in a clean matrix is estimated from the recovery of analytes in the LCS. The recovery of each spiked analyte in the MS, MSD (if performed) is completed using the following formula:

$$\text{Percent Recovery} = \%\text{R} = \frac{(\text{C}_\text{s} - \text{C}_\text{u})}{\text{C}_\text{n}}\,\text{X}\,100$$

Where:

C_s = Measured concentration of the spiked sample aliquot

C_u = Measured concentration of the unspiked sample aliquot

C_n = Nominal (theoretical) concentration increase that results from spiking the sample, or the nominal concentration of the spiked aliquot

The recovery of each spiked analyte in the LCS, LCSD (if performed), and surrogate is completed using the following formula:

$$\text{Percent Recovery} = \%\text{R} = \frac{(\text{C}_\text{s})}{\text{C}_\text{n}}\,\text{X}\,100$$

Where:

C_s = Measured concentration of the spiked sample aliquot

C_n = Nominal (theoretical) concentration increase that results from spiking the sample, or the nominal concentration of the spiked aliquot

3.8.2.2 ACCURACY FOR RADIOLOGICAL ANALYSES

Blank results for radiological analyses are generated by carrying all reagent and preparation materials normally used to prepare a sample through the same preparation process. It establishes how much, if any, of the measured analytes are contributed by the reagents and equipment used in the preparation processes. Measured results are usually corrected for instrument background and may be corrected for reagent background. Therefore, it is possible to obtain final blank results that are less than zero. Blank samples will be evaluated in accordance with their SOPs and as discussed in Appendix B.

When an aliquot of blank material is analyzed, or if a nominal aliquant is used in the data reduction, the measured blank result is an activity concentration. The laboratory will report method blank detections when method blanks are detected above the associated MDC, which are defined in Table 2-3a-ii of this QAPP.

The objective of the LCS is to measure the performance of the analytical process using a QC sample with a matrix similar to the field samples to be analyzed. This will allow inferences to be drawn about the reliability of the analytical process (USEPA 2004a). The requirements for LCS results are displayed below:

$$\%D = \frac{abs(SSR - SA)}{SA} * 100$$

Where:

abs = Absolute value
%D = percent difference
SSR = the spiked sample result
SA = is the spike activity (or concentration) added

Control limit determined by the laboratory= $\pm 3\varphi_{MR} \times 100\ \%$

Where:

φ_{MR}=relative standard deviation at any concentration greater than UBGR (Table 2-3a-ii)

If required per the analytical method, MS samples shall be prepared. MS samples provide information about the effect of each sample matrix on the preparation and measurement methodology (USEPA 2004a). The requirements for MS results are displayed below:

$$\%D = \frac{abs(SSR - SR - SA)}{SA} * 100$$

Where:

abs = Absolute value

%D = percent difference

SSR = the spiked sample result

SR = the unspiked sample result

SA = the spike concentration added (total activity divided by aliquot size)

$$\text{Control limit determined by the laboratory} = \pm\, 3\varphi_{MR} \times 100\ \%$$

Where:

φ_{MR} = relative standard deviation at any concentration greater than UBGR (Table 2-3a-ii)

A summary of laboratory acceptance criteria for accuracy analyses is included in Appendix C and also in accordance with the method-specific radiochemical SOPs (Appendix D-3). Third-party data validation for radiochemical data will utilize the criteria defined in *ANS Standard 41.5-2012* (ANS 2018) and with reference to *Chapter 8 of the USEPA MARLAP, document number USEPA 402-B-04-001A* (USEPA 2004a).

3.8.3 ANALYTICAL COMPLETENESS

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. The overall completeness of the analytical data will be determined by the data validator through a ratio of the number of validated sample analyses to the total number of sample results required by the sampling program, calculated as follows:

$$\text{Completeness} = \frac{\text{Number of valid samples collected}}{\text{Number of samples planned or expected}} \text{X } 100$$

These newly collected data are being collected to answer the PSQs (Section 3.2) and are considered critical information to answering these questions (Table 3-1). Therefore, the completeness goal is set (Section 3.8) in the attempt to have little to no rejected data (i.e., meets the quality objectives). Data quality for historical and reference data are discussed in Section 4.1.

Laboratory completeness is a measure of the amount of valid measurements obtained from the total number of laboratory measurements taken in this project. The laboratory completeness objective for this project, with respect to the data validation quality parameters established in the DQOs (Table 3-1), is 95%. The ability to meet or exceed a completeness objective is dependent on the nature of samples submitted for analysis. If validated data cannot be reported without qualifications, project completeness goals may still be met if the qualified data (i.e., if the data are not rejected) are suitable for specified project goals. Data will be qualified as specified in Appendix B and rejected as specified in Section 7.1.

3.8.4 ANALYTICAL REPRESENTATIVENESS

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. Representativeness may include both qualitative and quantitative terms. QC data for other data quality indicators (i.e., data quality indicators for precision and accuracy) will be used to help ensure that the samples are representative of the actual environmental conditions. If the data quality indicators for precision and accuracy are acceptable without rejection, it will be determined that the data are representative of environmental conditions at the site. Overall data representativeness is a function of the design of the sampling program as discussed in Section 3.0 as part of the DQOs. Corrective action, when representativeness is not met, is specified in Section 6.1.3.

Another quantitative term for data representativeness is if the samples are of acceptable temperature and preservation to be representative of actual site environmental conditions. Where applicable to the analytical method, the laboratory will maintain and verify that the sample temperatures and applicable preservations were met. These will be assessed upon receipt at the laboratory and as described in each laboratory sample receipt procedures specified in Appendix D. Sample temperatures will be verified using a temperature blank in each cooler and/or verification using an infrared gun at the laboratory. Samples bottles will be provided to the field team with the appropriate sample preservative.

3.8.5 ANALYTICAL COMPARABILITY

Comparability expresses the confidence with which one data set can be compared with another. Comparability is dependent upon the proper design of a sampling program and will be satisfied by ensuring that the sampling plan is followed and that appropriate sampling protocols are used. The DQOs were prepared following review of historical data associated with the site. Therefore, data will be compared to previously collected data, as specified in the OU-3 RI/FS Work Plan Section 2.0 and below in Section 4.0. Additionally, comparability is dependent upon the laboratory's ability to maintain required method certifications and adequately train personnel to analyze data in accordance with required analytical methods. Therefore, comparability measures are assessed using the data validation procedures for accuracy and precision. Detailed procedures for data validation are discussed in Appendix B and accuracy and precision measures in Sections 3.8.2.1 and 3.8.2.2, respectively.

3.8.6 ANALYTICAL SENSITIVITY

The sensitivity of each laboratory instrument will be dependent upon the required reporting limit and then the corresponding method required to meet the reporting limit. Therefore, the sensitivity requirements will be variable for each method. The sensitivity requirements are specified in each laboratory SOP (see Appendix D). MRLs, MDLs, and LOD/MDCs for radionuclides are included in QAPP Table 2-3a-ii. MDLs are developed using the procedures referenced in the laboratory QAMs (Appendix A), SOPs (Appendix D), and in accordance with the *40 Code of Federal Regulations (CFR), Appendix B to Part 136 (Revision 2), Procedures for Detection and Quantitation,* including current modifications.

Screening level are shown in Table 2-3a-i and Table 2-3a-ii: including, MCLs, RSLs (assuming a cancer risk of 10^{-6} and Hazard Quotient [HQ] of 0.1 and 1.0), and the MDNR groundwater protection standards. MRL and MDLs will be compared to the MCL first, then the USEPA RSL with a HQ of 0.1, and then the MDNR standard. However, after reviewing the data, an HQ of 1.0 may be used depending on the number of detected and co-occurring constituents as determined as part of the Baseline Risk Assessment Work Plan (BRAWP). For the purpose of identifying appropriate laboratory methods and detection limits, the lower screening limit was used in Table 2-3i. For radiochemistry (Table 2-3ii), the USEPA MCL, and the USEPA PRG are shown, along with the LOQ, LOD, and the radiological action level and variables discussed above to determine the best LOD. In vapor Table 2-3c, MRLs, MDLs, indoor air removal management levels, screening levels, and RSLs were used to develop the MDLs and MRLs. Final values will be reported to the MDL. Values between the MRL and the MDL will be qualified by the laboratory as estimated.

Sensitivity will be determined through data validation review. Dilutions and accuracy measurements will be assessed to ensure that dilutions were applied only when needed. In addition, sensitivity will be assessed through review of calibration logs and data provided by the laboratory.

3.9 GEOMETRIC AND FIELD DATA QUALITY OBJECTIVES

For geometric data and field data, the quality objectives are variable depending on the instrument and measurements performed. Field equipment and instruments used during this project organized by task are outlined in Table 3-1 of the FSP, calibration procedures for each instrument are described in FSP Section 4.0, and the instrument accuracy is shown in Table 2-3d. In general, the QA measurements for geospatial and field data are as follows:

- Accuracy: The accuracy of the geospatial attributes (latitude, longitude, and depth) is dependent on the accuracies of the equipment used to measure their values. The accuracy of field instruments is based on the instruments' capabilities and calibrations as specified in the FSP. Accuracy for geospatial data are also discussed in Section 5.1.2.1.4.

- Precision: Geospatial surveys are conducted only during appropriate weather conditions for the instruments. For example, for bathymetric surveys, surveying is not performed during storms or when winds are above 15 knots. Weather conditions, such as heavy storms, lightning storms, and heavy cloud cover, as well as water clarity, affect the collection process. Similarly, for field instruments, Trihydro will check with the manufacturer, instrument user manual, and rental company to ensure that calibrations and measurements are completed under appropriate conditions for that instrument.
- Compliance: The compliance objective for field measurements is to follow manufacturers' instructions for management of each individual instrument. Additionally, rented or subcontracted equipment will be calibrated by the subcontractor or instrument provider prior to being used in the field. On-site, the team will verify that the instruments are calibrated by reviewing logs, and if recommended, will recalibrate in the field (Section 5.1.4 and FSP Section 4.0). Field data QA procedures are discussed in Section 7.1.1.
- Representativeness: The representativeness of each field measurement will be determined by having technicians who have a thorough understanding of the instruments and understand typical field measurements. Qualitative terms for representativeness of data include adherence to methods specified in the FSP for calibration, maintenance, and monitoring of field instruments to ensure representativeness of field data. Field personnel will have previous data available at the time of routine sampling, will be able to use professional judgement to qualitatively evaluate representativeness of field measurements in "real time," and can take corrective action, if needed, to ensure that field measurements are representative. Field data will also be reviewed as specified in Section 7.1.1. Field procedures are discussed in detail in the FSP.
- Sensitivity: Sensitivity will be assessed through review of calibration logs and provided by field personnel.
- Completeness: Field completeness is a measure of the amount of valid data obtained from the instruments used in the field compared to the amount that was expected to be obtained under normal conditions. The field completeness objective for this project will be 95%. If necessary, the field crew may be required to return to the site in order to meet completeness objectives. Trihydro will coordinate with USEPA on these decisions. Any questionable data points will be removed or, if remeasurement is possible, remeasured.

3.10 SPECIAL TRAINING AND CERTIFICATIONS

Field personnel will participate in site-specific training and acquire specified certifications as required in this QAPP and associated FSP (Section 3.1.4). Trihydro site personnel requirements for safety are described further in the site-specific HASP. Laboratory personnel will conduct training and obtain certifications in accordance with descriptions listed in their QAM and accrediting body (The National Environmental Laboratories Accreditation Conference [NELAC] Institute) requirements (Appendix A). Field personnel will participate in site-specific orientation.

3.10.1 TRAINING

Field personnel are required to be familiar with the applicable company field procedures. Asbestos training may be required for drilling on-site wells if waste is anticipated. Field personnel will also have radiation awareness safety training as specified in the OU-1 Radiation Safety Plan. Field personnel will also have a Missouri Restricted Monitoring Well Installation Contractor for oversight of well drilling, coring, construction and plugging, and also test hole drilling, coring or plugging. Training, permits, and licensing is specified in FSP Section 3.1.4. The Trihydro PM will keep the training records for Trihydro field personnel. Safety training is discussed in the HASP.

Laboratory personnel will be required to undergo training as specified in the laboratory QAMs (Appendix A). The training records for the laboratory personnel will be kept with the laboratory QA departments.

3.10.2 CERTIFICATION

Personnel involved in this project as PMs, Quality Officers, and the Trihydro FTL (and associated personnel) will be required to review this QAPP and sign the front cover (or equivalent) indicating that they are familiar with the QAPP. Certifications are renewed on a regular basis; therefore, the most recent certifications were included (Appendix A). New certifications can be provided upon request, throughout the life of the project. A record of the signature page(s) will be kept in the project file at Trihydro, as follows:

- The Kansas Department of Environment and Health primarily (Appendix A-1B), certifies Pace-I to perform analyses.
- The Commonwealth of Pennsylvania Department of Environmental Protection (Appendix A-2B) and American National Standards Institute (ANSI) National Accreditation Board (Appendix A-2C), certifies Pace-P to perform analyses.
- The Pennsylvania Department of Environmental Protection, Bureau of Laboratories (Appendix A-3B), certifies Pace-E to perform analyses.
- The Kansas Department of Environment and Health (Appendix A-4B), certifies Pace-K to perform analyses.
- The State of Louisiana Department of Environmental Quality Environmental Services (Appendix A-5B) certifies Pace-N in Mt. Juliet, Tennessee to perform analyses.

- The American Association of State Highway and Transportation Officials (Appendix A-6A), certifies Advanced Terra Testing to perform analyses.
- The Perry Johnson Laboratory Accreditation for ISO/IEC 17025 as part of the Department of Energy Consolidated Audit Program (DOECAP) Program (Appendix A-7B), certifies MCLInc to perform analyses.
- The Oregon Environmental Laboratory Accreditation Program (Appendix A-8B), certifies ALS-S to perform analyses.
- The Canadian Association of Laboratory Accreditations, Inc. (Appendix A-9B), certifies ALS-W to perform analyses.
- The American Association of Laboratory Accreditation (A2LA) (Appendix A-10B, Appendix A-10C), certifies EMSL to perform analyses.

A rigorous QA/QC program will be maintained in accordance with this QAPP and the associated FSP to ensure that data quality is sufficient to meet the objectives of the investigation.

3.11 DOCUMENTATION AND RECORDS

Documentation and records will be maintained to help ensure field and laboratory observations and data are communicated appropriately and archived pursuant to the site requirements. Detailed descriptions of these records are discussed below.

3.11.1 DOCUMENTATION

Field observations are critical to the verification and interpretation of the laboratory data. Field observations during sampling will be recorded on the field form or applicable electronic means (e.g., data-logger, global positioning system [GPS] unit). In addition, the field activities will be documented in a bound field logbook with numbered pages. Entries in the logbook will be made with indelible ink. The information documented will include, at a minimum: field staff names that are involved in sample collection activities for the specific day; photos with descriptions and locations; amounts and types of any measurements; weather conditions; and/or GPS coordinates collected at each sampling point. The Sample Collection Log (Appendix A-2 of the FSP) will include the sample's unique identification number, sample type, sample location, sample time, field personnel, and analytical parameters and container counts for the sample. Associated QA/QC samples such as duplicates, trip blanks, equipment blanks, etc. will be noted. Field documentation procedures and field forms are included in the FSP.

3.11.2 RECORDS

Trihydro will be the custodian of records and will maintain the records for the site activities, including relevant reports, logs, field notebooks, photographs, subcontractor reports and data reviews in a secured, limited access area and under custody of the Trihydro PM. Electronic data will be stored in a secure cloud storage database with appropriate cybersecurity measures. Field data types may include field screening, water quality, fluid level, and location data. The final records may include:

- Field logbooks
- Field data and data deliverables
- Boring and well construction records
- Photographs
- Drawings/Figures
- Laboratory data deliverables
- Data validation reports
- Progress reports, QA reports, interim project reports, etc.
- Custody documentation
- Groundwater sample collection logs with well screening parameters
- Leachate sample collection logs
- Solid matrix (alluvium and bedrock) sample collection logs
- Vapor sample collection logs

Additional sample logs may be necessary if additional media are added to the OU-3 RI/FS field activities.

Trihydro will maintain site records at their Laramie, Wyoming, office for at least 10 years after the completion of site activities, or as deemed necessary by OU-3 Respondents. Additionally, the laboratory will retain records for 5 years after analyses.

The laboratory records will be kept with the Laboratory Project Managers. Data package deliverables from the laboratory meeting the requirements of the USEPA CLP (or CLP-like) specified data package deliverables, with modifications as required reflecting the use of USEPA-approved methods, will be maintained by Trihydro and each laboratory. For analyses that do not have CLP/CLP-like forms, the results will be provided in a standard laboratory information management system (LIMS) report and then as part of a data package. These data packages will be sufficient for the specified level of data validation. The laboratory reports will contain the information needed to sufficiently and unambiguously document and recreate laboratory results. Sample custody and associated analyses will be completely documented. Data packages will contain information to completely document laboratory analysis procedures.

4.0 DATA QUALITY ASSESSMENT

Data quality assessments are the evaluation of data to determine if data obtained from environmental data operations are of the right type, quality, and quantity to support their intended use. Data quality assessment completes the data life cycle by providing an assessment to determine if the planning objectives were achieved. Trihydro will use the data usability and statistics specified in this QAPP to document data quality assessment for the site environmental data. Data quality assessment procedures will be performed in accordance with the *Guidance for Data Quality Assessment: Practical Methods for Data Analysis, QA/G-9* (USEPA 2000a), *Data Quality Assessment: A Reviewer's Guide, QA/G-9R* (USEPA 2006b), and *Data Quality Assessment: Statistical Methods for Practitioners, QA/G-9S* (USEPA 2006c).

Samples will be collected from groundwater, leachate, alluvium, bedrock, and vapor pursuant to the OU-3 RI/FS Work Plan to characterize impacts that may exist. The sample design (locations, depths, number of samples) proposed in the OU-3 RI/FS Work Plan has been developed to address data requirements for both (1) site characterization and (2) future risk assessment. Additional phases of work are proposed to be conducted based on evaluation of the initial data, as described in OU-3 RI/FS Work Plan Section 4.0. Additional modification to the plan for data collection as part of the future phases of work may be required. The sample design will be evaluated for each phase of work for its adequacy relative to the goals of the OU-3 RI/FS process.

4.1 DATA USABILITY

Newly collected and historical data may be used to meet some project objectives for the current project SOW. However, these data may not be of the quality necessary to meet the current DQOs (Table 3-1). When planning to use data, the data will be evaluated relative to the project's DQOs by obtaining and reviewing project metadata (i.e., information that describes the data and their quality criteria), laboratory reports, and data validation reports.

Historical Data Usability

Once possible historical data and metadata are identified for the project, the following steps will be taken to help evaluate the existing data as discussed in Section 3.0 of the *Guidance for Quality Assurance Project Plans (USEPA QA/G-5)* (USEPA 2002b). In addition, existing data that may be used will be evaluated to determine if it meets the criteria for data usability including data sources, documentation, analytical methods, required MDL/MRLs, data quality indicators, data review, and risk assessment reports, as outlined in the *USEPA Guidance for Data Usability in Risk Assessment* (USEPA 1991):

1. Data sources - Data sources may be qualitative, semi-quantitative, or quantitative. Data sources must be comparable if data are combined for quantitative use. For the OU-3 RI/FS, existing data sources include but are not limited to OU-1 and OU-2 documents (OU-3 RI/FS Work Plan Section 2.0), third-party offsite documents for registered environmental sites, Environmental Data Resources (EDR), published data, and water provider records to be collected as described in the OU-3 RI/FS Work Plan, Section 5.2.1. Statistics will be used to evaluate the compatibility of data sets as described in Section 4.2.

2. Documentation - Deviations from the OU-3 RI/FS sampling procedures and SOPs will be evaluated to identify potential limitations in the data. For the OU-3 RI/FS, potential documentation of interest includes but is not limited to groundwater sampling and sample collection methods, vapor sampling methods, and groundwater stabilization criteria.

3. Analytical Methods and Detection/Reporting Limits – The laboratory analytical methods and associated MDL/MRLs or the LOD/MDC (for radionuclide data) will ideally be below the screening levels shown in the Table 2-3 series tables. Analytical methodology will be reviewed to determine if valid and USEPA (or other promulgated) methods were used to analyze the data.

4. Data Quality Indicators – The data quality indicators of precision, accuracy, completeness, representativeness, and comparability associated with historical data will be reviewed as outlined in Section 4.1. Prior to using existing laboratory data:

    - The data will be reviewed for precision to quantify the likelihood of false negatives and false positives through evaluation of QC samples and confidence limits from the QC data based on the analytical method and sample design.

    - The data will be reviewed for accuracy using the available laboratory QC package and validation reports. Flagged data will be identified and evaluated relative to the intended end use. The data will be reviewed for completeness, including but not limited to MDLs/MRLs, qualifiers, quantitation limits, geographic locations, appropriate analytical units (such as µg/L for water) for the matrix, and complete CoC.

    - The data will be reviewed for representativeness, including the COPC list, sample size, sample locations, and media.

    - The data will be reviewed for comparability in terms of laboratory methods, units of measure, temporal considerations and temporal considerations.

5. Data Review – The data review includes review of results, type of validation completed (automated vs. manual), and data qualifiers. If the data were rejected, the data will be considered unusable as a historical reference.

6. Risk Assessment Reports – Historical risk assessment reports if available will be used to evaluate data usability.

Similar to the procedures for evaluating the use of analytical data, historical field data (such as fluid levels and slug test data) will also be evaluated against the above criteria. Documentation of the data usability evaluations will be completed for each historical data source within the report in which the report is first utilized.

Newly Collected Data

Usability of newly collected data will be determined based on the following criteria:

1. Analytical Methods and Detection/Reporting Limits – The laboratory analytical methods and associated MDL/MRLs or the LOQ and LOD/MDC (for radionuclide data) will be in accordance with those shown in the Table 2-3 series tables. Note, the MDL and MRLs are evaluated annually (in accordance with certification requirements) and are subject to modification based on the laboratory capability studies.
2. Data Quality Indicators – The data quality indicators of precision, accuracy, completeness, representativeness, and comparability associated with historical data will be reviewed as outlined in Section 4.1. Prior to using the newly collected laboratory data, the data will go through the validation process outlined in Section 7.0. These newly collected data are being collected to answer the PSQs (Section 3.0) and are considered critical information to answering these questions. Therefore, the completeness goal is 95% (Section 3.8) in the attempt to have little to no rejected data (i.e., meets the quality objectives). If data are rejected, the USEPA will be notified of the rejected data and consulted to determine if resampling is necessary. Data will be more critical in cases where it is needed to calculate exposure point concentrations for the BRAWP, groundwater modeling considerations, or determination of spatial and temporal boundaries. Data may be found to be less critical in cases where multiple samples are available from the same location.

Newly collected field data (such as stabilization parameters, fluid levels and slug test data) will be reviewed in accordance with Section 4.1 and 7.1 of this QAPP.

4.2 EMPLOYING STATISTICAL AND DATA ASSESSMENT METHODS

Existing and newly collected data will be evaluated against a five-step statistical process described in detail in the *Data Quality Assessment: Statistical Methods for Practitioners* (USEPA 2006c). Five steps will be employed during the evaluation of the data:

1. Review of the site's objectives and sampling design: The goal of this activity is to develop quantitative statements of the reviewer's tolerance for uncertainty in the conclusions drawn from the data and in actions based on those conclusions.

2. Conduct a preliminary data review: The goal of this step is to review calculations of basic statistical methods and graphical representations of the data.
3. Select the statistical method: The goal of this step is to identify the appropriate statistical method that will be used to draw conclusions from the data.
4. Verify the assumptions of the statistical method: The goal of this step is to assess the validity of the statistical test chosen.
5. Draw conclusions from the data: The goal of this step is to use the chosen statistical test to draw conclusions to ensure that the data are adequate for the objectives described in Step 1.

In general, statistical and data assessment tools that may be used include:

- Tabular Displays
- Graphical Displays
- Data Groupings
- Summary Statistics
- Sample Size Evaluation
- Outlier Evaluation
- Background COPC Evaluation

Each of these data assessment tools is discussed in detail below.

4.2.1 TABULAR DISPLAYS

Tabular displays may be used to manage and present various types of unsorted (raw) and sorted field and laboratory data. The formats that will be used for tabular displays and related documentation forms will be consistent with those shown in the OU-3 RI/FS Work Plan and this QAPP. Tabular displays may be used for:

- Groundwater and leachate analytical results
- Solid matrix (alluvium and bedrock) analytical results
- Organic vapor screening results
- Groundwater, leachate, and surface water elevation

- Monitoring well construction
- Laboratory report of solid matrix (alluvial and bedrock) analysis
- Laboratory report of groundwater and leachate analysis

4.2.2 GRAPHICAL DISPLAYS

Graphical displays will be applied to manage and present various types of field and laboratory data. The formats that will be used for graphical displays and related documentation will be consistent with those shown in the OU-3 RI/FS Work Plan.

4.2.3 DATA GROUPING

Data will be grouped and evaluated (e.g., mean, maximum, minimum, detection frequency) based on media/exposure pathway. This allows examination of detection frequency and data variability.

Groundwater data will be grouped by the following populations as noted in Step 5 of the DQO Table 3-1:

- Vertical interval (AS, AI, AD, SS, SD)
- Background wells in the 600-series (located hydraulically upgradient or side gradient from the site)
- Onsite wells (existing and proposed wells as shown on Figure 5-2 of the RI/FS Work Plan)
- Off-site down-gradient wells (500-series wells) and third-party wells as identified by the Well Inventory

The maximum detected value will be compared to the appropriate screening levels (see the Table 2-3 series tables) following completion outlier testing and data validation (see Section 4.0). For ND analytes, the maximum RL will be used relative to the appropriate screening value.

4.2.4 SUMMARY STATISTICS

The summary statistics will be compiled for each media and presented in tabular format. These summary statistics may contain the following information, depending on the type of data and final use:

1. Number of samples
2. Number of detects and frequency of detection
3. Minimum detected value

4. Maximum detected value
5. Sample mean detected value
6. Sample median detected value
7. Sample standard deviation of detected value
8. Minimum reporting limit
9. Maximum reporting limit

Discussion related to reduction of the COPC list is included in OU-3 RI/FS Work Plan Section 6.2.5.

4.2.5 SAMPLE SIZE EVALUATION

ProUCL Version 5.1 (or the most recent version), Visual Sampling Plan, or equivalent software will be utilized to evaluate whether the sample size (number of background alluvial samples, number of groundwater wells and sampling events) is adequate. Since this verification requires some pre-existing data to assess variability in the dataset, the sample size will be evaluated after collection the data proposed in the OU-3 RI/FS Work Plan. The output from the sample size evaluation will be taken into consideration and balanced with cost. Type I and Type II errors allowable for each PSQ evaluation are specified in Step 6 of Table 3-1. The Type I error rate or significance level is the probability of rejecting the null hypothesis given that it is true. Usually, the significance level is set to 0.05 (5%), implying that it is acceptable to have a 5% probability of incorrectly rejecting the true null hypothesis. A 5% significance level is generally accepted in environmental investigations as being protective of human health and the environment. A false rejection decision error (Type I) is the more severe decision error for environmental remediation sites, and therefore, a more stringent criteria has been placed on this type of error. The Type II error rate is related to the power of a test and for this study will be set at 10%. Currently with the increased focus on site, it is also important to limit the Type II error rate. The Type II error rate may be reduced if it results in an unattainable number of samples.

After collection of multiple rounds of groundwater and leachate data, the analyte suite in Table 2-3a-i and 2-3a-ii will be evaluated to determine if modification of the analyte suite is required. A request will be submitted to the USEPA for review and approval based on an evaluation of the adequacy of the COPC data in conjunction with the well network adequacy as outlined above.

4.2.6 OUTLIER EVALUATION

Occasionally, an inconsistent large or small value may be observed in the data due to sampling, laboratory, transportation, and transcription errors, or even by chance alone. If such erroneous values (either too high or too low) were included in the data used in statistical evaluation, the resulting sample mean and standard deviation would be unreasonably large (or small), which in turn may increase (or decrease) the magnitude of estimates and increase in the false negative/positive rate (Type I/II error) of the statistical test (USEPA 2009). COPC concentration data will be evaluated for outliers using standard statistical methods such as Dixon's or Rosner's tests at the 95% level and any extreme and unusual values flagged as outliers by any of the outlier tests will be graphically confirmed using time series plots. Using time series plots, the median value of the concentrations around the time of the potential outlier will be estimated and the outlier(s) in question will be compared to three times (usually high value) or one-third (usually low value) the median concentration. If the outlier in question is above (three times) or below (one-third) the calculated median value of the data, the result will be considered an outlier and excluded from further statistical evaluation until the next sampling event and/or statistical evaluation since it could drive statistical test results and estimates (see Section 4.2.7). In addition, distributional testing will be conducted in an evaluation of outliers. Outlier tests will be used before combining data sets. See Step 7 of the DQO Table 3-1 for more details.

4.2.7 BACKGROUND COPC EVALUATION

A background evaluation will be completed with the primary objective to determine naturally-occurring levels of background COPCs that may exist that are not related to the site. There is also the potential for anthropogenic background COPCs to be present as a result of environmental releases at other sites, as discussed in the OU-3 RI/FS Work Plan (Section 5.3.3). As noted in Work Plan Section 5.3.3, if monitoring wells installed for the purpose of monitoring naturally-occurring background are determined to be impacted by anthropogenic background releases, then the statistical design of the monitoring well network with respect to naturally-occurring background will be reevaluated. Modifications to the background COPC evaluation monitoring network may be proposed to USEPA for review and approval, if appropriate.

In addition, depending on the location and applicability of the data related to newly collected data, historical data may be used. Published background for similar lithology in groundwater will be considered, including *Evaluation of Radon Occurrence in Groundwater from 16 Geologic Units in Pennsylvania, 1986-2015* (USGS 2017b). Background COPCs in indoor air will also be evaluated from USEPA's *Vapor Intrusion Database* (USEPA 2012).

As part of the evaluation of background COPCs, site-specific Background Threshold Values (BTV) will be determined for applicable COPCs and used in the screening-level evaluation as well as the BRAWP. In accordance with the

Unified Guidance (USEPA 2009), these background values may be updated as additional data are collected. Depending on the data richness for a given COPC and exposure area, background assessment may consist of straightforward comparisons between the maximum/average and BTVs as well statistical tests, which compare the site COPC concentration data and available background data. Information on background chemicals will be obtained from site-specific background samples and literature (e.g., USGS soil surveys for inorganic constituents). While the background assessment is typically conducted for inorganic analytes, some organic constituents, such as polyaromatic hydrocarbons, may have local anthropogenic origins (i.e., atmospheric deposition, forest/grass fires, asphalt/road runoff). As such, if the background and site concentration data suggest the presence of local anthropogenic inputs, the BRAWP will assess the relative risk contribution of non-site sources to inform risk management decisions.

Recommendations and procedures presented in current Unified Guidance (USEPA 2009) (or any future update or addendum) will be used to estimate the most appropriate BTV for each COPC. Depending on the number of available samples per COPC-well pairs, the attributes and characteristics of the data, and the intended use of the BTVs, BTVs such as prediction limits for observations or tolerance limits will be estimated at the project-specified 95% level. Upper prediction limits (UPL), such as 95% UPLs, are an estimate, such that an independently new or future collected observation from the background population would be less than or equal to the 95% UPL with a confidence of 0.95 (i.e., 95% sure that a single future value from the background population will be less than the 95% UPL with 95% confidence). If more than one new future observation is to be compared to the 95% UPL, the significance level, α, will be adjusted to the number of multiple comparisons to retain an overall project-specified Type I error of no more than 0.05.

Upper tolerance limits (UTL), such as UTL95-95 (95% confident that 95% of the data are below the UTL95-95 if they come from that same background), are designed to simultaneously provide coverage for 95% of all potential observations from the background population with 95% confidence. Therefore, UTL95-95 can be used in multiple comparison without increasing the overall Type I error rate; thus, any UTL95-95 will not be adjusted to the number of multiple comparisons. UTL95-95 are estimates, such that 95% of observations (current and future) from the background population would be less than or equal to the UTL95-95 with 95% confidence.

Both UPL and UTL rely on similar key assumptions (USEPA 2009): independent observations, spatial and temporal stationarity of the data, and no extreme outliers. Spatial variability among the background wells will be evaluated using statistical methods such as parametric or nonparametric ANOVA followed by ad hoc contrasts if evidence of spatial variation is supported by the analyses of variance, and temporal stationary will be evaluated through trend analysis (e.g., Mann-Kendall trend analysis). Depending on the presence of serial correlation and/or seasonal effect in the data, the seasonal Mann-Kendall, or Mann-Kendall for serially correlated data test will be used in lieu of the standard Mann-Kendall if the assumptions of the standard Mann-Kendall trend test are not met. In addition, BTVs should be representative of the background conditions. For this reason, extreme outliers will be excluded when computing BTV estimates as suggested by USEPA (2009, 2015b).

UPL and UTL can be estimated through parametric (i.e., assuming a specific underlying population distribution) and nonparametric (i.e., no specific underlying distribution is assumed) methods, if the data encompass at least 6-10 samples with 4 detected values (or more if choosing a nonparametric approach) (USEPA 2009, 2015b). The fit of potential distributions (i.e., normal, lognormal, and gamma) will be assessed with goodness-of-fit tests such as the Shapiro-Wilks test on detected results only, assuming the ND values follow the same underlying distribution as the detected results (USEPA 2015b). Even a small frequency of ND results (i.e., 5-10 % NDs) could constrain goodness-of-fit tests to reject their null hypothesis (i.e., the data fit the specified distribution) (USEPA 2009, 2015b). In the presence of NDs, Kaplan-Meier estimates for the sample mean and sample standard deviation will be used to compute BTV limits to account for the censored data and avoid any biases that the ND substitution method usually generate (USEPA 2015b). If none of the candidate distributions fit the data, a stable, realistic, and conservative nonparametric alternative such as the Chebyshev prediction limits will be considered.

5.0 DATA GENERATION AND ACQUISITION

The purpose of this section is to describe the data generation and acquisition that will be implemented by the project team. This appropriate tracking of data generation and acquisition will ensure that the data collected are of sufficient quality to meet overall project objectives as specified in the DQOs (Section 3.0). Data that may be generated as part of the work discussed in the OU-3 RI/FS Work Plan, include:

1. Historical and new chemistry/analytical and field parameter data from groundwater/leachate, fluid levels, solid matrices (alluvium and bedrock), or vapor samples.
2. Historical and new geospatial data from maps, figures, databases, new sample and well locations, and previous samples and well locations.
3. Historical and new geochemical, fluid level, and characteristic data from solid matrices (alluvium and bedrock).

The SOW and approach for this project includes a phased, lines-of-evidence approach that will provide an efficient, thorough, and cost-effective method to completing the project. The project design is outlined in the specific section of the OU-3 RI/FS Work Plan for the work being performed.

The Table 2-3 series tables includes a complete list of project target compounds and current laboratory determined detection limits for each analyte in addition to the sampling methods for groundwater/leachate, solid matrices (alluvium and bedrock), and vapor. Laboratory MDLs and MRLs have been determined according to *Appendix B of 40 CFR 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants"* as noted in the laboratory QAMs (Appendix A). For radiological analyses, the laboratory uses documented procedures for the determination of the LOD and LOQ for each analyte and matrix. The procedures for the radiological LOD and LOQ are determined using the specific analytical method and *Appendix B of 40 CFR 136, "Definition and Procedure for the Determination of the Method Detection Limit – Revision 2"* as noted in the QAM (Appendix A).

The laboratory will attempt, through the standardized analytical methods, to achieve these limits. However, limits are highly dependent on specific sample matrix effects. In order to achieve the most useable results, Trihydro will work with each laboratory to achieve the lowest possible limits within the appropriate levels of precision and accuracy. To ensure that data are useful for addressing the principal objectives of the RI/FS, samples will be analyzed and evaluated in accordance with this QAPP. A summary of laboratory reporting limits compared to potential risk-based criteria or clean up levels is included as Table 2-3a-i and 2-3a-ii for groundwater, 2-3b for alluvial/bedrock and 2-3c for vapor.

5.1 SAMPLE HANDLING AND CUSTODY

A majority of the data for this project will be generated in the laboratories in accordance with the laboratories' QAMs (Appendix A). However, some data will also be generated in the field during sample collection. The procedures for analytical and chemical data generated in the laboratory and field are explained in the following sections.

5.1.1 SAMPLE HANDLING AND CUSTODY

From sample collection through laboratory analysis to the final evidence files, the procedures for sample handling and custody of the samples are described below. A sample or evidence file is in one's custody if it is:

1. In one's physical possession
2. In one's view during their possession
3. In one's physical possession and placed in a secured location
4. In a secured area restricted to authorized personnel only

As few people as practical should have custody of the samples to reduce the chance of mishandling.

5.1.1.1 FIELD CUSTODY PROCEDURES

The Trihydro FTL (or qualified designee) is generally responsible for implementation of field custody procedures. Specific field custody procedures are discussed in detail in the FSP Section 2.3.

5.1.1.2 LABORATORY CUSTODY PROCEDURES

The analytical laboratory assumes responsibility for the integrity and security of the samples after custody transfer is completed from the sampling team or the transportation service (if appropriate) to the laboratory. Transportation to and from the laboratory will be completed in the most efficient way possible to meet holding times and preservation requirements. Transportation will be either through courier, direct laboratory drop off, or overnight transport (dependent upon holding times and preservation requirements). Most analyses will be shipped to one laboratory (PACE-I) for distribution of sample volume to other network laboratories, depending on the analyses. This does not apply to specialty and solid matrices characteristics analyses. The laboratory custody procedures are described in the QAMs in Appendix A. Sample receipt and disposal procedures are described in the SOPs in Appendix D. Analytical holding times and bottle requirements are included in the Table 2-2 series tables for all associated media.

5.1.2 ANALYTICAL METHODS

Both field and laboratory analytical procedures will be performed during this project. Environmental samples will be submitted to the laboratory for prescribed chemical analyses (see the Table 2-3 series tables). A summary of the field and laboratory analytical procedures are described below.

5.1.2.1 FIELD ANALYTICAL PROCEDURES

Samples will be collected in accordance with the sampling practices described in FSP Section 3.0. Samples will be collected using methods to avoid cross-contamination, sample agitation, and the most volatile analyses will be collected first (see Section 2.2 of the FSP). This section is specifically related to QA of field analytical procedures.

5.1.2.1.1 GROUNDWATER AND LEACHATE PROCEDURES

Groundwater and leachate samples will be collected using procedures discussed in detail in the FSP Section 3.0. Samples will be field analyzed for the field parameters as listed on Table 2-3d. Collection and analyses procedures and are in accordance with USEPA requirements. Sample collection and analysis procedures are specified in the FSP and in this QAPP and have been developed in accordance with USEPA requirements. Hand entry of field parameters will be subject to 100% QC checks. Data entered from dataloggers will be subject to spot checks (e.g., 10%) to confirm data were recorded and uploaded correctly. If problems are identified during spot checks, additional QC measures will be implemented.

The precision criteria for the each of the instruments are described in the SOPs in the FSP appendices and Table 2-3d. Instrument calibration for the water quality meter will be recorded on a calibration form as specified in Section 4.0 of the FSP. Calibration forms will be kept with the project field forms for each day of calibration.

5.1.2.1.2 SOLID MATRICES (ALLUVIUM AND BEDROCK) SAMPLING PROCEDURES

Specific collection procedures for alluvial and bedrock samples are detailed in Section 3.0 of the FSP. Alluvium and bedrock samples will be screened for total organic vapor (TOV) using a photoionization detector (PID). The PID will be used to measure the TOV for each interval. This information will be recorded in the logbook and field data sheet. The precision criteria for the TOV readings will be ±10% from the 100 parts per million (ppm) isobutylene in air calibration standard. Boreholes will be continuously cored, logged by a field geologist, and field screened using a PID.

5.1.2.1.3 VAPOR PROCEDURES

Vapor procedures are discussed in detail in Section 3.0 of the FSP. For vapor sampling, a questionnaire will be completed with the property owner to determine the presence of products or materials with the potential for sources of vapor-forming COPCs that could affect test results. In addition, the property will be screened with a low-level PID. Lastly, an ambient air sample will be collected in the vicinity of the building to verify no external sources are affecting the samples. The need for additional vapor monitoring will be evaluated as part of a vapor intrusion addendum (Work Plan Section 9.2.3. However, laboratory procedures and analytical methods for potential subslab and nearslab sampling are included in this QAPP as needed.

5.1.2.1.4 GEOSPATIAL PROCEDURES

Geospatial projects may involve collection of data through GPS measurements, aerial photography, imagery, shape files, geodatabases, latitude/longitude coordinate information, and land surveying. The project may also require acquisition of data from other external sources and databases. Prior to collecting any data, the types of data that may be needed will be verified with the Trihydro PM and APM. Any geospatial data collected for this project will be of sufficient quality to be paired with previously collected data, as follows:

1. Any geospatial datasets will be gathered from federal, state, or local government-sponsored internet sites.
2. Collected geospatial data will be in digital form or converted to digital form.
3. Geospatial data will be stored in a project specific geospatial file and database.
4. Geospatial data will be accompanied by metadata that is up to date.
5. The data will be projected into the following coordinate system and datum: North American Datum 1983 (NAD83) State Plane Missouri East US Feet 2401.
6. Meet, at minimum, NGDP Tier 2 standards of 1-5 m accuracy and precision.

GPS coordinates will be used for general samples. However, the existing wells (after repairs), new groundwater wells, staff gauges, and bathymetric survey locations will be surveyed for horizontal location in latitude/longitude coordinates and referenced in State Plane NAD83 coordinates by a Professional Licensed Surveyor in the State of Missouri. Geospatial measurement instruments will be field calibrated against the applicable federal database prior to each use.

5.1.2.2 LABORATORY ANALYTICAL PROCEDURES

Groundwater, leachate, solid matrix (alluvium and bedrock), and vapor samples will be laboratory analyzed as specified in the OU-3 RI/FS Work Plan. A summary of the analytes and analytical methods are listed in the Table 2-3 series tables by media type. The laboratories will implement the project-required SOPs (Appendix D).

The laboratory SOPs are based on the promulgated versions of analytical methods and other laboratory-developed procedures with the exception of methods analyzed by MCLInc and EMSL, including sequential extraction, XRD, and SEM-EDS. Due to the specialized nature of these methods, the QA/QC data will vary based on the SOP (Appendix D). Any modifications or deviations from the procedures outlined in the SOPs by the laboratories will be submitted to USEPA for review and approval prior to implementation. Sequential extraction, XRD, and SEM-EDS are described in greater detail below and in Appendix D.

1. Sequential extraction procedures (Appendix D-8) will be performed in general accordance with the method used by Liu and Hendry as published in Applied Geochemistry in December 2011 entitled, *"Controls on 226Ra during raffinate neutralization at the Key Lake uranium mill, Saskatchewan, Canada*" (Liu and Hendry 2011). Minor modifications have been made to the method to address concerns with health and safety and to enhance the Method. The SOP for this procedure is included in Appendix D-8. The premise for the sequential extraction is to use a series of solutions (lixiviates) to exchange or leach the contaminants of interest, performed in a sequence of increasing aggressiveness, to help categorize the potential mobilization of the contaminant. While these sequential extraction procedures cannot be used to identify the actual chemical or physical form of a given metal in solid matrices (true "speciation"), they are useful in categorizing the metal partitioning into several operationally defined geochemical fractions, relating to the tenacity of contaminant binding and thus the relative potential for mobility. The species determined in the extracts typically include iron (contributed from the predominant hydrous oxide component in solid samples that often retards the migration of uranium and other multi-valent cations) and a select suite analyte (e.g., radionuclides [dissolved radium, total uranium, and total thorium] and metals [total barium, total calcium, total iron, total manganese, total sulfur, or pH]) shown in Table 2-3b.

   QC for sequential extractions: No standard reference material is available for sequential extractions, nor are MS/MSDs applicable because the soluble analyte in the spiking solution will extract in the first extraction and not follow the less soluble analyte in the solid matrices that would be extracted later. Therefore, a set of laboratory-created sample duplicates, one per batch, will be analyzed to measure precision. The analysis of the extracts will have method blanks and LCS.

2. XRD will be used to identify crystalline minerals and SEM-EDS will be used to identify bulk elements. The purpose of the inclusion of these methods is to potentially identify minerals and elements not identified as part of

the other analyses (Table 2-3b). The methods are described in Appendix D-11. No QC data will be provided for these microscopy methods.

These SOPs provide sufficient details to evaluate the quality of the analytical methods and are applicable to the data goals and sample media of this investigation. The documentation of appropriate method validation for the project target compounds is included in Appendix D of this QAPP, and includes the criteria for acceptance, rejection, and qualification of data.

Additionally, the laboratories will be requested to send preliminary data for initial review within the standard turn-around-time for the analytical method. Non-conformances or re-analyses will be addressed by the Trihydro QAD with the laboratory as soon as possible to meet QA and holding time requirements.

5.1.3 QUALITY CONTROL

The QC objectives provide quantitative and qualitative measures of the ability to produce quality results through a properly designed sampling and analysis program. The objectives of the overall QA/QC program are to:

1. Ensure that procedures are documented, including any changes from the OU-3 RI/FS Work Plan protocol, FSP, or QAPP requirements.
2. Ensure that sampling and analytical procedures are conducted according to sound scientific principles.
3. Monitor the performance of the field sampling team and laboratory with a systematic audit program and provide for corrective action necessary to assure quality.
4. Evaluate the quality of the analytical data through a system of quantitative and qualitative criteria.
5. Ensure that data and observations are recorded and archived, as specified in Section 3.11.

5.1.3.1 FIELD QUALITY CONTROL CHECKS

The number/frequency for each QC sample type is summarized below and specified in the Table 5-1 series tables:

Blind Duplicate Samples:

1. Groundwater: 1 aqueous blind duplicate sample per 10 groundwater samples will be collected for the same analytical suite as the parent samples as shown in Table 5-1a.
2. Leachate: 1 aqueous blind duplicate sample per 10 leachate samples will be collected for the same analytical suite as the parent samples as shown in Table 5-1b.

3. Solid matrices (alluvium and bedrock): Blind duplicate samples will not be collected for solid matrix (alluvium and bedrock) samples as they are inherently non-homogenous (Table 5-1c and 5-1d).
4. Vapor: 1 vapor blind duplicate sample per 10 vapor samples will be collected for the same analytical suite as the parent samples as shown in Table 5-1e.

Equipment Blanks:

1. Groundwater: 1 aqueous equipment blank sample per day of groundwater sampling per sample crew (or 1 equipment blank per 20 groundwater samples, whichever is greater) will be collected for the same analytical suite as the parent samples as shown in Table 5-1a. Non-dedicated sampling equipment will be used for groundwater equipment blanks (water level probes).
2. Leachate: Dedicated equipment is used for leachate sampling and gauging; no equipment blanks for leachate sampling are proposed (Table 5-1b).
3. Alluvium: Equipment blanks will not be collected for alluvium samples (Table 5-1c).
4. Bedrock: Equipment blanks will not be collected for bedrock samples (Table 5-1d).
5. Vapor: Equipment blanks will not be collected for vapor samples. Vapor sampling equipment will be dedicated to each sample location (Table 5-1e).

Field Blanks:

1. Groundwater: 1 aqueous field blank per day of groundwater sampling per sample crew (or 1 field blank per 20 groundwater samples, whichever is greater) will be collected at the same time and location as the parent sample is collected. Groundwater field blanks will be collected for potential air-borne particulate or vapor-forming compounds as shown in Table 5-1a.
2. Leachate: 1 aqueous field blank per day of leachate sampling per sample crew (or 1 field blank per 20 leachate samples, whichever is greater) will be collected at the same time and location as the parent sample is collected. Leachate field blanks will be collected for potential air-borne particulate or vapor-forming compounds as shown in Table 5-1b.
3. Alluvium: Field blanks will not be collected for alluvium samples (Table 5-1c).
4. Bedrock: Field blanks will not be collected for bedrock samples (Table 5-1d).
5. Vapor: 1 ambient air sample will be collected for each day of vapor sampling to determine background air quality. The ambient air sample will be collected from an up-wind location for the same analytical suite as the parent

samples (VOCs, methane, radon, and polonium). The ambient air sample will be collected over the same time period used for collection of as the parent vapor sample. Both long-term and short-term radon measurements will be collected from the ambient air location (Table 5-1e).

Trip Blanks:

1. Groundwater: 1 aqueous trip blank will be shipped with each cooler containing groundwater sample jars for analysis of volatile parameters, including samples for analysis of VOCs and TPH (low range).
2. Leachate: 1 aqueous trip blank will be shipped with each cooler containing leachate sample jars for analysis of volatile parameters, including samples for analysis of VOCs and TPH (low range).

Matrix Spike and Matrix Spike Duplicate (MS/MSD):

1. Groundwater: 1 MS/MSD duplicate pair for groundwater will be collected for every 20 groundwater samples (or 1 per event, whichever is greater) for analysis of the analyte suite shown in Table 5-1a.
2. Leachate: 1 MS/MSD duplicate pair for leachate will be collected for every 20 leachate samples (or 1 per event, whichever is greater) for analysis of the analyte suite shown in Table 5-1b.
3. Alluvium: MS/MSDs for alluvium will be collected for total metals and radiochemistry (Table 5-1c).
4. Bedrock: MS/MSDs for bedrock are not proposed since sufficient sample is not expected to be available (Table 5-1d).
5. Vapor: MS/MSDs are not required for vapor analyses (Table 5-1e).

For radiochemical analyses, some methods do not use MS/MSDs; instead the method utilizes a stable carrier or radiotracer for sample-specific yield determination and for gamma spectroscopy.

When corrective action is taken because of field QC checks, the effectiveness of the corrective action will be measured based on the rate of reoccurrence of failure. In some cases, qualification of the data may be sufficient for evaluation of the data. In order to minimize the chance of cross-contamination, field and equipment blanks will be stored and shipped separately from source area samples, to the extent practicable. If quality procedures are not met and field personnel must return to the site to recollect data, the same quality procedures will be adhered to as above.

5.1.3.2 LABORATORY QUALITY CONTROL CHECKS

The laboratories have QC programs in place to ensure the reliability and validity of the analyses performed at the laboratory. Analytical procedures are documented in writing as SOPs and each SOP includes a QC section that addresses the minimum QC requirements for the analytical procedure (Appendix D). The internal QC checks differ slightly for each individual procedure, but, in general, the QC requirements include the following items:

1. Holding Times and Preservation
2. Instrument Tunes for Gas Chromatography/Mass Spectrometry (GC/MS) Analyses
3. Initial and Continuing Calibrations Verification (ICV and CCV)
4. System Performance Checks
5. Internal Standard Areas for GC/MS Analyses
6. Laboratory Blanks
7. System Monitoring Compounds (i.e., Surrogates)
8. LCS/LCSD (LCSDs will only be performed if necessary, as discussed further in Section 3.8)
9. MS/MSD (MS/MSD samples will be collected as described in Section 3.8 and 5.1.3.1)
10. Laboratory Duplicates

<u>For Radiological Analyses</u>:

1. Holding Times and Preservation
2. Background
3. ICV/CCV
4. Laboratory Blanks
5. LCS/LCSD (LCSDs will only be performed if necessary, as discussed further in Section 3.8)
6. MS/MSD (MS/MSD samples will be collected as described in Section 3.8 and 5.1.3.1)
7. Laboratory Duplicates
8. Chemical Yield
9. Analyte Quantitation
10. Negative Results

Slight differences in internal QC checks may be required for select analyses (i.e., XRD, SEM-EDS, sequential extraction, and geotechnical). These analyses will be analyzed in accordance with their specific SOPs (see Appendix D). Data obtained will be recorded in accordance with the QAM (Appendix A). The data packages will be sufficient to perform data verification, Tier III data validation (with exceptions, as specified in Section 7.1.2), and as defined in Table 2-1.

Sample results may be rejected based on the data validation (as described in Section 7.1). In this case, the laboratory may be requested by the Laboratory or Trihydro QAM to reanalyze the samples. In the case that QA criteria are not met, the laboratory will contact the Trihydro QAM to discuss the need for reanalysis. The determination if reanalysis is necessary will be on a case-by-case basis and determined depending on the importance of the results, the difficulty to recollect the samples, and the ability for reanalysis to occur within the proper holding time. The laboratory will re-analyze samples analyzed in nonconformance with the QC criteria, if sufficient sample volume/mass is available. It is expected that sufficient volumes/mass of samples will be collected to allow for reanalysis, when necessary. Preservation requirements, sample volumes, holding times, and sample containers are contained in the Table 2-2 series tables. If the QC fails and data are not usable, the laboratory will contact Trihydro. Trihydro and the OU-3 Respondents will determine the next steps on a case-by-case basis.

5.1.4 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

This section describes the procedures for maintaining the accuracy of instruments and measuring equipment which will be used for conducting field tests and laboratory analyses. Instruments and equipment will be maintained in order to promote the collection of precise and accurate data and to allow the project to proceed on schedule. To address the potential for impacted equipment interfering with sample readings, radiological screening of equipment, such as drilling rigs, will be completed prior to sampling, following sampling. Prior to leaving the OU-1 areas, equipment will be frisked to screen for radiological contamination as per the *OU-1 Radiation Safety Plan*.

5.1.4.1 FIELD EQUIPMENT MAINTENANCE

The cornerstones of the field preventative maintenance program are the checking and calibration of field instruments before they are shipped or carried to the field, and the provision for backup instruments and equipment. Equipment used for sampling will be identified by the project field manager or field task manager prior to mobilization. Each instrument will be checked and certified by the shipper, rental company, or Trihydro FTL prior to each field event. Routine maintenance will be conducted in accordance with the FSP and specific instrumentation manuals (see FSP Section 4.0). Routine calibration will minimize the potential for inaccurate field measurements.

Routine calibration will be conducted in accordance with procedures outlined in the FSP and specific instrumentation manuals. Routine calibration will minimize the potential for inaccurate field measurements.

5.1.4.2 LABORATORY INSTRUMENTS MAINTENANCE

A routine preventative maintenance program is conducted by each laboratory to minimize the occurrence of instrument failure and other system malfunctions. Designated laboratory employees regularly perform routine scheduled maintenance and repair of, or coordinate with the vendor for the repair of, laboratory instruments. Performed maintenance is documented in the laboratory's operating record. Laboratory instruments are maintained in accordance with manufacturer's specifications. Appendix A provides the maintenance protocols used by the laboratory to ensure proper operation of laboratory equipment. The laboratory operation procedures are verified by the accrediting bodies.

5.1.5 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Both field equipment and laboratory instrumentation will be calibrated in accordance with the specific SOPs or manufacturer guidelines. For both field equipment and laboratory instruments that are calibrated on an operational basis, calibration generally consists of the measurement of instrumental response to standards of known composition and concentration and may include the preparation of a standard response curve for the compound or parameter at different concentrations.

5.1.5.1 FIELD INSTRUMENT CALIBRATION

Routine calibration will minimize the potential for inaccurate field measurements. Equipment will be inspected and calibrated at the start of each field day or prior to use by the manufacturer. Equipment must be checked if unexpected or unexplained readings are obtained and the instrument re-calibrated, if necessary. Field instruments will be calibrated in accordance with procedures included in the FSP (Section 4.0).

5.1.5.2 LABORATORY INSTRUMENT CALIBRATION

For a description of the calibration procedures for a specific laboratory instrument, refer to the applicable SOPs in Appendix D of this QAPP. The SOP for each analysis performed in the laboratory describes the calibration procedures, their frequency, acceptance criteria, and the conditions that will require recalibration. In addition to Method requirements, instrument calibration must be checked if unexpected or unexplained readings are obtained and the instrument re-calibrated, if necessary. The laboratory shall maintain the following information within their records: instrument identification, date of calibration, analyst, calibration solutions run, and the samples associated with these calibrations.

5.1.6 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Equipment and supplies will be inspected prior to use. Faulty or defective supplies will be replaced to protect the integrity of the samples. Trihydro's company quality program addresses the acceptance of supplies and consumables. Trihydro will track any non-conformance of supplies and consumables and note them in corresponding quality discussions in the RI report.

5.2 EVALUATION OF OTHER NON-MEASUREMENT SOURCES

Data acquired from non-measurement sources, such as computer databases, spreadsheets, programs, and literature files, will be presented with references and guidance on understanding the application of the non-direct sources. Historical data quality will be assessed using methods described in Section 4.1.

5.3 DATA MANAGEMENT

Both field and laboratory data shall be collected as part of this project. Overall project data quality will be managed through a system of review extending from field and laboratory through the data reduction and reporting process. The Trihydro QAD or delegate will review the data entered into the project database and check that no encoding errors were made during transfer from field or laboratory data sheets. Other data analysis elements include the evaluation of data through storage and retention of data. Electronic copies of relevant data will be retained by Trihydro through the duration of the project. Electronic copies (electronic scans of reports) of the data will also be retained by the Laboratory PMs.

Once sampling and laboratory analyses are completed, the Trihydro QAD (or designee) will complete an initial Trihydro Tier I data validation/data verification and tracking form where general laboratory and field requirements are checked. The data validation levels are defined in Table 2-1. The results of the form are stored in a Trihydro-managed database and a request is sent to appropriate personnel for completion of data validation and QC. Data results will be maintained on a secure electronic network at the Trihydro office in Laramie, Wyoming. The electronic network is backed up to a cloud database daily. Field and laboratory data management will be completed as described in the following sections. Once data validation and Trihydro QC procedures (described in Section 7.1) are completed, the data will be exported into an USEPA-accessible database.

5.3.1 FIELD DATA MANAGEMENT PROCEDURES

The field data will include field observations, field parameter measurements, and health and safety data. Data and observations will be recorded in the instrument, field logbook or field forms. The forms are provided in the FSP (see Section 3.21). These forms and field books will be scanned into electronic format and kept with the project files for reference during data evaluation. Field data will be either directly input to the Trihydro database via the instrument or hand entered from the field data sheet. A second check will be used to verify that the data were correctly entered into the database. Once field data are reviewed and accepted, the field data will be exported into an USEPA-accessible database.

5.3.2 LABORATORY DATA MANAGEMENT PROCEDURES

Laboratory data management procedures will be performed according to the following protocol. Raw analytical data will be recorded in numerically identified laboratory notebooks (referenced by the laboratory as logbooks, analytical prep sheets, or similar) or in the LIMS. Data will be recorded in this notebook, laboratory SOP, or LIMS along with other pertinent information, such as the sample identification number and the sample tag number. Other details, such as the analytical method used, name of analyst, date of analysis, sample matrix, reagent concentrations, instrument settings, and the raw data will also be recorded in the laboratory notebook, analytical prep sheets or LIMS. Each page of the notebook (if applicable) will be initialed and dated by the analyst. Copies of any strip chart printouts (such as gas chromatograms) (if applicable) will be maintained on file. Periodic review of these notebooks (if applicable) by the laboratories will take place prior to final data reporting. The Laboratory QAOs will maintain records of notebook (if applicable) entry inspections.

For this project, the equations that will be employed in reducing data are presented in the SOPs in Appendix D of this document. Matrix effects are handled differently in each method and are specified in each method-specified SOP (Appendix D).   Laboratories will perform two levels of review for each data set, including an analyst and a second-level reviewer trained to verify data. Unacceptable data shall be appropriately qualified in the project report. The QA department will also review 10% of laboratory methods used on at least a quarterly basis, including a review of the raw data and data report for each reviewed method. Errors will be noted, and corrections made, but the original notations will be crossed out legibly, initialed and dated. QC data (e.g., laboratory duplicates, surrogates, MS/MSDs, LCS/LCSDs) will be compared to the historical limits unless a specific set of limits is set by the laboratory. Data considered acceptable will be entered into the LIMS and/or analytical reports (or similar). The data summary will be sent to the laboratory PM for review. Case or project narratives will be either manually or electronically generated to include information concerning data that fell outside acceptance limits, data qualifiers, and any other anomalous conditions encountered during sample preparation and analysis. The laboratories data package review departments are responsible for the review and assembly of each data package and they will ensure all sample and QC data are included and accurate prior to issuance. Electronic Data Deliverables (EDD) will be created by each lab (as possible) or will be entered into the electronic database by Trihydro. Once data validation and Trihydro QC procedures (described in Section 7.1) are completed, the data will be exported into an USEPA-accessible database.

5.3.3 GEOSPATIAL DATA MANAGEMENT PROCEDURES

The Trihydro GC will ensure data are stored in the project ArcSDE (Structured Query Language) database working from a Trihydro server in the Laramie, Wyoming office. ArcSDE allows for a more efficient storage and control of the data. During database construction only the Trihydro PM, Trihydro APM, and the Trihydro GC will have access to the data. Once the database is constructed and has been accepted by the Trihydro QA officer, the data will be used to create project figures and maps.

Any downloaded vector datasets will be projected into NAD83 State Plane Missouri East US Feet 2401. These data will be combined using the “merge” tool in the ArcMap toolbox. These data will be clipped to the site boundary using the “clip” tool in the ArcMap toolbox. These layers will be managed in ArcCatalog with final storage in an ArcSDE database. Raster datasets downloaded will projected into NAD83 State Plane Missouri East US Feet 2401. These data will be combined using the “append” tool in the ArcMap toolbox. These data will be clipped to the boundary using the “Clip” tool in the ArcMap toolbox. These layers will be managed in ArcCatalog with final storage in an ArcSDE database.

6.0 AUDITS AND OVERSIGHT

The field and laboratory data collected during this investigation will be used to evaluate the extent of contamination. The QC results associated with each analytical parameter will be compared to the objectives presented in the SOPs included in Appendix D. Only data generated in association with QC results meeting these objectives will be considered reliable for decision-making purposes.

6.1 AUDITS AND RESPONSE ACTIONS

Performance and system audits will be completed to assess whether the project personnel followed the appropriate QA and QC programs during field and laboratory activities. The Trihydro PM (or designee) will conduct internal field audits. The laboratories will conduct internal laboratory audits and the appropriate certification authorities may conduct external audits. Note that the members of the project team can stop work if an assessor in the field or laboratory observes that work is not in accordance with this QAPP, the FSP, the OU-3 RI/FS Work Plan, or the Laboratory QAMs or SOPs. In this instance, the assessor will contact the project team promptly to communicate the issue and proposed corrective action.

6.1.1 FIELD AUDITS

The Trihydro PM may schedule audits of field activities. The evaluation is directed toward the extent to which the procedures in the OU-3 RI/FS Work Plan, the FSP, and this document are being followed. The Trihydro PM (or designee) will check to see that CoC procedures are being followed and that samples are being kept in accordance with the custody protocol at all times (Section 5.1). Field documents pertaining to sample identification and control will be examined daily for completeness and accuracy by the Trihydro PM (or designee) to see that all entries are dated and signed, and the contents are legible, written in indelible material, and contain accurate and inclusive documentation of project activities. The Trihydro PM (or designee) will review field notebooks and field data forms. An example field-audit form is presented as Appendix E. If deficiencies are identified during the audit, the auditor will decide whether to repeat sample collection and analysis based on the extent of the deficiencies and their importance in the overall context of the project.

The external field audit may be performed by the USEPA and MDNR. External field audits may be conducted any time during the field operations. These audits may or may not be announced and are at the discretion of the USEPA and MDNR. External field audits will be conducted according to the field activity information presented in this document. The external field audit process may include the assessment of (but not be limited to) the following:

1. Sampling equipment decontamination procedures
2. Sample bottle preparation procedures
3. Sampling procedures
4. Examination of field sampling and safety plans
5. Sample vessel cleanliness and QA procedures
6. Procedures for verification of field duplicates
7. Procedures for the collection of filtered samples
8. Sample preservation and preparation for shipment
9. Field screening practices
10. Split sample collection and analyses
11. Procedures for field calibration of GPS and/or survey equipment (as specified in the FSP)

For vapor analyses, 100% complete canister certification will also be performed by the laboratory. Additionally, prior to sampling, the gauges will be checked to verify that the canister is working properly as described in the applicable FSP SOP.

6.1.2 LABORATORY AUDITS

The laboratories' QAOs will conduct the internal laboratory audits. The internal system audits will be done on at least an annual basis. The internal system audits will include an examination of laboratory documentation on sample receiving, sample login, sample storage, CoC procedures, sample preparation, sample analysis, instrument operating records, etc. The internal performance audits will be conducted as specified in the QAMs (Appendix A). The performance audits may involve preparing blind QC samples and submitting them along with project samples to the laboratory for analysis. The Laboratory Quality Manager will evaluate the analytical results of these blind performance samples to ensure the laboratory maintains acceptable QC performance. Laboratory audit procedures, criteria, and schedules are outlined in the QAMs located in Appendix A.

An external audit may be conducted in association with certification of the laboratory. Failure of any or all audit procedures can lead to laboratory disqualification and the requirement that another suitable laboratory be chosen.

An external on-site review may consist of examination of the following items and procedures:

1. Sample receipt procedures
2. Custody and sample security and login procedures
3. Sample tracking procedures
4. Instrument calibration records review
5. Instrument logs review
6. QA procedures review
7. Logbooks review
8. Sample preparation procedures
9. Sample storage procedures
10. Sample disposal procedures
11. Sample analytical SOP review
12. Field instrument review
13. Personnel interviews
14. Glassware prep

It is common practice when conducting an external laboratory audit to review one or more data packages from sample lots recently analyzed by the laboratory. This review would most likely include but not be limited to:

1. Comparison of resulting data to the SOP or method, including coding for deviations
2. Verification of ICV and CCV within control limits (ICV acceptance criteria varies by method and may not be the same as the CCV acceptance criteria)
3. Verification of surrogate recoveries and instrument timing results, where applicable
4. Review of extended quantitation reports for comparisons of library spectra to instrument spectra, where applicable
5. Review of recoveries from LCS analyses
6. Review of run logs with run times, ensuring proper order of analyses
7. Review of spike recoveries/QC sample data
8. Review of suspected manually integrated GC data and its cause (if applicable)

9. Review of GC peak resolution for isolated compounds as compared to reference chromatograms (if applicable)
10. Assurance that samples were run within holding times

Ideally, the data should be reviewed while on the premises, so that any data called into question can be discussed with the laboratory staff.

6.1.3 RESPONSE ACTIONS

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out of QC performance, which can affect data quality. Field team members may identify problems during sampling and laboratory analysts may identify problems during chemical analyses. Problems may be identified by the PMs and QAOs during the audit procedures. Corrective actions are described in the statements below.

Proposed and implemented laboratory corrective action will be documented in the regular QA reports to management. The Trihydro PM, or their designee, will only implement the proposed corrective action after approval from the OU-3 Project Coordinator. If immediate corrective action is required, approvals secured by telephone from the Trihydro PM will be documented in an additional memorandum.

For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the Trihydro PM, who in turn will notify the OU-3 Project Coordinator. The OU-3 Respondents will be promptly notified from the time the problem was communicated to the Trihydro PM. If the problem is analytical in nature, information about the problem will be promptly communicated to the OU-3 Project Coordinator. Implementation of corrective action will be confirmed in writing through the same channels. For problems that involve sampling that has not been done previously at a location, or for a new parameter, or for more conservative reporting limits, the corrective action will be determined based on the goals established in the OU-3 RI/FS Work Plan for that investigation. Note that the Trihydro PM has the ability to stop work due to a nonconformance issue.

Any nonconformance with the established QC procedures in this document will be identified and corrected in accordance with the QAPP. The Trihydro PM, or their designee, will issue a nonconformance report for each nonconformance condition. The effectiveness of the applied corrective action will be measured based on internal audits and observations, which will be reported to the OU-3 Project Coordinator. Nonconformance reports will be provided to USEPA and MDNR within 30 days of identification of any nonconformance condition unless suitable rational for additional time is provided, subject to USEPA approval.

6.1.3.1 FIELD CORRECTIVE ACTION

Corrective action in the field may be needed when the sample network is changed (i.e., more/less samples, sampling locations other than those specified in the QAPP, etc.), or if sampling procedures and/or field analytical procedures require modification, etc., due to unexpected conditions. It will be the responsibility of the Trihydro PM to ensure the corrective action has been implemented.

If the corrective action will supplement the existing sampling plan using existing and approved procedures in the QAPP, corrective action approved by the Trihydro PM will be documented. If corrective actions result in fewer samples (or analytical fractions), alternate locations, etc., which may cause project QA objectives not to be achieved, the OU-3 Respondents will be notified of the reason for the deviation.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The Trihydro PM (or designee) will identify deficiencies and recommend corrective action. The field team will implement the corrective actions. Corrective actions will be documented in the corresponding progress report.

Corrective actions will also be implemented and documented in the field records. Staff members will not initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, the Trihydro PM may stop work. If at any time a corrective action issue is identified which directly affects project objectives, the OU-3 Project Coordinator and the USEPA will be notified immediately.

6.1.3.2 LABORATORY CORRECTIVE ACTION

In general, the inability to achieve the QA objectives discussed in this QAPP may result in laboratory corrective action. A detailed description of laboratory responses to correct these deficiencies is presented in the laboratory SOPs. If the laboratory cannot correct the deficiencies, they will be handled in one of three ways:

1. The laboratory will be asked to reanalyze the samples in question, if sample holding times have not been exceeded. Otherwise, the laboratory may be asked to re-quantify relevant peaks in the chromatograms or reprocess other instrumental output, when applicable.
2. Trihydro will demonstrate that the noncompliance does not compromise the successful achievement of the OU-3 RI/FS Work Plan objectives.
3. Additional samples will be collected and analyzed to eliminate the non-compliance.

The Trihydro QAD may identify the need for corrective action during either the data validation or data assessment. Potential types of corrective action may include re-sampling by the field team or re-injection/re-analysis of samples by the laboratory. These actions are dependent upon the ability to mobilize the field team and whether the data to be collected is necessary to meet the required QA objectives (e.g., the holding time for samples is not exceeded, etc.). If the Trihydro QAD identifies a corrective action situation during data assessment, the Trihydro PM, OU-3 Respondents, and the USEPA will be responsible for approving the implementation of corrective action, including re-sampling. The Trihydro QAD will document all corrective actions of this type. Laboratory noncompliance and corrective actions will be discussed in the subsequent progress reports.

In the case that one of the chosen laboratories has major instrument failures, long-term power outages, natural disasters, or other concerns that would prevent them from analyzing the samples, a laboratory with similar capabilities will be selected and the SOPs, QAM, and certifications will be verified to be in accordance with this QAPP. Laboratory substitutions will be presented to the Trihydro PM/APM and OU-3 Project Coordinator for review. USEPA will be notified prior to the change.

6.1.4 GEOSPATIAL DATA ASSESSMENT AND RESPONSE

Each of the geospatial datasets will be reviewed. The Trihydro GC will be checking for display errors and attribute errors between datasets from different sources or newly collected and historical datasets.

The Trihydro GC will perform an assessment of the data by searching for display discontinuities and attribute discrepancies. Finding display errors is completed through visual inspection and looking for errors in the site border matches and, secondly, verifying that each dataset has similar features and attributes. If the datasets do not match, the Trihydro GC will review the projection. Any projection conflicts will be corrected. If this action shows the two datasets do not represent continuous data, a new search for matching data will take place. If these inconsistencies cannot be corrected, these datasets will not be included in the final database.

If attribute errors are found, anomalous data will be identified by its deviation from the expected or normal range of spatial location or value. This will be done through verification using field maps and field data. Raster datasets, such as the GIS maps, groundwater models and land use images will be assessed for general accuracy by looking at the values of different types or classes of pixels and their associated spatial patterns. In addition, Trihydro will use permanent features, such as roads, streams, and land features to compare metadata to aerial photos and ensure that the two sources are in agreement.

If problems are identified in any of the datasets, the Trihydro GC will contact the Trihydro PM or Trihydro APM to discuss additional assessment and solutions. The Trihydro GC will correct any data inaccuracies when there is sufficient information to support these corrective changes. Spatial data that cannot be verified or that appears to have errors that cannot be explained by resolution, acquisition date or other metadata entries may be discarded from this project.

6.2 REPORTS TO MANAGEMENT

Both field and laboratory data will be reported first to the Trihydro PM and APM and then the data will be sent to the Trihydro QAD for review. Once data are reviewed and determined to be final, they will be used for reporting purposes to OU-3 respondents and the regulatory agencies. Data reporting procedures shall be carried out for both field and laboratory operations, as described below.

6.2.1 FIELD DATA REPORTING

Field data reporting shall be conducted principally through the transmission of field data sheets containing tabulated results of all measurements made in the field, and documentation of all field calibration activities. Additionally, a separate QA section of the RI/FS report will be used to convey data usability, bias, results of the assessments, approved changes to the QAPP (if necessary), major personnel changes, corrective actions performed, and any other relevant QA information. Reports to management shall be completed by the Trihydro PM (or designee) and submitted to the OU-3 Project Coordinator. For specific information related to field data reporting, see Appendix A of the FSP (Section 3.21).

6.2.2 LABORATORY DATA REPORTING

The task of reporting laboratory data begins after the appropriate internal laboratory QA review has been concluded. Leveled data packages (II, III, and IV) will be available from all laboratories, as needed. The communication/ notification, reporting requirements, and analyses requirements are described in greater detail in Trihydro’s Tier I and Tier II Laboratory Performance Guidelines and Tier III and Tier IV Laboratory Performance Guidelines in Appendix F-1 and F-2, respectively, and as defined in Table 2-1. Standard turnaround times will be met by the laboratories unless otherwise requested. However, it should be noted that there may be a variation in the turnaround time for radiochemistry data and Level IV data packages as they are more complex than the standard analytical suite and take longer to produce. Requirements may vary due to the analytical procedure requirements. These variations will be discussed with the Trihydro QAD prior to sample collection.

Any program of environmental measurement can produce outlier results that are outside the "expected" range of values. Outlier values may be the result of:

1. A catastrophic occurrence, such as a spill
2. Inconsistent sampling or analytical chemistry methodology
3. Variation in field conditions (e.g., if construction work is being conducted near the site)
4. Errors in the transcription of data values or decimal points
5. True but extreme variability in concentration measurements

Documentation and validation of the cause of outliers will accompany the data; values will not be altered. Outlier values will not be omitted from the raw data reported to the USEPA and MDNR but will be identified as outliers within the data summary tables prepared, and may be "rejected" if determined incorrect during data validation review. Reasons for the outlying behavior will be provided in the data summary tables or in the Trihydro Tier II, Tier III, or Tier IV data validation reports (defined in Table 2-1).

Data below detection limits will be expressed as determined by individual Method SOPs and each laboratories' QAMs. If possible (as determined by the laboratory SOP or QAM), the data will be flagged with a "J" when detected between the MRL and MDL, for non-radiochemistry data. Data above the MDL will be expressed in units of micrograms per liter (µg/L) or milligrams per liter (mg/L) for groundwater, milligrams per kilogram (mg/kg) dry weight for alluvial and bedrock matrix, or micrograms per cubic meter (µg/m^3) or parts per million volume for vapor samples. Solid radiochemistry results will be reported in units of picocuries per gram (pCi/g). Water radiochemistry results will be reported in units of picocuries per Liter (pCi/L). The laboratory will qualify results, as appropriate for radiochemistry data, which will be in accordance with guidelines from the *ANS Standard 41.5-2012* (ANS 2018) and with reference to *Chapter 8 of the USEPA MARLAP, document number USEPA 402-B-04-001A* (USEPA 2004a).

The deliverables associated with the tasks identified in the OU-3 RI/FS Work Plan will contain data quality information collected during the task. Those reports will be the responsibility of the respective laboratories' Project Manager or designee and will include the QC summary for the accuracy, precision, and completeness of the data, and any corrective action needed or taken during the project. The laboratory data are reported through the LIMS. A copy of the laboratory data report will be included in the reports to the OU-3 Respondents, USEPA, and MDNR.

6.2.3 GEOSPATIAL DATA REPORTING

Geospatial data reporting will be started by the Trihydro GC (or designee) upon request from the Trihydro PM or Trihydro APM to create a figure or map and/or when the data results are being georeferenced to a physical location. The map will be reviewed by the Trihydro GC for any of the errors discussed in Section 6.1.4. If errors are found, the

Trihydro PM and Trihydro APM will be contacted to discuss solutions. The map will be revised until the Trihydro GC feels that the map is correct and can be released for quality review. The map will be reviewed by another trained Trihydro geospatial specialist, to verify that features are properly labeled, and attributes are properly shown. The reviewer will also check for any missed geospatial attribute errors. The map or figure will then go to the Trihydro PM/Trihydro APM for review. The map or figure will be reviewed in detail to again verify that features are properly labeled, and attributes are properly shown. This two-step review will include reviews from both a technical expert and a project expert.

7.0 DATA VALIDATION AND USABILITY

Data generated through field activities or by the laboratory shall be reduced and validated prior to reporting. Data shall be disseminated by the laboratory and the Trihydro QAD after it has been subjected to the laboratory QA/QC and review procedures. This section covers procedures to compile, validate, and report the data collected during the groundwater, leachate, solid matrix (alluvium and bedrock), and vapor analyses investigations.

7.1 DATA REVIEW, VERIFICATION, AND VALIDATION

The process of data validation is the examination of objective evidence that the requirements of the specified QC acceptance criteria are met. Data validation procedures shall be performed for both field and laboratory operations, as described below. Data will be validated in accordance with the procedures outlined in this QAPP and in accordance with the Trihydro specific data validation procedures (Appendix B) and Section 5.1.3.

7.1.1 FIELD DATA

The procedures to evaluate field data for this investigation include checking for transcription errors and review of field logbooks on the part of the field team. The Trihydro FTL (or designee) will review the field notes after completion of sampling. The objectives of this review are to identify and correct errors in the field notes. The Trihydro QAD will review the field audit and field notes and determine whether the samples were collected and handled according to this QAPP.

7.1.2 LABORATORY DATA

Trihydro will perform data validation review on data received from the laboratory. The data validation will include Trihydro Tier I, and either Tier II, Tier III, or Tier IV data validation reviews. The Trihydro data validation reviews (Tiers I through IV) are similar to USEPA Level I, II, III, and IV data validation reviews as described in Sections 7.1.2.1, 7.1.2.2, and 7.1.2.3, respectively. Trihydro levels of data validation are in accordance with full USEPA data validation levels and are defined in Table 2-1. The level of validation for each study are specified in the DQOs and OU-3 RI/FS Work Plan.

As described in Section 7.1.2.4, data qualifiers will be applied to the data based on the data validation review. These qualifiers will be maintained in the database with each data point.

As shown in Appendix B, organic data will be evaluated in accordance with the general validation criteria set forth in the *USEPA CLP National Functional Guidelines for Organic Superfund Methods Data Review* (USEPA 2017b) with additional reference to *USEPA CLP National Functional Guidelines for Organic Data Review* (USEPA 1999). Data from inorganic analyses will be evaluated according to validation criteria set forth in the *USEPA CLP National Functional Guidelines for Inorganic Superfund Methods Data Review* (USEPA 2017a), with additional reference to the *USEPA CLP National Functional Guidelines for Inorganic Data Review,* (USEPA 2004b). Review of duplicates will be conducted in accordance with *EPA New England Environmental Data Review Supplement for Region 1 Data Review Elements and Superfund Specific Guidance/Procedures* (USEPA 2018). If updated, the most recent promulgated version will be used for data validation. Data for radiological analyses will be validated in accordance with guidelines from the *ANS Standard 41.5-2012* (ANS 2018) and with reference to *Chapter 8 of the USEPA MARLAP, document number USEPA 402-B-04-001A* (USEPA 2004a). Alternative qualification approaches may be required as determined by the validator and their professional judgement, and if it is allowed per the guidance documents noted above. In these instances where application of an alternative protocol is necessary, the reason and approach will be documented in the corresponding data validation report to allow for USEPA review and approval.

Each analytical data report will be reviewed by the Laboratory PM (or qualified designee). The data validation reports will be verified by a radiochemist with at least two years of radiochemical separations and measurement experience (ANS 2018) and a Certified Health Physicist (CHP). The data validator will also evaluate the overall completeness of the data package. Completeness checks will be administered on data to evaluate whether deliverables specified in the QAPP are present. The following sections describe data validation procedures in greater detail.

The proposed validation levels new and existing data included in the OU-3 RI/FS are as follows:

1. Newly collected groundwater, leachate, alluvium, bedrock, and vapor data will be validated to a Tier III data validation level (specified in Table 2-1 and Section 7.1.2.3).
2. Newly collected geotechnical data, SEM-EDS, XRD, sequential extraction, and calculated values, which will be validated to a Tier I level or similar (described in Section 7.1.2.1).
3. Newly collected field data will be validated as specified in Section 7.1.1 and 5.1.3.
4. Geospatial data will be validated as specified in Section 7.1.2.5.
5. Historical groundwater, leachate, alluvial, bedrock, and vapor data will be evaluated on an as-needed basis according to the methods specified in Section 4.1. Data that are to be used for the groundwater model or risk assessment will be reviewed to assure that previous validation reports used for these purposes meet Tier III data validation criteria. For other quantitative purposes, such as trend charts and other data analysis purposes, the historical data will be reviewed to determine if previous validation reports meet Tier II level data validation criteria. For semi-quantitative or reference purposes such as historical detections or source-area fingerprinting, the

historical groundwater data will be reviewed to determine if previous validation reports meet Tier I data validation criteria.

All non-rejected qualified data will be used for assessment. Any “R” qualified data will be rejected. Data may be rejected for multiple reasons, but some of the more common include: extremely low LCS recoveries, samples are analyzed significantly out of preservation and holding requirements, significant calibration errors, significant matrix effects shown by MS/MSD or surrogate results, and other major analytical errors as specified in Appendix B. In addition, if the data do not meet the DQOs outlined in Section 3.0, they will not be used for assessment purposes.

7.1.2.1 TIER I DATA VALIDATION / DATA VERIFICATION

In addition to the field data validation procedures, the Tier I data validation (Table 2-1) is performed to verify and document that samples in the data set were analyzed according to the project requirements and that the laboratory analytical report is complete. An electronic Tier I validation checklist will be prepared in an electronic format for each laboratory analytical sample group. Tier I validations will be performed by a competent person with knowledge of the project requirements and are the first step prior to higher level validations. For higher level validations, the Tier I form will be incorporated into the higher tier report. The forms are electronically filed and the electronic printouts will be available to the USEPA for specialty data. The Tier I validation will include a review of the following elements:

1. Review of the cover letter signed by the Laboratory PM or designee.
2. Review of the case narrative discussing any technical problems or deviations from the analytical methods including if the laboratory received the samples in good condition. Samples are considered in good condition if the samples are at the proper temperature (4 degrees Celsius [°C] ± 2°C) (if applicable) or chemical preservative (if applicable), and if sample receipt condition is acceptable (i.e., the bottles are not broken, and the cooler custody seals are intact). Some analytical methods (e.g., radiochemical analyses and isotopes) may have specific temperature or chemical preservation requirements. These are noted in the Table 2-2 series tables of this QAPP.
3. Review of date and time of receipt.
4. Review of CoC forms to verify that samples were maintained under strict CoC with signatures from the field personnel and the lab personnel.
5. Comparison of sampling dates to sample extraction dates and analysis dates to check that samples were extracted and/or analyzed within proper holding times.
6. Review of target constituent list, analytical methods, and MDL, MRL, LOD/MDCs, or LOQ to verify conformance with the OU-3 RI/FS Work Plan.

7. Review of lab summary/chronicle describing client ID/analysis, laboratory identification number, prep number, collection date, extraction/prep date, analysis date, and laboratory PM sign off.
8. Review of sample data report including the results listed in alphabetical order (or by analytical method) with sample preparation, extraction, cleanup, digestion, and analytical methods, analysis date, extraction date, analyst initials, and qualifiers included.
9. Review of QC summary report including date of analyses, parameters determined, system monitoring compound summary, method blank data, sample duplicates and control samples, surrogate spike recoveries, and MS and MSD results.
10. Review of additional performance criteria specific to analytical methods.
11. Evaluation of corrective actions that may have been necessary and possible data quality assessment items.
12. Review of canister certifications to verify that canisters were sufficiently clean prior to sample collection.
13. Review of canister pressures to verify that there was not additional loss of pressure during transit.

7.1.2.2 TIER II DATA VALIDATION

In addition to the Tier I validation requirements, the Tier II evaluation will include a review of the basic laboratory QC data. A detailed data validation report, as shown in template (Appendix G), which provides sufficient detail to explain data qualifiers and data inadequacies, is produced by the reviewer. The Tier II data validation process provides sufficient detail for the data user to have an accurate idea of the data quality and reliability, and an understanding of how well the project objectives were met. The Tier II data validation is performed by a chemist or other trained scientist who is familiar with contract laboratory procedures and the methodology. The Tier II data validation will include a review of Tier I elements as well as the following criteria:

1. Review of field and laboratory blanks to evaluate possible contamination sources; consideration should be given to preparation techniques and frequencies, as well as the analytical results.
2. Review of field duplicate data for evaluation of field and laboratory precision.
3. Review of laboratory QA data for compliance with method or project required acceptance criteria.
4. Review of the analytical results to verify compliance with the specified project goals.
5. Review of additional method specific performance criteria, as appropriate, if provided by the laboratory.

The following criteria will be evaluated during the Tier I and II data validation process:

1. Chain-of-Custody: Is the CoC complete and were the analytical method(s) specified?
2. Sample Check in Conditions: Did the samples arrive at the correct temperature and with the correct container count? Were the sample labels complete and was integrity of the samples and the container maintained? Were the samples received properly preserved?
3. Holding Times: Were the samples extracted/digested within the method specified holding times? Were the samples analyzed within the method specified holding time?
4. Dilutions/MRLs: Were any samples diluted to an extent that the resulting reporting limits were raised to a degree which would render the associated data points unsuitable for the projects DQOs? Were the dilutions necessary and unavoidable? Is re-analysis of the sample extract possible or feasible?
5. LCS/LCSD (Second Source Standards): Was the LCS/LCSD compound list complete and were required analytes contained in the spike solution? Was the LCS/LCSD performance within the method specified limits for each compound?
6. MS/MSD Recovery: Was the specified sample from this project sample set used as the MS/MSD parent sample? Was the MS/MSD compound list complete and were required analytes contained in the spike solution? Were the MS/MSD recovery values within the method specified limits for each compound? The degree of matrix interferences in a sample can vary significantly, even within a sample set collected from the same site. Therefore, data qualifications will be assigned based on an evaluation of associated QC data and the professional judgment of the reviewer.
7. Duplicate Sample Repeatability (Field and Laboratory Duplicate Samples): Field duplicate RPD limits for groundwater/leachate are set at 0-30%, for solid matrices (alluvium and bedrock) are set at 0-50%, and for vapor are set at 0-25%, and laboratory RPD limits reference published or method specified limits. In cases where a compound is detected at concentrations less than five times the MDL, the precision goals will not apply in accordance with USEPA data validation guidelines. Repeatability (precision) failures will be "J" flagged. Duplicate samples and evaluation of field precision will be assessed on a case-by-case basis. The parent sample and duplicate sample may be flagged based on the results of the validation. Field duplicate samples will be evaluated in the overall quality of the associated data set.
8. Surrogate Recoveries: Surrogate compound recoveries are expected to be within the method or laboratory specified acceptance limits.
9. Radiochemical analyses will be validated as described in Appendix B, and in accordance with guidelines from the *ANS Standard 41.5-2012* (ANS 2018) and with reference to *Chapter 8 of the USEPA MARLAP, document number USEPA 402-B-04-001A* (USEPA 2004a). Changes to data validation procedures for radiological analyses may be

made at the discretion of the data validator and will be documented in the data validation reports. Data validation forms for each analyses and media are in Appendix B.

7.1.2.3 TIER III AND TIER IV DATA VALIDATION

A detailed data validation report, as shown in Appendix G-2, which provides sufficient detail to explain data qualifiers and data inadequacies, is produced by the reviewer. For most data collected as part of this QAPP, the data will be validated to a Tier III; however, if the validator finds major errors (i.e., laboratory operated outside of SOP procedures, or high amounts of rejected data) or inconsistencies that call the data into question, the validator may elect to do a Tier IV validation. These situations will be discussed with USEPA on a case-by-case basis. A Tier IV data validation will include a review of the raw analytical data, which is examined in detail to check for correctness of concentration calculations, compound identification and anomalies in the data. A detailed data validation report, that provides sufficient detail to explain data qualifiers and data inadequacies, is produced by the reviewer. The Tier III and IV data validation processes provide sufficient detail for the data user to have an accurate idea of the data quality and reliability, and an understanding of how well the project objectives were met. The Tier III and IV data validations will verify that the data were adequately analyzed, to allow their use in formal legal proceedings, risk assessments, and closures. Tier III and IV data validations are performed by a chemist or other trained scientist who is familiar with contract laboratory procedures. The Tier III and IV data validation will include a review of Tier I elements as well as some or all of the following criteria:

1. Review of field and laboratory blanks to evaluate possible contamination sources; consideration should be given to preparation techniques and frequencies, as well as the analytical results.
2. Review of field duplicate data for evaluation of field and laboratory precision.
3. Review of laboratory QA data (MS/MSD recoveries and RPD calculations, surrogate spike recoveries, LCS/LCSD recoveries and RPD calculations) for compliance with method or project required acceptance criteria.
4. Review of the analytical results to verify compliance with the specified project goals.
5. Review of laboratory summary of tuning and calibration checks.
6. Review of QC packages and sample raw data and calculations (the raw data and calculations are reviewed specifically with Tier IV data validation).
7. Review of serial dilutions (if applicable to the method requirements).
8. Limited review of chromatograms.
9. Review of ICV and CCV results (may have been conducted in a Tier II but required for a Tier III).

10. Review of instrument performance results (if applicable to the method requirements).
11. Review of internal standard results (if applicable to the method requirements)
12. Review of ICP interference check sample results (if applicable to the method requirements).
13. Review of MDLs.
14. Review of instrument and calibrations performance summaries (if provided).
15. Review of additional method specific performance criteria, as appropriate, if provided by the laboratory.

The following criteria will be evaluated during the Tier III/IV data validation process:

1. Chain-of-Custody: Is the CoC complete and were the analytical method(s) specified?
2. Sample Check in Conditions: Did the samples arrive at the correct temperature and with the correct container count? Were the sample labels complete and was integrity of the samples and the container maintained?
3. Holding Times: Were the samples extracted within the method specified holding times? Were the samples analyzed within the method specified holding time?
4. Dilutions/MRLs: Were any samples diluted to an extent that the resulting reporting limits were raised to a degree, which would render the associated data points unsuitable for the projects DQOs? Were the dilutions necessary and unavoidable? Is re-analysis of the sample extract possible or feasible? Were the same project quantitation limits used for each sampling event? If possible, from the laboratory, did the laboratory "J" flag detected results between the MRL and MDL?
5. LCS/LCSD (Second Source Standards): Was the LCS/LCSD compound list complete and were all required analytes contained in the spike solution? Was the LCS/LCSD performance within the method specified limits for each compound?
6. MS/MSD Recovery: Was the specified sample from this project sample set used as the MS/MSD parent sample? Was the MS/MSD compound list complete and were all required chemicals contained in the spike solution? Were the MS/MSD recovery values within the method specified limits for each compound? The degree of matrix interferences in a sample can vary significantly, even within a sample set collected from the same site. Therefore, data qualifications will be assigned based on an evaluation of all associated QC data and the professional judgment of the reviewer.
7. Duplicate Sample Repeatability (Field and Laboratory Duplicate Samples): Field duplicate RPD limits for groundwater/leachate are set at 0-30%, for solid matrices (alluvium and bedrock) are set at 0-50%, for vapor at 0-25%, and laboratory RPD limits reference published or method specified limits. In cases where an analyte is

detected at concentrations less than five times the MDL, the precision goals will not apply in accordance with USEPA data validation guidelines. Repeatability (precision) failures will be "J" flagged.

8. Duplicate samples and evaluation of field precision will be assessed on a case-by-case basis. The parent sample and duplicate sample may be flagged based on the results of the validation. Field duplicate samples will be evaluated in the overall quality of the associated data set. If a blind duplicate fails the acceptance criteria, the laboratory will be contacted to evaluate the possible cause of the error. If duplicate samples do not meet the acceptance criteria (30% for groundwater/leachate and 50% for solid matrix samples (alluvium and bedrock), and 25% for vapor, the parent and duplicate sample results will be qualified with "J" flags to indicate an estimated value. If the RPD is greater than or equal to 100%, associated sample results will be qualified with "J" flags for detections of that constituent or "UJ" for NDs.
9. Surrogate Recoveries: Surrogate compound recoveries are expected to be within the method or laboratory specified acceptance limits.
10. Internal Standards and Retention Time Windows (if available): The data sets will be required to fully meet the method specified requirements for these criteria.
11. CV and CCV; if available: ICV and CCVs will be checked to confirm that they met the method specified limits for accuracy and periodicity. If an ICV and/or CCV failure is noted, the data validator will document that samples analyzed prior to the ICV and/or CCV failure were re-analyzed after the instrument was re-calibrated.
12. Instrument Performance Checks (if available): The data validator will confirm that the method specified instrument performance checks were run and met the method requirements.

7.1.2.4 DATA VALIDATION QUALIFIERS

The data quality flags used to qualify analytical data will be similar to those outlined within the USEPA Data Validation Functional Guidelines for Evaluating Environmental Analyses and Appendix B. Data validation qualifiers for radiological data are established from guidelines described in the *ANS Standard 41.5-2012* (ANS 2018) and with reference to *Chapter 8 of the USEPA MARLAP, document number USEPA 402-B-04-001A* (USEPA 2004a). The most commonly used data quality flags are included in the Data Validation Variance Documentation in Appendix B.

7.1.2.5 GEOSPATIAL DATA VALIDATION

The Trihydro GC will be responsible for final verification and validation and ensuring that the QC checks (Section 6.2.3) were completed. For each dataset, the Trihydro GC will verify the:

1. Dataset was acquired from a state or federal sponsored website
2. Dataset has updated metadata from source
3. Data are projected into NAD83 State Plane Missouri East US Feet 2401
4. Data matches visually
5. Data attribute information matches across the site

7.1.2.6 DATA DEFICIENCIES

The data set will be reviewed for conformance to the method-specified recovery or repeatability values for each individual constituent in each required QC analysis. Analytical data points that are associated with procedural or analytical irregularities will be evaluated according to the following protocol:

1. Minor deficiencies: Deficiencies which are determined to have no significant effect on the accuracy of the data will be regarded as minor deficiencies. These occurrences will be noted and explained in the data validation report but will not affect the usability of the data points and the data will not be qualified.
2. Significant deficiencies: Significant deficiencies are serious enough to call the veracity of a given data point(s) into question. In these cases, the deficiencies are judged to result in known or probable variation from the normal analytical method performance standards, with relation to the precision and/or accuracy of the data point. Subject data points will be qualified with the appropriate qualifiers per USEPA data validation guidelines (Section 7.1.2).
3. Major deficiencies: Irregularities in the sample handling or analytical process which compromise the analytical result(s) to such an extent that the data are deemed unusable or unreliable. Such data points will typically be rejected, and the reason(s) will be explained in the data validation report on a sample-by-sample basis.

QC data will be discussed in detail in a quality section of the RI/FS report. QA information will be included in other chapters to the extent that it affects the interpretation of sample data. For radiochemistry data, data deficiency will result in either correction or recollection of the data.

7.2 RECONCILIATION WITH USER REQUIREMENTS

The data will be reconciled with this QAPP and the DQOs (described in the OU-3 RI/FS Work Plan) to evaluate the data usability, including a comparison with the media-specific screening values, an evaluation of whether additional data gaps exist, and an assessment of the need for further remedial investigation or action.

Results of the data validation process and DQO assessment will be reported to the USEPA with the RI/FS report. This process is documented in a Tier II, Tier III, or Tier IV Data Validation. Summary tables documenting analytical data will be denoted with any flags resulting from the Trihydro data validation process, in addition to the laboratory data qualifier flags. For example, samples that are rejected as part of the data validation process ("R" flag) would not meet the DQOs for the site.

As stated above, nonconformance with the QA objectives will result in corrective action and will be reported to the OU-3 Respondents. The data review will include an evaluation of the precision, accuracy, representativeness, comparability, and completeness according to the limits specified with the laboratory reports.

For geospatial data, if the data are not conforming to the QC criteria and assessment procedures, the data will not be used until those procedures are met. The accuracy of the data must be sufficient to be used for creating site maps that will be used to determine the current site conditions.

8.0 REFERENCES

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TABLES

TABLE 1-1. DOCUMENT DIRECTORY
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Scope of Work	WP Section	FSP Section	QAPP Section
Project Background and Setting	2.1, 2.2, 2.3, 2.4	1.1, 1.2	--
Project Personnel and Team Responsibilities	10.1, Figure 10-1	1.5	2.0, Figure 2-1, Table 3-1
Project Schedule	10.2, Figure 10-2	7.0	Table 3-1
Historical Datasets	2.5	--	Table 3-1
Conceptual Site Model	3.0	--	3.1.2, Table 3-1
Data Quality Objectives	4.1	1.3	3.0, Table 3-1
Field Instrument Calibration	5.1.2	4.0	5.1.5.1
Compile Existing Data	5.2	3.20	4.2, Table 3-1
Existing Monitoring Well Network	5.3.1, Figure 5-1, Appendix A and B	3.2.1, 3.2.2	Table 3-1
Proposed Monitoring Well Network	5.3.2, 5.3.3, 5.3.4, and Figures 5-2 to 5-5	3.5	5.0, 6.0, and 7.0[1]
Phased Approach	4.3, 5.4.1	1.3	1.2
Site Reconnaissance, Well Inventory, Repair, Replacement, and Abandonment	5.4.3, 5.4.4, 9.1	3.2, 3.11	--
Hydraulic Profiling Tool Pilot Test	5.4.5	3.5.2.1, Appendix I	5.0, 6.0, and 7.0[1], Table 3-1
Drill Rig Selection	5.4.6	3.5.2	--
Continuous Coring and Field Logging	5.4.7	3.5.2.2, 3.5.2.3, 3.5.2.4, Appendix I and K	Table 3-1
Alluvium and Bedrock Aquifer Matrix Sampling	5.4.8	3.6	5.1.2.1.2, Table 3-1
Borehole Geophysical Logging	5.4.9	3.7	Table 3-1
Packer Testing	5.4.10	3.8	Table 3-1
Monitoring Well Installation	5.4.11	3.9, Appendix K	Table 3-1
Monitoring Well Development	5.4.12	3.10, Appendix L	Table 3-1
Slug Testing	5.4.13	3.12, Appendix M	Table 3-1
Aquifer Pumping Test	5.4.14	3.13, Appendix M	Table 3-1
Water-level Measurements	5.4.15.1	3.16, Appendix F	Table 3-1
Monitoring Well Purging	5.4.15.2	3.14.1, 3.14.2	Table 3-1
Monitoring Well Sampling	5.4.15.3	3.14.3	Table 3-1
Staff Gauge Installation	5.4.16, Figure 5-6	3.17	Table 3-1
Leachate Collection System Sampling	5.4.17	3.15	5.1.2.1.1, Table 3-1
On-site Vapor Intrusion Assessment	5.4.18, Figure 5-10	3.18, Appendix N	5.1.2.1.3, Table 3-1
Ecological Survey	5.4.19	3.19	--
Surveying and Mapping of the Investigation Areas	5.4.20	3.4	5.1.2.1.5, 5.3.3, 6.1.4, 6.2.3, 7.1.2.5

TABLE 1-1. DOCUMENT DIRECTORY
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Scope of Work	WP Section	FSP Section	QAPP Section
Investigation Derived Waste	5.4.21	6.0	--
Decontamination Procedures	5.4.21	5.0, Appendix O	6.1.1
Additional Site Characterization	5.4.22	--	Table 3-1
Groundwater Modeling and Fate and Transport	5.5, 6.2.1	--	Table 3-1
Health and Safety (see Health and Safety Plan)	5.7	--	--
Data Management	6.1	--	5.3
Data Validation	6.1.1	--	4.1, 4.2, 7.0
Project Database	6.1.2, 6.2.2	--	5.3
Spatial Data	6.1.3	--	5.1.2.1.5, 5.3.3, 6.1.4, 6.2.3, 7.1.2.5
Field Logbooks	6.1.4.1	3.21.1, Appendix A	3.10
Field Datasheets	6.1.4.2	3.21.2, Appendix A	3.10
Data Evaluation	6.2	--	4.0, Table 3-1
Baseline Risk Assessment and RI Report	7.0	--	4.0, Table 3-1
Feasibility Study	8.0	--	--
RI/FS Report	9.0	--	--

Notes:

This table is not meant to be all inclusive but as a guide to help find the major components of these Scope of Work Items. Tables, Appendices, and Figures were only referenced if they contained a large portion of the information for that component.

Section 5.0, 6.0, and 7.0 of the QAPP addresses groundwater, leachate, alluvium, bedrock and vapor in the following sections:

5.1.1 - Sample Handling and Custody, 5.1.2 - Analytical Methods, 5.1.3 - Quality Control, 5.1.4/5.1.5 - Field Instrument/Equipment Procedures. 5.1.6 - Supplies and Consumables, 5.3 - Data Management, 6.1.1 - Field Audits, 6.2.1 - Field Data Reporting, 7.1.1 - Field Data Validation

Highlighted column indicates where the majority of information for that topic is discussed.

Abbreviations:

FSP: Field Sampling Plan
QAPP: Quality Assurance Project Plan
WP: Work Plan
RI: Remedial Investigation
FS: Feasibility Study

TABLE 2-1. DATA VALIDATION LEVELS
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Review Item[1,2]	Tier I	Tier II	Tier III*	Tier IV
Laboratory Notes and Narrative	Review	Review/Implications	Review/Implications	Review/Implications
Laboratory Qualifiers	Review	Review/Implications	Review/Implications	Review/Implications
Chain-of-Custody	Review	Review/Implications	Review/Implications	Review/Implications
Detection Limits	Review	Implications	Implications	Implications
Analytical Methods	Review	Review/Implications	Review/Implications	Review/Implications
Sample Receipt	Review	Review/Implications	Review/Implications	Review/Implications
Sample Preservation	Review	Review/Implications	Review/Implications	Review/Implications
Sample Temperature	Review	Review/Implications	Review/Implications	Review/Implications
Holding Times	Review	Review/Implications	Review/Implications	Review/Implications
Reported Units	Review	Review/Implications	Review/Implications	Review/Implications
Constituent Lists	Review	Implications	Implications	Implications
Method Blank /Preparation Blanks Completeness	--	Review/Implications	Review/Implications	Review/Implications
Method Blank /Preparation Blanks Detections	--	Review/Implications	Review/Implications	Review/Implications
Matrix Spike Completeness	--	Review/Implications	Review/Implications	Review/Implications
Matrix Spike Compliance	--	Review/Implications	Review/Implications	Review/Implications
Laboratory Control Sample Completeness	--	Review/Implications	Review/Implications	Review/Implications
Laboratory Control Sample Compliance	--	Review/Implications	Review/Implications	Review/Implications
Deuterated Monitoring Compounds/Surrogate Recoveries	--	Review/Implications	Review/Implications	Review/Implications
Trip/Field/Equipment Blanks Completeness	Review	Review/Implications	Review/Implications	Review/Implications
Trip/Field/Equipment Blanks Detections	Review	Review/Implications	Review/Implications	Review/Implications
Field Duplicate Completeness	Review	Review/Implications	Review/Implications	Review/Implications
Field Duplicate RPD Compliance	--	Review/Implications	Review/Implications	Review/Implications
Laboratory Duplicate Completeness	--	Review/Implications	Review/Implications	Review/Implications
Laboratory Duplicate RPD Compliance	--	Review/Implications	Review/Implications	Review/Implications
Initial Calibration	--	If Problems are Suspected	Review/Implications	Review/Implications
Initial Calibration Verification	--	If Problems are Suspected	Review/Implications	Review/Implications

TABLE 2-1. DATA VALIDATION LEVELS
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Review Item[1,2]	**Tier I**	**Tier II**	**Tier III***	**Tier IV**
Continuing Calibration Verification	--	If Problems are Suspected	Review/Implications	Review/Implications
Internal Standards	--	If Problems are Suspected	Review/Implications	Review/Implications
Continuing Calibration Blanks	--	If Problems are Suspected	Review/Implications	Review/Implications
Initial Calibration Blanks	--	If Problems are Suspected	Review/Implications	Review/Implications
Instrument Check Standards	--	If Problems are Suspected	Review/Implications	Review/Implications
Instrument Tunes	--	If Problems are Suspected	Review/Implications	Review/Implications
Serial Dilutions	--	If Problems are Suspected	Review/Implications	Review/Implications
Post-Digestion Spikes	--	If Problems are Suspected	Review/Implications	Review/Implications
Interference Check Samples	--	If Problems are Suspected	Review/Implications	Review/Implications
Reporting Limit Check Standards	--	If Problems are Suspected	Review/Implications	Review/Implications
Target Compound Identification	--	If Problems are Suspected	Review/Implications	Review/Implications
Tentatively Identified Compounds (TICs)	--	If Provided	Review/Implications	Review/Implications
System Performance Factors	--	--	Review/Implications	Review/Implications
Raw Data Calculations Verification	--	--	If Problems are Suspected	Review/Implications
Chromatogram Review	--	If Provided	If Problems are Suspected	Review/Implications
Retention Time Verification	--	--	If Problems are Suspected	Review/Implications
Deliverables				
	Check List	Report	Report+Summary	Report+Summary

Notes:

* Tier III is the preferred validation level for most data. Please see QAPP Section 7.0 for additional details.

1: Review items vary by methodology and may include more or less than specified in this list.

2: Radiochemical analyses will be validated as described in Attachment B and in accordance with guidelines from the American Nuclear Society Standard 41.5-2012 (ANS 2018) with reference to Chapter 8 of the USEPA MARLAP, document number EPA 402-B-04-001A (USEPA 2004).

TABLE 2-2A. ANALYTES, HOLDING TIME AND PRESERVATION REQUIREMENTS FOR GROUNDWATER/LEACHATE
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)	Laboratory
Total Metals	Total Metals	USEPA 6010B	250mL in plastic container	Nitric Acid to pH <2* Ambient or Cool to ≤6°C	Must be analyzed within 6 months of the collection date.	Pace - I
	Total Metals	USEPA 6020	250mL in plastic container	Nitric Acid to pH <2* Ambient or Cool to ≤6°C	Must be analyzed within 6 months of the collection date.	Pace - I
	Total Mercury	USEPA 7470A	250mL in plastic container	Nitric Acid to pH <2* Cool to ≤6°C	Analysis must be completed within 28 days of collection date.	Pace - I
	Chromium (III)	Calculation	NA	NA	NA	Pace - I
	Chromium (VI) Use one of these two methods.	USEPA 7196A	250mL in plastic container	Cool to ≤6°C	Analysis must be completed within 24 hours of colelction date.	Pace - I
		USEPA 7199	Filterable syringe	Ammonium sulfate/Ammonium hydroxide Cool to ≤6°C	Analysis must be completed within 28 days of collection date.	Pace - I / Pace - N
Dissolved Metals	Dissolved Metals	USEPA 6020	250mL in plastic container	Field Filtration Nitric Acid to pH <2* Ambient or Cool to ≤6°C	Must be analyzed within 6 months of the collection date.	Pace - I
	Dissolved Metals	USEPA 6010B	250mL in plastic container	Field Filtration Nitric Acid to pH <2* Ambient or Cool to ≤6°C	Must be analyzed within 6 months of the collection date.	Pace - I
	Dissolved Mercury	USEPA 7470A	250mL in plastic container	Field Filtration Nitric Acid to pH <2* Ambient or Cool to ≤6°C	Analysis must be completed within 28 days of collection date.	Pace - I
Semi-Volatile Organic Compounds	Semi-Volatile Organic Compounds	USEPA 8270C	2x100mL amber glass container with Teflon-lined lid, preferably wide mouth	Cool to ≤6°C	Sample must be extracted within 7 days of collection date and extract must be analyzed within 40 days of extraction date.	Pace - I
	Semi-Volatile Organic Compounds	USEPA 8270C SIM	2x100mL amber glass container with Teflon-lined lid, preferably wide mouth	Cool to ≤6°C	Sample must be extracted within 7 days of collection date and extract must be analyzed within 40 days of extraction date.	Pace - I

TABLE 2-2A. ANALYTES, HOLDING TIME AND PRESERVATION REQUIREMENTS FOR GROUNDWATER/LEACHATE
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)	Laboratory
Volatile Organic Compounds	Volatile Organic Compounds	USEPA 8260C Low Level	Minimum 3 VOA vials. Additional sample is required if MS/MSD is required.	Acidified w/ 1:1 Hydrochloric Acid to pH<2, no headspace Cool to ≤6°C	pH>2: Analysis must be completed within 7 days of collection date. pH <2: Analysis must be completed within 14 days of collection date. (pH determined post analysis)	Pace - I
	Volatile Organic Compounds	USEPA 8011	Minimum 3 VOA amber vials. Additional sample is required if MS/MSD is required.	Preserved w/ sodium thiosulfate, no headspace Cool to ≤6°C	Analysis must be completed within 14 days of collection date.	Pace - I
PCBs	Polychlorinated Biphenyls (PCBs)	USEPA 8082A	2x100mL wide mouth amber glass bottle	Cool to ≤6°C	Extract within 6 months of collection and analyze within 40 days of extraction	Pace - I
Chlorinated Herbicides	Chlorinated Herbicides	USEPA 8151A	2x1000mL amber glass container with Teflon-lined lid, preferably wide mouth	Cool to ≤6°C	Sample must be extracted within 7 days of collection date and extract must be analyzed within 40 days of extraction date.	Pace - I
Hydrocarbons	TPH - Aliphatic and Aromatic	TX 1006	(2) 40 ml HCL vials	Cool to ≤6°C	Analysis must be completed within 7 days.	Pace - N
	Total TPH	TX 1005	(2) 40 ml HCL vials	Cool to ≤6°C	Analysis must be completed within 7 days.	Pace - N
Dissolved Gases	Methane	AM20GAX	2x40mL vials	BAK, Cool to ≤6°C	Analysis must be completed in 14 days within 14 days of collection date.	Pace - E
	Carbon Dioxide	AM20GAX	2x40mL vials	BAK, Cool to ≤6°C	Analysis must be completed in 14 days within 14 days of collection date.	Pace - E

TABLE 2-2A. ANALYTES, HOLDING TIME AND PRESERVATION REQUIREMENTS FOR GROUNDWATER/LEACHATE
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)	Laboratory
Radiological Chemistry	Isotopic Thorium (Th-228, Th-230, Th-232) Dissolved Isotopic Thorium (Th-228, Th-230, Th-232)	HASL-300 Method U-02	1L plastic or glass container	Nitric acid pH<2	Sample must be analyzed within 180 days	Pace - P
	Isotopic Uranium (U-234, U-235, U-238) Dissolved Isotopic Uranium (U-234, U-235, U-238)	HASL-300 Method U-02	1L plastic or glass container	Nitric acid pH<2	Sample must be analyzed within 180 days	Pace - P
	Isotopic Radium-226 Dissolved Isotopic Radium-226	USEPA 903.1	1L plastic or glass container	Nitric acid pH<2	Sample must be analyzed within 180 days	Pace - P
	Isotopic Radium-228 Dissolved Isotopic Radium-228	USEPA 904.0	1L plastic or glass container	Nitric acid pH<2	Sample must be analyzed within 180 days	Pace - P
	Tritium	USEPA 906.0	500mL amber glass	Cool to ≤6°C	Sample must be analyzed within 180 days	Pace - P
Geochemistry	Alkalinity	SM 2320B	250mL minimum in plastic container	Cool to ≤6°C	Sample must be analyzed within 14 days of collection date.	Pace - I
	Bromide	USEPA 9056A	250mL minimum in plastic container	Cool to ≤6°C	Sample must be analyzed within 28 days of collection date.	Pace - I
	Carbonate	SM 2320B	250mL minimum in plastic container	Cool to ≤6°C	Sample must be analyzed within 14 days of collection date.	Pace - I
	Chemical Oxygen Demand	USEPA 410.4 Rev 2	One 250mL plastic or glass container	Sulfuric Acid to pH <2 Cool to ≤6°C	Sample must be analyzed within 28 days of collection date.	Pace - I
	Chloride, Fluoride, Sulfate, Iodide	USEPA 9056A	250mL in plastic container	Cool to ≤6°C	Analysis must be completed within 28 days of collection date.	Pace - I
	Cyanide	USEPA 9012A	250mL in plastic container	Preserved w/ sodium hydroxide to pH>10 Cool to ≤6°C	Sample must be analyzed within 14 days of collection date.	Pace - I
	Dissolved Organic Carbon	SM 5310C	250mL amber glass bottle	Field Filtered, Sulfuric Acid to pH <2 Cool to ≤6°C	Sample must be analyzed within 28 days of collection date.	Pace - I
	Nitrogen, Ammonia	SM 4500-NH_3 G/USEPA 350.1	250mL in plastic or glass container	Sulfuric Acid to pH <2 Cool to ≤6°C	Sample must be analyzed within 28 days of collection date.	Pace - I
	Nitrogen, Nitrate	USEPA 9056A	250mL in plastic container	Cool to ≤6°C	For unpreserved samples, analysis must be completed within 48 hours of collection.	Pace - I
	Nitrogen, Nitrate + Nitrite	USEPA 353.2 Rev 2	250mL in plastic container	For combined nitrate/nitrite analysis Sulfuric Acid to pH <2	For preserved samples, analysis must be completed within 28 days of collection date.	Pace - I

TABLE 2-2A. ANALYTES, HOLDING TIME AND PRESERVATION REQUIREMENTS FOR GROUNDWATER/LEACHATE
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)	Laboratory
Geochemistry	Nitrogen, Nitrite	USEPA 9056A	250mL in plastic container	Cool to ≤6°C	For unpreserved samples, analysis must be completed within 48 hours of collection.	Pace - I
	pH	SM 4500H+B	250mL minimum in plastic container	Cool to ≤6°C	Sample must be analyzed within 15 minutes of collection date.	Pace - I
	Phosphorous	USEPA 365.1	250mL in glass or plastic container	Preserved with H2SO4 to a pH<2, Cool to ≤6°C	Sample must be analyzed within 28 days of collection date.	Pace - I
	Sulfide	SM 4500-S^2-D	250mL in plastic container. Fill container completely without overflowing.	pH>9 with 1mL of 1:1 Sodium Hydroxide plus 0.5mL of 1N Zinc Acetate per 250mL sample. Cool to ≤6°C	Analysis must be completed within 7 days of collection.	Pace - I
	Total Dissolved Solids	SM 2540C	250mL minimum in plastic container	Cool to ≤6°C	Sample must be analyzed within 7 days of collection date.	Pace - I
	Total Hardness	USEPA 6010B/2340B Calculation	250mL in plastic container	Nitric Acid to pH <2* Ambient or Cool to ≤6°C	Must be analyzed within 6 months of the collection date.	Pace - I
	Total Organic Carbon	SM 5310C	250mL amber glass bottle	Sulfuric Acid to pH <2 Cool to ≤6°C	Sample must be analyzed within 28 days of collection date.	Pace - I
	Total Suspended Solids	SM 2540D	1L minimum in plastic container	Cool to ≤6°C	Sample must be analyzed within 7 days of collection date.	Pace - I

Notes:

* Samples received at pH >2 must be preserved to pH <2 with HNO3 and be allowed to equilibrate for 24 hours before being prepared for analysis. Acidification date and time are recorded in the Sample Preservation Logbook.

Abbreviations:

BAK: Benzalkonium Chloride
°C: degrees celsius
HASL: Health and Safety Laboratory
L: Liter
mL: milliliter
MS/MSD: Matrix Spike/Matrix Spike Duplicate
N: Normal
NA: Not Applicable
Pace - E: Pace Analytical Energy Services, LLC in Pittsburgh, Pennsylvania
Pace - I: Pace Analytical Services, LLC in Indianapolis, Indiana
Pace - K: Pace Analytical Services, LLC in Lenexa, Kansas
Pace - P: Pace Analytical Services, LLC in Pittsburgh, Pennsylvania
Pace - N: Pace Analytical National Center for Testing and Innovation in Mt. Juliet, Tennessee
PCBs: Polychlorinated biphenyl
SIM: Selective Ion Monitoring
SM: Standard Methods for the Examination of Water and Wastewater
TPH: Total Petroleum Hydrocarbons
USEPA: United States Environmental Protection Agency
VOA: Volatile Organic Analysis

TABLE 2-2B. ANALYTES, HOLDING TIME AND PRESERVATION REQUIREMENTS FOR ALLUVIAL AQUIFER MATRIX
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)	Laboratory
Total Metals	Total Metals	USEPA 6010B	4-oz glass with Teflon Lid	None	Must be analyzed within 6 months of the collection date.	Pace - I
	Total Metals	USEPA 6020	4-oz glass with Teflon Lid	None	Must be analyzed within 6 months of the collection date.	Pace - I
	Total Mercury	USEPA 7471A	4-oz glass with Teflon Lid	Cool to ≤6°C	28 days	Pace - I
	Ferrous Iron	HACH 8146, Modified	4-oz glass with Teflon Lid	Protect from Air before analysis	30 days	Pace - I
	Ferric Iron	Calculated Using SM 3500-Fe D, Modified	NA	Protect from Air before analysis	30 days	Pace - I
Radiological Chemistry	Total Isotopic Uranium (U-234, U-235, U-238)	HASL-300 Method U-02	4-oz glass with Teflon Lid	None	Sample must be analyzed within 180 days	Pace - P
	Total Isotopic Thorium (Th-228,Th-230, Th-232)	HASL-300 Method U-02	4-oz glass with Teflon Lid	None	Sample must be analyzed within 180 days	Pace - P
	Radium-226	USEPA 901.1M	16-oz glass with Teflon Lid	None	Sample must be analyzed within 180 days	Pace - P
	Radium-228	USEPA 901.1M	16-oz glass with Teflon Lid	None	Sample must be analyzed within 180 days	Pace - P
Major Minerals and Mineral Reactivity	X-Ray Diffraction	X-Ray Diffraction/Whole Pattern Fitting EMSL SOP MS- 01-1 Powder XRD	1 oz or larger, Plastic/glass	None	None	EMSL
	Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometry (SEM/EDS)	Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometry (SEM/EDS) EMSL SOPs.		None	None	EMSL
Mineralogical	Cation Exchange Capacity	USEPA 9081	4-oz glass with Teflon Lid	Cool to ≤6°C	Sample must be analyzed within 180 days	Pace - K
Geochemistry	pH	USEPA 9045D	4-oz glass with Teflon Lid	Cool to ≤6°C	Immediately	Pace - I
	Total Organic Carbon	Walkley-Black Procedure	4-oz amber glass with Teflon Lid	Cool to ≤6°C	28 days	Pace - N
	Bromide, Iodide, Fluoride, Chloride, and Sulfate	USEPA 9056	4-oz amber glass with Teflon Lid	Cool to ≤6°C	28 days	Pace - I
	Total Alkalinity (carbonate and bicarbonate)	SM 2320B	4-oz glass with Teflon Lid	Cool to ≤6°C	14 days	Pace - I

TABLE 2-2B. ANALYTES, HOLDING TIME AND PRESERVATION REQUIREMENTS FOR ALLUVIAL AQUIFER MATRIX
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)	Laboratory
Radionuclide Speciation	Following Sequential Extraction Analysis (Dissolved Radium and Dissolved Thorium)	USEPA 901.1M	(2) 1L Plastic**	HNO3	Sample must be analyzed within 180 days	MCLInc and Pace - P[3]
	Following Sequential Extraction Analysis (Total Uranium and Total Thorium)	HASL-300 Method U-02	250mL Plastic**	HNO3	Sample must be analyzed within 180 days	MCLInc and Pace - P[3]
	Following Sequential Extraction Analysis (Total Metals-Barium, Calcium, Iron, Manganese, Sulfur)	USEPA 6020	250mL Plastic	HNO3	Sample must be analyzed within 180 days	MCLInc and Pace - I[3]
	Following Sequential Extraction Analysis (pH)	USEPA 9045	250mL Plastic	Cool to ≤6°C	Sample must be analyzed within 15 minutes of collection date.	MCLInc
Geotechnical Parameter	Grain Size (3" Maximum)	ASTM D6913	Bulk Sample	None	Sample must be analyzed within 180 days	Advanced Terra Testing
	Grain Size with Hydrometer	ASTM D6319 and D7928	Bulk Sample[1]	None	Sample must be analyzed within 180 days	Advanced Terra Testing
	Atterberg Limits (Method A)	ASTM D4318	Bulk Sample[1]	None	Sample must be analyzed within 180 days	Advanced Terra Testing
	Specific Gravity	ASTM D854	Core Sample[2]	None	Sample must be analyzed within 180 days	Advanced Terra Testing
	Porosity	ASTM D7263	Core Sample[2]	None	Sample must be analyzed within 180 days	Advanced Terra Testing
	Moisture Content and Density	ASTM D7263	Core Sample[2]	None	Sample must be analyzed within 180 days	Advanced Terra Testing

Notes:

* Samples received at pH >2 must be preserved to pH <2 with HNO3 and be allowed to equilibrate for 24 hours before being prepared for analysis. Acidification date and time are recorded in the Sample Preservation Logbook.

** Limited sample extract will be available from sequential extraction procedure

1: As for quantity of bulk material, to run the grain size with hydrometer and atterberg tests, 2000 grams minimum will suffice

2: Density, porosity, specific gravity, moisture content cannot be run on a bulk sample, and can only be completed if there is enough intact sample to complete the analysis

3: Samples will be shipped to MCLInc for extraction and then to Pace for analyses.

Abbreviations:

ASTM: American Society for Testing and Materials
°C: degrees celsius
EMSL: EMSL Analytical, Inc.
HASL: Health and Safety Laboratory
HNO3: Nitric acid
L: Liter
MCL: Materials and Chemistry Laboratory
MCLInc: Materials and Chemistry Laboratory, Inc.
mL: milliliter
NA: Not Applicable
oz: ounce
Pace - I: Pace Analytical Services, LLC in Indianapolis, Indiana
Pace - K: Pace Analytical Services, LLC in Lenexa, Kansas
Pace - P: Pace Analytical Services, LLC in Pittsburgh, Pennsylvania
Pace - N: Pace Analytical National Center for Testing and Innovation in Mt. Juliet, Tennessee
SM: Standard Methods for the Examination of Water and Wastewater
USEPA: United States Environmental Protection Agency
VOA: Volatile Organic Analysis

TABLE 2-2C. ANALYTES, HOLDING TIME AND PRESERVATION REQUIREMENTS FOR BEDROCK AQUIFER MATRIX
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Containers[1] (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)	Laboratory
Total Metals	Total Metals	USEPA 6010B	NA	None	Must be analyzed within 6 months of the collection date.	Pace - I
	Total Metals	USEPA 6020	NA	None	Must be analyzed within 6 months of the collection date.	Pace - I
	Total Mercury	USEPA 7471A	NA	Cool to ≤6°C	28 days	Pace - I
	Ferrous Iron	HACH 8146, Modified	NA	Protect from Air before analysis	30 days	Pace - I
	Ferric Iron	Calculated Using SM 3500-Fe D, Modified	NA	Cool to ≤6°C	24 hours	Pace - I
Radiological Chemistry	Isotopic Uranium (U-234, U-235, U-238)	HASL-300 Method U-02	NA	None	Sample must be analyzed within 180 days	Pace - P
	Isotopic Thorium (Th-228,Th-230, Th-232)	HASL-300 Method U-02	NA	None	Sample must be analyzed within 180 days	Pace - P
	Radium-226	USEPA 901.1M	NA	None	Sample must be analyzed within 180 days	Pace - P
	Radium-228	USEPA 901.1M	NA	None	Sample must be analyzed within 180 days	Pace - P
Major Minerals and Mineral Reactivity	X-Ray Diffraction	X-Ray Diffraction/Whole Pattern Fitting EMSL SOP MS- 01-1 Powder XRD	NA	None	None	EMSL
	Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometry (SEM/EDS)	Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometry (SEM/EDS)	NA	None	None	EMSL
Mineralogical	Cation Exchange Capacity	USEPA 9081	NA	Cool to ≤6°C	Sample must be analyzed within 180 days	Pace - K
Geochemistry	pH	USEPA 9045C	NA	Cool to ≤6°C	Immediately	Pace - I
	Total Organic Carbon	Walkley-Black Procedure	NA	Cool to ≤6°C	28 days	Pace - N
	Total Alkalinity (carbonate and bicarbonate)	SM 2320B	NA	Cool to ≤6°C	14 days	Pace - I
	Bromide, Iodide, Fluoride, Chloride, and Sulfate	USEPA 9056	NA	Cool to ≤6°C	28 days	Pace - I

Notes:

1: Bedrock cores will be submitted to the laboratory for crushing and analysis. Approximately 1500g total are needed for the bedrock analytical suite. An approximately 6-inch core will be submitted to the laboratory.

* Samples received at pH >2 must be preserved to pH <2 with HNO3 and be allowed to equilibrate for 24 hours before being prepared for analysis. Acidification date and time are recorded in the Sample Preservation Logbook.

Abbreviations:

ASAP: As soon as possible
°C: degrees celsius
EMSL: EMSL Analytical, Inc.
HASL: Health and Safety Laboratory
HNO3: Nitric acid
L: Liter
M: Modified
MCL: Materials and Chemistry Laboratory
MCLInc: Materials and Chemistry Laboratory, Inc.
mL: milliliter
NA: Not Applicable
oz: ounce
Pace - I: Pace Analytical Services, LLC in Indianapolis, Indiana
Pace - K: Pace Analytical Services, LLC in Lenexa, Kansas
Pace - P: Pace Analytical Services, LLC in Pittsburgh, Pennsylvania
Pace - N: Pace Analytical National Center for Testing and Innovation in Mt. Juliet, Tennessee
SM: Standard Methods for the Examination of Water and Wastewater
USEPA: United States Environmental Protection Agency
VOA: Volatile Organic Analysis

TABLE 2-2D. ANALYTES, HOLDING TIME AND PRESERVATION REQUIREMENTS FOR VAPOR
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Analytical Group	**Analytical Method**	**Containers (number, size, and type)**	**Preservation Requirements (chemical, temperature, light protected)**	**Maximum Holding Time (preparation / analysis)**	**Laboratory**
Volatile Organic Compounds	TO-15/TO-15 MOD[1]	1 – 6 Liter Summa Can[2]	NA	30 Days	ALS-S
Methane	TO-3 Modified	1 – 6 Liter Summa Can[2]	NA	30 Days	ALS-S
Radon	USEPA 402-R-92-004	Electret Ion Chamber	NA	NA	ALS-W
Helium and Fixed Gases [3]	*3C Modified*	*1 – 6 Liter Summa Can* [2]	*NA*	*30 Days*	*ALS-S*

Notes:

1: TO-15 Modified will be used for samples that also require methods 3c Modified and TO-3 Modified.
2: VOCs, Helium, fixed gases, and methane will be analyzed from the same canister.
3: Contingent upon results of indoor air samples.

Abbreviations:

ALS-S: ALS Simi Valley, CA
ALS-W: ALS Winnipeg, MB
SIM: Selective Ion Monitoring
MOD: Modified
NA: Not applicable
USEPA: United States Environmental Protection Agency

TABLE 2-3a-i. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR GROUNDWATER AND LEACHATE SAMPLING
WEST LAKE LANDFILL OU-3, REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes[1]	HAZ[2]	CAS Number	Lab	Method	USEPA Maximum Contaminant Level (μg/L)[3]	Tap Water Regional SL (μg/L)[3] THQ = 1.0	Tap Water Regional SL (μg/L)[3] THQ = 0.1	MDNR Groundwater Protection Standards (μg/L)[4]	MDNR Groundwater Protection Standards (μg/L)[5]	Lowest SL USEPA MCL/MDNR GWPS (μg/L)	Pace Analytical Services, LLC		Comparison of Laboratory Limits to USEPA RSLs where THQ 1.0[3]	Comparison of Laboratory Limits to USEPA RSLs where THQ = 0.1[3]	Comparison of Laboratory Limits to Lowest Water Cleanup Levels[7]
											MRL (μg/L)[6]	MDL (μg/L)[6]			
Total Metals															
Aluminum		7429-90-5	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 6010B	NL	20000	2000	NL	50-200	50	200	53.9	MRL below RSL	MRL below RSL	SL Cannot be Met
Antimony	X	7440-36-0		USEPA 6020	6	7.8	0.78	6	6	0.78	1	0.18	MRL below RSL	RSL between MRL and MDL	SL between MRL and MDL
Arsenic	X	7440-38-2		USEPA 6020	10	0.052	0.052	50	10	0.052	1	0.223	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Barium		7440-39-3		USEPA 6010B	2000	3800	380	2000	2000	380	10	0.53	MRL below RSL	MRL below RSL	MRL below SL
Beryllium	X	7440-41-7		USEPA 6020	4	25	2.5	4	4	2.5	0.2	0.038	MRL below RSL	MRL below RSL	MRL below SL
Boron		7440-42-8		USEPA 6010B	NL	4000	400	2000	NL	400	100	7.71	MRL below RSL	MRL below RSL	MRL below SL
Cadmium	X	7440-43-9		USEPA 6020	5	0.922[8]	9.22[8]	5	5	5	0.2	0.03	MRL below RSL	MRL below RSL	MRL below SL
Calcium		7440-70-2		USEPA 6010B	NL	NL	NL	NL	NL	NA	500	72.93	NA	NA	NA
Chromium	X	7440-47-3		USEPA 6020	100	NL	NL	NL	10	10	2	0.177	NA	NA	MRL below SL
Chromium (III)		18540-29-9		Calculation	NL	0.035	0.035	100	NL	0.035	10	3.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Chromium (VI)	X	1066-30-4		USEPA 7196A/ USEPA 7199	NL	0.035[8]	0.035[8]	NL	NL	0.035	10	3.5	MRL below RSL	MRL below RSL	SL Cannot be Met
Cobalt		7440-48-4		USEPA 6010B	NL	6	0.6	1000	NL	0.6	5	0.75	MRL below RSL	RSL Cannot be Met	SL Cannot be Met
Copper	X	7440-50-8		USEPA 6020	1300	800	80	1300	1000	80	1	0.227	MRL below RSL	MRL below RSL	MRL below SL
Iron		7439-89-6		USEPA 6010B	NL	14000	1400	300	300	300	50	32.4	MRL below RSL	MRL below RSL	MRL below SL
Lead	X	7439-92-1		USEPA 6020	15	15	15	15	NL	15	1	0.227	MRL below RSL	MRL below RSL	MRL below SL
Lithium		7439-93-2		USEPA 6010B	NL	40	4	NL	NL	4	20	4.73	MRL below RSL	RSL Cannot be Met	SL Cannot be Met
Magnesium		7439-95-4		USEPA 6010B	NL	NL	NL	NL	NL	NA	500	57.5	NA	NA	NA
Manganese		7439-96-5		USEPA 6010B	NL	NL	NL	50	50	50	5	1.12	NA	NA	MRL below SL
Molybdenum		7439-98-7		USEPA 6010B	NL	100	10	NL	NL	10	10	0.64	MRL below RSL	MRL below RSL	MRL below SL
Mercury	X	7439-97-6		USEPA 7470A	2	0.63	0.063	2	2	0.063	0.2	0.1	MRL below RSL	RSL Cannot be Met	SL Cannot be Met
Nickel	X	7440-02-0		USEPA 6010B	NL	390	39	100	NL	39	10	1.45	MRL below RSL	MRL below RSL	MRL below SL
Potassium		7440-09-7		USEPA 6010B	NL	NL	NL	NL	NL	NA	1000	84.3	NA	NA	NA
Selenium	X	7782-49-2		USEPA 6020	50	100	10	50	50	10	1	0.311	MRL below RSL	MRL below RSL	MRL below SL
Silver	X	7440-22-4		USEPA 6020	NL	94	9.4	50	100	9.4	0.5	0.042	MRL below RSL	MRL below RSL	MRL below SL
Silicon		7440-21-3		USEPA 6010B	NL	NL	NL	NL	NL	NA	200	120	NA	NA	NA
Sodium	X	7440-23-5		USEPA 6010B	NL	20[9]	20[9]	NL	NL	20	1000	39.3	MRL below RSL	MRL below RSL	SL Cannot be Met
Strontium		7440-24-6		USEPA 6010B	NL	12000	1200	NL	NL	1200	10	0.38	MRL below RSL	MRL below RSL	MRL below SL
Thallium	X	7440-28-0		USEPA 6020	2	0.2	0.02	2	2	0.02	1	0.049	RSL between MRL and MDL	RSL Cannot be Met	SL Cannot be Met
Thorium		7440-29-1		USEPA 6020	NL	NL	NL	NL	NL	NA	1	0.25	NA	NA	NA
Tin		7440-31-5		USEPA 6010B	NL	12000	1200	NL	NL	1200	10	2.28	MRL below RSL	MRL below RSL	MRL below SL
Titanium		7440-32-6		USEPA 6010B	NL	NL	NL	NL	NL	NA	10	1.37	NA	NA	NA
Uranium		7440-61-1		USEPA 6020	NL	NL	NL	NL	NL	NA	1	0.011	NA	NA	NA
Vanadium		7440-62-2		USEPA 6020	NL	86	8.6	NL	NL	8.6	1	0.219	MRL below RSL	MRL below RSL	MRL below SL
Zinc	X	7440-66-6		USEPA 6010B	NL	6000	600	5000	5000	600	20	6.92	MRL below RSL	MRL below RSL	MRL below SL

TABLE 2-3a-i. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR GROUNDWATER AND LEACHATE SAMPLING
WEST LAKE LANDFILL OU-3, REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes^{1}	HAZ^{2}	CAS Number	Lab	Method	USEPA Maximum Contaminant Level (µg/L)^{3}	Tap Water Regional SL (µg/L)^{3} THQ = 1.0	Tap Water Regional SL (µg/L)^{3} THQ = 0.1	MDNR Groundwater Protection Standards (µg/L)^{4}	MDNR Groundwater Protection Standards (µg/L)^{5}	Lowest SL USEPA MCL/MDNR GWPS (µg/L)	Pace Analytical Services, LLC		Comparison of Laboratory Limits to USEPA RSLs where THQ 1.0^{3}	Comparison of Laboratory Limits to USEPA RSLs where THQ = 0.1^{3}	Comparison of Laboratory Limits to Lowest Water Cleanup Levels^{7}
											MRL (µg/L)^{6}	MDL (µg/L)^{6}			
Dissolved Metals															
Aluminum		7429-90-5	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 6010B	NL	20000	2000	NL	50-200	2000	200	53.9	MRL below RSL	MRL below RSL	MRL below SL
Antimony	X	7440-36-0		USEPA 6020	6	7.8	0.78	6	6	0.78	1	0.18	MRL below RSL	RSL between MRL and MDL	SL between MRL and MDL
Arsenic	X	7440-38-2		USEPA 6020	10	0.052	0.052	50	10	0.052	1	0.223	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Barium		7440-39-3		USEPA 6010B	2000	3800	380	2000	2000	380	10	0.53	MRL below RSL	MRL below RSL	MRL below SL
Beryllium	X	7440-41-7		USEPA 6020	4	25	2.5	4	4	2.5	0.2	0.038	MRL below RSL	MRL below RSL	MRL below SL
Boron		7440-42-8		USEPA 6010B	NL	4000	400	2000	NL	400	100	7.71	MRL below RSL	MRL below RSL	MRL below SL
Cadmium	X	7440-43-9		USEPA 6020	5	NL	NL	5	5	5	0.2	0.03	NA	NA	MRL below SL
Calcium		7440-70-2		USEPA 6010B	NL	NL	NL	NL	NL	NA	500	72.93	NA	NA	NA
Chromium	X	7440-47-3		USEPA 6020	100	NL	NL	NL	10	10	2	0.177	NA	NA	MRL below SL
Cobalt		7440-48-4		USEPA 6010B	NL	6	0.6	1000	NL	0.6	5	0.75	MRL below RSL	RSL Cannot be Met	SL Cannot be Met
Copper	X	7440-50-8		USEPA 6020	1300	800	80	1300	1000	80	1	0.227	MRL below RSL	MRL below RSL	MRL below SL
Iron		7439-89-6		USEPA 6010B	NL	14000	1400	300	300	300	50	32.4	MRL below RSL	MRL below RSL	MRL below SL
Lead	X	7439-92-1		USEPA 6020	15	15	15	15	NL	15	1	0.227	MRL below RSL	MRL below RSL	MRL below SL
Lithium		7439-93-2		USEPA 6010B	NL	40	4	NL	NL	4	20	4.73	MRL below RSL	RSL Cannot be Met	SL Cannot be Met
Magnesium		7439-95-4		USEPA 6010B	NL	NL	NL	NL	NL	NA	500	57.5	NA	NA	NA
Manganese		7439-96-5		USEPA 6010B	NL	NL	NL	50	50	50	5	1.12	NA	NA	MRL below SL
Molybdenum		7439-98-7		USEPA 6010B	NL	100	10	NL	NL	10	10	0.64	MRL below RSL	MRL below RSL	MRL below SL
Mercury	X	7439-97-6		USEPA 7470A	2	0.63	0.063	2	2	0.063	0.2	0.1	MRL below RSL	RSL Cannot be Met	SL Cannot be Met
Nickel	X	7440-02-0		USEPA 6010B	NL	390	39	100	NL	39	10	1.45	MRL below RSL	MRL below RSL	MRL below SL
Potassium		7440-09-7		USEPA 6010B	NL	NL	NL	NL	NL	NA	1000	84.3	NA	NA	NA
Selenium	X	7782-49-2		USEPA 6020	50	100	10	50	50	10	1	0.311	MRL below RSL	MRL below RSL	MRL below SL
Silver	X	7440-22-4		USEPA 6020	NL	94	9.4	50	100	9.4	0.5	0.042	MRL below RSL	MRL below RSL	MRL below SL
Silicon		7440-21-3		USEPA 6010B	NL	NL	NL	NL	NL	NA	200	120	NA	NA	NA
Sodium	X	7440-23-5		USEPA 6010B	NL	20^{5}	20^{5}	NL	NL	20	1000	39.3	MRL below RSL	MRL below RSL	SL Cannot be Met
Strontium		7440-24-6		USEPA 6010B	NL	12000	1200	NL	NL	1200	10	0.38	MRL below RSL	MRL below RSL	MRL below SL
Thallium	X	7440-28-0		USEPA 6020	2	0.2	0.02	2	2	0.02	1	0.049	RSL between MRL and MDL	RSL Cannot be Met	SL Cannot be Met
Thorium		7440-29-1		USEPA 6020	NL	NL	NL	NL	NL	NA	1	0.25	NA	NA	NA
Tin		7440-31-5		USEPA 6010B	NL	12000	1200	NL	NL	1200	10	2.28	MRL below RSL	MRL below RSL	MRL below SL
Titanium		7440-32-6		USEPA 6010B	NL	NL	NL	NL	NL	NA	10	1.37	NA	NA	NA
Uranium		7440-61-1		USEPA 6020	NL	NL	NL	NL	NL	NA	1	0.011	NA	NA	NA
Vanadium		7440-62-2		USEPA 6020	NL	86	8.6	NL	NL	8.6	1	0.219	MRL below RSL	MRL below RSL	MRL below SL
Zinc	X	7440-66-6		USEPA 6010B	NL	6000	600	5000	NL	600	20	6.92	MRL below RSL	MRL below RSL	MRL below SL
Semi-Volatile Organic Compounds															
Acenaphthene	X	83-32-9	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 8270C SIM	NL	530	53	1200	NL	53	1	0.015	MRL below RSL	MRL below RSL	MRL below SL
Acenaphthylene	X	208-96-8		USEPA 8270C SIM	NL	0.001^{10}	0.001^{10}	NL	NL	0.001	1	0.0131	MRL below RSL	MRL below RSL	SL Cannot be Met
Acetophenone	X	98-86-2		USEPA 8270C	NL	1900	190	NL	NL	190	10	3.5	MRL below RSL	MRL below RSL	MRL below SL
2-Acetylamino-fluorene	X	53-96-3		USEPA 8270C	NL	0.016	0.016	NL	NL	0.016	10	1.57	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
4-Aminobiphenyl	X	92-67-1		USEPA 8270C	NL	0.003	0.003	NL	NL	0.003	10	1.34	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Anthracene	X	120-12-7		USEPA 8270C SIM	NL	1800	180	9600	NL	180	0.1	0.0125	MRL below RSL	MRL below RSL	MRL below SL
Atrazine		1912-24-9		USEPA 8270C	3	0.3	0.3	3	NL	0.3	10	4.05	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Benzaldehyde		100-52-7		USEPA 8270C	NL	19	19	NL	NL	19	50	2.98	RSL between MRL and MDL	RSL between MRL and MDL	SL between MRL and MDL
Benz[a]anthracene	X	56-55-3		USEPA 8270C SIM	NL	0.03	0.03	0.0044	NL	0.0044	0.1	0.0272	RSL between MRL and MDL	RSL between MRL and MDL	SL Cannot be Met
Benzo[a]pyrene	X	50-32-8		USEPA 8270C SIM	0.2	0.025	0.025	0.2	NL	0.025	0.1	0.0262	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Benzo[b] fluoranthene	X	205-99-2		USEPA 8270C SIM	NL	0.25	0.25	0.0044	NL	0.0044	0.1	0.031	MRL below RSL	MRL below RSL	SL Cannot be Met
Benzo[g,h,i] perylene	X	191-24-2		USEPA 8270C SIM	NL	0.01^{10}	0.01^{10}	NL	NL	0.01	0.1	0.0236	MRL below RSL	MRL below RSL	SL Cannot be Met
Benzo[k] fluoranthene	X	207-08-9		USEPA 8270C SIM	NL	2.5	2.5	0.0044	NL	0.0044	0.1	0.0199	MRL below RSL	MRL below RSL	SL Cannot be Met
Benzyl alcohol		100-51-6		USEPA 8270C	NL	2000	200	NL	NL	200	10	3.87	MRL below RSL	MRL below RSL	MRL below SL
Biphenyl (1,1 - biphenyl)	X	92-52-4		USEPA 8270C	NL	0.83	0.083	NL	NL	0.083	10	2.1	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
bis(2-chloroethoxy) methane	X	111-91-1		USEPA 8270C	NL	59	5.9	NL	NL	5.9	10	3.77	MRL below RSL	RSL between MRL and MDL	SL between MRL and MDL
bis(2-chloroethyl) ether	X	111-44-4		USEPA 8270C	NL	0.014	0.014	0.03	NL	0.014	10	3.91	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
bis(2-chloro-1-methylethyl) ether*	X	108-60-1		USEPA 8270C	NL	710	71	300	NL	71	10	3.94	MRL below RSL	MRL below RSL	MRL below SL
bis(2-ethylhexyl) phthalate	X	117-81-7		USEPA 8270C	6	5.6	5.6	6	NL	5.6	10	4.99	RSL between MRL and MDL	RSL between MRL and MDL	SL between MRL and MDL

TABLE 2-3a-i. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR GROUNDWATER AND LEACHATE SAMPLING
WEST LAKE LANDFILL OU-3, REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes[1]	HAZ[2]	CAS Number	Lab	Method	USEPA Maximum Contaminant Level (µg/L)[3]	Tap Water Regional SL (µg/L)[3] THQ = 1.0	Tap Water Regional SL (µg/L)[3] THQ = 0.1	MDNR Groundwater Protection Standards (µg/L)[4]	MDNR Groundwater Protection Standards (µg/L)[5]	Lowest SL USEPA MCL/MDNR GWPS (µg/L)	Pace Analytical Services, LLC		Comparison of Laboratory Limits to USEPA RSLs where THQ 1.0[3]	Comparison of Laboratory Limits to USEPA RSLs where THQ = 0.1[3]	Comparison of Laboratory Limits to Lowest Water Cleanup Levels[7]
											MRL (µg/L)[6]	MDL (µg/L)[6]			
Semi-Volatile Organic Compounds (Cont)															
4-Bromophenyl phenyl ether		101-55-03	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 8270C	NL	NL	NL	NL	NL	NA	10	3.55	NA	NA	NA
Butyl benzyl phthalate	X	85-68-7		USEPA 8270C	NL	16	16	3000	NL	16	10	4.85	MRL below RSL	MRL below RSL	MRL below SL
4-Chloroaniline	X	106-47-8		USEPA 8270C	NL	0.37	0.37	NL	NL	0.37	10	3.75	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Chlorobenzilate	X	510-15-6		USEPA 8270C	NL	0.31	0.31	NL	NL	0.31	10	6.39	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
4-Chloro-3-methylphenol (p-chloro-m-Cresol)	X	59-50-7		USEPA 8270C	NL	1400	140	NL	NL	140	10	5.43	MRL below RSL	MRL below RSL	MRL below SL
2-Chloro-naphthalene	X	91-58-7		USEPA 8270C	NL	750	75	NL	NL	75	10	2	MRL below RSL	MRL below RSL	MRL below SL
2-Chlorophenol	X	95-57-8		USEPA 8270C	NL	91	9.1	0.1	NL	0.1	10	4.25	MRL below RSL	RSL between MRL and MDL	SL Cannot be Met
4-Chlorophenyl phenyl ether	X	7005-72-3		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	2.86	NA	NA	NA
Caprolactam		105-60-2		USEPA 8270C	NL	9900	990	NL	NL	990	10	4.08	MRL below RSL	MRL below RSL	MRL below SL
Carbazole		86-74-8		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	4.26	NA	NA	NA
Chrysene	X	218-01-9		USEPA 8270C SIM	NL	25	25	0.0044	NL	0.0044	0.5	0.025	MRL below RSL	MRL below RSL	SL Cannot be Met
Diallate	X	2303-16-4		USEPA 8270C	NL	0.54	0.54	NL	NL	0.54	10	3.15	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Dibenz[a,h]-anthracene	X	53-70-3		USEPA 8270C SIM	NL	0.025	0.025	0.0044	NL	0.0044	0.1	0.0707	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Dibenzofuran	X	132-64-9		USEPA 8270C	NL	7.9	0.79	NL	NL	0.79	10	3.24	RSL between MRL and MDL	RSL Cannot be Met	SL Cannot be Met
Di-*n*-butyl phthalate	X	84-74-2		USEPA 8270C	NL	900	90	2700	NL	90	10	6.56	MRL below RSL	MRL below RSL	MRL below SL
3,3'-Dichloro-benzidine	X	91-94-1		USEPA 8270C	NL	0.13	0.13	NL	NL	0.13	20	3.78	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
2,4-Dichlorophenol	X	120-83-2		USEPA 8270C	NL	46	4.6	93	NL	4.6	10	4.39	MRL below RSL	RSL between MRL and MDL	SL between MRL and MDL
2,6-Dichlorophenol	X	87-65-0		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	1.45	NA	NA	NA
Diethyl phthalate	X	84-66-2		USEPA 8270C	NL	15000	1500	23000	NL	1500	10	4.68	MRL below RSL	MRL below RSL	MRL below SL
Dimethoate	X	60-51-5		USEPA 8270C	NL	44	4.4	NL	NL	4.4	10	2.24	MRL below RSL	RSL between MRL and MDL	SL between MRL and MDL
P-Dimethylamino-azobenzene	X	60-11-7		USEPA 8270C	NL	0.005	0.005	NL	NL	0.005	10	2.04	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
2,4-Dimethylphenol	X	105-67-9		USEPA 8270C	NL	360	36	540	NL	36	10	4.61	MRL below RSL	MRL below RSL	MRL below SL
7,12-Dimethylbenz(a)-anthracene	X	57-97-6		USEPA 8270C	NL	0.0001	0.0001	NL	NL	0.0001	20	1.86	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
3,3-dimethylbenzidine	X	119-93-7		USEPA 8270C	NL	0.0065	0.0065	NL	NL	0.0065	20	2.33	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Dimethylphthalate	X	131-11-3		USEPA 8270C	NL	NL	NL	313000	NL	313000	10	5.16	NA	NA	MRL below SL
4,6-Dinitro-2-methylphenol	X	534-52-1		USEPA 8270C	NL	1.5	0.15	13	NL	0.15	20	5.84	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
1,3-Dinitrobenzene	X	99-65-0		USEPA 8270C	NL	2	0.2	1	NL	0.2	10	4.43	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
2,4-Dinitrophenol	X	51-28-5		USEPA 8270C	NL	39	3.9	70	NL	3.9	50	3.87	RSL between MRL and MDL	RSL between MRL and MDL	SL between MRL and MDL
2,4-Dinitrotoluene	X	121-14-2		USEPA 8270C	NL	0.24	0.24	0.04	NL	0.04	10	5.56	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
2,6-Dinitrotoluene	X	606-20-2		USEPA 8270C	NL	0.049	0.049	NL	NL	0.049	10	4.37	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Di-*n*-octyl phthalate	X	117-84-0		USEPA 8270C	NL	200	20	NL	NL	20	10	5.83	MRL below RSL	MRL below RSL	MRL below SL
Diphenylamine		122-39-4		USEPA 8270C	NL	1300	130	200	NL	130	10	4.47	MRL below RSL	MRL below RSL	MRL below SL
Disulfoton	X	298-04-4		USEPA 8270C	NL	0.5	0.05	0.3	NL	0.05	10	1.32	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Ethyl-methanesulfonate	X	62-50-0		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	1.72	NA	NA	NA
Famphur	X	52-85-7		USEPA 8270C	NL	NL	NL	NL	NL	NA	200	36.2	NA	NA	NA
Fluoranthene	X	206-44-0		USEPA 8270C SIM	NL	800	80	300	NL	80	1	0.0153	MRL below RSL	MRL below RSL	MRL below SL
Fluorene	X	86-73-7		USEPA 8270C SIM	NL	290	29	1300	NL	29	1	0.0362	MRL below RSL	MRL below RSL	MRL below SL
Hexachlorobenzene	X	118-74-1		USEPA 8270C	1	0.0098	0.0098	NL	NL	0.0098	10	3.91	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Hexachloro-1,3-butadiene	X	87-68-3		USEPA 8270C	NL	0.14	0.14	NL	NL	0.14	10	1.11	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Hexachlorocyclo-pentadiene	X	77-47-4		USEPA 8270C	50	0.41	0.041	NL	NL	0.041	10	1.56	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Hexachloroethane	X	67-72-1		USEPA 8270C	NL	0.33	0.33	2	NL	0.33	10	0.94	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Hexachlorophene	X	70-30-4		USEPA 8270C	NL	6	0.6	NL	NL	0.6	200	11.6	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Hexachloropropene	X	1888-71-7		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	1.56	NA	NA	NA

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QUALITY ASSURANCE PROJECT PLAN

Target Analytes[1]	HAZ[2]	CAS Number	Lab	Method	USEPA Maximum Contaminant Level (µg/L)[3]	Tap Water Regional SL (µg/L)[3] THQ = 1.0	Tap Water Regional SL (µg/L)[3] THQ = 0.1	MDNR Groundwater Protection Standards (µg/L)[4]	MDNR Groundwater Protection Standards (µg/L)[5]	Lowest SL USEPA MCL/MDNR GWPS (µg/L)	Pace Analytical Services, LLC		Comparison of Laboratory Limits to USEPA RSLs where THQ 1.0[3]	Comparison of Laboratory Limits to USEPA RSLs where THQ = 0.1[3]	Comparison of Laboratory Limits to Lowest Water Cleanup Levels[7]
											MRL (µg/L)[6]	MDL (µg/L)[6]			
Semi-Volatile Organic Compounds (Cont)															
Indeno[1,2,3-cd] pyrene	X	193-39-5	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 8270C SIM	NL	0.25	0.25	0.0044	NL	0.0044	0.1	0.0727	MRL below RSL	MRL below RSL	SL Cannot be Met
Isodrin	X	465-73-6		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	1.65	NA	NA	NA
Isophorone	X	78-59-1		USEPA 8270C	NL	78	78	36	NL	36	10	4.33	MRL below RSL	MRL below RSL	MRL below SL
Isosafrole	X	120-58-1		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	2.17	NA	NA	NA
Kepone	X	143-50-0		USEPA 8270C	NL	0.0035	0.0035	NL	NL	0.0035	200	22.8	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Methapyrilene	X	91-80-5		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	5.85	NA	NA	NA
3-Methyl-cholanthrene	X	56-49-5		USEPA 8270C	NL	0.0011	0.0011	NL	NL	0.0011	10	2.37	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Methyl methanesulfonate		66-27-3		USEPA 8270C	NL	0.79	0.79	NL	NL	0.79	10	10	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Methyl parathion	X	298-00-0		USEPA 8270C	NL	4.5	0.45	2	NL	0.45	10	4.98	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
2-Methylphenol (o-Cresol)	X	95-48-7		USEPA 8270C	NL	930	93	NL	NL	93	10	3.78	MRL below RSL	MRL below RSL	MRL below SL
3 & 4-Methylphenol (m & p Cresols)[1]	X	108-39-4, 106-44-5		USEPA 8270C	NL	1850[8]	185[8]	NL	NL	185	10	3.94	MRL below RSL	MRL below RSL	MRL below SL
1-Methylnaphthalene		90-12-0		USEPA 8270C SIM	NL	1.1	1.1	NL	NL	1.1	1	0.0139	MRL below RSL	MRL below RSL	MRL below SL
2-Methylnaphthalene		91-57-6		USEPA 8270C SIM	NL	36	3.6	NL	NL	3.6	1	0.0147	MRL below RSL	MRL below RSL	MRL below SL
N-Nitroso-di-*n*-propylamine	X	621-64-7		USEPA 8270C	NL	0.011	0.011	NL	NL	0.011	50	4.27	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
N-Nitroso-diphenylamine	X	86-30-6		USEPA 8270C	NL	12	12	5	NL	5	10	4.49	MRL below RSL	MRL below RSL	SL between MRL and MDL
1-Naphthalenamine	X	134-32-7		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	2.44	NA	NA	NA
2-Naphthalenamine	X	91-59-8		USEPA 8270C	NL	0.039	0.039	NL	NL	0.039	10	2.02	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Naphthalene	X	91-20-3		USEPA 8270C SIM	NL	0.17	0.17	NL	NL	0.17	1	0.0141	RSL between MRL and MDL	RSL between MRL and MDL	SL between MRL and MDL
1,4-Naphthoquinone	X	130-15-4		USEPA 8270C	NL	NL	NL	NL	NL	NA	20	4.59	NA	NA	NA
2-Nitroaniline		88-74-4		USEPA 8270C	NL	190	19	NL	NL	19	10	5.8	MRL below RSL	MRL below RSL	MRL below SL
3-Nitroaniline		99-09-2		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	5.03	NA	NA	NA
4-Nitroaniline	X	100-01-6		USEPA 8270C	NL	3.8	3.8	NL	NL	3.8	10	4.87	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Nitrobenzene	X	98-95-3		USEPA 8270C	NL	0.14	0.14	NL	NL	0.14	10	4.12	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
2-Nitrophenol	X	88-75-5		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	5.27	NA	NA	NA
4-Nitrophenol	X	100-02-7		USEPA 8270C	NL	NL	NL	NL	NL	NA	50	6.05	NA	NA	NA
5-Nitro-o-toluidine	X	99-55-8		USEPA 8270C	NL	8.2	8.2	NL	NL	8.2	10	7.19	RSL between MRL and MDL	RSL between MRL and MDL	SL between MRL and MDL
N-Nitroso-diethylamine	X	55-18-5		USEPA 8270C	NL	0.00017	0.00017	NL	NL	0.00017	10	1.3	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
N-Nitroso-dimethylamine	X	62-75-9		USEPA 8270C	NL	0.00011	0.00011	0.0007	NL	0.00011	10	2.86	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
N-Nitroso-di-n-butylamine	X	924-16-3		USEPA 8270C	NL	0.0027	0.0027	NL	NL	0.0027	10	2.31	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
N-Nitroso-di-n-propylamine	X	621-64-7		USEPA 8270C	NL	0.011	0.011	1.4	NL	0.011	50	4.27	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
N-Nitroso-methylethylamine		10595-95-6		USEPA 8270C	NL	0.00071	0.00071	NL	NL	0.00071	10	4.49	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
N-Nitrosopiperidine	X	100-75-4		USEPA 8270C	NL	0.0082	0.0082	NL	NL	0.0082	10	1.4	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
N-Nitrosopyrrolidine	X	930-55-2		USEPA 8270C	NL	0.037	0.037	NL	NL	0.037	10	1.24	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Parathion (Ethyl parathion)	X	56-38-2		USEPA 8270C	NL	86	8.6	0.04	NL	0.04	10	5.48	MRL below RSL	RSL between MRL and MDL	SL Cannot be Met
Pentachlorobenzene	X	608-93-5		USEPA 8270C	NL	3.2	0.32	3.5	NL	0.32	10	2.33	RSL between MRL and MDL	RSL Cannot be Met	SL Cannot be Met
Pentachloronitro-benzene	X	82-68-8		USEPA 8270C	NL	0.12	0.12	NL	NL	0.12	10	5.05	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met

TABLE 2-3a-i. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR GROUNDWATER AND LEACHATE SAMPLING
WEST LAKE LANDFILL OU-3, REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes[1]	HAZ[2]	CAS Number	Lab	Method	USEPA Maximum Contaminant Level (µg/L)[3]	Tap Water Regional SL (µg/L)[3] THQ = 1.0	Tap Water Regional SL (µg/L)[3] THQ = 0.1	MDNR Groundwater Protection Standards (µg/L)[4]	MDNR Groundwater Protection Standards (µg/L)[5]	Lowest SL USEPA MCL/MDNR GWPS (µg/L)	Pace Analytical Services, LLC		Comparison of Laboratory Limits to USEPA RSLs where THQ 1.0[3]	Comparison of Laboratory Limits to USEPA RSLs where THQ = 0.1[3]	Comparison of Laboratory Limits to Lowest Water Cleanup Levels[7]
											MRL (µg/L)[6]	MDL (µg/L)[6]			
Semi-Volatile Organic Compounds (Cont)															
Pentachlorophenol	X	87-86-5	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 8270C	1	0.041	0.041	1	NL	0.041	50	4.47	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Phenacetin	X	62-44-2		USEPA 8270C	NL	34	34	NL	NL	34	10	1.79	MRL below RSL	MRL below RSL	MRL below SL
Phenanthrene	X	85-01-8		USEPA 8270C SIM	NL	0.001[10]	0.001[10]	NL	NL	0.001	1	0.0213	MRL below RSL	MRL below RSL	SL Cannot be Met
Phenol	X	108-95-2		USEPA 8270C	NL	5800	580	300	NL	300	10	2.4	MRL below RSL	MRL below RSL	MRL below SL
p-Phenylenediamine	X	106-50-3		USEPA 8270C	NL	20	2	NL	NL	2	20	20	MRL below RSL	RSL Cannot be Met	SL Cannot be Met
Phorate	X	298-02-2		USEPA 8270C	NL	3	0.3	NL	NL	0.3	10	4.66	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Pronamide	X	23950-58-5		USEPA 8270C	NL	1200	120	50.0	NL	50	10	1.51	MRL below RSL	MRL below RSL	MRL below SL
Pyrene	X	129-00-0		USEPA 8270C SIM	NL	120	12	960	NL	12	1	0.0197	MRL below RSL	MRL below RSL	MRL below SL
Safrole	X	94-59-7		USEPA 8270C	NL	0.096	0.096	NL	NL	0.096	10	2.15	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
1,2,4,5-Tetrachlorobenzene	X	95-94-3		USEPA 8270C	NL	1.7	0.17	NL	NL	0.17	10	1.87	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
2,3,4,6-Tetrachlorophenol	X	58-90-2		USEPA 8270C	NL	240	24	NL	NL	24	10	4.79	MRL below RSL	MRL below RSL	MRL below SL
Thionazin	X	297-97-2		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	2.88	NA	NA	NA
O-Toluidine	X	95-53-4		USEPA 8270C	NL	4.7	4.7	NL	NL	4.7	10	1.19	RSL between MRL and MDL	RSL between MRL and MDL	SL between MRL and MDL
O,O,O-Triethylphosphorothioate		126-68-1		USEPA 8270C	NL	NL	NL	NL	NL	NA	10	2.37	NA	NA	NA
2,4,5-Trichlorophenol	X	95-95-4		USEPA 8270C	NL	1200	120	2600	NL	120	10	4.9	MRL below RSL	MRL below RSL	MRL below SL
2,4,6-Trichlorophenol	X	88-06-2		USEPA 8270C	NL	4.1	1.2	2	NL	1.2	10	4.77	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
1,3,5-Trinitrobenzene	X	99-35-4		USEPA 8270C	NL	590	59	NL	NL	59	20	2.37	MRL below RSL	MRL below RSL	MRL below SL
Volatile Organic Compounds															
Acetone	X	67-64-1	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 8260C LL	NL	14000	1400	NL	NL	1400	20	10	MRL below RSL	MRL below RSL	MRL below SL
Acetonitrile	X	75-05-8		USEPA 8260C LL	NL	130	13	NL	NL	13	100	1	MRL below RSL	RSL between MRL and MDL	SL between MRL and MDL
Acrolein	X	107-02-8		USEPA 8260C LL	NL	0.042	0.0042	320	NL	0.0042	20	10	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Acrylonitrile	X	107-13-1		USEPA 8260C LL	NL	0.052	0.052	0.058	NL	0.052	100	50	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Allyl Chloride	X	107-05-1		USEPA 8260C LL	NL	0.73	0.21	NL	NL	0.21	20	10	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Benzene	X	71-43-2		USEPA 8260C LL	5	0.46	0.46	5	NL	0.46	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Bromobenzene		108-86-1		USEPA 8260C LL	NL	62	6.2	NL	NL	6.2	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
Bromodichloromethane	X	75-27-4		USEPA 8260C LL	80	0.13	0.13	0.56	NL	0.13	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Bromoform	X	75-25-2		USEPA 8260C LL	80	3.3	3.3	4.3	NL	3.3	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
Bromomethane (Methyl Bromide)	X	74-83-9		USEPA 8260C LL	NL	7.5	0.75	48	NL	0.75	5	2.5	MRL below RSL	RSL Cannot be Met	SL Cannot be Met
Bromochloromethane		74-97-5		USEPA 8260C LL	NL	83	8.3	90	NL	8.3	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
2-Butanone	X	78-93-3		USEPA 8260C LL	NL	5600	560	NL	NL	560	20	10	MRL below RSL	MRL below RSL	MRL below SL
n-Butylbenzene		104-51-8		USEPA 8260C LL	NL	1000	100	NL	NL	100	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
sec-Butylbenzene		135-98-8		USEPA 8260C LL	NL	2000	200	NL	NL	200	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
tert-Butylbenzene		98-06-6		USEPA 8260C LL	NL	690	69	NL	NL	69	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
Carbon disulfide	X	75-15-0		USEPA 8260C LL	NL	810	81	NL	NL	81	5	2.5	MRL below RSL	MRL below RSL	MRL below SL
Carbon tetrachloride	X	56-23-5		USEPA 8260C LL	5	0.46	0.46	5	NL	0.46	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Chlorobenzene	X	108-90-7		USEPA 8260C LL	100	78	7.8	100	NL	7.8	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
Chloroethane (Ethyl Chloride)	X	75-00-3		USEPA 8260C LL	NL	21000	2100	NL	NL	2100	2	1	MRL below RSL	MRL below RSL	MRL below SL
Chloroform	X	67-66-3		USEPA 8260C LL	80	0.22	0.22	5.7	NL	0.22	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Chloromethane (Methyl Chloride)	X	74-87-3		USEPA 8260C LL	NL	190	19	5	NL	5	2	1	MRL below RSL	MRL below RSL	MRL below SL
Chloroprene	X	126-99-8		USEPA 8260C LL	NL	0.019	0.019	NL	NL	0.019	100	1	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
2-Chlorotoluene		95-49-8		USEPA 8260C LL	NL	240	24	100.0	NL	24	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
4-Chlorotoluene		106-43-4		USEPA 8260C LL	NL	250	25	100.0	NL	25	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
Cyclohexane	X	110-82-7		USEPA 8260C LL	NL	13000	1300	NL	NL	1300	20	10	MRL below RSL	MRL below RSL	MRL below SL
Dibromochloromethane	X	124-48-1		USEPA 8260C LL	80	0.87	0.87	0.41	NL	0.41	1	0.5	RSL between MRL and MDL	RSL between MRL and MDL	SL Cannot be Met

TABLE 2-3a-i. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR GROUNDWATER AND LEACHATE SAMPLING
WEST LAKE LANDFILL OU-3, REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes[1]	HAZ[2]	CAS Number	Lab	Method	USEPA Maximum Contaminant Level (μg/L)[3]	Tap Water Regional SL (μg/L)[3] THQ = 1.0	Tap Water Regional SL (μg/L)[3] THQ = 0.1	MDNR Groundwater Protection Standards (μg/L)[4]	MDNR Groundwater Protection Standards (μg/L)[5]	Lowest SL USEPA MCL/MDNR GWPS (μg/L)	Pace Analytical Services, LLC		Comparison of Laboratory Limits to USEPA RSLs where THQ 1.0[3]	Comparison of Laboratory Limits to USEPA RSLs where THQ = 0.1[3]	Comparison of Laboratory Limits to Lowest Water Cleanup Levels[7]
											MRL (μg/L)[6]	MDL (μg/L)[6]			
Volatile Organic Compounds (Cont)															
1,2-Dibromoethane	X	106-93-4	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 8011	0.1	0.0075	0.0075	0.05	NL	0.0075	0.035	0.005	RSL between MRL and MDL	RSL between MRL and MDL	SL between MRL and MDL
1,2-Dibromo-3-chloropropane	X	96-12-8		USEPA 8011	0.2	0.00033	0.00033	0.2	NL	0.00033	0.035	0.005	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Dibromomethane (Methylene Bromide)	X	74-95-3		USEPA 8260C LL	NL	8.3	0.83	NL	NL	0.83	1	0.5	MRL below RSL	RSL between MRL and MDL	SL between MRL and MDL
trans-1,4-Dichloro-2-butene		110-57-6		USEPA 8260C LL	NL	0.0013	0.0013	NL	NL	0.0013	100	50	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
1,2-Dichlorobenzene	X	95-50-1		USEPA 8260C LL	600	300	30	600	NL	30	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
1,3-Dichlorobenzene	X	541-73-1		USEPA 8260C LL	NL	NL	NL	600	NL	600	1	0.5	NA	NA	MRL below SL
1,4-Dichlorobenzene	X	106-46-7		USEPA 8260C LL	75	0.48	0.48	75	NL	0.48	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Dichloro-difluoromethane	X	75-71-8		USEPA 8260C LL	NL	200	20	NL	NL	20	2	1	MRL below RSL	MRL below RSL	MRL below SL
1,1-Dichloroethane	X	75-34-3		USEPA 8260C LL	NL	2.8	2.8	NL	NL	2.8	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
1,2-Dichloroethane	X	107-06-2		USEPA 8260C LL	5	0.17	0.17	5	NL	0.17	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
1,1-Dichloroethene	X	75-35-4		USEPA 8260C LL	7	280	28	7	NL	7	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
cis-1,2-Dichloro-ethene		156-59-2		USEPA 8260C LL	70	36	3.6	70	NL	3.6	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
trans-1,2-Dichloroethene	X	156-60-5		USEPA 8260C LL	100	360	36	100	NL	36	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
1,2-Dichloropropane	X	78-87-5		USEPA 8260C LL	5	0.85	0.82	0.52	NL	0.52	1	0.5	RSL between MRL and MDL	RSL between MRL and MDL	SL between MRL and MDL
1,3-Dichloropropane	X	142-28-9		USEPA 8260C LL	NL	370	37	NL	NL	37	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
2,2-Dichloropropane		594-20-7		USEPA 8260C LL	NL	NL	NL	NL	NL	NA	1	0.5	NA	NA	NA
1,1-Dichloropropene		563-58-6		USEPA 8260C LL	NL	NL	NL	NL	NL	NA	1	0.5	NA	NA	NA
cis-1,3-Dichloro-propene		10061-01-5		USEPA 8260C LL	NL	NL	NL	NL	NL	NA	1	0.5	NA	NA	NA
trans-1,3-Dichloropropene		10061-02-6		USEPA 8260C LL	NL	NL	NL	NL	NL	NA	1	0.5	NA	NA	NA
1,4-Dioxane	X	123-91-1		USEPA 8260C LL	NL	0.46	0.46	NL	NL	0.46	100	50	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Diethyl ether	X	60-29-7		USEPA 8260C LL	NL	3900	390	NL	NL	390	20	10	MRL below RSL	MRL below RSL	MRL below SL
Ethylbenzene	X	100-41-4		USEPA 8260C LL	700	1.5	1.5	700	NL	1.5	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
Ethyl methacrylate	X	97-63-2		USEPA 8260C LL	NL	630	63	NL	NL	63	20	10	MRL below RSL	MRL below RSL	MRL below SL
Hexachloro-1,3-butadiene	X	87-68-3		USEPA 8260C LL	NL	0.14	0.14	0.45	NL	0.14	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
n-Hexane	X	110-54-3		USEPA 8260C LL	NL	1500	150	NL	NL	150	5	2.5	MRL below RSL	MRL below RSL	MRL below SL
2-Hexanone		591-78-6		USEPA 8260C LL	NL	38	3.8	NL	NL	3.8	20	10	MRL below RSL	RSL Cannot be Met	SL Cannot be Met
Iodomethane	X	74-88-4		USEPA 8260C LL	NL	NL	NL	NL	NL	NA	5	2.5	NA	NA	NA
Isobutyl Alcohol	X	78-83-1		USEPA 8260C LL	NL	5900	590	NL	NL	590	100	50	MRL below RSL	MRL below RSL	MRL below SL
Isopropylbenzene (Cumene)	X	98-82-8		USEPA 8260C LL	NL	450	45	NL	NL	45	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
p-Isopropyltoluene		99-87-6		USEPA 8260C LL	NL	NL	NL	NL	NL	NA	1	0.5	NA	NA	NA
Methyl Acetate		79-20-9		USEPA 8260C LL	NL	20000	2000	NL	NL	2000	20	10	MRL below RSL	MRL below RSL	MRL below SL
Methacrylonitrile	X	126-98-7		USEPA 8260C LL	NL	1.9	0.19	NL	NL	0.19	100	5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Methylcyclohexane		108-87-2		USEPA 8260C LL	NL	NL	NL	NL	NL	NA	20	10	NA	NA	NA
Methylene Chloride	X	75-09-2		USEPA 8260C LL	5	11	11	NL	NL	5	5	0.5	MRL below RSL	MRL below RSL	MRL below SL
Methyl methacrylate	X	80-62-6		USEPA 8260C LL	NL	1400	140	NL	NL	140	20	5	MRL below RSL	MRL below RSL	MRL below SL
4-Methyl-2-pentanone	X	108-10-1		USEPA 8260C LL	NL	6300	630	NL	NL	630	20	10	MRL below RSL	MRL below RSL	MRL below SL
Methyl-tert-butyl-Ether	X	1634-04-4		USEPA 8260C LL	NL	14	14	NL	NL	14	4	2	MRL below RSL	MRL below RSL	MRL below SL
Propionitrile	X	107-12-0		USEPA 8260C LL	NL	NL	NL	NL	NL	NA	100	10	NA	NA	NA
n-Propylbenzene		103-65-1		USEPA 8260C LL	NL	660	66	NL	NL	66	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
Styrene	X	100-42-5		USEPA 8260C LL	100	1200	120	100	NL	100	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
1,1,1,2-Tetrachloro-ethane	X	630-20-6		USEPA 8260C LL	NL	0.57	0.57	70	NL	0.57	1	0.5	RSL between MRL and MDL	RSL between MRL and MDL	SL between MRL and MDL

TABLE 2-3a-i. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR GROUNDWATER AND LEACHATE SAMPLING
WEST LAKE LANDFILL OU-3, REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes[1]	HAZ[2]	CAS Number	Lab	Method	USEPA Maximum Contaminant Level (µg/L)[3]	Tap Water Regional SL (µg/L)[3] THQ = 1.0	Tap Water Regional SL (µg/L)[3] THQ = 0.1	MDNR Groundwater Protection Standards (µg/L)[4]	MDNR Groundwater Protection Standards (µg/L)[5]	Lowest SL USEPA MCL/MDNR GWPS (µg/L)	Pace Analytical Services, LLC MRL (µg/L)[6]	Pace Analytical Services, LLC MDL (µg/L)[6]	Comparison of Laboratory Limits to USEPA RSLs where THQ 1.0[3]	Comparison of Laboratory Limits to USEPA RSLs where THQ = 0.1[3]	Comparison of Laboratory Limits to Lowest Water Cleanup Levels[7]
Volatile Organic Compounds (Cont)															
1,1,2,2-Tetrachloroethane	X	79-34-5		USEPA 8260C LL	NL	0.076	0.076	0.17	NL	0.076	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Tetrachloroethene	X	127-18-4		USEPA 8260C LL	5	11	4.1	0.8	NL	0.8	1	0.5	MRL below RSL	MRL below RSL	SL between MRL and MDL
Toluene	X	108-88-3		USEPA 8260C LL	1000	1100	110	1000	NL	110	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
1,2,3-Trichlorobenzene		87-61-6		USEPA 8260C LL	NL	7	0.7	NL	NL	0.7	1	0.5	MRL below RSL	RSL between MRL and MDL	SL between MRL and MDL
1,2,4-Trichlorobenzene	X	120-82-1		USEPA 8260C LL	70	1.2	0.4	70	NL	0.4	1	0.5	MRL below RSL	RSL Cannot be Met	SL Cannot be Met
1,1,1-Trichloroethane	X	71-55-6		USEPA 8260C LL	200	8000	800	200	NL	200	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
1,1,2-Trichloroethane	X	79-00-5		USEPA 8260C LL	5	0.28	0.041	5	NL	0.041	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
1,1,2-Trichlorotrifluoroethane		76-13-1	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 8260C LL	NL	10000	1000	NL	NL	1000	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
Trichloroethene	X	79-01-6		USEPA 8260C LL	5	0.49	0.28	5	NL	0.28	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Trichlorofluoromethane	X	75-69-4		USEPA 8260C LL	NL	5200	520	2000	NL	520	2	1	MRL below RSL	MRL below RSL	MRL below SL
1,2,3-Trichloropropane		96-18-4		USEPA 8260C LL	NL	0.00075	0.00075	40	NL	0.00075	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
1,2,4-Trimethylbenzene		95-63-6		USEPA 8260C LL	NL	56	5.6	NL	NL	5.6	5	2.5	MRL below RSL	MRL below RSL	MRL below SL
1,3,5-Trimethylbenzene		108-67-8		USEPA 8260C LL	NL	60	6	NL	NL	6	5	2.5	MRL below RSL	MRL below RSL	MRL below SL
Vinyl Acetate	X	108-05-4		USEPA 8260C LL	NL	410	41	NL	NL	41	20	10	MRL below RSL	MRL below RSL	MRL below SL
Vinyl Chloride	X	75-01-4		USEPA 8260C LL	2	0.019	0.019	2	NL	0.019	1	0.5	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
m,p-Xylenes	X	MPXylene		USEPA 8260C LL	NL	190	19	NL	NL	19	2	1	MRL below RSL	MRL below RSL	MRL below SL
o-Xylenes	X	95-47-6		USEPA 8260C LL	NL	190	19	NL	NL	19	1	0.5	MRL below RSL	MRL below RSL	MRL below SL
Xylenes, Total	X	1330-20-7		USEPA 8260C LL	10000	190	19	10000	NL	19	3	1.5	MRL below RSL	MRL below RSL	MRL below SL
Polychlorinated Biphenyls															
Aroclor 1016	X	12674-11-2	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 8082A	0.5	0.22	0.14	NL	NL	0.14	0.1	0.072	MRL below RSL	MRL below RSL	MRL below SL
Aroclor 1221	X	11104-28-2		USEPA 8082A	0.5	0.0047	0.0047	NL	NL	0.0047	0.1	0.087	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Aroclor 1232	X	11141-16-5		USEPA 8082A	0.5	0.0047	0.0047	NL	NL	0.0047	0.1	0.077	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Aroclor 1242	X	53469-21-9		USEPA 8082A	0.5	0.0078	0.0078	NL	NL	0.0078	0.1	0.077	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Aroclor 1248	X	12672-29-6		USEPA 8082A	0.5	0.0078	0.0078	NL	NL	0.0078	0.1	0.064	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Aroclor 1254	X	11097-69-1		USEPA 8082A	0.5	0.0078	0.0078	NL	NL	0.0078	0.1	0.081	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Aroclor 1260	X	11096-82-5		USEPA 8082A	0.5	0.0078	0.0078	NL	NL	0.0078	0.1	0.071	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Total PCBs	X	12767-79-2		USEPA 8082A	0.5	NL	NL	NL	NL	0.5	0.1	0.1	NA	NA	MRL below SL
Herbicides															
2,4-D		94-75-7		USEPA 8151A	70	170	17	70	NL	17	1.0	0.468	MRL below RSL	MRL below RSL	MRL below SL
Dinoseb	X	88-85-7		USEPA 8151A	7	15	1.5	7	NL	1.5	1.0	0.641	MRL below RSL	MRL below RSL	MRL below SL
2,4,5-T	X	93-76-5		USEPA 8151A	NL	160	16	70	NL	16	1.0	0.512	MRL below RSL	MRL below RSL	MRL below SL
2,4,5-TP (Silvex)	X	93-72-1		USEPA 8151A	50	110	11	50	NL	11	1.0	0.516	MRL below RSL	MRL below RSL	MRL below SL

TABLE 2-3a-i. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR GROUNDWATER AND LEACHATE SAMPLING
WEST LAKE LANDFILL OU-3, REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes[1]	HAZ[2]	CAS Number	Lab	Method	USEPA Maximum Contaminant Level (µg/L)[3]	Tap Water Regional SL (µg/L)[3] THQ = 1.0	Tap Water Regional SL (µg/L)[3] THQ = 0.1	MDNR Groundwater Protection Standards (µg/L)[4]	MDNR Groundwater Protection Standards (µg/L)[5]	Lowest SL USEPA MCL/MDNR GWPS (µg/L)	Pace Analytical Services, LLC		Comparison of Laboratory Limits to USEPA RSLs where THQ 1.0[3]	Comparison of Laboratory Limits to USEPA RSLs where THQ = 0.1[3]	Comparison of Laboratory Limits to Lowest Water Cleanup Levels[7]
											MRL (µg/L)[6]	MDL (µg/L)[6]			
Hydrocarbons (Laboratory Analyzed)															
C6 Aliphatics		NA	Pace Analytical National Center for Testing and Innovation Mt. Juliet, Tennessee	TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	1000	500	NA	NA	NA
C6-C8 Aliphatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	1000	500	NA	NA	NA
C8-C10 Aliphatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	1000	500	NA	NA	NA
C10-C12 Aliphatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	1000	500	NA	NA	NA
C12-C16 Aliphatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	1000	500	NA	NA	NA
C16-C21 Aliphatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	1000	500	NA	NA	NA
C21-C35 Aliphatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	2000	1000	NA	NA	NA
C7-C8 Aromatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	1000	500	NA	NA	NA
C8-C10 Aromatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	1000	500	NA	NA	NA
C10-C12 Aromatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	1000	500	NA	NA	NA
C12-C16 Aromatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	1000	500	NA	NA	NA
C16-C21 Aromatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	1000	500	NA	NA	NA
C21-C35 Aromatics		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	2000	1000	NA	NA	NA
TPH C6-C35		NA		TX 1006	NL[12]	NL[12]	NL[12]	NL	NL	NA	2000	1000	NA	NA	NA
TPH C6-C12		NA		TX 1005	NL[12]	NL[12]	NL[12]	NL	NL	NA	900	600	NA	NA	NA
TPH C12-C28		NA		TX 1005	NL[12]	NL[12]	NL[12]	NL	NL	NA	900	600	NA	NA	NA
TPH C28-C35		NA		TX 1005	NL[12]	NL[12]	NL[12]	NL	NL	NA	900	600	NA	NA	NA
TPH C6-C35		NA		TX 1005	NL[12]	NL[12]	NL[12]	NL	NL	NA	900	600	NA	NA	NA
Hydrocarbons (Limits)															
TPH - Aliphatic High (C19-C32)		E1790670	NA	--	NL	60000	6000	NL	NL	6000	NA[12]	NA[12]	NA[12]	NA[12]	NA[12]
TPH - Aliphatic Low (C5-C8)		E1790666		--	NL	1300	130	NL	NL	130	NA[12]	NA[12]	NA[12]	NA[12]	NA[12]
TPH - Aliphatic Medium (C9-C18)		E1790668		--	NL	100	10	NL	NL	10	NA[12]	NA[12]	NA[12]	NA[12]	NA[12]
TPH - Aromatic High (C17-C32)		E1790676		--	NL	800	80	NL	NL	80	NA[12]	NA[12]	NA[12]	NA[12]	NA[12]
TPH - Aromatic Low (C6-C8)		E1790672		--	NL	33	3.3	NL	NL	3.3	NA[12]	NA[12]	NA[12]	NA[12]	NA[12]
TPH - Aromatic Medium (C9-C16)		E1790674		--	NL	5.5	0.55	NL	NL	0.55	NA[12]	NA[12]	NA[12]	NA[12]	NA[12]
Dissolved Gasses															
Methane		74-82-8	Pace Analytical Energy Services, LLC Pittsburgh, Pennsylvania	AM20GAX	NL	NL	NL	NL	NL	NA	0.5	0.094	NA	NA	NA
Carbon Dioxide		124-38-9		AM20GAX	NL	NL	NL	NL	NL	NA	5000	472	NA	NA	NA
Geochemistry/General Chemistry															
Alkalinity		NA	Pace Analytical Services, LLC Indianapolis, Indiana	SM 2320B	NL	NL	NL	NL	NL	NA	2000	1000	NA	NA	NA
Bromide		24959-67-9		USEPA 9056A	NL	NL	NL	NL	NL	NA	50	14.39	NA	NA	NA
Carbonate (HCO3-)		3812-32-6		SM 2320B	NL	NL	NL	NL	NL	NA	2000	1000	NA	NA	NA
Cations + Anions[11]		Calculation		Calculation	NL	NL	NL	NL	NL	NA	NA	NA	NA	NA	NA
Chemical Oxygen Demand		NA		USEPA 410.4	NL	NL	NL	NL	NL	NA	10000	3740	NA	NA	NA
Chloride		16887-00-6		USEPA 9056A	NL	NL	NL	NL	250	250	250	91.1	NA	NA	MRL below SL
Cyanide		57-12-5		USEPA 9012A	200	1.5	0.15	NL	0.2	0.15	10	5.8	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Dissolved Organic Carbon		7440-44-0		SM 5310C	NL	NL	NL	NL	NL	NA	1000	146	NA	NA	NA
Fluoride		16984-48-8		USEPA 9056A	4000	800	80	4	2	2	100	12	MRL below RSL	RSL between MRL and MDL	SL Cannot be Met
Nitrogen as Ammonia		NA		SM 4500-NH_3 G USEPA 350.1	NL	NL	NL	NL	NL	NA	100	26.6	NA	NA	NA

TABLE 2-3a-i. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR GROUNDWATER AND LEACHATE SAMPLING
WEST LAKE LANDFILL OU-3, REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes[1]	**HAZ[2]**	**CAS Number**	**Lab**	**Method**	**USEPA Maximum Contaminant Level (µg/L)[3]**	**Tap Water Regional SL (µg/L)[3] THQ = 1.0**	**Tap Water Regional SL (µg/L)[3] THQ = 0.1**	**MDNR Groundwater Protection Standards (µg/L)[4]**	**MDNR Groundwater Protection Standards (µg/L)[5]**	**Lowest SL USEPA MCL/MDNR GWPS (µg/L)**	**Pace Analytical Services, LLC**		**Comparison of Laboratory Limits to USEPA RSLs where THQ 1.0[3]**	**Comparison of Laboratory Limits to USEPA RSLs where THQ = 0.1[3]**	**Comparison of Laboratory Limits to Lowest Water Cleanup Levels[7]**
											MRL (µg/L)[6]	**MDL (µg/L)[6]**			
Geochemistry/General Chemistry (Cont)															
Nitrate as Nitrogen		NA	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 9056A	10000	NL	NL	10000	10000	10000	50	20	NA	NA	MRL below SL
Nitrite + Nitrate as Nitrogen		NA		USEPA 353.2	10000	NL	NL	NL	10000	10000	100	20	NA	NA	MRL below SL
Nitrite as Nitrogen		NA		USEPA 9056A	1000	NL	NL	NL	1000	1000	50	5	NA	NA	MRL below SL
Iodide		7553-56-2		USEPA 9056A	NL	200	20	NL	NL	20	500	94	RSL between MRL and MDL	RSL Cannot be Met	SL Cannot be Met
pH		NA		SM4500H+B	NL	NL	NL	NL	NL	NA	NA	NA	NA	NA	NA
Phosphorus	X	7723-14-0		USEPA 365.1	NL	0.399[8]	0.0399[8]	NL	NL	0.0399	50	21	RSL Cannot be Met	RSL Cannot be Met	SL Cannot be Met
Sulfate		14808-79-8		USEPA 9056A	NL	NL	NL	NL	250	NA	250	173	NA	NA	NA
Sulfide		18496-25-8		SM 4500-S^{2}-D	NL	NL	NL	NL	NL	NA	1000	17	NA	NA	NA
Total Dissolved Solids		NA		SM 2540C	NL	NL	NL	NL	500000	500000	10000	10000	NA	NA	MRL below SL
Total Hardness		NA		USEPA 6010 /2340B Calc	NL	NL	NL	NL	NL	NA	NA	NA	NA	NA	NA
Total Organic Carbon		7440-44-0		SM 5310C	NL	NL	NL	NL	NL	NA	1000	146	NA	NA	NA
Total Suspended Solids (0.45 micron filter)		7732-18-5, 9004-34-6		SM 2540D	NL	NL	NL	NL	NL	NA	5000	5000	NA	NA	NA

Notes:

1: Screening levels for 4-methylphenol were used because it was more conservative than those of 3-methylphenol

2: Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Hazardous Substances found at 40 Code of Federal Regulations (CFR) 302.4

3: USEPA. Regional Screening Levels (RSLs) - Generic Tables ((TR=1E-06 THQ=0.1) and (TR=1E-06 THQ 1.0). November 2019; both used for screening purposes.

4: MDNR Groundwater Protection Standards (GWPS)- Table A1. Criteria for Designated Uses and Health Advisory Levels. Division 20, Chapter 7. January 2019.

5: MDNR Groundwater Protection Standards (GWPS) - Division 60, Chapter 4 Section 60-4.030 and 60-4.070. January 2019.

6: Note, that the MDL and MRLs are evaluated annually (in accordance with certification requirements) and are subject to modification based on the laboratory capability studies.

7: Where MRL or MDLs do not meet the screening levels, the lowest limit will be used

8: USEPA. RSLs - RSL Calculator

9: USEPA. Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Sodium. February 2003.

10: USEPA. Development of Relative Potency Factor Approach for PAH Mixtures. February 2010.

11: Cations and Anions will be calculated using the cations and anions from this table (cations: aluminum, barium, calcium, magnesium, lithium, potassium, silver, sodium, strontium, and zinc; anions: flouride, chloride, bromide, sulfate, carbonate, cyanide, and alkalinity)

12: TPH is listed in the RSLs as aliphatic or aromatic: high, low, and medium. The exact hydrocarbon ranges are derived from the Provisional Peer-Reviewed Toxicity Values (PPRTVs) for the six fractions listed and included in the supplemental RSL guidance. No USEPA promulgated method recommends these hydrocarbon ranges. Therefore, the ranges that will be provided by the laboratory and the ranges listed in the RSLs are provided in the hydrocarbon section of this table. TX 1005 will be analyzed as recommend by TX 1006 Method (See Appendix D) to better characterize risk. The limits for the carbon ranges in TX 1006 and TX 1005 do not directly apply to the RSL ranges. As such, the screening limits may be higher in some cases once the mapping is completed. MDNR screening levels will be a better measurement quality objective for TPH at this time prior to developing exposure point concentrations. The Baseline Risk Assessment Work Plan will establish the use of these carbon ranges for risk evaluation, if determined to be a constituent of concern. Hydrocarbon Level IV reports will be available if additional information is needed on hydrocarbon during evaluation of data.

The hydrocarbon mapping is as follows:

	RSL Hydrocarbon Ranges	TX 1006 Hydrocarbon Ranges
Aliphatic Low	C5-C8	C6-C8
Aliphatic Medium	C9-C18	C8-C10, C10-C12,
Aliphatic High	C19-C32	C12-C16, C16-C21, C16-C21, C21-C35
Aromatic Low	C6-C8	C7-C8, C8-C10
Aromatic Medium	C9-C18	C8-C10, C10-C12, C12-C16, C16-C21
Aromatic High	C17-C32	C16-C21, C21-C35

Abbreviations:

GWPS: Groundwater Protection Standards
HAZ: Hazardous Substance
LL: Low Level
MDL: Method Detection Limit
µg/L: micrograms per Liter
MDNR: Missouri Department of Natural Resources
MRL: Method Reporting Limit
NA: Not Applicable
NL: Not listed in referenced document
RL: Reporting Limit
RSL: Regional Screening Level
SIM: Selective Ion Monitoring
SL: Screening Level
SM: Standard Methods for the Examination of Water and Wastewater
TPH: Total Petroleum Hydrocarbons
TX: Texas Natyral Resource Conservation Commission
USEPA: United States Environmental Protection Agency

TABLE 2-3a-ii. LIST OF RADIOLOGICAL CHEMICAL CONSTITUENTS AND DESIRED REPORTING LIMITS FOR GROUNDWATER AND LEACHATE SAMPLING
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes	Laboratory	Method	USEPA Maximum Contamination Level (pCi/L)[1]	USEPA PRG (pCi/L)[2]	Pace Analytical Services, LLC									
					LOQ[3] (pCi/L)	LOD/MDC/RDL[3] (pCi/L)	Critical Level (pCi/L)	Action Level (UBGR)[4] (pCi/L)	LBGR (13% - 1Σ Uncertainty)[4] (pCi/L)	Gray Region[4] (pCi/L)	Required Method Uncertainty[5] (pCi/L) (u_{MR})	Relative Standard Deviation[5] (φ_{MR})	Control Efficiency Limits	Energy and Background Limits
Total Isotopic Thorium - 228	Pace Analytical Services, LLC Pittsburgh, Pennsylvania	HASL-300 Method U-02	NL	0.00107	Not Applicable	1	Critical Level will be calculated for each sample and analyte at the time of analysis. The laboratory anticipates it to be approximately 25% of the MDC[6].	1	0.87	0.87 to 1	0.013	0.013	Control efficiency limits will be set by the lab with a tolerance of 3%, with one-sigma equal to 1%[6].	Energy and background limits will be set with a limit of 3 standard deviations of a mean established at the time of instrument setup or on an ongoing basis[6].
Dissolved Isotopic Thorium - 228		HASL-300 Method U-02	NL	0.00107	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Total Isotopic Thorium - 230		HASL-300 Method U-02	NL	0.000396	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Dissolved Isotopic Thorium - 230		HASL-300 Method U-02	NL	0.000396	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Total Isotopic Thorium - 232		HASL-300 Method U-02	NL	0.000959	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Dissolved Isotopic Thorium - 232		HASL-300 Method U-02	NL	0.000959	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Total Isotopic Uranium - 234		HASL-300 Method U-02	NL	0.000395	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Dissolved Isotopic Uranium - 234		HASL-300 Method U-02	NL	0.000395	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Total Isotopic Uranium - 235		HASL-300 Method U-02	NL	0.0162	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Dissolved Isotopic Uranium - 235		HASL-300 Method U-02	NL	0.0162	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Total Isotopic Uranium - 238		HASL-300 Method U-02	NL	0.000394	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Dissolved Isotopic Uranium - 238		HASL-300 Method U-02	NL	0.000394	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Total Isotopic Radium- 226		USEPA 903.1	5	0.000397	Not Applicable	1		5	4.35	4.35 to 5	0.065	0.013		
Dissolved Isotopic Radium- 226		USEPA 903.1	NL	0.000397	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Total Isotopic Radium- 228		USEPA 904.0	5	NL	Not Applicable	1		5	4.35	4.35 to 5	0.065	0.013		
Dissolved Isotopic Radium- 228		USEPA 904.0	NL	NL	Not Applicable	1		1	0.87	0.87 to 1	0.013	0.013		
Tritium		USEPA 906.0	NL	NL	400	1		Not a COPC (leachate indicator)						

Notes:

1: USEPA. Regional Screening Levels (RSLs) - Generic Tables, November 2019.

2: USEPA. Preliminary Remediation Goals for Radionuclide Contaminants at Superfund Sites, November 2019.

3: The LOQ/LOD/MDC/RDL are evaluated annually (in accordance with certification requirements) and are subject to modification based on the laboratory capability studies.

4: Action Level and Gray Region will be subject to revision after some data are collected.

5: Required Method Uncertainty and Relative Standard Deviation are based on a LBGR of 0 but will be updated after some data is collected.

6: Subject to multiple factors, as described in the SOP (Appendix D).

Abbreviations:

COPC: Constituents of Potential Concern
HASL: Health and Safety Laboratory
LBGR: Lower Boundary of the Gray Region
LOD: Limit of Detection
LOQ: Limit of Quantitation
MDC: Minimum Detectable Concentration
NL: Not listed in referenced document
pCi/L: picocuries per liter
PRG: Preliminary Remediation Goal
u_{MR}: Required Method Uncertainty
φ_{MR}: Relative Standard Deviation
RDL: Required Detection Limit
RL: Reporting Limit
RSL: Regional Screening Level
SOP: Standard Operating Procedure
UBGR: Upper Boundary of the Gray Region
USEPA: United States Environmental Protection Agency

TABLE 2-3b. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR ALLUVIUM AND BEDROCK SAMPLING
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes	CAS Number	Laboratory	Method	MRL[7] (mg/kg - unless otherwise noted)	MDL[7,8] (mg/kg - unless otherwise noted)
Total Metals					
Aluminum	7429-90-5	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 6010B	50	3.68
Antimony	7440-36-0		USEPA 6010B	1	0.24
Arsenic	7440-38-2		USEPA 6010B	1	0.2
Barium	7440-39-3		USEPA 6010B	1	0.06
Beryllium	7440-41-7		USEPA 6010B	0.5	0.02
Boron	7440-42-8		USEPA 6010B	5	0.48
Cadmium	7440-43-9		USEPA 6010B	0.5	0.02
Calcium	7440-70-2		USEPA 6010B	50	9.84
Chromium	7440-47-3		USEPA 6010B	1	0.29
Cobalt	7440-48-4		USEPA 6010B	1	0.03
Copper	7440-50-8		USEPA 6010B	1	0.12
Iron	7439-89-6		USEPA 6010B	50	4.92
Lead	7439-92-1		USEPA 6010B	1	0.15
Lithium	7439-93-2		USEPA 6010B	5	1
Magnesium	7439-95-4		USEPA 6010B	50	2.83
Manganese	7439-96-5		USEPA 6010B	1	0.12
Molybdenum	7439-98-7		USEPA 6010B	1	0.05
Total Mercury	7439-97-6		USEPA 7471A	0.2	0.1
Nickel	7440-02-0		USEPA 6010B	1	0.11
Potassium	7440-09-7		USEPA 6010B	50	5.81
Selenium	7782-49-2		USEPA 6010B	1	0.37
Silver	7440-22-4		USEPA 6010B	0.5	0.28
Sodium	7440-23-5		USEPA 6010B	50	8.19
Strontium	7440-24-6		USEPA 6010B	1	0.07
Thallium	7440-28-0		USEPA 6010B	1	0.24
Thorium	7440-29-1		USEPA 6020	0.1	0.05
Tin	7440-31-5		USEPA 6010B	5	2.02
Titanium	7440-32-6		USEPA 6010B	1	0.09
Uranium	7440-61-1		USEPA 6020	0.1	0.05
Vanadium	7440-62-2		USEPA 6010B	1	0.11
Zinc	7440-66-6		USEPA 6010B	1	0.35
Ferric Iron	20074-52-6		SM 3500-Fe D, Modified Calculation[9]	5	1.5
Ferrous Iron	15438-31-0		HACH 8146, Modified	5	1.5
Radiological Chemistry[1]					
Total Isotopic Thorium - 228	Not Applicable	Pace Analytical Services, LLC Pittsburgh, Pennsylvania	HASL-300 Method U-02	Not Applicable	0.001 pCi/g
Total Isotopic Thorium - 230	Not Applicable		HASL-300 Method U-02	Not Applicable	0.001 pCi/g
Total Isotopic Thorium - 232	Not Applicable		HASL-300 Method U-02	Not Applicable	0.001 pCi/g
Total Isotopic Uranium - 234	Not Applicable		HASL-300 Method U-02	Not Applicable	0.001 pCi/g
Total Isotopic Uranium - 235	Not Applicable		HASL-300 Method U-02	Not Applicable	0.001 pCi/g
Total Isotopic Uranium - 238	Not Applicable		HASL-300 Method U-02	Not Applicable	0.001 pCi/g
Total Isotopic Radium - 226	Not Applicable		USEPA 901.1M	Not Applicable	0.001 pCi/g
Total Isotopic Radium - 228	Not Applicable		USEPA 901.1M	Not Applicable	0.001 pCi/g
X-Ray Diffraction[2]					
Abundance of Major Minerals	Not Applicable	EMSL	X-Ray Diffraction/Whole Pattern Fitting EMSL SOP MS- 01-1 Powder XRD	Not Applicable	Not Applicable

TABLE 2-3b. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR ALLUVIUM AND BEDROCK SAMPLING
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes	CAS Number	Laboratory	Method	MRL[7] (mg/kg - unless otherwise noted)	MDL[7,8] (mg/kg - unless otherwise noted)
Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometry (SEM-EDS)[3]					
Elemental Association	Not Applicable	EMSL	Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometry (SEM/EDS)	Not Applicable	Not Applicable
Geochemistry					
Cation Exchange Capacity	Not Applicable	Pace Analytical Services, LLC Lenexa, Kansas	USEPA 9081	0.1 meq/100 g	0.050
Total Organic Carbon	7440-44-0	Pace Analytical National Center for Testing and Innovation Mt. Juliet, Tennessee	Walkley-Black Procedure	644.2 mg/kg (LOQ)	193.27 mg/kg (LOD)
pH	Not Applicable	Pace Analytical Services, LLC Indianapolis, Indiana	USEPA 9045D	Not Applicable	Not Applicable
Iodide	7553-56-2		USEPA 9056A	5	5
Bromide	24959-67-9		USEPA 9056A	0.5	0.5
Fluoride	7782-41-4		USEPA 9056A	1	1
Chloride	16887-00-6		USEPA 9056A	2.5	2.5
Sulfate	14808-79-8		USEPA 9056A	2.5	2.5
Total Alkalinity	Not Applicable		SM 2320B	100	50
Carbonate (HCO3-)	3812-32-6		SM 2320B	100	50
Cation + Anion	Not Applicable		Calculation[6]		
Radchem and Sequential Extraction (Soils Only)					
Dissolved Radium	Not Applicable	MCLInc	USEPA 901.1M	Not Applicable[4]	Not Applicable[4]
Total Uranium	Not Applicable		HASL-300 Method U-02	Not Applicable[4]	Not Applicable[4]
Total Thorium	Not Applicable		HASL-300 Method U-02	Not Applicable[4]	Not Applicable[4]
pH	Not Applicable		USEPA 9045D	Not Applicable[4]	Not Applicable[4]
Total Barium	7440-39-3		USEPA 6010B	Not Applicable[4]	Not Applicable[4]
Total Calcium	7440-70-2		USEPA 6010B	Not Applicable[4]	Not Applicable[4]
Total Iron	7439-89-6		USEPA 6010B	Not Applicable[4]	Not Applicable[4]
Total Manganese	7439-96-5		USEPA 6010B	Not Applicable[4]	Not Applicable[4]
Total Sulfur	7704-34-9		USEPA 6020	Not Applicable[4]	Not Applicable[4]

TABLE 2-3b. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR ALLUVIUM AND BEDROCK SAMPLING
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes	CAS Number	Laboratory	Method	MRL[7] (mg/kg - unless otherwise noted)	MDL[7,8] (mg/kg - unless otherwise noted)
Soil Characteristics (Soils Only)					
Grain Size Distribution by Sieve Analyses (3" Maximum)	Not Applicable	Advanced Terra Testing	ASTM D6913	Not Applicable	Not Applicable
Grain Size Distribution by Hydrometer Analyses	Not Applicable		ASTM D6319 and D7928	Not Applicable	Not Applicable
Atterberg Limits (Method A)	Not Applicable		ASTM D4318	Not Applicable	Not Applicable
Specific Gravity	Not Applicable		ASTM D854	Not Applicable	Not Applicable
Porosity[5]	Not Applicable		ASTM D7263	Not Applicable	Not Applicable
Moisture Content and Density[5]	Not Applicable		ASTM D7263	Not Applicable	Not Applicable

Notes:

1: The radiological data will be determined by analysis of a filtered aqueous sample. The results will be pCi/L and converted to pCi/g by dividing by 1000.
2: X-Ray Diffraction (XRD) quantifies the abundance of major minerals. Procedures for this analysis are provided in standard operating procedure (SOP) MCL-7708 (Appendix D).
3: Scanning Electron Microscope with Energy Dispersive X-ray Spectrometry (SEM-EDS), provides a semi-quantitative method for elemental association. Procedures for this analysis are provided in SOP MCL-7712 (Appendix D).
4: Sequential Extraction results in a variety of limits due to the nature of the methodology. Procedures for sequential extraction are discussed in the QAPP text and Appendix D.
5: Density and porosity cannot be run on a bulk sample, and can only be completed if there is enough intact sample to complete the analysis.
6: Cations and Anions will be calculated using the cations and anions from this table (cations: aluminum, barium, calcium, magnesium, lithium, potassium, silver, sodium, strontium, and zinc; anions: fluoride, chloride, bromide, sulfate, carbonate, and alkalinity).
7: The LOQ/LOD/MDC/RDL are evaluated annually (in accordance with certification requirements) and are subject to modification based on the laboratory capability studies.
8: Includes the Limit of Detection (LOD) for radiochemical analyses. Note that radiochemical MQOs are shown on Table 2-3a-ii. Soil analyses for radiochemistry will be from a leachate and will be verify similar to the water analyses but the units will be converted to soil units by the lab at the end of the analyses.
9: Weigh 1g of sample, add 5mL of 0.5M HCl, swirl for 30 seconds and allow to stand for 1 hour, filter the extract, bring it to 25mL

Abbreviations:

ASTM: American Society of Testing and Material
EMSL: EMSL Analytical, Inc.
g: gram
HCl: Hydrochloric acid
LOD: Limit of Detection
LOQ: Limit of Quantitation
MCLInc & MCL: Materials and Chemistry Laboratory, Inc.
meq: milliequivalents
MRL: Method Reporting Limit
MDL: Method Detection Limit
MDNR: Missouri Department of Natural Resources
mg/kg: milligrams per kilogram
mL: milliLiter
NL: Not listed in referenced document
RSL: Regional Screening Level
mg/kg: milligrams per kilogram
USEPA: United States Environmental Protection Agency

TABLE 2-3c. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR VAPOR ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes[1]	CAS Number	Industrial RSL (µg/m^3)[2] HQ = 1.0	Indoor Air Removal Management Level (µg/m^3 unless otherwise noted)[3]	Vapor Intrusion Screening Level for Subslab Samples (µg/m^3 unless otherwise noted)[4]	Industrial RSL (µg/m^3)[2] HQ = 0.1	Exterior Soil Gas Screening Level (µg/m^3 unless otherwise noted)[5]	ALS		Comparison of Laboratory Limits to Indoor Air Management Level	Comparison of Laboratory Limits to Exterior Soil Gas Screening Level
							Method Reporting Limit (µg/m^3 unless otherwise noted)[6,7]	Method Detection Limit (µg/m^3 unless otherwise noted)[6,7]		
1,1,1-Trichloroethane	71-55-6	22000	22000	733333	2200	73333	0.54	0.066	IA RML above MDL	ISL above MDL
1,1,2,2-Tetrachloroethane	79-34-5	0.21	21	700	0.21	70.0	0.53	0.074	IA RML above MDL	ISL above MDL
1,1,2-Trichloroethane	79-00-5	0.77	77	2567	0.088	2.9	0.54	0.054	IA RML above MDL	ISL above MDL
1,1-Dichloroethane	75-34-3	7.7	770	25667	7.7	2567	0.52	0.078	IA RML above MDL	ISL above MDL
1,1-Dichloroethene	75-35-4	880	880	29333	88	2933	0.54	0.074	IA RML above MDL	ISL above MDL
1,2,4-Trichlorobenzene	120-82-1	8.8	8.8	293	0.88	29.3	0.53	0.13	IA RML above MDL	ISL above MDL
1,2,4-Trimethylbenzene	95-63-6	260	260	8667	26	867	0.53	0.074	IA RML above MDL	ISL above MDL
1,2-Dibromo-3-chloropropane	96-12-8	0.002	0.2	6.7	0.002	0.67	0.52	0.1	IA RML above MDL	ISL above MDL
1,2-Dibromoethane	106-93-4	0.02	2	66.7	0.02	6.7	0.54	0.062	IA RML above MDL	ISL above MDL
1,2-Dichloro-1,1,2,2-tetrafluoroethane (CFC 114)	76-14-2	NL	NL	NL	NL	NL	0.51	0.084	Not Applicable	Not Applicable
1,2-Dichlorobenzene	95-50-1	880	880	29333	88	2933	0.54	0.079	IA RML above MDL	ISL above MDL
1,2-Dichloroethane	107-06-2	0.47	47	1567	0.47	157	0.53	0.059	IA RML above MDL	ISL above MDL
1,2-Dichloropropane	78-87-5	3.3	330	11000	1.8	60.0	0.54	0.066	IA RML above MDL	ISL above MDL
1,3,5-Trimethylbenzene	108-67-8	260	260	8667	26	867	0.53	0.077	IA RML above MDL	ISL above MDL
1,3-Butadiene	106-99-0	0.41	41	1367	0.41	137	0.52	0.088	IA RML above MDL	ISL above MDL
1,3-Dichlorobenzene	541-73-1	NL	NL	NL	NL	NL	0.54	0.08	Not Applicable	Not Applicable
1,4-Dichlorobenzene	106-46-7	1.1	110	3667	1.1	367	0.54	0.082	IA RML above MDL	ISL above MDL
1,4-Dioxane	123-91-1	2.5	250	8333.3	2.5	833	0.53	0.063	IA RML above MDL	ISL above MDL
2-Propanol (Isopropyl Alcohol)	67-63-0	880	880	29333	88	2933	2.1	0.22	IA RML above MDL	ISL above MDL
3-Chloro-1-propene (Allyl Chloride)	107-05-1	2	200	6667	0.44	14.7	0.53	0.072	IA RML above MDL	ISL above MDL
4-Ethyltoluene	622-96-8	NL	NL	NL	NL	NL	0.53	0.085	Not Applicable	Not Applicable
4-Methyl-2-pentanone (MIBK)	108-10-1	13000	13000	433333	1300	43333	0.53	0.073	IA RML above MDL	ISL above MDL
Acetone	67-64-1	140000	140000	4666667	14000	466667	5.4	1.2	IA RML above MDL	ISL above MDL
Acetonitrile	75-05-8	260	260	8667	26	867	0.52	0.13	IA RML above MDL	ISL above MDL
Acrolein	107-02-8	0.088	0.088	2.9	0.0088	0.29	1	0.15	IA RML Cannot be Met	ISL above MDL
Acrylonitrile	107-13-1	0.18	18	600	0.18	60.0	0.52	0.11	IA RML above MDL	ISL above MDL
alpha-Pinene	80-56-8	NL	NL	NL	NL	NL	0.52	0.082	Not Applicable	Not Applicable
Benzene	71-43-2	1.6	160	5333.3	1.6	533	0.52	0.077	IA RML above MDL	ISL above MDL
Benzyl Chloride	100-44-7	0.25	25	833.3	0.25	83.3	1.1	0.12	IA RML above MDL	ISL above MDL
Bromodichloromethane	75-27-4	0.33	33	1100.0	0.33	110	0.53	0.077	IA RML above MDL	ISL above MDL
Bromoform	75-25-2	11	1100	36667	11	3667	0.53	0.11	IA RML above MDL	ISL above MDL
Bromomethane	74-83-9	22	22	733	2.2	73.3	0.5	0.074	IA RML above MDL	ISL above MDL
Carbon Disulfide	75-15-0	3100	3100	103333	310	10333	1.1	0.16	IA RML above MDL	ISL above MDL
Carbon Tetrachloride	56-23-5	2	200	6667	2	667	0.52	0.074	IA RML above MDL	ISL above MDL

TABLE 2-3c. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR VAPOR ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes[1]	CAS Number	Industrial RSL (µg/m^3)[2] HQ = 1.0	Indoor Air Removal Management Level (µg/m^3 unless otherwise noted)[3]	Vapor Intrusion Screening Level for Subslab Samples (µg/m^3 unless otherwise noted)[4]	Industrial RSL (µg/m^3)[2] HQ = 0.1	Exterior Soil Gas Screening Level (µg/m^3 unless otherwise noted)[5]	ALS		Comparison of Laboratory Limits to Indoor Air Management Level	Comparison of Laboratory Limits to Exterior Soil Gas Screening Level
							Method Reporting Limit (µg/m^3 unless otherwise noted)[6,7]	Method Detection Limit (µg/m^3 unless otherwise noted)[6,7]		
Chlorobenzene	108-90-7	220	220	7333	22	733	0.53	0.071	IA RML above MDL	ISL above MDL
Chloroethane	75-00-3	44000	44000	1466667	4400	146667	0.51	0.066	IA RML above MDL	ISL above MDL
Chloroform	67-66-3	0.53	53	1767	0.53	177	0.54	0.071	IA RML above MDL	ISL above MDL
Chloromethane	74-87-3	390	390	13000	39	1300	0.5	0.086	IA RML above MDL	ISL above MDL
cis-1,2-Dichloroethene	156-59-2	NL	NL	NL	NL	NL	0.53	0.075	Not Applicable	Not Applicable
cis-1,3-Dichloropropene	10061-01-5	NL	NL	NL	NL	NL	0.56	0.083	Not Applicable	Not Applicable
Cyclohexane	110-82-7	26000	26000	866667	2600	86667	1	0.15	IA RML above MDL	ISL above MDL
Dibromochloromethane	124-48-1	NL	NL	NL	NL	NL	0.54	0.07	Not Applicable	Not Applicable
Dichlorodifluoromethane (CFC 12)	75-71-8	440	440	14667	44	1467	0.52	0.087	IA RML above MDL	ISL above MDL
d-Limonene	5989-27-5	NL	NL	NL	NL	NL	0.51	0.11	Not Applicable	Not Applicable
Ethanol	64-17-5	NL	NL	NL	NL	NL	5.1	0.37	Not Applicable	Not Applicable
Ethyl Acetate	141-78-6	310	310	10333	31	1033	1.1	0.28	IA RML above MDL	ISL above MDL
Ethylbenzene	100-41-4	4.9	490	16333	4.9	1633	0.52	0.075	IA RML above MDL	ISL above MDL
Hexachlorobutadiene	87-68-3	0.56	56	1866.7	0.56	187	0.53	0.11	IA RML above MDL	ISL above MDL
Isopropylbenzene (Cumene)	98-82-8	1800	1800	60000	180	6000	0.53	0.077	IA RML above MDL	ISL above MDL
m+p-Xylene	179601-23-1	NL	NL	NL	NL	NL	1.1	0.14	Not Applicable	Not Applicable
Methyl Butyl Ketone (2-Hexanone)	591-78-6	130	130	4333	13	433	0.54	0.066	IA RML above MDL	ISL above MDL
Methyl Ethyl Ketone (2-Butanone)	78-93-3	22000	22000	733333	2200	73333	1	0.11	IA RML above MDL	ISL above MDL
Methyl Methacrylate	80-62-6	3100	3100	103333	310	10333	1.1	0.19	IA RML above MDL	ISL above MDL
Methylene Chloride	75-09-2	1200	120000	4000000	260	8667	0.54	0.15	IA RML above MDL	ISL above MDL
Methyl-tert-Butyl Ether	1634-04-4	47	4700	156667	47	15667	0.54	0.063	IA RML above MDL	ISL above MDL
n-Butyl Acetate	123-86-4	NL	NL	NL	NL	NL	0.54	0.073	Not Applicable	Not Applicable
n-Heptane	142-82-5	1800	1800	60000	180	6000	0.54	0.085	IA RML above MDL	ISL above MDL
n-Hexane	110-54-3	3100	3100	103333	310	10333	0.54	0.11	IA RML above MDL	ISL above MDL
Naphthalene	91-20-3	0.36	36	1200	0.36	120	0.51	0.13	IA RML above MDL	ISL above MDL
n-Nonane	111-84-2	88	88	2933	8.8	293	0.54	0.089	IA RML above MDL	ISL above MDL
n-Octane	111-65-9	NL	NL	NL	NL	NL	0.54	0.12	Not Applicable	Not Applicable
n-Propylbenzene	103-65-1	4400	4400	146667	440	14667	0.54	0.077	IA RML above MDL	ISL above MDL
o-Xylene	95-47-6	440	440	14667	44	1467	0.53	0.077	IA RML above MDL	ISL above MDL
Propene	115-07-1	13000	13000	433333	1300	43333	0.52	0.13	IA RML above MDL	ISL above MDL
Styrene	100-42-5	4400	4400	146667	440	14667	0.53	0.086	IA RML above MDL	ISL above MDL
Tetrachloroethene	127-18-4	47	4700	156667	18	600	0.53	0.069	IA RML above MDL	ISL above MDL
Tetrahydrofuran (THF)	109-99-9	8800	8800	293333	880	29333	0.53	0.067	IA RML above MDL	ISL above MDL
Toluene	108-88-3	22000	22000	733333	2200	73333	0.53	0.065	IA RML above MDL	ISL above MDL

TABLE 2-3c. LIST OF CONSTITUENTS AND DESIRED REPORTING LIMITS FOR VAPOR ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analytes[1]	CAS Number	Industrial RSL (µg/m^3)[2] HQ = 1.0	Indoor Air Removal Management Level (µg/m^3 unless otherwise noted)[3]	Vapor Intrusion Screening Level for Subslab Samples (µg/m^3 unless otherwise noted)[4]	Industrial RSL (µg/m^3)[2] HQ = 0.1	Exterior Soil Gas Screening Level (µg/m^3 unless otherwise noted)[5]	ALS		Comparison of Laboratory Limits to Indoor Air Management Level	Comparison of Laboratory Limits to Exterior Soil Gas Screening Level
							Method Reporting Limit (µg/m^3 unless otherwise noted)[6,7]	Method Detection Limit (µg/m^3 unless otherwise noted)[6,7]		
trans-1,2-Dichloroethene	156-60-5	NL	NL	NL	NL	NL	0.53	0.074	Not Applicable	Not Applicable
trans-1,3-Dichloropropene	10061-02-6	NL	NL	NL	NL	NL	0.53	0.11	Not Applicable	Not Applicable
Trichloroethene[9]	79-01-6	3	6	200	0.88	29.3	0.53	0.072	IA RML above MDL	ISL above MDL
Trichlorofluoromethane	75-69-4	NL	NL	NL	NL	NL	0.53	0.081	Not Applicable	Not Applicable
Trichlorotrifluoroethane (CFC 113)	76-13-1	22000	22000	733333	2200	73333	0.53	0.076	IA RML above MDL	ISL above MDL
Vinyl Acetate	108-05-4	880	880	29333	88	2933	5.3	1.2	IA RML above MDL	ISL above MDL
Vinyl Chloride	75-01-4	2.8	280	9333	2.8	933	0.53	0.057	IA RML above MDL	ISL above MDL
Methane[9]	74-82-8	The LEL for methane is 5% (50,000 ppm), NIOSH 8-hour threshold limit is 1,000 ppm					1.0 ppm	0.28 ppm	Not Applicable	Not Applicable
Hydrogen[9]	*1333-74-0*	*NL*	*NL*	*NL*	*NL*	*NL*	*1000 ppm*	--	*Not Applicable*	*Not Applicable*
Oxygen[9]	*7782-44-7*	*NL*	*NL*	*NL*	*NL*	*NL*	*1000 ppm*	--	*Not Applicable*	*Not Applicable*
Carbon dioxide[9]	*124-38-9*	*NL*	*NL*	*NL*	*NL*	*NL*	*1000 ppm*	--	*Not Applicable*	*Not Applicable*
Helium[9]	*7440-59-7*	*NL*	*NL*	*NL*	*NL*	*NL*	*25 ppm*	*4.7 ppm*	*Not Applicable*	*Not Applicable*
Radon[10]										
Radon - Short Term	EPA 402-R-92-004	NL	4.0 pCi/L[11]	133.3 pCi/L	4.0 pCi/L[11]	133.3 pCi/L	6 Bq/m^3 = 0.162 pCi/L	NA	IA RML above MRL	ISL above MRL
Radon - Long Term	EPA 402-R-92-004	NL	4.0 pCi/L[11]	133.3 pCi/L	4.0 pCi/L[11]	133.3 pCi/L	7 Bq/m^3 = 0.189 pCi/L	NA	IA RML above MRL	ISL above MRL

Notes:

1: Target analyte list is based on ALS Global TO-15 Low Level list.
2: Industrial Regional Screening Levels (November 2019) as found from the following website: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
3: Based on USEPA Industrial RSL adjusted for 10E-4 Cancer Risk and HQ=1
4: Based on subslab to indoor air attenuation factor of 0.03
5: Based on USEPA Industrial RSL adjusted for 10E-5 Cancer Risk, HQ=0.1, and soil gas to indoor air attenuation factor of 0.03
6: USEPA Test Method TO-15/TO-15 MOD (the modified method for those samples that need fixed gas and helium analyses also) for 6-Liter Canister
7: The MRL/MDL are evaluated annually (in accordance with certification requirements) and are subject to modification based on the laboratory capability studies.
8: Region 7 removal management level for indoor air used (not RSL)
9: Analyzed using USEPA Method TO-3 and 3C Modified (see Table 2-2). Hydrogen, Oxygen, Carbon dioxide, and Helium contingent on results of indoor air samples.
10: Conversion based on 1 pCi/L is equal to 37 Bq/m3
11: USEPA Action Level above which USEPA recommends corrective measures to reduce radon gas exposure be taken

Abbreviations:

ALS: Analytical Laboratory Services
Bq/m^3: Becquerel per meters cubed
CAS: Chemical Abstracts Service
HQ: Hazard Quotient
IA: Indoor Air
ISL: Industrial Screening Level
LEL: Lower Explosive Limit
MRL: Method Reporting Limit
MDL: Method Detection Limit
NA: Not Applicable
NIOSH: National Institute for Occupational Safety and Health
NL: Not listed in referenced document
OSHA: Occupational Safety and Health Administration
PEL: Permissible Exposure Limit
pCi/L: picocurie per liter
RML: Removal Management Level
RSL: Regional Screening Level
TWA: Time-weighted Average
µg/m^3: micrograms per cubic meter
USEPA: United States Environmental Protection Agency

TABLE 2-3d. LIST OF FIELD PARAMETERS, EQUIPMENT, AND STABILIZATION CRITERIA
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analyte/Data Collected	Equipment/Test	Model	Range	Resolution	Accuracy	Stabilization Criteria	Units
Sampling Parameters (Groundwater and Leachate)[1]							
pH	Water Quality Meter	In-Situ Aqua Troll 600, or equivalent	0 - 14	0.01	± 0.1	± 0.1	s.u.
Temperature	Water Quality Meter	In-Situ Aqua Troll 600, or equivalent	-5 - 50	0.01	± 0.1	± 3%	°C
Specific Conductance	Water Quality Meter	In-Situ Aqua Troll 600, or equivalent	0 - 350	0.1 µS/cm	±0.5% plus 0.0001 mS/cm from 0 to 100 mS/cm ±1.0% from 100 to 200 mS/cm ±2% from 200 to 350 mS/cm	± 3%	mS/cm
Dissolved Oxygen	Water Quality Meter	In-Situ Aqua Troll 600, or equivalent	0 - 60	0.01	±0.1 mg/L from 0 to 20 mg/L ±2% from 20 to 60 mg/L	± 0.3	mg/L
Oxygen Reduction Potential	Water Quality Meter	In-Situ Aqua Troll 600, or equivalent	-1,400 - 1,400	0.1	± 5	± 10	mV
Turbidity	Water Quality Meter	In-Situ Aqua Troll 600, or equivalent	0 - 4,000	0.01 NTU (0 to 1,000 NTU) 0.1 NTU (1,000 to 4,000 NTU)	±2% or ±0.5 NTU, whichever is greater	± 10% or <10 NTU	NTU
Additional Field Parameters (Groundwater)							
Ammonium	Field Test Kit	Supelco MQuant® Ammonium Test (Model 11117)[2], or equivalent	0.5 - 10	0.5, 1, 2, 3, 5, 7,10	± 0.5, 1, 2, 3	NA	mg/L
Iron, Ferrous	Field Test Kit	HACH Iron Test Kit (IR-18C)	0.2 - 7	0.2	± 0.2	NA	mg/L
Iron, Total	Field Test Kit	HACH Iron Test Kit (IR-18B)	0.25 - 7	0.25	± 0.25	NA	mg/L
Iron, Ferric	Calculation	NA	0.25 - 7	0.25	± 0.25	NA	mg/L
Radon and Polonium[9]	Electronic Radon Detector with In Water Accessory	RAD7 H2O[3]	10 - 400,000	0.05 cpm/(pCi/L) (250 mL bottle)	± 5%	NA	pCi/L
Water Levels and Downhole Parameters							
Water Level[4]	Water Level Indicator	Solinst 102, or equivalent	0 - 300, or as appropriate	0.01	± 0.01	NA	ft
Water Level[4]	Sonic Water Level Meter	WL650	10 - 1200	0.1	± 0.2%	NA	ft
Water Level[4]	Pressure Transducer	Solinst Levelogger Model 3001 Edge, or equivalent	0 - 650	± 0.002%	± 0.05%	NA	ft
Water Level[5]	Pressure Transducer	In Situ Level Troll 700H (Vented)	35	± 0.005%	0 - 15 ft: ± 0.01ft >15 ft: ± 0.1%	NA	ft
LNAPL/DNAPL	Oil/water interface probe	Solinst 122, or equivalent	0 - 300, or as appropriate	0.01	± 0.01	NA	ft
Barometric Pressure	Barometric Transducer	Solinst Barologger Model 3001 Edge, or equivalent	Atmospheric[6]	± 0.002%	± 0.05	NA	kPa
Well Casing Integrity	Downhole Inspection Camera	Heron dipper-See EXAMINER	0 - 500	0.01 for depth 800 x 1024 pixel resolution, (7 inch camera)	± 0.01	NA	ft

TABLE 2-3d. LIST OF FIELD PARAMETERS, EQUIPMENT, AND STABILIZATION CRITERIA
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analyte/Data Collected	Equipment/Test	Model	Range	Resolution	Accuracy	Stabilization Criteria	Units
Additional Field Parameters (Vapor)[7]							
Total Organic Vapor	Photoionization Detector	ppbRae 3000 with 10.6 eV lamp, or equivalent	1 ppb - 10,000 ppm	1 ppb	10 - 2,000 ppm: ± 3% <10 ppm: ± 10%	± 10%	ppb/ppm
Radon and Polonium[9]	Electronic Radon Detector	RAD7	0.1 - 20,000	SNIFF mode, 0.25 cpm/(pCi/L) NORMAL mode, 0.5 cpm/(pCi/L) AUTO mode, automatic switch from SNIFF to NORMAL after 3 hours	± 5%	NA	pCi/L
Methane	Landfill Gas Meter	Landtec GEM 2000, or equivalent	0 - 70%	0.1%	0 - 5% volume: ± 0.3% 5 - 15% volume: ± 1% 15% - FS volume: ± 3%	± 10%	%
Oxygen[11]	*Landfill Gas Meter*	*Landtec GEM 2000, or equivalent*	*0 - 25%*	*0.1%*	*0 - 5% volume: ± 1%* *5 - 15% volume: ± 1%* *15% - FS volume: ± 1%*	*± 10%*	*%*
Carbon Dioxide[11]	*Landfill Gas Meter*	*Landtec GEM 2000, or equivalent*	*0 - 40%*	*0.1%*	*0 - 5% volume: ± 0.3%* *5 - 15% volume: ± 1%* *15% - FS volume: ± 3%*	*± 10%*	*%*
Helium[11]	*Helium Detector*	*Dielectric MGD2002™, or equivalent*	*25 ppm - 1,000,000 ppm*	*± 25 ppm (low range)* *± 0.2% (high range)*	*± 2%*	*± 10%*	*ppm*
Screening Parameters (Soils)							
Total Organic Vapor	Photoionization Detector	ppbRae 3000 with 10.6 eV lamp, or equivalent	1 ppb - 10,000 ppm	1 ppb	10 - 2,000 ppm: ± 3% <10 ppm: ± 10%	NA	ppb/ppm

TABLE 2-3d. LIST OF FIELD PARAMETERS, EQUIPMENT, AND STABILIZATION CRITERIA
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Target Analyte/Data Collected	Equipment/Test	Model	Range	Resolution	Accuracy	Stabilization Criteria	Units
Geospatial Instruments							
Latitude and Longitude	Global Positioning System	Trimble R1 GNSS Receiver	NAD83	1 m	± 1 m	NA	m
Northing and Easting	Robotic Total Station/GNSS Receiver	Trimble VX Spatial Station	NAD83	0.5[8]	± 0.0098	NA	US Survey ft
Latitude and Longitude	Robotic Total Station/GNSS Receiver	Trimble VX Spatial Station	NAD83	0.01[8]	± 0.0098	NA	ft
Elevation	Robotic Total Station/GNSS Receiver	Trimble VX Spatial Station	NADV88	0.01[8]	± 0.0098	NA	ft
Bathymetric Data	Single Frequency Echosounder/additional Global Positioning System	Seafloor HydroLite-TM/Trimble R8s GNSS Receiver	0.3 m - 75 m	0.01 m	± 0.01 m, 0.1%	NA	m

Notes:

1: USEPA. 2002. Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers. Yeskis, Douglas and Bernard Zavala.
2: Supelco MQuant® Ammonium Tests are available for different ranges of concentrations. The test kit model selected (i.e, concentration range) will be adjusted as necessary.
3: The RAD7 H_2O instrument can measure from a range of less than 10 pCi/L to greater than 400 pCi/L. Sample to sample variation can range from ± 10 - 20% due variation inherent to sample collection procedures.
4: Equipment used to gauge groundwater levels
5: Equipment used to gauge surface water levels (staff gauge location)
6: Barologger range is sufficient for all applicable atmospheric conditions
7: Electric Power Research Institute (EPRI) Reference Handbook for Site-Specific Assessment of Subsurface Vapor Intrusion to Indoor Air, March 2005
8: Units reported as required in the Field Sampling Plan (FSP). The total station is a 1 second gun, and will be able to collect repeatable measurements within 0.01 ft.
9: Polonium isotope count data will also be recorded with the Rad7 meters and downloaded through the CAPTURE software.
10. Sub-slab radon activity readings, including polonium isotopes, will be collected until adequate precision and stabilization is observed. Adequate stabilization is defined as <10% change in radon activity concentration from the previous measurement, and precision is considered adequate when the standard deviation is <10% of the radon activity concentration measurement
11: Analyses contingent upon results of indoor air samples.

Abbreviations:

±: plus or minus
<: less than
%: percent
°C: degrees Celsius
cpm: counts per minute
DMS: Degrees, Minutes, Seconds
DNAPL: dense non-aqueous liquid
eV: ionization potential
FS: full scale
ft: feet
GNSS: Global Navigation Satellite System
H_2O: Water
kPa: kilopascal
LNAPL: light non-aqueous liquid
m: meter
mg/L: milligrams per Liter
mS/cm: millisiemens per centimeter
mV: millivolts
NA: Not applicable
NAD83: North American Datum of 1983
NADV88: North American Vertical Datum of 1988
NTU: Nephelometric Turbidity Unit
pCi/L: picocuries per Liter
PID: Photoionization Detector
ppb: parts per billion
ppm: parts per million
s.u.: standard unit

TABLE 3-1. DATA QUALITY OBJECTIVES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Step 1 - State the Problem		**- Give a concise description of the problem** **- Identify leader and members of the planning team.** **- Develop a conceptual model of the environmental hazard to be investigated.** **- Determine resources - budget, personnel, and schedule.**
Description of the Problem	**Conceptual Model of the Environmental Hazard**	**Project Resources - Budget, Personnel, Schedule**
Petroleum hydrocarbons, VOCs, trace metals, trace anions, and various radionuclides have been detected in groundwater at the site. The nature and extent of site-related impacts to groundwater, indoor air, and groundwater-related impacts to surface water and sediment are unknown. An improved understanding of the nature, extent, and source(s) of groundwater contamination at the site, and the mechanisms of contaminant migration, will be used to: 1) Assess the potential for site-related contamination to migrate beyond site boundaries into critical exposure pathways, 2)Determine the attendant current and predicted future risks posed to human health and the environment, and 3)Develop potential groundwater remedies as necessary.	At this time, there is no off-site monitoring well network for evaluation of groundwater conditions available for use in the development of the RI/FS Work Plan and associated documents. However, based on the evaluation of existing information, described in the Work Plan, the general framework of a Conceptual Site Model (CSM) has been developed. A CSM of the potential current and future hazards for Operable Unit 3 (OU-3) groundwater conditions is anticipated to include the following elements: 1. Constituents of potential concern (COPCs) are present in onsite groundwater related to the former onsite landfills (Operable Unit 1/Operable Unit 2 [OU-1/OU-2]). The impacted groundwater may extend off-site vertically and laterally, but the extent is unknown. 2. COPCs may also be present in groundwater due to up-gradient sources, including both naturally-occurring and anthropogenic sources.	1. Personnel: - OU-3 Respondents: Representatives of Bridgeton Landfill, LLC, Cotter Corporation, N.S.L., and Department of Energy (DOE) - OU-3 Project Coordinator: Paul Rosasco, Engineering Management Support, Inc. (EMSI) - Stakeholders: United States Environmental Protection Agency (USEPA) Region 7, Missouri Department of Natural Resources (MDNR), United States Geological Survey (USGS) - Technical Advisor: Ralph Golia (AMO Environmental Decisions, Inc.) - Trihydro Corporation: Gary Risse (Project Principal), Allison Riffel (Project Manager), Michael Sweetenham (Assistant Project Manager), Dan Gravelding (Technical Director), Wilson Clayton, PhD (Modeling Technical Lead), Craig Carlson (Radiation Technical Lead), Andrew Pawlisz (Risk Assessment Technical Lead), Justin Pruis (Vapor Intrusion Technical Lead), Todd Forry (Health and Safety) - Subcontractors: Ameriphysics (Radiation Safety, Health Physicist), Chad Drummond (Geochemical/Radionuclide Modeling), Feezor Engineering (Radiation Safety, Field Support), Pace Analytical Services, LLC, Materials and Chemical Laboratory, Inc. (MCLInc; Specialty), Advanced Terra Testing (Geotechnical), ALS Laboratory (Vapor), EMSL (X-Ray Diffraction [XRD], Scanning Electron Microscope with Energy Dispersive X-ray Spectrometry [SEM-EDS]), To Be Determined Driller
	3. Groundwater may be used as a water supply source, which may pose a risk to human health and/or ecological health.	2. Budget: $19 MM through 2023 for completion of the RI activities included in the OU-3 RI/FS Work Plan, excluding long term monitoring and agency fees
	4. Groundwater may be hydraulically connected to surface water bodies including the Missouri River and nearby ponds, which may also pose a risk to human and/or ecological health. 5. Groundwater may contain vapor-forming COPCs, which may pose a risk to human health from the volatilization into indoor air. Vapor migration into the vadose zone from the waste units may also be occurring. 6. Further refinement of the CSM is necessary as additional data are obtained related to aquifer properties, hydraulic gradients, flow directions, background groundwater quality, up-gradient groundwater quality, geochemistry, future COPC concentrations, effects of infrastructure, and temporal and spatial variations in flow directions.	3. Anticipated Schedule (Work Plan Section 10.3): Milestones for the major project tasks are currently estimated as follows based on the assumption that the OU-3 RI/FS Work Plan will be approved by July 1, 2020: - Initial Tasks (Well Inventory, Staff Gauge Installation, Access Agreements, Permitting, Fluid Level Monitoring) – Spring 2020 pending USEPA approval to expedite tasks - Well Inventory Summary Report – Summer 2020 - Interim Groundwater Sampling – Summer 2020 and Early 2021 - Quarterly Groundwater Sampling – Spring 2021 through Summer 2022 - Phase I and II Well Installation – Summer 2020 – Spring 2021 - Addendum to RI Work Plan – Late 2020 - Additional RI Well Installation – Spring 2021 - Groundwater Modeling Work Plan – Late 2021 - Groundwater Modeling Report – Early 2023 - Baseline Risk Assessment Work Plan – Fall 2022 - RI Report – Late 2023 - Baseline Risk Assessment Report – Late 2023 - Feasibility Study – Spring 2025

TABLE 3-1. DATA QUALITY OBJECTIVES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Step 2. Identify the Goal of the Study
(Note that goals pertaining to groundwater modeling, risk assessment, and evaluation of potential remedies are not included at this time due to extensive data gaps, and will be developed subsequent to initial data collection)

- Identify principal study question(s).
- Consider alternative outcomes or actions that can occur upon answering the question(s).
- For decision problems, develop decision statement(s), organize multiple decisions.
- For estimation problems, state what needs to be estimated and key assumptions.

Study	**Principal Study Questions (PSQ)**	**Decision Statements/Estimation Statements**	**Alternative Outcomes**
Nature and Extent of Impacts	1. Are COPCs present in groundwater above screening levels? - COPCs and screening levels are listed on Quality Assurance Project Plan [QAPP] Table 2-2a (groundwater).	- Determine if the concentrations/activity levels of COPCs in groundwater are above screening levels.	- If groundwater COPCs are present at levels equal to or above screening levels, evaluate if further action is appropriate. - If groundwater COPCs are not present above screening levels, evaluate if no further action is appropriate.
	2. What is the vertical and horizontal spatial distribution of COPCs above screening levels in groundwater?	- Estimate the horizontal distribution and spatial variability of COPCs above applicable screening levels in groundwater. - Estimate the vertical distribution and spatial variability of COPCs in groundwater above applicable screening levels in the different geologic units. - Estimate the temporal variability in COPC groundwater concentrations, if present.	- COPCs are present in groundwater above applicable screening levels onsite/nearsite, or offsite, or both onsite and offsite. - COPCs may or may not be present above applicable screening levels within one or more of the alluvial zones (shallow alluvium [AS], intermediate alluvium [AI], deep alluvium [AD]), and one or more of the bedrock zones (Upper Salem/St. Louis Formation [SS], Salem Formation bedrock zone [SD], and/or the Keokuk [KS] bedrock zone). - COPCs are present above applicable screening levels consistently throughout the year, or concentrations vary seasonally.

TABLE 3-1. DATA QUALITY OBJECTIVES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Step 2. Identify the Goal of the Study
(Note that goals pertaining to groundwater modeling, risk assessment, and evaluation of potential remedies are not included at this time due to extensive data gaps, and will be developed subsequent to initial data collection)

- Identify principal study question(s).
- Consider alternative outcomes or actions that can occur upon answering the question(s).
- For decision problems, develop decision statement(s), organize multiple decisions.
- For estimation problems, state what needs to be estimated and key assumptions.

Study	**Principal Study Questions (PSQ)**	**Decision Statements/Estimation Statements**	**Alternative Outcomes**
Source	3. Are the COPCs site-related?	- Determine if any COPCs present in groundwater above screening levels are not related to the site.	An individual COPC at a specific location is site-related, or is not-site-related, or a combination of both.
	4. What are the sources of site-related COPCs in groundwater?	- Determine which of the site-specific sources are contributing COPCs to groundwater.	- Site-specific sources (e.g., individual landfill cells or other units, e.g., USTs) may be distinguishable, including potentially Area 1, Area 2, Former Inactive Sanitary Landfill, and Bridgeton Landfill. - Alternately, the individual sources may be indistinguishable, so the site will be treated as a source as a whole.
		- Determine whether radiologically impacted material (RIM) is providing a source of radionuclides to groundwater.	RIM is a source of radionuclides to groundwater, so the areas with RIM will be managed as a source (OU-1).
		- Determine whether Municipal Solid Waste (MSW) is providing a source of COPCs to groundwater.	MSW is a primary source of COPCs to groundwater, so MSW areas will be managed as a source. Alternative outcomes include: - MSW from the Inactive Sanitary Landfill is a source, - MSW from the Bridgeton Landfill is a source, - MSW from Area 1 is a source, - MSW from Area 2 is a source, - MSW from the former C&D landfill is a source, - Both landfills are sources, or - Neither landfill is a source.
		- Determine whether the geochemistry of landfill leachate, the subsurface reaction (SSR), and/or landfill gases are resulting in the release of COPCs from naturally occurring aquifer materials into groundwater, including naturally-occurring radium.	- Landfill leachate is resulting in the release of COPCs to groundwater due to changes in pH, redox, and other geochemical processes, so that areas with landfill leachate are identified as contributing sources of COPCs to groundwater, or not. - The SSR is resulting in the release of COPCs into groundwater due to elevated pressures, elevated temperatures, reducing conditions, and landfill mass matrix destruction, or not. - Landfill gas from the site is resulting in changes to the pH, redox, and other geochemical processes, so that areas with landfill gases are identified as contributing sources of COPCs to groundwater, or not.

TABLE 3-1. DATA QUALITY OBJECTIVES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Step 2. Identify the Goal of the Study
(Note that goals pertaining to groundwater modeling, risk assessment, and evaluation of potential remedies are not included at this time due to extensive data gaps, and will be developed subsequent to initial data collection)

- **Identify principal study question(s).**
- **Consider alternative outcomes or actions that can occur upon answering the question(s).**
- **For decision problems, develop decision statement(s), organize multiple decisions.**
- **For estimation problems, state what needs to be estimated and key assumptions.**

Study	Principal Study Questions (PSQ)	Decision Statements/Estimation Statements	Alternative Outcomes
Fate and Transport	5. Where will COPCs migrate in the future?	- Estimate the lateral and vertical gradients and flow within the groundwater system, including any spatial and temporal variability thereof.	- Spatial distribution of gradients and flow within the groundwater system integrates and builds upon existing CSM framework. - Spatial distribution of gradients and flow within the groundwater system is inconsistent with CSM, and CSM has to be reconsidered. - Groundwater flow has temporal variability (e.g. seasonal variation), or is consistent throughout the year.
		- Estimate the attenuation parameters.	COPCs are attenuated and do not migrate offsite, or may be somewhat attenuated, or are not attenuated.
		- Determine the effect of and hydraulic interactions with various features and stresses on the hydrogeologic system, including recharge and discharge. - Determine the water balance for the system.	Site features, pumping, leachate extraction, and stresses influence current and future COPC migration, or do not.

TABLE 3-1. DATA QUALITY OBJECTIVES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Step 3. Identify Information Inputs		**- Identify types and sources of information needed to resolve decisions or produce estimates. - Identify the basis of information that will guide or support choices to be made in later steps of the DQO Process. - Select appropriate sampling and analysis methods for generating the information.**	
Principal Study Questions (From Step 2)	**Identify the Types of Information Needed**	**Identify the Source of Information**	**Identify Appropriate Sampling and Analysis Methods**
1. Are COPCs present in groundwater above screening levels?	- Newly collected groundwater COPC data - Quality assurance samples (QAPP Table 5-1) - Field instrument data reports - Field forms (Appendix A of the FSP) - Level IV laboratory analytical reports - Laboratory Electronic Data Deliverable (EDD) files - Validated data - Maximum Contaminant Levels (MCLs) - USEPA Regional Screening Levels (RSLs) - Preliminary Remediation Goals (PRGs) - Historical data may also be used for reference purposes, see QAPP Section 4.1.	- Groundwater data collected from existing monitoring wells (Work Plan Figure 5-1) - Groundwater data collected from new monitoring wells (Work Plan Figure 5-5a) - Data validation qualifiers (qualifiers for historical data are identified in the reports listed in Work Plan Section 2.4; data qualifiers for new data are to be determined) The results from groundwater sampling (analytical and field) will be recorded in the Trihydro Project Direct database and a USEPA-accessible database. In addition, Level IV laboratory reports, Level III data validation reports, and field forms will be loaded to the Trihydro Project Direct data file for each data set. Sources for the screening levels include: MCLs and the latest USEPA RSLs (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables), and PRGs (https://www.epa.gov/risk/calculating-preliminary-remediation-goals-prgs).	- Groundwater samples will be laboratory analyzed for COPC concentrations/activity levels and by methods listed in QAPP Table 2-2a. - Groundwater samples will be field analyzed for select COPC concentrations by methods listed in QAPP Table 2-3a-i and 2-3a-ii. - Methods for well construction, development, and groundwater sampling are specified in the Field Sampling Plan (FSP) Sections 3.9, 3.10, and 3.14. - Data validation reports will be completed for each data set (Section 7.1 of the QAPP). The level of validation for each data set as shown in QAPP Table 2-1. Data validation will be completed as reported in Appendix B in accordance with USEPA Contract Laboratory Program and Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) requirements. *Note, that In the case that data specific errors are found that the chemist (through professional judgement) determines the data are suspect (e.g. abnormal sample results, major instrument errors, significant interferences, large fluctuations, etc.), a higher level of validation (raw results and chromatograms) may be completed to verify analytical accuracy. This will be done on a case-by-case, analyte-by-analyte, and/or sample-by-sample basis.* The laboratory analyses will be completed by the laboratories listed in Step 1 and in accordance with the following: - The analytical chemistry laboratory certifications for the methodology under the National Environmental Laboratory Accreditation Conference (NELAC) as shown in QAPP Appendix A. - The laboratory quality assurance manuals (QAMs) are included in QAPP Appendix A. - The laboratory Standard Operating Procedures (SOPs) are included in QAPP Appendix D. Field analyses and sampling methodology will be completed as specified in accordance with the SOPs (FSP Appendices) and the instrument manufacturer requirements. Field parameters and accuracy measurements for field method are shown in Table 2-3d and further described in the FSP SOPs.

TABLE 3-1. DATA QUALITY OBJECTIVES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Step 3. Identify Information Inputs		**- Identify types and sources of information needed to resolve decisions or produce estimates.** **- Identify the basis of information that will guide or support choices to be made in later steps of the DQO Process.** **- Select appropriate sampling and analysis methods for generating the information.**	
Principal Study Questions (From Step 2)	**Identify the Types of Information Needed**	**Identify the Source of Information**	**Identify Appropriate Sampling and Analysis Methods**
2. What is the vertical and horizontal spatial distribution of COPCs above screening levels in groundwater?	Same as PSQ #1. In addition, - Surveyed locations of historic and new wells. - Depth of well, depth to groundwater, depth of sample. Also, - On-site and off-site COPC groundwater data to include data from different vertical intervals. - Data from multiple events over each year needed to account for potential seasonal variability.	Same as PSQ #1. Also, - Groundwater data will include data from multi-level wells (AS, AI, AD, SS, SD, KS) sampled for multiple events for at least one year. - Geospatial data (xyz) will be loaded to the Trihydro Project Direct database and into GIS for use in spatial evaluations.	Same as PSQ #1 Geospatial: The data will be projected into the following coordinate system and datum: North American Datum 1983 (NAD83) State Plane Missouri East United States Feet 2401. The data will also meet, at minimum, National Geospatial Data Policy (NGDP) Tier 2 standards of 1-5 meters (m) accuracy and precision (See QAPP Section 5.1.2.1.5 and 5.3.3 for additional details).
	Historical groundwater COPC concentration / activity level data, data validation reports, well elevations, groundwater elevations, and sample locations.	Historical reports from OU-1 and OU-2 (See Work Plan Section 2.4).	Existing OU-1 and OU-2 groundwater COPC data will ideally have been collected using similar sampling techniques as noted in FSP Sections 3.9 and 3.14, or collected using methods considered to be standard procedures for environmental investigations (for example non low-flow sampling methods such as bailers, waterra pumps, submersible pumps). Laboratory analytical methods should be similar to those proposed in the QAPP for the OU-3 sampling. See QAPP Table 2-2a or Table 2-3a-i and Table 2-3a-ii for groundwater analytical methods. Historical COPC data will be reviewed to determine if a Level III or higher validation level has been used. Specific information regarding data usability of historical data are included in QAPP Section 4.1. Geospatial: The data will be projected into the following coordinate system and datum: NAD83 State Plane Missouri East US Feet 2401. The data will also meet, at minimum, NGDP Tier 2 standards of 1-5 m accuracy and precision (See Section QAPP 5.1.2.1.5 and 5.3.3 for additional details).
	Third-party off-site groundwater COPC concentration / activity level data, data validation reports, well elevations, groundwater elevations, and sample locations.	Existing third-party reports from environmental sites in the area; reports may be available from MDNR Files (Work Plan Section 5.2).	Existing third-party COPC data will ideally have been collected using similar sampling techniques as noted in FSP Section 3.14, or collected using methods considered to be standard procedures for environmental investigations (for example non low-flow sampling methods such as bailers, waterra pumps, submersible pumps). Laboratory analytical methods should be similar to those proposed in the QAPP for the OU-3 sampling. See QAPP Table 2-2a or Table 2-3a-i and Table 2-3a-ii for groundwater analytical methods. Third-party COPC data will be reviewed to determine if a Level III or higher validation level has been used. Specific information regarding data usability of third-party data are included in QAPP Section 4.1. Geospatial: The data will be projected into the following coordinate system and datum: NAD83 State Plane Missouri East US Feet 2401. The data will also meet, at minimum, NGDP Tier 2 standards of 1-5 m accuracy and precision (See Section 5.1.2.1.4 and 5.3.3 for additional details).

TABLE 3-1. DATA QUALITY OBJECTIVES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Step 3. Identify Information Inputs		**- Identify types and sources of information needed to resolve decisions or produce estimates.** **- Identify the basis of information that will guide or support choices to be made in later steps of the DQO Process.** **- Select appropriate sampling and analysis methods for generating the information.**	
Principal Study Questions (From Step 2)	**Identify the Types of Information Needed**	**Identify the Source of Information**	**Identify Appropriate Sampling and Analysis Methods**
3. Are the COPCs site-related?	Same as PSQ #1, especially COPC data from onsite	Same as PSQ #1. The existing onsite wells, the proposed 100-, 200-, 300-, 400- Series onsite / nearsite wells, and onsite leachate data will be important as indicators of onsite water quality (see Work Plan Table 5-4). The proposed 500-Series wells are located offsite and will be a source of information to tie data from the site to offsite impacts (where present).	Same as PSQ #1
	Historical COPC concentration/activity level data for groundwater and leachate at the site	Historical reports with groundwater and leachate COPC concentrations / activity levels from OU-1 and OU-2 (See Section 2.4 of the Work Plan). See Work Plan Table 5-4 for a list of existing and proposed onsite / nearsite wells.	Existing OU-1 and OU-2 groundwater COPC data will ideally have been collected using similar sampling techniques as noted in FSP Section 3.14, or collected using methods considered to be standard procedures for environmental investigations (for example non low-flow sampling methods such as bailers, waterra pumps, submersible pumps). Laboratory analytical methods should be similar to those proposed in the QAPP for the OU-3 sampling. See QAPP Table 2-2a or Table 2-3a-i and Table 2-3a-ii for groundwater analytical methods. Existing leachate data will ideally have been sampled from leachate collection points using extraction pumps similar to what is currently installed at the site. See QAPP Table 2-2a or Table 2-3a-i and Table 2-3a-ii for leachate analytical methods. Historical COPC data will be reviewed to determine if a Level III or higher validation level has been used. Specific information regarding data usability of historical data are included in QAPP Section 4.1.
	- Published groundwater COPC data from known anthropogenic sources up-gradient of the site. - Third-party off-site reports, including: groundwater COPC concentration / activity level data, data validation reports, well elevations, groundwater elevations, and sample locations.	Existing third-party reports from environmental sites in the area; reports may be available from MDNR Files (Work Plan Section 5.2).	Existing third-party COPC data will ideally have been collected using similar sampling techniques as noted in FSP Section 3.14, or collected using methods considered to be standard procedures for environmental investigations (for example non low-flow sampling methods such as bailers, waterra pumps, submersible pumps). Laboratory analytical methods should be similar to those proposed in the QAPP for the OU-3 sampling. See QAPP Table 2-2a or Table 2-3a-i and Table 2-3a-ii for groundwater analytical methods. Third-party COPC data will be reviewed to determine if a Level III or higher validation level has been used. Specific information regarding data usability of historical data are included in QAPP Section 4.1.

TABLE 3-1. DATA QUALITY OBJECTIVES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Step 3. Identify Information Inputs		**- Identify types and sources of information needed to resolve decisions or produce estimates.** **- Identify the basis of information that will guide or support choices to be made in later steps of the DQO Process.** **- Select appropriate sampling and analysis methods for generating the information.**	
Principal Study Questions (From Step 2)	**Identify the Types of Information Needed**	**Identify the Source of Information**	**Identify Appropriate Sampling and Analysis Methods**
4. What are the sources of site-related COPCs in groundwater?	- Detected results of COPC data from groundwater adjacent to potential source area - Detected results of COPC data from leachate adjacent to potential source areas - Data qualifiers from the validation reports	To be collected, groundwater and leachate data collected from the proposed monitoring well network (Work Plan Table 5-4), especially wells adjacent to the different source areas (Work Plan Table 5-8).	Groundwater sampling will be conducted as part of PSQ #1. Leachate will be sampled from leachate collection points using extraction pumps as noted in FSP Section 3.15. See QAPP Table 2-2a for groundwater analytical methods and for leachate analytical methods.
		Historical OU-1 and OU-2 reports with groundwater and leachate data near potential source areas. See Work Plan Table 5.8 for a list of wells associated with the potential source areas, and Work Plan Section 2.4 for historical report reference list.	Existing OU-1 and OU-2 groundwater COPC data will ideally have been collected using similar sampling techniques as noted in FSP Section 3.14, or collected using methods considered to be standard procedures for environmental investigations (for example non low-flow sampling methods such as bailers, waterra pumps, submersible pumps). Laboratory analytical methods should be similar to those proposed in the QAPP for the OU-3 sampling. Existing leachate data will ideally have been sampled from leachate collection points using extraction pumps similar to what is currently installed at the site. See QAPP Table 2-2a for groundwater analytical methods and for leachate analytical methods. Historical COPC data will be reviewed to determine if a Level III or higher validation level has been used. Specific information regarding data usability of historical data are included in QAPP Section 4.1.
	- Ra228 and Ra226 activity levels and ratios from areas with detected RIM - Figures showing locations with detectable levels of RIM	To be collected, groundwater and leachate radionuclide data from existing and new on-site monitoring wells (Work Plan Table 5-4) located within Areas 1 and 2 with RIM and downgradient from Areas 1 and 2. Ra226/Ra228 ratios will be calculated from Ra226 and Ra228 isotope activity levels.	Groundwater sampling methods will be the same as PSQ #1. Leachate will be sampled from leachate collection points using extraction pumps as noted in FSP Section 3.15. See QAPP Table 2-2a for groundwater analytical methods and for leachate analytical methods, including radionuclides.
		- Historical reports with OU-1 and OU-2 groundwater and leachate data from wells located in and around RIM, including from Areas 1 and 2 (see Work Plan Table 5-8 for a list of wells associated with Areas 1 and 2, and Work Plan Section 2.4 for historical report reference list). Ra226/Ra228 ratios will be calculated from Ra226 and Ra228 isotope activity levels. - Third-party reports with off-site groundwater data from wells located downgradient from Areas 1 and 2 based on wells identified in the off-site records search (Work Plan Section 5.2). Ra226/Ra228 ratios will be calculated from Ra226 and Ra228 isotope activity levels (where available).	Existing third-party groundwater data, and historical OU-1 and OU-2 COPC groundwater data will ideally have been collected using similar sampling techniques as noted in FSP Section 3.14, and lab analytical methods (including radionuclides) as the proposed OU-3 sampling as the proposed OU-3 sampling. Existing leachate data will ideally have been sampled from leachate collection points using extraction pumps, similar to what is proposed in FSP Section 3.15. See QAPP Table 2-2a for groundwater analytical methods and for leachate analytical methods.

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Step 3. Identify Information Inputs		**- Identify types and sources of information needed to resolve decisions or produce estimates.** **- Identify the basis of information that will guide or support choices to be made in later steps of the DQO Process.** **- Select appropriate sampling and analysis methods for generating the information.**	
Principal Study Questions (From Step 2)	**Identify the Types of Information Needed**	**Identify the Source of Information**	**Identify Appropriate Sampling and Analysis Methods**
4. What are the sources of site-related COPCs in groundwater and leachate?	- COPC data from groundwater and leachate adjacent to and downgradient from Municipal Solid Waste (MSW) areas. - Landfill leachate indicator concentration data to determine if groundwater is influenced by landfill leachate. Primary constituents that comprise expected landfill leachate indicator parameters are listed in Work Plan Table 5-6. - Data qualifiers from the validation reports.	To be collected, groundwater and leachate data (including COPCs and landfill leachate indicators) from existing and new on-site monitoring wells (Work Plan Table 5-4) at locations near the Inactive Sanitary Landfill and Bridgeton Landfill and downgradient from these areas.	Groundwater sampling methods will be the same as PSQ #1. Leachate will be sampled from leachate collection points using extraction pumps as noted in FSP Section 3.15. See QAPP Table 2-2a for groundwater analytical methods for leachate analytical methods, including radionuclides.
		- Historical OU-1 and OU-2 groundwater and leachate COPC and landfill leachate indicator from wells and leachate points (Work Plan Section 2.4), including locations near the Inactive Sanitary Landfill and Bridgeton Landfill and downgradient from these areas. - Third-party offsite data as referenced in Work Plan Section 2.4 and other wells identified pending completion of off-site records search (Work Plan Section 5.2)	Existing historical OU-1 and OU-2 COPC groundwater data will ideally have been collected using similar sampling techniques as noted in FSP Section 3.14, or collected using methods considered to be standard procedures for environmental investigations (for example non low-flow sampling methods such as bailers, waterra pumps, submersible pumps). Laboratory analytical methods should be similar to those proposed in the QAPP for the OU-3 sampling. Existing leachate data will ideally have been sampled from leachate collection points using extraction pumps similar to what is currently installed at the site. See QAPP Table 2-2a for groundwater analytical methods and for leachate analytical methods.
	Naturally-occurring COPC concentrations in aquifer solids (alluvium and bedrock), redox indicator data, landfill leachate water quality, landfill leachate indicators in groundwater, groundwater temperature and pressure data as an indicator of the SSR, COPC groundwater concentration data within the study area, landfill gas extraction information to identify gas generating areas, and data qualifiers from the validation reports.	To be collected: - Aquifer matrix sampling of alluvium and bedrock cores (Work Plan Section 5.4.8) - Downhole screening of bedrock for gamma emitters using geophysical tools such as gamma-gamma, natural gamma, spectral gamma; downhole screening of alluvium using spectral gamma (Work Plan Section 5.4.9). Note, no drilling is proposed through waste materials or radiologically impacted materials (RIM) as part of the OU-3 groundwater assessment activities. - Groundwater temperature data (Work Plan Section 5.4.15) - Ground temperature, vadose zone pressure, and gas extraction data collected by Bridgeton Landfill (Weekly Reports) (Work Plan Section 5.4.17) - COPC data in groundwater, including dissolved landfill gases (Work Plan Section 5.4.15.3) - COPC data in leachate, including dissolved landfill gases and landfill leachate indicator data (Work Plan Section 5.4.17)	Aquifer Matrix sampling methods will include core sampling as described in FSP Section 3.6. Groundwater sampling methods will be the same as PSQ #1. Leachate will be sampled from leachate collection points using extraction pumps as per FSP Section 3.15. See QAPP Table 2-2a for groundwater COPCs and landfill leachate indicators, QAPP Table 2-2b for alluvium analytical methods and bedrock analytical methods. Groundwater temperature will be measured using a field parameter meter as described in FSP Section 3.14. Ground temperature, vadose zone pressure, and gas extraction data will be collected based on the methods described in FSP Section 3.20 (using information provided by Bridgeton Landfill).
		Existing third-party and historical OU-1 and OU-2 data (Work Plan Section 2.4): - Aquifer matrix sampling of alluvium and bedrock cores - Downhole screening of bedrock for gamma emitters using geophysical tools such as gamma-gamma, natural gamma, spectral gamma; downhole screening of alluvium using spectral gamma - Groundwater temperature data - Ground temperature, vadose zone pressure, and gas extraction data collected by Bridgeton Landfill (Weekly Reports) - COPC data in groundwater, including dissolved landfill gases - COPC data in leachate, including dissolved landfill gases and landfill leachate indicator data	Existing third-party data, and historical OU-1 and OU-2 data will ideally have been collected using similar techniques and lab analytical methods as the proposed OU-3 sampling.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 3. Identify Information Inputs		**- Identify types and sources of information needed to resolve decisions or produce estimates. - Identify the basis of information that will guide or support choices to be made in later steps of the DQO Process. - Select appropriate sampling and analysis methods for generating the information.**	
Principal Study Questions (From Step 2)	**Identify the Types of Information Needed**	**Identify the Source of Information**	**Identify Appropriate Sampling and Analysis Methods**
5. Where will COPCs migrate in the future?	Aquifer Properties (Hydraulic Conductivity, Storage Coefficient, Alluvium and Bedrock Types, Aquifer Discharge Rates, Density, Porosity and Grain Size)	- Historical OU-1 and OU-2 reports with aquifer property data (Work Plan Section 2.4). Data must meet historical data usability objectives (QAPP Section 4.1). - Third-party reports with aquifer properties (Work Plan Section 5.2)	Existing OU-1 and OU-2 data and third-party offsite aquifer property data will ideally have been collected using the same techniques and lab analytical methods as the proposed OU-3 sampling noted below.
		To be collected, hydraulic conductivity from slug testing data (Work Plan Table 5-4), hydraulic profiling tool (HPT) data (Work Plan Section 5.4.5), and straddle packer testing data (Work Plan Section 5.4.10)	See FSP Section 3.12 (slug testing), FSP Section 3.5.2.1 (HPT), and FSP Section 3.8 (packer testing)
		To be collected, aquifer transmissivity, storativity and discharge rate from aquifer pumping test data (Work Plan Section 5.4.14)	See FSP Section 3.13
		To be collected, bedrock types from lithologic parameter data obtained by downhole geophysical logs such as induction/conductivity electromagnetic (EM) logs, heat pulse flow meter logs, fluid temperature and electrical resistivity logs (Work Plan Section 5.4.9)	See FSP Section 3.7
		To be collected, in place soil density, porosity, grain size, and Atterberg Limits (Work Plan Section 5.4.8)	See FSP Section 3.6
	Horizontal and vertical hydraulic gradients within and between hydrostratigraphic zones	Historical OU-1 and OU-2 water level data (Work Plan Section 3.1.5.3)	Existing OU-1 and OU-2 water level data will ideally have been collected using similar techniques as the proposed OU-3 sampling.
		Existing third-party offsite water level data as referenced in Work Plan Section 5.2	Existing third-party water level data will ideally have been collected using similar techniques as the proposed OU-3 sampling.
		- To be collected, water levels from the proposed well network in Work Plan Tables 3-2 and 5-2, and third-party offsite wells identified pending completion of off-site records search (Work Plan Section 5.2) (See PSQ #2). - To be collected, surface water depth profile information from the surface water bodies noted in Work Plan Section 5.4.20.	See FSP Section 3.16 (water levels), FSP Section 3.4 (surface water survey)
	Aquifer Thickness and Preferential Pathways (Fractures, Cavities)	Existing aquifer thickness data (Work Plan Section 3.1.3.2.1), and fracture data from borehole/continuous core data (Work Plan Section 3.1.5.2.2)	See FSP 3.5.2 and 3.7.2
		To be collected, fracture/cavity data from borehole/continuous core data (Work Plan Section 5.4.7) and downhole geophysical logs such as SP/resistivity logs, induction/conductivity EM logs, and gamma-gamma logs (Work Plan Section 5.4.9)	
		To be collected, aquifer thickness (Work Plan Section 5.4.7)	

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 3. Identify Information Inputs		**- Identify types and sources of information needed to resolve decisions or produce estimates.** **- Identify the basis of information that will guide or support choices to be made in later steps of the DQO Process.** **- Select appropriate sampling and analysis methods for generating the information.**	
Principal Study Questions (From Step 2)	**Identify the Types of Information Needed**	**Identify the Source of Information**	**Identify Appropriate Sampling and Analysis Methods**
5. Where will COPCs migrate in the future?	Inorganic and Organic Retardation Parameters in Alluvium/Bedrock and Groundwater	Existing organic carbon partition data in literature	See FSP 3.6
		Potential for sorption loss as measured by proposed total organic carbon measurements which can be used to calculate fraction organic carbon (Work Plan Sections 5.4.8 Alluvium/Bedrock and 5.4.15 Groundwater)	
		Cation exchange capacity potential (inorganic retardation) as measured by proposed SEM-EDS mineralogical phase association analysis (Work Plan Section 5.4.8)	
		Cation exchange capacity potential (inorganic retardation) as measured by proposed sequential extraction testing and ferrous/ferric iron analysis (Work Plan Section 5.4.8)	
	Dispersion Coefficients	Existing third-party offsite COPC groundwater data from environmental reports in the area; reports may be available from MDNR Files pending completion of off-site records search (Work Plan Section 5.2).	See PSQ #2
		Plume morphology using COPC groundwater data to be collected (QAPP Table 2-2a and Work Plan Section 5.4.15). COPC nature and extent determined from PSQ #1-4.	
	Hydraulic Effects of Leachate Extraction from the Bridgeton Landfill on Discharge	To be collected, leachate extraction flow rates, volume totals, and fluid levels (Work Plan Section 5.4.17)	See FSP 3.16 and 3.20 (third-party data collection)
	Effects of the Ethylene Vinyl Alcohol (EVOH) Cover and Other Covers on Recharge	Existing onsite precipitation station, Lambert Field precipitation station, and water levels (Work Plan Section 5.4.16). Also needed for this study is information on landfill covers, including current and future spatial extent, permeability, and anticipated date of final cover placement.	See FSP 3.16 and 3.20 (third-party data collection)
	Effects of Precipitation on Recharge		
	Hydraulic Effects of Pumping Rates at Other Extraction Points	Third-party extraction data from environmental sites in the area; reports may be available from MDNR Files pending completion of off-site records search (Work Plan Section 5.2).	MDNR well database will be used to identify third-party extraction wells. Flow data will be requested if available; estimates will be made of the extraction rate if flow information is not available. The method for measuring flow will be determined on a case by case basis for each extraction well identified. Geospatial data for third-party extraction wells will be collected following the surveying procedures in FSP Section 3.4.
	Effects of Nearby Surface Water Features on Recharge and Discharge	Proposed staff gauge and water level data (Work Plan Section 5.4.16), geospatial data for surface water bodies	See FSP 3.4 (surveying), and FSP 3.17 (staff gauges)

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 4. Define the Boundaries of the Study			**- Define the target population of interest and its relevant spatial boundaries.** **- Define what constitutes a sampling unit.** **- Specify temporal boundaries and other practical constraints associated with sample/data collection.** **- Specify the smallest unit on which decisions or estimates will be made.**	
Principal Study Questions (From Step 2)	**Target Population**	**Spatial and Temporal Boundaries**	**Practical Constraints**	**Scale of Inference**
1. Are COPCs present in groundwater above screening levels?	The target population for this study includes current COPC concentrations / activity levels for the existing on-site wells and proposed new on-site and off-site wells.	The spatial boundary for the on-site and off-site OU-3 well network is shown on Work Plan Figure 3-17 as the study area. The vertical boundary of the well network is the Keokuk Formation based on the current understanding of the extent of COPCs, but could extend deeper if the vertical extent of COPCs extends into the KS. The temporal boundary is based on the date the well was installed. However, limited data are available prior to 1979 based on the oldest available on-site groundwater data. Proposed wells located within or near Area 1 and Area 2 of OU-1 will be abandoned, which will limit the temporal window for proposed groundwater sampling.	1. Lack of access to install new off-site wells at private properties. 2. Existing on-site wells may not be accessible due to the subsurface reaction (SSR). 3. Existing on-site wells may not be usable due to integrity issues (damaged or constricted) or removal due to OU-1 activities. 4. Limited availability of sonic drill rigs necessary to drill through the alluvium. 5. Flowing sands during drilling.	The scale for decisions about existing and new wells will be made on a per well location and per constituent basis.
	The target population for this study includes groundwater COPC concentration / activity level data from the third-party offsite locations to be identified in the off-site records search, including recent existing data and, where available, new data (to be collected pending access).	The spatial boundary for the off-site search is a 2-mile radius around the facility, which includes the properties west of the site up to the Missouri River and the developed properties north of the site. No temporal boundary exists for the off-site search where there is the potential for human receptors to be affected. MDNR well online well records are available for wells drilled after 1987; offline records are available for older wells from MDNR.	1. Lack of access to sample third-party existing off-site wells. 2. Incomplete MDNR files to identify potentially useful third-party wells as part of the off-site records search. 3. Poor quality and limited availability of third-party data.	The scale for decisions about existing and new wells for groundwater sampling locations will be made on a per location and per constituent basis.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 4. Define the Boundaries of the Study			**- Define the target population of interest and its relevant spatial boundaries.** **- Define what constitutes a sampling unit.** **- Specify temporal boundaries and other practical constraints associated with sample/data collection.** **- Specify the smallest unit on which decisions or estimates will be made.**	
Principal Study Questions (From Step 2)	**Target Population**	**Spatial and Temporal Boundaries**	**Practical Constraints**	**Scale of Inference**
2. What is the vertical and horizontal spatial distribution of COPCs above screening levels in groundwater?	The target population for this study includes current COPC concentrations / activity levels in groundwater from the existing on-site wells and proposed new on-site and off-site wells.	The spatial boundary for the on-site and off-site OU-3 well network is shown on Work Plan Figure 3-17 as the study area. The vertical boundary of the well network is the Keokuk Formation based on the current understanding of the extent of COPCs, but could extend deeper if the vertical extent of COPCs extends into the Keokuk. The temporal boundary is based on the date the well was installed. However, limited data are available prior to 1979 based on the oldest available on-site groundwater data. Proposed wells located within or near Area 1 and Area 2 of OU-1 will be abandoned, which will limit the temporal window for proposed groundwater sampling.	1. Lack of access to install new off-site wells. 2. Existing onsite wells and leachate sumps may not be accessible due to the SSR. 3. Existing onsite wells may not be usable due to integrity issues (damaged or constricted) or removal due to OU-1 activities. 4. Limited availability of sonic drill rigs necessary to drill through the alluvium. 5. Flowing sands during drilling.	The scale for decisions about the lateral distribution of COPCs will be made on a per well and per leachate sump basis. The scale for decisions about the vertical distribution of COPCs will be made on a per well and per leachate sump basis using wells or sumps within each of the water-bearing zones (AS, AI, AD, SS, SD, KS). Information from wells within each of these units will be evaluated as separate populations for this PSQ.
	The target population for this study includes historical COPC concentration / activity level data from the existing onsite wells.	The spatial boundary for the historical COPC groundwater data are shown on Work Plan Figure 3-17 as the study area. The vertical boundary for the groundwater well network is the Keokuk Formation based on the current understanding of the extent of COPCs, but could extend deeper if the vertical extent of COPCs extends into the Keokuk. The temporal boundary is based on the date the well was installed. However, limited data are available prior to 1979 based on the oldest available on-site groundwater data.	1. Poor quality and limited availability of historical data.	
	The target population for this study includes COPC concentration / activity level data from the third-party offsite groundwater wells, including existing data and, where available new data (to be collected pending access), and including recent and historical data.	The spatial boundary for the off-site data search is a 2-mile radius around the facility, which includes the properties west of the site up to the Missouri River and the developed properties north of the site. The temporal boundary for the off-site data search will be limited to the date the MDNR well records began. Online well records are available for wells drilled after 1987; offline records are available for older wells from MDNR directly.	1. Lack of access to sample third-party existing off-site off-site wells. 2. Incomplete MDNR files to identify potentially useful third-party wells as part of the off-site records search. 3. Poor quality and availability of third-party data.	

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 4. Define the Boundaries of the Study			**- Define the target population of interest and its relevant spatial boundaries.** **- Define what constitutes a sampling unit.** **- Specify temporal boundaries and other practical constraints associated with sample/data collection.** **- Specify the smallest unit on which decisions or estimates will be made.**	
Principal Study Questions (From Step 2)	**Target Population**	**Spatial and Temporal Boundaries**	**Practical Constraints**	**Scale of Inference**
3. Are the COPCs site-related?	The target population for this study includes current COPC concentrations for the existing onsite wells and proposed new on-site and off-site wells, especially wells associated with potential source areas and wells downgradient from the potential source areas.	For groundwater: The spatial boundary for the on-site and off-site OU-3 well network is shown on Work Plan Figure 3-17 as the study area. The vertical boundary of the well network is the Keokuk Formation based on the current understanding of the extent of COPCs, but could extend deeper if the vertical extent of COPCs extends into the Keokuk. The temporal boundary is based on the date the well was installed. Proposed wells located within or near Area 1 and Area 2 of OU-1 will be abandoned, which will limit the temporal window for sampling. For leachate: The spatial boundary for leachate points will be the perimeter of the former waste units. The vertical boundary will be the base of the former waste units. The temporal boundary for the leachate points will be based on the date that the leachate point was installed. Some of the LCS leachate points are no longer accessible due to the SSR.	1. Lack of access to install new off-site wells at private properties. 2. Existing onsite wells and leachate sumps may not be accessible due to the SSR. 3. Existing onsite wells may not be usable due to integrity issues (damaged or constricted) or removal due to OU-1 activities. 4. Limited availability of sonic drill rigs necessary to drill through the alluvium. 5. Flowing sands during drilling.	The scale for decisions about the lateral distribution of COPCs will be made on a per well and per leachate sump basis. The scale for decisions about the vertical distribution of COPCs will be made on a per well and per leachate sump basis using wells or sumps within each of the water-bearing zones (AS, AI, AD, SS, SD, KS). Information from wells within each of these units will be evaluated as separate populations for this PSQ.
	The target population for this study includes historical groundwater COPC concentration data from wells and leachate points associated with potential source areas are listed in Table 5-8 of the Work Plan. Also COPC concentration data from former wells and leachate points that have been plugged/abandoned, damaged, or removed will be included.	For groundwater: The spatial boundary for the on-site and off-site OU-3 well network is shown on Work Plan Figure 3-17 as the study area. The vertical boundary of the well network is the KS Formation based on the current understanding of the extent of COPCs, but could extend deeper if the vertical extent of COPCs extends into the KS. The temporal boundary is based on the date the well was installed. However, limited data are available prior to 1979 based on the oldest available on-site groundwater data. For leachate: The COPC concentration data in leachate, the spatial boundary will be the perimeter of the former waste units. The vertical boundary will be the base of the former waste units. The temporal boundary for the leachate points will be based on the date that the leachate point was installed. Historical data from LCS leachate points may include LCS locations which are currently not accessible due to the SSR.	1. Poor quality and limited availability of historical data.	
	The target population for this study includes COPC concentration / activity level data from the third-party offsite wells, including existing data and, where available, new data (to be collected pending access), and including recent and historical data.	The spatial boundary for the off-site data search is a 2-mile radius around the facility, which includes the properties west of the site up to the Missouri River and the developed properties north of the site. The temporal boundary for the off-site data search will be limited to the date the MDNR well records began. Online well records are available for wells drilled after 1987; offline records are available for older wells from MDNR directly.	1. Lack of access to sample third-party existing off-site data. 2. Incomplete MDNR files to identify potentially useful third-party wells as part of the off-site records search. 3. Poor quality and availability of third-party data.	

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 4. Define the Boundaries of the Study			**- Define the target population of interest and its relevant spatial boundaries.** **- Define what constitutes a sampling unit.** **- Specify temporal boundaries and other practical constraints associated with sample/data collection.** **- Specify the smallest unit on which decisions or estimates will be made.**	
Principal Study Questions (From Step 2)	**Target Population**	**Spatial and Temporal Boundaries**	**Practical Constraints**	**Scale of Inference**
4. What are the sources of site-related COPCs in groundwater?	The target population for this study includes current COPC concentration data from wells and leachate points associated with potential source areas are listed in Table 5-8 of the Work Plan.	For the current and historical COPC concentration data in groundwater, the spatial boundary for the on-site and off-site OU-3 well network is shown on Work Plan, Figure 3-17 as the study area. The vertical boundary of the well network is the Keokuk Formation based on the current understanding of the extent of COPCs, but could extend deeper if the vertical extent of COPCs extends into the Keokuk. The temporal boundary for the proposed wells is based on the date the well was installed. Proposed wells located within or near Area 1 and Area 2 of OU-1 will be abandoned, which will limit the temporal window for proposed groundwater sampling. For the current and historical COPC concentration data in leachate, the spatial boundary will be the perimeter of the former waste units. The vertical boundary will be the base of the former waste units. The temporal boundary for the leachate points will be based on the date that the leachate point was installed. Some of the Leachate Collection Sump (LCS) leachate points are no longer accessible due to the SSR.	1. Lack of access to install new off-site wells. 2. Existing onsite wells and leachate sumps may not be accessible due to the SSR. 3. Existing onsite wells may not be usable due to integrity issues (damaged or constricted) or removal due to OU-1 activities. 4. Limited availability of sonic drill rigs necessary to drill through the alluvium. 5. Flowing sands during drilling.	The scale for decisions about the sources of COPCs will be made on a per waste unit basis. Information from wells within each of these units will be evaluated as separate populations for this PSQ.
	The target population for this study includes historical COPC concentration data from wells and leachate points associated with potential source areas are listed in Table 5-8 of the Work Plan. Also COPC concentration data from former wells and leachate points that have been plugged/abandoned, damaged, or removed will be included.		1. Poor quality and limited availability of historical data.	
	The target population for this study includes current radionuclide COPC concentration data from existing and new wells and leachate points associated with areas with RIM and downgradient locations.		1. Lack of access to install new off-site wells. 2. Existing onsite wells and leachate sumps may not be accessible due to the SSR. 3. Existing onsite wells may not be usable due to integrity issues (damaged or constricted) or removal due to OU-1 activities. 4. Limited availability of sonic drill rigs necessary to drill through the alluvium. 5. Flowing sands during drilling.	
	The target population for this study includes historical radionuclide COPC concentration data from wells and leachate points associated with RIM deposition areas. Also radionuclide COPC concentration data from former wells and leachate points that have been plugged/abandoned, damaged, or removed will be included.		1. Poor quality and limited availability of historical data.	
	The target population for this study includes current COPC and landfill leachate indicator concentration data from wells and leachate points associated with areas with MSW and downgradient locations.		1. Lack of access to install new off-site wells. 2. Existing onsite wells and leachate sumps may not be accessible due to the SSR. 3. Existing onsite wells may not be usable due to integrity issues (damaged or constricted) or removal due to OU-1 activities. 4. Limited availability of sonic drill rigs necessary to drill through the alluvium. 5. Flowing sands during drilling.	
	The target population for this study includes historical COPC and landfill leachate indicator concentration data from wells and leachate points associated with MSW. Also COPC and landfill leachate indicator concentration data from former wells and leachate points that have been plugged/abandoned, damaged, or removed will be included.		1. Poor quality and limited availability of historical data.	

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 4. Define the Boundaries of the Study			**- Define the target population of interest and its relevant spatial boundaries.** **- Define what constitutes a sampling unit.** **- Specify temporal boundaries and other practical constraints associated with sample/data collection.** **- Specify the smallest unit on which decisions or estimates will be made.**	
Principal Study Questions (From Step 2)	**Target Population**	**Spatial and Temporal Boundaries**	**Practical Constraints**	**Scale of Inference**
5. Where will COPCs migrate in the future?	The target population includes naturally-occurring COPC data in aquifer matrix material (alluvium and bedrock); groundwater COPC and landfill leachate indicator concentration data from wells and leachate points; groundwater temperature data; ground temperature, vadose zone pressure, and gas extraction data.	The spatial boundary for the aquifer matrix sampling and downhole geophysics includes background wells located upgradient or sidegradient from the site to provide naturally-occurring COPC data. The vertical boundary of the aquifer matrix sampling and downhole geophysics is the base of the Salem Formation based on the current understanding of the extent of COPCs, but could extend deeper if the vertical extent of COPCs extends into the KS. The temporal boundary for the aquifer matrix sampling and downhole geophysics for naturally-occurring COPCs is unlimited since this background data may be useful to establishing a statistically significant average concentration of naturally-occurring COPCs. The boundaries for the groundwater sampling are the same as PSQ#1. The boundaries for the leachate sampling are listed above (cite more specifically). The spatial boundary for the groundwater temperature and ground temperature, pressure and gas extraction rates is limited to onsite and nearsite where landfill-related changes in these parameters is anticipated. The vertical boundary for these measurements is below the measurable influence of the SSR which is currently to the base of the Salem Formation though this may change over time.	Same as PSQ #1. Also: 1. Low or poor recovery of alluvium and/or bedrock cores by the drill rig, including loss due to flowing sands. 2. Mechanical failure of drill rig. 3. Lack of access to leachate collection points, gas extraction points, and temperature probes due to SSR health and safety concerns (high pressure, high temperature). 4. Ongoing heat exchange system operation in SSR area may obscure trends.	The scale for decisions about the occurrence of naturally-occurring COPCs in aquifer matrix materials will be all background locations as one decision unit per vertical interval (AS, AI, AD, SS, SD). The scale for decisions about groundwater wells will be made on a per well basis. The scale for decisions about the leachate collection points, groundwater temperature, ground temperature/pressure, and gas extraction rates will be by landfill unit, including South Quarry and North Quarry.
	The target population for this study includes existing third-party and historical OU-1 and OU-2 naturally-occurring COPC data from sampling of aquifer matrix material (alluvium and bedrock); downhole geophysical screening for gamma emitters; groundwater COPC and landfill leachate indicator concentration data from wells and leachate points; groundwater temperature data; ground temperature, vadose zone pressure, and gas extraction data. Also COPC and landfill leachate indicator concentration data from former wells and leachate points that have been plugged/abandoned, damaged, or removed will be included.			
	The target population includes historical slug test data with hydraulic conductivity estimates, aquifer pumping test data estimates with aquifer storativity coefficients, packer testing data with transmissivity estimates, downhole geophysical hydrogeologic parameter data with soil/alluvium and bedrock type estimates, and geotechnical data (grain size, porosity, density, Atterberg limits).	The spatial boundary for the aquifer property data collection includes the modeling domain shown in Work Plan Figure 3-17. The vertical boundary is to the KS Formation, which is consistent with the groundwater sampling vertical boundary. The vertical boundary for collection of aquifer property data could change if the vertical extent of COPCs extends into the KS. The temporal boundary for the aquifer property data are unlimited since a broad dataset may be useful in refining the CSM.	Same as PSQ #1. Also: 1. Low or poor recovery of alluvium and/or bedrock cores by the drill rig, including loss due to flowing sands. 2. Mechanical failure of drill rig. 3. Cost constraints of generating and disposing of large quantities of Investigation Derived Waste during aquifer pumping test. 4. Bent casing can limit deployment of geophysical tooling.	The scale for decisions will be by hydrostratigraphic zone.
	The target population includes proposed slug test data, HPT data, packer testing data.			
	The target population includes proposed aquifer transmissivity, storativity, and discharge rate data.			
	The target population includes bedrock types from downhole geophysics, including data from at least one of these types of logs: induction/conductivity EM logs, heat pulse flow meter logs, fluid temperature and electrical resistivity logs.			
	The target population includes proposed geotechnical data (grain size, porosity, density, Atterberg limits).			

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Step 4. Define the Boundaries of the Study			**- Define the target population of interest and its relevant spatial boundaries.** **- Define what constitutes a sampling unit.** **- Specify temporal boundaries and other practical constraints associated with sample/data collection.** **- Specify the smallest unit on which decisions or estimates will be made.**	
Principal Study Questions (From Step 2)	**Target Population**	**Spatial and Temporal Boundaries**	**Practical Constraints**	**Scale of Inference**
5. Where will COPCs migrate in the future?	The target population includes historical and proposed water level data collected from on-site, near-site, off-site, background, and third-party wells. The target population also includes the depth profile for surface water bodies.	The spatial boundary for water level data includes the modeling domain shown in Work Plan Figure 3-17. The vertical boundary for water level data collection extends to the screened intervals of wells installed in the KS Formation, but could change if the vertical extent of COPCs extends into the KS. The temporal boundary for water level data will be based on usability of data collected during the monitoring well inventory. Historical on-site water levels currently extend back to 1979. The spatial boundary for the surface water depth profile information is the study area as shown in Work Plan Figure 3-17. The vertical boundary is the maximum depth of the surface water bodies. The temporal boundary for surface water depth profile information is based on current depth information, though historical depth information (where available) could be useful for areas where the depths have changed over time.	Same as PSQ #1	The scale for decisions on water levels will be within and between hydrostratigraphic zones. The scale for decisions on surface water body depth profile will be based on an individual surface water body basis.
	The target population includes the thickness of the hydrostratigraphic zones based on correlation between existing and proposed borehole logs and continuous core data. Also includes fracture/cavity information from SP/resistivity logs, induction/conductivity EM logs, and gamma-gamma logs to identify preferential pathways such as fractures/cavities.	The spatial boundary for aquifer thickness, fracture/cavity log, and lithology from downhole geophysics data includes the modeling domain shown in Work Plan Figure 3-17. The vertical boundary extends to the screened intervals of wells installed in the KS Formation, but could change if the vertical extent of COPCs extends into the Keokuk. There is no temporal boundary for aquifer thickness data.	Same as PSQ #1. Also: 1. Low or poor recovery of alluvium and/or bedrock cores by the drill rig, including loss due to flowing sands. 2. Mechanical failure of drill rig. 3. Cost constraints of generating and disposing of large quantities of Investigation Derived Waste during aquifer pumping test. 4. Bent casing can limit deployment of geophysical tooling.	The scale for decisions will be within and between hydrostratigraphic zone.
	The target population includes existing site-specific measurements and literature values for total organic carbon or fraction organic carbon for the Missouri River alluvium and bedrock.	The spatial boundary for retardation parameters includes the modeling domain shown in Work Plan Figure 3-17. The vertical boundary extends to the screened intervals of wells installed in the Keokuk Formation, but could change if the vertical extent of COPCs extends into the Keokuk. There is no temporal boundary for aquifer thickness data.	Same as PSQ #1. Also: 1. Low or poor recovery of alluvium and/or bedrock cores by the drill rig, including loss due to flowing sands. 2. Mechanical failure of drill rig. 3. Cost constraints of generating and disposing of large quantities of Investigation Derived Waste during aquifer pumping test.	The scale for decisions will be within and between each hydrostratigraphic zone.
	The target population includes proposed total organic carbon data proposed to be collected from alluvium and bedrock samples, which will be used to calculate fraction of organic carbon.			
	The target population includes the abundance of the major minerals and radionuclide speciation from XRD analysis of alluvium and bedrock samples. The target population also includes elemental analysis and phase associations from SEM-EDS analysis of alluvium and bedrock matrix samples.			
	The target population includes results of leaching tests to be conducted on alluvium samples (bedrock samples cannot be run for sequential analysis according to the MCLI laboratory).			

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Step 4. Define the Boundaries of the Study			**- Define the target population of interest and its relevant spatial boundaries.** **- Define what constitutes a sampling unit.** **- Specify temporal boundaries and other practical constraints associated with sample/data collection.** **- Specify the smallest unit on which decisions or estimates will be made.**	
Principal Study Questions (From Step 2)	**Target Population**	**Spatial and Temporal Boundaries**	**Practical Constraints**	**Scale of Inference**
5. Where will COPCs migrate in the future?	The target population includes COPC data from off-site and third-party wells, which will be used to support prediction of dispersion coefficients.	Same as PSQ #1	Same as PSQ #1	The scale for decisions will be within and between each hydrostratigraphic zone.
	The target population includes pumping rates and totalizer readings from the Bridgeton Landfill; fluid levels from the leachate collection system; and water levels collected from on-site and off-site alluvial and bedrock wells.	The spatial boundary for leachate extraction flow rates, volume totals, and fluid levels includes the Bridgeton Landfill. The vertical boundary extends to the base of the South Quarry portion of the Bridgeton Landfill. The temporal boundary currently extends back to 1996.	Same as PSQ #1	The scale for decisions will be within and between hydrostratigraphic zone.
	The target population includes water level data collected from on-site, off-site, and third-party monitoring wells.	The spatial boundary for effects of the EVOH and other covers on recharge includes the site boundary. The vertical boundary extends to the Salem Formation. The temporal boundary extends back to 1979.		
	The target population includes precipitation data collected from the on-site precipitation station and the Lambert Field precipitation station.	The spatial boundary for the effects of precipitation on recharge include the modeling domain shown in Work Plan Figure 3-17. The vertical boundary extends to the Salem Formation. The temporal boundary currently extends back to 1979, but will be based on the results of the records search for third-party wells.		
	The target population includes third-party pumping rates or totalizer volumes.	The spatial boundary for effects of pumping rates at other extraction points includes the modeling domain shown in Work Plan Figure 3-17. The vertical boundary extends to the Salem Formation. The temporal boundary currently extends back to 1979, but will be based on the results of the records search for third-party wells.		
	The target population includes water level data collected from on-site, off-site and third-party staff gauges and monitoring wells.	The spatial boundary for effects of nearby surface water features on recharge and discharge includes the modeling domain shown on Work Plan Figure 3-17. The vertical boundary extends to the Salem Formation. The temporal boundary currently extends back to 1984, but will be reevaluated if other surface water data are available.		

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Step 5. Develop the Analytic Approach		**- Specify appropriate population parameters for making decisions or estimates.** **- For decision problems, choose a workable Action Level and generate an "If … then … else" decision rule which involves it.** **- For estimation problems, specify the estimator and the estimation procedure.**
Principal Study Questions (From Step 2)	**Population Parameter**	**Decision Problem / Action Level**
1. Are COPCs present in groundwater above screening levels?	The population parameter is an individual groundwater constituent in an individual sample in an individual well. The detected concentrations will be compared to screening levels. The COPC concentrations are from the existing and proposed wells in the OU-3 well network (Work Plan Table 5-4), and existing water wells within a 2-mile radius of the site, including active or inactive domestic, drinking water, irrigation, livestock, industrial water supply, injection wells, monitoring wells, and extraction wells to be identified in off-site records search (Work Plan Section 5.2). Groundwater COPCs are listed in QAPP Table 2-3a, including method detection limits (MDLs), Method Reporting Limit (MRL), and USEPA RSLs, MCLs, and PRGs (as applicable). The COPC list for groundwater will be evaluated after multiple events worth of data are available; requests will be submitted to the USEPA to remove analytes once sufficient data are collected to support the request.	- If groundwater concentrations are above applicable screening levels, then those constituents will be reviewed as part of the final COPC identification process (Work Plan Section 6.2.5). - If concentrations of semi-volatile organic compounds (SVOCs), polychlorinated biphenyl (PCBs), and fuels are non-detected or below screening levels in on-site/near-site wells for multiple events, then a proposal will be made to the USEPA to delete those methods and/or analytes from future monitoring events (Work Plan Section 6.2.5.3). - Any constituent detected above the screening level in any well will be retained as a COPC unless a line of evidence decision can be made (subject to USEPA approval) showing that the constituent can be removed (Work Plan 6.2.5).

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Step 5. Develop the Analytic Approach		**- Specify appropriate population parameters for making decisions or estimates.** **- For decision problems, choose a workable Action Level and generate an "If … then … else" decision rule which involves it.** **- For estimation problems, specify the estimator and the estimation procedure.**
Principal Study Questions (From Step 2)	**Population Parameter**	**Decision Problem / Action Level**
2. What is the vertical and horizontal spatial distribution of COPCs above screening levels in groundwater?	The population parameter is an individual groundwater constituent in an individual sample in an individual well. The detected concentrations will be compared to screening levels. The COPC concentrations are from the existing and proposed wells in the OU-3 well network (Work Plan Table 5-4), and existing water wells within a 2-mile radius of the site, including active or inactive domestic, drinking water, irrigation, livestock, industrial water supply, injection wells, monitoring wells, and extraction wells to be identified in records search (Work Plan Section 5.2). Groundwater COPCs are listed in QAPP Table 2-3a, including MDLs, MRL, and USEPA RSLs, MCLs, and PRGs (as applicable). The COPC list for groundwater will be evaluated after multiple events worth of data are available; requests will be submitted to the USEPA to remove analytes once sufficient data are collected to support the request.	- If groundwater COPC concentrations are present above applicable screening levels in a well, then the estimated extent of the groundwater impacts for that COPC will extend to that well location. Additional step out wells will be installed down-gradient from impacted wells until the extent of groundwater impacts is defined laterally. - If groundwater COPC concentrations are present below applicable screening levels in the proposed initial set of 500-series wells, then step-in wells will be installed at selected locations closer to the site to confirm whether COPCs are present offsite between the 500-series wells and the property boundary. - If groundwater COPC concentrations are present above applicable screening levels within one or more water bearing zone(s), then additional step-out wells will be installed to define the extent of groundwater impacts within the impacted vertical zone including one well above the impacted zone and one well below the impacted zone. For example, if elevated radium is detected in the AD zone, the step out well will include at least three wells screened within the AI, AD, and SS zones. - Initial COPC data from proposed and existing wells will be used to evaluate the adequacy of the well network based on the process noted in QAPP Section 4.2. If the well network is determined to be inadequate, then additional wells will be proposed in an addendum of the OU-3 Remedial Investigation/Feasibility Study (RI/FS) Work Plan. Additional wells may include step-out wells and step-in wells, additional background wells, or wells to address data gaps that arise. - If groundwater has detections of constituents that are not COPCs, but that are relevant to an overall geochemical evaluation, such as some of the landfill leachate indicators or redox parameters (Work Plan Table 5-6), then these will be retained but will not be used in determination of COPC groundwater plume extent.
		- Historical data will be used for reference purposes to assist with evaluating the well network adequacy and to help with making decisions related to PSQ#2. This data may also be used to verify seasonal data trends.
		- Third-party wells will be evaluated to determine if the well is located down-gradient from the facility, and if constituents detected in the third-party well are site related. If groundwater concentrations in third-party wells meeting these requirements are above applicable screening levels, then data from these locations will be considered for estimating the lateral and vertical distribution of groundwater impacts. Step in and step out wells are not proposed based on data from third-party wells at this time. - If third-party wells groundwater concentrations are below applicable screening levels, then that information will be used as confirmation (along with other lines of evidence) to determine the extent of a groundwater plume.

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Step 5. Develop the Analytic Approach		**- Specify appropriate population parameters for making decisions or estimates.** **- For decision problems, choose a workable Action Level and generate an "If … then … else" decision rule which involves it.** **- For estimation problems, specify the estimator and the estimation procedure.**
Principal Study Questions (From Step 2)	**Population Parameter**	**Decision Problem / Action Level**
3. Are the COPCs site-related?	Same as PSQ #1 Background COPC concentrations will be calculated using a 95% upper confidence limit (UCL) as per QAPP Section 4.3.7. The minimum number of sampling events required for the calculation will be determined after collection of at least four monitoring events and by the method specified in the QAPP.	- If the 95% UCL for a COPC from the background well population is less than the screening level, then any exceedance of that COPC will not be attributable to background conditions (i.e. not naturally-occurring). - If the 95% UCL for a COPC from the background well population is greater than the screening level, then any of exceedance of that COPC will be at least partially attributable to background conditions. The relative contribution of the background COPC concentration / activity level will be estimated spatially over the study area to understand lateral and vertical variability. Multiple lines of evidence will be used to designate COPCs in offsite groundwater as site-related: - If source area COPCs are also present in offsite groundwater wells, then COPCs may have migrated offsite. - If an offsite well is located hydraulically downgradient, then the data from this well will be used to show COPC migration. - If an up-gradient offsite source with similar COPCs is not documented, then the documentation will be reviewed to determine if this shows an up-gradient source. Multiple lines of evidence will be used to designate COPCs in offsite groundwater as not site-related: - If COPC concentrations are consistent with naturally-occurring background water quality based on the 95% UCL (noted above), then the COPC concentrations may be partially or fully related to the naturally-occurring background. - If the off-site well with COPCs is located hydraulically downgradient of an identified off-site source of environmental release of the same or similar COPCs, then COPCs may be migrating off-site. - If the off-site well is located where COPCs are not otherwise anticipated to be present resulting from groundwater migration from site-related sources, then the COPCs may have migrated outside of the expected area.

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Step 5. Develop the Analytic Approach		**- Specify appropriate population parameters for making decisions or estimates.** **- For decision problems, choose a workable Action Level and generate an “If … then … else” decision rule which involves it.** **- For estimation problems, specify the estimator and the estimation procedure.**
Principal Study Questions (From Step 2)	**Population Parameter**	**Decision Problem / Action Level**
4. What are the sources of site-related COPCs in groundwater?	The population parameter is an individual constituent in an individual sample in an individual well or leachate collection point. The detected concentrations will be compared to screening levels. The COPC concentrations are from the existing wells and leachate points, the proposed wells in the OU-3 well network (Work Plan Table 5-4), and existing water wells within a 2-mile radius of the site, including active or inactive domestic, drinking water, irrigation, livestock, industrial water supply, injection wells, monitoring wells, and extraction wells to be identified in records search (Work Plan Section 5.2). Groundwater COPCs are listed in QAPP Table 2-3a and leachate COPCs are listed in QAPP Table 2-3b, including MDLs, MRL, and USEPA RSLs, MCLs, and PRGs (as applicable). The COPC list for groundwater will be evaluated after multiple events worth of data are available; requests will be submitted to the USEPA to remove analytes once sufficient data are collected to support the request.	This decision will be based on multiple lines of evidence: - If groundwater or leachate associated with a source area has COPCs that are common to down-gradient off-site groundwater, then that source area may be contributing to down-gradient impacts offsite. - If groundwater or leachate concentrations associated with a source area have similar concentrations to off-site groundwater, then that source area may be contributing to groundwater impacts offsite. - If groundwater associated with a source area have unique redox or geochemical fingerprints, then redox parameters and geochemical analyte concentrations may be used to identify potential sources in downgradient water quality. - If groundwater flow direction indicates that a potential source is located hydraulically upgradient from an off-site area with impacted groundwater, then that source area may be contributing to groundwater impacts offsite.
	Same as PSQ #1. COPC groundwater data from Areas 1 and 2 will be one population associated with RIM. Down-gradient COPC groundwater data will be a second population.	This decision will be based on multiple lines of evidence: - If groundwater or leachate associated with RIM areas have radionuclide COPCs that are common to downgradient offsite groundwater monitoring locations, then the RIM areas may be contributing to downgradient impacts offsite. - If groundwater or leachate associated with RIM areas have similar Ra226/Ra228 activity level ratios to downgradient offsite groundwater monitoring locations, then the RIM areas may be contributing to downgradient impacts offsite.
	Same as PSQ #1. COPC and leachate groundwater data from MSW areas (Inactive Sanitary Landfill, Bridgeton Landfill) will be one population. Downgradient COPC groundwater data will be a second population.	This decision will be based on multiple lines of evidence: - If wells or leachate associated with MSW areas have COPCs that are common to down-gradient off-site groundwater monitoring locations, then the MSW areas may be contributing to down-gradient impacts offsite. - If wells have evidence of landfill leachate from MSW based on the presence of similar leachate indicators in source wells and down-gradient off-site groundwater monitoring wells, then the MSW may be contributing to down-gradient impacts offsite.
	The population parameters for the aquifer matrix sampling and downhole geophysics include five populations of COPC results from the background wells, including results from the five vertical intervals (AS, AI, AD, SS, SD); no sampling is proposed in the KS Formation. The aquifer matrix sampling and downhole geophysics results from the onsite wells will be one population representative of site conditions. The aquifer matrix sampling and downhole geophysics results from the offsite downgradient wells will be one population representative of downgradient site conditions for comparison purposes. The population parameter for the groundwater and leachate sampling from locations with evidence of landfill leachate indicators (Work Plan Table 5-6) will be one population. The population parameter for groundwater sampling locations without evidence of landfill leachate indicators such as results from individual offsite downgradient wells will be one population for comparison purposes. Landfill indicator data from onsite (groundwater temperature, ground temperature, pressure, and gas extraction rates) will be one population. A second population would be data from background locations which will be used to establish background levels. A third population would be data from downgradient locations for comparison purposes.	This decision will be based on multiple lines of evidence: - Groundwater and leachate data from onsite will be evaluated to identify common landfill indicator COPCs and/or or redox conditions (Work Plan Table 5-6). If the statistically-based leachate chemical fingerprint that is generated is similar to the down-gradient off-site groundwater water quality, then the landfill leachate may be contributing to down-gradient impacts offsite. - Background COPC concentrations of landfill leachate indicators in groundwater will be calculated (see QAPP Section 4.3.7). If down-gradient off-site groundwater monitoring wells with possible leachate indicators have COPC concentrations / activity levels that are greater than background COPC groundwater concentrations, then the landfill leachate may be contributing to down-gradient impacts offsite. - If the COPC aquifer matrix concentrations / activity levels and gamma activity levels from the downhole geophysics are comparable (background vs onsite vs downgradient), then COPCs have been liberated by leachate. - If landfill gas pressure, groundwater temperature, and ground temperature readings are mapped and show that the spatial extent of landfill influences based on a comparison with background well readings are similar, then leachate may not be influenced by up-gradient sources.

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Step 5. Develop the Analytic Approach		**- Specify appropriate population parameters for making decisions or estimates.** **- For decision problems, choose a workable Action Level and generate an "If … then … else" decision rule which involves it.** **- For estimation problems, specify the estimator and the estimation procedure.**
Principal Study Questions (From Step 2)	**Population Parameter**	**Decision Problem / Action Level**
5. Where will COPCs migrate in the future?	See below for population parameters for data from existing reports	Multiple factors from each input parameter below within PSQ #5 will be used to evaluate COPC migration potential currently and in the future. - Results from aquifer property testing will be compared to historical measurements for consistency and spatial variability. If the values are consistent, then the historical and new results will both be considered in future calculations. - If newly collected aquifer property data meets the data quality objectives, then it will be compared between wells to estimate variability. - If the aquifer property data meets the data quality objectives, then it will be used to refine the CSM and reported as part of the Annual Hydrogeologic Report. - If the aquifer properties noted above meet data quality objectives, then that data will be used as inputs into a fate and transport evaluation to determine the potential for future migration. - If the fate and transport evaluation indicates there is not a potential for the COPCs to migrate beyond the current extent of impacts in the future, then the technical reasons for the groundwater plume stability will be determined to assist with long-term planning for the site. This may include evaluating the potential offsite migration in the absence of leachate extraction and other scenarios as defined in the Groundwater Modeling Work Plan. - If the fate and transport evaluation indicates there is a potential for COPCs to migrate beyond the current extent of impacts in the future, then simulations will be run to determine the potential future extent and remedial option alternatives will be proposed as necessary to support the Feasibility Study phase of work. - See below for estimation statements for each PSQ #5 data input:
	- The population parameters for Slug Testing: Fluid Levels (feet above mean sea level), Time (minutes) - The population parameters for HPT Testing: Injection Pressure (pounds per square inch), Flow Rate (milliliters per minute), Rate of Penetration (feet per minute), Electrical Conductivity (milli-siemens per meter), Depth every 0.05 ft (feet above mean sea level), Estimated hydraulic conductivity (cm/sec) - The population parameters for Straddle Packer Testing: Hydraulic conductivity (cm/sec), Depth (ft above mean sea level), Pressure of Packer and Gauge (pounds per square inch), Discharge Rate (gallons per 5 minutes), Flow Rate (gallons per minute), Time (seconds)	- Estimate the mean or geometric mean values for hydraulic conductivity from at least six data points for each zone (AS, AI, AD, SS, SD). - Estimate and identify the primary groundwater flow paths in conjunction with geotechnical data (below) and extent of COPCs from PSQ #2.
	The population parameters for Aquifer Pumping Tests: Flow Rates (gallons per minute), Fluid Levels (feet above mean sea level), Time (minutes)	- Estimate the aquifer storativity results from aquifer pumping tests.
	- The population parameters for induction/conductivity EM logs: depth below top of casing (feet) and electromagnetic conductivity (millisiemens per meter) - The population parameters for heat pulse flow meter logs: depth below top of casing (feet), pulse - kilohertz (KHz), volumetric flow rate (gpm), flow velocity (ft/min) - The population parameters for fluid temperature: depth below top of casing (ft) and temperature (degrees Fahrenheit) - The population parameters for electrical resistivity logs: depth below top of casing (ft) and resistance – ohms	- Estimate the bedrock types from the downhole geophysics in conjunction with visual logging.
	The population parameters for geotechnical testing: Grain size distribution (percent by millimeter diameter), Porosity (unitless), Density (grams per cubic foot), Atterberg Limits (liquidity index)	- Estimate and identify the primary groundwater flow paths in conjunction with results from HPT pilot testing, slug testing, packer testing, and COPC extent from PSQ #2.
	The population parameters for horizontal and vertical hydraulic gradients: groundwater elevations (ft above mean sea level), distance between measuring points (feet), horizontal gradients (ft/foot), vertical gradients (ft/foot). The population parameter for the surface water depth profile: base of pond (ft above mean sea level).	- Estimate and determine the groundwater flow direction and gradients throughout the year and over the preliminary model domain that will be used to evaluate the potential groundwater flow paths.

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Step 5. Develop the Analytic Approach		**- Specify appropriate population parameters for making decisions or estimates.** **- For decision problems, choose a workable Action Level and generate an "If … then … else" decision rule which involves it.** **- For estimation problems, specify the estimator and the estimation procedure.**
Principal Study Questions (From Step 2)	**Population Parameter**	**Decision Problem / Action Level**
5. Where will COPCs migrate in the future?	The population parameters for aquifer thickness and fractures/cavities: thickness of alluvial zones (ft), SP/resistivity logs (depth below top of casing [feet]; spontaneous potential [millivolts]), induction/conductivity EM logs (depth below top of casing [feet],electromagnetic conductivity [millisiemens per meter]), and gamma-gamma logs (depth below top of casing [feet], API [counts per second])	- Estimate the aquifer thickness, fracture, and cavity geospatial locations and dimensions that will be identified from downhole geophysical methods in conjunction with visual logging.
	The population parameters for retardation: organic carbon partition coefficient (liters per kilogram), fraction organic carbon (grams per gram)	- Estimate the organic carbon partition coefficient that will be used to evaluate the organic sorption potential and the potential for COPC migration.
	The population parameter for XRD is percent by weight for each mineral and percent by weight for each element. The population parameter for SEM-EDS is the mineral phase associations.	- Estimate the mineral percent by weight and mineral phase associations that will be used to evaluate the inorganic sorption potential and the potential for COPC migration.
	The population parameter for the leaching test is the COPC concentration or activity level after each leaching for the seven steps in micrograms per Liter (ug/L) or picocuries per Liter (pCi/L).	- Estimate the changes in COPC concentrations within different geochemical environments, including areas with leachate influence using geochemical parameters.
	The population parameters for dispersion coefficients: constituent concentration data (milligrams per liter); dissolved phase groundwater plume length, width, and height (feet); longitudinal, transverse, and vertical dispersivity (ft); groundwater velocity (ft per day)	- Estimate the dispersion coefficients that will be used to evaluate the potential for COPC migration.
	The population parameters for leachate extraction: flow rates (gallons per minute), totalizer volumes (gallons), and groundwater/fluid elevations (feet above mean sea level)	- Estimate the effects of the leachate extraction at Bridgeton Landfill to determine what extent the pumping (if any) is affecting the potential migration of off-site COPCs.
	The population parameters for effects of the EVOH cover, other covers, and effects of precipitation on recharge: infiltration rates (feet per day), precipitation (inches per day), groundwater elevations (ft above mean sea level)	- Estimate the inputs and outputs for a water balance involving the landfill covers and estimate to what extent the covers may have an effect on the water balance now or in the future. - Estimate the extent the recharge may have the COPC migration potential using precipitation data.
	The population parameters for effects of pumping rates at other extraction points: pumping rates (gallons per minute), groundwater elevations (ft above mean sea level)	- Estimate the effects from third-party offsite pumping to determine to what extent the pumping may be affecting the potential COPC migration offsite.
	The population parameters for effects of nearby surface water features: surface water stage/elevation (ft above mean sea level), groundwater elevations (ft above mean sea level)	- Estimate the surface water elevations and depth profile relative to the groundwater elevations to determine the potential for surface water interaction and migration into surface water bodies.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 6. Specify Performance or Acceptance Criteria	**- For decision problems, specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.** **- For estimation problems, specify acceptable limits on estimation uncertainty.**
Principal Study Questions (From Step 2)	**Performance or Acceptance Criteria**
1. Are COPCs present in groundwater above screening levels?	Baseline Condition/Null Hypothesis: Previous groundwater monitoring at the site indicates the potential for COPCs to be present above screening levels. Therefore, the Baseline Condition/Null Hypothesis is that concentrations in groundwater are greater than or equal to the respective screening levels (QAPP Table 2-3a-i and Table 2-3a-ii). Alternative Hypothesis: The COPC concentrations in groundwater are less than the screening levels. Decision Errors: Type I Errors: The probability of rejecting the null hypothesis when it is true. The COPC concentration in groundwater is reported as less than the screening level when the true concentration is actually greater than or equal to the screening level. The probability of this occurrence (α) should be no more than 5%. A Type I error could result in misrepresentation of the nature of the groundwater impacts, errors in the risk assessment or errors in groundwater modeling. Additionally, the use of institutional controls in the area should avoid exposure to human and ecological receptors on-site. An error in off-site data could be of greater consequence. The use of multiple wells in each aquifer, multiple rounds of sampling, groundwater modeling, and data validation should help indicate that this error occurred. Type II Errors: The probability of accepting a false null hypothesis. The COPC concentration in groundwater is reported greater than or equal to the screening level when the true concentration is actually less than the screening level. The error may be found through review of laboratory results for high percent recoveries in surrogates, calibrations, matrix spikes, or laboratory control samples. The Type II error would result in a biased low concentration and qualified in accordance with Appendix B. The probability of this occurrence (β) should be no more than 10%. A "Type II" error could result in more remediation completed than required. This error is of no significant concern to human or ecological health. Performance indicators (precision, accuracy, representativeness, completeness, sensitivity and compliance) will be used to verify that measurement quality objectives (MQOs) are met (see QAPP Section 3.0). No statistics are performed at this step because it is a direct comparison. Range of Values: For COPCs (except radiological data and geochemical data), the range of possible values may range from the MDL to an unknown detected concentration. The true values corresponding to our null hypotheses are those values that are greater than the screening level. However, true values that are corresponding to our alternative hypothesis are those that are less than the RSL to less than the MDL. Method uncertainty: The area between the MDL and MRL has a 99% confidence level that it is greater than zero, indicating that the values above the PQL have a 100% certainty that that the value is greater than zero. Values that fall between the MDL and MRL will be qualified as estimated. This will not apply to geochemistry analyses or radiochemical, where PQLs are not applicable. **Note that the RSL or screening level may fall below the MDL, between the MDL and MRL, or above the MRL, as indicated on QAPP Table 2-3a. In this case, the lowest possible MDL for that compound and sample will be reported. Additionally, some constituents may not have screening levels. These constituents will be evaluated qualitatively and are likely not COPCs, unless determined to be during the risk assessment phase. For radiological COPCs, the values may range from the critical level (or zero) to an unknown detected concentration. The true values corresponding to our null hypotheses are those values greater than the PRG or upper gray region. However, true values that are corresponding to the alternative hypothesis are those that are less than the PRG or lower gray region, to the critical level. Upper Boundary: Will be the action level (See QAPP Table 2-3a). Lower Boundary: The lower boundary of the gray region will be 13% 1-sigma uncertainty of the action level. Grey Region: The grey region for will be the area between the action level and the lower boundary. These boundaries will be subject to change, following collection of the first rounds of data. Anything greater than half way between the upper and lower boundary of the gray zone will be considered an exceedance. Anything less than half way between the upper and lower boundary of the gray zone will be subject to further data evaluation (either through validation, reanalyses, or review of future sample results). Anything below the gray zone will be considered a non-exceedance.
2. What is the vertical and horizontal spatial distribution of COPCs above screening levels in groundwater?	Same as PSQ #1.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 6. Specify Performance or Acceptance Criteria	**- For decision problems, specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.** **- For estimation problems, specify acceptable limits on estimation uncertainty.**
Principal Study Questions (From Step 2)	**Performance or Acceptance Criteria**
3. Are the COPCs site-related?	Same as PSQ#1, with the following exception: Baseline Condition/Null Hypothesis: There are potential sources of COPCs present onsite. Therefore, the Baseline Condition/Null Hypothesis is that COPCs are site-related and that the 95% UCL background COPC concentrations are below the USEPA RSLs or screening level. Alternative Hypothesis: However, other sources of COPCs are potentially present. Therefore, the Alternative Hypothesis is that the COPCs are not site-related (due to third-party anthropogenic releases) or are attributable to background water quality. Decision Errors: Type I Errors: The probability of rejecting the null hypothesis when it is true. The COPCs are determined to be not site-related, when in fact they are. The probability of this occurrence (α) should be no more than 5%. A Type I error could result in the conclusion that no remediation is necessary to address site-related impacts when actually remediation is necessary. Another Type I error could be a request to reduce the analyte list based on incorrect information. The use of multiple wells associated with on-site sources will be used to reduce this error, including wells within each vertical zone, multiple rounds of sampling, groundwater modeling, and data validation. The adequacy of the background well network will be evaluated after four rounds of groundwater data to determine if additional wells or sampling is required to calculate the 95% UCL. Type II Errors: The probability of accepting a false null hypothesis. The COPCs are determined to be site-related, when in fact they are not. The Type II error would result in unnecessary remediation being conducted by the Respondents. The probability of this occurrence (β) should be no more than 10%. This error is of low consequence to human or ecological health but may result in additional costs. For COPCs, the upper/lower boundary and gray region will remain the same as PSQ #1 at this time. However, they will be subject to change once the initial data are collected and reviewed. Statistical methods that may be employed are listed in Section 4.0 of the QAPP. The data will be reviewed with USEPA prior to deciding on the final statistical approach and if sufficient data or additional data need to be collected prior to data analyses. The DQOs will be revised to reflect changes through this iterative process, as needed.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 6. Specify Performance or Acceptance Criteria	**- For decision problems, specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.** **- For estimation problems, specify acceptable limits on estimation uncertainty.**
Principal Study Questions (From Step 2)	**Performance or Acceptance Criteria**
4. What are the sources of site-related COPCs in groundwater?	See PSQ #1 with the following changes to the decision statements: Baseline Condition/Null Hypothesis: The West Lake Landfill site has several potential sources of COPCs to groundwater, including Areas 1 and 2 which contain RIM, and the Inactive Sanitary Landfill and Bridgeton Landfill which contain MSW. Groundwater monitoring has occurred at the site since 1979. COPCs have been detected in groundwater onsite. Therefore, the Baseline Condition/Null Hypothesis is that site-specific sources of COPCs to groundwater are distinguishable. Alternative Hypothesis: Site-specific sources of COPCs to groundwater are not distinguishable. Decision Errors: Type I Errors: The probability of rejecting the null hypothesis when it is true. The Type I error would be that site-specific sources are determined to not be distinguishable from each other, when in fact the sources of COPCs in groundwater are distinguishable. The probability of this occurrence (α) should be no more than 5%. A Type I error could result in site-wide assessment or remediation being recommended instead of focusing on a specific source area. Sampling multiple onsite wells around potential source areas will help reduce this error. See below for evaluation of background sources of naturally-occurring metals and radionuclides. Type II Errors: The probability of accepting a false null hypothesis. The Type II error would be that one or more areas are identified as sources of COPCs to groundwater, when in fact the data are indistinguishable. The probability of this occurrence (β) should be no more than 10%. A Type II error could result in unnecessary site assessment or remediation being conducted on a specific source area. Use of multiple lines of evidence will be used to reduce this error. For COPCs, the upper/lower boundary and gray region will remain the same as PSQ #1 at this time. However, they will be subject to change once the initial data are collected and reviewed. Statistical methods that may be employed are listed in Section 4.0 of the QAPP. The data will be reviewed with USEPA prior to deciding on the final statistical approach and if sufficient data or additional data need to be collected prior to data analyses. The DQOs will be revised to reflect changes through this iterative process, as needed.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 6. Specify Performance or Acceptance Criteria	**- For decision problems, specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.** **- For estimation problems, specify acceptable limits on estimation uncertainty.**
Principal Study Questions (From Step 2)	**Performance or Acceptance Criteria**
4. What are the sources of site-related COPCs in groundwater?	See PSQ #1 with the following changes to the decision statements: Baseline Condition/Null Hypothesis: Spent barium sulfate residuals were deposited in Areas 1 and 2 at the site in 1973, resulting in the presence of RIM onsite. Radium has been detected in groundwater above the MCL onsite/nearsite based on the historical data as described in Section 2.4 of the Work Plan. Partial removal of RIM is being conducted under OU-1 . The removal action may affect radionuclide activity levels in groundwater in the short-term and long-term. Therefore, the Baseline/Null Hypothesis is that RIM in Areas 1 and 2 (OU-1) is a contributing source of radionuclides in groundwater. Alternative hypothesis: The RIM in Areas 1 and 2 are not a contributing source of radionuclides in groundwater. Decision Errors: Type I Errors: The probability of rejecting the null hypothesis when it is true. The Type I Error would be determining that RIM in Areas 1 and 2 is a not contributing source of radionuclides to groundwater due to either the presence of naturally-occurring radionuclides or radionuclides being present in other areas of the site, when in fact Areas 1 and 2 are contributing sources of radionuclides. For radiological data, the probability of this occurrence (α) should be no more than 5%. A Type I error could result in the unnecessary assessment to identify the location of sources of radionuclides outside of Areas 1 and 2. Use of multiple wells and sampling events will help reduce this error. This type of error could have low consequences on cost due to unnecessary assessment and/or remediation, but will not have significant affect on human and ecological health. Type II Errors: The probability of accepting a false null hypothesis. The Type II Error would be determining that RIM in Areas 1 and 2 is a contributing source of radionuclides to groundwater, when in fact RIM in Areas 1 and 2 is not a contributing source. For radiological data, the probability of this occurrence (β) should be no more than 10%. A Type II error could result in the incorrect reliance on the upcoming removal activities under OU-1 as the remedial option for addressing radionuclides in groundwater. Use of multiple wells and sampling events will help reduce this error. If other sources of radionuclides are present onsite, the consequences of this type of error could be of greater consequence if no remediation is proposed outside of Areas 1 and 2 when in fact remediation is necessary. For COPCs, the upper/lower boundary and gray region will remain the same as PSQ #1 at this time. However, they will be subject to change once the initial data are collected and reviewed. Statistical methods that may be employed are listed in Section 4.0 of the QAPP. The data will be reviewed with USEPA prior to deciding on the final statistical approach and if sufficient data or additional data need to be collected prior to data analyses. The Data Quality Objectivies (DQOs) will be revised to reflect changes through this iterative process, as needed. The decision statement will be evaluated as a baseline condition as part of the proposed OU-3 RI/FS Work Plan, with follow up evaluation to be conducted after remedy implementation of Areas 1 and 2.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 6. Specify Performance or Acceptance Criteria	**- For decision problems, specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.** **- For estimation problems, specify acceptable limits on estimation uncertainty.**
Principal Study Questions (From Step 2)	**Performance or Acceptance Criteria**
4. What are the sources of site-related COPCs in groundwater?	See PSQ #1 with the following changes to the decision statements: Baseline Condition/Null Hypothesis: Previous groundwater monitoring at the site has identified several COPCs present, including arsenic, benzene, vinyl chloride, iron, manganese, chloride, total dissolved solids, fluoride, and total petroleum hydrocarbons, which may have resulted from historical waste deposition at the Inactive Sanitary Landfill and Bridgeton Landfill at the site. Therefore, the baseline condition/ null hypothesis is that the former onsite landfills, specifically the Inactive Sanitary Landfill and the Bridgeton Landfill, are contributing sources of COPCs in groundwater Alternative hypothesis: MSW from these areas are not contributing sources of COPCs in groundwater. Decision Errors: Type I Errors: The probability of rejecting the null hypothesis when it is true. The Type I Error would be the conclusion that MSW is not providing a source of COPCs to groundwater, when in fact MSW is a contributing source. The probability of this occurrence (α) should be no more than 5%. A Type I error could result in the recommendation for no assessment and remediation of the MSW disposal areas. Use of multiple wells and sampling events from areas near the MSW disposal areas will help eliminate this error. Type II Errors: The probability of accepting a false null hypothesis. The Type II Error would be the conclusion that MSW is a contributing source of COPCs in groundwater, when in fact MSW is not a contributing source. The probability of this occurrence (β) should be no more than 10%. A Type II error could result in MSW areas being unnecessarily assessed and remediated. Use of multiple wells and sampling events in MSW areas will help eliminate this error. For COPCs, the upper/lower boundary and gray region will remain the same as PSQ #1 at this time. However, they will be subject to change once the initial data are collected and reviewed. Statistical methods that may be employed are listed in Section 4.0 of the QAPP. The data will be reviewed with USEPA prior to deciding on the final statistical approach and if sufficient data or additional data need to be collected prior to data analyses. The DQOs will be revised to reflect changes through this iterative process, as needed.
	See PSQ #1 with the following changes to the decision statements: Baseline Condition/Null Hypothesis: In the 2015 USGS report, leachate-related impacts were reported in 47 of 83 wells tested onsite/nearsite (USGS 2015). Recent increases in COPC groundwater concentrations have been noted as part of the OU-2 groundwater monitoring program, which have been attributed to the SSR. There are landfill gas migration studies in progress under the OU-2 program due to detections of elevated methane and pressures in one location onsite. Therefore, the baseline condition /null hypothesis is that the geochemistry of landfill leachate, the SSR, and/or landfill gases are resulting in a release of COPCs to groundwater, including naturally-occurring radium. Alternative hypothesis: Geochemistry of landfill leachate, the SSR, and/or landfill gases are not resulting in a release of COPCs in groundwater. Decision Errors: Type I Errors: The probability of rejecting the null hypothesis when it is true. The Type I Error would be determining that the geochemistry of the landfill leachate, the SSR, and/or landfill gases are not resulting in the release of COPCs in groundwater, including naturally-occurring radium, when in fact some or all of these factors are resulting in the release of COPCs. The probability of this occurrence (α) should be no more than 5%. A Type I error could result in incorrect recommendations being made on remedy decisions. Use of multiple wells and sampling events will help reduce this error. This type of error could have greater consequences on cost and over remediation and could have a significant affect on human and ecological health. Type II Errors: The probability of accepting a false null hypothesis. The Type II Error would be determining that the geochemistry of landfill leachate, the SSR, and/or landfill gases are resulting in the release of COPCs in groundwater, including naturally-occurring radium, when in fact these factors are not. The probability of this occurrence (β) should be no more than 10%. A Type II error could result in unnecessary site assessment and remediation. Use of multiple wells and sampling events will help reduce this error. This type of error could be of greater consequence on cost due to unnecessary site assessment and remediation, but will have low consequences on human and ecological health. For COPCs, the upper/lower boundary and gray region will remain the same as PSQ #1 at this time. However, they will be subject to change once the initial data are collected and reviewed. Statistical methods that may be employed are listed in Section 4.0 of the QAPP. The data will be reviewed with USEPA prior to deciding on the final statistical approach and if sufficient data or additional data need to be collected prior to data analyses. The DQOs will be revised to reflect changes through this iterative process, as needed.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 6. Specify Performance or Acceptance Criteria	**- For decision problems, specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.** **- For estimation problems, specify acceptable limits on estimation uncertainty.**
Principal Study Questions (From Step 2)	**Performance or Acceptance Criteria**
5. Where will COPCs migrate in the future?	Same as PSQ#1, with the following changes: Baseline Condition/Null Hypothesis: COPCs have been documented to be present at the perimeter of the facility above screening levels in several locations (Work Plan Section 2.4.14). Although there is leachate extraction occurring at the site associated with Bridgeton Landfill, there is the potential for offsite migration of COPCs in groundwater including lateral and vertical migration. The lateral extent of groundwater migration could extend offsite and impact water wells and/or surface water bodies such as the Missouri River. An upward vertical gradient is documented in the area, but the potential exists for current and historical leachate extraction and dewatering onsite to have created localized downward vertical gradients. Therefore, the null hypothesis is that COPCs will migrate beyond the site perimeter laterally in one or more vertical intervals, that COPCs migrate vertically downwards due to downward vertical gradients, and that COPCs migrate into one or more surface water bodies. Alternative Hypothesis: The alternative hypothesis for this PSQ is that COPCs will not migrate laterally beyond the landfill perimeter, that COPCs will not migrate vertically downwards, and that COPCs will not migrate into surface water bodies. Decision Errors: Type I Errors: The probability of rejecting the null hypothesis when it is true. The Type I Error would be the conclusion that COPCs will not migrate beyond the current lateral and vertical distribution in the future, but in fact will. The probability of this occurrence (α) should be no more than 5%. A Type I error could result in an exposure offsite in the future to site-related COPCs in groundwater. This error will be controlled by groundwater fate and transport model which will be used to determine the lateral and vertical distances anticipated for the migration of COPCs. In addition, the use of multiple wells in each aquifer, multiple rounds of sampling, and data validation should help indicate that this error occurred. Type II Errors: The probability of accepting a false null hypothesis. The Type II Error would be the conclusion that COPCs will migrate beyond the current lateral and vertical distribution in the future, but in fact will not. The Type II error would result in unnecessary site assessment and remediation. The probability of this occurrence (β) should be no more than 10%. Field sampling procedures for the collection of aquifer property data to evaluate groundwater migration potential are specified in FSP Sections 3.6, 3.7, and 3.8. Software packages will be used to assist with data evaluation , including: - AQTESOLV for Slug Testing (Work Plan Section 5.4.9) - Groundwater modeling software will be identified in the Groundwater Modeling Work Plan (Work Plan Section 6.2.1.2) These software packages will be used in accordance with the instruction manuals for that software.

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Step 7. Develop the Detailed Plan for Obtaining Data	**- Compile all information and outputs generated in Steps 1 through 6.** **- Use this information to identify alternative sampling and analysis designs that are appropriate for your intended use.** **- Select and document a design that will yield data that will best achieve your performance or acceptance criteria.**	
Principal Study Questions (From Step 2)	**Sampling Design**	**Key Assumptions**
1. Are COPCs present in groundwater above screening levels?	This PSQ will help determine what COPCs will be carried forward in the next PSQs. Therefore the sample design will include but not necessarily be limited to: - Collect groundwater samples from the proposed well network shown in Work Plan Table 5-4, including existing site wells and proposed wells. This area is based on the most probable area for detecting COPCs based on historical results. - Sample the groundwater well network for analytes listed in QAPP Table 2-2a. These analytes were determined based on the state and federal requirements, previously detected analytes at the site, typical landfill leachate indicator parameters, oxidation-reduction (redox parameters), and typical landfill waste parameters. - Complete routine groundwater sampling of the well network for COPCs as shown on the proposed schedule (Work Plan Figure 10-2). Two interim groundwater sampling will be conducted during the well drilling phase of work such that existing wells and newly installed wells will be sampled. Once the proposed well network in Work Plan Table 5-4 is installed, at least six additional groundwater events will be conducted for a total of eight events. - Complete data validation to verify MQOs are met (QAPP Table 2-2a, Table 2-3a-i, Table 2-3a-ii, Appendix B, Appendix C, Appendix D). - Evaluate the groundwater COPC data using Dixon or Rosner statistical method plus graphical representations to identify outliers within each population which may be supported by site knowledge and sampling information (QAPP Section 4). Additionally, trend charts will be completed for detected constituents. Results will be used to identify outliers and may trigger a higher level of validation on outliers, if inconsistent with historical or most recent data. - If data meet the MQOs, data results will be used in subsequent Steps of this DQO table to answer the PSQs.	- Access is granted to offsite locations. - Rejected data will not be used for critical decision-making purposes (nature and extent of COPCs, risk assessment or groundwater modeling). - Qualified data will be used as specified in the QAPP Section 4.0. - Additional KS wells are unnecessary at this time based on data from the existing overlying SD formation unit and existing KS formation.

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Step 7. Develop the Detailed Plan for Obtaining Data	**- Compile all information and outputs generated in Steps 1 through 6.** **- Use this information to identify alternative sampling and analysis designs that are appropriate for your intended use.** **- Select and document a design that will yield data that will best achieve your performance or acceptance criteria.**	
Principal Study Questions (From Step 2)	**Sampling Design**	**Key Assumptions**
2. What is the vertical and horizontal spatial distribution of COPCs above screening levels in groundwater?	The sample design will include but not necessarily be limited to: - If feasible and effective in site specific conditions, hydraulic profiling within the alluvium may be used at each wellsite with proposed alluvial wells to identify zones of high groundwater flow. Due to the potential for the gravel present in the AD to interfere with deploying the HPT, an HPT pilot test will be conducted (Work Plan Section 5.4.5). - Install wells onsite and offsite within five vertical intervals (AS, AI, AD, SS, SD). Not all locations will have wells in all vertical intervals, as described in Work Plan Table 5-4. Well screens will be placed within high hydraulic conductivity portions of each unit based on the results of the hydraulic profiling and the aquifer property data collected during well installation (see PSQ #5). Wells will be installed around the perimeter of the site and in potential downgradient flow directions for delineation purposes. - Collect groundwater samples from the proposed well network shown in Work Plan Table 5-4, including existing site wells and proposed wells within the AS, AI, AD, SS, SD, and KS formations. - Sample the well network for analytes listed in QAPP Tables 2-3a-i and Table 2-3a-ii. - Complete routine groundwater sampling of the well network for COPCs as shown on the proposed schedule (Work Plan Figure 10-2). Two interim groundwater sampling events will be conducted during the well drilling phase of work such that existing wells and newly installed wells will be sampled. Once the proposed well network in Work Plan Table 5-4 is installed, at least six additional groundwater events will be conducted for a total of eight events. At least four rounds of sampling will be used to evaluate seasonality in COPC concentrations. - Groundwater data will be evaluated as part of a vapor addendum, which will propose additional vapor sampling if there is a potential risk to indoor air from groundwater impacts (Field Sampling Plan 3.18). Collect one round of indoor air testing at on-site occupied and enclosed structures and sample for vapor-forming compounds. - Data from the indoor air and groundwater sampling will be used to prepare a vapor intrusion addendum to the Work Plan to evaluate the need for further vapor sampling (Work Plan Section 9.2.3). Conduct three more rounds of indoor air testing to confirm first round of indoor air testing over a one year time frame to evaluate seasonality. - Data validation will be completed to verify MQOs are met (QAPP Table 2-2, Table 2-3a, Appendix B, Appendix C, Appendix D). - Evaluate the groundwater COPC data using Dixon or Rosner statistical method plus graphical representations to identify outliers within each population which may be supported by site knowledge and sampling information (QAPP Section 4). Additionally, trend charts will be completed for detected constituents. Results will be used to identify outliers and may trigger a higher level of validation on outliers, if inconsistent with historical or most recent data. - Based on the results from groundwater sampling of the proposed well network in Work Plan Table 5-4, propose locations for step-in and/or step-out wells in an Addendum to the OU-3 RI/FS Work Plan within 60 days of receipt of the final laboratory data. The need for step-in/step-out wells will be evaluated after each groundwater monitoring event. - Evaluate the potential application of Hydropunch grab groundwater sampling for plume delineation during step-in/step-out well assessment work, depending on whether the cone penetrometer test (CPT) rig was successful at reaching target depths during the HPT pilot test. - If third-party wells are identified within the Study Area (Work Plan Section 5.2) that may assist with defining the vertical and lateral extent of groundwater impacts, a request will be made to the property owner for access. Sampling and quality procedures will follow the same procedures for other groundwater sampling as specified in PSQ #1. - If data meet the MQOs, data results will be used in subsequent Steps of this DQO table to answer the PSQs.	Same as PSQ #1.

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Step 7. Develop the Detailed Plan for Obtaining Data	**- Compile all information and outputs generated in Steps 1 through 6.** **- Use this information to identify alternative sampling and analysis designs that are appropriate for your intended use.** **- Select and document a design that will yield data that will best achieve your performance or acceptance criteria.**	
Principal Study Questions (From Step 2)	**Sampling Design**	**Key Assumptions**
3. Are the COPCs site-related?	The sample design will include but not necessarily be limited to: - Collect samples from the proposed well network shown in Work Plan Table 5-4, including onsite wells. - If offsite third-party wells associated with relevant sources of COPCs are present, evaluate the historical data and determine the need to sample third-party wells to establish non-site related water quality. - Sample the well network for analytes listed in QAPP Tables 2-3a-i and Table 2-3a-ii. - Complete six quarters of sampling of the well network for COPCs. The decision regarding the need for additional wells to define the lateral and vertical distribution of COPCs will be determined based on at least one round of monitoring from the existing well network, and will be evaluated thereafter based on data from each monitoring event. - Calculate 95% UCL background COPC concentrations. After four rounds of groundwater data are collected, evaluate adequacy of sampling design according to the statistical method specified in QAPP Section 4.3.7. - If additional data are necessary, an addendum to the Work Plan will be submitted with proposed additional data collection. - If initial data indicate that background wells are impacted with anthropogenic COPCs, a replacement well will be proposed in an addendum of the Work Plan. - Data validation will be completed to verify MQOs are met (Table 2-1, Table 2-3a, Appendix B, Appendix C, Appendix D of the QAPP). - Evaluate the groundwater COPC data after six events using Dixon or Rosner statistical method plus graphical representations to identify outliers within each population which may be supported by site knowledge and sampling information (QAPP Section 4). Additionally, trend charts will be completed for detected constituents. Results will be used to identify outliers and may trigger a higher level of validation on outliers, if inconsistent with historical or most recent data. Outliers may be attributable to offsite sources of COPCs. Locations with outlier data will be compared to the MDNR database of known releases to determine if similar COPCs are present. - If data meet the MQOs, data results will be used in subsequent Steps of this DQO table to answer the PSQs.	Same as PSQ #1.

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Step 7. Develop the Detailed Plan for Obtaining Data	**- Compile all information and outputs generated in Steps 1 through 6.** **- Use this information to identify alternative sampling and analysis designs that are appropriate for your intended use.** **- Select and document a design that will yield data that will best achieve your performance or acceptance criteria.**	
Principal Study Questions (From Step 2)	**Sampling Design**	**Key Assumptions**
4. What are the sources of site-related COPCs in groundwater?	The sample design to evaluate potential sources will include but not necessarily be limited to: - Collect samples from the proposed well network shown in Work Plan Table 5-4, including wells associated with each potential source area (Work Plan Table 5-8). - Sample the well network for analytes listed in QAPP Tables 2-3a-i and Table 2-3a-ii. - Evaluate the groundwater and leachate data to determine whether similarities exist between source area groundwater and leachate when compared with offsite impacts (if present) through statistical evaluation of the different populations, geochemical fingerprinting, and redox parameter fingerprinting. Prepare Piper diagrams, Stiff diagrams, isoconcentration maps, and redox scores for each population. - Complete six quarters of sampling of the well network for COPCs. - Data validation will be completed to verify MQOs are met (Table 2-1, Table 2-3a, Appendix B, Appendix C, Appendix D of the QAPP). - Evaluate the groundwater COPC data using Dixon or Rosner statistical method plus graphical representations to identify outliers within each population which may be supported by site knowledge and sampling information (QAPP Section 4). Additionally, trend charts will be completed for detected constituents. Results will be used to identify outliers and may trigger a higher level of validation on outliers, if inconsistent with historical or most recent data. - If data meet the MQOs, data results will be used in subsequent Steps of this DQO table to answer the PSQs.	Same as PSQ #1. - Water quality associated with wells and leachate monitoring points may represent the water quality for more than one source area. - COPC concentrations, redox conditions, and geochemistry in groundwater associated with the different potential source areas are distinctive.
	The sample design to evaluate RIM as a source will include but not necessarily be limited to: - Collect samples from the proposed well network shown in Work Plan Table 5-4, including wells associated with RIM deposition areas and down-gradient areas (Work Plan Table 5-8). - Sample the well network for analytes listed in QAPP Tables 2-3a-i and Table 2-3a-ii, including radionuclides. - Collect leachate samples from the leachate collection system locations shown on Work Plan Figure 5-5a for analytes listed in Tables 2-2a of the QAPP, including radionuclides. - Evaluate the groundwater and leachate data to determine whether similarities exist between RIM-impacted groundwater and leachate when compared with off-site impacts (if present) through statistical evaluation of the populations. - Calculate the mean Ra226/Ra228 activity level ratios for each sample location. - Complete six quarters of sampling of the well network for radionuclide COPCs. - Data validation will be completed to verify MQOs are met (QAPP Table 2-2a, Table 2-3a-i, Table 2-3a-ii, Appendix B, Appendix C, Appendix D). - Evaluate the groundwater COPC data using Dixon or Rosner statistical method plus graphical representations to identify outliers within each population which may be supported by site knowledge and sampling information (QAPP Section 4). Additionally, trend charts will be completed for detected constituents. Results will be used to identify outliers and may trigger a higher level of validation on outliers, if inconsistent with historical or most recent data. - If data meet the MQOs, data results will be used in subsequent Steps of this DQO table to answer the PSQs.	Same as PSQ #1. Assumes RIM is deposited only in Areas 1 and 2.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 7. Develop the Detailed Plan for Obtaining Data	**- Compile all information and outputs generated in Steps 1 through 6.** **- Use this information to identify alternative sampling and analysis designs that are appropriate for your intended use.** **- Select and document a design that will yield data that will best achieve your performance or acceptance criteria.**	
Principal Study Questions (From Step 2)	**Sampling Design**	**Key Assumptions**
4. What are the sources of site-related COPCs in groundwater?	The sample design to evaluate MSW as a source will include but not necessarily be limited to: - Collect groundwater samples from the proposed well network shown in Work Plan Table 5-4, including wells associated with MSW areas and downgradient areas (Work Plan Table 5-8). - Sample the well network for analytes listed in QAPP Tables 2-3a-i and Table 2-3a-ii, including radionuclides. - Collect leachate samples from the leachate collection system locations shown on Work Plan Figure 5-5a for analytes listed in Tables 2-2a of the QAPP, including radionuclides. - Evaluate the groundwater and leachate data to determine whether similarities exist between groundwater and leachate in MSW areas when compared with offsite impacts (if present) through statistical evaluation of the populations. - Evaluate the potential statistical correlation between landfill leachate indicators from MSW and the presence of COPCs in groundwater. - Complete six quarters of sampling of the well network and leachate points for COPCs and landfill leachate indicators. - Data validation will be completed to verify MQOs are met (QAPP Table 2-2a, Table 2-3a-i, Table 2-3a-ii, Appendix B, Appendix C, Appendix D). - Evaluate the groundwater COPC data using Dixon or Rosner statistical method plus graphical representations to identify outliers within each population which may be supported by site knowledge and sampling information (QAPP Section 4). Additionally, trend charts will be completed for detected constituents. Results will be used to identify outliers and may trigger a higher level of validation on outliers, if inconsistent with historical or most recent data. - If data meet the MQOs, data results will be used in subsequent Steps of this DQO table to answer the PSQs.	Same as PSQ #1. Assumes MSW is present in the Inactive Sanitary Landfill and the Bridgeton Landfill (North and South Quarries).
	The sample design to evaluate geochemistry of landfill leachate, the SSR, and/or landfill gases will include but not necessarily be limited to: - Collect aquifer matrix material from sufficient background locations to calculate a COPC background concentration / activity level as described in QAPP Section 4.2.7. - Sample aquifer matrix material for the presence of naturally-occurring COPCs based on the analyte list in Tables 2-3b of the QAPP. - Collect downhole gamma readings from geophysical logs such as gamma-gamma, natural gamma, spectral gamma to support determination of COPC background concentration / activity level as described in QAPP Section 4.2.7. - Collect groundwater samples from the proposed well network shown in Work Plan Table 5-4, including wells associated with leachate influence and downgradient areas (Work Plan Table 5-8). - Collect leachate samples from the leachate collection system locations shown on Work Plan Figure 5-5a. - Sample the groundwater and leachate locations for analytes listed in Table 2-2a of the QAPP, including COPCs and landfill leachate indicators. Also, collect field parameters (including temperature) during sampling of groundwater and leachate points. - Evaluate the groundwater and leachate data to determine whether similarities exist between groundwater and leachate in MSW areas when compared with offsite impacts (if present) through statistical evaluation of the populations. - Evaluate the potential statistical correlation between landfill leachate indicators from MSW and the presence of COPCs in groundwater. - Evaluate the potential statistical correlation between elevated temperature and pressure from the SSR with COPC concentrations in groundwater and leachate. - Evaluate the potential statistical correlation between landfill gas extraction rates with COPC concentrations in groundwater and leachate. - Complete up to six quarters of sampling of the well network and leachate points for COPCs and landfill leachate indicators. - Collect ground temperature, pressure, and gas extraction data from the locations onsite and offsite monitored during routine weekly Bridgeton Landfill sampling (provided by OU-2). - Data validation will be completed to verify MQOs are met (QAPP Table 2-2a, Table 2-3a-i, Table 2-3a-ii, Appendix B, Appendix C, Appendix D). - Evaluate the groundwater COPC data using Dixon or Rosner statistical method plus graphical representations to identify outliers within each population which may be supported by site knowledge and sampling information (QAPP Section 4). Additionally, trend charts will be completed for detected constituents. Results will be used to identify outliers and may trigger a higher level of validation on outliers, if inconsistent with historical or most recent data. - If data meet the MQOs, data results will be used in subsequent Steps of this DQO table to answer the PSQs.	Same as PSQ #1. Assumes groundwater and leachate water quality data from onsite can be used to generate a "fingerprint" for evaluating offsite impacts.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 7. Develop the Detailed Plan for Obtaining Data	**- Compile all information and outputs generated in Steps 1 through 6.** **- Use this information to identify alternative sampling and analysis designs that are appropriate for your intended use.** **- Select and document a design that will yield data that will best achieve your performance or acceptance criteria.**	
Principal Study Questions (From Step 2)	**Sampling Design**	**Key Assumptions**
5. Where will COPCs migrate in the future?	The sample design for collection of historical aquifer property data will include but not necessarily be limited to: - Compile data from OU-1 and OU-2 sources listed in Work Plan Section 2.4 (already completed). - Compile data from third-party reports with aquifer properties as specified in Work Plan Section 5.2. - Compare and contrast historical and newly collected aquifer property data to refine the Conceptual Site Model and determine appropriate inputs for the groundwater model.	- Assumes OU-1, OU-2, and third-party reports are of sufficient quality and completeness to compare to newly collected data.
	The sample design for slug testing (Work Plan Section 5.4.13 and FSP Section 3.12): - Conduct slug testing to determine hydraulic conductivity of the formation of new wells and select existing monitoring wells which have not been previously tested (Work Plan Table 5-4). - Conduct pneumatic testing where possible and conventional testing if the screened interval intersects the water table. - Evaluate the slug tests for similarities with historical hydraulic conductivity results and new data with the same hydrostratographic zones. - Verify that the field data meets the quality objectives specified in Section 5.0 of the QAPP. - Evaluate using AQTESOLV software; the Bouwer-Rice method will be used to calculate hydraulic conductivity, which is appropriate for an unconfined aquifer. - Evaluate variability across the study area. Incorporate findings into the CSM.	Same as PSQ #1. - Assumes the CPT drill rig is able to advance to assist with identifying the high hydraulic conductivity zone within the shallow and mid-depth alluvial zones.
	The sample design for packer testing (Work Plan Section 5.4.10 and FSP Section 3.8): - For the deepest bedrock well in each cluster, conduct constant head and step test injection packer test on open bedrock boreholes in select vertical intervals identified during continuous coring based on fracture frequency and porosity, and intervals identified during borehole geophysical logging. - Double and single downhole packer assemblies will be used. - Determine aquifer properties of the bedrock and identify higher transmissivity zones. - Evaluate data to determine the high flow zones for screen placement. - Evaluate variability across the study area. Incorporate findings into the CSM.	Same as PSQ #1. - Assumes the CPT drill rig is able to advance to assist with identifying the high hydraulic conductivity zone within the shallow and mid-depth alluvial zones.
	The sample design for the HPT testing (Work Plan Section 5.4.5 and FSP Section 3.5.2.1): - Conduct an HPT pilot test using CPT by well D-6 in a transect. - Monitor injection pressure and flow rate of water into the alliuvium during advancement. - Approximate hydraulic conductivity using the output from the HPT. - Compare estimated hydraulic conductivity from the HPT pilot test to existing hydraulic conductivity data from the nearby well D-6 slug test. - Determine if the HPT pilot test can reach the top of the deep alluvial zone in order to determine if HPT should be used to identify screen interval depths for other wells. - Evaluate variability across the study area. Incorporate findings into the CSM.	Same as PSQ #1. - Assumes the CPT drill rig is able to advance to assist with identifying the high hydraulic conductivity zone within the shallow and mid-depth alluvial zones. - Gravel may result in damage to HPT, so depth of drilling may terminate at gravel interface prior to reaching the deep alluvial zone.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 7. Develop the Detailed Plan for Obtaining Data	**- Compile all information and outputs generated in Steps 1 through 6.** **- Use this information to identify alternative sampling and analysis designs that are appropriate for your intended use.** **- Select and document a design that will yield data that will best achieve your performance or acceptance criteria.**	
Principal Study Questions (From Step 2)	**Sampling Design**	**Key Assumptions**
5. Where will COPCs migrate in the future?	The sample design for aquifer pumping tests (Work Plan Section 5.4.14 and FSP Section 3.13): - Conduct aquifer pumping tests at one well location, which has all five vertical intervals represented that are representative of geology relative to the groundwater model, which has groundwater without COPC impacts (to reduce investigation derived waste [IDW] disposal costs). The location for the aquifer pumping test will be determined after collection of the initial groundwater data (water quality and groundwater elevations from the wells in Work Plan Table 5-4. - Install piezometers around aquifer pumping test well to monitor drawdown. The scope of work for the aquifer pumping test, including the number of piezometers and construction details, will be submitted as an addendum. - Conduct an initial step drawdown test, followed by a constant rate pumping test for each water-bearing zone using field methods in USEPA guidance (see FSP Section 3.13) - Estimate transmissivity and storativity of the water-bearing zones using drawdown curves evaluated in AQTESOLV. - Evaluate variability across the study area. Incorporate findings into the CSM.	Same as PSQ #1.
	The sample design for the downhole geophysics (Work Plan Section 5.4.9 and FSP Section 3.7): - Select at least one tool for evaluating lithology based on vendor availability. - Record geophysical logs for alluvium and bedrock (see FSP Table 3-5). - Evaluate variability across the study area. Incorporate findings into the CSM.	Same as PSQ #1. - Some tooling may not be available by vendors. - Borehole / casing width may require narrow tooling that is not as readily available.
	The sample design for geotechnical sample collection (Work Plan Section 5.4.8 and FSP Section 3.5.2.3): - Collect saturated alluvial aquifer matrix samples for grain size analysis from select locations shown on Work Plan Figure 5-8a every 20 vertical feet from just above the water table to the bottom of the borehole. Collect a bulk alluvium sample for grain size. - Collect saturated alluvial aquifer matrix samples for other geotechnical analyses (porosity, density, Atterberg Limits) from select locations shown on Work Plan Figure 5-8b. Push Shelby tubes into undisturbed alluvium for density and porosity analysis. Collect a bulk alluvium sample for Atterberg limits. - Submit samples to geotechnical laboratory. - Data validation will be completed, as applicable (Tier I). - Using geotechnical data, determine Unified Soil Classification System (USCS) classification and depositional environment of the three alluvial zones (AS, AI, AD). - Evaluate variability across the study area. Incorporate findings into the CSM.	Same as PSQ #1. - Assumes Shelby tube cores are able to be pushed through the alluvium to collect density and porosity sample.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Step 7. Develop the Detailed Plan for Obtaining Data	**- Compile all information and outputs generated in Steps 1 through 6.** **- Use this information to identify alternative sampling and analysis designs that are appropriate for your intended use.** **- Select and document a design that will yield data that will best achieve your performance or acceptance criteria.**	
Principal Study Questions (From Step 2)	**Sampling Design**	**Key Assumptions**
5. Where will COPCs migrate in the future?	The sample design for evaluation of temporal and spatial variability of horizontal and vertical hydraulic gradients within and between hydrostratigraphic zones (Work Plan Section 5.4.15.1, 5.4.16; FSP Section 3.16): - Obtain OU-1 and OU-2 and third-party fluid level data. - Obtain bathymetric survey data to obtain surface water depth profile information for North Surface Water Pond from OU-1 and the onsite retention pond. - Conduct a bathymetric survey to obtain surface water depth profile data for other surface water bodies as shown on Work Plan Figure 5-6. - Measure depth to static groundwater each month in the proposed well network (Work Plan Table 5-4) within a 24-hour period for at least 24 consecutive months. - Use an oil/water interface probe accurate to the nearest +/- 0.01 ft. - Utilize pressure transducers in select wells to understand variability due to nearby groundwater extraction, Missouri River surface water stage, precipitation, and seasonal groundwater elevation fluctuations. - Utilize groundwater elevations to develop potentiometric surface maps using geographic information system (GIS) and computer aided design and drafting (CADD). - Utilize groundwater elevation data to estimate vertical and horizontal gradient across the study area and between hydrostratigraphic zones. - Utilize bathymetric survey data to evaluate potential for surface water and groundwater interactions over time. Determine need for further assessment of sediment pore water/sediment/surface water in conjunction with ongoing OU-1 activities. - Evaluate variability over time and across the study area. Incorporate findings into the CSM.	Same as PSQ #1. Also: - Monthly manual groundwater elevation monitoring is needed to confirm continuous monitoring elevation data. - Continuous groundwater elevation monitoring at select wells is needed to account for short term changes in groundwater elevations. - Groundwater elevations vary throughout the year, requiring year-long data collection.
	The sample design for the aquifer thickness and fracture/cavity data collection (FSP Sections 3.5.2 and 3.7.2): - Use existing borehole data and information (Work Plan Sections 3.1.3.2.1 and 3.1.5.2.2) to compare to new data and help guide drilling (provide assumptions). - For all boreholes, continuously core in the alluvium and bedrock horizon (Work Plan Section 5.4.7). - Classify/describe alluvium cores: USCS, color, grain size, porosity, stiffness or density, moisture content, sorting, angularity, mineralogy, and plasticity as applicable. - Classify/describe bedrock cores: weathering, bedding, color, grain/crystal size, strength, lithologic description, geologic formation, geologic formation, core recovery, rock quality designation (RQD), fractures per foot, weathering index, strength index, and discontinuity, and note cavities if present. - Field screened using a 10.6 eV photoionization detector (PID). - Logging tools that may be used include: Acoustic Televiewer, Spontaneous Potential (SP)/Resistivity Probe, Induction/Conductivity, Heat Pulse Flow Meter, Fluid Temperature and Resistivity, Gamma-Gamma Density, Natural Gamma, Spectral Gamma, and Caliper (Work Plan Section 5.4.9). - Incorporate findings into the CSM. - Data from the borehole logs will be used to develop the groundwater model and determine both aquifer thickness and preferential pathways. - Evaluate transient hydraulic response during aquifer pumping tests, to identify potential hydraulic effects of high-K preferential flow zones. - Evaluate variability across the study area. Incorporate findings into the CSM.	Same as PSQ #1.

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Step 7. Develop the Detailed Plan for Obtaining Data	**- Compile all information and outputs generated in Steps 1 through 6.** **- Use this information to identify alternative sampling and analysis designs that are appropriate for your intended use.** **- Select and document a design that will yield data that will best achieve your performance or acceptance criteria.**	
Principal Study Questions (From Step 2)	**Sampling Design**	**Key Assumptions**
5. Where will COPCs migrate in the future?	The sample design for retardation, attenuation, and geochemical parameters (FSP Section 3.6): - Compile retardation, attenuation, and geochemical data from OU-1 and OU-2 sources listed in Work Plan Section 2.4. - Compile data from third-party reports with aquifer properties as specified in Work Plan Section 5.2. - Utilize existing retardation, attenuation, and geochemical data to compare and contrast between newly collected data. - For all boreholes, continuously core in the alluvium and bedrock horizon (Work Plan Section 5.4.7) - Classify/describe alluvium cores: USCS, color, grain size, stiffness or density, moisture content, sorting, angularity, mineralogy, and plasticity as applicable. - Classify/describe bedrock cores: weathering, bedding, color, grain/crystal size, strength, lithologic description, geologic formation, geologic formation, core recovery, RQD, fractures per foot, weathering index, strength index, and discontinuity, and note cavities if present. - Collect alluvial and bedrock samples for total organic carbon to evaluate retardation (Work Plan Section 5.4.8). - Collect alluvial and bedrock samples for XRD and SEM-EDS to evaluate attenuation due to phase associations from select locations shown on Work Plan Figure 5-8b. - Collect alluvial samples for sequential extraction based on Liu et al. as specified in Work Plan Section 5.4.8 from select locations shown on Work Plan Figure 5-8b. Analyze extracts for pH, barium, calcium, iron, manganese, sulfur, dissolved radium, total uranium and total thorium (QAPP Table 2-3b). - Analyze alluvial and bedrock samples for the analytes listed in QAPP Table 2-3b. - A Tier I data validation will be completed to verify the MQO were met (the QAPP Table 2-2 and Table 2-3 series tables). - Evaluate variability across the study area. Incorporate findings into the CSM. - Data will be used to evaluate COPC fate and transport using a groundwater model.	Same as PSQ #1. Also: - Assumes OU-1, OU-2, and third-party reports are of sufficient quality and completeness to compare to newly collected data.
	The sample design for determining the dispersion coefficient is the same as PSQ #2. Also: - The groundwater velocity in each vertical zone across the study area will be calculated using the estimated hydraulic conductivity and porosity estimated above. - The COPC distribution and groundwater velocity will be used to estimate a dispersion coefficient for each COPC. - Evaluate variability over time and across the study area. Incorporate findings into the CSM. - Data will be used to evaluate COPC fate and transport using a groundwater model.	Same as PSQ #1.
	The sample design for the Effects of Leachate Extraction from the Bridgeton Landfill on Discharge (FSP Section 3.15 and 3.16): - Collect groundwater and leachate data to determine the extent of leachate-related COPC impacts (Work Plan Sections 5.4.15 and 5.4.17). - Utilize the groundwater elevation data to determine groundwater flow direction near the leachate extraction points (Work Plan Section 5.4.15.1). - Utilize the groundwater elevation data to estimate horizontal and vertical hydraulic gradients. Evaluate the temporal and spatial variability of hydraulic gradients within and between hydrostratigraphic zones noted above. - Compile weekly leachate levels and pump rates reported by Bridgeton Landfill (Work Plan 5.4.17). Evaluate the historical and new COPC concentration trends and leaching pumping volumes over time in wells near Bridgeton Landfill. - Conduct data validation to verify that MQOs were met (the QAPP series Table 2-2 and Table 2-3 series tables). - Evaluate variability over time and across the study area. Incorporate findings into the CSM. - Update the water balance based on the results of this evaluation on the effects of the leachate extraction by Bridgeton Landfill. - Data will be used to evaluate COPC fate and transport using a groundwater model.	Same as PSQ #1. Also: - Assumes data collected under OU-2 from Bridgeton Landfill for leachate levels and extraction flow rates are available.

TABLE 3-1. DATA QUALITY OBJECTIVES
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Principal Study Questions (From Step 2)	**Sampling Design**	**Key Assumptions**
5. Where will COPCs migrate in the future?	The sample design for Effects of the EVOH Cover and Other Covers on Recharge and Effects of Precipitation on Recharge (FSP Section 3.16): - Compile data from the existing on-site precipitation station, Lambert Field precipitation station, and groundwater water levels (Work Plan Section 5.4.16). - Compile information regarding landfill covers, including current and future spatial extent, permeability, and anticipated date of final cover placement. - Utilize information to complete a water balance on the site, including zones of recharge. - Evaluate variability over time and across the study area. Incorporate findings into the CSM. - Data will be used to evaluate COPC fate and transport using a groundwater model.	- Third-party precipitation data are of sufficient quality to conduct this evaluation. - Information required for the water balance, including details on the anticipated future covers at the site are available.
	The sample design for Effects of Pumping Rates at Other Extraction Points on Discharge (FSP Section 3.4): - Conduct an off-site records search to identify potential extraction points, including an MDNR database search (Work Plan Section 5.2). - Request historical and current extraction rates and pumping history for each location from operator (Work Plan Section 5.4.16). - Estimate location of identified extraction points (if present) or (if access is granted) complete a professional land survey in accordance with geospatial quality requirements (QAPP Section 5.1.2.1.5). - Update water balance based on pumping information from extraction points. - Evaluate variability over time and across the study area. Incorporate findings into the CSM. - Data will be used to evaluate COPC fate and transport using a groundwater model.	- If extraction points are identified, property owner will provide requested information on pumping rates and historical pumping volumes.
	The sample design for Effects of Nearby Surface Water Features on Recharge and Discharge (FSP Section 3.4/3.17): - Install staff gauges at water bodies in the study area as shown on Work Plan Figure 5-6 (Work Plan Section 5.4.16). - Measure the depth of surface water bodies or request this information from property owners (Work Plan Section 5.4.20). - Utilize groundwater level and surface water staff gauge data to evaluate the potential for discharge of groundwater into surface water and the recharge of groundwater by surface water bodies (Work Plan Section 5.4.15.1). - Update the water balance based on the surface water recharge and discharge evaluation. - Evaluate variability over time and across the study area. Incorporate findings into the CSM. - Data will be used to evaluate COPC fate and transport using a groundwater model.	Same as PSQ #1. Also: - Depth of surface water bodies is able to be measured, or is known to the property owner and the owner will provide the information when requested.

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Abbreviations:

AD: Deep Alluvium
AI: Intermediate Alluvium
AS: Shallow Alluvium
CADD: Computer Aided Design and Drafting
cm/sec: centimeters per second
COPC: Constituent of Potential Concern
CPT: Cone Penetrometer Test
CSM: Conceptual Site Model
DOE: Department of Energy
DQO: Data Quality Objective
EDD: Laboratory Electronic Data Deliverable
EM: Electromagnetic
EMSI: Engineering Management Support, Inc.
EVOH: Ethylene vinyl alcohol
FSP: Field Sampling Plan
ft/min: feet per minute
ft: feet
GIS: Geographic Information System
gpm: gallons per minute
HPT: Hydraulic Profiling Tool
KHz: kilohertz
KS: Keokuk
LCS: Leachate Collection Sump
m: meter
MARLAP: Multi-Agency Radiological Laboratory Analytical Protocols
MCL: Maximum Contaminant Level
MCLInc: Materials and Chemical Laboratory, Inc.
MDL: Method Detection Limit
MDNR: Missouri Department of Natural Resources
MQO: Measurement Quality Objective
MRL: Method Reporting Limit
MSW: Municipal Solid Waste
NAD: North American Datum
NELAC: National Environmental Laboratory Accreditation Conference
NGDP: National Geospatial Data Policy
OU-1: Operable Unit 1
OU-2: Operable Unit 2
OU-3: Operable Unit 3
PCB: Polychlorinated Biphenyl
pCi/L: picocuries per Liter
PID: Photoionization Detector
PRG: Preliminary Remediation Goal
PSQ: Principal Study Question
QAMs: Quality Assurance Manuals
QAPP: Quality Assurance Project Plan
Ra226: Radium 226
Ra228: Radium 228
RI/FS: Remedial Investigation/Feasibility Study
RIM: Radiologically Impacted Materials
RSL: Regional Screening Levels
SD: Deep Salem
SEM-EDS: Scanning Electron Microscope with Energy Dispersive X-ray Spectrometry
SOP: Standard Operating Procedure
SP: Spontaneous Potential
SS: Upper Salem/St. Louis Formation
SSR: Subsurface Reaction
SVOC: Semi-volatile Organic Compounds
UCL: Upper Confidence Limit
ug/L: micrograms per Liter
US: United States
USCS: Unified Soil Classification System
USEPA: United States Environmental Protection Agency
USGS: United States Geological Survey
VOC: Volatile Organic Compound
XRD: X-Ray Diffraction

TABLE 5-1a. SAMPLING PLAN AND QA SAMPLES FOR GROUNDWATER ANALYSES
WEST LAKE LANDFILL OU-3
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Category	Analytical Group	Analytical Method	Matrix	Number of Samples[1]	Number of Duplicates[2]	Number of Equipment Blanks[3]	Number of Field Blanks[3]	Number of Trip Blanks[3]	Number of MS/MSDs[4]	Total Number of Samples
Total Metals	Total Metals	USEPA 6010B	W	1168	118	59	59	0	59	1463
	Total Metals	USEPA 6020	W	1168	118	59	59	0	59	1463
	Total Mercury	USEPA 7470A	W	1168	118	59	59	0	59	1463
	Chromium (III)	Calculation	W	1168	118	59	59	0	59	1463
	Chromium (VI)	USEPA 7196A/USEPA 7199	W	1168	118	59	59	0	59	1463
Dissolved Metals	Dissolved Metals	USEPA 6020	W	1168	118	59	59	0	59	1463
	Dissolved Metals	USEPA 6010B	W	1168	118	59	59	0	59	1463
	Dissolved Mercury	USEPA 7470A	W	1168	118	59	59	0	59	1463
Semi-Volatile Organic Compounds	Semi-Volatile Organic Compounds	USEPA 8270C	W	1168	118	59	59	0	59	1463
	Semi-Volatile Organic Compounds	USEPA 8270C SIM*	W	1168	118	59	59	0	59	1463
Volatile Organic Compounds	Volatile Organic Compounds	USEPA 8260C Low Level	W	1168	118	59	59	59	59	1522
	Volatile Organic Compounds	USEPA 8011	W	1168	118	59	59	59	59	1522
PCBs	Polychlorinated Biphenyls (PCBs)	USEPA 8082A	W	1168	118	59	59	0	59	1463
Hydrocarbons[6]	C6 Aliphatics	TX 1006	W	1168	118	59	59	0	59	1463
	C6-C8 Aliphatics	TX 1006	W	1168	118	59	59	59	59	1522
	C8-C10 Aliphatics	TX 1006	W	1168	118	59	59	0	59	1463
	C10-C12 Aliphatics	TX 1006	W	1168	118	59	59	0	59	1463
	C12-C16 Aliphatics	TX 1006	W	1168	118	59	59	0	59	1463
	C16-C21 Aliphatics	TX 1006	W	1168	118	59	59	0	59	1463
	C21-C35 Aliphatics	TX 1006	W	1168	118	59	59	0	59	1463
	C7-C8 Aromatics	TX 1006	W	1168	118	59	59	59	59	1522
	C8-C10 Aromatics	TX 1006	W	1168	118	59	59	59	59	1522
	C10-C12 Aromatics	TX 1006	W	1168	118	59	59	0	59	1463
	C12-C16 Aromatics	TX 1006	W	1168	118	59	59	0	59	1463
	C16-C21 Aromatics	TX 1006	W	1168	118	59	59	0	59	1463
	C21-C35 Aromatics	TX 1006	W	1168	118	59	59	0	59	1463
	TPH C6-C35	TX 1006	W	1168	118	59	59	0	59	1463
	TPH C6-C12	TX 1005	W	1168	118	59	59	0	59	1463
	TPH C12-C28	TX 1005	W	1168	118	59	59	0	59	1463
	TPH C28-C35	TX 1005	W	1168	118	59	59	0	59	1463
	TPH C6-C35	TX 1005	W	1168	118	59	59	0	59	1463

TABLE 5-1a. SAMPLING PLAN AND QA SAMPLES FOR GROUNDWATER ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Matrix	Number of Samples[1]	Number of Duplicates[2]	Number of Equipment Blanks[3]	Number of Field Blanks[3]	Number of Trip Blanks[3]	Number of MS/MSDs[4]	Total Number of Samples
Chlorinated Herbicides	Chlorinated Herbicides	USEPA 8151A	W	1168	118	59	59	0	59	1463
Radiological Chemistry	Total Isotopic Thorium (Th-228, Th-230, Th-232)	HASL-300 Method U-02	W	1168	118	59	59	0	59	1463
	Dissolved Isotopic Thorium (Th-228, Th-230, Th-232)	HASL-300 Method U-02	W	1168	118	59	59	0	59	1463
	Total Isotopic Uranium (U-234, U-235, U-238)	HASL-300 Method U-02	W	1168	118	59	59	0	59	1463
	Dissolved Isotopic Uranium (U-234, U-235, U-238)	HASL-300 Method U-02	W	1168	118	59	59	0	59	1463
	Radium-226	USEPA 903.1	W	1168	118	59	59	0	59	1463
	Radium-228	USEPA 904.0	W	1168	118	59	59	0	59	1463
	Dissolved Isotopic Radium-226	USEPA 903.1	W	1168	118	59	59	0	59	1463
	Dissolved Isotopic Radium-228	USEPA 904.0	W	1168	118	59	59	0	59	1463
	Tritium	USEPA 906.0	W	1168	118	59	59	0	59	1463
Dissolved Gases	Methane	AM20GAX	W	1168	118	59	59	0	59	1463
	Carbon Dioxide	AM20GAX	W	1168	118	59	59	0	59	1463

TABLE 5-1a. SAMPLING PLAN AND QA SAMPLES FOR GROUNDWATER ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Matrix	Number of Samples[1]	Number of Duplicates[2]	Number of Equipment Blanks[3]	Number of Field Blanks[3]	Number of Trip Blanks[3]	Number of MS/MSDs[4]	Total Number of Samples
Geochemistry	Alkalinity	SM 2320B	W	1168	118	59	0	0	0	1345
	Bromide	USEPA 9056A	W	1168	118	59	0	0	59	1404
	Carbonate (HC03-)	SM 2320B	W	1168	118	59	0	0	0	1345
	Cations + Anions[5]	Calculation	W	1168	118	59	0	0	0	1345
	Chemical Oxygen Demand	USEPA 410.4 Rev 2	W	1168	118	59	0	0	59	1404
	Chloride Fluoride Sulfate	USEPA 9056A	W	1168	118	59	0	0	59	1404
	Cyanide	USEPA 9012A	W	1168	118	59	0	0	59	1404
	Dissolved Organic Carbon	SM 5310C	W	1168	118	59	0	0	59	1404
	Nitrogen, Ammonia	SM 4500-NH_3 G USEPA 350.1	W	1168	118	59	0	0	59	1404
	Nitrogen, Nitrate	USEPA 9056A	W	1168	118	59	0	0	59	1404
	Nitrogen, Nitrate + Nitrite	USEPA 353.2 Rev 2	W	1168	118	59	0	0	59	1404
	Nitrogen, Nitrite	USEPA 9056A	W	1168	118	59	0	0	59	1404
	Iodide	USEPA 9056A	W	1168	118	59	0	0	59	1404
	pH	SM 4500H+B	W	1168	118	59	0	0	0	1345
	Phosphorous	USEPA 365.1	W	1168	118	59	0	0	59	1404
	Sulfide	SM 4500-S^2-D	W	1168	118	59	0	0	0	1345
	Total Dissolved Solids	SM 2540C	W	1168	118	59	0	0	0	1345
	Total Hardness	USEPA 6010B/2340B Calculation	W	1168	118	59	0	0	0	1345
	Total Organic Carbon	SM 5310C	W	1168	118	59	0	0	59	1404
	Total Suspended Solids	SM 2540D	W	1168	118	59	0	0	0	1345

Notes:

* - SVOC-SIM will be used to analyze PAHs.
1: Assumes: Event 1: 80 existing and 20 new wells; Event 2: 80 existing and 40 new wells; Events 3-8: 80 existing and 78 new wells (6 events)
2: One duplicate per 10 samples. The number was rounded to account for the separate sampling events.
3: Field blanks and equipment blanks collected at a rate of one per day of sampling per sampling crew or at a rate of one per 20 samples, whichever is larger.
4: Considers an MS and MSD as one sample on methods where the laboratory completes MS/MSDs in accordance with the SOPs.
5: Cations and Anions analytes are noted in Table 2-3a.
6: See Table 2-3a for hydrocarbon fractions related to Regional Screening Levels

Abbreviations:

MS/MSD: Matrix Spike/Matrix Spike Duplicate
PCBs: Polychlorinated biphenyl
SIM: Selective Ion Monitoring
SM: Standard Methods for the Examination of Water and Wastewater
SOP: Standard Operating Procedure
TPH: Total Petroleum Hydrocarbons
USEPA: United States Environmental Protection Agency
W: Water Matrix

TABLE 5-1b. SAMPLING PLAN AND QA SAMPLES FOR LEACHATE ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Matrix	Number of Samples[1]	Number of Duplicates[2]	Number of Equipment Blanks[3]	Number of Field Blanks[3]	Number of Trip Blanks[3]	Number of MS/MSDS[4]	Total Number of Samples
Total Metals	Total Metals	USEPA 6010B	W	48	8	0	8	0	8	72
	Total Metals	USEPA 6020	W	48	8	0	8	0	8	72
	Total Mercury	USEPA 7470A	W	48	8	0	8	0	8	72
	Chromium (III)	Calculation	W	48	8	0	8	0	8	72
	Chromium (VI)	USEPA 7196A	W	48	8	0	8	0	8	72
Dissolved Metals	Dissolved Metals	USEPA 6020	W	48	8	0	8	0	8	72
	Dissolved Metals	USEPA 6010B	W	48	8	0	8	0	8	72
	Dissolved Mercury	USEPA 7470A	W	48	8	0	8	0	8	72
Semi-Volatile Organic Compounds	Semi-Volatile Organic Compounds	USEPA 8270C	W	48	8	0	8	0	8	72
	Semi-Volatile Organic Compounds	USEPA 8270C SIM*	W	48	8	0	8	0	8	72
Volatile Organic Compounds	Volatile Organic Compounds	USEPA 8260C Low Level	W	48	8	0	8	8	8	80
	Volatile Organic Compounds	USEPA 8011	W	48	8	0	8	8	8	80
PCBs	Polychlorinated Biphenyls (PCBs)	USEPA 8082A	W	48	8	0	8	0	8	72
Hydrocarbons[6]	C6 Aliphatics	TX 1006	W	48	8	0	8	0	8	72
	C6-C8 Aliphatics	TX 1006	W	48	8	0	8	8	8	80
	C8-C10 Aliphatics	TX 1006	W	48	8	0	8	0	8	72
	C10-C12 Aliphatics	TX 1006	W	48	8	0	8	0	8	72
	C12-C16 Aliphatics	TX 1006	W	48	8	0	8	0	8	72
	C16-C21 Aliphatics	TX 1006	W	48	8	0	8	0	8	72
	C21-C35 Aliphatics	TX 1006	W	48	8	0	8	0	8	72
	C7-C8 Aromatics	TX 1006	W	48	8	0	8	8	8	80
	C8-C10 Aromatics	TX 1006	W	48	8	0	8	8	8	80
	C10-C12 Aromatics	TX 1006	W	48	8	0	8	0	8	72
	C12-C16 Aromatics	TX 1006	W	48	8	0	8	0	8	72
	C16-C21 Aromatics	TX 1006	W	48	8	0	8	0	8	72
	C21-C35 Aromatics	TX 1006	W	48	8	0	8	0	8	72
	TPH C6-C35	TX 1006	W	48	8	0	8	0	8	72
	TPH C6-C12	TX 1005	W	48	8	0	8	0	8	72
	TPH C12-C28	TX 1005	W	48	8	0	8	0	8	72
	TPH C28-C35	TX 1005	W	48	8	0	8	0	8	72
	TPH C6-C35	TX 1005	W	48	8	0	8	0	8	72

TABLE 5-1b. SAMPLING PLAN AND QA SAMPLES FOR LEACHATE ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Matrix	Number of Samples[1]	Number of Duplicates[2]	Number of Equipment Blanks[3]	Number of Field Blanks[3]	Number of Trip Blanks[3]	Number of MS/MSDS[4]	Total Number of Samples
Chlorinated Herbicides	Chlorinated Herbicides	USEPA 8151	W	48	8	0	8	0	8	72
Radiological Chemistry	Total Isotopic Thorium (Th-228, Th-230, Th-232)	HASL-300 Method U-02	W	48	8	0	8	0	8	72
	Dissolved Isotopic Thorium (Th-228, Th-230, Th-232)	HASL-300 Method U-02	W	48	8	0	8	0	8	72
	Total Isotopic Uranium (U-234, U-235, U-238)	HASL-300 Method U-02	W	48	8	0	8	0	8	72
	Dissolved Isotopic Uranium (U-234, U-235, U-238)	HASL-300 Method U-02	W	48	8	0	8	0	8	72
	Radium-226	USEPA 903.1	W	48	8	0	8	0	8	72
	Radium-228	USEPA 904.0	W	48	8	0	8	0	8	72
	Dissolved Isotopic Radium-226	USEPA 903.1	W	48	8	0	8	0	8	72
	Dissolved Isotopic Radium-228	USEPA 904.0	W	48	8	0	8	0	8	64
	Tritium	USEPA 906.0	W	48	8	0	8	0	8	72
Dissolved Gases	Methane	AM20GAX	W	48	8	0	8	0	8	72
	Carbon Dioxide	AM20GAX	W	48	8	0	8	0	8	72

TABLE 5-1b. SAMPLING PLAN AND QA SAMPLES FOR LEACHATE ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Matrix	Number of Samples[1]	Number of Duplicates[2]	Number of Equipment Blanks[3]	Number of Field Blanks[3]	Number of Trip Blanks[3]	Number of MS/MSDS[4]	Total Number of Samples
Geochemistry	Alkalinity	SM 2320B	W	48	8	0	8	0	8	72
	Bromide	USEPA 9056A	W	48	8	0	8	0	8	72
	Carbonate	USEPA 2320B	W	48	8	0	8	0	8	72
	Cations + Anions[5]	Calculation	W	48	8	0	8	0	8	72
	Chemical Oxygen Demand	USEPA 410.4 Rev 2	W	48	8	0	8	0	8	72
	Chloride Fluoride Sulfate	USEPA 9056A	W	48	8	0	8	0	8	72
	Cyanide	USEPA 9012A	W	48	8	0	8	0	8	72
	Dissolved Organic Carbon	SM 5310C	W	48	8	0	8	0	8	72
	Iodide	USEPA 9056A	W	48	8	0	8	0	8	72
	Nitrogen, Ammonia	SM 4500-NH$_3$ G USEPA 350.1	W	48	8	0	8	0	8	72
	Nitrogen, Nitrate	USEPA 9056A	W	48	8	0	8	0	8	72
	Nitrogen, Nitrate + Nitrite	USEPA 353.2 Rev 2	W	48	8	0	8	0	8	72
	Nitrogen, Nitrite	USEPA 9056A	W	48	8	0	8	0	8	72
	pH	SM 4500H+B	W	48	8	0	8	0	8	72
	Phosphate	USEPA 365.1	W	48	8	0	8	0	8	72
	Sulfide	SM 4500-S^{2}-D	W	48	8	0	8	0	8	72
	Total Dissolved Solids	SM 2540C	W	48	8	0	8	0	8	72
	Total Hardness	USEPA 6010BCalc	W	48	8	0	8	0	8	72
	Total Organic Carbon	SM 5310C	W	48	8	0	8	0	8	72
	Total Suspended Solids	SM 2540D	W	48	8	0	8	0	8	72

Notes:
* - SVOC-SIM will be used to analyze PAHs.
1: Assumes 6 leachate collection sumps, sampled for 8 events = 48 samples
2: One duplicate per 10 samples. The number was rounded to account for the separate sampling events.
3: Field blanks will be collected at a rate of one per day of sampling per sampling crew or at a rate of one per 20 samples, whichever is larger. 8 leachate collection events are assumed, or 8 field blanks. No equipment blanks will be collected for leachate samples.
4: Considers an MS and MSD as one sample on methods where the laboratory completes MS/MSDs in accordance with the SOPs.
5: Cations and Anions analytes are noted in Table 2-3a.
6: See Table 2-3a for hydrocarbon fractions related to Regional Screening Levels

Abbreviations:
MS/MSD: Matrix Spike/Matrix Spike Duplicate
PCBs: Polychlorinated biphenyl
SIM: Selective Ion Monitoring
SM: Standard Methods for the Examination of Water and Wastewater
SOP: Standard Operating Procedure
TPH: Total Petroleum Hydrocarbons
USEPA: United States Environmental Protection Agency
W: Water Matrix

TABLE 5-1c. SAMPLING PLAN AND QA SAMPLES FOR ALLUVIAL AQUIFER MATRIX ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Matrix	Number of Samples[1]	Number of Duplicates[2]	Number of Equipment Blanks[4]	Number of Field Blanks[4]	Number of Trip Blanks[4]	Number of MS/MSDs[5]	Total Number of Samples
Total Metals	Total Metals	USEPA 6010B	S	45	0	0	0	0	3	48
	Total Metals	USEPA 6020	S	45	0	0	0	0	3	48
	Total Mercury	USEPA 7471A	S	45	0	0	0	0	3	48
	Ferrous Iron	HACH 8146, Modified	S	45	0	0	0	0	0	45
	Ferric Iron	Calculation Using SM 3500-Fe D, Modified	S	45	0	0	0	0	0	45
Radiological Chemistry	Isotopic Uranium (U-234, U-235, U-238)	HASL-300 Method U-02	S	45	0	0	0	0	3	48
	Isotopic Thorium (Th-228,Th-230, Th-232)	HASL-300 Method U-02	S	45	0	0	0	0	3	48
	Radium-226	USEPA 901.1M	S	45	0	0	0	0	3	48
	Radium-228	USEPA 901.1M	S	45	0	0	0	0	3	48
Major Minerals and Mineral Reactivity[2]	X-Ray Diffraction	X-Ray Diffraction/Whole Pattern Fitting EMSL SOP MS- 01-1 Powder XRD	S	9	0	0	0	0	0	9
	Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometry (SEM-EDS)	Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometry	S	9	0	0	0	0	0	9
Mineralogical	Cation Exchange Capacity	USEPA 9081	S	45	0	0	0	0	0	45
Geochemistry	pH	USEPA 9045D	S	45	0	0	0	0	0	45
	Total Organic Carbon	Walkley-Black Procedure	S	45	0	0	0	0	0	45
	Total Alkalinity (carbonate and bicarb)	SM 2320B	S	45	0	0	0	0	0	45
	Bromide, Iodide, Fluoride, Chloride, and Sulfate	USEPA 9056A	S	45	0	0	0	0	0	45

TABLE 5-1c. SAMPLING PLAN AND QA SAMPLES FOR ALLUVIAL AQUIFER MATRIX ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Matrix	Number of Samples[1]	Number of Duplicates[2]	Number of Equipment Blanks[4]	Number of Field Blanks[4]	Number of Trip Blanks[4]	Number of MS/MSDs[5]	Total Number of Samples
Radionuclide Speciation[3]	Following Sequential Extraction Analysis (Dissolved Radium)	USEPA 901.1M	S	9	0	0	0	0	0	9
	Following Sequential Extraction Analysis (Total Uranium and Total Thorium)	HASL-300 Method U-02	S	9	0	0	0	0	0	9
	Following Sequential Extraction Analysis (Total Metals-Barium, Calcium, Iron, Manganese, Sulfur)	USEPA 6020	S	9	0	0	0	0	0	9
	Following Sequential Extraction Analysis (pH)	USEPA 9045D	S	9	0	0	0	0	0	9
Geotechnical	Grain Size (3" Maximum)	ASTM D6913	S	45	0	0	0	0	0	45
	Grain Size with Hydrometer	ASTM D6319 and D7928	S	45	0	0	0	0	0	45
	Specific Gravity and Porosity	ASTM D854	S	9	0	0	0	0	0	9
	Atterberg Limits (Method A)	ASTM D4318	S	9	0	0	0	0	0	9
	Moisture Content and Density	ASTM D7263	S	9	0	0	0	0	0	9

Notes:

1: Assumes 45 alluvial samples based on collecting samples every 20 ft at 9 locations assuming 100 ft of alluvium.
2: Assumes 9 alluvial matrix samples for Sequential Extraction, XRD, SEM-EDS, and most geotechnical analyses based on locations shown on Work Plan Figure 5-8.
3: Sequential Extraction will include a 7-point extraction completed by MCL,Inc.; extracts to be analyzed by Pace.
4: No Trip, Equipment, and Field Blanks proposed for alluvium samples.
5: Considers an MS and MSD as one sample on methods where the laboratory completes MS/MSDs in accordance with the SOPs.

Abbreviations:

ASTM: American Society for Testing and Materials
CEC: Cation Exchange Compacity
HASL: Health and Safety Laboratory
M: Modified
MS/MSD: Matrix Spike/Matrix Spike Duplicate
S: Solid Matrix
SM: Standard Methods for the Examination of Water and Wastewater
USEPA: United States Environmental Protection Agency

TABLE 5-1d. SAMPLING PLAN AND QA SAMPLES FOR BEDROCK AQUIFER MATRIX ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Matrix	Number of Samples[1]	Number of Duplicates	Number of Equipment Blanks[3]	Number of Field Blanks[3]	Number of Trip Blanks[3]	Number of MS/MSDs[4]	Total Number of Samples
Total Metals	Total Metals	USEPA 6010B	S	73	0	0	0	0	0	73
	Total Metals	USEPA 6020	S	73	0	0	0	0	0	73
	Total Mercury	USEPA 7471A	S	73	0	0	0	0	0	73
	Ferrous Iron	HACH 8146, Modified	S	73	0	0	0	0	0	73
	Ferric Iron	Calculation Using SM 3500-Fe D, Modified	S	73	0	0	0	0	0	73
Radiological Chemistry	Isotopic Uranium (U-234, U-235, U-238)	HASL-300 Method U-02	S	73	0	0	0	0	0	73
	Isotopic Thorium (Th-228,Th-230, Th-232)	HASL-300 Method U-02	S	73	0	0	0	0	0	73
	Radium-226	USEPA 901.1 M	S	73	0	0	0	0	0	73
	Radium-228	USEPA 901.1 M	S	73	0	0	0	0	0	73
Major Minerals and Mineral Reactivity	X-Ray Diffraction	X-Ray Diffraction/Whole Pattern Fitting EMSL SOP MS- 01-1 Powder XRD	S	9	0	0	0	0	0	9
	Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometry	Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometry	S	9	0	0	0	0	0	9
Mineralogical	Cation Exchange Capacity	USEPA 9081	S	73	0	0	0	0	0	73
Geochemistry	pH	USEPA 9045D	S	73	0	0	0	0	0	73
	Total Organic Carbon	Walkley-Black Procedure	S	73	0	0	0	0	0	73
	Total Alkalinity (carbonate and bicarb)	SM 2320B	S	73	0	0	0	0	0	73
	Bromide, Iodide, Fluoride, Chloride, and Sulfate	USEPA 9056A	S	73	0	0	0	0	0	73

Notes:

1: Assumes 73 bedrock samples based on collecting samples every 20 ft at 9 locations assuming 140 ft of bedrock west of the edge of the alluvium and 240 ft of bedrock east of the edge of the alluvium.

2: Assumes 9 bedrock samples for XRD, SEM-EDS, and ferric and ferrous iron, based on locations shown on Work Plan Figure 5-8; sequential extraction is not possible for bedrock samples.

3: No Trip, Equipment, and Field Blanks proposed for bedrock samples.

4: Considers an MS and MSD as one sample. Due to the matrix, no extra sample will be able to be collected.

Abbreviations:

CEC: Cation Exchange Capacity
HASL: Health and Safety Laboratory
MCL: Materials and Chemistry Laboratory, Inc.
MS/MSD: Matrix Spike/Matrix Spike Duplicate
S: Soil Matrix
SM: Standard Methods for the Examination of Water and Wastewater
SOP: Standard Operating Procedure
USEPA: United States Environmental Protection Agency
XRD: X-Ray Diffraction

TABLE 5-1e. SAMPLING PLAN AND QA SAMPLES FOR VAPOR ANALYSES
WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Category	Analytical Group	Analytical Method	Matrix	Number of Indoor Air Samples[1]	Number of Duplicate Indoor Air Samples[2]	Number of Ambient Blanks[3]	Total Number of Samples
Volatiles	Volatile Organic Compounds	TO-15	Air	24	4	4	32
Methane	Methane	Method TO-3 Modified	Air	24	4	4	32
Radon	Long-Term Radon	USEPA 402-R-92-004	Air	24	4	4	32

Notes:

1: A total of 6 indoor air samples collected from four buildings

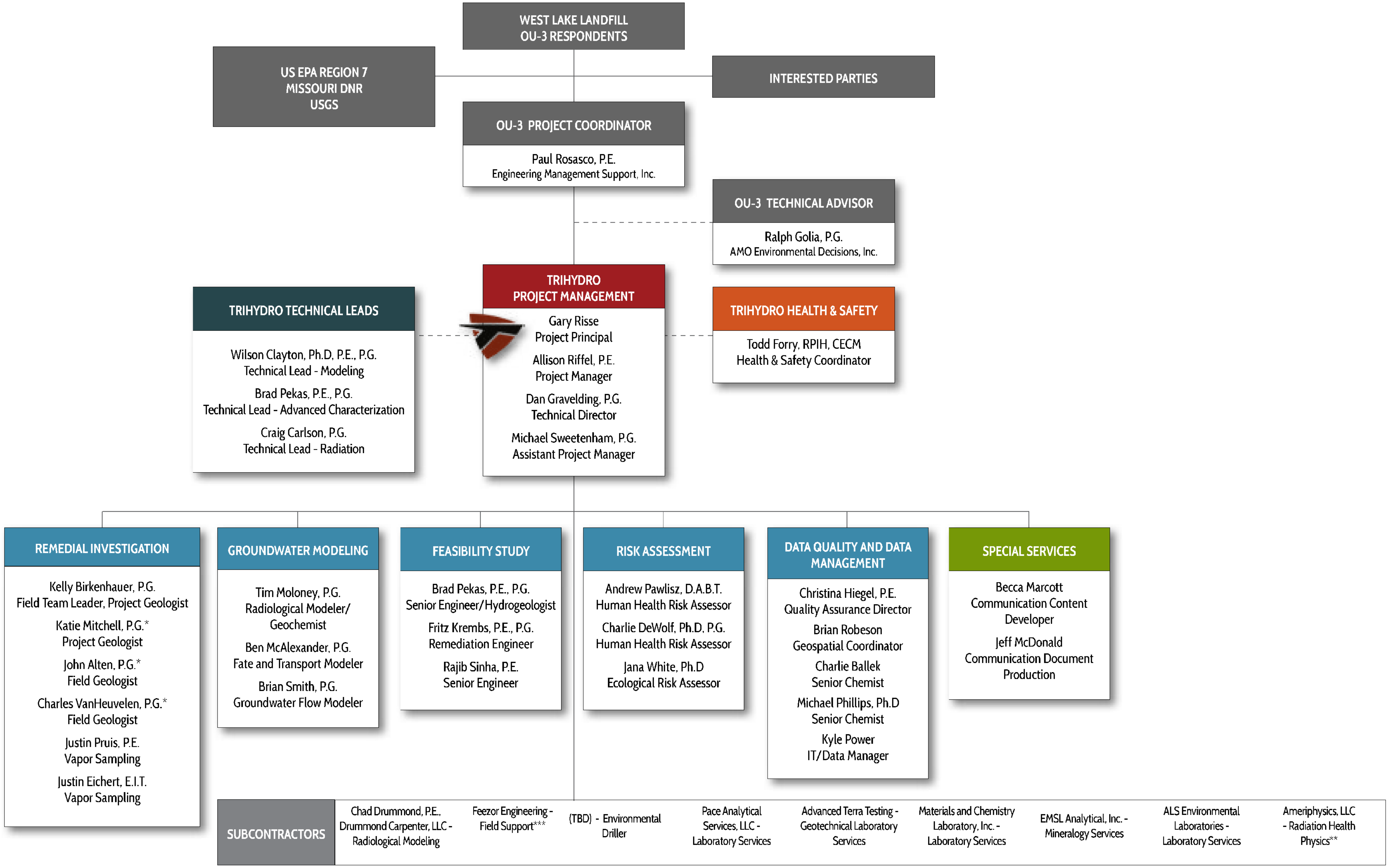
2: Duplicate samples collected at a rate of one per 10 vapor samples or 1 per event per sample type, whichever is greater.

3: A total of 1 ambient air sample will be collected up-wind of the site per event, and will function as a blank sample.

Abbreviation:

USEPA: United States Environmental Protection Agency

FIGURE



WEST LAKE LANDFILL OU-3 RESPONDENTS

US EPA REGION 7
MISSOURI DNR
USGS

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Vapor Sampling

GROUNDWATER MODELING
Tim Moloney, P.G.
Radiological Modeler/ Geochemist
Ben McAlexander, P.G.
Fate and Transport Modeler
Brian Smith, P.G.
Groundwater Flow Modeler

FEASIBILITY STUDY
Brad Pekas, P.E., P.G.
Senior Engineer/Hydrogeologist
Fritz Krembs, P.E., P.G.
Remediation Engineer
Rajib Sinha, P.E.
Senior Engineer

RISK ASSESSMENT
Andrew Pawlisz, D.A.B.T.
Human Health Risk Assessor
Charlie DeWolf, Ph.D. P.G.
Human Health Risk Assessor
Jana White, Ph.D
Ecological Risk Assessor

DATA QUALITY AND DATA MANAGEMENT
Christina Hiegel, P.E.
Quality Assurance Director
Brian Robeson
Geospatial Coordinator
Charlie Ballek
Senior Chemist
Michael Phillips, Ph.D
Senior Chemist
Kyle Power
IT/Data Manager

SPECIAL SERVICES
Becca Marcott
Communication Content Developer
Jeff McDonald
Communication Document Production

SUBCONTRACTORS
- Chad Drummond, P.E., Drummond Carpenter, LLC - Radiological Modeling
- Feezor Engineering - Field Support***
- (TBD) - Environmental Driller
- Pace Analytical Services, LLC - Laboratory Services
- Advanced Terra Testing - Geotechnical Laboratory Services
- Materials and Chemistry Laboratory, Inc. - Laboratory Services
- EMSL Analytical, Inc. - Mineralogy Services
- ALS Environmental Laboratories - Laboratory Services
- Ameriphysics, LLC - Radiation Health Physics**

NOTES:

US EPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
DNR - DEPARTMENT OF NATURAL RESOURCES
USGS - UNITED STATES GEOLOGICAL SURVEY
OU-3 - OPERABLE UNIT 3
P.E. - PROFESSIONAL ENGINEER
P.G. - PROFESSIONAL GEOLOGIST
USACE - UNITED STATES ARMY CORPS OF ENGINEERS
RPIH - REGISTERED PROFESSIONAL INDUSTRIAL HYGIENIST
CECM - CERTIFIED ENVIRONMENTAL COMPLIANCE MANAGER
E.I.T - ENGINEER IN TRAINING

D.A.B.T - DIPLOMAT OF THE AMERICAN BOARD OF TOXICOLOGY
PH.D - DOCTOR OF PHILOSOPHY
TBD - TO BE DETERMINED
IT - INFORMATION TECHNOLOGY
LLC - LIMITED LIABILITY COMPANY
* MAY SERVE AS SITE QUALITY CONTROL OFFICER AND/OR SITE HEALTH AND SAFETY OFFICER AT ANYTIME.
** RADIATION SAFETY OFFICER AND RADIOLOGICAL CONTROL SUPERVISOR
*** RADIOLOGICAL CONTROL SUPERVISOR

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FIGURE 2-1

PROJECT ORGANIZATIONAL CHART

WEST LAKE LANDFILL OU-3
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
QUALITY ASSURANCE PROJECT PLAN

Drawn By: KEJ	Checked By: MS		Date: 4/22/20	File: 2-1_OrgChart_Fig2-1.mxd

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