



Response to Comments for the Well Placement / Development Plan for the Installation of Additional Monitoring Wells at the Bottom Ash Settling Area Surface Impoundment

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

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Jared Morrison  
Director Environmental Services  
Evergy, Inc.

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Date

May 5, 2023  
File No. 0129778

U.S. Environmental Protection Agency – Region 7  
11201 Renner Boulevard  
Lenexa, Kansas 66219

Subject: Response to Comments for the Well Placement / Development Plan for the Installation of Additional Monitoring Wells at the Bottom Ash Settling Area Surface Impoundment dated January 24, 2023  
Bottom Ash Settling Area, Tecumseh Energy Center, Tecumseh, Kansas

The Tecumseh Energy Center (TEC) Bottom Ash Settling Area (BASA) Surface Impoundment Well Placement/Development Plan for the Installation of Additional Monitoring Wells at the Bottom Ash Settling Area Surface Impoundment (Well Development Plan), dated January 24, 2023, was prepared pursuant to Paragraph 10.e. of the Consent Agreement and Final Order (CAFO) between the U.S. Environmental Protection Agency (USEPA) and Evergy Kansas Central, Inc. (Evergy) In the Matter of Evergy Kansas Central, Inc.: Docket No. RCRA-07-2023-0001 dated November 7, 2022. Paragraph 10.e. of the CAFO requires that Evergy provide USEPA a Surface Impoundment Well Placement/Development Plan for the installation of additional wells at the BASA surface impoundment.

This Evergy response letter responds to the USEPA's April 5, 2023 email from Ms. Cynthia Sans (Email) containing an attachment with USEPA comments regarding the Well Placement/Development Plan for the BASA. This response repeats each individual comment in the Email followed by the specific Evergy response to each individual comment.

## **Evergy Comment Responses**

### **USEPA General Comment #1:**

*The 2020 Sampling and Analysis Plan (SAP) only appears to include the landfill the figures and text do not specifically include the Bottom Ash Settling Area (BASA) other than in Section 1.2, Background. Considering the age of the previous SAP, it is recommended that an updated SAP be developed for the BASA.*

### **Response to General Comment #1:**

The SAP was updated to remove the BASA in 2020 to reflect the closure of the BASA from the Coal Combustion Residuals (CCR) Rule groundwater monitoring program. As agreed upon during a conference call on April 5, 2023, the SAP will be updated to reflect the status change of the BASA to include figures and text describing relevant sampling and analysis information and procedures for the

BASA. The SAP will be revised to reflect USEPA comments on both the Well Development Plan and the “Nature and Extent Investigation Well Placement and Development Plan” (N&E Development Plan).

**USEPA General Comment #2:**

*The eastern boundary of the BASA is not currently covered by the monitoring network. This is a significant area of several hundred linear feet. Given the possibilities of seasonal fluctuation in the shallow groundwater table it is recommended that another monitoring well be added along the eastern boundary (§257.91(a)).*

**Response to General Comment #2:**

Additional proposed monitoring wells located at the eastern boundary of the BASA are described in the N&E Development Plan. The purpose of these wells is to characterize groundwater and formation conditions upgradient of the BASA as part of the nature and extent evaluation. These wells may also be incorporated into the groundwater monitoring network as appropriate. A map showing the well locations proposed in the N&E Development Plan is included in Attachment A. Additional language has been added in Paragraph 6 of Section 2.1 (Monitoring Well Locations) of the revised Well Development Plan to detail the potential incorporation of N&E wells.

**USEPA General Comment #3:**

*The 2016 and 2020 Sampling and Analysis Plan (SAP) versions do not include any standard operating procedures (SOPs) for monitoring well drilling, completion, installation, and development. It is recommended that either this work plan and/or the SAPs be updated to include this information. The 2020 SAP does not include the BASA in the figures and it is unclear if this SAP is intended to also cover the BASA.*

**Response to General Comment #3:**

The Well Development Plan has been revised to include the SOPs for monitoring well drilling, completion, installation, and development. These revisions are included in Section 2.1.1 (Monitoring Well Drilling and Installation) of the revised Well Development Plan. As discussed in response to Comment #1, the SAP will also be updated to reflect USEPA comments on the N&E Development Plan.

**USEPA Comment # 4: Section 2.1, Monitoring Well Installation, Page 3, fourth paragraph.**

*Please provide a reference to the site-specific technical information being used to make the decisions on number, spacing and depth of proposed monitoring wells for the BASA (§257.91(a)). The 2016 and 2020 SAPs do not include any decision criteria.*

**Response to Comment #4:**

The Well Development Plan has been revised to provide site-specific technical information that was used to support the number, spacing, and depth of proposed monitoring wells for the BASA in accordance with Title 40 Code of Federal Regulations (40 CFR) § 257.91(b). These revisions are included in Paragraph 2 of Section 1.1.1 (Monitoring Network) of the revised Well Development Plan.

**USEPA Comment #5: Section 2.1, Monitoring Well Installation, Page 3, fifth paragraph.**

*Monitoring wells should also be installed in compliance with the Kansas Department of Health and Environment (KDHE) regulations and by a KDHE-licensed water well driller (Kansas Administrative Regulations Article 30 which applies to all monitoring wells installed in Kansas). As stated in Comment 2, the 2016 and 2020 current SAP does not provide any monitoring well drilling, installation, and development procedures.*

**Response to Comment #5:**

The Well Development Plan has been revised to state that monitoring wells will be installed in accordance with Kansas Administrative Regulations (K.A.R.) Article 30. This revision is included in Paragraph 1 of Section 2.1.1 (Monitoring Drilling and Well Installation) of the revised Well Development Plan.

**USEPA Comment #6: Section 2.1, Monitoring Well Installation, Page 3, sixth paragraph.**

*Please clarify how the determination of adequate saturated thickness will be made for determining screened intervals (§257.91(b)). Decision criteria are not included for drilling and completion of monitoring criteria in the 2016 and 2020 SAPs.*

**Response to Comment #6:**

The Well Development Plan has been revised to analyze for the determination of adequate saturated thickness and to include SOPs for monitoring well drilling and completion. These revisions are included in Paragraph 2 of Section 2.1.1.1 (Monitoring Well Drilling) of the revised Well Development Plan.

**USEPA Comment #7: Section 2.1, Monitoring Well Installation, Page 3, sixth paragraph.**

*Screening through multiple hydrostratigraphic zones may not produce groundwater samples comparable to those only screened through one and may also provide a hydraulic conduit linking zones that may impact lower zones. Please clarify (§257.91(b)).*

**Response to Comment #7:**

Evergy is not proposing to screen multiple hydrostratigraphic zones in the same monitoring well. Rather, Evergy has acknowledged that there may be insufficient saturated thickness at certain locations to complete productive monitoring wells. Where this occurs, Evergy is proposing to drill deeper to, and potentially complete monitoring wells in, a deeper hydrostratigraphic zone. The purpose of this is to ensure that a sufficient number of monitoring wells is constructed to satisfy requirements of the CCR Rule. It is recognized that water quality in a deeper saturated interval may differ, and additional geochemical characterization may be required to define hydraulic and geochemical relationships between the respective saturated intervals.

Should advancement to a deeper unit be required, the monitoring wells will be drilled and installed using methods to seal the screened interval from higher zones, using well installation methods outlined

in K.A.R. Article 30.<sup>1</sup> This additional detail has been added to Paragraph 3 of Section 2.1.1.1 (Monitoring Well Drilling) of the revised Well Development Plan.

**USEPA Comment #8: Section 2.1, Monitoring Well Installation, Page 4, third paragraph.**

*The method for obtaining water level measurements and the precision of water level measurements should be clarified. The measurement precision is not stated in the 2016 or 2020 SAPs (§257.91(b)).*

**Response to Comment #8:**

The SAP will be revised to include water level measurement procedures for the BASA. As discussed in response to Comment #1, the SAP will also be updated to reflect USEPA comments on the N&E Development Plan.

**USEPA Comment 9: Section 2.1, Monitoring Well Installation, Page 4, third paragraph.**

*Surveying of new monitoring wells is not discussed. Surveying is not included in the 2016 or 2020 SAPs. Please clarify (§257.91(b)).*

**Response to Comment #9:**

The Well Development Plan has been revised to provide details for surveying of the new monitoring wells. These revisions are included in Paragraph 1 of Section 2.1.2 (Survey) of the revised Well Development Plan.

**USEPA Comment #10: Section 3.1, Re-Initiation of Detection Monitoring, Page 5, third paragraph.**

*The text should clarify that statistical analysis of detection monitoring data will be performed according to the methods specified in the referenced Statistical Data Analysis Plan consistent with the provisions of §257.93.*

**Response to Comment #10:**

The Well Development Plan has been revised to provide clarification that statistical analyses will be performed according to the methods specified in the TEC Statistical Data Analysis Plan consistent with the provisions of 40 CFR § 257.93. These revisions are included in Paragraph 3 of Section 3.1 (Re-Initiation of Assessment Monitoring) of the revised Well Development Plan.

**USEPA Comment #11: Section 3.4, Nature and Extent Investigation, Page 6 and Section 4, Reporting, Page 7.**

*The text should clarify that the Sampling and Analysis Plan and any other supporting documents, work plans, etc. will be updated to include the nature and extent investigation pursuant to §257.95(g).*

**Response to Comment #11:**

The Well Development Plan has been revised to clarify that the SAP will be updated to include relevant information in support of the nature and extent investigation pursuant to 40 CFR § 257.95(g)(1). These

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<sup>1</sup> Kansas Department of Health and Environment, 2013. Kansas Administrative Regulations, Article 30, Water Well Contractor's License; Water Well Construction. June 2013.

U.S. Environmental Protection Agency

May 5, 2023

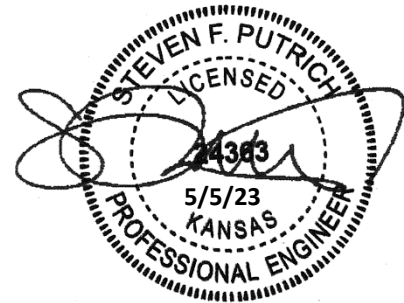
Page 5

changes are included in Paragraph 3 of Section 3.4 (Nature and Extent Investigation) and Section 4 (Reporting).

Please contact Jared Morrison ([jared.morrison@evergy.com](mailto:jared.morrison@evergy.com)) with any questions that you may have regarding the information contained in this letter.

**WELL PLACEMENT / DEVELOPMENT PLAN FOR THE  
INSTALLATION OF ADDITIONAL MONITORING WELLS AT THE  
BOTTOM ASH SETTLING AREA SURFACE IMPOUNDMENT  
TECUMSEH ENERGY CENTER  
BOTTOM ASH SETTLING AREA  
TECUMSEH, KANSAS**

by  
Haley & Aldrich, Inc.  
Phoenix, Arizona



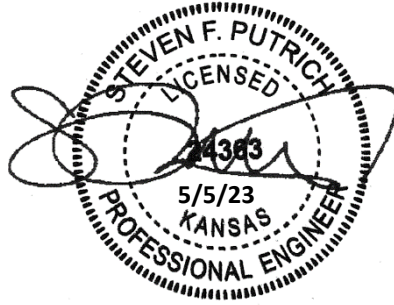
for  
Evergy Kansas Central, Inc.



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# 1. Introduction

This document is a well placement and development plan prepared pursuant to Paragraph 10.e. of the Consent Agreement and Final Order (CAFO) between the U.S. Environmental Protection Agency (USEPA) and Evergy Kansas Central, Inc. (Evergy) In the Matter of Evergy Kansas Central, Inc.: Docket No. RCRA-07-2023-0001 dated November 7, 2022. Paragraph 10.e. of the CAFO requires that Evergy provide USEPA a Surface Impoundment Well Placement/Development Plan (Plan) for the installation of additional wells at the Bottom Ash Settling Area (BASA) surface impoundment.

## 1.1 BACKGROUND

Evergy Tecumseh Energy Center (TEC) is a closed coal fired power generation facility. While TEC was active, coal combustion residuals (CCR) were dewatered at the BASA and permanently disposed of at the TEC solid waste landfill. The BASA CCR management unit has ceased operations and been removed. All CCR material within the BASA has been removed, together with the berms that created the impoundment and all visible CCR material. The BASA site has been returned to its approximate pre-development surface grade.

Bottom ash slurry generated at TEC was sluiced and gravity fed to the BASA where it was allowed to settle out. Excess water was decanted via gravity to the Clear Pond located north of the BASA, where it was gravity decanted again to Tecumseh Creek. Ultimately, the clear process water flowed into Tecumseh Creek and the Kansas River in accordance with the terms of a Kansas Pollutant Discharge Elimination System permit at Outfall 002X1. Bottom ash was recovered from the BASA, dewatered, and transported by truck to Ash Landfill 322.

Pursuant to Paragraph 10.e. of the CAFO, this Plan has been prepared for the installation of additional monitoring wells at the BASA surface impoundment. The items requested by USEPA in Paragraphs 10.e.i. through 10.e.vii. of the CAFO are provided in the following sections.

### 1.1.1 Monitoring Network

Consistent with Code of Federal Regulations Title 40 (40 CFR) § 257.90 through § 257.95, Evergy installed and certified a groundwater monitoring network for the BASA at TEC and collected eight rounds of groundwater samples for the analysis of Appendix III and Appendix IV baseline constituents. The groundwater monitoring network at the BASA includes one upgradient monitoring well (MW-7) and three downgradient monitoring wells (MW-8, MW-9, and MW-10); and one cross gradient well (MW-11) is used to monitor groundwater elevations for the purpose of establishing groundwater flow direction at each sampling event.

The monitoring network was designed to monitor the glacial till material, which constitutes the uppermost aquifer beneath the CCR unit and has a saturated thickness of approximately 4 to 18 feet based on observations made during drilling at TEC. The hydraulic conductivity of the uppermost aquifer was calculated using data generated from slug tests conducted after monitoring well installation and development and is approximately  $1.6 \times 10^{-3}$  centimeters per second (cm/sec). Based on slug test results, effective porosity of the uppermost aquifer is estimated to be 5 percent. The groundwater flow velocity was calculated to be approximately 202 feet per year (feet/year) toward the northwest. Groundwater

flowing at this velocity and direction will convey groundwater from beneath the BASA, past the waste boundary within the monitoring timeframe.

The monitoring wells have been constructed at the waste boundary at locations on the west, northwest, and north sides of the unit to intercept representative groundwater flow paths passing beneath the unit. Due to space constraints, the downgradient monitoring wells were constructed in the berms surrounding the BASA. The locations of the monitoring wells are shown on Figure 1, and well construction details are provided in Table 1.

During semi-annual assessment monitoring sampling completed in December 2019, downgradient monitoring well MW-9 was found to contain too little water to support sample collection using the dedicated low flow pump system and was consequently identified as dry.

## **1.2 PURPOSE AND SCOPE**

This document addresses requirements set forth in Paragraph 10.e. of the CAFO and is consistent with requirements outlined in 40 CFR §§ 257.90(b)(1) and 257.91 for groundwater monitoring and system, and applicable requirements outlined in 40 CFR § 257.95. The specific requirements for this Plan listed in the CAFO are provided in Sections 2 through 4 of this Plan and are in bold italic font, followed by a narrative describing how each requirement has been met.

## 2. Groundwater Monitoring Well Installation

### 2.1 MONITORING WELL LOCATIONS

**Paragraph 10.e.i. of the CAFO requires:**

*“A discussion of how the proposed new well(s) will comply with 40 CFR §§ 257.90(b)(1) and 257.91. The discussion should include how the well(s) replace(s) or augment(s) the failed and/or lost capacity of the required unit boundary monitoring network and how the proposed well(s) overcome(s) the factors that led to the non-productivity of MW-9.”*

Downgradient monitoring well MW-9 was installed July 6, 2015 and was sampled 14 times between installation and October 2019. Beginning in December 2019, MW-9 was reported to have too little water to support conventional sampling. The groundwater elevation at MW-9 declined following cessation of operations at the BASA in preparation for CCR unit closure in accordance with 40 CFR § 257.102(c). Due to the low water level, groundwater samples were not collected from MW-9 after October 2019. In January 2023, downgradient monitoring wells MW-8 and MW-10 were found to have water levels that were too low to complete sampling.

In accordance with CAFO Paragraph 10.e.i., the installation of three new downgradient monitoring wells at TEC BASA is proposed to monitor groundwater quality passing the former waste boundary of the BASA (Figure 2) pursuant to 40 CFR § 257.90(b)(1)(i) and the performance standard of 40 CFR § 257.91(a). These wells augment MW-9 and provide additional capacity for the required unit boundary monitoring network.

Pursuant to 40 CFR § 257.91(b), the number, spacing, and depths of proposed monitoring wells were determined based upon the site-specific technical information provided in Section 1.1.1 of this Plan, which were obtained during drilling, installation, and testing of the original monitoring wells at the BASA, including stratigraphy, lithology, hydraulic conductivity, porosity, and site-specific data developed during previous characterization activities.

As directed in 40 CFR § 257.91(c), following installation of the proposed monitoring wells, the BASA monitoring system will include at least one upgradient monitoring well and as many as five downgradient monitoring wells. Downgradient monitoring wells will be separated by a horizontal spacing ranging between approximately 60 and 150 feet along the former waste boundary of the CCR unit. The minimum number of upgradient monitoring wells is appropriate for this unit based on the size of the unit and the consistent groundwater flow direction observed during the baseline sampling and compliance monitoring sampling events.

Additional monitoring wells have been proposed in the Nature and Extent Investigation Well Placement/Development Plan (N&E Development Plan) required under CAFO paragraph 10.d. Following the installation and evaluation of the proposed monitoring wells in this Plan and the N&E Development Plan, N&E wells may be incorporated into the BASA groundwater monitoring network, as appropriate.

The proposed schedule for the initiation of installation of new BASA monitoring wells is provided in Table 2.

### 2.1.1 Monitoring Well Drilling and Installation

Monitoring wells will be drilled and installed by a Kansas Department of Health and Environment-licensed water well driller in accordance with Kansas Administrative Regulations (K.A.R.) Article 30.<sup>1</sup> Procedures for monitoring well drilling, completion, installation, and development are summarized below and will be completed in accordance with Article 30 and the standard operating procedures (SOP) provided in Appendix A.

Prior to any subsurface work, federal and state laws require excavators to notify appropriate utility companies before digging. Kansas 811 will be contacted at least 72 hours in advance of any subsurface work to mark public utilities. Evergy will clear site utilities by reviewing facility as-built drawings and potential drilling locations for the presence of underground utility hazards (utility lines, subsurface structures, etc.). Each proposed monitoring well location will be cleared by hand auguring the top 5 feet below ground surface (bgs).

#### 2.1.1.1 Monitoring Well Drilling

Based on historic groundwater elevation data, the groundwater flow direction is toward the northwest, and the water bearing geologic formation nearest the natural ground surface at the BASA is composed of poorly sorted glacial till material that includes clay, sand, and gravel. The proposed monitoring wells will be drilled using hollow stem auger to a depth of approximately 30 to 40 feet bgs where the shale confining unit (bedrock) is expected to be encountered. A lithologic log will be created for each boring, which will note depth of groundwater, characterize soil samples in accordance with the Unified Soil Classification System, and describe each bedrock core, if applicable. Split spoon soil samples will be collected every 5 feet, to the top of bedrock, to support continued lithologic logging.

During drilling, moisture levels of the subsurface material will be observed and documented. Upon reaching the proposed depth of the monitoring well, an evaluation of ambient adequate saturated thickness will be conducted by allowing the boring to stand open for a period of at least two hours to allow equilibration. Water levels will be measured in the boring periodically to evaluate the rate and direction of change. These data will be used to determine if sufficient saturated thickness exists to support low flow groundwater sampling. A minimum of 10 feet of saturate thickness is recommended to support the collection of consistent and representative groundwater samples. If adequate saturated thickness is not encountered in the glacial till material above the shale (directly above the shale confining unit), drilling will continue until the next deeper saturated interval is detected. The proposed monitoring well will be screened within the deeper hydrogeologic zone below the top of the shale, at a depth of no greater than 100 feet. Drilling into and through the shale will be accomplished using coring methods.

Evergy is not proposing to screen multiple hydrostratigraphic zones in the same monitoring well. Rather, Evergy has acknowledged that there may be insufficient saturated thickness at certain locations to complete productive monitoring wells. Where this occurs, Evergy is proposing to drill deeper to and potentially complete monitoring wells in a deeper hydrostratigraphic zone. The purpose of this is to ensure that a sufficient number of monitoring wells are constructed to satisfy requirements of the CCR Rule. It is recognized that water quality in a deeper saturated interval may differ, and additional

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<sup>1</sup> Kansas Department of Health and Environment, 2013. Kansas Administrative Regulations, Article 30, Water Well Contractor's License; Water Well Construction. June 2013.

geochemical characterization may be required to define hydraulic and geochemical relationships between the respective saturated intervals.

#### 2.1.1.2 *Monitoring Well Installation*

The proposed monitoring wells will be installed to a depth of approximately 30 to 40 feet bgs and will be screened within the glacial till material directly above the underlying shale. The depth and location of the proposed wells are intended to overcome the factors that led to the non-productivity of MW-9. The proposed monitoring wells will be designed and installed in accordance with 40 CFR § 257.91(e), and K.A.R. 28-30-6. The planned well design is provided in Figure 3.

#### 2.1.1.3 *Monitoring Well Completion*

Monitoring wells will be completed with 2-inch inside diameter flush threaded, 2-inch polyvinyl chloride (PVC) plug, well screen, and riser. The well screen will be up to 10 feet long and have 0.020-inch slots. The annular space between the borehole walls and the PVC materials will be filled with appropriately sized sand pack (No. 8-12 silica sand) to approximately 5 feet above the well screen. A bentonite seal of fine chips or pellets of approximately 5 feet will be placed above the filter pack. Bentonite grout will be used to backfill the hole to surface grade and will be placed via tremie pipe. The top of the riser will be secured with a locking watertight cap. Each well will be completed with an above ground protective casing that will be locked once installation is complete. Monitoring well construction may be adjusted based on field observations. The planned well design is provided in Figure 3.

#### 2.1.1.4 *Monitoring Well Development*

The newly installed monitoring wells will be allowed to set for a minimum of 12 hours prior to well development. The wells will be developed by swabbing, bailing, airlifting, and/or pumping methods in accordance with the SOP in Appendix A. Monitoring well development will be complete once the monitoring well is visibly clear and sediment free, turbidity is reduced to less than 10 Nephelometric Turbidity Units (NTU) or has stabilized, and when pH, temperature, and conductivity have stabilized. Water level elevations will be measured with a decontaminated water level indicator throughout the well development.

### 2.1.2 **Survey**

Following monitoring well drilling, installation, and development, a surveyor licensed in the state of Kansas will be contracted to establish final well locations and the vertical elevation (surface and casing) at each monitoring well.

## 2.2 **BASELINE SAMPLING**

### ***Paragraph 10.e.ii. of the CAFO requires:***

*“A proposed sampling schedule to meet the requirements of 40 CFR § 257.90(b)(1)(iii).”*

A detection monitoring program will be initiated at the newly installed monitoring wells in accordance with 40 CFR § 257.90(b)(1)(iii) within 30 days of monitoring well development. The program will include a minimum of eight independent baseline groundwater samples collected from each new monitoring well and analyzed for the constituents listed in Appendices III and IV. Based on historical groundwater elevation data and the calculated groundwater flow velocity at the BASA, independent samples will be

collected bi-monthly from the newly installed monitoring wells to obtain the initial eight baseline samples over 16 months, which will provide analytical data representative of seasonal variability.

All samples will be analyzed by a laboratory certified by the State of Kansas. Data validation and usability assessment will be performed in accordance with guidance and requirements established in the documents titled *USEPA National Functional Guidelines for Inorganic Data Review (USEPA, 2020)*<sup>2</sup> and *the Evaluation of Radiochemical Data Usability (Paar, 1997)*.<sup>3</sup>

The baseline sampling schedule for the new BASA monitoring wells is provided in Table 2.

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<sup>2</sup> U.S. Environmental Protection Agency, 2020. National Functional Guidelines for Inorganic Superfund Methods Data Review. EPA-540-R-2017-001. January.

<sup>3</sup> Paar, J.G., 1997. Evaluation of Radiochemical Data Usability. April.

### 3. Assessment Monitoring Groundwater Sampling Program

#### 3.1 RE-INITIATION OF ASSESSMENT MONITORING

**Paragraph 10.e.iii. of the of the CAFO requires:**

*“A proposed well development/reconditioning plan and sampling schedule to re-initiate assessment monitoring for Appendix III and Appendix IV constituents at MW-7, MW-8 and MW-10. The schedule shall include a plan for incorporating the new well(s) into the assessment monitoring sampling program when viable. The proposed schedule shall include a schedule to initiate the annual assessment monitoring event.”*

Evergy will re-initiate assessment monitoring at upgradient monitoring well MW-7 and downgradient monitoring wells MW-8 and MW-10. The wells will be re-developed by swabbing, bailing, airlifting, and/or pumping methods. Development will be complete once the monitoring well is visibly clear and sediment free, turbidity is reduced to less than 10 NTU or has stabilized, and when pH, temperature, and conductivity have stabilized. Water level elevations will be measured with a decontaminated water level indicator throughout the well re-development.

The assessment monitoring program will include sampling and analysis of Appendix III and Appendix IV constituents followed by statistical analysis in accordance with the sampling and analysis program (40 CFR § 257.90(b)(1)(ii) and (iv)) and the TEC Statistical Data Analysis Plan (40 CFR § 257.93). The initial annual assessment monitoring sampling event will consist of all Appendix IV constituents pursuant to 40 CFR § 257.95(b). Upon completion of eight baseline sampling events at the newly installed BASA monitoring wells, the new monitoring wells will be included in the assessment monitoring program together with MW-7, MW-8, and MW-10 and be certified as part of the network in accordance with 40 CFR § 257.91(f).

The schedule for re-initiation of assessment monitoring at BASA is provided in Table 2.

#### 3.2 SEMI-ANNUAL ASSESSMENT MONITORING SAMPLING

**Paragraph 10.e.iv. of the CAFO requires:**

*“A proposed sampling schedule for semi-annual assessment monitoring for any Appendix III and Appendix IV constituents identified in the annual assessment monitoring event pursuant to 40 CFR § 257.95(d).”*

In accordance with 40 CFR § 257.95(d)(1), assessment monitoring sampling will be completed at monitoring wells MW-7, MW-8, and MW-10 on a semi-annual basis beginning within 90 days of obtaining validated results from the initial annual assessment monitoring sampling event. The schedule for the initial and semi-annual assessment monitoring sample is provided in Table 2.



### 3.3 GROUNDWATER PROTECTION STANDARDS

**Paragraph 10.e.v. of the CAFO requires:**

*“A proposed schedule for establishing groundwater protection standards pursuant to 40 CFR § 257.95(h) in order to evaluate whether closure has been accomplished pursuant to 40 CFR § 257.102(c);”*

In accordance with 40 CFR § 257.95(d)(2), groundwater protection standards (GWPS) will be established following the initial assessment monitoring for all Appendix IV constituents detected during the annual assessment monitoring sampling event. GWPS values for each of the detected Appendix IV constituents will be set equal to the highest value of the maximum contaminant level, levels provided in 40 CFR § 257.95(h)(2) (from regional screening levels), or background concentrations.

Following the establishment of GWPS, semi-annual assessment monitoring will be conducted to determine if the BASA meets requirements for closure set forth in 40 CFR § 257.102(c) in accordance with the schedule outlined in Table 2.

### 3.4 NATURE AND EXTENT INVESTIGATION

**Paragraph 10.e.vi. of the CAFO requires:**

*“A proposed schedule for establishing nature and extent investigation for any new statistically significant levels detected during the re-initiated assessment monitoring of additional Appendix IV constituents. An SSL at a newly established well for a constituent previously identified as an SSL under item (c) of this section is assumed to be associated with a previous release and not “new” per this paragraph Requirements under 40 CFR § 257.95(g) for these SSL(s) are satisfied by the plan and actions associated with item (d).”*

In accordance with 40 CFR § 257.95(g), a nature and extent investigation will be conducted at the BASA, as shown in the schedule in Table 2. As described in Paragraph 10.e.vi. of the CAFO, a statistically significant level (SSL) at a newly established well for a constituent previously identified as a SSL under Paragraph 10.c. of the CAFO is not considered “new” and will be addressed during nature and extent characterization required pursuant to CAFO Paragraph 10.d.

The Sampling and Analysis Plan (SAP) for TEC will be revised to include additional wells, analytical constituents, and sampling procedures to support the implementation of the nature and extent investigation at the BASA pursuant to 40 CFR § 257.95(g)(1).

### 3.5 CORRECTIVE MEASURES ASSESSMENT

Based on the requirements of paragraph 10.c. of the CAFO and subsequent actions by Evergy, Evergy initiated a Corrective Measures Assessment (CMA) at the BASA on March 13, 2023. The timeline for completion of the CMA is dependent on the installation of wells described in this and subsequent plans required by CAFO. The requirement to complete these plans and obtain approval with USEPA is not included under the standard timeline for CMA completion in 40 CFR § 257.96. Evergy has outlined an anticipated CMA completion schedule that takes into consideration these CAFO plans and approvals in the Nature and Extent Investigation Well Placement/Development Plan required under CAFO paragraph 10.d.

## 4. Reporting

**Paragraph 10.e.vii. of the CAFO requires:**

*“Identification of any potential updates and/or modifications to reports/notifications in respondent’s operating record and on Respondent’s publicly available CCR compliance webpage, and a schedule for making the updates and/or modifications.”*

In accordance with CAFO Paragraph 10.e.vii., the following reports/notifications will be updated or modified to reflect the additional groundwater monitoring wells, re-initiation of assessment monitoring, and nature and extent investigation, as applicable. The schedule for document updates is presented in Table 3:

- Groundwater System Certification – 40 CFR § 257.91(f)
- Sampling and Analysis Plan – 40 CFR § 257.93(a)
- Statistical Data Analysis Plan – 40 CFR § 257.93
- Statistical Method Certification – 40 CFR § 257.93(f)(6)

## **TABLES**

**TABLE 1**  
**MONITORING WELL CONSTRUCTION INFORMATION**  
EVERGY KANSAS CENTRAL, INC.  
TECUMSEH ENERGY CENTER  
TECUMSEH, KANSAS

Location	Well Identification	Well Installation Date	Casing Diameter (inches)	Blank Casing Type	Screened Casing Type	Slot Size (inch)	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Well Depth (feet bgs)	Depth to Water <sup>a</sup> (feet btoc)	Water Level Elevation (feet amsl)	Water Column Depth (feet)	Northing <sup>b</sup>	Easting <sup>b</sup>	Ground Surface Elevation (feet amsl) <sup>c</sup>	Top of Casing Elevation (feet amsl) <sup>c</sup>
<b>Bottom Ash Settling Area</b>																
Downgradient	MW-8	5/27/2015	2	Schd 40 PVC	Schd 40 PVC	0.020	12	22	22	18.40	851.34	3.60	271159.2111	2001886.2591	867.09	869.84
	MW-9 <sup>d</sup>	7/6/2015	2	Schd 40 PVC	Schd 40 PVC	0.020	12	22	22	-	-	-	271115.6500	2001608.3036	864.89	868.66
	MW-10	5/27/2015	2	Schd 40 PVC	Schd 40 PVC	0.020	12	22	22	18.10	851.54	3.9	270957.7952	2001594.1357	864.84	869.11
	MW-11	4/9/2016	2	Schd 40 PVC	Schd 40 PVC	0.020	20	30	30	25.56	851.29	4.44	270892.7851	2001649.954	873.94	876.85
Upgradient	MW-7	7/6/2015	2	Schd 40 PVC	Schd 40 PVC	0.020	24	34	34	25.04	854.69	8.96	270755.4546	2001876.9832	875.38	878.19

**Notes:**

Monitoring Well Used for Piezometric Observation Only

<sup>a</sup> Depth to water from groundwater elevation survey on December 5, 2019.

<sup>b</sup> Data Source: Evergy Kansas Central, Inc (f/k/a Westar Energy, Inc.) Tecumseh Energy Center, August 2016.

<sup>c</sup> Survey elevations revised February 2020 after well casings were shortened during unit closure activities prior to the September/October 2019 groundwater sampling event.

<sup>d</sup> Monitoring Well MW-9 was dry during the December 2019 sampling event and a depth to water was unsuccessful.

amsl - above mean sea level

bgs - below ground surface

btoc - below top of casing

Schd 40 PVC - Schedule 40 polyvinyl chloride

**TABLE 2**  
**PROPOSED SCHEDULE FOR CONSENT AGREEMENT PARAGRAPH 10.e.**  
EVERGY KANSAS CENTRAL, INC.  
TECUMSEH ENERGY CENTER  
TECUMSEH, KANSAS

Schedule Item <sup>1</sup>	CAFO Item	CCR Rule Regulation	Estimated Start Date
<b>Assessment Monitoring Program and Nature &amp; Extent Investigation</b>			
Re-initiate assessment monitoring for MW-7, MW-8, and MW-10 - Initial Annual Assessment Monitoring sampling event	<i>Paragraph 10.e.iii.</i>	<i>40 CFR § 257.95(b)</i>	Within 90 days of statistical analyses completed under Paragraph 10.c. of the CAFO
Establish Groundwater Protection Standards	<i>Paragraph 10.e.v.</i>	<i>40 CFR § 257.95(d)(2)</i>	Within 30 days of obtaining validated results from the initial annual assessment monitoring sampling event
First re-initiated semi-annual sampling for MW-7, MW-8, and MW-10	<i>Paragraph 10.e.iv.</i>	<i>40 CFR § 257.95(d)(1)</i>	Within 90 days of obtaining results from the annual assessment monitoring sampling event
Establish a Nature and Extent Investigation	<i>Paragraph 10.e.vi.</i>	<i>40 CFR § 257.95(g)(1)</i>	Within 180 days of newly detected SSLs identified during the first re-initiated semi-annual assessment monitoring sampling event
Semi-annual assessment monitoring sampling for MW-7, MW-8, and MW-10	<i>Paragraph 10.e.iv.</i>	<i>40 CFR § 257.95(d)(1)</i>	Within 6 months of completing the first re-initiated semi-annual assessment monitoring sampling event
<b>New Monitoring Wells</b>			
Install new wells	<i>Paragraph 10.e.i.</i>	<i>40 CFR § 257.90(b)(1)(i)</i> <i>40 CFR § 257.91</i>	Within 180 days of USEPA approval of this Plan <sup>2</sup>
Initiate baseline sampling of new wells	<i>Paragraph 10.e.ii.</i>	<i>40 CFR § 257.90(b)(1)(iii)</i>	Within 30 days of monitoring well development
Incorporation of new wells into network	<i>Paragraph 10.e.iii.</i>	<i>40 CFR § 257.90(b)(1)(iv)</i>	Within 30 days of obtaining validated results from eight independent baseline sampling events

**Notes:**

1. Proposed schedule address the requirements in Paragraph 10.e. of a consent agreement between the U.S. Environmental Protection Agency and Evergy dated November 7, 2022
  2. Surface Impoundment Well Placement/Development Plan (Plan) for the installation of additional wells at the Bottom Ash Settling Area surface impoundment
- CAFO = Consent Agreement and Final Order  
CCR = Coal Combustion Residual  
CFR = Code of Federal Regulation  
SSL = statistically significant level  
USEPA = U.S. Environmental Protection Agency

**TABLE 3**  
**PROPOSED SCHEDULE FOR REPORTING UPDATES / MODIFICATIONS**  
 EVERGY KANSAS CENTRAL, INC.  
 TECUMSEH ENERGY CENTER  
 TECUMSEH, KANSAS

Report Item <sup>1</sup>	CCR Rule Regulation	Estimated Completion Date
Groundwater System Certification	40 CFR § 257.91(f)	Within 60 days of incorporating new monitoring wells into the monitoring well network
Sampling and Analysis Plan	40 CFR § 257.90(b)(1)(ii) 40 CFR § 257.93(a)	Within 60 days of incorporating new monitoring wells into the monitoring well network
Statistical Data Analysis Plan	40 CFR § 257.93	Upon completion of statistical analyses following the re-initiation semi-annual assessment monitoring sampling event
Statistical Method Certification	40 CFR § 257.93(f)(6)	Upon completion of statistical analyses following the re-initiation semi-annual assessment monitoring sampling event

**Notes:**

1. Proposed schedule address the requirements in Paragraph 10.e.vii. of a consent agreement between the U.S. Environmental Protection Agency (EPA) and Evergy dated November 7, 2022

CAFO = Consent Agreement and Final Order




CCR = Coal Combustion Residual

CFR = Code of Federal Regulation

## **FIGURES**

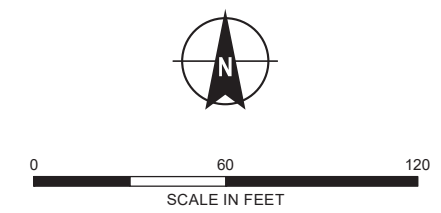


**LEGEND**

-  MONITORING WELL
-  PIEZOMETER OBSERVATION ONLY
-  BOTTOM ASH SETTLING AREA UNIT BOUNDARY/APPROXIMATE EDGE OF FORMER WASTE BOUNDARY

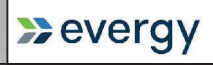
**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI, NOVEMBER 7, 2019



EVERGY KANSAS CENTRAL, INC.  
TECUMSEH ENERGY CENTER  
TECUMSEH, KANSAS

**BOTTOM ASH SETTLING AREA  
MONITORING WELL LOCATION MAP**








MAY 2023



GIS FILE PATH: \\haleyaldrich.com\share\proj\_common\Projects\Weslar\Tecumseh Energy Center (TEC)\GIS\MXDs\2022\_11\28778\_039\_0002\_PROPOSED\_GROUNDWATER\_MONITORING\_WELLS.mxd — USER: khransen — LAST SAVED: 1/18/2023 9:40:19 AM

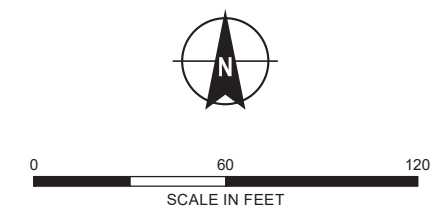


**LEGEND**

-  MONITORING WELL
-  PIEZOMETER OBSERVATION ONLY
-  TYPICAL GROUNDWATER FLOW DIRECTION
-  APPROXIMATE AREA FOR PROPOSED MONITORING WELL
-  BOTTOM ASH SETTLING AREA UNIT BOUNDARY/APPROXIMATE EDGE OF FORMER WASTE BOUNDARY

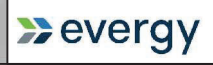
**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI, NOVEMBER 7, 2019



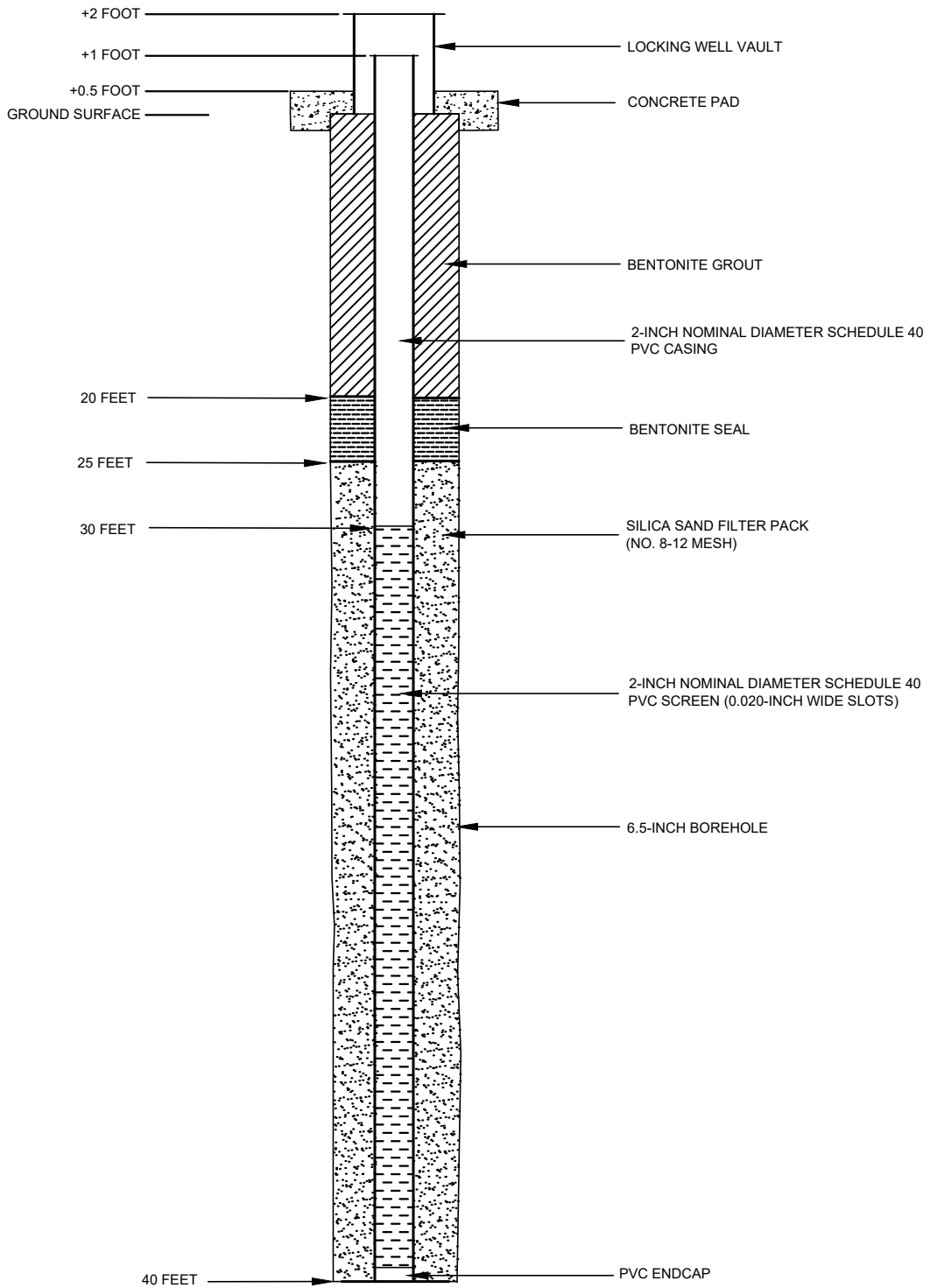
EVERGY KANSAS CENTRAL, INC.  
TECUMSEH ENERGY CENTER  
TECUMSEH, KANSAS

**PROPOSED GROUNDWATER  
MONITORING WELLS**



MAY 2023

FIGURE 2



G:\PROJECTS\WESTAR\TECUMSEH ENERGY CENTER (TEC)\CAD\PROPOSED MONITORING WELL DESIGN.DWG



EVERGY KANSAS CENTRAL, INC.  
 TECUMSEH ENERGY CENTER  
 TECUMSEH, KANSAS

**PROPOSED MONITORING  
 WELL DESIGN**

NOT TO SCALE  
 MAY 2023

**FIGURE 3**

**APPENDIX A**  
**Standard Operating Procedures**

# OPERATING PROCEDURE: OP2000

## MONITORING FIELD EXPLORATIONS

### PREPARATION AND APPROVALS

VERSION	AUTHORED/DATE	REVIEWED / DATE	REVIEWED / DATE	REVIEWED / DATE	APPROVED / DATE
Ver. 0.0	CSO/ 12-02	JAM/ 01-03		STP/6-1-03	SRK/7-1-03

**Total Pages: 56**

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**OPERATING PROCEDURE: OP2000**

**MONITORING FIELD EXPLORATIONS**

**1. PURPOSE**

Exploratory test borings, probes and test pits represent important sources of subsurface information relating to geologic conditions and site suitability fundamental to environmental site assessment and geotechnical engineering design recommendations. The following procedure is an outline of the field staff responsibilities while monitoring subsurface exploration methods utilized by Haley & Aldrich Inc. (H&A) to obtain the best possible data for geologic characterization, laboratory testing and subsequent engineering evaluations and environmental assessment.

**2. EQUIPMENT & MATERIALS**

**2.1 Standard Required Equipment**

Required	Additional as Required
1. Proposal (signed by Client)	20. First Aid Kit
2. Site Plan	21. Cellular Phone
3. Contract with Subcontractor (pay items)	22. Health & Safety Plan
4. Exploration Criteria/Specifications	23. Respirator & Tyvek Suit
5. Field Book	24. Laptop Computer
6. Clipboard	25. Camera & Film
7. Logs & Forms	26. Field Procedures
8. Office Supplies (pencils & markers)	27. Maps and References
9. Engineer's Scale	28. Sample Bags & Jars with Labels
10. 6 ft. Ruler	29. Survey Stakes/Paint/Flagging
11. 100 ft. Measuring Tape	30. Shovel
12. Hand Lens, magnifying	31. Geologist's Pick
13. Pocket Knife	32. Flashlight
14. Hard Hat	33. Roadway Box Key/Socket Wrench
15. Safety Glasses	34. Water Level Indicator
16. Sound Dampeners	35. Hand Level
17. Steel Toe Boots	36. Brunton Compass
18. Protective Gloves	37. Pocket Penetrometer
19. Rain Gear	38. Torvane

## 2.2 Required Environmental Equipment

Most environmental fieldwork will have extensive equipment requirements and supplies specifically related to the project needs. The following list is a representative list of equipment classed as type-specific groups. A comprehensive list of equipment and materials must be developed for each project in coordination with the Project Manager (PM) and Health & Safety (H&S) Coordinator prior to the start of the field program.

1. Personal Protection Equipment (PPE)
  - Air Purifying Respirator & Cartridges (Type GMC-Type H)
  - Latex/Nitrile Inner Gloves/Boot Covers
  - Tyvek/Saranex Coveralls/Sleeves/Apron
2. Decontamination Equipment and Supplies
  - Decontamination Kit
    - 5 gallon bucket
    - 5 gallon water jug
    - alconox detergent
    - brushes & paper towels
    - methanol/hexane/deionized water
  - Decontamination Tub
  - Absorption Pads
  - Polyethylene Sheeting
  - Polyethylene Trash Bags
3. Air Quality/Headspace Monitoring Equipment
  - Photo-Ionization Detector (PID)
  - Flame Ionization Detector (FID)
  - Organic Vapor Analyzer (OVA)
  - Combustible Gas Meter-LEL/O<sub>2</sub>
  - Dust Monitor
  - Multigas Meter-HCn/Methane/H<sub>2</sub>S
  - Gas Pointer
  - Draeger Tube Sampling Kit
  - Radiation Survey Meter
4. Soil Sampling Equipment and Supplies
  - Hand Auger
  - Soil Core Sampler
  - Shovel/Trowel/Remote Sampler
  - Stainless Steel Bowl
  - Aluminum Foil
  - Tongue Depressors
  - Sample Bags/Laboratory Glassware & Labels
  - Cooler & Ice Blocks

5. Water Sampling Equipment and Supplies
  - Water Level Indicator
  - Oil/Water Interface Probe
  - Centrifugal Pump-Volume
  - Submersible Pump-Low Flow
  - Peristaltic Pump & Silicone Tubing
  - Purge Pump & DC Supply
  - Waterra® Tubing/Foot Valves/Filters
  - Stainless Steel/Teflon Bailers & Rope
  - Remote Sampler
  - Water Testing Equipment
    - Flow Cell (pH, temperature, conductivity, DO, turbidity, ORP and salinity)
    - Dissolved Oxygen (DO) Meter
    - Oxidation-Reduction Potential (ORP) Meter
    - Turbidity Meter
    - Downhole Temperature/Resistivity/Conductivity/Salinity Meter
    - pH/ Turbidity/DO/ Temperature/Resistivity/Conductivity/Salinity Meter
  - Laboratory Glassware & Labels
  - Cooler & Ice Blocks

### 2.3 Additional Equipment, Specialized Instrumentation, Materials & Company Vehicles

Company-wide, Haley & Aldrich maintains an array of equipment, vehicles and specialized instrumentation for a broad variety of uses in addition to the selected equipment listed above. Additional equipment, vehicles and materials may be rented or purchased as needed with the approval of the project manager. Project equipment needs should be addressed proactively so that interoffice allocation can take place. It is recommended that the field staff familiarize themselves with the use, function and availability of all types of equipment standard to the industry. The following list is representative of the additional equipment currently available but is not intended to be a comprehensive list.

1. Survey Instrumentation
  - Theodolite/Transit/ Level & Rod
  - Global Positioning System (GPS)
2. Subsurface Locating Equipment
  - Ground Penetrating Radar (GPR)
  - Metal Detector
  - Magnetometer
3. Air-Soil-Water Quality/Analytical Equipment
  - Gas Chromatograph (GC)
  - TPH Analyzer
  - Infrared Oil Analyzer
  - Radiation Survey Meter
  - Oxidation-Reduction Potential Meter (ORP)



4. Geotechnical Equipment & Instrumentation
  - Vane Shear Test Equipment
  - Vibrating Wire Piezometer Equipment
  - Pressuremeter Testing Equipment
  - Seismograph Equipment
  - Inclinator Equipment
  - Nuclear Moisture-Density Gauge
  - Sound Level Meter
5. Hydrogeologic Equipment & Instrumentation
  - Datalogger/Levellogger Hardware & Software
  - Stream Flow Gauge & Equipment
6. Photographic Equipment
  - Video Camera
  - Digital Camera
  - 35mm Camera
7. Communication Equipment
  - Cellular Telephone
  - Satellite Telephone
  - Two-Way Radio
8. Computer Hardware & Software

#### **2.4 Billing Equipment & Materials**

Equipment and materials are billed to the project as used on a daily or per item basis. Completion of equipment usage and billing forms and submission of original receipts for items purchased or rented is required in order to charge the project for reimbursement.

### **3. PROCEDURE**

#### **3.1 Preliminary Preparations**

##### **3.1.1 Project Briefing**

Prior to the beginning of an exploration program all field staff should attend a project briefing with the project manager and office staff involved in the proposed project. At this time a file folder for the field activities should be created for the purpose of containing all relevant project information including: copies of the original proposal, site and utility plans, contract documents and drawings, applicable regulations, exploration and sampling criteria, site contacts, phone numbers of team members, health

and safety (H&S) plans, log and report forms and any other related documents or references. The field folder should be organized and maintained such that all documents likely to be useful for the completion of field activities by others are readily available in the event of personnel changes.

During the project briefing each team member should become thoroughly familiar with the overall scope of the project in addition to the task items and individual requirements of the work plan. Development of an outline of the specific activities envisioned and a review of the details concerning each task may facilitate the formulation of alternate approaches to field methods as well as the creation of action, materials and equipment lists.

Field staff should review all existing applicable information that relates to site geology and possess detailed familiarity and understanding of the contract specifications in order that knowledgeable field decisions can be made. Field staff should be experienced in all of the various field exploration procedures, instrumentation installation and sampling techniques required for the project. Requests for training, guidance or assistance should be made by the field staff as needed. Haley & Aldrich, Inc. fosters a supportive environment where all staff are encouraged to share knowledge and experiences with each other.

### **3.1.2 Health & Safety**

Safety in the workplace is a prime concern of Haley & Aldrich, Inc. on all projects. It is essential that field personnel understand and comply with all regulations governing worker safety in the field including applicable OSHA guidelines. Certain projects will require the field staff to attend a Health & Safety briefing due to specific occupational safety concerns. The nature of these concerns will be addressed by a site specific Health & Safety Plan. It is the responsibility of the project manager to notify the field staff of the existence of the Health & Safety Plan, however all field staff are encouraged to inquire with the Project Manager and with the Health & Safety Coordinator directly to avoid any possible oversight. Safety awareness and safe work practices are the responsibility of the field staff at all times and on all projects whether or not site or task specific guidelines are in existence. In the event of an accident, exposure or if unexpected contamination is encountered, the Project Manager and the Health & Safety Coordinator must be contacted immediately. Standard H&A safety recommendations for subsurface explorations are provided OP1001 Excavation and Trenching Safety and OP1002 Drilling Safety.

## **3.2 Duties and Responsibilities**

### **3.2.1 General**

The principal reason for providing Haley & Aldrich field representation is to assure that the field data being collected is accurate and of the type necessary to properly evaluate the site geologic conditions for use in the subsequent engineering analyses and environmental assessment.

### **3.2.2 Supervision of Subsurface Exploration Programs**

Each subsurface exploration program carried out under H&A supervision is designed to accommodate the specific requirements of a given project. Subsurface exploration programs routinely include the excavation of test pits and the drilling of test borings with associated instrumentation installation, special testing and sampling requirements. Modifications to the fieldwork criteria, sampling and testing are often made during the execution of the subsurface exploration program as the accumulated geologic data and test results are interpreted. For this reason it is essential that all records are current and complete and that uncertainties are identified for resolution. Field staff are responsible for maintaining communication with the project manager and logistical coordination of the field effort within the workscope and budgetary limits.

### **3.2.3 Verification of Subsurface Exploration Techniques and Services**

It is the role of H&A field staff to verify that instrumentation installation, subsurface sampling and testing methods are in conformance with applicable approved standards and specifications and to document conditions and results. Performance of sampling and testing is commonly conducted with subcontractor support and equipment. It is the responsibility of the H&A field staff to verify that proper equipment and techniques are employed and to obtain measurements and make observations independently. H&A field staff are responsible for complete field logging of groundwater, soil and bedrock conditions, the maintenance of accurate test records and field exploration location sketches, and ensuring proper instrumentation installation, sample preservation and handling. In addition, payment for services rendered on behalf of the client is commonly handled with H&A providing a daily field report (DFR) including an accurate breakdown of the work activities and itemized costs on a daily basis. Subcontractor pay items and method of payment are defined in their contract.

### **3.2.4 Right of Access**

Prior to site entry, Haley & Aldrich staff members must ensure that permission has been gained from the property owner to access the property.

### **3.2.5 Layout and Utility Clearance**

Prior to the start of any subsurface exploration all proposed locations must have utility clearance from all appropriate agencies and utility owners. Utility owners typically do not enter private properties. If there are particular concerns regarding utilities on private property, arrangements can be made with a private utility locating service. Prior to contacting any utility agency or service all proposed exploration locations must first be clearly marked in the field either with white paint or staked and white flagged. Additional colors can be used to highlight the location if the ground is snow covered. Alternate locations should be laid out in areas of suspected utilities. H&A requires the subsurface exploration subcontractor to obtain the utility clearance within the terms of the contract or services agreement. H&A field staff should verify with the driller/test pit contractor that the utilities have been cleared and obtain the clearance number prior to the start of subsurface explorations. Pre-excavation

may be necessary in areas of closely spaced utilities either by hand, vacuum, or other means. Additional guidance is provided in OP1003 Utility Clearance.

### **3.2.6 Site Safety and Subcontractor Briefing**

At the start of fieldwork, H&A field staff should coordinate a site briefing to review the schedule and workscope with all subcontractors involved with the project. This briefing should include a review of the equipment and material needs, exploration criteria and priority, testing and sampling specifics, pay items, site conditions, environmental concerns, known or suspected contamination, H&S information, decontamination requirements, site restoration and waste disposal issues, a site walkover and utility check. While it is the subcontractor's responsibility to obtain the utility clearance, the field representative should pay attention to the utility plans as well as surface manifestations of utilities involving manholes or catch basin grates, and gate or roadway boxes. Distance to overhead utilities must be considered as well. Observations of potential conflicts with utilities should be addressed with the subcontractor for their consideration.

### **3.2.7 Exploration Monitoring**

#### **3.2.7.1 General**

Haley & Aldrich field staff should become familiar with the technical details and suitability of all exploration equipment and methods. Test borings are the most common method employed by H&A to obtain high quality data on subsurface conditions. Unsampled probes can be used in a limited capacity to document overburden thickness. Specialty equipment is routinely used in sampled probes for environmental sampling. Test pits are preferred for surficial geological mapping and to document fill or overburden thickness. In addition to these typical exploration methods a variety of special testing techniques and instrumentation installations may supplement the subsurface exploration program. Specific H&A procedures must be consulted for details relating to special testing, sampling and instrumentation installation.

#### **3.2.7.2 Exploration Equipment and Use**

Exploration equipment selection is based upon a detailed understanding of the capabilities of the equipment with regard to the anticipated site geological conditions. In addition, the particular project needs may necessitate or preclude certain techniques and equipment. During the initial site walkover or layout, equipment access is considered and the type of exploration method is determined. Relatively small drill rigs are routinely used for overburden sampling, bedrock coring and groundwater monitoring well installations on a variety of projects. Larger pneumatic-percussive well rigs are used for drilling aquifer test and production wells. Excavation equipment may be preferred for initial surficial geologic mapping and to provide access prior to drilling. Various probe equipment may be considered for preliminary estimation of overburden thickness. Access to a water supply must be arranged for cased test borings and rock coring. Shallow water conditions and potentially liquefaction-susceptible soils preclude the use of augers. Bedrock monitoring wells must be cored in sufficient diameter to

allow sand pack and seals. Enclosed areas may necessitate alternate fuels or low overhead equipment. Ecologically sensitive areas may require non-petroleum-based hydraulics or lightweight equipment. Many factors affect the equipment selection resulting in some trade-off in performance, cost and reliability of data.

### 3.2.7.3 Test Boring Techniques

- A. *Cased Borings* - Cased borings are the primary method of obtaining high quality overburden samples and for penetration to bedrock prior to rock coring. The drill casing (pipe) is typically advanced in 5 ft. increments either by driving or spinning and then is washed out with an axially discharging tricone rollerbit pumping water or drill slurry from the recirculation tub. Upon flushing, the rollerbit is removed and a splitspoon sampler is fixed to the drill string (rods), lowered to the bottom of the borehole and driven into the undisturbed soils below the bottom of the casing. The procedure is repeated until the termination depth criterion is reached or bedrock is encountered. Common casing inside diameter (I.D.) ranges from 3 inch to 6 inch depending upon conditions and criteria. Rollerbits are sized to fit inside the casing with approximately 1/16 to 1/8 in. clearance. Typically boreholes are started with 5 or 6 in. I.D. casing fitted with a hard-shoe or drive-shoe in the lead (bottom) section. The casing is driven and splitspoon sampling is conducted at 5 ft. intervals (standard sampling) until an obstruction is encountered or the casing is seated into material such as clay that will maintain itself uncased. In the event of an obstruction the rollerbit or a buttonbit may be used to advance through the obstruction. In some cases the obstruction may break or a boulder-buster may be successfully employed and the casing is advanced. In other cases the next smaller diameter casing will be telescoped down the borehole and advanced through the hole in the obstruction created by the buttonbit. In the event that material such as clay that will maintain itself uncased is encountered, the open hole is extended as deep as possible. The borehole may be maintained by a bentonite or polymer slurry (mud rotary drilling). Casing fitted with a spin-shoe (econoshoe) is advanced by drilling in a similar manner to rollerbit advancement. Slurry or water is pumped down the casing to cool the bit and flush away the drill solids. Prior to splitspoon sampling the rollerbit must be lowered down the borehole and the spun casing must be drilled out in the same fashion as with driven casing. Spun or driven casing must be seated into the top of the bedrock in order to achieve an effective seal prior to rock coring.
- B. *Mud Rotary Drilling* - Mud rotary drilling typically is conducted in deeper overburden borings and on projects where there are special concerns for soil sample integrity or particularly soft soils. Various products are used to make drill mud depending upon conditions and project requirements. Some mud is bentonite-silica based (heavy mud), some are compatible with saline conditions for ocean drilling, and some polymers are biodegradable for use in boreholes intended for environmental groundwater monitoring well installation. In all cases, mud drilling requires that a positive head be maintained in the casing at all times to stabilize the borehole. The practice is to fit a bypass line to

the recirculation circuit that can be easily used to fill the casing as the rollerbit is being withdrawn. Use of a mud balance is required under certain circumstances to ensure sample integrity at the bottom of the borehole. The specific gravity to maintain in the drill mud will be specified on these projects.

- C. *Auger Borings* - Hollow stem augers (HSA) are an effective and fast method for drilling shallow borings in softer soils above the water table without introducing water or drill slurry. Hollow stem augers are preferred for environmental studies where continuous soil sampling and minimization of potential cross contamination due to the use of drilling fluids is desired. Hollow stem augers and solid stem augers are also used as shallow probes. Auger flights are typically 5 ft. in length and are commonly 3.5 to 4.25 in. I.D. The lead section is fitted with a cutter head upon which are fixed several hardened, replaceable teeth. Using a center plug fixed to the bottom of the rods, hollow stem augers are typically advanced by drilling to the desired depth whereupon the center plug is replaced by the splitspoon and driven below the bottom of the lead section. Disturbance below the bottom of the augers due to the cutter head is typically substantial and heave is common at the bottom of the borehole due to the piston like effect of the center plug during removal. As such, augers are not favored for test borings on many geotechnical projects where high quality samples and penetration resistance data are required.
- D. *Splitspoon Sampling and the Standard Penetration Test (SPT)* - The typical method for obtaining representative samples and a measure of the penetrative resistance of soils in test borings is by means of the Standard Penetration Test (SPT). This is accomplished utilizing a hollow tube splitspoon sampler assembly attached to the drill rods and driven into the soils at the bottom of the borehole at regular intervals. Splitspoon samplers are manufactured in various sizes with the most commonly used being 1 3/8 in. I.D. (2 in. O.D.) and having an interior sample chamber length of 24 in. (approximately 36 in. overall length). Once lowered to the sampling depth, the sampler is typically driven 24 in. into the soils with a 140 lb. hammer freely-falling over a 30 in. drop and the number of blows (SPT blowcount) required for each 6 in. of penetration is recorded. The penetrative resistance in blows per foot obtained from the summation of the blowcounts from 6 in. to 18 in. is referred to as the "N-value". Terminology for density of granular soils and consistency of cohesive soils has been correlated to N-values. When performed properly the SPT provides useful data for determination of the geotechnical behavior of soils and engineering design in addition to representative remolded soil samples for geological interpretation.
- E. *Bedrock Coring* - Bedrock coring is conducted in cased borings to obtain accurate detail of the bedrock properties and high quality samples for laboratory testing. A wide variety of rock core equipment is available and rock coring techniques vary greatly depending upon the driller, rock type, equipment and many other factors. Observations related to drilling activities are a primary focus during rock coring including bit weight, feed restriction, head speed, engine speed and gear, pump volume, water loss

and fluid return, core rate, drilling halts, jamming, rapid advances, equipment defects, bit type, bit wear, core barrel type, core barrel adjustment. For all projects it is essential that accurate measurements be made when determining the depth of the bedrock surface from drill action or SPT and that detailed observations are recorded concerning the effects noted and the procedures executed upon encountering bedrock. Coring should begin at the minimum depth below the bedrock surface required to seat the casing in order to document the bedrock condition in the uppermost zone where typically fracturing and weathering transitions are greatest. Core hole depth must be verified following each run to account for lost core. When necessary, logging should be broken down into a two step process beginning with sample preservation, labeling and recording of a simple description including recovery and RQD measurements followed by detailed logging of individual features and properties as time and conditions permit.

- F. *Observation Well Installation* - Groundwater observation or monitoring wells are commonly installed in completed test borings as a means obtaining accurate stabilized groundwater readings essential to engineering design, and hydrogeologic modeling. In addition, permanent observation or monitoring well installations provide for continual long-term sampling for environmental analyses. A wide variety of material types and sizes are employed depending upon the intended use. Typical observation or monitoring wells installations consist of 2 in. I.D. PVC pipe with a machine slotted screen section backfilled with filter sand and sealed with bentonite within the desired stratum or zone. Solid riser sections above the sealed zone may be grouted or backfilled with a variety of materials depending upon the project needs and finished at the ground surface with either a flush-mount roadway box or with a protective casing such as a guard pipe and padlock for undeveloped sites. Careful attention to the placement of screens, backfill and seals is required and accurate depth measurements must be recorded during installation. Initial well development may occur immediately upon completion in order set the sand pack and remove the effects of drill fluids from the formation waters.

#### 3.2.7.4 Probes

- A. *Unsampled Probes* - The term probe has historically referred to the advancement of a solid drill bit or rod by various means without sampling in order to estimate potential soft sediment thickness and refusal or obstruction depths. Small diameter rods advanced by hand have been useful in determining minimum peat and organic thickness in wetlands. Mechanical advancement of solid stem augers with conventional drilling equipment and pneumatic-percussive air track drilling are routinely used to supplement or replace test borings in areas of known shallow bedrock. Direct-push methods include simple rod assemblies to sophisticated electro-piezoecone mechanisms. The principle advantage to conducting probes is that a great deal of data points can be rapidly obtained to create detailed contours of the desired surface or stratum. Implicit in the conduct of non-instrumented unsampled probes is that variations in drill action

or rod advance is used to estimate strata changes. Acoustic listening devices placed within a saturated bedrock well near an air track rig will enhance the listener's ability to hear the pneumatic-percussive bit encounter bedrock. Primary among the disadvantages to conducting probes is the uncertainty resulting from relying strictly upon drill action without a hard data sample. Close proximity probes in zones of shallow refusal and repeated probes adjacent to those terminated on suspected obstructions help boost confidence and define aberrations. Secondary among the disadvantages to conducting probes is the inaccuracy inherent in the measurement of an often rapidly moving reference point as the drill advances through obstructions or variable zones into progressively more competent bedrock. Solid stem augers with conventional drilling equipment are slow to progress through dense soils and may be defeated by boulders but can be advanced below the water table without problems. Pneumatic-percussive air track drilling will rapidly advance through dense soils, boulders and bedrock but is inhibited below the groundwater table by borehole collapse and particularly when the air evacuation is suspended as rods are added to the drill string. Depending upon site conditions and termination depth, dozens of probes may be conducted in a single day. As such, horizontal and vertical control should be established at each probe location separate from the probe effort in order to obtain the most use from the rig time and to maximize the accuracy of the data.

- B. Sampled Probes* - Small diameter hand augers, soil plugs and manual soil cores are routinely used for surface soil sampling for rudimentary site reconnaissance, environmental sampling and hydric soils mapping. Direct-push and percussive or vibration driven soil core equipment preferred for shallow environmental sampling ranges in size from small diameter hand held units to vehicle mounted machinery capable of obtaining soil cores within polycarbonate liners 3.6 in. I.D. by 8 ft. length. As with any uncased borehole, additional soil cores may be obtained until the termination depth criterion is reached or sample integrity is compromised due to borehole collapse. Care must be exercised in establishing collapsed or resampled zones when documenting direct-push samples or soil cores.

#### 3.2.7.5 Test Pits

Test pits are an extremely economical and effective way to rapidly characterize shallow subsurface conditions. Test pits are particularly useful for surficial geologic mapping, determining fill thickness and content, contouring shallow bedrock conditions and in determining oversized (cobble and boulder) percentages. Small backhoes with an approximately  $\frac{1}{4}$  cubic yard bucket capacity are capable of excavating test pits up to 12 ft. depth in most materials and can be used with minimal site damage. Larger excavators with an approximately  $\frac{3}{4}$  cubic yard bucket capacity are capable of excavating test pits up to 16 to 20 ft. depth and can be used to construct access for drill rigs on difficult sites. Given sufficient area, excavators can safely enter the excavation and extend the test pit indefinitely. During test pit excavation careful consideration must be given to potential bearing surface disturbance within proposed structures. In addition, care must be taken to minimize other site impacts



requiring costly restoration including damage to trees, pavement, curbing, landscaping and utilities.

### 3.2.7.6 Environmental Sampling & Monitoring

Environmental sampling combined with discrete field screening of soil and groundwater for contaminants is routinely conducted during the performance of subsurface explorations. In addition, continuous monitoring of air quality within the work zone or at the project site may be required to address H&S concerns. Potential contaminants and sources may be identified in the initial stage of project planning and prior arrangements made for PPE, monitoring, sampling and laboratory analysis.

To minimize the risk of cross-contamination typical environmental sampling programs work from known or suspected clean areas toward areas of known or suspected contamination. Contamination encountered unexpectedly may present serious exposure risks to field personnel without proper PPE and monitoring instrumentation, particularly if the contamination is gross or unidentified. In the event unexpected contamination is encountered, all fieldwork should be suspended and the area evacuated immediately until the Project Manager and the Health & Safety Coordinator can be contacted so that H&S and sampling guidelines can be developed.

- A. *Decontamination Procedures & Waste Management* - Standard equipment decontamination practices may include the establishment of a decontamination area such that decontamination fluids are collected and properly stored for disposal. Typically a location within the site is chosen away from sensitive or occupied zones and a decontamination pad is created within a bermed area using polyethylene sheeting. A high-pressure steam cleaner is used to wash all equipment prior to each exploration and wastewater is pumped into adjacent drums. Splitspoons and hand sampling tools are scrubbed between samples at the exploration location using a detergent (water andalconox) solution rinsed with control (tap) water followed by a solvent (methanol) rinse, wiped with a paper towel and rinsed with deionized water before being allowed to air dry. Hexane may be needed for removal of heavy petroleum, grease and coal tar. Decontamination waste, sample residue and drill cuttings are typically drummed, labeled and staged onsite for proper disposal.
- B. *Environmental Soil Sampling* - Environmental soil samples obtained for chemical analyses are collected in surface samples and by using many of the techniques employed in typical subsurface explorations with special attention given to decontamination procedures. Preservation, handling and glassware for environmental soil samples varies considerably depending upon several factors including the type and degree of contamination, the analytical method to be conducted, the analytical laboratory being used and the governing regulations. In addition, the depth and location of samples may be strictly controlled under agency guidelines. Documentation of volatile organic compounds (VOC) in the soil through headspace screening is required in order to provide real-time guidance in the field to direct the sampling.

Clean 8 oz. jars are partially filled with newly obtained soils and covered with aluminum foil and allowed to stabilize prior to screening with a photoionization detector (PID). The presence of metals in soils is not associated with odors, while coal tar, fuels and solvents are often easily distinguished. Particular attention is given to discoloration or odors noted, however it is company policy to avoid fumes and odors at all times. Soils collected from a discrete zone should be homogenized and a representative portion placed into laboratory glassware and labeled. Analytical samples are kept in a cooler with ice blocks and a Chain of Custody form is maintained until transfer to the analytical laboratory.

- C. *Environmental Water Sampling* - Groundwater monitoring (observation) wells must undergo an initial well development following installation and prior to sampling. This is intended to optimize well function and to produce formation-derived groundwater samples and valid analytical testing results. Groundwater sampling from existing monitoring wells for chemical analyses involves initially gauging the static groundwater level and the well depth in order to determine the well volume. Waterra® footvalves and tubing, bailers, submersible pumps or peristaltic pumps may be used to purge a minimum of three well volumes in order to minimize well effects. Turbidity, conductivity, resistivity, salinity, dissolved oxygen, oxidation-reduction potential, temperature and pH are recorded periodically after purging and groundwater parameters must be stable prior to sampling. Low-flow groundwater sampling is required for certain analyses to be valid. In such cases, variable speed submersible pumps are used at extremely slow rates to minimize drawdown and turbidity. Sampling of surface waters or open-body water at depth may be done with remote or variable depth, bottle-type samplers. Preservation, handling and glassware for environmental water samples varies considerably depending upon several factors including the type and degree of contamination, the analytical method to be conducted, the analytical laboratory being used and the governing regulations.

#### 4.2.7.7 Special Testing, Sampling and Instrumentation

H&A utilizes a wide variety of well established and state-of-the-art soil, rock and groundwater testing procedures and instrumentation to supplement many subsurface exploration programs. Among the methods and techniques routinely used are fixed-piston tube sampling, vane shear testing, pressuremeter testing, permeability testing, water pressure (packer) testing in rock, inclinometer installation, multiposition borehole extensometers (MPBX) installation and aquifer (pump) testing. Prior to attempting an unfamiliar technique H&A field staff must review all related procedures and consult experienced personnel. Outside support or training that may be necessary to perform new procedures shall be sought with project manager approval. Notes and references obtained should be retained for potential development into new operating procedure.

## APPENDIX A REFERENCES

### A.1 References

- American Society for Testing and Materials, current edition, "Annual Book of ASTM Standards," Vol.04.08, D420-98, "Standard Guide to Site Characterization for Engineering Design and Construction Purposes."
- American Society for Testing and Materials, current edition, "Annual Book of ASTM Standards," Vol.04.08, D653-01, "Standard Terminology Relating to Soil, Rock and Contained Fluids."
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- American Society for Testing and Materials, current edition, "Annual Book of ASTM Standards," Vol.04.09, D6286-98, "Standard Guide for Selection of Drilling Methods for Environmental Site Characterization."
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- American Society for Testing and Materials, current edition, "Annual Book of ASTM Standards," Vol.04.09, D6517-00, "Standard Guide for Field Preservation of Ground-Water Samples."

Haley & Aldrich

**APPENDIX B  
RELATED HALEY & ALDRICH PROCEDURES**

- OP1001 Excavation and Trenching Safety
- OP1002 Drilling Safety
- OP1003 Utility Clearance
- OP2001 Identification & Description of Soils in the Field Using Visual-Manual Methods
- OP2002 Identification & Description of Rock in the Field Using Visual-Manual Methods
- OP2003 Surficial Geologic Mapping
- OP2005 Test Borings, Sampling, Standard Penetration Testing (STP) and Borehole Abandonment
- OP2017 Rock Coring
- OP2020 Groundwater Monitoring (Observation) Well Installation, Development and Abandonment
- OP2026 Exploratory Test Pits
- OP2028 Exploratory Probes
- OP2030 Direct Push Borings (Percussion-Vibration Driven Probes)

## APPENDIX C FORMS AND EXAMPLES

### C.1 Forms

All Haley & Aldrich field forms are maintained on the server at K:\techproc\sop\Forms. The following is a list of selected current forms available for use in routine field exploration programs.

#### Site Investigations

- Form 2024 Site Investigation Form

#### Test Borings

- Form 2004 Subcontractor Quantities For Test Borings
- Form 2029 Sampling Labels - Geotechnical
- Form 2003 Test Boring Daily Field Report
- Form 2001 Test Boring Reports
- Form 2002 Core Boring Reports
- Form 2028 Geotechnical Sample Receiving Form

#### Observation (Monitoring) Wells

- Form 2007 Observation Well Installation Form
- Form 2013 Well Decommissioning Report
- Form 3006 Monitoring Well Development Report
- Form 2021 Groundwater Monitoring Report

#### Test Pits

- Form 2006 Test Pit Logs
- Form 2028 Geotechnical Sample Receiving Form

#### Test Probes

- Form 2022 Test Probe Report
- Form 2023 Test Probe Summary
- Form 2025 Vibracore Report



## Environmental Sampling

- Form 1010 Headspace Screening Report
- Form 3001 Sampling Labels – Environmental
- Form 3002 Chain of Custody Electronic
- Form 3003 Chain of Custody Field
- Form 3004 Sampling Record
- Form 3005 Groundwater Sampling Record

### C.2 Examples

The following examples of selected completed forms are intended to provide guidance in the standard documentation conventions practiced by H&A.

# SITE INVESTIGATION FORM

<b>PROJECT</b> _____	<b>H&amp;A FILE NO.</b> _____
<b>LOCATION</b> _____	<b>PROJECT MGR.</b> _____
<b>CLIENT</b> _____	<b>FIELD REP</b> _____
<b>CONTRACTOR</b> _____	<b>DATE</b> _____

**SITE ACCESS**  
 Paved     Gravel     Trails     None     Water     Inside     Other \_\_\_\_\_

**ENTRANCE**  
 Enclosed     Gate/Keys    Comments: \_\_\_\_\_

**EXPLORATION EQUIPMENT**

<input type="checkbox"/> Truck Rig	<input type="checkbox"/> ATV Rig	<input type="checkbox"/> Skid Rig	<input type="checkbox"/> Tripod	<input type="checkbox"/> Geoprobe	<input type="checkbox"/> Other _____
<input type="checkbox"/> Backhoe	<input type="checkbox"/> Bobcat	<input type="checkbox"/> Excavator	<input type="checkbox"/> Sm Excavator	<input type="checkbox"/> Barge	<input type="checkbox"/> Other _____
<input type="checkbox"/> Chainsaw	<input type="checkbox"/> Haybales	<input type="checkbox"/> Plywood	<input type="checkbox"/> 4WD Vehicle	<input type="checkbox"/> Other _____	

<b>WATER SUPPLY AVAILABLE</b>	<b>ELECTRIC AVAILABLE:</b>
<input type="checkbox"/> Hydrant <input type="checkbox"/> Tap <input type="checkbox"/> River/Lake <input type="checkbox"/> None	<input type="checkbox"/> Yes <input type="checkbox"/> No

**TOPOGRAPHY**  
 Low Lying     Level     Sloping     Cliffs     Mountains     Other \_\_\_\_\_

**PHYSIOGRAPHY**

<input type="checkbox"/> Bedrock	<input type="checkbox"/> Till Upland	<input type="checkbox"/> Valley Floor	<input type="checkbox"/> Flood Plain	<input type="checkbox"/> Coastal Plain	<input type="checkbox"/> Other _____
<input type="checkbox"/> Wetlands	<input type="checkbox"/> Tidal Marsh	<input type="checkbox"/> Estuarine	<input type="checkbox"/> Lakes/Ponds	<input type="checkbox"/> Outwash Plain	<input type="checkbox"/> Other _____
<input type="checkbox"/> Developed	<input type="checkbox"/> Filled Land	<input type="checkbox"/> Paved	<input type="checkbox"/> Landscaped	<input type="checkbox"/> Other _____	

**DRAINAGE**  
 Rivers     Streams     Rills     Canals     Ditches     Culverts     Other \_\_\_\_\_

**ESTIMATED GROUND SURFACE ELEVATION:** \_\_\_\_\_ ft

**ESTIMATED GROUNDWATER DEPTH/ELEVATION:** \_\_\_\_\_ ft

**WOODED**  
 Heavily     Partially     Sparsely     Comments: \_\_\_\_\_

**VEGETATION**  
 Brush     Grass     None     Comments: \_\_\_\_\_

<b>BEDROCK OUTCROPS</b>	<b>SOIL EXPOSURES</b>
LOCATION: _____	LOCATION: _____
TYPE: _____	TYPE: _____

**EXISTING STRUCTURES**  
 Buildings     Warehouse     Slabs     Bridges     Foundations     Other \_\_\_\_\_

**UNDERGROUND STORAGE TANKS**  
 Yes     No

**VISIBLE EVIDENCE OF CONTAMINATION**  
 Drums     Staining     Site history     Unauthorized dumping     Other \_\_\_\_\_

<b>OVERHEAD UTILITIES</b>	<b>UNDERGROUND UTILITIES</b>
LOCATION: _____	LOCATION: _____
TYPE: _____	TYPE: _____

**COMMENTS:** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_



**SUBCONTRACTOR QUANTITIES FOR TEST BORINGS**

<b>Project</b>	<b>File No.</b>
<b>Location</b>	<b>Date</b>
<b>Contractor</b>	<b>Project Manager</b>

No.	Description	Unit	Quantity
<b>I MOBILIZATION/DEMOBILIZATION</b>			
1	Mob/Demob of Truck rig w/ OSHA-trained crew within 100 miles of contractor yard*	ea	
2	Mob/Demob of Skid rig with OSHA-trained crew within 100 miles of contractor yard*	ea	
3	Mob/Demob of Bomb/ATV rig with OSHA-trained crew within 100 miles of contractor yard*	ea	
4	Mob/Demob of Geoprobe rig w/ OSHA-trained crew within 100 miles of contractor yard*	ea	
<b>II DRILLING - FOOTAGE RATE</b>			
5	3-in. dia. cased overburden drilling (0-100 ft.) with no sampling	lf	
6	cased overburden drilling (0-100 ft.) with standard 5-ft. interval sampling	lf	
7	cased overburden drilling (0-100 ft.) continuous sampling	lf	
8	4-in. dia. cased overburden drilling (0-100 ft.) with no sampling	lf	
9	cased overburden drilling (0-100 ft.) with standard 5-ft. interval sampling	lf	
10	cased overburden drilling (0-100 ft.) continuous sampling	lf	
11	4-¼ in. dia. hollow stem auger overburden drilling (0-100 ft.) with no sampling	lf	
12	hollow stem auger overburden drilling (0-100 ft.) w/ standard 5-ft. interval sampling	lf	
13	hollow stem auger overburden drilling (0-100 ft.) continuous sampling	lf	
14	NX rock core via double-tube core barrel (includes bit wear)	lf	
15	HX rock core via double-tube core barrel (includes bit wear)	lf	
16	Extra split spoon samples (for footage rates only)	ea	
17	3-in. undisturbed tube samples	ea	
18	Standby Time for rig and crew/Decon of equipment	hr	
<b>III DRILLING - DAY RATE</b>			
19	Truck mounted drill rig with OSHA-trained crew	day	
20	Truck mounted drill rig with OSHA-trained crew (overtime rate)	hr	
21	Skid rig with OSHA-trained crew	day	
22	Skid rig with OSHA-trained crew (overtime rate)	hr	
23	Bomb/ATV drill rig with OSHA-trained crew	day	
24	Bomb/ATV drill rig with OSHA-trained crew (overtime rate)	hr	
25	Geoprobe rig with OSHA-trained crew	day	
26	Geoprobe rig with OSHA-trained crew (overtime rate)	hr	
27	NX rock core via double-tube core barrel (includes bit wear for day rates)	lf	
28	HX rock core via double-tube core barrel (includes bit wear for day rates)	lf	
29	Geoprobe push samples liners (4' section)	ea	
<b>IV OBSERVATION WELL INSTALLATION</b>			
30	1-in. dia. piezometer (Sch 40 PVC) installed	lf	
31	2-in. dia. well (Sch 40 PVC) installed (slotted and screened)	lf	
32	4-in. dia. well (Sch 40 PVC) installed (slotted and screened)	lf	
33	Standard 4-in. dia. roadway box	ea	
34	Standard 8-in. dia. roadway box	ea	
35	5 ft. protective guard pipe with padlock (4-in. diameter)	ea	
<b>V ADDITIONAL ITEMS</b>			
36	Utility Clearance	ea	
37	Permits - Determined on a job to job basis	ls	
38	State Police Detail	hr	
39	Laborer	hr	
40	Chain Saw	day	
41	Steam Cleaner with Generator	day	
42	Upgrade Crew Personnel Protection to Level "C"	hr	
43	55 gal. soil/water drum	ea	
44	Borehole Grouting (4-in. diameter)	lf	
45	Sand	bag	
46	Concrete	bag	
47	Cold Patch	bag	
48			
49			
<b>VI COMMENTS</b>			

<b>Driller Signature</b> _____	<b>Date</b> _____
<b>Geologist Signature</b> _____	<b>Date</b> _____

<b>HALEY &amp; ALDRICH</b>		Haley & Aldrich, Inc. 465 Medford St., Suite 2200 Boston, MA 02129 Tel: 617-886-7400	
Boring ID:	File Number:		
Sample Interval:	Project:		
Depth:	PM:		
Recovery:	Blow Counts:		
Collected By:	/ / /		
Comments:			

<b>HALEY &amp; ALDRICH</b>		Haley & Aldrich, Inc. 465 Medford St., Suite 2200 Boston, MA 02129 Tel: 617-886-7400	
Boring ID:	File Number:		
Sample Interval:	Project:		
Depth:	PM:		
Recovery:	Blow Counts:		
Collected By:	/ / /		
Comments:			

<b>HALEY &amp; ALDRICH</b>		Haley & Aldrich, Inc. 465 Medford St., Suite 2200 Boston, MA 02129 Tel: 617-886-7400	
Boring ID:	File Number:		
Sample Interval:	Project:		
Depth:	PM:		
Recovery:	Blow Counts:		
Collected By:	/ / /		
Comments:			

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Sample Interval:	Project:		
Depth:	PM:		
Recovery:	Blow Counts:		
Collected By:	/ / /		
Comments:			

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Sample Interval:	Project:		
Depth:	PM:		
Recovery:	Blow Counts:		
Collected By:	/ / /		
Comments:			

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Boring ID:	File Number:		
Sample Interval:	Project:		
Depth:	PM:		
Recovery:	Blow Counts:		
Collected By:	/ / /		
Comments:			

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Boring ID:	File Number:		
Sample Interval:	Project:		
Depth:	PM:		
Recovery:	Blow Counts:		
Collected By:	/ / /		
Comments:			

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Boring ID:	File Number:		
Sample Interval:	Project:		
Depth:	PM:		
Recovery:	Blow Counts:		
Collected By:	/ / /		
Comments:			

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Depth:	PM:		
Recovery:	Blow Counts:		
Collected By:	/ / /		
Comments:			

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Boring ID:	File Number:		
Sample Interval:	Project:		
Depth:	PM:		
Recovery:	Blow Counts:		
Collected By:	/ / /		
Comments:			















# GEOTECHNICAL SAMPLE RECEIVING REPORT

<b>PROJECT</b> _____	<b>H&amp;A FILE NO.</b> _____
<b>LOCATION</b> _____	<b>PROJECT MGR.</b> _____
<b>CLIENT</b> _____	<b>PROJECT ENGR.</b> _____
<b>DELIVERED BY</b> _____	<b>DATE</b> _____

### TYPE OF SAMPLE

<b>SOIL:</b> Jar Samples _____ box(es)  Undisturbed Tube Samples: Outside Diameter: <input type="checkbox"/> 3-in. <input type="checkbox"/> 2-in. _____ tube(s)  *** Bag Samples _____ bag(s) *** 5-gal. Bucket Samples _____ bucket(s)	<b>ROCK CORE:</b> Boxes: _____ box(es) Other: _____ sample(s)  <b>OTHER:</b> _____
--	--

HAZARDOUS MATERIALS?  Yes  No      CONTAMINANTS (please list major contaminants) \_\_\_\_\_

If geology/pre-construction project, fill out Section A - If Con-Mon project, fill out Section B.

A:	Box No.	Exploration No.	Sample No.(s) From - To	Depth From - To	Remarks <small>{if multiple types of samples, list type, (e.g., jars, tube, bag, rock)}</small>

B:	Explor. No.	Sample No.	Depth Range (ft)	Sample Description (USCS or geologic unit)	Sample Source <small>(on-site, Contractor Pit, etc.)</small>	Proposed Use <small>(see below)</small>

For "Proposed Use" try to use the term from the specifications (e.g., structural fill, common fill, dense graded, State Highway Spec. No., etc.)

Notes: \_\_\_\_\_

\*\*\* ANY BAG/BUCKET SAMPLE WHICH HAS NOT HAD TESTING ASSIGNED AFTER 3 WEEKS OF RECEIVING WILL BE AUTOMATICALLY DISPOSED OF UNLESS THE LABORATORY MANAGER IS GIVEN PRIOR WRITTEN NOTIFICATION OF THE NEED TO RETAIN THE SAMPLE.

**To be completed by lab personnel:**

Sample received by: \_\_\_\_\_ Boxes Labeled?  Yes  No

STORAGE LOCATION:  
 Geotechnical Laboratory       Storage Room / Shelf Location: \_\_\_\_\_  
 Humid Room       Other: \_\_\_\_\_





# OBSERVATION WELL INSTALLATION REPORT

Well No. \_\_\_\_\_  
Boring No. \_\_\_\_\_

PROJECT _____	H&A FILE NO. _____
LOCATION _____	PROJECT MGR. _____
CLIENT _____	FIELD REP. _____
CONTRACTOR _____	DATE INSTALLED _____
DRILLER _____	WATER LEVEL _____

Ground El. \_\_\_\_\_ ft      Location \_\_\_\_\_       Guard Pipe  
 El. Datum \_\_\_\_\_       Roadway Box

SOIL/ROCK CONDITIONS	BOREHOLE BACKFILL					
<div style="text-align: center;"> </div>		Type of protective cover/lock _____				
		Height/Depth of top of guard pipe/roadway box above/below ground surface _____ ft				
		Height/Depth of top of riser pipe above/below ground surface _____ ft				
		Type of protective casing: _____				
		Length _____ ft				
		Inside Diameter _____ in				
		Depth of bottom of guard pipe/roadway box _____ ft				
				<u>Type of Seals</u>	<u>Top of Seal (ft)</u>	<u>Thickness (ft)</u>
				Concrete _____	_____	_____
				Bentonite Seal _____	_____	_____
		Type of riser pipe: _____				
		Inside diameter of riser pipe _____ in				
		Type of backfill around riser _____				
		Diameter of borehole _____ in				
		Depth to top of well screen _____ ft				
		Type of screen _____				
		Screen gauge or size of openings _____ in				
		Diameter of screen _____ in				
		Type of backfill around screen _____				
		Depth of bottom of well screen _____ ft				
		Bottom of Silt trap _____ ft				
		Depth of bottom of borehole _____ ft				

(Bottom of Exploration)  
(Numbers refer to depth from ground surface in feet)

(Not to Scale)

\_\_\_\_\_ ft + \_\_\_\_\_ ft + \_\_\_\_\_ ft = \_\_\_\_\_ ft  
 Riser Pay Length (L1)      Length of screen (L2)      Length of silt trap (L3)      Pay length

COMMENTS: \_\_\_\_\_

# MONITORING WELL DEVELOPMENT REPORT

Well No. \_\_\_\_\_

Page 1 of 1

PROJECT	_____	H&A FILE NO.	_____
LOCATION	_____	PROJECT MGR.	_____
CLIENT	_____	FIELD REP.	_____
CONTRACTOR	_____	DATE	_____
ELEVATION SUBTRAHEND	_____		

**Estimated Volume of Water Lost During Drilling:** \_\_\_\_\_ gallons

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Depth to Water Before Development:** \_\_\_\_\_ feet

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Depth to Well Bottom Before Development:** \_\_\_\_\_ feet

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Turbidity of Water Before Development:** \_\_\_\_\_ NTU

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Volume of Water Removed:** \_\_\_\_\_ gallons

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Method of Removal (bailing, pumping):** \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Depth to Well Bottom After Development:** \_\_\_\_\_ feet

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Depth to Water After Development:** \_\_\_\_\_ feet

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Turbidity of Water After Development:** \_\_\_\_\_ NTU

Comments: \_\_\_\_\_  
\_\_\_\_\_














# VIBRACORE REPORT

Probe No. \_\_\_\_\_

Page 1 of 1

PROJECT _____	H&A FILE NO. _____
LOCATION _____	PROJECT MGR. _____
CLIENT _____	GEOLOGIST _____
CONTRACTOR _____	DATE _____
EQUIPMENT _____	CHECKED BY _____

Depth (ft)	Sketch	Visual Description	Recovery			
			Section	Tube Length	Sample Length	Total Weight
0						
1	—		Top: _____			
			Bottom: _____			
			Notes: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.			
			Remarks:			
2	—					
3	—					
4	—					
5	—					
6	—					
7	—					
8	—					
9	—					
10	—					





Haley & Aldrich, Inc.  
 465 Medford St., Suite 2200  
 Boston, MA 02129  
 Tel: 617-886-7400

Sample ID:	File Number:
Depth:	Project:
Date:	Analysis:
Time:	Preservative:
Collected By:	Laboratory:
Comments:	



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Comments:	



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Collected By:	Laboratory:
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Collected By:	Laboratory:
Comments:	



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Sample ID:	File Number:
Depth:	Project:
Date:	Analysis:
Time:	Preservative:
Collected By:	Laboratory:
Comments:	



WATER AND WASTEWATER METHODS			Solid	Liquid	
<u>Analysis Description</u>	<u>Method No.</u>	<u>Preservative</u>	<u>Sample Volume/Container</u>	<u>Sample Volume/Container</u>	<u>Holding Time</u>
Alkalinity	310	Cool 4° C	N/A	250 mL HDPE	14 days
Amenable Cyanide	Std. Mth. 412 F.	pH>12 NaOH, Cool 4° C	N/A	1 L HDPE	14 days
Ammonia	350	pH<2 H2SO4, Cool 4° C	N/A	1 L HDPE	28 days
Base/Neutral & Acid Extractables	625	Cool 4° C	N/A	1 L Amber	7 days Ext/40 days Analyze
Biochemical Oxygen Demand (BOD)	405.1	Cool 4° C	N/A	2 L HDPE	48 hours
Chemical Oxygen Demand (COD)	410	pH<2 H2SO4, Cool 4° C	N/A	125 mL HDPE	28 days
Chloride	300.0, 325	None Required	N/A	125 mL HDPE	28 days
Chromium, Hexavalent	3500D, 218.4/5	None Required	N/A	1 L HDPE	24 hours
Fluoride	300.0, 340	None Required	N/A	500 mL HDPE	28 days
Hardness, Total (as CaCO3)	130	pH<2 H2SO4, Cool 4° C	N/A	250 mL HDPE	6 Months
Nitrate	300.0, 352.1	Cool 4° C	N/A	250 mL HDPE	48 Hours
Nitrite	300.0, 354.1	Cool 4° C	N/A	125 mL HDPE	48 Hours
Orthophosphate	300.0, 365	Filter, Cool 4° C	N/A	125 mL HDPE	48 Hours
PCBs	608	Cool 4° C	N/A	1 L Amber	7 days Ext/40 days Analyze
Pesticides	608	Cool 4° C	N/A	1 L Amber	7 days Ext/40 days Analyze
Physiologically Available Cyanid	MADEP draft	pH>12 NaOH, 4° C	N/A	1 L HDPE	14 days
Priority Pollutant Metals (13 Metals)	200.7/AA, 200 Series	pH<2 HNO3, 4° C	N/A	1 L HDPE	28 days (Hg), 6 mos. (others)
Purgeable Halocarbons & Aromatic:	601/602	pH 2 HCl, Cool 4° C	N/A	40 mL Glass Vial	14 days
RCRA Metals (8 Metals)	200.7/AA, 200 Series	pH<2 HNO3, 4° C	N/A	1 L HDPE	28 days (Hg), 6 mos. (others)
Sulfate	300.0, 375	Cool 4° C	N/A	250 mL HDPE	28 days
Sulfide	376	pH>9 NaOH, Zn Acetate, Cool 4° C	N/A	1 L HDPE	7 days
Sulfite	377.1	None Required	N/A	125 mL HDPE	Analyze Immediately
Total Cyanide	335	pH>12 NaOH, Cool 4° C	N/A	1 L HDPE	14 days
Total Dissolved Solids (TDS)	209	Cool 4° C	N/A	250 mL HDPE	7 days
Total Organic Carbon (TOC)	415	pH<2 HCl or H2SO4, Cool 4° C, Dark	N/A	40 mL Amber	28 days
Total Organic Halogen (TOX)	506	pH<2 HNO3, 4° C	N/A	1 L Amber	check with lab
Total Phenolic:	420.1	pH<2 H2SO4, Cool 4° C	N/A	1 L Amber	28 days
Total Phosphorus	365	pH<2 H2SO4, Cool 4oC	N/A	125 mL HDPE	28 days
Total Solids (TS)	160.3	Cool 4° C	N/A	250 mL HDPE	7 days
Total Suspended Solids (TSS)	160.2	Cool 4° C	N/A	250 mL HDPE	7 days
Volatile Organics	624	pH 2 HCl, Cool 4° C	N/A	40 mL Glass Vial	14 days
Weak and Dissociable Cyanide	Std. Mth. 412 H.	pH>12 NaOH, Cool 4° C	N/A	1 L HDPE	14 days
<b>DRINKING WATER ANALYSIS</b>					
Volatile Organics	502.2 or 524.2	pH 2 HCl, Cool 4° C	N/A	40 mL Glass Vial	14 days
<b>MICROBIOLOGY</b>					
Fecal Coliform	STDMTH	Cool 4o C	N/A	sterile, 125 mL	6 hours
Standard Plate Count	STDMTH	Cool 4o C	N/A	sterile, 125 mL	6 hours
Total Coliform	STDMTH	Cool 4o C	N/A	sterile, 125 mL	6 hours
Yeast and Mold	STDMTH	Cool 4o C	N/A	sterile, 125 mL	6 hours
<b>SOIL/SEDIMENTS/WATER</b>					
<u>Analysis Description</u>	<u>Method No.</u>	<u>Solids (S) / Liquids (L)</u> <u>Preservative</u>	<u>Solid</u> <u>Sample Volume/Container</u>	<u>Liquid</u> <u>Sample Volume/Container</u>	<u>Holding Time</u>
Acid Extractables/Base/Neutral Extractable:	8270	S/L: Cool 4° C	8 oz. CWM	1 L Amber	7 days Ext/40 days Analyze
Amenable Cyanide	-	S: 4° C / L: pH>12 NaOH, 4° C	4 oz. CWM	1 L HDPE	14 days
Chromium, Hexavalent	3060A/7196	S/L: Cool 4° C	8 oz. CWM	1 L HDPE	24 hours
Extractable Hydrocarbons:	8015B	S: Cool 4° C / L: pH<2 HCl, 4° C	8 oz. CWM	1 L Amber	7 days Ext/40 days Analyze
Herbicides	8150	S/L: Cool 4° C	8 oz. CWM	1 L Amber	7 days Ext/40 days Analyze
Non-Halogenated Organics	8015B	S: Cool 4° C / L: pH<2 HCl, 4° C	4 oz. CWM	40 mL Glass Vial	14 days
PAH (low level)	8310 or GC/MS SIM	S/L: Cool 4° C	8 oz. AWM	1 L Amber	7 days Ext/40 days Analyze
Paint Filter Liquids Test	9095	S: Cool 4° C	8 oz. CWM	1 L Amber	Analyze ASAP
PCBs	8082	S/L: Cool 4° C	8 oz. CWM	1 L Amber	7 days Ext/40 days Analyze
Pesticides	8081	S/L: Cool 4° C	8 oz. CWM	1 L Amber	7 days Ext/40 days Analyze
Physiologically Available Cyanid	MADEP draft	S: 4° C / L: pH>12 NaOH, 4° C	4 oz. CWM	1 L HDPE	14 days
Priority Pollutant Metals(13 Metals)	6010&7000	S: 4° C / L: pH<2 HNO3, 4° C	8 oz. CWM	1 L Amber	28 days (Hg), 6 mos. (others)
RCRA Metals (8 Metals)	6010&7000	S: 4° C / L: pH<2 HNO3, 4° C	8 oz. CWM	1 L Amber	28 days (Hg), 6 mos. (others)
Total Cyanide	9010	S: 4° C / L: pH>12 NaOH, 4° C	4 oz. CWM	1 L HDPE	14 days
Volatile Hydrocarbons:	8015B	S: Cool 4° C / L: pH<2 HCl, 4° C	4 oz. CWM	40 mL Glass Vial	14 days
Volatile Organics	8260B, 8021	S: methanol/NaHSO4, 4° C / L: pH<2 HCl, 4° C	4 oz. CWM	40 mL Glass Vial	14 days
<b>RCRA HAZARDOUS WASTE CHARACTERIZATION</b>					
Corrosivity (pH only)	SW846-7.2	S: Cool 4° C	4 oz. CWM	check with lab	Analyze ASAP
Ignitability/Flashpoint	SW846-7.1	S: Cool 4° C	4 oz. CWM	check with lab	Analyze ASAP
Reactivity (CN-/S2-)	SW846-7.3	S: Cool 4° C	4 oz. CWM	check with lab	Analyze ASAP
TCLP (RCRA 8) Metals (check for mercury)	1311	S: Cool 4° C	16 oz. CWM	check with lab	6 mos. Ext/6 mos. Analyze
TCLP Pesticides/Herbicides	1311	S: Cool 4° C	16 oz. CWM	check with lab	14 days Ext/40 days Analyze
TCLP Semivolatiles	1311	S: Cool 4° C	16 oz. CWM	check with lab	14 days Ext/40 days Analyze
TCLP Volatiles	1311	S: Cool 4° C	8 oz. CWM	check with lab	14 days Ext/14 days Analyze
<b>HYDROCARBON OIL &amp; GREASE ANALYSIS</b>					
MADEP EPH Method	MADEP REV. 0	S: Cool 4° C / L: pH<2 HCl, 4° C	4 oz. Amber	1 L Amber	S:7 days Ext / L:14 days Ext
MADEP EPH Method (C-Ranges only)	MADEP REV. 0	S: Cool 4° C / L: pH<2 HCl, 4° C	4 oz. Amber	1 L Amber	S:7 days Ext / L:14 days Ext
MADEP VPH Method	MADEP REV. 0	S: methanol, 4° C / L: pH<2 HCl, 4° C	40 mL+2 oz. CWM.	40 mL Glass Vial	S: 28 days / L: 14 days
MADEP VPH Method (C-Ranges only)	MADEP REV. 0	S: methanol, 4° C / L: pH<2 HCl, 4° C	40 mL+2 oz. CWM.	40 mL Glass Vial	S: 28 days / L: 14 days
MADEP EPH Method - with selected PAHs (including acenaphthene, naphthalene, 2-methylnaphthalene, and phenanthrene	MADEP REV. 0	S: Cool 4° C / L: pH<2 HCl, 4° C	4 oz. Amber	1 L Amber	S:7 days Ext / L:14 days Ext
Petroleum Identifier	ASTM D3328				
Quantitative (include Chromatograms		S: Cool 4° C / L: pH<2 H2SO4, 4° C	4 oz. CWM	1 L Amber	S: 7 days / L: 28 days
Total Petroleum Hydrocarbons (Infrared	418.1	S: Cool 4° C / L: pH<2 H2SO4, 4° C	4 oz. CWM	1 L Amber	S: 7 days / L: 28 days
<b>AIR METHODS</b>					
<u>Analysis Description</u>	<u>Method No.</u>	<u>Preservative</u>	<u>Sample Volume/Container</u>	<u>Sample Volume/Container</u>	<u>Holding Time</u>
Volatile Organic Compounds	EPA T01/T02	tubes: 4° C; Tedlar Bags: dark	N/A	N/A	tube: 14 days; bag: 72 hours
Volatile Organic Compounds	EPA T014	check with lab	N/A	N/A	can: 14 days; bag: 72 hours
VPH in air	EPA T01/T02	tubes: 4° C; Tedlar Bags: dark	N/A	N/A	tube: 14 days; bag: 72 hours
VPH in air	EPA T014	check with lab	N/A	N/A	can: 14 days; bag: 72 hours

This table is offered for informational purposes only and is intended to be followed and used by persons having related technical skills and at their own discretion and risk. Since conditions and the manner of use are outside of Haley & Aldrich's control, we make no warranties, express or implied, and accept no liability in connection with any use of this information. IT IS THE USER'S RESPONSIBILITY TO VERIFY THE SUITABILITY OF USE AND CORRECTNESS OF THE INFORMATION SUPPLIED.



# GROUNDWATER SAMPLING RECORD

<b>PROJECT</b> _____	<b>H&amp;A FILE NO.</b> _____
<b>LOCATION</b> _____	<b>PROJECT MGR.</b> _____
<b>CLIENT</b> _____	<b>FIELD REP</b> _____
<b>CONTRACTOR</b> _____	<b>DATE</b> _____

### GROUNDWATER SAMPLING INFORMATION

Well No.						
Water Depth (ft)						
Time						
Product						
Depth Of Well (ft)						
Inside Diameter (in)						
Standing Water Depth (ft) <sup>(1)</sup>						
Volume Of Water In Well (gal)						
Purging Device						
Volume of Bailer/Pump Capacity						
Cleaning Procedure						
Bails Removed/ Volume Removed						
Time Purging Started						
Time Purging Stopped						
Sampling Device						
Cleaning Procedure						
<b>TIME SAMPLES TAKEN</b>	VOA					
	ABN					
	Metals					
<b>PARAMETERS</b>	Color					
	Odor					
	pH					
	Conductivity					
	Turbidity					
	Dissolved Oxygen					
	Temp, ° C					
	Salinity					

Remarks: (ie: field filtrations, persons communicated with at site, etc.)

1. Standing Water Depth = Depth of Well - Water Depth

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_







# TEST PIT LOG

Test Pit No.  
**TP-1**  
Page 1 of 1

<b>PROJECT</b>	New England Hospital	<b>H&amp;A FILE NO.</b>	10715-205
<b>LOCATION</b>	Boston, Massachusetts	<b>PROJECT MGR.</b>	M.X. Haley
<b>CLIENT</b>	PFT Associates	<b>FIELD REP</b>	C. S. Osgood
<b>CONTRACTOR</b>	J. Marchese & Sons Const.	<b>DATE</b>	07-Jan-02
<b>EQUIPMENT</b>	CAT 416 Rubber Tire Extendahoe 0.24 cu.yd. bucket capacity	<b>WEATHER</b>	Mostly Clear 20s

<b>Ground El.</b>	36.3	<b>ft.</b>	<b>Location</b>	West of Pedestrian Tunnel	<b>Groundwater depths/entry rates (in./min.):</b>	7.8 ft. Steadily
<b>El. Datum</b>	NGVD					

Depth (ft.)	Sample ID	Stratum Change Depth (ft.)	USCS Symbol	Visual Identification (density/consistency, color, GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions, geologic interpretation)	Gravel		Sand			Field Test				
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
2	0.5		SM	Dark brown silty SAND (SM), mps 5 mm, organic odor, moist. Fines largely organic.	5	5	10	45	40	R				
		1.3		-LOAM FILL-										
	S3		CH	Yellow brown to olive brown sandy fat CLAY (CH), trace roots, clinker fragments, cinder particles and fragments, clay pipe fragments, metal wire, asphalt fragments. 10% cobbles, <5% boulders, mps 30 in., no odor, moist.	5	5	5	10	15	60	N	M	H	
4	4.0			Note: Poured concrete foundation wall on east side of test pit from 0.0 -4.4 ft.										
	4.0			Note: Poured concrete footing 4.4-5.4 ft.										
6	S2													
	8.0	8.0												
8	S1		CH	Yellow brown fat CLAY (CH), trace fine sand. mps 0.5 mm, no odor, dry. Appartantly laminated with frequent fine sand partings and possible organic fibers.					5	95	N	M	H	
	9.0			-MARINE DEPOSIT-										
10														
	11.0													
12			CL	Yellow brown to gray sandy lean CLAY (CL) with gravel. mps 35 mm, Distinct disrupted laminae in discrete zones. Coarse fraction consists of well-rounded igneous and metamorphic lithologies.	5	10	10	10	15	50	S	M	L	
	12.0	12.0		-GLACIOMARINE DEPOSIT-										
14				Note: Possible stratum change to gray lean CLAY with sand (CL) below 12.0 ft. Coarse fraction apparantly less abundant.										
				-MARINE DEPOSIT-										
				<b>BOTTOM OF EXPLORATION 13.5 FT.</b>										

<b>Obstructions:</b>	<b>Remarks:</b>	<b>Field Tests</b>
	Note: Bag samples S1-S3 obtained for potential mechanical analysis from depths indicated.	Dilatancy: R - Rapid S - Slow N - None Toughness: L - Low M - Medium H - High Plasticity: N - Nonplastic L - Low M - Medium H - High Dry Strength: N - None L - Low M - Medium H - High V - Very High

<b>Standing water in completed pit:</b>		<b>Boulders:</b>			<b>Test Pit Dimensions (ft.):</b>	
at depth	13.2 ft.	Diameter (in.)	Number	Approx. vol. (cu. ft.)	Pit Depth	13.5
measured after	0.1 hrs. elapsed	12 to 24	1 =	1.8	Pit Length X Width	9.0 x 6.0
		over 24	1 =	8.2		

NOTE: Soil identifications based on visual/manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

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# ENVIRONMENTAL TEST PIT LOG

Test Pit No.  
**TP 214**  
Page 1 of 1

PROJECT	Mirror Lake Watershed Study	H&A FILE NO.	28675-309
LOCATION	Essex, Massachusetts	PROJECT MGR.	D.H. Gevalt
CLIENT	Citizens Advisory Partnership	FIELD REP	C.S. Osgood
CONTRACTOR	Stanley Lynde Const. Co., Inc.	DATE	19-Jul-02
EQUIPMENT	Case 580 rubber tire backhoe - 1/4 cu. yd. bucket	WEATHER	Thunderstorms 90's

Ground El.	74.5	ft.	Location	N 2,089,041.101	Groundwater depths/entry rates (in./min.):
El. Datum	NGVD			E 801,444.238	None

Depth (ft.)	Sample ID	PID Reading (ppm.)	Stratum Change Depth (ft.)	USCS Symbol	Visual Identification (density/consistency, color, GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions,	Gravel		Sand		Field Test									
						% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
					Note: Ground surface strewn with boulders. Numerous depressions indicating subsurface voids noted.														
2	S2	15.9			15% coarse to fine sand, 15% cinder fragments and particles, 10% unidentifiable, white ash-like material, 10% fines (largely organic), 10% coarse to fine gravel, 10% wood (manufactured and treated), 5% glass fragments, 5% metal strips and wire, 5% charcoal fragments. Matrix generally dark brown to gray in color with pockets of white and red. 5% plastic sheeting (possibly polyethelene bags), 5% brick particles, 5% clay pipe fragments. 15% boulders, 15% cobbles. Maximum particle size 36 inches.														
					Distinct decomposed gasoline odor, possible faint naphthalene odor. Visible irridescen sheen on moist solids 4.6 to 5.2 ft.														
4					-FILL-														
	S1	140	5.2		Note: Bedrock surface smooth and flat, consisting of very hard to hard, slightly weathered, light gray to pink, coarse to fine grained granite. Single high angle joint noted.														
					REFUSAL ON BEDROCK 5.2 FT.														
6																			
8																			

Obstructions:	Remarks:	Field Tests
	Note: Sample S1 submitted for laboratory chemical analysis.	Dilatancy: R - Rapid S - Slow N - None
	Note: Field monitoring of breathing zone and headspace screening conducted using an hNU 11.7 ev. PID.	Toughness: L - Low M - Medium H - High
	Bucket Decontamination Method: Steam cleaned	Plasticity: N - Nonplastic L - Low M - Medium H - High Dry Strength: N - None L - Low M - Medium H - High V - Very High

Standing water in completed pit: at depth _____ NE _____ ft. measured after _____ 0.75 _____ hrs. elapsed	Boulders:		Test Pit Dimensions (ft.): Pit Depth _____ 5.2 Pit Length X Width _____ 10.5 x 4.3
	Diameter (in.)	Number	
	12 to 24	6.0	= 18.0
	over 24	1.0	= 33.0

NOTE: Soil identifications based on visual/manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

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## APPENDIX D CHECKLISTS

### D.1 Field Monitoring Checklist

#### D.1.1 Preliminary Preparation

- A. Project Briefing
- B. Field Project File and Document Assembly
  - Proposal
  - Contract Documents
  - Locus, Site & Utility Plans
  - Exploration Criteria
  - Subcontractor Agreement
  - Site and Project Contacts
  - Forms
    - DFR
    - Subcontractor Quantities
    - Test Boring Report
    - Core Boring Report
    - Observation Well Installation Form
    - Test Pit Log
    - Special Testing / Instrumentation Forms
    - COC
    - Equipment Usage and Billing Form
    - Sample Receiving Form
- C. H&S Briefing
  - H&S Plan
- D. Equipment Request and Assembly

#### D.1.2 Onsite Duties

- A. Site Walkover and Subcontractor Utility and Safety Briefing
- B. Exploration Program Review
  - Exploration Layout
  - Site Conditions Sketch
  - Preliminary Surficial Geologic Map
  - Exploration Monitoring
    - Equipment Inventory
    - Exploration Layout & Utility Check
    - Field Logging Soil & Rock
    - Water Level Measurements
    - Production and Budget Quantities
    - Sample Handling & Transport
    - Instrumentation & Testing Records
    - As-Built Sketches & Exploration Locations

**D.1.3 Follow Up & Summary**

- Proof Logs and Test Reports
- Finalize DFR and Subcontractor Quantities
- Sample Receiving and Disposition
- Equipment Return and Billing
- Exploration Program Summary
- Final Site & Geological Conditions Summary
- Geologic Profiles

Haley & Aldrich

# OPERATING PROCEDURE: OP3009

## MONITORING WELL DEVELOPMENT PROCEDURE

### PREPARATION AND APPROVALS

VERSION	AUTHORED/DATE	REVIEWED / DATE	REVIEWED / DATE	REVIEWED / DATE	APPROVED / DATE
Ver. 0.0	BAM/ 08-02	JCP/ 08-02	GJM/ 06-03		JAK/ 06-03

**Total Pages: 20**

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**OPERATING PROCEDURE: OP3009**

**MONITORING WELL DEVELOPMENT PROCEDURE**

**1. PURPOSE**

This procedure provides guidance on methods and techniques for groundwater monitoring well development typically performed after well installation, but prior to groundwater quality sampling, specifically for instrumentation installed in overburden or bedrock for environmental monitoring and geotechnical purposes. Groundwater well development increases the yield of the well by removing fine sediments and particles from within the well and the well filter pack, enhances the hydraulic communication between the well and the screened formation, decreases turbidity, increases precision of hydrologic measurements, and increases representativeness of groundwater quality data. Well development is an integral component of a groundwater sampling program, with the objective of obtaining high quality, reproducible groundwater quality data.

The selected method and duration of groundwater well development will be dependent on a number of factors, including: well construction method and materials, depth to groundwater, anticipated groundwater testing parameters and data quality objectives, presence of contamination (i.e., degree of contamination and presence of free-phase non-aqueous phase liquids), method of borehole advancement, and site physical setting/access.

**IMPORTANT NOTES:**

It is not necessary to follow all of the methods in this procedure for every monitoring well development performed. The procedures may be adapted to conform to specific local practice, site-specific geologic conditions, or to support local, municipal or state regulatory requirements.

The term “groundwater monitoring well” or “well” in the procedure is used to denote groundwater monitoring wells, groundwater observation wells, piezometers, gas monitoring wells, lysimeters or other devices constructed in similar manner to a well. Certain well constructions (i.e., large-diameter pumping test wells, injection/extraction wells, commercial, residential or industrial water supply wells) may be developed using the information contained in the procedure, but are typically installed using specialized drilling equipment and are typically developed using that equipment by specific methods that are beyond the scope and intent of this field procedure.

## 2. EQUIPMENT & SUPPLIES

### Required

---

- |  |  |
|--|--|
| 1. Water Level Indicator, Sinco or equivalent  | 17. Ruler, engineer's 6 ft. folding                    |
| 2. Oil/Water Interface Probe   | 18. Scale, engineer's                                  |
| 3. Thermometer   | 19. Graduated tape, 100 ft. length, weighted end       |
| 4. pH meter and buffering/calibration solutions  | 20. Field Logs & Forms/Field Book 6.                   |
| 5. Conductivity meter and probe  | 21. Site Plan, Maps, Boring and Well Installation Logs |
| Dissolved oxygen meter and probe   | 22. Personal protective equipment                      |
| 7. Turbidity meter and probe   | 23. Calculator   |
| 8. Oxidation/Reduction Potential meter and probe   | 24. Keys to well padlocks/covers                       |
| 9. Salinity meter  | 25. Paper towels                                       |
| 10. Pump (Grundfos, peristaltic, whale etc.)   | 26. Trash bags   |
| 11. Pump accessories (Cables, fittings, tools)   |  |
| 12. ½ in. or 5/8 in. HDPE or Teflon discharge tubing; also silicon tubing for peristaltic pump   |  |
| 13. Power source for pump (generator with fuel; automotive battery, rechargeable battery)  |  |
| 14. Graduated plastic bucket (5-gallon) or flow meter  |  |
| 15. Stopwatch  |  |
| 16. Standard decontamination equipment (water jug, buckets or washtubs, brushes, Alconox, distilled water, tap water, methanol, squeeze bottles) |  |

### Optional:

---

1. Horiba MultiMeter (measures pH, temperature, conductivity, DO, turbidity, and salinity)
  2. Horiba U-22 Flow Cell (measures pH, temperature, conductivity, DO, turbidity, ORP and salinity)
  3. Inertial Pump Materials: Waterra Foot Valves, HDPE Tubing
  4. Bailers; rope, knife
- 

## 3. PROCEDURE

### 3.1 Summary of Procedure Purpose and Intent

The primary purpose of developing groundwater quality monitoring wells at sites containing, or potentially containing, solid or hazardous materials or their byproducts, is to create an effective filter pack around the well screen, rectify impact to the formation caused by drilling and the associated drilling fluid, remove fine

particles from the formation near the borehole and assist in restoring the natural water quality of the aquifer in the vicinity of the well. The properly developed well ensures the reliable collection of representative ground water samples, of acceptably low turbidity.

Well development induces movement of water in two directions across the well screen and filter pack. This movement removes fines or other foreign materials from within the well, the filter pack, and the surrounding natural formation, creating a stable graded filter yielding water of relatively low turbidity.

### **3.2 Role of Environmental Professional or Engineer**

Groundwater monitoring well development requires evaluation and consideration of a variety of site-specific characteristics, which precludes the use of one single development practice or procedure. The procedure is provided as a guide to aid the environmental professional, geologist or engineer in selecting the technical approach and methodology to effectively complete a well development program.

At the initiation of project planning, the Project Manager, Project Engineer or Scientist, and field personnel, determine any project-specific requirements for groundwater well development. Municipal, state or federal regulations, local practice, client requirements or project requirements may dictate the use of a different or modified well development method.

### **3.3 General Methods of Monitoring Well Development**

There are three general types of well development methods typically employed on small diameter monitoring wells (equal to or less than 4 in. I.D.) installed for environmental purposes:

- Pumping and overpumping
- Bailing
- Surging with a Surge Block

Well development methods that potentially alter the chemical composition of the groundwater are not acceptable. Therefore, methods that introduce fluids (including water pumped from the well) or air, to accomplish development are generally considered unsuitable. This eliminates several methods commonly used to develop large-diameter water supply wells. These methods include backwashing, jetting, airlift pumping or air surging.

The majority of well development for environmental purposes is conducted by mechanical pumping and overpumping, use of inertial lift pumps, inertial lift pumps with surge blocks, bailers, or a combination of these methods.

### **3.4 Preliminary Procedures**

In preparation for well development activities (and subsequent groundwater quality sampling event), the Project Manager and groundwater developer/sampler reviews project-specific requirements and considerations of the well development and groundwater sampling program.



The information reviewed may include site map or plans, drilling methods and records, well construction records, depth to groundwater data, previous groundwater quality data, data trends, earlier sampling records and field procedures used, and preferred well sampling sequence or sampling order. Identify project documentation needs and records of well development execution.

Other information to be reviewed are specific laboratory analyses to be performed on samples to be obtained from each well, sampling glassware, need for field filtration and container preservatives. Related aspects of the procedure include site health & safety plan review, evaluation of the site physical setting, availability of electrical power, property access permission and constraints, and purge water disposal.

Design the well development program to support the data quality objectives of the chemical analyses of the groundwater samples to be obtained. Based on the types of data to be collected in the field, identify the appropriate types of mechanical purging required (by pumps or other specialized equipment), likelihood of the presence of non-aqueous phase liquid (NAPL) and accommodations for measuring NAPL. Generally, a series of wells are developed starting with the least contaminated well working towards the well exhibiting the most significant contamination, if known.

Other considerations are identifying protocol for personnel protective equipment (PPE) use and specialized handling of purged water and decontamination wastewater, as generated. Recently installed monitoring wells should not be developed before well sealant materials (bentonite annular seal, cement/bentonite grout) have set or cured, typically assumed to be approximately one week.

In some cases, groundwater obtained from wells installed and sealed with a column of cement grout has exhibited artificially high pH, due to migration and influence of the calcium carbonate from the cement. The Project Manager and field representative are cautioned of this possibility, manifested during the well development procedure by inconsistent, unstable or high pH readings.

Table I presents common well development equipment, and lists advantages/disadvantages of the equipment.

### 3.5 Calculate Volume of Standing Water in Well

Calculate the estimated volume of standing water in the well. Some useful formulae for calculating well volumes are provided below:

- $V = L r^2 (0.163)$

Where:

V = volume of standing water in well, in gallons

r = internal radius of well, in inches

L = length of standing water column, in feet

0.163 = derived constant converting well radius in inches to feet, and cubic feet to gallons

Other useful formulae:

- Gallons per 100 ft. =  $4.08 * (D)^2$

Where D = Inside well or borehole diameter, in inches

- Cubic feet of water per 100 ft. =  $0.55 * (D)^2$

Where D = Inside well or borehole diameter, in inches

- 7.48 gallons = 1 cubic foot
- 0.134 cubic feet = 1 gallon

### **3.6 Field Procedures**

#### **3.6.1 Locate Well**

Locate the subject well in the field, using site plans, sketches, fixed references or other available documentation. Metal detectors may be useful in locating buried metal well casings; however, non-ferrous (i.e., aluminum or PVC) or missing well casings will not respond to metal detector signals.

Verify well designation, particularly individual wells located in closely spaced well clusters or well nests. If necessary, verify and document the location of the well to be decommissioned, referenced by taped distance to three fixed features, or acquire coordinates using global positioning system (GPS) methods or by instrument survey.

#### **3.6.2 Evaluate Well Integrity and Construction**

Evaluate and document condition of protective well casing and surface seal (padlock missing/broken, well cap missing, staining on well riser observed, concrete surface seal cracked, surface runoff entering well etc.). Record well construction material (stainless steel, PVC, fiberglass, galvanized steel, black carbon steel etc.).

Establish/verify monitoring well reference point (i.e., PVC rim, roadway box rim, protective guard pipe casing rim, ground surface).

### **3.7 Well Development Procedure – Mechanical Pump Method**

Mechanical pumps include electrically powered submersible pumps (Grundfos and Whale brands), or suction lift surficial pumps, such as centrifugal or peristaltic types. Pumps may have variable speed controls to regulate discharge rate. Other types of suction lift surface pumps may be driven by internal combustion gasoline engines (not discussed in this procedure).

## Monitoring Well Development Procedure (OP3009)

1. Follow Preliminary Procedures above, including evaluation of well integrity and documentation of well construction details.
2. Don appropriate personnel protective equipment (PPE) as identified in project health & safety plan. Pay particular attention to splash hazards.
3. Decontaminate all downhole development equipment prior to placement within wells, between uses in either the same well, or in other wells. Clean and prepare equipment using an Alconox soapy wash, tap water rinse, methanol rinse, and distilled/deionized water rinse. Containerize decontamination rinseate, if required.
4. If warranted, measure for possible presence of non-aqueous phase liquids (NAPL), using oil/water interface probe. Modify well development program based on findings and discussion with Project Manager, including postponing/canceling well development.
5. Measure well diameter, depth to water (static water level), depth to bottom of well using water level indicator or weighted graduated tape. Calculate standing water volume (see above).
6. Verify information on the respective well record, if available, and note any discrepancies. If well logs are not available, determine screen length and depth, if possible, to determine whether the well construction will provide useful data.
7. Evaluate obstructions present within the well or material accumulated in bottom of well. The presence of substantial quantity of accumulated materials (i.e., silt > 0.5 ft.) in bottom of well may warrant modifying the well development method to remove the sediment (i.e., use of peristaltic pump or hand bailer to remove sediment).
8. Remove any unsuitable dedicated groundwater sampling devices, if present (i.e., Waterra-type inertial pumps and discharge tubing, bailers, SoakEase absorbent material). Retain and discard as solid waste.
9. Groundwater purged from the borehole may or may not require containment or may be discharged on the ground in vicinity of well head, depending on groundwater quality, site setting, regulatory considerations and project requirements. Resolve with Project Manager prior to entering field.
10. Cut a clean piece of discharge tubing for selected pump (typically ½ in. or 5/8 in. high density polyethylene (HDPE) or Teflon tubing) of sufficient length to fully penetrate the well to its screened depth and to accommodate measuring purge volumes and inorganic parameters at ground surface. Cut tubing should not fall or drop into the well.
11. For submersible pumps, attached tubing and lower pump intake into well, suspending pump intake at the approximate midpoint of the saturated zone for water table wells, or at the screen midpoint for deeper wells. Connect power cables and controller box, and operate the pump according to manufacturer's instructions.

12. Initially operate pump at a discharge rate approximately equal to well recharge rate, using graduated bucket or flow meter and stopwatch to estimate flow, and adjust until drawdown of approximately 0.3 ft. is obtained. At the start of purging, obtain inorganic field parameters of the discharge, in the following order: pH, temperature, specific conductance (conductivity), oxidation-reduction potential (ORP), dissolved oxygen (DO) and turbidity, and record on field forms or in logbook.
13. Well development continues until representative groundwater, free from drilling fluids, drill cuttings, accumulated sediment or other materials introduced during the well construction is obtained.

Unless determined by project specific requirements, remove approximately 3 to 5 well volumes, measuring and recording inorganic field parameters for each well volume removed. If, during removal of 3 to 5 well volumes, field parameters have stabilized within 10% for two successive readings, and turbidity has been reduced to 5 nephelometric turbidity units (NTU) or less, then well development is considered complete. Based on discussion with the Project Manager or environmental professional, consider the applicability of Step 14 below, and complete if warranted.

In certain circumstances and based on project objectives, well development may consist of removing a fixed volume of water from the well that is predicated on the drilling method used for well installation. For wells installed without the introduction of drilling fluids (i.e., hollow stem augers, driven well points), three (3) well volumes are removed. For wells where drilling fluids were introduced (i.e., cased borings, rock coring, mud rotary methods), ten (10) well volumes are removed. In these cases, inorganic field parameter readings may be obtained for informational purposes.

14. A parallel objective of well development may be to remove drilling fluid lost to the formation(s) that was introduced during the drilling process. This aspect of development is complete when the identified volume of fluid is removed, and stabilized inorganic parameters are achieved.
15. If field parameters have not stabilized after Step 13, increase pumping rate to dislodge fine-grained materials from the filter pack, or remove sediment in suspension. It may be necessary to lower pump intake to accommodate drawdown. Avoid pulling coarse sediment into well intake to prevent pump impeller damage.
16. If slow recharge rate does not allow for continuous operation, shut off pump, allow well to recharge, and resume pumping at slower rate and well evacuation until discharge water clears. Resume measuring field parameters (Step 13) until stabilized.
17. Complete documentation as appropriate.

### **3.8 Well Development Procedure – Inertial Pump Methods**

Inertial pumps use a dedicated pre-cleaned single ball check valve (“foot valve”) and HDPE discharge tubing to manually remove water from the well.

1. Follow Preliminary Procedures above, including evaluation of well integrity and documentation of well construction details, and Section 5.7, Steps 1 through 10.
2. Attach foot valve (i.e. Waterra type) to bottom end of HDPE tubing and lower into well. Allow approximately 2 to 4 ft. extra tubing above well casing for controlling discharge of purge water.
3. To remove groundwater from the well, manually lift and lower the HDPE tubing within the well bore by hand, approximately once every three to five seconds, timing the motion to optimize purge water volume removed with each stroke. Clean foot valve if it becomes clogged or obstructed by sediment by carefully removing tubing from well, unthreading the foot valve, and rinsing with distilled water.
4. Monitor inorganic field parameters as in Steps 12 to 14, above.
5. If slow recharge rate does not allow for continuous purging, allow well to recharge, and resume purging and well evacuation until discharge water clears. Resume measuring field parameters until stabilized. HDPE tubing and foot valves are typically dedicated and left in groundwater well following sampling.
6. Complete documentation as appropriate.

### **3.9 Well Development Procedure - Surge Blocks**

Surge blocks can be used in conjunction with pre-cleaned, dedicated inertial pumps (single ball check valve or “foot valve”) and HDPE discharge tubing.

1. Follow Preliminary Procedures above, including evaluation of well integrity and documentation of well construction details, and Section 5.7, Steps 1 through 10.
2. Press fit the surge block device securely onto foot valve (i.e. Waterra type), attach foot valve to bottom end of HDPE tubing and lower into well. Allow approximately 2 to 4 ft. extra tubing above well casing for controlling discharge of purge water.
3. To surge the groundwater, lower the surge block into the water column and use as a “plunger” by manually lifting and lowering the HDPE tubing by hand, forcing water to flow into and out of the screened portion of the aquifer. Surge each well for a minimum of 30 minutes to remove the finer material from the aquifer surrounding the borehole, providing a developed zone of uniformly graded sand of higher porosity and higher permeability surrounding the well screen, allowing the water to flow more freely into the well, and reducing potential turbidity.
4. Following the surging portion of the well development, remove the surge block from the foot valve, and purge a minimum of one well volume from the well by removing the fine particles brought into the well during surging.
5. Monitor inorganic field parameters as in Steps 12 to 14, above.

6. If slow recharge rate does not allow for continuous purging, allow well to recharge, and resume purging and well evacuation until discharge water clears. Resume measuring field parameters until stabilized. HDPE tubing and foot valves are typically dedicated and left in well following sampling.
7. Complete documentation as appropriate.

### **3.10 Well Development Procedure - Bailers**

Hollow, cylindrical bailers are a type of grab sampling device, and may be constructed of stainless steel, Teflon, or PTFE, typically with a single ball check valve fixed on the bottom. They are manually lowered into the well using a rope tether, allowed to collect well water, then lifted from the well. The collected water is discharged to a graduated bucket, and the process repeated until the well is deemed adequately developed. Stainless steel bailers are generally simple to decontaminate. Teflon or PTFE bailers are considered dedicated or disposable after one-time use.

In general, the use of bailers are not a preferred well development method, due to the time required to remove potentially large volumes of development water, especially in deep wells. Their use, however, creates agitation and mixing within the water column, which suspends sediment and fines, incrementally aiding in clearing the well and filter pack, thereby reducing turbidity.

PTFE ("clear") bailers are often used to collect NAPL for thickness measurements or product analysis. Although not discussed in this procedure, bailers are generally not recommended for groundwater sampling overall, and not acceptable for low-flow groundwater sampling in particular, especially sampling for volatile organic compounds (VOCs), volatile petroleum hydrocarbons (VPH), dissolved metals or other analytes requiring field filtration.

### **3.11 Restoration and Cleanup**

The area around the well head and ground surface shall be completely cleaned up of any development materials (plastic sheeting, tubing, paper towels, litter, etc.), and the well secured.

### **3.12 Documentation**

A complete record of the well development procedure should be documented and incorporated into the project file. Complete portions of the Groundwater Sampling Record form, recording the following information:

- Project information, date and personnel present
- Well location and designation
- Well condition inventory
- Presence of NAPL

- Diameter, depth of well, screened interval (if known), depth to static groundwater, volume of standing water column in well
- Detailed description of well development equipment and procedure used
- Time(s) development started and ended
- Incremental and total volume of purge water removed
- Inorganic field parameter measurements
- Comments on discharge water quality
- Modifications to procedures
- Decontamination method, and discharge water management method
- Drum count of accumulated discharge water, if applicable

Appendix C contains a blank Sampling Report (Form #3004), Groundwater Sampling Record (Form #3005), Monitoring Well Development Report (Form #3006) and Low Flow Field Sampling Form (Form #3010) for reference.

### **3.13 Precision and Bias**

This procedure provides qualitative information only; therefore, a precision and bias statement is not applicable.

**TABLE 1**  
**Common Well Development Equipment**

Material	Type	Power Requirement	Positive Attributes	Negative Attributes
<b>Mechanical Pumps:</b>				
Grundfos Pump	Submersible pump (variable speed)	120V A.C. current	-Lift height only constrained by cable length (+/- 150 ft.) -Controllable, variable flow rate from 0.01 to ≈35 L/minute -Stainless steel disassembles for simple decontamination See note 1	-Requires generator if no power source available -Risk of cross contamination of sample glassware or tubing from generator fuel -Heavy/cumbersome -Sediment may clog pump impellers -2.0 in. minimum well diameter See note 2
GeoDurham	Submersible Pump (variable speed)	12V D.C. current (Automotive battery)	-Portable power supply -Lift height only constrained by cable length (+/- 75 ft.) -Controllable, variable flow rate -Stainless steel for simple decontamination See note 1	-Limit on lowest pump speed/discharge -Sediment may clog pump impellers -Power supply limits duration of pump use -2.0 in. minimum well diameter See note 2
Whale Pumps	Submersible pump (variable speed)	12V D.C. current (Automotive battery)	-Portable power supply -Lift height only constrained by cable length (+/- 30 ft.) -Disassembles for simple decontamination -1.5 in. minimum well diameter	-Power supply limits duration of pump use See note 2
Peristaltic Pumps	Suction/lift surface pump (single speed)	12V D.C. current (Automotive Battery)	-Good for purging sediment from silt trap during development -Dedicated tubing -Easy to operate -0.5 in. minimum well diameter	-Not appropriate for sampling VOCs (agitation) -Lift limited to ≈25 ft. BGS -Pump rate 0.01 L/min.
<b>Manual Methods:</b>				
Inertial Pump	Submersible foot valve with discharge tubing	Manually operated	-Dedicated tubing -Inexpensive -Simple to operate -0.5 in. minimum well diameter	-Depth limited by manual capability to lift tubing (typically 70 to 80 ft.) -Tiring for large volumes of development water -Sediment may clog foot valve
Stainless Steel Bailer	Grab sample device with single check valve	Manually operated	-Disassembles for simple decontamination -Simple to operate	-Not appropriate for groundwater sampling (agitation) -Tiring for large volumes of development water -Splash hazard
Teflon Bailer	Grab sample device with single check valve	Manually operated	-Dedicated -Simple to operate -Inexpensive	-Not appropriate for groundwater sampling (agitation) -Tiring for large volumes of development water -Splash hazard
Clear Bailer	Grab sample device with single check valve	Manually operated	-Dedicated -Simple to operate -Inexpensive -Can collect NAPL for evaluation	-Not appropriate for groundwater sampling (agitation) -Tiring for large volumes of development water -Splash hazard

## Notes and References:

1. Appropriate for low flow/low stress groundwater sampling.
2. Not appropriate if DNAPL/LNAPL present in monitoring well.



## **APPENDIX A REFERENCES**

### **A.1 Reference Procedures**

- American Society for Testing and Materials, current edition, "Annual Book of ASTM Standards," Vol.04.08, D5521-94, "Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers."
- Puls, R.W., Barcelona, M.J., 1996. "Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures," US EPA Ground Water Issue, US Environmental Protection Agency. Office of Solid Waste, EPA/540/S-95/504, pp. 1 to 12.
- US Environmental Protection Agency, Region I, (30 July 1996). "Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells," SOP # GW 0001, Revision 2.

### **A.2 Other References**

- US Environmental Protection Agency, 1992. Office of Solid Waste," RCRA Groundwater Monitoring: Draft Technical Guidance," EPA/530/R-93/001, NTIS PB 93-139350, November 1992, pp. 6-46 to 6-50.
- American Society for Testing and Materials, current edition, "Annual Book of ASTM Standards," Vol.04.08, D6634-01, "Standard Guide for the Selection of Purging and Sampling Devices for Groundwater Monitoring Wells."
- American Society for Testing and Materials, current edition, "Annual Book of ASTM Standards," Vol.04.08, D5903-96 (Reapproved 2001), "Standard Guide for Planning and Preparing for a Groundwater Sampling Event."
- Massachusetts Department of Environmental Protection, "Standard References For Monitoring Wells," January 1991, document WSC-310-91, Section 4.5 Well Development.

### **A.3 COMMENTS ON REFERENCE PROCEDURES**

The procedures and equipment listed in EFP No. 01a and used by Haley & Aldrich are generally as specified in the ASTM and US EPA Reference Procedures. Deviations of EFP No. 01a from the Reference Procedures are not provided. The procedure described in Section 5 has been developed to assist Haley & Aldrich personnel in performing well development, and in some cases simplifies the Reference Procedures.

**APPENDIX B  
RELATED HALEY & ALDRICH PROCEDURES**

- OP2020 Groundwater Monitoring (Observation) Well Abandonment
- OP2031 Groundwater Monitoring (Observation) Well Installation
- OP3000 General Environmental Field Procedures and Protocols
- OP3007 Procedures for Surface Water Sampling
- OP3008 Manual Water Level Measurement Procedure
- OP3010 Groundwater Quality Sampling Procedure
- OP3012 Low Stress/Low Flow Groundwater Sample Collection Procedure
- OP3014 NAPL Monitoring and Sampling
- OP3015 Aquifer Parameter Testing Procedure

**APPENDIX C  
FORMS**

- 3004 Sampling Report
- 3005 Groundwater Sampling Record
- 3006 Monitoring Well Development Report
- 3010 Low Flow Field Sampling Form

Haley & Aldrich



# GROUNDWATER SAMPLING RECORD

<b>PROJECT</b> _____	<b>H&amp;A FILE NO.</b> _____
<b>LOCATION</b> _____	<b>PROJECT MGR.</b> _____
<b>CLIENT</b> _____	<b>FIELD REP</b> _____
<b>CONTRACTOR</b> _____	<b>DATE</b> _____

### GROUNDWATER SAMPLING INFORMATION

Well No.						
Water Depth (ft)						
Time						
Product						
Depth Of Well (ft)						
Inside Diameter (in)						
Standing Water Depth (ft) <sup>(1)</sup>						
Volume Of Water In Well (gal)						
Purging Device						
Volume of Bailer/Pump Capacity						
Cleaning Procedure						
Bails Removed/ Volume Removed						
Time Purging Started						
Time Purging Stopped						
Sampling Device						
Cleaning Procedure						
TIME SAMPLES TAKEN	VOA					
	ABN					
	Metals					
PARAMETERS	Color					
	Odor					
	pH					
	Conductivity					
	Turbidity					
	Dissolved Oxygen					
	Temp, ° C					
	Salinity					

Remarks: (ie: field filtrations, persons communicated with at site, etc.)

1. Standing Water Depth = Depth of Well - Water Depth

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

# MONITORING WELL DEVELOPMENT REPORT

Well No. \_\_\_\_\_

Page 1 of 1

PROJECT	_____	H&A FILE NO.	_____
LOCATION	_____	PROJECT MGR.	_____
CLIENT	_____	FIELD REP.	_____
CONTRACTOR	_____	DATE	_____
ELEVATION SUBTRAHEND	_____		

**Estimated Volume of Water Lost During Drilling:** \_\_\_\_\_ gallons

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Depth to Water Before Development:** \_\_\_\_\_ feet

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Depth to Well Bottom Before Development:** \_\_\_\_\_ feet

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Turbidity of Water Before Development:** \_\_\_\_\_ NTU

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Volume of Water Removed:** \_\_\_\_\_ gallons

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Method of Removal (bailing, pumping):** \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Depth to Well Bottom After Development:** \_\_\_\_\_ feet

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Depth to Water After Development:** \_\_\_\_\_ feet

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Turbidity of Water After Development:** \_\_\_\_\_ NTU

Comments: \_\_\_\_\_  
\_\_\_\_\_

