STANDARD OPERATING PROCEDURE FOR:

MONITORING WELL AND PIEZOMETER INSTALLATION AND COMPLETION

TVA-KIF-SOP-39

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for

Tennessee Valley Authority
Environment and Technology
Environmental Resources

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1.0 PURPOSE

The purpose of this procedure is to describe the techniques to be followed in order to ensure acceptable, consistent installation and development of monitoring wells that shall be used to collect representative groundwater samples; and acceptable, consistent installation of piezometers used to measure hydraulic head at the Kingston Fossil Plant (KIF) Ash Recovery Project in Tennessee. This Standard Operating Procedure (SOP) is applicable to subsurface drilling, monitoring well construction and completion, and piezometer construction and completion.

Subsurface drilling shall be conducted using one of the following:

- Hollow-stem auger drilling,
- Air rotary drilling, or
- Mud rotary drilling.

Field personnel conducting drilling activities are required to be familiar with the procedures provided in this SOP as well as standard industry practices. The requirements and guidelines for KIF well drilling using the methods listed above are included in this SOP.

2.0 GENERAL CONSIDERATIONS

Potential hazards associated with the planned tasks shall be thoroughly evaluated prior to conducting field activities. Refer to the *Site-Wide Safety and Health Plan* (SWSHP) for a description of potential hazards and associated safety and control measures. Potential hazards associated with the planned tasks shall be thoroughly evaluated prior to conducting field activities. A pre-Job Safety Analysis (JSA) to identify potential hazards shall be discussed at each sampling event. Well and piezometer installation events must be scheduled with the sampling coordinator and TVA technical contract manager (TCM).

Well installation personnel must wear powder-free nitrile gloves while installing monitoring wells used to collect representative groundwater samples and piezometers used to measure hydraulic head in aquifers. Specifically, nitrile gloves must be worn while handling the well screen or as necessary to prevent the possibility of cross-contamination with the well screen.

Prior to intrusive subsurface activities, the appropriate utility notifications (that is, National 811 One Call) must be made and the dates of intrusive activities must be within the lawful dates provided by the One Call Center. The Field Team Leader verifies, to the extent practicable, that utilities have responded to the One Call request and have marked their respective utility. If there is uncertainty associated with potentially unmarked utilities, the Field Team Leader shall suspend work until the issues can be resolved. The Field Team Leader also contacts plan personnel to obtain clearance for drilling locations on TVA property.

Prior to field activities, the field team considers how investigation-derived waste (IDW) (such as drill cuttings, purge water, and decontamination fluids) is to be handled. Refer to the *Management of Investigation-Derived Waste* SOP (TVA-KIF-SOP-12) for specific IDW handling procedures.

3.0 PROCEDURES

This section documents general operating procedures and methods associated with subsurface drilling, monitoring well construction and completion, and piezometer construction and completion. Any variation in these procedures must be approved by the Project Manager and Quality Assurance/Quality Control (QA/QC) Lead and must be fully documented. Field work cannot progress until deviations are approved or resolved.

3.1 Pre-Job Preparation

The Project Manager is responsible for overall implementation of this SOP and ensuring that the SOP complies with current regulations and standards as these are subject to change. The Project Manager is also responsible for the following activities:

a. Review copies of the SWSHP, *Quality Assurance Project Plan* (TVA-KIF-QAPP), and any other applicable project work control documents.

b. Obtain appropriate site maps with planned well locations clearly labeled, if appropriate. Identify location staking and survey requirements.

c. Verify with the Project Manager that the appropriate number of solid and liquid U.S. Department of Transportation (DOT) -approved drums or other suitable containers is available for disposal of investigation-derived soil cuttings.

d. Obtain the equipment necessary for completing the activities (see Table 1 for an example checklist of well installation and completion equipment and materials).

e. Provide the Field Team Leader with the work plan schedule. Verify that site access and legal right-of-entry has been obtained, where required.

f. Obtain utility clearance for subsurface excavation/penetration locations, as required.

3.2 Field Preparation

Prior to leaving for the collection site, the Field Team Leader ensures that the following activities have been completed.

a. Locate and mark planned well locations and verify utility clearance prior to intrusive subsurface drilling deeper than one foot (usually conducted by Field Team Leader or a designee). Verify that the appropriate utility clearance service has marked utilities at off-site drilling locations. Confirm with the Project Manager that clearance and right-of-access permission has been obtained. Document clearance activities and utility markings in the field logbook and request sign-offs from the Project Manager.

b. Pre-identify any potential site access logistical issues. Note any slope stability, overhead obstruction, or other physical constraints that could hinder or preclude drilling activities. Notify the Project Manager of any identified drilling issues and provide recommendations for any relocation based on field observations.

c. Establish the decontamination area away from (and preferably up wind of) potentially contaminated areas where possible. Decontaminate non-disposable sampling equipment and downhole tools that may come in contact with the sample matrix prior to use in accordance with *Decontamination of Equipment* SOP (TVA-KIF-SOP-08).

d. Obtain potable water for decontamination. Record the water source in the field logbook. Obtain approval for using on-site water for decontamination from the Project Manager or Technical Lead prior to use.

3.3 Monitoring Well Installation

The general borehole advancement and monitoring well installation procedures are described below.

a. Decontaminate the drill rods, tools, drill bits, and split spoons prior to advancement at each borehole on a decontamination pad. The decontamination pad is typically constructed of polyethylene sheeting placed over a series of straw bales or other structure. The decontamination pad is located downwind of proposed (marked) well locations and existing monitoring wells. Wastes generated during decontamination are managed in accordance with the *Management of Investigation-Derived Waste* SOP (TVA-KIF-SOP-12).

b. Mobilize drilling rig to the marked location, set up the exclusion or safety zone, and have the subcontractor construct the plastic-lined fluid collection area, if necessary.

c. If required, obtain the anticipated number of 55-gallon drums needed to contain the overburden and rock cuttings, drilling fluids, purged groundwater, and decontamination waste. Position the drums so the drums can be removed or staged.

d. Shrouds, canopies, or directional pipes can be used to contain and direct the drill cuttings and fluids into the fluid collection area or 55-gallon drums, as necessary.

e. Visually screen the soil cuttings and liquid obtained from the uppermost water-bearing zone for signs of potential site impacts. Note the results in the field logbook. Retain the samples from the representative well borehole onsite for inspection until completion of the characterization activities.

f. Log drill cuttings and/or split spoon samples to ensure consistent lithologic descriptions are made during borehole advancement activities. Refer to Section 3.8.1 of this SOP for further description of the appropriate observations and documentation.

g. If a borehole is not completed the same day that it is started, secure the borehole overnight by leaving the drill rod in the borehole or by placing a temporary cap on the well or borehole.

h. Bore, drill, or auger the borehole as close to vertical as possible and check with a plumb bob or level. Deviation from plumb shall be within 1° per 50 feet of depth.

i. Minimize use of joint lubrication compounds. If these lubrication compounds are required, record the joint compound used (such as brand name, chemical composition, and amount used) into the field logbook. Petroleum-based lubrication compounds are not acceptable for use as joint lubrication.

j. Use rigid PVC materials meeting National Sanitary Foundation (NSF) Standard 14 type well casing for groundwater monitoring wells. The PVC well casing is flush threaded. A protective steel casing with a lockable cap is installed at least 3 feet into the grout seal of each monitoring well installed with a stickup casing. Flush-mounted casings are constructed using a flush-mounted steel vault mounted within a cement-concrete skirt. Flush-mounted finished wells are fitted with a locking, water tight cap and a padlock. Above ground finished wells are fitted with a water tight cap and padlock, and the PVC is notched to allow for natural water level fluctuations. Above ground riser and flush mount details are provided in Section 3.5 of this SOP.

   Keys to locks are given to the Field Team Leader who places the keys in the project files upon returning from the field. Care is taken to allow for an appropriate vertical clearance between the inner casing and well cap to allow for installation of down-hole monitoring equipment.

k. Verify that at least 2 inches of annular space are available between the casing and the borehole or between two casings to allow sufficient space for emplacement of the sandpack and/or the annular seal. Grouts or slurries used for annular seals are emplaced using a tremie pipe. Bentonite pellets, chips, or powder may be poured in from the top of the well but are poured slowly to prevent bridging. If bentonite pellets are used, they shall be less than 1/5 the width of the annular space also to prevent bridging.

   Intermittent sounding (using a weighted tape measure) of the top of solid annular materials is conducted and documented.

l. Install a cement pad around the base of each protective casing. Document the well number, depth, yield, and the completion date in the field logbook and record on the inside cover of the well. Permanently mark the well number (and permit number, if applicable) on the outer protective casing. Construction details for the cement well pad are provided in Section 3.5 of this SOP.

m. After the well is completed, establish the location and elevation of the well (relative to a standard datum). Accurately locate the monitoring well and reference to a vertical datum by a licensed surveyor.

3.3.1 Overburden Monitoring Well Installation Using Hollow-Stem Auger

At sites where groundwater is anticipated to be present in unconsolidated surficial material, monitoring wells are installed using hollow-stem augers. One 2-foot split-spoon sample is collected per each 5-foot interval or at smaller intervals if changes in subsurface lithology or a water horizon are encountered. In general, continuous split-spoon samples are collected at a minimum of one well boring associated with each site area.

The vertical placement of the well screen within a borehole is dependent upon the purpose of the well, site hydrogeologic conditions, and the physical and chemical characteristics of potential contaminants. Generally, the groundwater monitoring wells installed in the unconsolidated materials are designed to screen the water table to ensure that free-phase floating products are detected, if present. The Project Manager confirms well construction (well screen depth, length, and diameter) with the Field Team Leader.

a. After the borehole is drilled to the desired depth, gently lower the well screen and casing assembly through the augers to the bottom of the borehole and gradually remove the auger string from the borehole while simultaneously filling the annulus with the appropriately sized clean, uniform sand.

   Note: The appropriate sand size and screen slot size are based on the formation's grain size distribution. For fine grain soils, the screen is 10 slot (0.010-inch opening) and the sand pack is made of number 0 Morie sand or equivalent. For coarse grain soil, the screen is 20 slot (0.020-inch opening) and the sand pack is made of number 1 Morie sand or equivalent.

b. In the event that the borehole walls are unstable or in flowing sand condition, use a plug at the bottom of the auger string to prevent native material from entering the annulus. This plug is "punched out" prior to backfilling the annulus.

c. Place a cap or cover over the top of the well casing or riser before pouring the sand pack to prevent any filter pack materials or sealing materials from falling inside the well.

d. Fill the annular space around the screen to a minimum of 2 feet above the top of the screen.

   Note: The Field Team Leader shall be aware of sticking problems when withdrawing the auger from the borehole. Reasonable force can be applied if the screen is stuck in the auger; however, too much force can cause damage to the screen, which is pulled for inspection if this occurs.

e. To ensure that the sand pack provides an adequate cover over the screen, determine the depth to the top of the sand pack with a weighted tape.

Note: Consideration is also given to the use of engineered screens (prepackaged) to ensure proper well installation.

f. When the sand pack is at the desired level, place a minimum 2-foot layer of bentonite on the sand pack. Apply the bentonite either via tremie pipe or by slowly pouring pellets (coated, if placed below the water table) down the annulus to minimize bridging. To prevent bridging the pellets are 1/5 the size of the annulus. For a 2-inch well the annulus is 2 inches and the pellets are less than 0.4 inches. The bentonite is sodium montmorillonite from a commercial source

Note: If the pellets are placed above the water table, potable water is added to the annulus. If the sides of the borehole are unstable or there are problems with using pellets, a slurry is mixed at a ratio of 1.5 pounds of bentonite per gallon of water and emplaced using a tremie pipe. The slurry is initially directed into a bucket to determine if the mixture is pumpable.

g. Measure the top of the bentonite seal with a weighted tape to verify that the proper thickness of the seal has been placed in the annulus.

h. Grout the remaining annular space with a Portland cement/bentonite mixture to ground surface. The grout mixture consists of approximately 4 pounds of pure bentonite per 94-pound bag of Portland cement with 6 to 7 gallons of potable water. The mixture is pumped through a tremie pipe until undiluted grout rises from the annulus to the ground surface.

i. Record well construction details and soil boring information in the field book or boring log forms (see Section 3.8.1 of this SOP).

3.3.2 Air Rotary Drilling/Bedrock and Overburden Monitoring Well Installation

Air rotary or percussion drilling techniques is used to install both shallow and deep bedrock monitoring wells and overburden wells; however, air rotary are only used for overburden wells when hollow-stem augering techniques fail. Potable water can be added to the borehole, if required, for dust control. The source of the potable water is noted in the field notebook. The well construction detail and soil boring information is also recorded in the field book or log forms.

3.3.2.1 Shallow Bedrock Well Construction (Single-Cased)

A shallow bedrock monitoring well is typically located in the first significant water-bearing zone encountered in bedrock.

a. To construct a shallow bedrock monitoring well, use air rotary techniques to drill a 10-inch diameter borehole, unless specified otherwise in project-specific control documents, through the overburden to a minimum of 3 feet into competent bedrock.

b. Collect cuttings every 5 feet or more frequently as necessary to describe the subsurface conditions.

Note: If saturated conditions are observed near the soil/bedrock interface and the objective is to monitor the uppermost water-bearing unit, a waiting period may be required prior to casing installation to assess static groundwater conditions. As appropriate, the borehole may be completed as a single-cased, screened well if water is observed to enter the borehole after a waiting period. If water is not observed in the borehole after a waiting period, a 6-inch-diameter well casing is installed at least 5 feet into competent bedrock to approximately 2 feet above ground surface.

c. Seal the annular space around the casing by pumping grout through a tremie pipe from the base of the borehole to ground surface. The grout consists of 4 pounds of pure powdered bentonite for each 94-pound bag of Portland cement, mixed with 6 to 7 gallons of potable water.

d. After grouting of the casing, do not drill in the well until the grout has cured in that well (a minimum of 24 hours). The Field Team Leader determines when drilling can proceed.

e. Drill a nominal 5-inch diameter open borehole below the base of the 6-inch casing and complete as an open borehole or screened well. Drilling advances the borehole until a quantity of water sufficient for sampling is encountered. A recovery period may be required if the borehole produces very low yields.

f. Record well construction details and soil boring information in the field book or boring log forms (see Section 3.8.1 of this SOP).

3.3.2.2 Deep Bedrock Well Construction (Double-Cased)

A deep bedrock monitoring well is typically located in a water-bearing zone below the shallow bedrock water-bearing zone. In some cases, deep bedrock monitoring wells may require double casing.

a. Drill a minimum 14-inch diameter borehole, unless specified otherwise in project-specific control documents, through the unconsolidated material to at least 5 feet into competent bedrock. Collect representative cuttings at least every 5 feet or more frequently as required to describe the subsurface conditions.

b. Install a 10-inch diameter well casing and tremie-grout in place from the base of the borehole to the ground surface. Cut off this casing at 6 inches above ground surface, unless specified otherwise in project-specific control documents.

c. Grout and curing times are consistent with the shallow well construction methods. After the grout has cured properly, drill a 9-inch diameter borehole through the casing to the top of the deep interval to be monitored.

d. A 6-inch inner casing is either tremie-grouted through the annular space between the outer and inner casing or pressure-grouted through the center of the casing by displacing the grout with pressurized potable water. The grout mixture and curing times are consistent with the shallow well construction specification.

e. After the grout seal has cured, drill a 5-inch open borehole below the base of the casing to the specified water-bearing zone. Complete each deep well as an open borehole unless the borehole is unstable, in which case the well is screened as described below.

f. Record well construction details and soil boring information in the field book or boring log forms (see Section 3.8.1 of this SOP).

3.3.2.3 Screened Bedrock Wells

If the sides of the open borehole are unstable during drilling, the monitoring well is completed with a 2-inch or 4-inch diameter casing and screen. The annular space around the screen is packed with clean, uniform, commercially bagged sand a minimum of 2 feet above the top of the screen. For finer grained soil formations, the screen is 10 slot (0.010 inch opening) with number 0 Morie sand or equivalent. For coarser grain soil formations the screen is 20 slot (0.020 inch opening) with number 1 Morie sand or equivalent.

A 2-foot thick minimum layer of bentonite pellets, less than 1/5 the size of the annulus, is placed above the sand pack. The remaining annular space is tremie-grouted to the surface with a cement/bentonite slurry, as previously described in this subsection.

3.4 Mud Rotary Drilling

Mud rotary drilling may be used when borehole stability problems preclude the use of hollow-stem augering or air rotary methods.

Potable water and natural materials (such as bentonite powder) are used for drilling mud. A record of the specific mud type used (such as brand name, chemical composition, and amount used) is entered into the field logbook.

Steps are taken, to the extent possible, to avoid the use of the mud rotary drilling method in the potential water-producing zone of a potential well because this drilling method may impact well production and groundwater chemistry. Extended development may be required for groundwater monitoring wells installed using mud rotary drilling.

3.5 Well Protection

The following provides descriptions for well protection.

3.5.1 Flush Mount Well Pad

The well pad is installed at the same time as the outer protective casing. Cement is placed in the pad form and borehole, on top of grout, in one fluid operation. The cement pad for a 2-inch well measures 4 feet by 4 feet by 4 inches. Round pads with equivalent measurements are also acceptable.

The pad is finished with a slight slope allowing any surface drainage to flow away from the protective casing.

3.5.2 Above-Ground Riser Pipe

The outer protective casing is a steel construction with a hinged locking cap and extends approximately 2.5 feet above ground surface. The casing for a 2-inch well is generally 4-inch square by 5 feet long with a weep hole drilled just above the well pad. The weep hole is ¼ inches in diameter and meant to allow drainage of accumulated rain or spilled purge water.

3.5.2 Surface Protection

A minimum of three bumper guards are placed around any well that is in a high traffic area. These bumper guards are 3- to 4-inch diameter hollow steel pipes, approximately 5 feet long. The guards are installed 3 feet below ground surface and extend 2 feet above. The guards are filled with concrete and painted with high visibility paint. For additional strength and protection, welding bars can be placed between guards.

There is never a connection between the guards and the protective casing.

3.6 Piezometer Installation

Piezometers are installed (in general) using the same procedures as described above for monitoring wells. Note that the intended purpose of piezometers is to measure hydraulic head and are never used to collect groundwater samples for chemical analysis.

Piezometers typically have a very short screen and filter zone located at a determined depth, so that they can represent the hydraulic head at a determined point in the aquifer (punctual piezometer). However, there may be instances where it is desirable to measure the potentiometric surface throughout a water column (windowed piezometer). The windowed piezometer cannot be used to obtain information on vertical flows.

3.6.1 Punctual Piezometer

The punctual piezometer consists of a filter tip joined to a riser pipe. The following procedure is used for its installation.

a. Place the filter tip in a sand zone and place a bentonite seal above the sand to isolate the pore water pressure at the tip. The sand zone and bentonite seal are created the same as previously detailed (Section 3.3.2.3).

b. Backfill the annular space between the riser pipe and the borehole to the surface with a bentonite grout to prevent unwanted vertical migration of water.

c. Terminate the riser pipe above ground level with a vented cap.

3.6.2 Windowed Piezometer

The following procedure is used for installation of the windowed piezometer.

a. Construct the windowed piezometer using the same materials as the punctual piezometer, but install without a bentonite seal; rather, backfill the borehole with gravel or sand.

b. Seal the top of the borehole to prevent the entry of surface runoff, and terminate the riser pipe above ground level.

3.7 Groundwater Monitoring Well Development

The following procedure is used for groundwater monitoring well development.

a. Develop the groundwater monitoring wells after the grout seal has properly cured (determined by the Field Team Leader). Typically, a minimum 24-hour waiting period is required prior to development.

b. Develop the monitoring well until the formation water discharged from the well is as clean and free of sand and fines as is practical to ensure that the well provides representative aquifer samples.

c. Determine when to terminate development based on the well reaching steady state conditions as measured by the following criteria:

- Turbidity (10 NTU's)
- Appearance (opaque, transparent, or clear)
- Flow rate (maximum stabilized flow rate attained)

d. Develop the monitoring wells using surge-block techniques, purging with air, purging with a pump, or a combination of these techniques.

e. Do not add water to assist monitoring well development without the approval of the Project Manager.

f. If a monitoring well cannot be cleaned of fines to produce formation water because the aquifer yields insufficient water, inject small amounts of potable water to clean up the poorly yielding well.

g. Record the volume and source of potable water in the field logbook.

h. During development, maintain the following information in the field logbook and/or on a monitoring well development form (Table 2) by the field team:

- Development time,
- Development method,
- Rate and volume of discharge water,
- Temperature, pH, turbidity, and specific conductance of discharge water, and
- Depth to water-level readings before and after well development.

Estimated well yield piezometers do not require development.

Effective well development requires movement of water in both directions through screen openings (or water-producing bedrock fractures). Reverse flow helps to reduce bridging of sand and fines.

3.7.1 Overpumping

A surface or submersible pump is used to develop the well by the overpumping method.

a. To verify proper development by this method, initially set the pump intake at the bottom of the well and then move toward the top of the borehole or screen as development proceeds.

This method is most effective when used in conjunction with the surge-block development technique.

3.7.2 Surge-Block Techniques

This method forces fluids into the formation as the surge block is lowered or pushed down the borehole. The upstroke motion creates a suction that loosens the fluids and pulls loose sediment from the formation into the well.

a. Purge the well as often as possible between surging to remove loose sediment.

b. If applicable, measure the drawdown in nearby well(s) during development to characterize the interconnections of the wells.

3.8 Field Logbook Documentation

Field logbooks to record daily activities, including boring logs and well construction diagrams, are maintained by the Field Team Leader. Information is entered into the field logbook by the appropriate field team member. Entries are made in indelible ink. In addition to the minimum requirements discussed in the *Field Documentation* SOP (TVA-KIF-SOP-06), the field logbooks document those sampling characteristics specific to this SOP and as defined in the applicable project work control documents. A location map or site sketch locating the well or boring in relation to other onsite features is recorded in the field logbook.

The Field Team Leader and/or designee reviews the field logbook entries on a weekly basis during installation activities for completeness and accuracy and indicates this review by initialing the entries. The Field Team Leader is also responsible for the completion of required data collection forms.

3.8.1 Boring Log and Well Construction Diagram

A boring log and well construction diagram is completed for each boring and well installation conducted. An example of the boring log form (Attachment 1) and monitoring well installation field log form (Attachment 2) are attached. These forms are necessary to provide consistent and detailed information for use in project evaluation and documentation. The information listed below is included in a boring log, at a minimum.

a. General Site Information

- Facility name where the borings are located
- Well and/or boring number consistently referenced throughout reports and plans
- Start and completion date and time
- Name of the individual logging the well and/or boring
- Driller's name and name of drilling company
- Drilling method
- Drill make and model

b. Well Completion Information

- Completion Diagram: Detailed monitoring well schematic which indicates but is not limited to:
  - Borehole diameter and depth
  - Type, diameter, and depth of well
  - Type and length of casing and screen
  - Slotted screen size
  - Grain size of sand pack
  - Depth to top of screen, sand pack, and bentonite seal.

- Top of well casing in mean sea level (MSL) elevation in feet. Elevation measurements are determined by a Professional Land Surveyor (PLS) following completion of the monitoring well.
- Top of screen, bottom of screen, and bottom of well in feet below ground surface.

c. Boring Log Information

- Water Level: Water level first encountered and at completion of the well
- Penetration Rate: Blow count, min/ft, etc.
- Depth in feet below ground level
- Interval and Recovery
- Organic Vapor Detector readings
- Location and Analysis of Samples Collected
- Classification of Soils via Burmeister or USCS which include but are not limited to:
  - Rock Type/Soil Type: Primary and secondary lithologies
  - Composition/Texture: Size and shape of the particles
  - Strength/Consistency
  - Color
  - Moisture

3.9 Decontamination and Waste Management

Equipment used for well installation and development are decontaminated in a manner consistent with the *Decontamination of Equipment* SOP (TVA-KIF-SOP-08).

IDW includes excess samples, cuttings, decontamination fluids, disposable sampling equipment, and disposable personal protective equipment (PPE). IDW is containerized according to the *Management of Investigation-Derived Waste* SOP (TVA-KIF-SOP-12). Fluids and solids generated during decontamination are managed in accordance with TVA-KIF-SOP-12. The Ash Recovery Waste Coordinator (Michele Cagley) is notified of IDW stored onsite. The work area is disassembled and, to the extent practical, returned to its original condition.

4.0 REFERENCES

- American Society of Testing and Materials (ASTM) International. ASTM D-2487, *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*, May 1, 2006.
- ASTM. ASTM-D5092-04, *Standard Practice for Design and Installation of Groundwater Monitoring Wells*, June 2004.
- Tennessee Department of Environment and Conservation: Division of Underground Storage Tanks. *Technical Guidance* (TGD – 006), *Standard Drilling Log,* January 1, 1994.

- Tennessee Valley Authority (TVA). *Decontamination of Equipment* SOP (TVA-KIF-SOP-08), 2010.
- TVA. *Field Documentation* SOP (TVA-KIF-SOP-06), 2009.
- TVA. *Management of Investigation-Derived Waste* SOP (TVA-KIF-SOP-12), 2010.
- TVA. *Quality Assurance Project Plan for the Tennessee Valley Authority Kingston Ash Recovery Project* (TVA-KIF-QAPP), December 18, 2009.
- TVA. *Site-Wide Safety and Health Plan for the TVA Kingston Fossil Plant Ash Release Response* (SWSHP), Jacobs, April 6, 2009.
- U. S. Environmental Protection Agency (EPA) Region 4. *Design and Installation of Monitoring Wells*. Document # SESDGUID-101-R0, February18, 2008.

Table 1: Suggested Well Installation and Completion Equipment & Materials Checklist	
Item Description	**Check**
Health & Safety	
Nitrile gloves	
Hard hat	
Steel-toed boots	
Hearing protection	
Field first-aid kit	
Eyewash	
Safety glasses	
Barricades, cones, flashing lights, signs	
Respirator and cartridges (if necessary)	
Saranex™/Tyvek® suits and booties (if necessary)	
Paperwork	
Site-Wide Safety and Health Plan	
Sampling plan/scope-of-work/project guidance documents	
Well construction data, location map, field data from previous sampling events	
Grain-size chart/color table	
Field logbook	
Chain-of-custody forms and custody seals	
Drum labels	
Permanent marker for completing drum label	
Flags for marking well locations	
Equipment	
Dremmel tool for labeling outside of well casing	
PVC riser	
PVC well screen	
Locking well caps	
Bentonite pellets	
Driller sand	
Grout and cement	
Locks	
Drums	
Digital camera	
Water level/interface probe	
Measuring tape/ruler	
Stopwatch	
Bucket	

Table 2. Monitoring Well Development Form

General Information

Date: _____ Monitoring Well Number: _____________
Project Name: _____ Development Method: _____________
Developed By: _____ Discharge Rate: _____________
Oversight By: _____ Discharge Volume: _____________

Before Development

Start Time: _____ Depth to Water: ________________________________ ft bgs

During Development

Time: _____ Temp (^oC): ______________________________________
Turbidity: _____ Specific Conductance: ______________________________________
pH: _____

During Development

Time: _____ Temp (^oC): ______________________________________
Turbidity: _____ Specific Conductance: ______________________________________
pH: _____

During Development

Time: _____ Temp (^oC): ______________________________________
Turbidity: _____ Specific Conductance: ______________________________________
pH: _____

After Development

End Time: _____ Depth to Water: __________________________ ft bgs
Time: _____ Temp (^oC): ______________________________________
Turbidity: _____ Specific Conductance: ______________________________________
pH: _____

End of Procedure

Attachment 1

Boring Log

BORING LOG

FACILITY NAME: FACILITY ID:	SOIL BORING #		PAGE 1 OF 1
DRILLING COMPANY:	DATE/TIME STARTED:	DATE/TIME COMPLETED:	
DRILL RIG:	WATER DEPTH: 1ST ENCOUNTER	AT COMPLETION	
DRILLING METHOD: DRILLED BY:	LOGGED BY:		
TOTAL DEPTH:	TOC ELEVATION:		

DEPTH (FT. BGS)	PID READING (PPM)	INTERVAL RECOVERY (INCHES)	PENETRATION RATE (EX. MIN/FT)	LITHOLOGIC DESCRIPTION	SAMPLE LOCATION AND ANALYSIS	REMARKS
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

BGS = BELOW GROUND SURFACE
PID CALIBRATED TO 100 PPM ISOBUTYLENE CALIBRATION GAS
BKGD = BACKGROUND PID READING (0.0 PPM)
SAA = SAME AS PREVIOUS DESCRIPTION

TVA

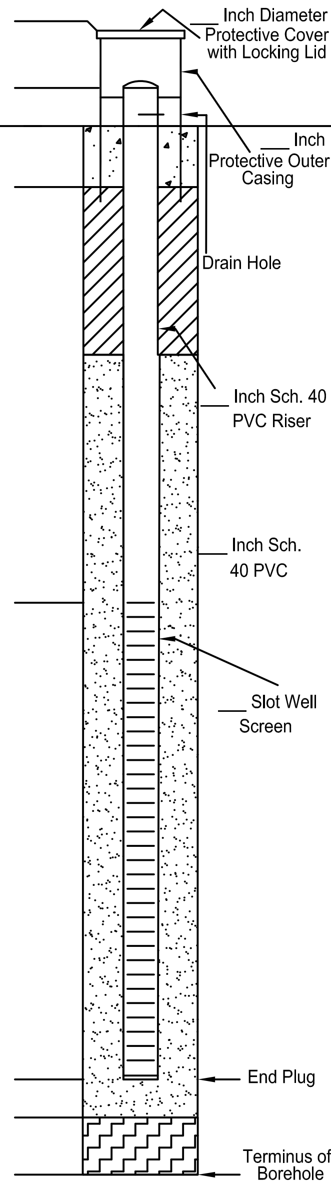
Attachment 2

Monitoring Well Installation Field Log

MONITORING WELL INSTALLATION FIELD LOG

FACILITY NAME:	FACILITY ID:	WELL NO.:
GEOLOGIST:	DRILLING METHOD:	LOCATION/COORDINATES:
WEATHER:	DRILLING COMPANY:	DATE/TIME
TEMPERATURE:	DRILL RIG: DRILLER:	STARTED: COMPLETED:

LITHOLOGIC DESCRIPTION	ELEVATION/ DEPTH	PID (ppm)	BLOWS/ft.	WELL CONSTRUCTION Depth (feet BGS) Details



MATERIALS INVENTORY

BENTONITE SEAL: TOP: BOTTOM:
FILTER PACK GRAINSIZE:
FILTER PACK : TOP: BOTTOM:
GROUT QUANTITY:
GROUT : TOP: BOTTOM:
GROUT TYPE:
SCREEN TYPE:
WELL SCREEN: in. l.f.
SLOT SIZE:
WELL CASING: Inches in Diameter l.f.
CASING TYPE:
TOP OF CASING (AGS):
BOREHOLE (IN. DIAMETER):
BOTTOM OF BOREHOLE (FT BGS):
TOP OF CASING ELEVATION (FT ABOVE MSL):

CAVE IN (SLOUGH) COARSE SAND FINE FILTER SAND BENTONITE GROUT CEMENT PAD

TVA