Development and Implementation of a Quality Assurance Program for the TVA Kingston Ash Recovery Project

Joseph P. Kraycik[1], Stephen D. Brower[1], Rock J. Vitale[1], and William J. Rogers[2].

[1]Environmental Standards, Inc., 1140 Valley Forge Road, Valley Forge, PA;
[2]Tennessee Valley Authority, 714 Swan Pond Road, Harriman, TN .

KEYWORDS: Coal ash, quality assurance (QA), release, environmental monitoring

INTRODUCTION

On December 22, 2008, a coal fly ash release occurred at the Tennessee Valley Authority's (TVA's) Kingston Fossil Plant (KIF), allowing a large amount of fly ash to escape into the adjacent waters of the Emory River. The plant is located in Roane County, Tennessee, near the town of Kingston. Ash produced by the combustion of coal for power generation is stored on site in containment areas including a former dredge cell. KIF generates 10 billion kilowatts of electricity per year-enough to supply electricity to approximately 670,000 homes. There are nine coal-fired generating units in operation at KIF and the plant consumes an average of 14,000 tons (12,698 metric tons) of coal per day.

A dike associated with the former dredge cell failed resulting in a release of approximately 5.4 million cubic yards (4.1 million cubic meters) of coal ash that covered about 300 acres (121 hectares) and affected about 40 area homes. Coal ash filled Swan Pond Embayment to the north of the KIF property adjacent to the former dredge cell. In addition, a section of the Emory River channel was blocked by released ash[1].

On January 12, 2009, the Tennessee Department of Environment and Conservation (TDEC) issued a Commissioner's Order requiring action be taken as necessary to respond to the emergency under Tennessee Code Annotated §69-3-109(b)(1), the Water Quality Control Act. The TDEC Order required a plan for the comprehensive assessment of soil, surface water, and groundwater; remediation of impacted media; and restoration of all natural resources damaged as a result of the coal ash release[2]. On May 11, 2009, an Administrative Order and Agreement on Consent was signed between US EPA and TVA providing the regulatory framework for the restoration efforts. US EPA's Administrative Order directed the restoration work to be conducted under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)[3].

In response to the containment area discharge event, TVA initiated comprehensive measures to assess, contain, and remediate the fly ash spill. Initial environmental monitoring included an immediate assessment of the surface water quality and an assessment of the extent of ash deposits that entered the adjacent river system.

Over time, the monitoring scope was expanded to include air monitoring, ash and sediment sampling, waste disposal characterization, and aquatic and terrestrial biota monitoring. A quality assurance (QA) program has been developed to ensure the generation of high-quality, defensible data for use in decision-making and regulatory compliance. The data generated from the project sampling and monitoring activities are being used for operational decision-making, risk assessment and human health evaluations, delineation of the extent of contamination, and demonstration of achievement of cleanup objectives. The remainder of this paper provides a discussion of the overall QA program for the TVA KIF Ash Recovery Project as well as a focused discussion of the field auditing component of the QA program.

PROBLEM STATEMENT

From December 22, 2008, until mid-January 2009, the response actions were operated in emergency response mode. Although the sampling and data collection approaches were carefully thought out, the activities were somewhat disorganized due to the hectic nature of the project at this time and the fact that a cohesive data management process had not yet been developed. In addition to the TVA sampling activities, multiple regulatory agencies and interested third-party researchers were also conducting environmental sampling at the ash release site. As a result, TVA was concerned about the integrity and quality of its data.

From the outset, TVA recognized issues associated with sampling, laboratory analysis, and data management. Data generated from the project sampling and monitoring activities are being used for operational decision-making, risk assessment and human health evaluations, delineation of the extent of contamination, and demonstration of achievement of cleanup objectives; therefore, the need for reliable, legally-defensible data was identified as a critical project need.

PROJECT-WIDE QA PROGRAM

In order to address the need for reliable, legally-defensible data, TVA determined that a project-wide QA program was necessary. On January 21, 2009, Environmental Standards, Inc. (Environmental Standards) was retained by TVA to provide quality oversight of the sampling and analytical activities and program-wide data management. The choice by TVA to retain Environmental Standards rather than conduct QA oversight internally was significant because an independent third-party would be responsible for the quality oversight on the project. Dr. William Rogers of TVA serves as the Project QA Officer and is the Technical Contract Manager to whom Environmental Standards reports. Several other TVA employees also assist Dr. Rogers and perform quality-related activities.

The retention of Environmental Standards by TVA and subsequent institution of a QA program lead to the establishment of specific points-of-contact for sampling, laboratory, and data-related issues. Business processes were developed and instituted to ensure that consistency and quality were maintained throughout the course of the project. When deficient items are identified, a formal corrective action process is used to correct the issues and to promote continuous program improvement. Overarching guidance documents including QA Plans and Standard Operating Procedures (SOPs) were also developed. The QA program was designed as an integrated approach to capture the full lifecycle of environmental data from pre-event planning through final use and archival of data. The QA program consists of three primary components; laboratory QA, field QA, and data management, as described below.

LABORATORY QA

The laboratory QA component consists of analytical chemistry consulting and oversight and involves the following activities:

- Prepare technical requests for proposals (RFPs) for laboratory analytical work associated with various sampling programs.
- Develop laboratory selection criteria to meet rigorous technical and data defensibility requirements.
- Engage in continual communication with laboratory personnel.
- Perform periodic laboratory audits.
- Develop performance evaluation studies.
- Perform data verification and validation.

FIELD QA

The field QA component was designed to focus on eliminating errors associated with the up-front planning and sample collection. Specifically, these activities include:

- Guidance document preparation (QAPP, SOPs, and Sampling Plans).
- Training of sampling personnel.
- Sample event planning and chain-of-custody (COC) record generation.
- Field oversight (auditing).
- Documentation and field data review.
- Ongoing communication and coordination with sampling crews.

DATA QA

The third component of the QA program involved the implementation of a full-cycle data management process. Examples of activities associated with data management QA include:

- Data management from sample planning through reporting.
- Use of EQuIS® Database for data warehousing and posting.

- Train database users.
- Data review and reconciliation.
- Data queries and output.
- Loading of historical data.
- Graphical displays and presentation of data.
- Data transfer to regulatory websites and databases.
- Plan for end-of-project data delivery.
- Statistical analysis.

GUIDANCE DOCUMENTS

The development of project guidance documents was critical to establish project QA requirements and expectations. The primary guidance documents generated for the project include the Quality Assurance Project Plan (QAPP), multiple Standard Operating Procedures (SOPs), Data Management Plan, Sampling and Analysis Plan, the Site-Wide Safety and Health Plan (prepared by Jacobs Engineering), and a variety of individual task-specific sampling plans.

The QAPP provides the overall framework of the project QA program and identifies obligations of the entities responsible for generating environmental data. To date, 62 individual SOPs have been developed that provide technical requirements, operational guidelines, and instruction to project personnel for various sampling, monitoring, and associated tasks. The SOPs span all three QA components.

FIELD AUDITING

Field oversight or auditing is a valuable practice that has been used extensively by Environmental Standards QA personnel on the KIF Ash Recovery Project. Field auditing is often viewed as a critical first step in the data defensibility process because an improperly collected sample will likely result in poor data quality. Likewise, inadequate pre-event planning will usually lead to a less than adequate sampling event. Field auditing is a tool used to identify and correct planning, sampling, and documentation deficiencies before they become consequential.

Because field procedures directly affect data quality, the QA Team relied heavily on field auditing to develop consistency between sampling personnel and to verify that the requirements of the project guidance documents were being satisfied. Following a field audit, a debrief is conducted and a formal report or project memorandum is generated by Environmental Standards; the debrief is used to document the sampling event, observations and findings identified during the audit, and recommendations regarding process improvements or corrective action.

The field auditing process begins by indentifying the activity to be audited. For the KIF Ash Recovery Project, the QA Team typically targets new activities or tasks and attempts to audit these activities soon after initiation. Additionally, there are a variety of on-going or routine sampling activities that are also audited. It is useful to audit the routine activities periodically because complacency and personnel turnover can lead to errors or omissions.

After identifying the task to be audited, an appropriate QA Team member (Auditor) with previous experience in this type of activity is assigned to conduct the audit. The QA Auditor prepares by reviewing the relevant project guidance documents and generates a checklist for use and reference during the audit. The audit usually begins by attending the daily sample planning meeting and then involves coordinating logistics with the samplers. The Auditor will often observe daily calibrations of instruments that will be used during the sampling event. During the sampling event, the Auditor observes and documents the activities conducted by the sampling crew. The Auditor is careful to remind the sampling crew that the audit is being conducted to help improve the program and should not be viewed as an adversarial situation. If issues affecting data quality are observed during the audit, the Auditor will address these issues either at the time of discovery or during the post-audit debrief. The goal is not to make someone look bad, but to correct issues as soon as possible before data quality is affected. When regulatory agencies and independent researchers conduct sampling activities, a third-party QA representative is present. During these oversight events, however, the QA representative simply observes and documents the activities.   Formal documentation of the event is provided to TVA in the form of a report or project memorandum. The TVA QA Officer may follow up with the agencies or independent researchers at his discretion.

Following conclusion of the sampling event, a post-audit debrief is conducted. During the debriefing, the Auditor will inform the sampling crew of observations and findings noted during the event. Positive feedback as well as suggestions for improvement are presented by the Auditor. This debrief provides a forum for open dialogue and allows the sampling crew to ask questions or give the Auditor feedback. Depending on the nature of the sampling event, a formal report or project memorandum is generated by Environmental Standards to document the sampling event, observations and findings identified during the audit, and recommendations regarding process improvements or corrective action. If necessary, corrective actions are instituted to correct deficient items identified during the audit.

To date, over 200 individual audits have been conducted of TVA or TVA-contracted sampling crews associated with the KIF Ash Recovery Project. The audited activities have included surface water sampling; groundwater sampling; soil, ash, and sediment sampling; sediment pore water sampling; air and particulate monitoring; collection of various biota samples including fish, benthic organisms, avian eggs, insects, reptiles, and amphibians; and waste characterization sampling.   In addition, observation and documentation has been conducted when US EPA and TDEC conduct split sampling with the TVA sampling crews. Environmental Standards has also observed and documented over 35 sampling events conducted by independent third-party researchers.

ISSUES IDENTIFIED AND LESSONS LEARNED

A number of interesting issues have been identified by the QA Team over the course of the KIF Ash Recovery Project leading to some important lessons-learned. Some of the specific issues identified and subsequently corrected include:

- Anomalous lead results were reported in surface water samples. An investigation by the QA Team revealed that fabricated sampling weights containing bismuth alloy were the source of lead contamination. Following discovery of the issue, the weights were replaced with solid PVC and the issue was corrected.

- Custody seals used on sample coolers were damaged or fell off during sample shipment. Multiple custody seals were tested until an adequate tamper-evident seal was identified that could also be signed and dated.

- As with any project, adequate field documentation is often a challenge. By instituting a “Field Documentation” SOP and conducting training, sampling personnel were educated on the requirements and expectations associated with field documentation. TVA and TVA-contracted samplers have done a consistently excellent job in documenting field work since implementation of the SOP.

- Issues associated with the proper completion of COC records, both field and laboratory-related, have been encountered during the project. Again, the implementation of an SOP greatly reduced errors related to COCs. In addition, the QA Team performs a final review of each COC record generated on the project following laboratory sample receipt and follows up when custody or documentation errors are identified.

- Homogenization of bulk coal ash during sampling can be very difficult due to the physical properties of the ash. The QA Team worked closely with sampling personnel to identify appropriate homogenization techniques that were subsequently incorporated into an SOP.

- Sampling personnel were not always clear on the proper way to collect quality control (QC) samples such as split samples, duplicate samples, equipment blanks, and method spike samples. In order to correct this issue, the QA Team prepared a “QC Sampling” SOP and trained sampling personnel on proper QC sample collection techniques.

- At the recommendation of the QA Team, a change in the existing site groundwater sampling protocol from a volume-averaged (2 well-volume purge) to low-flow (low-stress) methodology was proposed to TDEC to increase data quality. This recommendation was subsequently approved by TDEC and US EPA.

- Early on in the project, sampling crews sometimes used metal tools during solid sample compositing and homogenization. Since samples are being analyzed for metals, the QA Team strongly recommended that metal tools not be used during sampling. As a result, the sampling team used alternative non-metal tools and containers for compositing and homogenizing solid samples.

- On occasion, despite diligent efforts, sampling equipment sometimes comes into contact with either the ground surface or the deck of a boat, thereby presenting a cross-contamination risk. In order to prevent this risk, several of the project SOPs specifically require that plastic sheeting be placed on the ground or deck of the boat prior to initiating sampling activities.

CONCLUSIONS

Institution of a QA Program was necessary for the TVA KIF Ash Recovery Project to ensure that sound, legally-defensible data were generated and properly managed. A multidisciplinary QA approach (Chemistry, Data Management, and Field QA) was used to capture the full lifecycle of environmental data from pre-event planning to final use and archival of data. The development of Project Guidance documents was critical in order to establish project QA requirements and expectations.

Field auditing, a technique used extensively on this project, is an important step in generating reliable data. Field audits are conducted to:

- Ensure that personnel are properly trained.
- Improve field procedures and efficiency.
- Identify deficiencies early and promote continuous program improvement.

Valuable documentation is generated during field audits including the Auditor's observations and findings as well as making sure field crews are adequately documenting sampling events. When properly executed, field audits save time, money, and can prevent poor decisions.

REFERENCES

[1] Tennessee Valley Authority (TVA). Kingston Ash Recovery Project, Non-Time Critical Removal Action for the River System, Sampling and Analysis Plan. 2010, p. 1-1.

[2] Tennessee Department of Environment and Conservation (TDEC). Commissioner's Order, Case No. OGC09-0001, Division of Water Pollution Control. January 12, 2009.

[3] US Environmental Protection Agency (US EPA). Administrative Order and Agreement on Consent, Docket No. *CERCLA-04-2009-3766*, Region 4. May 11, 2009.