Public Health Assessment

Final Release

TENNESSEE VALLEY AUTHORITY (TVA) KINGSTON FOSSIL PLANT

COAL ASH RELEASE
714 SWAN POND ROAD
HARRIMAN, ROANE COUNTY, TENNESSEE

Prepared by the
Tennessee Department of Health

SEPTEMBER 7, 2010

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR's Cooperative Agreement Partner pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR's Cooperative Agreement Partner has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR's Cooperative Agreement Partner which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Foreword

This document summarizes an environmental public health investigation performed by the State of Tennessee Department of Health's Environmental Epidemiology Program. Our work is conducted under a Cooperative Agreement with the federal Agency for Toxic Substances and Disease Registry. In order for the Environmental Epidemiology Program to answer an environmental public health question, several actions are performed:

Evaluate Exposure: Tennessee health assessors begin by reviewing available information about environmental conditions at a site. We interpret environmental data, review site reports, and talk with environmental officials. Usually, we do not collect our own environmental sampling data. We rely on information provided by the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency, and other government agencies, businesses, or the public. We work to understand how much contamination may be present, where it is located on a site, and how people might be exposed to it. We look for evidence that people may have been exposed to, are being exposed to, or in the future could be exposed to harmful substances.

Evaluate Health Effects: If people could be exposed to contamination, then health assessors take steps to determine if it could be harmful to human health. We base our health conclusions on exposure pathways, risk assessment, toxicology, cleanup actions, and the scientific literature.

Make Recommendations: Based on our conclusions, we will recommend that any potential health hazard posed by a site be reduced or eliminated. Reducing or eliminating the health hazard will prevent possible harmful health effects. The role of the Environmental Epidemiology Program in dealing with hazardous waste sites is to be an advisor. Often, our recommendations will be action items for other agencies. However, if there is an urgent public health hazard, the Tennessee Department of Health can issue a public health advisory warning people of the danger, and will work with other agencies to resolve the problem.

If you have questions or comments about this report, we encourage you to contact us.

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Acronyms and Glossary

^{228}Ac:	Actinium with an atomic number of 228 and containing 89 protons and 138 neutrons, also written as actinium-228
Acute exposure	Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].
Aerodynamic diameter	Aerodynamic diameter is the diameter of a unit density (1 gram per cubic centimeter or 1 g/cm3) sphere that has the same gravitational settling velocity as the particle of interest and is a useful metric for characterizing particles greater than about 1 µm. The aerodynamic diameter is used because it is a way to account for particles of different shapes and densities that behave the same way in air.
APC:	Division of Air Pollution Control
ASU:	Appalachian State University
ATSDR	Agency for Toxic Substances and Disease Registry is an agency within the Centers for Disease Control and Prevention, part of the U.S. Department of Health and Human Services
Average	The same as mean. The sum of a list of values divided by the number of values.
Bioavailable	After ingestion of a substance, only a portion of the substance would be absorbed by the body and could react with body organs.
CDC	Centers for Disease Control and Prevention, part of the U.S. Department of Health and Human Services
Chronic exposure	Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]
Concentration	The relative amount of a substance mixed with another substance. The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media. An example is five parts per million (ppm) of carbon monoxide in air or 1 milligram per liter (mg/L) of iron in water.
Criteria pollutants	Six pollutants regulated by the U.S. EPA under the authority of the Clean Air Act. The six pollutants are carbon monoxide, lead, nitrogen dioxide, PM10, PM2.5, ozone, and sulfur dioxide.
CTEH:	Center for Toxicology and Environmental Health, a contractor for the Tennessee Valley Authority
Curie (Ci)	A unit of radioactivity, defined as 1 Ci=3.7×10^{10} becquerels. This is the same as 3.7×10^{10} decays per second. 3.7×10^{10} = 37,000,000,000. This is roughly the radioactivity of 1 gram of the radium isotope, Radium 226, a substance studied by the pioneers of radiology, Marie and Pierre Curie.
Decay products	Degraded radioactive materials, often referred to as "daughters" or "progeny"; radon-222 is a decay product of radiuim-226.

Dermal	Referring to the skin. For example, dermal absorption means passing through the skin.
Dike	A levee, embankment, usually earthen, that can act as a barrier for containment purposes.
Dose	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
Duplicate	A second sample that may be analyzed along with the original sample in order to determine the precision of the analytical method.
EEP	Environmental Epidemiology Program, part of the Communicable & Environmental Disease Services Section of the Tennessee Department of Health
EIP:	Environmental Integrity Project
Embayment	A bay or bay-like shape in a body of water.
EMEG	Environmental Media Evaluation Guide; a health comparison value derived by ATSDR from minimal risk levels (MRLs), specific to soil, water, or air for periods of exposure up to 2 weeks (acute EMEG), for periods up to a year (intermediate EMEG), or for over a year (chronic EMEG)
Environmental Media	Soil, sediment, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.
EPA	United States Environmental Protection Agency
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].
FRM:	Federal Reference Method
Finished water	Water that has been through treatment at a water treatment plant and is distributed to customers.
Health comparison values	The concentration of a chemical that is not likely to cause harmful effects during a lifetime. An example is an Environmental Media Evaluation Guide for soil. Health comparison values are used as screening levels, not for absolute predictions of harm.
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance may enter the body this way.
Inhalation	The act of breathing. A hazardous substance may enter the body this way.

Inorganic chemicals	Chemicals that do not contain carbon. Metals are inorganic chemicals. Coal is made of metals and organic compounds.
Intermediate exposure	Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].
Ionizing radiation	Ionizing radiation is energy in the form of waves or particles that has enough force to remove electrons from atoms.
IRIS	EPA's Integrated Risk Information System. An electronic database containing the EPA's latest descriptive and quantitative regulatory information on toxic chemicals.
Isotope	A variation of an element that has the same atomic number of protons but a different weight because of the number of neutrons. Various isotopes of the same element may have different radioactive behaviors, some are highly unstable.
kg/mg:	kilogram per milligram; used as a conversion factor in dose equations
KIF	TVA's Kingston Fossil Plant
LCAC:	Leachable Coal Ash Contaminants
^{210}Pb:	Lead with an atomic weight of 210 and containing 82 protons and 128 neutrons, also written as lead-210
^{214}Pb:	Lead with an atomic weight of 214 and containing 82 protons and 132 neutrons, also written as lead-214
LOAEL	The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals. Lowest Observed Adverse Effect Level
MCL	Maximum Contaminant Level, a regulatory standard for a safe concentration of a chemical in municipal drinking water
Mean	The sum of a list of values divided by the number of values. The same as an average.
mg	Milligram, one thousandth of a gram
mg/kg	Milligram of a toxic or hazardous substance per kilogram of a solid substance, such as in soil, sediment, or coal ash. A way to measure concentration.
mg/kg·day	Milligrams per kilogram per day; units for MRLs and RfDs
mg/L	Milligram of a toxic or hazardous substance per liter of water. A way to measure the concentration of a chemical in water.
µg	Microgram, one millionth of a gram
µg/L:	Micrograms per liter. A way to measure small concentrations of a chemical in water.
Micrometer	One millionth of a meter; the same as micron

Micron	One millionth of a meter; the same as micrometer
Microroentgen	The roentgen is a unit used to measure exposure. This can only be used for gamma radiation and X-rays in air. A microroentgen is one millionth of a roentgen.
MRL	Minimal Risk Level, a health comparison value for a chemical derived by ATSDR. The MRL is a dose of the chemical for which no adverse health effects are expected.
NAAQS	National Ambient Air Quality Standards. Standards for carbon monoxide, lead, nitrogen dioxide, PM10, PM2.5, ozone, and sulfur dioxide (criteria pollutants) in air set by the U.S. EPA.
NCEH	National Center for Environmental Health, part of the Centers for Disease Control and Prevention
NOAEL	The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals. No Observed Adverse Effect Level
Organic compounds	Chemical compounds that contain carbon. Living organisms are made up of organic compounds, such as proteins, fats, and carbohydrates. Coal is made of many organic compounds, such as polyaromatic hydrocarbons, as well as metals. Other types of organic compounds are the volatile organic compounds, VOCs).
PAH	Polyaromatic Hydrocarbon, a type of chemical that is found in tar, coal, charred food, and in organic material that has burned
^{210}Pb:	Lead with an atomic number of 210 and containing 82 protons and 128 neutrons, also written as lead-210
^{214}Pb:	Lead with an atomic number of 214 and containing 82 protons and 132 neutrons, also written as lead-214
pH	The pH scale measures how acidic or basic a substance is. It ranges from 0 to 14. A pH of 7 is neutral. A pH less than 7 is acidic, and a pH greater than 7 is basic.
Picocurie	One trillionth of a Curie. This can also be written as 1/1,000,000,000 Curies or $1x10^{-12}$ Curies.
PM50	Particulate matter with a diameter equal to or less than 50 microns
PM10	Particulate matter with a diameter equal to or less than 10 microns
PM4	Particulate matter with a diameter equal to or less than 4 microns
PM2.5	Particulate matter with a diameter equal to or less than 2.5 microns
Potable water	Water that is safe for drinking and cooking.
ppb	Part per billion, a unit of measure that is used to describe the micrograms of a chemical per kilogram of a solid substance, such as soil or ash. It can also be used to describe the micrograms of a chemical per gram of water.

ppm	Part per million, a unit of measure that is used to describe the milligrams of a chemical per kilogram of a solid substance, such as soil or ash. It can also be used to describe the milligrams of a chemical per gram of water.
Quality assurance	The sum total of all laboratory activities that are undertaken to ensure generation of accurate and reliable results. The objective is to ensure credibility of the laboratory and generate confidence in laboratory results. Laboratories have internal quality control and external quality assessment by independent agencies.
Quality control	The measures that must be included during each analytical test procedure to verify that the test procedure is working properly. The objective of quality control is to ensure that the results generated by the test procedure are correct.
Radioactive decay	Spontaneous change in an atom by emission of charged particles and/or gamma rays; also known as radioactive disintegration and radioactivity.
Radioactive Substances	Substances that emit ionizing radiation.
Radioisotope	An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.
^{226}Ra:	Radium with an atomic weight of 226 and containing 88 protons and 138 neutrons, also written as radium-226
^{228}Ra:	Radium with an atomic weight of 228 and containing 88 protons and 140 neutrons, also written as radium-228
Raw water	Water obtained from a surface water source, such as a lake, river, or reservoir, prior to any treatment or use.
Respirable particles	Particles that are capable of being deposited in the gas exchange region of the lungs are considered respirable particles. Inhaled particles smaller than 10 microns in diameter have some probability of penetrating to and being deposited deep in the lungs in the gas exchange (alveolar) region of the lungs. There is at least a 50% probability that particles smaller than 4 microns in diameter will reach the gas-exchange region.
RfC	Reference Concentration, a health comparison value derived by EPA for inhalation of a toxic substance. The RfC is a numerical estimate of a daily inhalation exposure to the human population, including sensitive subgroups such as children, that is not likely to cause harmful effects during a lifetime. RfCs are generally used for health effects that are thought to have a threshold or low dose limit for producing effects.
RfD	Reference Dose, a health comparison value derived by EPA for ingestion of a toxic substance. The RfD is a numerical estimate of a daily oral exposure to the human population, including sensitive subgroups such as children, that is not likely to cause harmful effects during a lifetime. RfDs are generally used for health effects that are thought to have a threshold or low dose limit for producing effects.

Risk	A measure of the probability that damage to life, health, property, and/or the environment will occur as a result of a given hazard.
River miles	A measure of distance in miles along a river from its mouth. River mile numbers begin at zero and increase further upstream.
RMEG	RfD Media Evaluation Guide. An environmental media evaluation guide derived by ATSDR from an EPA Reference Dose. A RMEG is a health comparison value derived by ATSDR from EPA's Reference Dose (RfD), specific to soil or water for periods up to a year (intermediate EMEG). EPA uses their RfDs for lifetime exposures to non-carcinogens.
SDWA	Federal Safe Drinking Water Act
Secular equilibrium	The point at which the decay rate of a parent radioactive material is roughly equal to the accumulation of its radioactive decay products. In relation to radiation, the point at which the radioactivity of elements within a radioactive series is neither increasing nor decreasing. Also called activity equilibrium.
Sensitive populations	People who can be affected by toxic chemicals more severely or at lower concentrations than other people, such as asthmatics, children, and the elderly.
SESD	Science and Ecosystem Support Division, EPA Region 4
Slope factor	An upper-bound estimate of a chemical's probability of causing cancer over a 70 year lifetime.
START	Superfund Technical Assessment and Response Team. Tetra Tech holds EPA Region 4's contractor for START. Tetra Tech provides technical support to EPA's site assessment activities and response, prevention, and preparedness activities.
Syndromic surveillance	The term "syndromic surveillance" applies to observation of health-related body system data that may indicate that an outbreak of a disease is beginning to occur and that may warrant further public health response.
TCLP	Toxicity Characteristic Leaching Procedure, an EPA laboratory procedure used to determine how much a metal will leave a particle of a solid and dissolve in water. The laboratory method mimics what would happen to waste when it contacts water, such as rain or groundwater.
TDEC	Tennessee Department of Environment and Conservation
TDH	Tennessee Department of Health
TDS	Total Dissolved Solids. All material that passes the standard glass river filter; now called total filterable residue. The term is used to reflect salinity.
Toxicology	The study of the harmful effects of substances on humans or animals.
TSP	Total suspended particles. A method of monitoring airborne particulate matter by total weight. Total suspended particles in air

TSS	Total Suspended Solids . A measure of the suspended solids in wastewater, effluent, or water bodies, determined by tests for "total suspended non-filterable solids
t-test with unequal variance	A statistical test to determine if two groups of data are the same or different. A student t-test with unequal variance is used when sample sizes are very small and when the samples have *unequal sizes and unequal variance*.
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
VOC	Volatile Organic Compound. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.
Weir	A dam placed across a river to raise or divert the water. Weirs are used at the TVA ash release site to retain ash while allowing cleaner water near the surface to pass.

Summary

INTRODUCTION

On Monday, December 22, 2008, around 1:00 A.M. the retention wall of a coal ash-holding pond failed at the Tennessee Valley Authority Fossil Plant in Roane County, Tennessee. More than 5.4 million cubic yards of coal ash, mixed with 327 million gallons of water, spilled into a branch of the Emory River, two Emory River inlets, and the main channel of the Emory River. The release covered approximately 300 acres outside of the Tennessee Valley Authority coal ash dewatering and storage areas, and is considered one of the largest environmental disasters in U.S. history.

The massive coal ash slide disrupted power and ruptured a gas line, causing the evacuation of 22 residents. There were no deaths or injuries caused by this extraordinary ash slide. The spill has dramatically affected the environment and disrupted citizens' lives. Water quality in the Emory River at the site of the ash spill was impaired and aquatic habitat was destroyed.

The spilled ash filled coves north of the ash containment pond with ash, soils, and debris (from trees and boat docks). The ash and soil completely filled in these coves and spilled across the yards of a few homes. Several homeowners owned boat docks and boats and used the coves as an entrance to the larger open water area of the Emory River. Homeowners used the areas behind their homes for recreation and fishing. The ash spill damaged three homes to the point that they were condemned. The Tennessee Valley Authority provided the families living in these homes compensation and other housing. As of August 2009, TVA had compensated more than 100 property owners living near or affected by the spill.

Many residents, whose yards backed up to the coves, were concerned about the health effects of ash in their yards and in the coves. People farther from the site were concerned about health effects of airborne ash.

Soon after the environmental disaster, various governmental agencies began their emergency response activities. The first response came from the Roane County Emergency Management and Homeland Security Agency. The Tennessee Emergency Management Agency (TEMA) responded next. They requested assistance from the National Response Center, who notified the U.S. Environmental Protection Agency, Region 4 in Atlanta. The Environmental Protection Agency set up a unified command with local and state officials, the Tennessee Department of Environment and Conservation, the Tennessee Department of Health, and the Tennessee Valley Authority. Initial response activities focused on evacuating people, restoring power, repairing the ruptured gas line, and clearing roads for access to the coal ash release area.

When coal is burned, the metals in the coal become concentrated in the ash. The metals in the coal ash have the potential to cause harm to the environmental and to people. For this reason, the Tennessee Valley Authority, the Environmental Protection Agency, and the Tennessee Department of Environment and Conservation immediately began sampling and analysis of the ash itself, surface water, groundwater, drinking water, and air. The Tennessee Department of Health reviewed all analytical results to make sure that public health was protected.

Several residents, other concerned citizens, and several environmental organizations petitioned the Agency for Toxic Substances and Disease Registry for a Public Health Assessment. The Tennessee Department of Health's Environmental Epidemiology Program wrote this Public Health Assessment. Its purpose is to help people understand:

- what government agencies did to protect people and the environment,
- if the coal ash could have caused, is causing, or will cause harm to people's health,
- how the Environmental Epidemiology Program made its conclusions, and
- what steps need to be taken next to continue protecting people's health.

The Environmental Epidemiology Program used environmental sampling data collected and analyzed by the Tennessee Valley Authority, U.S. Environmental Protection Agency, and Tennessee Department of Environment and Conservation to make its conclusions about public health impacts of the coal ash release. The conclusions about public health impacts were based on potential long-term chronic exposures, except for two conclusions dealing with the immediate impact of the coal ash release. By considering long-term, chronic exposures, we were being prudent and most protective in our evaluations. The Public Health Assessment is not a 'health study' done by monitoring people.

When the coal ash was released from the failed retention wall of one of the coal ash storage ponds, people in the path of the ash could have been harmed by the magnitude and suddenness of the ash release. If the release had occurred during a summer day when people were on the river or riverbanks, many people could have been harmed or killed.

Based on TDH's review of data, the coal ash at the site of the KIF coal ash release should not have caused harm to the community's health. The coal ash and the metals in coal ash have not:

- gotten into private well or spring water,
- impacted the municipal drinking water from the Kingston and Rockwood water treatment plants,
- limited recreational opportunities such as swimming and boating, except in the immediate vicinity of the coal ash release and clean up, nor
- increased particulate matter or metals concentrations in ambient air around the site.

The Environmental Epidemiology Program wrote this public health assessment in collaboration with the Agency for Toxic Substances and Disease Registry. ATSDR reviewed the document at each stage in the process to make sure that the science was correct and that the conclusions and recommendations were valid and protective of public health.

This Public Health Assessment is not the end of the Tennessee Department of Health's work on the TVA Kingston Coal Ash Release Site. The Department of Health will continue to work with our state and local partners including the Tennessee Department of Environmental and Conservation, the Agency for Toxic Substances and Disease Registry, and the Environmental Protection Agency throughout the cleanup. The East Tennessee Regional Health Office and the Roane County Public Health Department will continue to be local sources of information for citizens. The State Laboratory will continue to analyze environmental samples. The Environmental Epidemiology Program will continue to review environmental sampling data and continue to make recommendations to protect public health from harmful effects of the release.

OVERVIEW

CONCLUSION 1	**When the coal ash was released from the failed retention wall of one of the coal ash storage ponds, people in the path of the ash could have been harmed by the magnitude and suddenness of the ash release. The ash could have buried them if they had been on the portion of the Swan Pond Road that was covered. The ash could have buried them if they had been boating, swimming, or fishing in the Emory River or in the Church, Berkshire, or Swan Pond sloughs. If the release had occurred during a summer day when people were on the river or riverbanks, many people could have been harmed or killed.**
BASIS FOR DECISION	An enormous amount of ash quickly filled the Emory River and two coves, moving one house from its foundation and causing two other homes to be uninhabitable. The force of the release ruptured a gas line and disrupted power, causing the evacuation of the neighborhoods along Swan Pond Road and Emory River Drive. A train derailed when it ran into a portion of the huge pile of coal ash. People driving home during the night found that Swan Pond Circle Road was impassable due to the ash. Fortunately, no one on the road or river was buried by the coal ash release.
WHAT WAS DONE	The Roane County Office of Emergency Services and Homeland Security acted immediately to protect people. The Tennessee Valley Authority, the U.S. Environmental Protection Agency, the Tennessee Department of Environment and Conservation, the Tennessee Emergency Management Agency, and the Tennessee Department of Health began to assist through a unified command structure. Although the command center was demobilized in January 2009, the response from state and federal agencies has continued, and will continue until the area is returned to the conditions existing before the coal ash release. The Tennessee Department of Health and the Tennessee Department of Environment and Conservation will continue to widely publicize the following message: *If you do contact the ash, then practice good hygiene, especially washing your hands before eating or smoking. Wash thoroughly, including your hands, clothes and shoes if you, your children, or pets come in contact with the ash. Basically, wash the same way you would after mud exposure. Remember, the metals are bound to the ash. Occasional exposures for brief periods of time should not harm people's health.*

This coal ash release highlights the continued need for industries and federal, state, and local officials to work closely together to develop comprehensive emergency response plans and capabilities in communities where acute environmental incidents are possible.

CONCLUSION 2	**The Tennessee Department of Health concludes that it is unlikely that harm occurred to people from touching the coal ash when they had to climb out of their damaged houses on the morning of December 22, 2008, and to those who returned to retrieve personal property.**
BASIS FOR DECISION	Longer-term contact would be necessary to cause any significant local skin irritation, such as coal ash that has gotten under a bandage. Casual contact with coal ash should not cause skin irritation. In addition, the metals in the coal ash are not likely to get into people's bodies from touching the ash.
WHAT WAS DONE / NEXT STEPS	People whose homes were destroyed have been relocated. In addition, the Tennessee Valley Authority has relocated most of the families whose property was near the affected portions of the Emory River and coves. The U.S. Environmental Protection Agency, the Tennessee Department of Environment and Conservation, and the Tennessee Valley Authority should continue to work cooperatively to clean up the ash as quickly as possible while protecting the people in the community from touching, accidentally eating, drinking, or breathing the coal ash.

CONCLUSION 3	**The Tennessee Department of Health concludes that no harm to the community's health is expected from touching the coal ash. This includes children who might touch the ash while playing.**
BASIS FOR DECISION	Longer-term contact would be necessary to cause any significant local skin irritation, such as coal ash that has gotten under a bandage. Casual contact with coal ash should not cause skin irritation. In addition, the metals in the coal ash are not likely to get into people's bodies from touching the ash. The ash has been fenced, clearly marking the areas with coal ash. The opportunity for people, especially children, to touch the ash is currently minimal.
NEXT STEPS	The Tennessee Valley Authority should continue working in cooperation with the U.S. Environmental Protection Agency and the Tennessee Department of Environment and Conservation to clean up the coal ash while protecting the people in the community from touching the coal ash.

CONCLUSION 4	**The Tennessee Department of Health concludes that no harm to people's health is expected from accidentally eating a small amount of coal ash.**
BASIS FOR DECISION	The concentrations of metals in the coal ash, except arsenic, are below levels known to cause harm if eaten. Because exposure to the coal ash was brief and the arsenic in the coal ash is not completely available for absorption, no harm to health is expected even if the coal ash were accidentally eaten. The ash has been fenced, clearly marking the areas with coal ash.
NEXT STEPS	The Tennessee Valley Authority should continue working in cooperation with the U.S. Environmental Protection Agency and the Tennessee Department of Environment and Conservation to clean up the coal ash while protecting the people in the community from eating the coal ash.

CONCLUSION 5	**The Tennessee Department of Health concludes that using the Emory River at the site of the coal ash release (near Emory River mile 2) could result in harm to residents or trespassers from physical hazards associated with cleanup efforts and from the volume of ash present, if residents or trespassers entered the area.**
BASIS FOR DECISION	The Tennessee Valley Authority is using heavy machinery to build dikes and weirs to contain the ash and to remove the ash. The U.S. Environmental Protection Agency and the Tennessee Valley Authority have brought in large hydraulic dredge equipment to expedite the removal of ash from the Emory River. People could be harmed if their boats became entangled in any cable or tie-offs for the dredging equipment or if any of the transport piping used to transport dredged ash were to blowout resulting in materials hitting someone nearby. In addition, boaters could hit partially submerged obstructions in the work area or have decreased visibility by not being able to see around the large equipment. By summer 2010, ash removal in the main channel of the Emory River will have been completed and all heavy equipment will be removed.
NEXT STEPS	The Tennessee Valley Authority is working in cooperation with the U.S. Environmental Protection Agency and the Tennessee Department of Environment and Conservation to clean up the coal ash while protecting the people in the community. While cleanup is underway, heavy machinery will be present. The Tennessee Valley Authority should continue to actively patrol the area so that unauthorized persons cannot enter the area. The U.S. Environmental Protection Agency, in conjunction with the Tennessee Departments of Health and Environmental Conservation and the Tennessee Valley Authority, issued a Recreational Advisory for Watts Bar Reservoir in June 2009. This advisory states, in part: *The public is cautioned to avoid recreational use of the lower Emory River in the vicinity of the ash release down to the confluence of the Emory and Clinch Rivers, which includes adjacent coves, inlets, islands, and sand bars. Small vessel traffic is currently channeled through a well-marked navigational lane, but swimming, jet skiing, water skiing and tubing are not advised at this time in these areas. In addition to construction related risks, contact with submerged or floating ash should be avoided, and if ash is contacted it should be washed off with soap and water. Chronic exposure by incidental ingestion and inhalation should also be avoided.* On August 11, 2009, the Environmental Protection Agency, in conjunction with the Tennessee Department of Environment and

Conservation and the Tennessee Valley Authority, closed the Emory River from mile marker 1.5 to mile marker 3. The river closure was extended from mile marker 0.0 to mile marker 6.0. The river was closed to river traffic through May 28, 2010.

CONCLUSION 6	**The Tennessee Department of Health concludes that using municipal drinking water from the Kingston and Rockwood water treatment plants will not harm people's health because the raw and finished water have continuously met drinking water standards.**
BASIS FOR DECISION	The Environmental Protection Agency's contractor tested raw and finished drinking water for the Kingston and Rockwood water treatment plants every day between December 23, 2008, and January 5, 2009. The Tennessee Department of Environment and Conservation tested the water every day between January 2 and January 22, 2009, and continues to sample the water weekly. At no time, has the raw or finished water contained metals above primary drinking water standards. The water intake for the Kingston water treatment plant is about 6 miles downstream of the ash release site. The water intake for the Rockwood water treatment plant is about 23 miles downstream of the ash release.
NEXT STEPS	The Tennessee Department of Environment and Conservation should continue to sample and analyze raw and finished water at the Kingston and Rockwood water treatment plants. If any at any time, violations of water quality are detected, the Tennessee Department of Environment and Conservation will take immediate action to protect the health of the communities using the municipal water.

CONCLUSION 7	**The Tennessee Department of Health concludes that using well or spring water within four miles of the coal ash release will not harm people's health from exposure to coal ash or metals in the coal ash because no evidence has been found for groundwater contamination by coal ash.**
BASIS FOR DECISION	Between December 30, 2008, and March 12, 2009, the U.S. Environmental Protection Agency, the Tennessee Department of Environment and Conservation, and the Tennessee Department of Health sampled and analyzed water from 102 privately owned wells and springs within a four-mile radius of the ash spill. None of the water tested had any contaminants above the national or state primary drinking water limits called Maximum Contaminant Levels (MCLs). There is no indication from groundwater sampling and analysis that coal ash has contaminated the groundwater.
NEXT STEPS	The Tennessee Department of Environment and Conservation should continue to take samples of groundwater from private wells and springs for analysis periodically to make sure that the coal ash is not affecting groundwater. If elevated concentrations of any of the metals from the coal ash are found in groundwater, the Tennessee Department of Environment and Conservation will take immediate action to protect the health of the community. If site conditions at the Kingston Fossil Plant coal ash release should change, then the groundwater sampling timeframe should be re-evaluated.

CONCLUSION 8 **The Tennessee Department of Health concludes that no harm to people's health should result from recreational use of the Emory, Clinch, and Tennessee Rivers outside the area of the lower Emory River down to the confluence of the Emory and Clinch Rivers, as specified in the recreational advisory and river closure. Previous fish advisories should be followed.**

BASIS FOR DECISION Sampling and analysis for metals associated with coal ash indicated that metals in all other areas of the Emory River and the Clinch River have remained below any health comparison values. Concentrations of total suspended solids have remained low in all areas of the Emory and Clinch Rivers except at the site of the coal ash release. The Tennessee Department of Environment and Conservation and the Tennessee Valley Authority will continue to sample and analyze surface water in the Emory, Clinch, and Tennessee Rivers. If at any time, violations of water quality are detected, the Tennessee Department of Environment and Conservation will take immediate action to protect the health of people using the rivers for recreation.

The Tennessee Department of Environment and Conservation and the Tennessee Wildlife Resources Agency advise avoiding consumption of striped bass and limiting consumption of catfish and sauger. The pollutants of concern are polychlorinated biphenyls (PCBs) and mercury from historical activities not related to the Tennessee Valley Authority (see Appendix D).

NEXT STEPS The Tennessee Valley Authority should continue to clean up the site of the coal ash release as fast as possible while, at the same time, protecting both public health and the health of the river and its aquatic life. The Tennessee Department of Environment and Conservation should continue to monitor the Emory and Clinch Rivers to make sure they remain safe for recreational activities. The Tennessee Wildlife Resources Agency and the Tennessee Department of Environment and Conservation are sampling fish to make sure the coal ash does not affect them and indirectly harm people who eat the fish.

Cleanup of the coal ash release is being conducted in a way that will not disturb historical contamination of the river sediments with polychlorinated biphenyls (PCBs) and mercury. TVA and EPA entered into an Administrative Order and Agreement on Consent on May 6, 2009, to ensure that the environmental impacts associated with the ash spill are thoroughly assessed and that appropriate response actions are taken as necessary to protect public health, welfare of the environment, and to ensure that the response actions satisfy all federal as well as state environmental requirements. TDEC's

	Commissioner's Order of January 12, 2009, and TDEC's collaboration with TWRA in protecting fish are included in the TVA/EPA order.

CONCLUSION 9	**While no air measurements were obtained during the time period between December 22 through December 27, 2008, the Tennessee Department of Health concludes that it is unlikely that any harm to public health should have resulted from breathing ambient air from December 22, 2008, through December 27, 2008. However, any dust that may have been inhaled could have aggravated symptoms in sensitive populations, that is, people with asthma, emphysema, and other respiratory or cardiovascular conditions.**
BASIS FOR DECISION	The coal ash was wet when it spilled. Wet weather for three days after the spill, combined with low temperatures and slow wind speeds, would have kept the coal ash from drying out and getting into the air.
WHAT WAS DONE	Since no air measurements were obtained during the time period between December 22 through December 27, 2008, it is not possible to know precisely what the air conditions were during this time. All emergency operations were aimed at protecting the public from released coal ash and dealing with emergency situations created by derailed trains, ruptured gas lines, destroyed homes, and destroyed roads. The U.S. Environmental Protection Agency began taking air samples on site on December 27, 2008. Various types of air sampling in the community began on December 28, 2008, by the Tennessee Valley Authority, on December 30, 2008, by the Environmental Protection Agency, and on January 19, 2009, by the Tennessee Department of Environment and Conservation.

CONCLUSION 10a	**The Tennessee Department of Health concludes that breathing ambient air near the coal ash release is not expected to harm people's health as long as adequate dust suppression measures are in place.**
CONCLUSION 10b	**The Tennessee Department of Health concludes that no harm to people's health is expected from occasionally breathing coal ash if it should become airborne for short periods of time.**
CONCLUSION 10c	**If dust suppression measures should fail and particulate matter is present in concentrations greater than National Ambient Air Quality Standards due to the coal ash becoming airborne for periods longer than one day, the Tennessee Department of Health concludes that particulate matter from airborne coal ash could harm people's health, especially for those persons with pre-existing respiratory or heart conditions. Such harm could include upper airway irritation and aggravation of pre-existing conditions such as asthma, emphysema, and other respiratory or cardiovascular conditions.**
BASIS FOR DECISION	Sampling and analysis of particulate matter by all agencies indicated that particulate matter, less than or equal to 2.5 microns in diameter (PM2.5) and less than or equal to 10 microns in diameter (PM10), in ambient air surrounding the coal ash release met all National Ambient Air Quality Standards. Coal ash is considered a nuisance dust because of the size range of the particulate matter. Metals in the ash are not at high enough concentrations to cause harm if they are breathed. If the coal ash were breathed in for longer periods or more frequently, the particulate matter in the airborne coal ash would cause the same harm as breathing in other dusts (such as dust from a ball field or farm land). Examples of such harm are upper airway irritation and aggravation of pre-existing problems such as asthma, emphysema, and other respiratory or cardiovascular conditions. The Tennessee Valley Authority's air monitors did not often detect metals in total particulate matter. Most measurements were below health comparison values. Arsenic and chromium detected by the Tennessee Valley Authority in total particulates on-site were within the range found in the United States for metals on particulate matter. Sampling and analysis of ambient air off-site were done by using temporary monitors that sampled total particulate matter, not just respirable or inhalable particulates. One sample taken on January 26,

2009, had cadmium in total particulates above the health comparison value. This sample represents just one sampling result within results for five sampling stations with daily sampling from January 1 through March 10, 2009 (345 samples).

Metals in total suspended particulates measured by the Tennessee Department of Environment and Conservation were all below health comparison values, except for two samples of arsenic that were slightly above the health comparison values. These two detections of arsenic should have no impact on public health because the concentrations of arsenic detected were extremely low. In addition, metals measured in total suspended particulates include metals of all sizes of particulate matter, not just particulate matter that is respirable.

NEXT STEPS

The Tennessee Valley Authority and the Tennessee Department of Environment and Conservation should continue to measure particulate matter and metals in particulate matter in the air near the release until the coal ash release is cleaned up.

The Tennessee Department of Health, the Tennessee Department of Environment and Conservation, and the Tennessee Valley Authority will ensure that a system is in place to warn people if the air quality is likely to fail to meet National Ambient Air Quality Standards.

CONCLUSION 11	**The Tennessee Department of Health cannot conclude whether breathing dust near the quarry and along the routes of the quarry trucks has or will harm people's health. Such dust can be irritating to upper airways and can aggravate pre-existing conditions such as asthma, emphysema, and other respiratory or cardiovascular conditions.**
BASIS FOR DECISION	Of the 47,909 real-time measurements of particulate matter less than or equal to 10 microns in diameter (PM10) in the community near the ash release, 0.1% were above 150 micrograms per cubic meter, the 24-hour average National Ambient Air Quality Standard for PM10. Many of these samples were taken near the quarry and along the quarry truck routes. Because the samples were collected during a short time period, three to five minutes, we cannot make any predictions about the 24-hour average concentrations. We can say that the quarry dust does not typically contain heavy metals like the coal ash. Quarry dust contains chemicals present in limestone, such as calcium, magnesium, and carbonates. Such dust can be irritating to upper airways and can aggravate pre-existing conditions such as asthma, emphysema, and other respiratory or cardiovascular conditions.
NEXT STEPS	If the rock dust from the quarry was a health problem, it was because it is particulate in nature. The Tennessee Department of Environment and Conservation should continue to work with the quarry and with the Tennessee Valley Authority to lessen the dust at the quarry and along the truck routes.

CONCLUSION 12	**The Tennessee Department of Health concludes that the small amount of radiation from the coal ash is not expected to harm people's health. Any exposure to radiation from the small amount of naturally occurring radionuclides present in coal ash, even in the more concentrated forms in coal ash, would be too small to give a radiation dose to people that would be substantially greater than the normal, everyday background radiation dose to which all people are exposed.**
BASIS FOR DECISION	The radioactive materials of concern in coal ash include both radium-226 and radium-228. Although the concentration of these materials in the coal ash exceeded the average regional background soil concentrations, the levels are below the health-based directive used by both the U.S. Environmental Protection Agency and the Agency for Toxic Substances and Disease Registry. This regulatory limit was set to protect the health of people, including the health of sensitive populations.
NEXT STEPS	No additional public health actions are needed related to radiation from the released coal ash. The Tennessee Valley Authority, the U.S. Army Corps of Engineers, the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Tennessee Department of Environment and Conservation signed the continuing Interagency Agreement Watts Bar Reservoir Permit Coordination in February 1991. This agreement governs any activities that could result in the disturbance, resuspension, removal, and/or disposal of sediments contaminated by Oak Ridge Reservation past activities. The cleanup of ash in Watts Bar Reservoir is functioning under this agreement to prevent dredging of legacy contamination not related to the coal ash release.

CONCLUSION 13	**The Tennessee Department of Health supports the efforts of the non-governmental organizations to collect environmental data in the days after the coal ash release. The Tennessee Department of Health concludes that data collected by non-governmental organizations confirm data collected by governmental agencies at the site of the coal ash release. Because the data were collected for a brief time immediately after the coal ash release and were collected only at the site of the release, they could not be used in establishing the long-term public health implications of the coal ash release for Watts Bar Reservoir.** **Data from all agencies agree that arsenic in the coal ash was at levels above health comparison values, that arsenic in the Emory River at the site of the ash release was elevated immediately following the release. They also agree that groundwater in the vicinity of the coal ash release was not impacted by the coal ash. Non-governmental organizations, as well as the Tennessee Departments of Health and Environment and Conservation and the U.S. Environmental Protection Agency, expressed concern about the potential for harm to health from breathing airborne coal ash. See Conclusion 10 for more about this.** **The data provided by non-governmental organizations about selenium in certain fish were not replicated by Tennessee Department of Environment and Conservation's, the Tennessee Wildlife Resources Agency's, or the U.S. Environmental Protection Agency's sampling and analysis. However, it has signaled the need for further investigation by government agencies. The Environmental Protection Agency's Science Review Panel and the U.S. Corps of Engineers have generated two reports on selenium impacts at the site of the coal ash release.**
BASIS FOR DECISION	Non-governmental organizations (NGOs) collected most of their data in the days just after the coal ash release and in areas near the release. In some cases, the Tennessee Department of Health could not determine the exact sampling and analysis techniques or quality control and quality assurance measures. We appreciate this additional data and the concern about the environment and the health of Tennesseans by the non-governmental organizations. By working together, all governmental and non-governmental agencies can protect the environment and the health of the people who live in the area of the coal ash release. Sampling and analysis of groundwater, surface drinking water, well water, and air continues by the Tennessee Valley Authority and the Tennessee Department of Environment and Conservation. This

	continuing sampling will allow the Tennessee Department of Health and the Tennessee Department of Environment and Conservation to ensure that the health of the public near the coal ash release continues to be protected.
NEXT STEPS	None at this time.

CONCLUSION 14	**Based on the Community Health Survey, the Tennessee Department of Health concludes that many residents living in the area of the coal ash release experienced stress and anxiety. Some residents reported respiratory symptoms after the ash release. It is important to note that the survey was done soon after the spill, but was not repeated later. Therefore, the results are only applicable for the short period soon after the spill.**
BASIS FOR DECISION	Analysis of questions from the Community Health Survey indicated that 52 percent of the persons who answered questions for the survey experienced stress and anxiety. Symptoms of stress and anxiety are natural and to be expected since the coal ash release destroyed homes, disrupted lives, and drastically changed the landscape. Since the coal release occurred just before Christmas, even more stress was added to the lives of the people living near the coal ash release. Forty percent of the persons who answered questions for the survey reported a change in health status since the spill, primarily worsening of either cough or headaches, wheezing, or shortness of breath. It is important to note that the survey was done soon after spill, but was not repeated later. Therefore, the results are only applicable to the short period soon after the spill.
NEXT STEPS	The Tennessee Department of Health has continually encouraged people to see their primary care provider for any health concerns. People are encouraged to contact the Oak Ridge Associated Universities to sign up for health screenings if they are concerned that their health has been harmed by the coal ash release. The health screenings will be done by medical toxicologists from the Tennessee Poison Center, Vanderbilt University Medical Center. The Department of Mental Health and the Tennessee Valley Authority worked with Ridgeview Community Mental Health Center in Oak Ridge and Harriman to provide services to people affected by the coal ash release.

CONCLUSION 15	**Community members living near the quarry and along the routes that quarry trucks traveled made complaints specific to dust at the Tennessee Valley Authority's Community Involvement Center. Complaints about respiratory symptoms were widespread and were not oriented toward either the site of the coal ash release or the route of the quarry trucks.**
BASIS FOR DECISION	The Tennessee Department of Health analyzed written complaints to the Tennessee Valley Authority's Community Involvement Center related to health concerns. The Tennessee Department of Health performed geographical analysis that indicated that dust concerns were strongly oriented to the location of the quarry and to routes traveled by the quarry trucks. Geographical analysis indicated that respiratory concerns were not geographically related to either the quarry or the coal ash release site.
NEXT STEPS	The Tennessee Department of Environment and Conservation should continue to work with the quarry to control dust. TVA has implemented many dust control measures at the site of the coal ash release and for trucks leaving the site. Dust controls will continue to be required of trucks driving on county roads. The Tennessee Department of Health has continually encouraged people to see their primary care provider for any health concerns. People are encouraged to contact the Oak Ridge Associated Universities to sign up for health screenings if they are concerned that their health has been harmed by the coal ash release. The health screenings will be done by medical toxicologists from the Tennessee Poison Center, Vanderbilt University Medical Center.

CONCLUSION 16	**The Tennessee Department of Health concluded that screening people's blood or urine for metals would not be helpful.**
BASIS FOR DECISION	Based on environmental test results, the Tennessee Department of Health does not expect harm to health from touching, eating, drinking, or breathing the metals in coal fly ash. No harm is expected from breathing the air as long as adequate dust suppression measures are in place. Any exposures would have been very brief, and any possible absorption of metals from the coal ash would have been undetectable.
NEXT STEPS	If people chose to have metals' testing and they are concerned about their results, they should talk with their primary care provider or talk with a medical toxicologist at the clinics set up in the area by Oak Ridge Associated Universities and the Tennessee Poison Center at Vanderbilt University Medical Center.

THE FUTURE	**The Tennessee Department of Health understands that people are concerned about whether the coal ash may be a health hazard in the future. The Tennessee Department of Health will continue to consult with the Tennessee Department of Environment and Conservation and the U.S. Environmental Protection Agency to make sure that future sampling will be adequate in all respects to make determinations about the health of the people living near the coal ash release. The Tennessee Department of Health will continue to follow all sampling and analysis activities and will inform the Tennessee Department of Environment and Conservation and the U.S. Environmental Protection Agency immediately if any results might be a cause of health concern. The Tennessee Department of Health, the Agency for Toxic Substances and Disease Registry, the U.S. Environmental Protection Agency, the Tennessee Department of Environment and Conservation, the Tennessee Valley Authority, Oak Ridge Associated Universities, and the Tennessee Poison Center will continue to work together to ensure that public health is protected during the long cleanup process.** **The Tennessee Department of Health will continue to keep people informed about any new issues or any new findings through the Environmental Epidemiology Program's website, reports, community meetings, and press releases.**
Since the Public Health Assessment Was Begun	**All conclusions remain valid and unchanged as of July 2010. The Tennessee Department of Health has reviewed data continually as it has become available to make sure the public health of the community near the Tennessee Valley Authority spill site is protected.**
FOR MORE INFORMATION	If you have concerns about your health, as it relates to the coal ash release, you should contact your local health care provider. You may contact Oak Ridge Associated Universities for general health questions related to the coal ash release at kingstonquestions@orau.org or for information about free health screenings related to the coal ash release at kingstonsignups@orau.org. The Oak Ridge Associated Universities' telephone number is 865-576-3115. You may also call the Tennessee Department of Health at 615-741-7247 or 1-800-404-3006 during normal business hours or email the Department of Health at EEP.Health@tn.gov. You can obtain information from the Tennessee Department of Health website, http://health.state.tn.us/.

1. Background

TVA: TN Valley Authority

KIF: Kingston Fossil Plant

1.1 Introduction

The Tennessee Valley Authority (TVA) Kingston Fossil Plant (KIF) is located on the Emory River close to the confluence of the Clinch and Tennessee Rivers near Kingston, Tennessee. Construction of the plant began in 1951 and was completed in 1955. KIF generates 10 billion kilowatt-hours of electricity a year, enough to supply the needs of about 670,000 homes in the Tennessee Valley. The plant burns approximately 14,000 tons of coal every day when operating at full power. This results in about 1,000 tons of ash. The ash was deposited in an aboveground ash containment slurry pond with three cells. TVA managed the ash by mixing it with water to prevent deposition of the fly ash downwind from the plant (TVA 2009).

Two types of coal ash are formed when coal is burned in a power plant to produce electricity. Combustion rates in modern facilities are nearly 100 percent, meaning that the organic material in coal is completely burned up, while the metals that are left over become more concentrated. Bottom ash forms in the bottom and on the sides of the furnaces and consists mostly of the non-combustible constituents of coal. The portion of the ash that escapes up the stack is referred to as fly ash. The fly ash in the stack solidifies in the exhaust gases and is collected for disposal. Coal fly ash contains small particles and can become airborne if it dries out. KIF collects coal ash in ponds to keep the fly ash wet. The coal ash produced by KIF is approximately 10 percent bottom ash and 90 percent fly ash. However, the coal ash in the ponds was nearly 100% fly ash [Joseph J. Hoagland, TVA, personal communication]. Fly ash is mainly silicon dioxide, aluminum dioxide, iron oxide, and some other metals.

On Monday December 22, 2008, around 1:00 a.m., the retention wall of one of the coal ash holding ponds failed. More than 5.4 million cubic yards of coal ash mixed with 327 million gallons of water spilled and covered more than 300 acres of surrounding water and land, entering a branch of the Emory River, two Emory River embayments, and eventually spilling into the main Emory River. The release covered approximately 300 acres outside of the coal ash dewatering and storage areas of the plant. The massive ash slide disrupted power and ruptured a gas line, causing the evacuation of a nearby neighborhood. Approximately 22 residents were evacuated due to the gas line leak. There were no deaths or injuries caused by this extraordinary ash slide. The spill has dramatically affected the environment and disrupted citizens' lives.

Water quality in the Emory River at the site of the ash spill has been impaired and the aquatic habitat has been destroyed. See Figures 1 and 2 for aerial photographs before and after the release and Figure 3 for an overview of the waterways in the area.

The spilled coal ash filled coves north of the ash containment pond with ash, soils, and debris (from trees and boat docks). The ash and soil completely filled these coves and spilled across yards of a few homes. Several homeowners also owned boat docks and boats and used the coves as an entrance to the larger open water area of the river. Homeowners used the areas behind their homes for recreation and fishing. The ash spill damaged three homes to the point that they were condemned. The families were provided compensation and other housing by TVA.

As of July 31, 2010, TVA had purchased 165 properties (parcels) near KIF and entered into settlement agreements with owners of the properties. Residents whose yards backed up to the coves were concerned about the health effects of ash in their yards and in the coves. People farther from the site were concerned about health effects of airborne ash.

1.2 Response of Governmental Agencies

A local resident made a 911 emergency call soon after the ash release. Local emergency officials from the Roane County Emergency Management and Homeland Security Agency first responded to the scene, and soon began to assist residents affected by the flows of coal ash sludge. The Tennessee Emergency Management Agency (TEMA) also responded. The Roane County Emergency Management and Homeland Security Agency represents some of the most highly trained emergency response personnel in Tennessee. Their unique expertise can be attributed partly to the long established partnership between the U.S. Department of Energy and the State of Tennessee formed to respond to an off-site emergency at the Oak Ridge Reservation. The high level of expertise displayed by the Roane County Emergency Management and Homeland Security Agency demonstrated a rapid and highly effective response to the coal ash release even though there was not an emergency plan for an off-site event at KIF.

Three residential homes were condemned because of damage sustained during the release. No injuries or missing persons were reported. Roane County Emergency Management and Homeland Security Agency and the TEMA requested assistance from the National Response Center who notified the U.S. Environmental Protection Agency (EPA) Region 4.

EPA Region 4's on-scene coordinator and EPA Region 4's contractor, Tetra Tech, arrived on site the afternoon of December 22, 2008. Tetra Tech holds the EPA Superfund Technical Assessment and Response Team (START) contract. EPA set up a unified command with local and state officials, the Tennessee Department of Environment and Conservation (TDEC), the Tennessee Department of Health (TDH), and TVA responders. Initial response activities focused on restoring power and repairing the gas line as well as clearing roads for access to the spill.

TVA: TN Valley Authority

KIF: Kingston Fossil Plant

TEMA: Tennessee Emergency Management Agency

EPA: U.S. Environmental Protection Agency

Tetra Tech: Superfund Technical Assessment and Response Team (START) contractor for EPA Region 4

TDEC: TN Department of Environment & Conservation

TDH: Tennessee Department of Health

TVA initiated spill response cleanup by mobilizing large numbers of backhoes, amphibious backhoes, bulldozers, dump trucks, related equipment, and personnel to clear and repair affected roadways and rail lines necessary to plant operations. The heavy equipment was also used to clear waterways to allow creeks to drain that had been blocked by the coal ash release. Barges were used to bring in riprap to install a dike to slow the flow of ash downstream. Booms were placed in the Emory and Clinch Rivers to contain floating cenospheres that migrated downstream[1]. TVA contractors vacuumed the cenospheres and cleaned up debris along the waterways. TVA restored gas and water supplies to affected residents.

In addition to these emergency responses, all agencies began a program of environmental sampling to determine if the coal ash presented a threat to public health. TVA, EPA, and TDEC all wanted to know if the coal ash was affecting drinking water, well water, springs, or the air. They wanted to know if contact with the coal ash could harm people's health.

On December 22, 2008, government agencies began collecting environmental samples. TVA began daily real time instantaneous air sampling at many locations on December 28, 2008. This sampling was done with a portable monitor that took a sample for 3 to 5 minutes. TVA also did sampling and analysis for particulate matter less than or equal to 2.5 microns in diameter (PM2.5) and for particulate matter less than or equal to 10 microns in diameter (PM10) on December 31, 2008. The particulate samples were analyzed for metals.

As requested by EPA, Tetra Tech provided technical assistance during response activities at the KIF coal ash response site from December 22, 2008, through January 10, 2009. Between December 23, 2008, and January 2, 2009, Tetra Tech collected 23 surface water samples, three duplicate samples, and two background samples along an approximate 10-mile stretch of the Emory, Clinch, and Tennessee Rivers. Tetra Tech specifically collected some surface water samples in areas where cenospheres were visible just downstream from the release area.

Between December 23, 2008, and January 5, 2009, Tetra Tech collected seven potable water samples from the Kingston and Rockwood water treatment plants. On December 30, 2008, EPA's Science and Ecosystem Support Division (SESD) laboratory collected 10 potable water samples from the upstream Cumberland water treatment plant and the downstream Kingston and Rockwood water treatment plants. Four samples were taken from private drinking water wells.

From December 23, 2008, through January 5, 2009, Tetra Tech collected seven ash samples and one duplicate sample from the Emory River, fly ash storage area (dredge cell), and from released ash along affected roadways. From

TVA: TN Valley Authority

EPA: U.S. Environmental Protection Agency

TDEC: TN Department of Environment & Conservation

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

PM10: particles in air with a diameter equal to or less than 10 microns

Tetra Tech: Superfund Technical Assessment and Response Team (START) contractor for EPA Region 4

SESD: EPA's Science and Ecosystem Support Division

[1] Cenospheres are small, hollow ceramic spheres of varying chemical composition that are generated during high-efficiency coal combustion at thermal power plants. They are much less dense than water and float easily.

December 28, 2008, through January 5, 2009, nine soil samples, two duplicates, and four background samples were collected from residential and public shoreline locations along the Emory and Clinch Rivers.

On January 11, 2009, EPA transferred the role of lead federal agency to TVA and demobilized all remaining personnel and equipment from the site. This was done as the emergency response phase transitioned to long-term operations. In May 2009, EPA and TVA entered into an Administrative Order and Agreement on Consent. EPA will oversee TVA's cleanup of the site, in consultation with TDEC.

EPA requested assistance from the Agency for Toxic Substances and Disease Registry (ATSDR) in evaluating data for its public health implications, reviewing future sampling plans, and working on risk communication messages. ATSDR received EPA data on December 26, 2008, and again on January 1, 2009. ATSDR's emergency response staff responded with telephone calls, emails, and two ATSDR Record of Activity documents.

ATSDR is a federal public health agency whose purpose is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. TDH's Environmental Epidemiology Program (EEP) has funding from ATSDR as a cooperative agreement state.

TDEC began sampling and analysis of air on January 19, 2009. TDEC tested for particulate matter less than or equal to 10 microns in diameter (PM10) and total suspended particles (TSP) plus metals.

TDEC performed daily (seven days per week) sampling and analysis of raw and finished drinking water and reported the results daily for the Kingston and Rockwood water treatment plants from January 2 through January 22, 2009. The environmental laboratory in TDH supported TDEC's sampling efforts by providing weekend laboratory coverage. On January 26, 2009, TDEC changed to weekly drinking water analyses.

TDEC has sampled river water at other locations and has taken fish samples with the Tennessee Wildlife Resources Agency (TWRA).

TDH, at the local, regional, and state levels, was a part of the initial response. EEP staff assisted with sampling, data management, and risk communication. TDH, with assistance from the National Center for Environmental Health (NCEH), performed a door-to-door survey to obtain baseline information about people affected by the ash release. Results of the survey will be discussed in a later section. TDH provided education to area health care providers. The education will be discussed in a later section of this public health assessment.

TVA set up a Community Outreach Center in Kingston. This center provided, and still provides at the time of this report, a central area where residents concerned about the ash release could go for assistance and to file property or

EPA: U.S. Environmental Protection Agency

TVA: TN Valley Authority

TDEC: TN Department of Environment & Conservation

ATSDR: Agency for Toxic Substances & Disease Registry

TDH: Tennessee Department of Health

EEP: Environmental Epidemiology Program

PM10: particles in air with a diameter equal to or less than 10 microns

TSP: Total suspended particles

TWRA: Tennessee Wildlife Resources Agency

NCEH: National Center for Environmental Health

health claims. As of April 7, 2009, more than 600 families had contacted the center to address their questions, concerns, and property damage claims.

TDH's EEP and ATSDR looked at all sampling results during the initial response to determine if a people's health could be immediately harmed from exposure to the coal ash and to the chemicals in the coal ash. EEP's and ATSDR's conclusion was that there was no immediate threat to public health.

TVA, TDEC, and TDH have held several meetings to keep the community aware of issues. On December 28, 2008, the Kingston City Council held a special meeting with TVA at the Roane County High School gymnasium. About 300 people attended that meeting. On January 6, 2009, TVA, EPA, TDEC, and the Roane County Emergency Management Service held a meeting at a church in Harriman. The mayor of Harriman led the meeting of about 200 attendees.

On January 15, 2009, TVA hosted a meeting with EPA, TDEC, ATSDR, and TDH at the Roane State Community College gymnasium. There were no presentations, but people were free to talk with each agency at their tables. Many people attended this meeting. On March 5, 2009, TDEC and TDH held a joint meeting at the Roane State Community College student lounge. Formal presentations were made of all recent work, environmental sampling, and analysis by TDEC. TDH presented its conclusions about health impacts from the coal ash release. Once again, people were free to talk to each agency in attendance at the end of the presentations.

TVA and EPA entered into an Administrative Order and Agreement on Consent on May 6, 2009, to ensure that the environmental impacts associated with the ash spill are thoroughly assessed and that appropriate response actions are taken as necessary to protect public health, welfare of the environment, and to ensure that the response actions satisfy all federal as well as state environmental requirements. The Commissioner's Order from TDEC, dated January 12, 2009, and TDEC's collaboration with TWRA in protecting fish are included in the TVA/EPA order.

This public health assessment (PHA) is a follow-up to ATSDR's Record of Activity documents. This PHA is a direct response to petitions to ATSDR for a public health assessment. This report will document the public health implications of the coal ash itself and our findings about the impacts of the coal ash on groundwater, drinking water, and air. This PHA will only address human health. It will not include any discussion of the ash's impact on wildlife, domestic animals, or water quality as it affects fish and aquatic life. It will not determine the cause of any personal health symptoms.

1.3 Potential Routes of Exposure

EEP evaluates ways that could lead to human exposure to determine whether persons have been or are likely to be exposed to chemicals. An exposure pathway has five parts:

TDH: Tennessee Department of Health

EEP: Environmental Epidemiology Program

ATSDR: Agency for Toxic Substances & Disease Registry

TVA: TN Valley Authority

TDEC: TN Department of Environment & Conservation

TWRA: Tennessee Wildlife Resources Agency

PHA: Public Health Assessment

- a source of contamination,
- contaminant transport through an environmental medium,
- a point of exposure,
- a route of human exposure, and
- an exposed population.

If there is evidence that all five of these parts are present, an exposure pathway is considered complete. An exposure pathway is considered incomplete if one or more of these parts is missing.

For the TVA coal ash release, the source of contamination is, of course, the coal ash itself. Contaminant transport occurred when the ash was released from the ash pond. Contaminant transport could occur if the coal ash were transported in Watts Bar Reservoir to the intakes of the water treatment plants at Kingston and Rockwood. Contaminant transport could potentially occur if the metals in the coal ash leached out of the ash and into the groundwater, contaminating residential drinking water wells and springs. Another contaminant transport mechanism would be if the coal ash dried out and became airborne dust. Routes of exposure could be dermal exposure to the ash, ingestion of the ash itself or of water impacted by the ash, ingestion of fish impacted by the ash, and inhalation of airborne coal ash. EEP will discuss each of these routes of exposure in this Public Health Assessment. The people who live near enough to the coal ash release to have potential exposures are the receptor population.

TVA: TN Valley Authority

EEP: Environmental Epidemiology Program

Physical contact alone with a potentially harmful chemical in the environment by itself does not necessarily mean that a person will be harmed by the chemical. A chemical's ability to affect a person's health depends on a number of other factors, including the:

- amount of the chemical that a person is exposed to (dose)
- length of time that a person is exposed to the chemical (duration)
- number of times a person is exposed to the chemical (frequency)
- person's age and health status, and
- person's diet and nutritional habits.

The purpose of this public health consultation is to examine any potential health hazard from coal ash or chemicals in the coal ash to people living near the site of the coal ash release.

To evaluate exposure to a hazardous substance, health assessors often use health comparison values. If the chemical concentrations are below the comparison value, then health assessors can be reasonably certain that no adverse health effects will occur in people who might be exposed. If concentrations are above the comparison values for a particular chemical, then further evaluation of that chemical is needed.

1.4 Health Comparison Values

EEP and other environmental public health organizations use health comparison values to help them make determinations about the contaminants in the environment and their impact on public health. ATSDR and EPA are the two main agencies who have environmental toxicologists who are fully able to make decisions about levels of contaminants that will not harm people. They do this using a process called risk assessment. Details about the various health comparisons values EEP will use in this public health assessment can be found in Appendix A: Health Comparison Values.

ATSDR is charged by Congress with providing support in the assessment of any health hazard posed by Superfund or other hazardous waste sites. Part of that charge is to thoroughly research what is known about toxic and hazardous chemicals. The purpose of the research is to establish health comparison values. These health comparison values are used by ATSDR and TDH so that when toxic or hazardous substances are found in the environment, we can understand the public health implications using the best science available.

If the chemical concentrations are below health guidance values, then environmental scientists can be reasonably certain that no adverse health effects will occur in people who are exposed. If concentrations are above the guidance values (ATSDR 2007a, 2008) for a particular chemical, then further evaluation is needed. In this public health assessment, we will do further evaluation for arsenic in coal ash for the ingestion route of exposure.

ATSDR's health comparison values for chemicals that do not cause cancer are called Minimal Risk Levels (MRLs). Chronic MRLs represent doses that a person could receive everyday for a lifetime without harm. To be more useful to scientists doing health and risk assessment, MRLs are mathematically converted to Environmental Media Evaluation Guidelines (EMEGs). EMEGs represent concentrations of chemicals in an environmental media, such as soil, air, or water, which people could be exposed to for varying amounts of time without adverse health effects.

ATSDR developed EMEGs for varying times of exposure and for children and adults. Acute exposure means exposure to a chemical every day for 14 days or less. Intermediate exposure means exposure to a chemical everyday for 15 through 364 days. Chronic exposure means exposure to a chemical everyday for one year or more, up to a lifetime. EEP will use these definitions of acute, intermediate, and chronic exposures. EPA definitions may differ.

For example, the chronic EMEG for a child exposed to the chemical arsenic in soil (or ash in this case) is 20 milligrams per kilogram (mg/kg). This means that a child could accidentally eat soil or ash with 20 mg/kg arsenic in it for over a year without harm. If a child is exposed to soil or ash with more than 20 mg/kg arsenic in it, the child would not necessarily be harmed. Health and risk assessors would need to look more closely at details of how often the child is

EEP: Environmental Epidemiology Program

ATSDR: Agency for Toxic Substances & Disease Registry

EPA: U.S. Environmental Protection Agency

TDH: Tennessee Department of Health

MRL: ATSDR minimal risk level

EMEG: ATSDR environmental media evaluation guide

mg/kg: milligram per kilogram

exposed, how well the arsenic would be absorbed into the child's body, how long the exposure lasts, and details about how the EMEG was derived. In our calculations, we assumed that children would accidentally eat 200 mg/day of soil. The 200 mg/day ingestion rate is 2 times the central tendency ingestion rate for children from 1 year to less than 6 years of age (100 mg/day) for incidental ingestion of soil and outdoor settled dust (EPA 2008).

The EPA is also mandated to publish toxicity information. EPA's values are very similar to ATSDR's MRLs and EMEGs. EPA's reference dose (RfD) and reference concentration (RfC) are analogous to ATSDR's chronic MRL. RfDs are used in cases of oral exposure (eating or drinking) to the chemical in question. RfC's are used for inhalation exposure (breathing) the chemical in question.

For cancer effects, ATSDR uses EPA information to set their cancer risk evaluation guidelines (CREGs) for lifetime exposure.

Health comparison values will change periodically as scientists discover more about how a particular chemical does or does not cause harm to people. Thus, MRLs and cancer risk values can be reset higher or lower.

EEP used comparison values for chronic exposures to children whenever possible. This means that EEP assumed that all exposures would last more than one year and could last for a lifetime. This is a cautious way to look at possible risks from exposures to chemicals in the environment. Details for each exposure pathway will be discussed in each section of the public health assessment.

If concentrations are below the chronic EMEG for a particular chemical, the health assessor can be reasonably certain that no adverse health effects will occur in people who are exposed. Stated another way, the health assessor can be very sure that even long-term, continuous exposure to a chemical at concentrations below its chronic EMEG will not harm people's health.

EEP used ATSDR's MRLS and EMEGs for chronic exposure to children whenever possible. EMEGs developed for children and chronic exposure are the most stringent health comparison values. For certain metals, ATSDR used an EPA value comparable to their MRLs to calculate a Reference Dose Media Evaluation Guide (RMEG). If ATSDR's EMEGs or RMEGs were unavailable, EEP used comparison values developed by regional EPA offices or EEP developed comparison values for use at this ash release site.

1.4.1 Proper Use of Health Comparison Values

Health comparison values may be properly used as:

1. Screening values to identify substances/chemicals of concern at hazardous waste sites that need further investigation
2. Identification of populations at potential risk

EMEG: ATSDR environmental media evaluation guide

mg/day: milligrams per day

EPA: U.S. Environmental Protection Agency

ATSDR: Agency for Toxic Substances & Disease Registry

MRL: ATSDR minimal risk level

EMEG: ATSDR environmental media evaluation guide

RfD: EPA Reference Dose

RfC: EPA Reference Concentration

CREG: Cancer risk evaluation guide

EEP: Environmental Epidemiology Program

RMEG: ATSDR-derived reference dose media evaluation guide

Health comparison values should not be used as:

1. Threshold levels for a toxic effect
2. Predictors of toxicity at any given level above the health guidance value
3. Absolute values (since there is an inherent area of uncertainty surrounding them)
4. Screening values for all effects and populations (without first evaluating the relevance of the critical effect upon which the health guidance value is based) (DeRosa 2002).

This means that the health comparison values we use are simply screening values. If the concentrations of chemicals found in soil, ash, air, surface water, or groundwater are less than any health comparison values, we are sure that those chemicals will not cause harm to anyone. If the concentrations found are above the health comparison values, we cannot say that exposure to those concentrations would cause harm. We would investigate further to see if people are being exposed, what the duration and frequency of exposure is, and how sure we are in the health comparison value. We would look at all relevant data and circumstances of exposure. All this further investigation would be necessary before we could say whether the chemicals could cause any harm.

1.4.2 Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances (ATSDR 1997, 1998). Children have lower body weights than adults. Yet, children drink a larger volume of water per mass of body weight than adults. Therefore, a child's lower body weight and higher intake rate results in a greater dose of per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health.

In preparation of this health document, the health of children was thoughtfully considered. The most important difference was in the evaluation of the threat to children and adults who might accidentally ingest ash. Regulatory limits for air and drinking water are set to protect sensitive populations.

1.4.3 Toxicity Characteristic Leaching Procedure

EPA has a special way to look at wastes containing metals. They use a concept called the toxicity characteristic leaching procedure (TCLP). Title 40: Protection of the Environment, Section 261.24 – Toxicity Characteristic defines TCLP. Waste with metals is treated in the laboratory in a way that will remove metals from the solid particles and put them in solution. The

EPA: U.S. Environmental Protection Agency

TCLP: toxicity characteristic leaching procedure laboratory method mimics what would happen to the waste when it contacts water, such as rain or groundwater. Regulatory standards have been developed that define TCLP values above which a waste is classified as hazardous.

TCLP: toxicity characteristic leaching procedure

SDWA: Safe Drinking Water Act

EPA: U.S. Environmental Protection Agency

MCL: maximum contaminant level

µg/L: microgram per liter. 1000 µg are in 1 milligram

TDEC: TN Department of Environment & Conservation

1.4.4 Drinking Water Regulatory Limits

The Safe Drinking Water Act (SDWA) was passed in 1974 and amended in 1986 and 1996. It gives the Environmental Protection Agency (EPA) the authority to set drinking water standards. Primary Drinking Water Standards are called Maximum Contaminant Levels (MCLs). MCLs are legally enforceable standards that apply to public water systems often called municipal water systems. Primary standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in water.

The EPA has established MCLs for a total of 87 chemicals, microorganisms, or compounds in drinking water. Besides the microorganisms, chemicals that have established MCLs include disinfection by-products, disinfectants, inorganic chemicals, organic chemicals, and radionuclides. MCLs are based in part on health-based standards and are legally enforced.

Lead does not have an MCL, rather it has an action level of 15 micrograms per liter (µg/L). This action level is based on a statistically derived sampling plan at homes, rather than a numeric value for the finished water leaving a municipal water treatment plant.

The EPA has also set Secondary Drinking Water Regulations. These federal guidelines for contaminants that may cause the water to appear cloudy or colored or to taste or smell bad. EPA recommends, but does not enforce, that municipal water utilities follow the secondary guidelines. TDEC has the authority to enforce their Secondary Drinking Water Regulations, which are similar to EPA's Secondary Drinking Water Standards.

Primary and Secondary Drinking Water Standards do not apply to privately owned drinking water wells or springs. The individual homeowner assumes the responsibility for making his or her well water or spring safe to use. No national drinking water quality standards have been set for privately owned water wells or springs. When groundwater from a residential drinking water well or spring is sampled and tested, the results are often compared to the MCLs and secondary standards. This is especially true in cases where documented contamination has occurred in the general area. Following the coal ash release, TDEC assessed if the coal ash release affected local drinking water wells and springs. The primary and secondary drinking water standards were used for these private drinking water wells or springs for comparison purposes only as there are no legally enforceable standards for these water sources.

1.4.5 Tennessee Water Quality Criteria

The Tennessee Water Quality Control Board sets standards of quality for Tennessee's waters. *The Tennessee Water Quality Criteria* (TDEC 2008) contains descriptive and quantitative criteria for various uses of water. These uses include domestic water supply, industrial water supply, fish and aquatic life, and recreation. In most cases, quantitative criteria for the domestic water supply are the same number as MCLs. The exception is lead. Lead does not have an MCL, rather it has an action level of 15 µg/L. This action level is based on a statistically derived sampling plan at homes, rather than a numeric value for the finished water leaving a municipal water treatment plant. The water quality criteria for domestic water supply is 5 µg/L for lead.

Descriptive criteria have been set for solids in water. The criteria for domestic water supply specifies that total dissolved solids shall at no time exceed 500 milligrams per liter (mg/L). The criteria for Fish and Aquatic Life states that there shall be no turbidity, total suspended solids, or color in such amounts or of such character that will materially affect fish and aquatic life. Criteria for Recreation states there shall be no total suspended solids, turbidity or color in such amount or character that will result in any objectionable appearance of the water, considering the nature and location of the water.

1.4.6 Criteria Air Pollutants

The Clean Air Act was passed 1970 and last amended in 1990. The Clean Air Act is the comprehensive federal law that regulates air emissions. This law requires EPA to establish National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants. They include standards for carbon monoxide, lead, nitrogen dioxide, PM10, PM2.5, ozone, and sulfur dioxide. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter of air ($\mu g/m^3$). PM2.5, PM10, and lead will be discussed further in the Air section.

MCL: maximum contaminant level

µg/L: microgram per liter. 1000 µg are in 1 milligram

mg/L: milligram per liter

EPA: U.S. Environmental Protection Agency

NAAQS: National Ambient Air Quality Standards

PM10: particles in air with a diameter equal to or less than 10 microns

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

ppm: parts per million

mg/m^3: milligram per cubic meter of air

$\mu g/m^3$: microgram per cubic meter of air

1.5 Tennessee Department of Health's Mission for this Public Health Assessment

The Tennessee Department of Health's mission is to protect the health of people living in or visiting Tennessee.

Following the coal ash release, we want to make sure that Roane County residents:

- are safe living close to the coal ash release until it can be cleaned up,
- have clean air to breathe,
- have clean water to drink,
- have documentation that potential harm to public health is being investigated, and
- have knowledge that the Tennessee Department of Health is closely following all environmental sampling and cleanup efforts so the we can be sure that the people of Roane County will not be harmed.

The Environmental Epidemiology Program used environmental sampling data taken by the Tennessee Valley Authority, U.S. Environmental Protection Agency, and Tennessee Department of Environment and Conservation to make its conclusions about public health impacts of the coal ash release. The conclusions about public health impacts were based on long-term chronic exposures, except for two conclusions dealing with the immediate impact of the coal ash release. The Public Health Assessment is not a 'health study' done by monitoring people.

2. Discussion

The discussion will be organized by media - coal ash, water issues, and air and by topic - radiation, non-governmental agencies' response, community health survey, physician education, and community concerns. Each media will have an introductory section and sections on routes of exposure, analytical results, toxicology (if necessary), and public health implications.

Figures with a small letter, such as Figure a, are within the text; figures with a number, such as Figure 1 are at the end of the text. Table with a small letter, such as Table a, are within the text; Tables with a number, such as Table 1 are at the end of the text.

The first section will be on the coal ash itself and direct contact with the ash. The section on water issues will include details for surface water, municipal drinking water, and groundwater. TVA sampling and analysis is discussed first, followed by discussion of EPA's and then TDEC's sampling and analysis of air. Table a below summarizes the sampling activities that were used in this report.

TVA: TN Valley Authority

EPA: U.S. Environmental Protection Agency

TDEC: TN Department of Environment & Conservation

ATSDR: Agency for Toxic Substances & Disease Registry

Table a. Summary of data collections by TVA, EPA, and TDEC used in the Public Health Assessment: Tennessee Valley Authority (TVA) Kingston Fossil Plant Coal Ash Release.

Media Sampled	Agency	Dates of Sampling	Number of Samples	Source of Health Comparison Values
Ponded Fly Ash	TVA	Feb 5, 2002	1	ATSDR, EPA
Ash at Residences	TVA	Dec 27, 2008 – Jan 2, 2009	7	ATSDR, EPA
	EPA	Dec 23, 2008 – Jan 5, 2009	7	ATSDR, EPA
	TDEC	Jan 6, 7, 2009	13	ATSDSR, EPA
Soil at Residences	EPA	Dec 28, 2008 – Jan 5, 2009	9	ATSDR, EPA
	TDEC	Jan 6, 7, 2009	15	ATSDR, EPA
Surface Water	TVA	Dec 23, 2008 – May 8, 2009	1044	EPA, TDEC
	EPA	Dec 23, 28, 29, 2008, Jan 2, 2009	52	EPA, TDEC
	TDEC	Jan 8 – May 14, 2009	252	EPA, TDEC
Drinking Water (Surface, Raw & Treated)	TDEC	Dec31, 2008 – May 18, 2009	404	EPA, TDEC
Drinking Water (Ground)	TDEC	Dec 30, 2008 – Mar 12, 2009	113	EPA, TDEC
Air	TVA	Dec 31, 2008 – Feb 4, 2009 (mobile laboratory)	19 - 35	EPA, ATSDR, background, EEP
	TVA	Dec 28, 2008 – Mar 9, 2009 (temporary stationary monitors)	360	EPA, ATSDR, background, EEP
	TVA	Feb12, 2009 – May 13, 2009 (stationary long-term monitors)	96 - 240	EPA, ATSDR, background, EEP
	TVA	Dec 28, 2008 – May 31, 2009 (instantaneous)	47,908	EPA
	EPA	Dec 27, 2008 – Jan 10, 2009	123	OSHA, EPA
	TDEC	Jan 19, 2009 – Apr 19, 2009 (PM10)	90	EPA, ATSDR, background, EEP
	TDEC	Jan 19, 2009 – April 19, 2009	15	EPA, ATSDR, background, EEP

2.1 Coal Ash

2.1.1 Introduction

KIF: Kingston Fossil Plant

TVA: TN Valley Authority

TDEC: TN Department of Environment & Conservation

Coal ash will usually contain the following metals: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, vanadium, and zinc. The concentrations of the metals will vary depending upon the origin of the coal. Current ash generation at KIF results from burning a 50%/50% blend of Central Appalachian / Powder River Basin (personal communication, Steven C. Strunk, TVA, March 17, 2009).

On March 1, 2002, TVA published data from sampling and analyses of the KIF ponded fly ash from a dredge cell (Table 1). These data represent a historical record of the metallic content of the coal ash standing in the holding ponds. As part of the coal ash release investigation and response, TVA also took samples of ash near residential property and at other locations between December 23, 2008, and January 6, 2009. See Table 2 for a summary of TVA's ash data.

Compared with local soil sampled by TDEC, some metals are concentrated in coal ash while other metals are not. Aluminum, arsenic, barium, cadmium, and calcium concentrations in KIF's coal ash were higher than in soil. On average, concentrations of copper, magnesium, and manganese were lower in KIF's coal ash than in soil. Concentrations of antimony, chromium, iron, lead, mercury, nickel, selenium, silver, thallium, and zinc were not much different in KIF coal ash than in soil.

2.1.2 Routes of Exposure to Coal Ash

In this section, routes of exposure will be touching the coal ash or ingesting it directly. The populations who might be exposed are those people living in the three houses destroyed by the ash as they escaped from their homes, people living along the water where the ash came onto their property (less than 20 homes), and people who came into the contact with the ash by visiting the areas with coal ash or helping to clean it up. TVA relocated people most at risk very quickly and had fenced off the ash within a month. The duration of exposure would be two months as a maximum, except for workers cleaning up the ash. This public health assessment will focus on the public health implications of the coal ash release and will not focus on worker exposure.

2.1.3 Sampling

As part of the environmental response, TVA, EPA, and TDEC took samples of ash and soil (see Figure 4 for locations of samples) and had them analyzed for various chemicals that might be associated with coal ash. The soil sampling results were useful as background information and in helping all agencies to understand the areal extent of the coal ash release.

EPA's contractor, Tetra Tech, collected ash and shoreline soil samples of affected and potentially affected areas of the coal ash release. From December 23, 2008, through January 5, 2009, Tetra Tech collected seven ash samples and one duplicate sample from the Emory River, fly ash storage area (dredge cell), and from released ash along affected roadways. From December 28, 2008, through January 5, 2009, nine soil samples, two duplicates, and four background samples were collected from shoreline locations along the Emory and Clinch Rivers. Samples were analyzed for metals and volatile organic compounds (VOCs). See Tables 3 and 4 for EPA's soil and ash data (Tetra Tech 2009).

TDEC collected soil samples from 15 residential properties on January 6 and 7, 2009. TDEC also collected 13 ash samples either from the same residential property or near the same residential property for comparison. This extra sampling would help to determine if coal ash or coal ash dust had gotten onto residential yards. See Figure 4 for the soil and ash sample locations. See Tables 5 and 6 for a summary of TDEC's soil and ash data. TDEC analyzed samples for metals in the coal ash, polyaromatic hydrocarbons (PAHs), VOCs, and radioactivity.

As can be seen in Figure 4, the various agencies took samples in different areas of the coal ash spill. Therefore, it is not surprising to see variations in measured concentrations among the different agencies.

EPA: U.S. Environmental Protection Agency

Tetra Tech: Superfund Technical Assessment and Response Team (START) contractor for EPA Region 4

VOC: volatile organic compound

TDEC: TN Department of Environment & Conservation

PAH: polyaromatic hydrocarbon

EEP: Environmental Epidemiology Program

MDL: method detection limit

mg/kg: milligram per kilogram

2.1.4 Analytical Results

EEP received environmental data in a variety of formats from the various government agencies responding to the coal ash release. EEP treated data for the coal ash itself in the following way. If a data point was listed as MDL (method detection limit) or with a U (undetected) designation, the data point was considered to be zero for statistical purposes. This was because EEP was not always provided the method detection limits (MDLs). If a data point was listed with a less than (<) character or a J (estimated) designation, the data point concentration was treated as the number listed for statistical purposes. This does not lend to complete consistency in EEP's treatment of data from different agencies, but was necessary considering the various formats in which the volumes of data were received. This had no effect on the conclusions about health hazards. For these chemicals, when concentrations were detected, they were well below levels of health concern.

2.1.4.1 Soil

Soil was tested to find out if the coal ash had contaminated soil. Analysis of the EPA shoreline soil samples (Table 3) collected from December 28, 2008, to January 5, 2009, and TDEC's soil samples (Table 5) indicated that all metals in the samples were below health comparison values, except arsenic. In one EPA sample, arsenic was detected at 34 milligrams per kilogram (mg/kg), above the health comparison value for chronic exposure of a child. However, the average concentration was below the health comparison value of 20 mg/kg. No VOCs or PAHs were detected.

2.1.4.2 Ash

TVA residential ash samples collected from December 27, 2008, through January 2, 2009, contained average arsenic concentrations above the health comparison value of 20 mg/kg. Arsenic concentrations ranged from 2.78 mg/kg to 107 mg/kg, with an average of 48.5 mg/kg. All other samples contained metals at concentrations below health comparison values. Table 2 contains validated sample data.

Analysis of the EPA ash samples collected from December 23, 2008, to January 5, 2009, indicated that all KIF ash samples exceeded the health comparison value for arsenic of 20 milligrams per kilogram (mg/kg). Arsenic concentrations in the ash ranged from 44.8 mg/kg to 81.3 mg/kg. Table 4 contains validated summary data of the ash samples collected during these dates.

TDEC's analytical results for ash showed that, except for arsenic, all samples contained metals at concentrations below health comparison values. Arsenic was detected in all samples at concentrations above the health comparison value of 20 mg/kg. Arsenic concentrations in the ash ranged from 56 mg/kg to 100 mg/kg, with an average concentration of 78 mg/kg (Table 6).

Environmental regulatory agencies have a special way to look at wastes containing metals. They use a concept called the toxicity characteristic leaching procedure, called TCLP for short. Title 40: Protection of the Environment, Section 261.24 – Toxicity Characteristic defines TCLP. Waste with metals is treated in the laboratory in a way that will remove metals from the solid particles and put them in solution. The laboratory method mimics what would happen to the waste when it contacts water, such as rain or groundwater. Regulatory standards have been developed that define TCLP values above which a waste is considered hazardous.

EPA and TDEC determined TCLP concentrations of arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver in the ash samples. Laboratory results indicated that very little of the metals leached from the coal ash. On average, about 0.5 percent of the arsenic leached in the EPA samples collected and about 0.7 percent of the arsenic leached in the TDEC samples collected.

2.1.5 Discussion of Arsenic and Health Comparison Values for Metals without Applicable Comparison Values

As discussed earlier in the Health Comparison Values section, EEP used ATSDR or EPA health comparison values when they were available. Tables 3 through 6 detail TVA, EPA, and TDEC analysis of metals and the health comparison values chosen to be protective of public health for ingestion of

mg/kg: milligram per kilogram
VOC: volatile organic compound
PAH: polyaromatic hydrocarbon
TVA: TN Valley Authority
mg/kg: milligram per kilogram
EPA: U.S. Environmental Protection Agency
KIF: Kingston Fossil Plant
TDEC: TN Department of Environment & Conservation
TCLP: toxicity characteristic leaching procedure
EEP: Environmental Epidemiology Program
ATSDR: Agency for Toxic Substances & Disease Registry

(accidentally eating) coal ash at the KIF ash site. Arsenic will be discussed because it was detected above health comparison values in ash. In addition, those comparison values needing explanation will be discussed.

KIF: Kingston Fossil Plant

ppm: parts per million

DHHS: U.S. Department of Health and Human Services

IARC: International Agency for Research on Cancer

pH: The pH scale measures how acidic or basic a substance is

2.1.5.1 Arsenic

Arsenic is widely distributed in the Earth's crust and occurs naturally in soil and minerals. People normally take in small amounts of arsenic in air, water, soil, and food. Of these, food is usually the most common source of arsenic for people (ATSDR 2007).

In Tennessee, soils contain a range of arsenic concentrations, from 1 part per million (ppm) to 120 ppm. Statistical analysis of the soils data indicated that, in 95% of samples, arsenic concentrations were less than or equal to 20 ppm in Tennessee (Head 2006). In nature, arsenic is mostly found in minerals and only to a small extent in its elemental form. In coal fly ash, arsenic is in an inorganic form, mostly as an arsenate ion, AsO_4^{3-} (Shoji et al. 2002). In the pH range of natural waters, arsenic most usually exists as the arsenate ions, $H_2AsO_4^-$ and $HAsO_4^{2-}$(ATSDR 2007).

Current understanding of arsenic's toxicology suggests that at low-level exposures, arsenic compounds are detoxified—that is, changed into less harmful forms—and then excreted in the urine. At higher-level exposures, however, the body may not have the ability to detoxify the increased amount of arsenic. When this overload happens, blood levels of arsenic increase and adverse health effects may occur. Arsenic, like some other chemicals, does not seem to cause adverse health effects until a certain amount, or threshold, of the chemical has entered the body. Once the threshold, also known as the minimal effective dose, is reached, and the body is no longer able to detoxify arsenic compounds, adverse health effects may result (ATSDR 2007).

Inorganic arsenic has been recognized as a human poison since ancient times. Arsenic may cause irritation of the stomach and intestines when eaten in higher concentrations than found in the coal ash. Other effects from oral exposure to higher concentrations of arsenic include decreased production of red and white blood cells, which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function (ATSDR 2007).

Perhaps the single most characteristic effect of long-term oral exposure to inorganic arsenic is a pattern of skin changes. These include patches of darkened skin and the appearance of small "corns" or "warts" on the palms, soles, and torso, and are often associated with changes in the blood vessels of the skin. Skin cancer may also develop (ATSDR 2007).

Oral exposure to arsenic has also been reported to increase the risk of cancer in the liver, bladder, and lungs. The Department of Health and Human Services (DHHS) has determined that inorganic arsenic is known to be a human carcinogen (a chemical that causes cancer). The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans. EPA also has classified inorganic arsenic as a known human carcinogen (ATSDR 2007).

Dermal exposure (getting arsenic on the skin) to high concentrations of inorganic arsenic compounds may irritate the skin, with some redness and swelling. The skin irritation goes away after contact stops. However, it does not appear that skin contact is likely to lead to any serious internal effects (ATSDR 2007).

ATSDR has an arsenic chronic oral EMEG for children of 20 mg/kg, calculated from ATSDR's chronic MRL of 0.0003 mg/kg·day. This MRL is the same as EPA's RfD of 0.0003 mg/kg·day. The EMEG is a screening value. Since arsenic concentrations were often greater than 20 mg/kg, more detailed analysis was required to assess the public health implications. This analysis is in the section, Public Health Implications of Dermal and Ingestion Exposure to Coal Ash.

2.1.5.2 Other health comparison values

As discussed in the section on Health Comparison Values, EEP choose ATSDR or EPA health comparison values when they were available. Directly applicable values for ingestion were not available for iron, calcium, magnesium, potassium, sodium, or thallium. Therefore, other health assessment methods were used to assess the public health implications of these metals. These are discussed below.

2.1.5.2.1 Calcium and magnesium were analyzed in samples from all agencies – TDEC, EPA, and TVA. Magnesium and calcium are essential nutrients that are not usually considered toxic. Health comparison values are not available for either of these metals. For purposes of comparison, the normal daily intake or the recommended daily intake was compared to the calculated intake. Using cautious assumptions, EEP assumed that a child would eat 200 milligrams of ash that contained the highest concentration of the metal that was measured. The intake of these metals was calculated using other standard assumptions described in the ATSDR Public Health Assessment Guidance Manual.

The dietary reference intake[2] for calcium is 500 mg/day for children aged 1 through 3 years and the tolerable upper intake level[3] is 2500 mg/day for all ages (NAS 1997). This value can be compared to the daily intake calculated for a child accidentally eating 200 mg/day of soil containing the maximum measured concentration of 19,500 mg/kg calcium. This calculated worst case intake would be approximately 4 mg/day.

As part of the Food and Drug Administration (FDA) Total Diet study from 1982-1984, the average daily intake of magnesium for a two-year old child was

EPA: U.S. Environmental Protection Agency
ATSDR: Agency for Toxic Substances & Disease Registry
EMEG: ATSDR environmental media evaluation guide
mg/kg: milligram per kilogram
MRL: ATSDR minimal risk level
RfD: EPA Reference Dose
EEP: Environmental Epidemiology Program
TDEC: TN Department of Environment & Conservation
TVA: TN Valley Authority
mg/day: milligram per day
FDA: U.S. Food and Drug Administration

[2] *Dietary Reference Intakes (DRIs)* are reference values that can be used for planning and assessing diets for healthy populations and for many other purposes.
[3] The *Tolerable Upper Intake Level* (UL) is the highest level of daily nutrient intake that is likely to pose no risks of adverse health effects in almost all individuals in the specified life stage group.

determined to be 155 mg/day. The National Academy of Science (NAS) has established a value of 65 mg/day as an estimated average requirement[4] for magnesium in children 1 through 3 years of age (NAS 1997). These values can be compared to the daily intake calculated for a child accidentally eating 200 mg/day of ash containing the maximum concentration of 4,160 mg/kg magnesium. This calculated worst case intake is approximately 0.8 mg/day.

2.5.1.2.2 Iron is an essential nutrient. It is found in large amounts in the Earth's crust. Neither ATSDR nor EPA has published toxicity profiles for iron. NAS has estimated tolerable upper intake levels of 40 mg/day for children and 45 mg/day for adults (NAS 2001). EEP used EPA's Regional Screening Levels for Chemical Contaminants at Superfund Sites (RSL 2009) for a health comparison value for iron. The health comparison value is 55,000 mg/kg in soil. This value can be compared to the daily intake calculated for a child accidentally eating 200 mg/day of soil containing the maximum measured concentration of 39,700 mg/kg iron. This calculated worst case intake would be approximately 8 mg/day.

2.5.1.2.3 Potassium and sodium were measured in ash by EPA and in surface water by TVA. NAS has recommended a tolerable upper intake level for sodium of 2.3 grams per day and an adequate intake level for potassium of 4.7 grams per day (NAS 2005). Because the concentrations of these metals in ash and surface water resulted in intakes a thousand-fold lower than the dietary reference intakes, they were not considered in this review of the data.

2.5.1.2.4 Thallium does not have an ATSDR - derived health comparison value because of a lack of toxicological data, although it is a toxic metal. All people are exposed daily to normal environmental levels of thallium, mostly from food. It has been estimated that the average person eats two micrograms per kilogram (µg/kg) of thallium in food on a daily basis (ATSDR 1992). EEP used EPA's Regional Screening Levels for Chemical Contaminants at Superfund Sites (RSL 2009) for a health comparison value for thallium in ash and soil. Screening values for various salts of thallium ranged from 5.1 to 7.0 milligram of thallium per kilogram of soil, with a value of 7.0 mg/kg for soluble salts of thallium. EEP chose to use 5 to 7 mg/kg in ash for health comparison purposes.

2.1.6 Public Health Implications of Dermal and Ingestion Exposure to Coal Ash

TDH's public health message about contact with the coal ash has been, "If you do contact the ash, then practice good hygiene, especially washing your hands before eating or smoking. Wash thoroughly, including your hands, clothes and shoes if you, your children, or pets come in contact with the ash. Basically,

NAS: National Academy of Sciences
mg/day: milligram per day
mg/kg: milligram per kilogram
ATSDR: Agency for Toxic Substances & Disease Registry
EPA: U.S. Environmental Protection Agency
EEP: Environmental Epidemiology Program
µg/kg: microgram per kilogram
TDH: Tennessee Department of Health

[4] The estimated average requirement is the intake that meets the estimated nutrient needs of 50 percent of the individuals in a group

wash the same way you would after mud exposure. Remember, the metals are bound to the ash. Occasional exposures for brief periods of time should not harm people's health." This message is still correct.

EPA: U.S. Environmental Protection Agency

ATSDR: Agency for Toxic Substances & Disease Registry

EMEG: ATSDR environmental media evaluation guide

mg/kg: milligram per kilogram

TVA: TN Valley Authority

TDEC: TN Department of Environment & Conservation

2.1.6.1 Dermal Contact

None of the metals in the coal ash will be absorbed through the skin from touching the ash or getting the ash on skin. However, prolonged contact with the coal ash could result in local skin irritation (ATSDR 2007). The ash that is along the shorelines has been fenced off. Since the ash is not easily accessible and because the public health message to avoid contact with the ash has been widely publicized, no continued dermal contact with ash is expected for residents of the area.

2.1.6.2 Incidental Ingestion

Incidental ingestion (accidentally eating) occurs through hand-to-mouth behaviors. That is, when playing or working in the soil, people may get dust or dirt on their hands and then put their hands in their mouth. Children and adults may eat without washing their hands. Adults do not usually wash their hands before smoking. EPA has determined that, on average, a child will accidentally ingest about 100 to 200 milligrams of dust or dirt each day.

Concentrations of metals, except arsenic, were below health comparison values.

The concentrations of arsenic in some ash samples and the average concentration of arsenic in ash samples were higher than the ATSDR chronic EMEG for a child (20 mg/kg). The average concentration of arsenic in ash samples varied between 48.5 mg/kg for TVA ash samples and 78 mg/kg for TDEC ash samples. All three agencies, TVA, EPA, and TDEC, found arsenic in the fly ash above health comparison values (see Tables 2, 4, and 6).

Because arsenic was found at levels above the health comparison values, more detailed analysis was needed to determine if the arsenic found in the coal ash posed a health hazard. EEP did this by looking at how much arsenic a sensitive member of the population (a child) would ingest (the dose). Additionally, we needed to estimate how much of the ingested arsenic would be absorbed from the child's gastrointestinal tract into his blood (bioavailable). Experiments in animals have shown that between about 5% to 50% of arsenic in soil is absorbed from the gastrointestinal tract or is bioavailable (ATSDR 2007). EPA generally assumes for risk assessments that children will incidentally ingest from 100 to 200 milligrams of soil per day. EEP assumed that young children would not play in the ash unattended except for brief periods. We assumed that 50% of the daily ingestion would be ash and 50% would be soil.

The equation used to estimate an oral dose from ingestion of contaminated soil (or ash in this case) is as follows:

$$Oral\ dose = \frac{CA\ x\ abs\ x\ IR\ x\ CF\ x\ FI}{BW}$$

Where:

CA = concentration in ash; for arsenic, we used the highest mean, 78 mg/kg, from TDEC data
abs = percent likely to be absorbable, assume 50% (0.5)
IR = ingestion rate, 200 mg/day for a child[5]
CF = conversion factor, 10^{-6} kg/mg or 1 kg/1,000,000 mg
FI = fraction ingested, assume 0.5, half of the incidental ingestion is ash
BW = body weight, 16 kg, the approximate average weight for a child aged 1 to 6 years

$$Oral\ dose = \frac{78\frac{mg}{kg}\ x\ 0.5\ x\ \frac{200mg}{day}\ x1\ kg\ x\ 0.5}{16\ kg\ x\ 1{,}000{,}000\ mg}$$

$$Oral\ dose = 0.0002\ mg/kg \cdot day$$

The oral dose calculates to be about to be 0.0002 mg/kg·day. This theoretical calculated arsenic dose is less than the ATSDR chronic MRL and the EPA RfD of 0.0003 mg/kg·day.

This mathematical computation for calculating a dose of arsenic is an example of a reasonable worst case scenario. The highest mean concentration of arsenic found in sampling and analysis was used. The percent absorption from the gastrointestinal tract used in this example (50%) is the maximum absorption found in experiments. The exposure period was during the winter months when most small children would not be playing outside near the water for long periods. People with ash in their yards were moved quickly, making the exposure time short.

Since the ash is not easily accessible and because the public health message to avoid contact with the ash has been widely publicized, no continued ingestion of ash is expected for residents of the area. No harm to the health of children or adults is expected from the possible very brief exposure time.

mg/kg: milligram per kilogram
TDEC: TN Department of Environment & Conservation
mg/day: milligram per day
kg/mg: kilogram per milligram
mg/kg·day: milligram of substance per kilogram body weight per day
ATSDR: Agency for Toxic Substances & Disease Registry
MRL: ATSDR minimal risk level
EPA: U.S. Environmental Protection Agency
RfD: EPA Reference Dose

[5] The 200 mg/day ingestion rate is 2 times the central tendency ingestion rate for children from 1 year to less than 6 years of age (100 mg/day) for incidental ingestion of soil and outdoor settled dust (EPA 2008).

2.2 Water

TVA: TN Valley Authority
EPA: U.S. Environmental Protection Agency
MCL: maximum contaminant level

The physical impacts of the TVA coal ash spill to water were immediate – ash from the failed impoundment completely filled embayments and a portion of the Emory River main channel. Ash was carried downstream into the Clinch River. Plumes of ash in the water were observed entering the Tennessee River after heavy rainfall. The initial impacts of the spill killed or displaced fish and other aquatic life or caused physical impacts to fish through gillways and ingestion. This public health assessment focuses on potential harm to human health.

The surface water system in the area of the coal ash release is complex and is affected by the Watts Bar Dam in the Tennessee River. The entire surface water system is called the Watts Bar Reservoir. It includes the lower portions of the Emory River, the Clinch River, and the Tennessee River upstream of Watts Bar Dam. This complex river system is widely used for recreation – fishing, swimming, and boating. See Figure 3 for an overview of the water system.

Characteristics of coal combustion wastewater have the potential to impact human health and the environment. Many of the common pollutants found in coal combustion wastewater (e.g., selenium, mercury, and arsenic) are known to cause environmental harm and can potentially present a human health risk (EPA 2009). For this reason, all environmental regulatory agencies and TVA immediately began sampling and analysis of the materials spilled for potentially toxic constituents of coal ash in area waters.

Two types of contamination from the coal ash spill are visible – ash in the water and cenospheres[6] floating on the water. Visible coal ash often times makes a gray plume of ash in the water. Visible coal ash that floats is made up of cenospheres. Metals, that either dissolve in the water or are on very small particles that are suspended in the water, will not be visible.

Routes of exposure for this section include contact with the river water, incidental ingestion during recreational activities, ingestion of fish caught in the river, and use of river water and groundwater as a potable drinking water source.

Concentrations of metals in river water were compared to Tennessee's Water Quality Criteria for either domestic water supply or recreation. Analytical results for municipal and private well or spring water were compared to EPA's Maximum Contaminant Levels (MCLs). These were discussed in the Background section. Water Quality Criteria and MCLs are listed in Table b. below

[6] Cenospheres are small, hollow ceramic spheres of varying chemical composition that are generated during high-efficiency coal combustion at thermal power plants. They are much less dense than water and float easily.

Table b. Tennessee Department of Environment and Conservation Water Quality Criteria and Environmental Protection Agency Maximum Contaminant Levels for Metals. Units in μg/L.

Metal	Water Quality Criteria for Domestic Water Supply	Water Quality Criteria for Recreation [1]	MCL	
			Primary	Secondary
Aluminum	NA	NA	NA	50 - 200
Antimony	6	5.6	6	NA
Arsenic	10	10.0	10	NA
Barium	2,000	NA	2,000	NA
Beryllium	4	NA	4	NA
Cadmium	5	NA	5	NA
Chromium, total	100	NA	100	NA
Iron	NA	NA	NA	300
Lead	5	NA	15 [2]	NA
Manganese	NA	NA	NA	50
Mercury	2	0.05	2	NA
Nickel	100	610	NA	NA
Selenium	50	NA	50	NA
Silver	NA	NA	NA	100
Thallium	2	0.24	2	NA
Zinc	NA	NA	NA	5,000

[1] includes both contact with water and consumption of fish
[2] EPA action level
NA = not available

μg/L: microgram per liter. 1000 μg are in 1 milligram

MCL: maximum contaminant level

EEP: Environmental Epidemiology Program

TDH: Tennessee Department of Health

TDEC: TN Department of Environment & Conservation

TWRA: Tennessee Wildlife Resources Agency

TVA: TN Valley Authority

2.2.1 Surface Water (River Water)

2.2.1.1 Introduction

As discussed in the Background section, surface waters are protected by the use of Tennessee's Water Quality Criteria. For this public health assessment, EEP was concerned with uses of domestic water supply and recreation. TDH values TDEC's protection of fish and aquatic life, although TDH's role is protection of public health.

EEP will only address concerns about public health and will not address any ecological issues in this public health assessment. TDEC, TWRA, TVA, and Oak Ridge National Laboratory sampled fish in the Emory and Clinch Rivers for two reasons. They needed to determine if there would be any effect from the coal ash on fish and aquatic life. They also needed to determine whether there would be any human health effects from eating fish that may have accumulated metals from the coal ash. Fillet samples were collected from 75 fish, including largemouth bass, spotted bass, channel catfish and blue catfish, in January, February, March, and April of 2009. With the exception of two catfish samples, all levels of metals were below human health protection standards. These two catfish samples exceeded the standard of 0.3 ppm of mercury. Levels of selenium were well below EPA's proposed toxicity standards for protection of fish and other aquatic life.

2.2.1.2 Historical Contamination

It is important to remember that there is an existing fish advisory on the lower Emory and Clinch Rivers that was in place before the coal ash release. TDEC and TWRA advise avoiding consumption of striped bass and limiting consumption of catfish and sauger. The pollutants of concern are polychlorinated biphenyls (PCBs) and mercury. See Appendix D for more information on the advisories. As part of their on-going activities, TDEC and TWRA continue to sample fish for historical contamination. Cleanup of the coal ash release is being done in a manner that will not disturb the river sediments in which these contaminants exist. TDEC and TWRA will continue to sample fish for historical contaminants and for contaminants from the coal ash spill that could harm the fish or that could accumulate in fish tissue that would be eaten by people.

During the dose reconstruction for PCBs at the Oak Ridge Reservation, it was determined that the vast majority of PCBs detected in fish in the lower Watts Bar Reservoir occurred as a result of releases to the Tennessee River upstream of the Clinch River (HydroQual 1995). While TVA may have contributed to the PCB contamination in the past, more than 20 other major sources on the Tennessee River contributed the bulk of PCB sediment contamination to Watts Bar Reservoir (ChemRisk 1999a).

Mercury in fish and sediments in lower Watts Bar Reservoir are due to mercury releases from the Oak Ridge Reservation Y-12 plant. Lithium separation operations used more than 24 million pounds of mercury between 1950 and 1963 (ChemRisk 1999b).

2.2.1.3 Routes of Exposure

Routes of exposure for this section include contact with the river water, incidental ingestion during recreational activities, and ingestion of fish caught in the river. During the winter months, few people would likely have any direct contact with river water. Any contact would be brief.

During the summer, many people have contact with the river water, including children. This issue was fully evaluated by TVA, EPA, TDEC, and TDH, resulting in fact sheets and advisories for the river system. Advisories stated that recreational activities were safe in all parts of the Watts Bar Reservoir except for the area around the coal ash release. Existing advisories for fish consumption in the Watts Bar Reservoir remain in effect.

ppm: parts per million

EPA: U.S. Environmental Protection Agency

TDEC: TN Department of Environment & Conservation

TWRA: Tennessee Wildlife Resources Agency

PCB: polychlorinated biphenyl

TVA: TN Valley Authority

TDH: Tennessee Department of Health

2.2.1.4 Sampling of River Water

Starting the day of the coal ash release, December 22, 2008, TVA has sampled surface water at several locations in the Emory, Clinch, and Tennessee Rivers for dissolved metals and total metals. TVA continues to sample at these locations. See Figure 5 for the location of sampling points.

Between December 23, 2008, and January 2, 2009, EPA had their contractor, Tetra Tech, collect surface water samples from potentially affected waterways. Tetra Tech collected 23 surface water samples, three duplicate samples, and 2 background samples along an approximate 10-mile stretch of the Emory, Clinch, and Tennessee Rivers. Some surface water samples were collected in areas where cenospheres[7] were visible, floating on the water just downstream from the release area.

Location on rivers is designated by river mile. Distance is measured from the mouth of a river, designated as river mile 0.0 and then going upstream. The mouth of a river is where the river enters another river, a lake, or the ocean.

Tetra Tech selected surface water sampling locations to include both upstream surface waters on the Emory River to mile marker 9.0[8] and downstream surface waters on the Clinch River to mile marker 0.0, as shown in Figure 6. Tetra Tech collected an additional upstream sample from the Tennessee River before its confluence with the Clinch River at Tennessee River mile marker 568.5.

On December 23 and 29, 2008, Tetra Tech accompanied TVA personnel in a boat to collect a total of 19 surface water samples and two duplicate samples from the Emory, Clinch, and Tennessee Rivers. On December 28, 2008, Tetra Tech collected an additional four surface water samples and one duplicate from public and residential shorelines of the Emory and Clinch Rivers. Tetra Tech reported no visual evidence of coal ash at these locations. On January 2, 2009, Tetra Tech also collected two background surface water samples, one each from the Emory and Clinch Rivers.

All EPA samples were analyzed for total metals, dissolved metals, and total suspended solids (also called suspended residue on some laboratory results forms).

TDEC began sampling on January 2, 2009, and continues to sample the Emory River at miles 0.1, 1.7, 2.1, and 4.0, the Clinch Rivers at miles 2.3 and 4.5, and the Tennessee River at mile 568.5. See Figure 7 for TDEC's river surface

TVA: TN Valley Authority

EPA: U.S. Environmental Protection Agency

Tetra Tech: Superfund Technical Assessment and Response Team (START) contractor for EPA Region 4

TDEC: TN Department of Environment & Conservation

pH: The pH scale measures how acidic or basic a substance is

[7] Cenospheres are small, hollow ceramic spheres of varying chemical composition that are generated during high-efficiency coal combustion at thermal power plants. They are much less dense than water and float easily.

[8] Location on rivers is designated by river mile. Distance is measured from the mouth of a river, designated as river mile 0.0 and then going upstream. The mouth of a river is where the river enters another river, a lake, or the ocean. An example is TRM568.2, meaning river mile 568.2 of the Tennessee River; EMR designates Emory River mile; CRM designates Clinch River mile.

water sampling locations. Samples were analyzed for total metals to check for possible impact from the coal ash. Other parameters such as dissolved oxygen, suspended solids, and pH were also measured.

TVA: TN Valley Authority

mg/L: milligram per liter

µg/L: microgram per liter. 1000 µg are in 1 milligram

EPA: U.S. Environmental Protection Agency

2.2.1.5 Results River Water Sampling

2.2.1.5.1 TVA

TVA sampling and analysis values for arsenic and other metals peaked in the Emory and Clinch Rivers around January 7, 2009. Arsenic concentrations are detailed below in Table c. Concentrations were near the detection limits before the peaks, and quickly returned to lower concentrations after the peaks. TVA reported concentrations of total suspended solids (TSS) in spreadsheets beginning on February 23, 2009. A review of TVA's website indicated that TSS concentrations peaked around January 10, 2009, at more than 3,000 mg/L TSS (TVA 2009). Data taken from TVA spreadsheets indicated that minor peaks of TSS occurred in mid-March and mid-April following heavy rainfall (TVA 2009). See Tables 7 through 19 for details. All other results from over 1,000 samples from surface water obtained by TVA were below health comparison values.

Table c. TVA surface water data for arsenic peaks on January 7, 2009. Kingston Fossil Plant coal ash release, Harriman, Roane County, Tennessee.

January 7, 2009, Peaks	Total Arsenic, µg/L	Dissolved Arsenic, µg/L
Emory River mile 0.1	132	27.3
Emory River mile 1.75	189	28.1
Emory River mile 2.1	131	19.3
Emory River mile 4.0	16.3	4.77
Clinch River mile 0.0	14	7
Clinch River mile 2.0	93.7	24.2
Clinch River mile 4.0	109	21.6

2.2.1.5.2 EPA

EPA's sampling and analysis of river surface water began on December 23, 2008, and ended on January 2, 2009. See Tables 20 through 23 for details of these analyses.

Analysis of samples for dissolved metals in the Emory River showed that most metals were below either Water Quality Criteria for domestic uses or the analytical detection limit. However, the detection limits for antimony, arsenic, and beryllium were higher than the Water Quality Criteria. For antimony, the detection limit was 20 µg/L and the Water Quality Criteria is 6 µg/L. For arsenic, the detection limit was 50 µg/L and the Water Quality Criteria is 10 µg/L. For beryllium, the detection limit was 10 µg/L and the Water Quality Criteria is 4 µg/L.

On December 23, 2008, the concentration of dissolved arsenic was estimated to be 11.6 µg/L at Emory River mile 0.1, slightly above the Water Quality Criteria for domestic water use. By December 28, 2008, at all points sampled on the Emory River, concentrations of arsenic had returned to levels less than the detection limit of 20 µg/L. Concentrations of dissolved antimony and beryllium were below the detection limits at all sampling points on each date sampled. The actual concentrations of antimony, arsenic, and beryllium could have been negligible or they could have been greater than the Water Quality Criteria. Other metals were below criteria on all days. EPA obtained approximately 450 data points and 52 samples for dissolved metals. The actual concentration of arsenic could have been negligible or it could have been greater than the health comparison value.

µg/L: microgram per liter. 1000 µg are in 1 milligram

EPA: U.S. Environmental Protection Agency

TDEC: TN Department of Environment & Conservation

Analysis of samples for total metals in the Emory River also showed that most metals were below either water quality criteria or the detection limits. As for dissolved metals, the detection limits for antimony, arsenic, and beryllium were above the criteria.

On December 28, 2008, at Emory River miles 0.1 and 1.9, antimony, arsenic, and beryllium were above Water Quality Criteria. For all other dates and locations sampled, antimony, arsenic, and beryllium were found at levels below the detection limits.

Analysis of samples from the Clinch River for dissolved metals showed that concentrations were below either the water quality criteria or the detection limit. As for sampling and analysis on the Emory River, the detection limits for arsenic and beryllium were above the criteria.

Analysis of samples for total metals in the Clinch River, showed that concentrations were below either the Water Quality Criteria or the detection limit at all locations on all dates, with 1 exception out of approximately 500 data points and 52 samples. On December 28, 2008, the concentration of arsenic at the Kingston City Park South Boat Ramp was estimated to be 48 µg/L.

2.2.1.5.3 TDEC

See Tables 24 through 32 for results of TDEC's sampling and analysis of river water from January 8, through April 8, 2009.

Analysis of total metals in the Emory River showed that most metals were below either Water Quality Criteria or the analytical detection limit at all locations and dates (see the Background, Tennessee Water Quality Criteria, page 10). Arsenic and lead were the only exceptions. Arsenic and lead concentrations peaked on January 22, and February 5, 2009, at Emory River mile 1.7. Arsenic was above the water quality criteria for domestic water use and for recreation. On January 22, 2009, lead was above the water quality criteria for domestic water use and the action level for drinking water. On February 5, 2009, the concentration of lead had dropped so that its level in the

Emory River was below the action level. Total suspended solids were also increased at Emory River miles 1.7 and 2.1. The ash release is located at these locations on the Emory River. See the figures below.

TSS: total suspended solids

EPA: U.S. Environmental Protection Agency

STORET: an acronym for Storage and Retrieval Data Warehouse

Arsenic was elevated in the Emory River at mile 2.1 on January 13 and 15, March 26, 31, and April 8, 2009. These increases are shown in the figures below. TSS was increased at Emory River miles 1.7 and 2.1. Emory River miles 1.7 and 2.1 are at the site of the ash release.

Figures a - c for arsenic and lead show concentrations with time at the site of the coal ash spill into the Emory River. For arsenic, the green line indicates the Water Quality Criteria for arsenic in recreational waters. The yellow line represents the average concentration historically found in the Emory River at mile 18.3, upstream of any Watts Bar dam effects. For lead, the red line indicates the EPA action level for lead in drinking water. The green line represents the Water Quality Criteria for lead in domestic water. The yellow line represents the average concentration of lead at mile 18.3, upstream of any Watts Bar dam effects. Keep in mind that the Emory River near the ash spill is not used as a drinking water source.

Figures d – f show concentrations of selenium in the Emory and Clinch Rivers and iron in the Emory River. For selenium, the red line represents the Water Quality Criteria for selenium, as a maximum concentration, to protect fish and aquatic life. The green line represents the Water Quality Criteria for selenium, continuous concentration, to protect fish and aquatic life. For iron, the yellow line represents the average concentration in the Emory River at mile 18.3, upstream of any Watts Bar dam effects. The figures for selenium and iron are representative of all metals analyses at all sampling locations in the Emory, Clinch, and Tennessee Rivers (close to 100,000 data points and 252 samples), except for arsenic and lead at the site of the spill as discussed above.

Average concentrations were calculated from EPA STORET data. Average for the Emory River at mile 18.3 were calculated STORET data for the dates July, 24, 2002 through July 10, 2003.

Figure a. Arsenic concentrations at Emory River Mile 1.7. Data from Tennessee Department of Environment and Conservation sampling and analysis for total metals. January 8, 2009, through January 8, 2010.

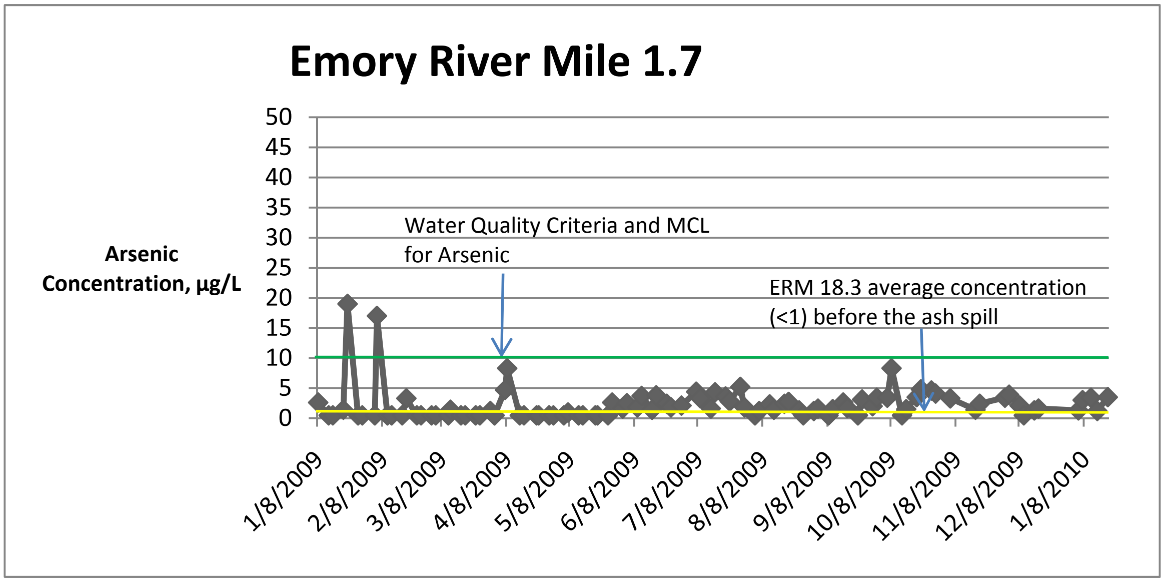


Figure b. Arsenic concentrations at Emory River Mile 2.1. Data from Tennessee Department of Environment and Conservation sampling and analysis for total metals. January 2, 2009, through January 2, 2010.

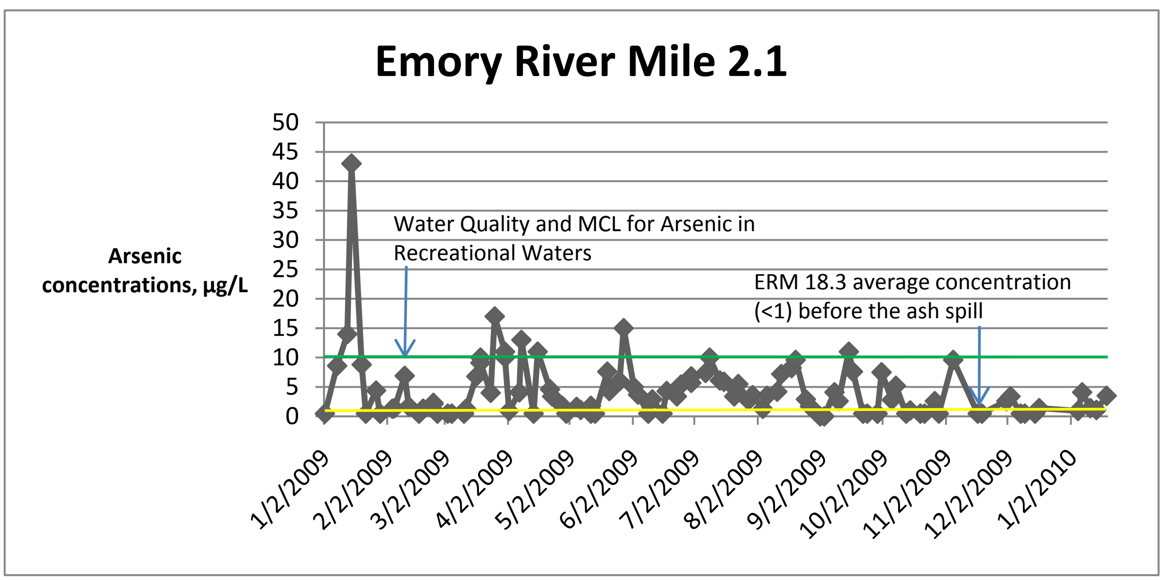


Figure c. Lead concentrations at Emory River Mile 1.7. Data from Tennessee Department of Environment and Conservation sampling and analysis for total metals. January 8, 2009, through January 8, 2010.

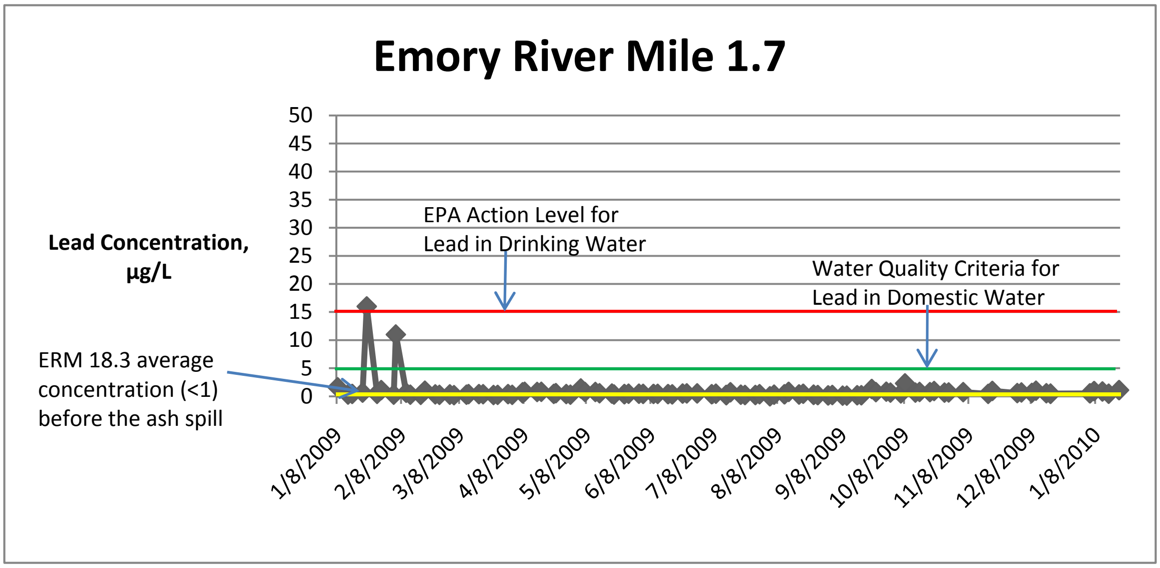


Figure d. Selenium concentrations at Emory River Mile 1.7. Data from Tennessee Department of Environment and Conservation sampling and analysis for total metals. January 8, 2009, through January 8, 2010.

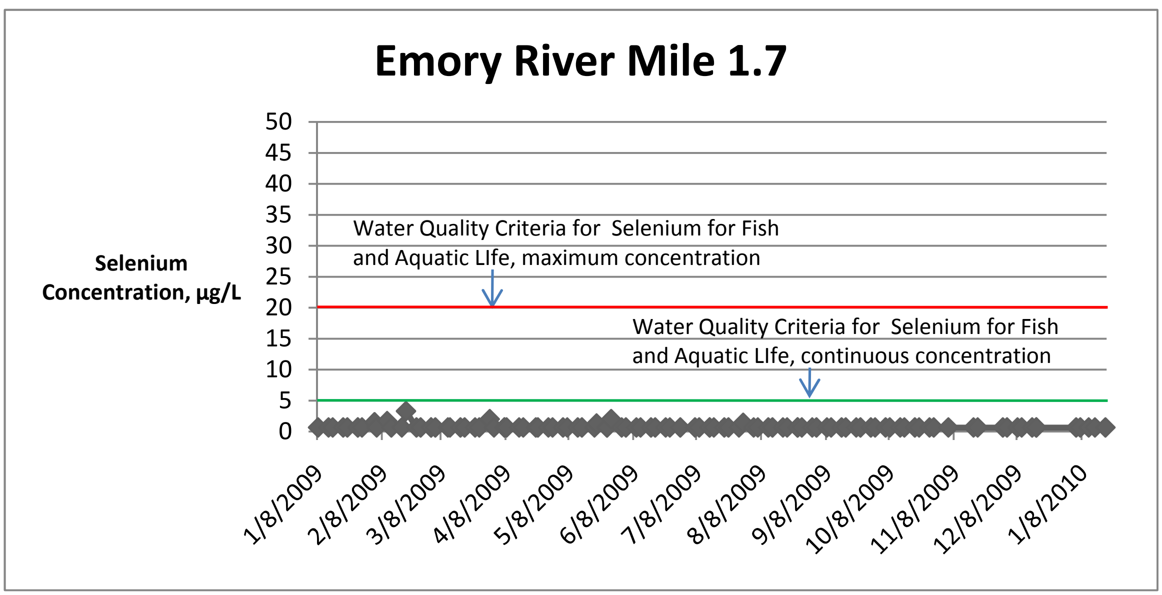


Figure e. Selenium concentrations at Clinch River Mile 2.3. Data from Tennessee Department of Environment and Conservation sampling and analysis for total metals. January 8, 2009, through January 8, 2010.

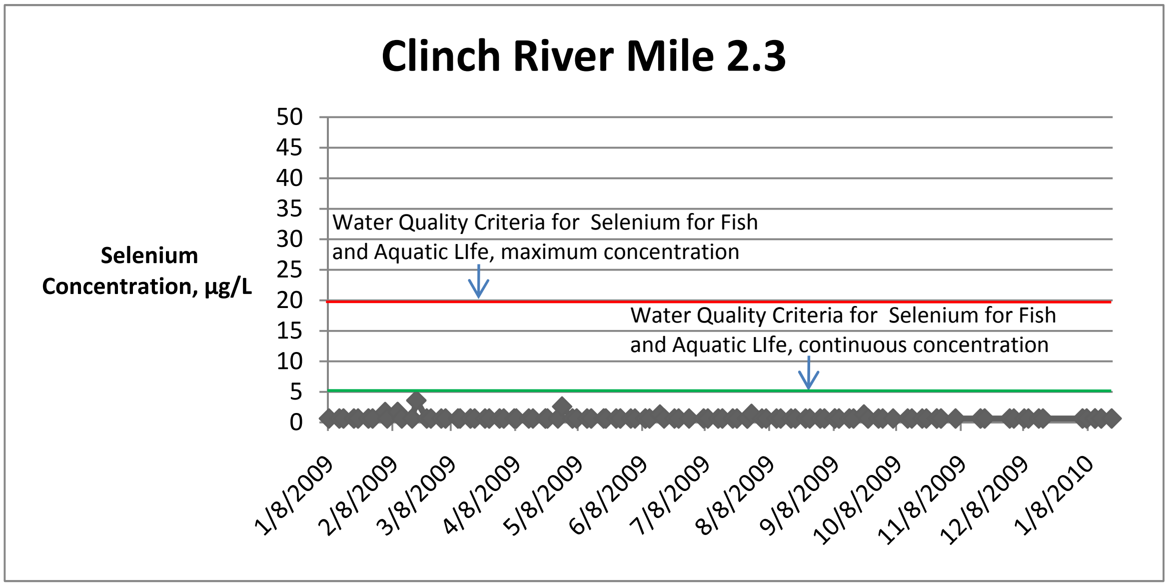
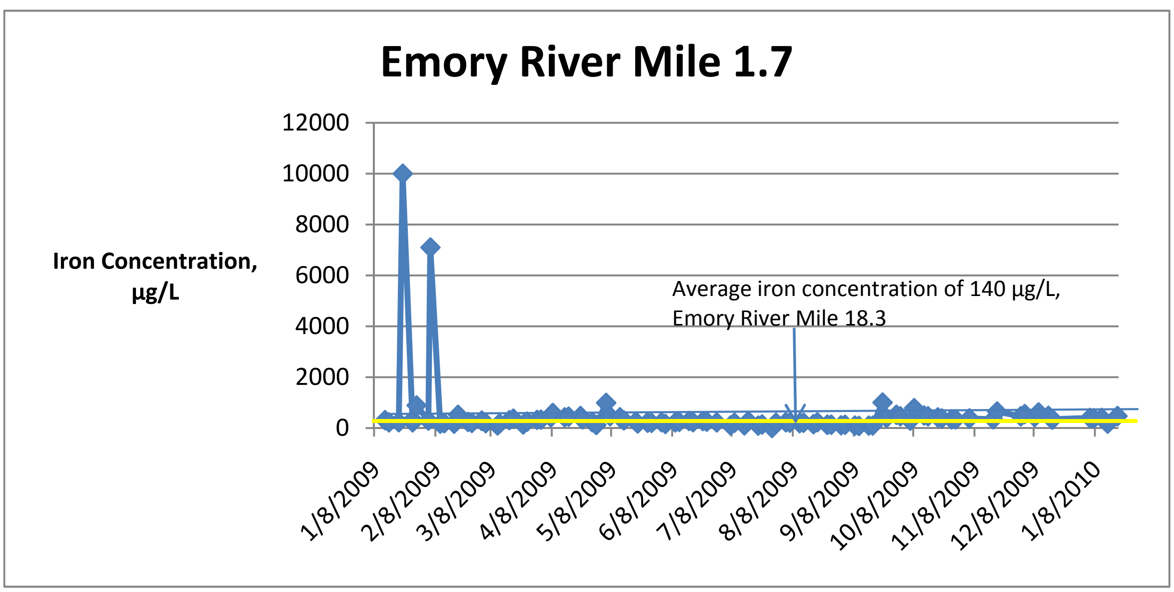


Figure f. Iron concentrations at Emory River Mile 1.7. Data from Tennessee Department of Environment and Conservation sampling and analysis for total metals. January 8, 2009, through January 8, 2010.



2.2.1.6 Public Health Implications

Sampling and analysis indicated that metals and total suspended solids in river water have generally remained below any health comparison values. TDEC and TVA are continuing to monitor the river water to make sure that river water remains safe for recreation and for fish and aquatic life. EEP will continue to work with all agencies to make sure public health is protected.

Concentrations of arsenic and lead were elevated above health comparison values near the release site (Emory River around mile 2.0) on several occasions. The health comparison values used were Tennessee Water Quality Criteria for domestic water use and for recreational use. After the coal ash release, the river was not navigable in the area of the release. In addition, that portion of the river is not used as a source of drinking water.

The EPA, TDH, TDEC, and TVA issued an advisory on June 10, 2009, regarding boating, swimming and fishing on Watts Bar Reservoir. See the figure below. The advisory cautioned the public to avoid recreational use of the lower Emory River near the ash release down to the confluence of the Emory and Clinch Rivers, which included adjacent coves, inlets, islands, and sand bars.

The advisory stated that water-based recreation on other areas of the Emory River, the Clinch River, and the Tennessee River should not be impacted in summer 2009 (and it was not), and that it was not impacted except in the Lower Emory River. Current fish advisories to limit consumption of striped bass and limit consumption of catfish and sauger are still in effect because of historical contamination with polychlorinated biphenyls (PCBs) and mercury (not related to TVA activities).

Because EPA and TVA brought in large hydraulic equipment to expedite the removal of ash from the Emory River, they began initial river closure on August 11, 2009 between mile marker 1.5 and mile marker 3.0. On February 10, 2010, the river closure was extended from mile marker 0.0 to mile marker 6.0 through May 28, 2010. The U.S. Coast Guard, EPA, and TVA extended the closure to protect the public from any possible physical hazards due to the continuing cleanup operations.

TDEC: TN Department of Environment & Conservation

TVA: TN Valley Authority

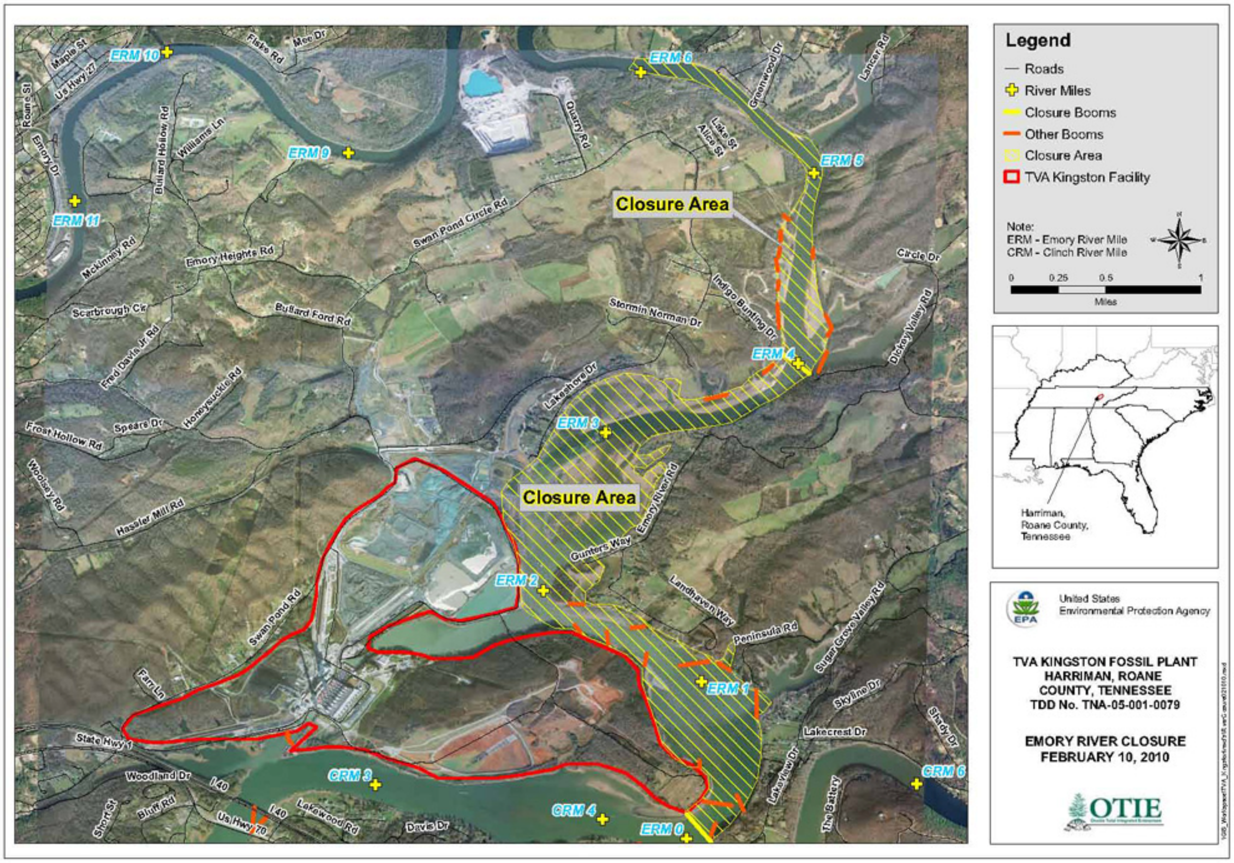
EEP: Environmental Epidemiology Program

EPA: U.S. Environmental Protection Agency

TDH: Tennessee Department of Health

PCB: polychlorinated biphenyl

Figure g. Figure from the February 10, 2010, advisory and the river closure showing the Emory and Clinch Rivers near the coal ash release site.



KIF: Kingston Fossil Plant

TVA: TN Valley Authority

Tetra Tech: Superfund Technical Assessment and Response Team (START) contractor for EPA Region 4

EPA: U.S. Environmental Protection Agency

SESD: EPA's Science and Ecosystem Support Division

TDEC: TN Department of Environment & Conservation

2.2.2 Public Drinking Water

2.2.2.1 Introduction

The Kingston and Rockwood Water Treatment Plants are located closest to the KIF coal ash release site. The Kingston plant is located at Tennessee River mile 568.4, before the Clinch River joins the Tennessee River (about 6.5 miles downstream of the coal ash release). The Tennessee River would have to flow backwards to impact the Kingston water intake. Since these rivers are part of a large reservoir system, with flow controlled by dams, this is possible. After heavy rains in May 2009, ash reached the intake to the Kingston Water Treatment Plant, but did not affect the quality of the finished drinking water. By managing river flows through the Kingston area, TVA plans to manage river flow as much as possible to keep coal ash that might be flowing down the Clinch River from moving upstream toward the water intake.

The Rockwood water intake is on an embayment 1.9 miles upstream from the Tennessee River proper (about 24 miles downstream of the coal ash release). The embayment enters the Tennessee River at mile 553. The Harriman water intake is located at mile 12.8 of the Emory River. The Harriman water intake would not likely be impacted by the KIF coal ash release because it is too far upstream of the spill site and the reservoir does not cause backflow to that extent. See Figures 3 and 6 for clearer presentations of locations.

2.2.2.2 Routes of Exposure

The route of exposure for this section is the use of treated river water as a source of potable water. Since the contaminants from the coal ash are metals, with no volatile organic compounds, the only applicable route of exposure is ingestion of the water.

The Kingston water treatment plant serves a population of 8,939, with 3,694 connections. The Rockwood water treatment plant serves a population of 9,167 with 3,788 connections. All these people use the treated river water and could be affected if any coal ash contaminated this potable water. To ensure the safety of the public water supplies, EPA and TDEC immediately began a program to sample raw and finished water.

2.2.2.3 Public Drinking Water Sampling

Between December 23, 2008, and January 5, 2009, Tetra Tech collected seven raw water samples and one duplicate sample from the Kingston and Rockwood water treatment plants. On December 30, 2008, EPA's SESD collected 10 potable water samples and 1 duplicate from the upstream Cumberland water treatment plant, the Kingston and Rockwood water treatment plants, and four samples and one duplicate from residential properties.

TDEC collected raw water samples at the intakes to the Kingston and Rockwood Water Treatment Plants on December 31, 2008, and began collecting daily raw water samples from January 2, 2009, to January 20, 2009. TDEC also took finished water samples at the treatment plants.

TDEC: TN Department of Environment & Conservation

MDL: method detection limit

TDEC sent the water samples to the state laboratory for analysis for the parameters listed in Table d below.

Table d. Parameters for analysis of raw and finished water at the Kingston and Rockwood Water Treatment Plants. Kingston Fossil Plant coal ash release, Harriman, Roane County, Tennessee.

Analyte	Frequency of Analysis
Aluminum	Weekly
Antimony	Weekly
Arsenic	Daily
Barium	Daily
Beryllium	Daily
Cadmium	Daily
Calcium	Weekly
Calcium Hardness	Daily
Chloride	Weekly
Chromium	Daily
Cobalt	Daily
Copper	Weekly
Fluoride	Weekly
Iron	Weekly
Lead	Daily
Magnesium	Weekly

Analyte	Frequency of Analysis
Manganese	Daily
Mercury	Daily
Molybdenum	Weekly
Nickel	Weekly
Potassium	Weekly
Selenium	Daily
Silver	Weekly
Sodium	Weekly
Strontium	Daily through 1/5/09, then Weekly
Sulfate	Weekly
Thallium	Daily
Total Alkalinity	Daily
Uranium	Daily through 1/5/09, then Weekly
Vanadium	Daily
Zinc	Daily

TDEC collected another untreated water sample on January 22, 2009, before deciding to reduce the sampling frequency to once per week starting January 26, 2009. These weekly samples were analyzed for the same parameters as previously analyzed on a daily basis. Weekly samples will continue to be collected and analyzed. Staff of the Kingston water treatment plant continues to take daily samples to make sure their water meets all criteria for safe drinking water.

2.2.2.4 Public Drinking Water Results

Results for sampling and analysis can be seen in Tables 33 through 36. Data were analyzed as follows. If a data point was listed as MDL (minimum detection limit) with a U designation, the data point was considered to be half of the MDL. If a data point was listed with a less than (<) character or a J designation, the data point concentration was treated as the number listed.

2.2.2.4.1 Raw Water

Raw water is the river water entering the water treatment plant, before it is treated. Water was tested every day between January 2 through January 22, 2009. It has been tested weekly since January 26, 2009.

At the Kingston water treatment plant intake, water sampling showed results that either were below detection limits or met MCLs. These samples were taken prior to processing in the water treatment plant. For the analytes with a Secondary Drinking Water Standard, raw water entering the Kingston water treatment plant met all secondary standards with the exception of iron and manganese. Iron and manganese levels were within concentration ranges normally present in the Tennessee River, approximately 200 µg/L for iron (91 to 401 µg/L) and around 50 µg/L (31-78 µg/L) for manganese (STORET data, Tennessee River mile 568.2, March 26, 2003, through June 21, 2007).

At the Rockwood water treatment plant, water sampling showed results that either were below detection levels or met MCLs. Additionally, for the analytes with a Secondary Drinking Water Standard, the Rockwood intake water met secondary standards.

MCL: maximum contaminant level

µg/L: microgram per liter. 1000 µg are in 1 milligram

STORET: an acronym for Storage and Retrieval Data Warehouse

EPA: U.S. Environmental Protection Agency

TDEC: TN Department of Environment & Conservation

EEP: Environmental Epidemiology Program

2.2.2.4.2 Finished Water

Finished water is the water that has been through treatment at the water treatment plant and is the water that is distributed to customers. For the analytes with MCL, water sampling showed results that either were below detection levels or met primary drinking water standards after processing at both the Kingston and Rockwood water treatment plants. Additionally, for the elements with a secondary Drinking Water Standard, the finished water met all secondary standards.

2.2.2.5 Public Health Implications of Raw and Treated Public Drinking Water

EEP used Primary and Secondary Drinking Water Standards as comparison values. Refer to the Background section for a discussion of drinking water standards. Primary Drinking Water Standards (MCLs) are enforceable. Secondary Drinking Water Standards are not considered enforceable by EPA, but are considered enforceable by TDEC. They are recommendations for taste, odor, and other aesthetic properties of drinking water.

Public drinking water from the Kingston and Rockwood water treatment plants is safe for consumption. There are no adverse public health implications from use of these public water supplies.

TDEC is continuing to perform weekly sampling and analyses to ensure the safety of the drinking water. EEP will continue to study the data to make sure that public health is protected.

2.2.3 Private Drinking Water Wells and Springs

2.2.3.1 Introduction to Groundwater

Groundwater is a resource found under the Earth's surface. Most groundwater comes from rain or melting snow soaking into the ground. Water fills the spaces within rock and soils, making an "aquifer." About half of our nation's drinking water comes from groundwater. Municipal water treatment provides clean surface or groundwater water to many households. Some families use private, household wells and springs as their source of fresh water drinking water and for cooking, and bathing.

Groundwater contains many naturally occurring dissolved chemicals and compounds, including dissolved solids, iron, calcium, magnesium, aluminum, sodium, acids, chloride, sulfate, nitrate, and minor and secondary elements to name just a few. Groundwater also contains many dissolved gases such as oxygen, methane, hydrogen sulfide, and carbon dioxide. Several microorganisms live in groundwater and include *E-coli* bacteria and *Salmonella*. Radionuclides also naturally occur in groundwater, but not typically at amounts that constitute a public health threat (Davis and DeWiest 1966).

Groundwater's depth from the surface, quality for drinking water, and chance of being polluted vary from place to place. Generally, the deeper the well is, the better the groundwater. The amount of new water flowing into the area also affects groundwater quality. Groundwater may contain some natural impurities or contaminants, even with no human activity or pollution. Natural contaminants can come from many conditions in the watershed or in the ground. Water moving through underground rocks and soils may pick up salts of magnesium, calcium and chlorides, as well as soluble radium. Some groundwater naturally contains dissolved elements such as arsenic, boron, selenium, or radon. Whether these natural contaminants may be health concerns depends on the amount of the substance present. In addition to natural contaminants, groundwater is often polluted by human activities such as:

- improper use of fertilizers, animal manures, herbicides, insecticides, and pesticides
- improperly built or poorly located and/or maintained septic systems for household wastewater
- leaking or abandoned underground storage tanks and piping
- storm-water drains that discharge chemicals to groundwater
- improper disposal or storage of wastes
- chemical spills at local industrial sites

Private drinking water wells are pipes that are put into the ground that act as a straw and allow access to water beneath the ground. Wells may be used by members of a single household or by more than one household. Wells are dug, driven, or drilled into the ground to capture water for drinking, cooking, bathing, waste disposal, and recreation. Water occurs beneath the ground in what is called an "aquifer". An aquifer is a geologic formation that will provide useable quantities of groundwater to a well over a long period of time. Aquifers can exist over areas as small as one mile or less. Aquifers can also extend to hundreds of miles in extent. They can exist as little as several feet to hundreds of feet underground. Aquifers can also exist as areas where cracks or fractures occur in bedrock underground. Thus, there are many types of aquifers.

Springs are above ground exits of groundwater. Springs generally occur on the side of a hill, ridge, or rock exposure where the groundwater flows from a fracture or joint in the rock. Springs are abundant where there are rolling hills or rock outcrops. Many springs occur within and along creeks and rivers. They create creeks, ponds, or wet-weather conveyances of water. Springs are the most easily accessible source of ground water for rural families. Because they are on the surface, springs are also the easiest water source to become polluted by the activities outlined above.

TVA: TN Valley Authority
VOC: volatile organic compound
EPA: U.S. Environmental Protection Agency
TDEC: TN Department of Environment & Conservation

About 15 percent of Americans have their own sources of drinking water, such as wells, cisterns, and springs (EPA 2009a). Unlike public drinking water systems serving many people, water quality from private wells and springs is rarely checked. Individual well owners have primary responsibility for the safety of the water drawn from their wells. The government's Drinking Water Standards do not apply to private water sources.

For this part of the public health assessment, we are concerning ourselves with metals that might be related to the TVA ash release that may have been introduced into groundwater from the coal ash release.

Some homes may have filtering or water-softening devices installed in the piping from their water well. Any filtering device may assist in filtering out some of the metals that may be attached to very small sand- or clay-sized particles that could be present in drinking water. Typically, some portion of naturally occurring metals is dissolved in the groundwater and is unable to be filtered out.

2.2.3.2 Routes of Exposure

The route of exposure for this section is the use of groundwater as a source of potable water. Since the contaminants from the coal ash are metals, with no VOCs, the only applicable route of exposure is ingestion of the water. No coal ash related chemicals would get into the air from showering, cooking, or washing dishes. Within a four-mile radius of the ash release, about 120 households have private water wells or springs that they use as a source of potable water. EPA and TDEC received permission from 113 households to sample their well or spring water to make sure that coal ash has not affected their water supply.

2.2.3.3 Environmental Sampling of Private Drinking Water Wells and Springs

EPA sampled a small number of private wells immediately after the coal ash release. Shortly after the coal ash release, TDEC implemented a private water well and spring sampling program. The program focused on testing private groundwater sources within a four-mile radius of the coal ash release to identify which households had water wells or springs, if they used them for household use, and if they would like them to be sampled. For those households who provided access to their wells and springs, EPA and TDEC sampled the groundwater for alkalinity, hardness, and fourteen different metals. See Figure 8 for locations of the sampling.

Alkalinity and hardness results are not discussed in this public health assessment because they are only a rough indicator of water quality and are not very useful for determining human health effects. However, their concentration can indicate the presence of a solution with abundant metals that could enter the groundwater of an area. Households received explanations of alkalinity and hardness with their results. Alkalinity is a reliable measure of the amount of carbonate (CO_3^{2-}) and bicarbonate (HCO_3^{1-}) ions in most natural waters. Most carbonate and bicarbonate ions in groundwater are derived from carbon dioxide in the atmosphere, carbon dioxide in soils, and solution of carbonate rocks. Alkalinity concentrations between 50 and 400 milligrams per liter (mg/L) are most common. Water hardness is primarily the amount of calcium and magnesium, and to a lesser extent, iron in the water. Water hardness is measured by adding the concentrations of calcium, magnesium and converting this value to an equivalent concentration of calcium carbonate ($CaCO_3$) in mg/L of water. Water hardness in most ground water is naturally occurring from weathering of limestone, sedimentary rock and calcium bearing minerals. Generally, water having a hardness of less than 60 mg/L is considered soft while water with a hardness of 120 to less than 180 mg/L is considered hard. Water having hardness values more than 180 mg/L is considered very hard and has a high amount of dissolved minerals.

For the EPA and TDEC groundwater studies, an outdoor spigot or an indoor faucet was the source of water for sample collection from household drinking water wells. For springs, containers were dipped into the spring water and allowed to fill slowly. The water sample was collected in laboratory-supplied containers. It then was placed on ice until delivery to the laboratory where the testing would be performed. All samples were transported to the laboratory using all standard, appropriate, and secure measures for transporting environmental samples. The testing laboratory analyzed the samples using standard methods developed by the EPA for testing of drinking water (EPA 1994). Well and spring samples collected by EPA and TDEC were tested initially by an independent laboratory, Microbac Laboratories, Inc. of Maryville, Tennessee (State of Tennessee laboratory Certification Identification Number TN02017). The majority of well water sampled by TDEC was analyzed by the TDH's analytical laboratory.

EPA and TDEC sampled wells and springs closer to the TVA KIF first because EPA and TDEC wanted to identify any potential release to groundwater from the KIF coal ash release as early as possible. Wells and springs farther from the KIF and up to the four-mile radius were sampled later. Water well and spring sampling began on December 30, 2008, and ended on March 12, 2009. EPA and TDEC sampled 113 privately owned water wells and springs.

mg/L: milligram per liter

EPA: U.S. Environmental Protection Agency

TDEC: TN Department of Environment & Conservation

TDH: Tennessee Department of Health

TVA: TN Valley Authority

KIF: Kingston Fossil Plant

2.2.3.4 Results of Sampling Private Drinking Water Wells and Springs

EEP used Primary and Secondary Drinking Water Standards as comparison values, even though these standards are not enforceable for private wells and springs. Refer to the Background section for a discussion of drinking water standards.

Results indicated that there were several metals present in water wells and springs within a four-mile radius of the KIF. Table 37 shows the results of TDEC's water sampling. Metals identified in water well and spring samples all occur naturally within the groundwater in this area of Tennessee. EPA, TDEC, and EEP compared the amount of each metal in the private well and spring water to EPA Primary and Secondary Drinking Water Standards. EPA and TDEC have set MCLs for arsenic, barium, beryllium, cadmium, chromium, cobalt, mercury, selenium, and thallium. EPA has established a secondary Drinking Water Standard for manganese. No standards or guidelines exist for strontium or vanadium; their concentrations were compared to EPA's Regional Screening Levels for Chemical Contaminants for Superfund Sites (RSL 2009).

All metals detected were less than MCLs, secondary Drinking Water Guidelines, or EPA Region 3 screening table values, except for one well with an elevated manganese level. Manganese's secondary Drinking Water Guideline was not derived for health reasons, but for aesthetic reasons in drinking water (the water may taste bad or stain clothing).

2.2.3.5 Public Health Implications of Sampling Results in Groundwater

The coal ash release has not impacted water from private drinking water wells and springs within four miles of the coal ash release. TDEC talked with the owner of the well with an elevated level of manganese about ways to reduce the manganese level.

Groundwater is not static. Its chemistry can and does change over time as does the rate at which it moves. Pumping of wells can influence groundwater flow rates and the public's use of land can influence its chemical make-up. It sometimes takes days, months, or years for an outside influence to show up in the groundwater of an area. Metals concentrations in groundwater are mainly a reflection of the mineral content of the soils and rocks through which the groundwater moves. The amounts of metals present in groundwater near the KIF may or may not change.

TDEC has implemented a program to sample designated private drinking water wells surrounding the coal ash release. They will sample these wells two times per year to ensure the safety of the groundwater. EEP will continue to study the data from this sampling as they are made available.

EEP: Environmental Epidemiology Program

KIF: Kingston Fossil Plant

TDEC: TN Department of Environment & Conservation

EPA: U.S. Environmental Protection Agency

MCL: maximum contaminant level

2.3 Air

EEP will discuss air sampling and analysis performed by each government agency. Within the air discussion for each agency, environmental sampling and analytical results will be discussed. Discussions about other air issues will be included as necessary. This section is organized as outlined:

– Introduction to Air Pollution Standards
– ***Introduction to Coal Fly Ash***
– ***Routes of Exposure***
– ***Summary of Air Monitoring***
– ***TVA***
  - *Sampling*
  - *Analytical Results*
– ***EPA***
  - *Sampling*
  - *Analytical Results*
– ***TDEC***
  - *Sampling*
  - *Analytical Results*
– ***Discussion of Metals and Their Health Comparison Values***
– ***Public Health Implications of the Airborne Coal Ash***
– ***Dust***

EEP: Environmental Epidemiology Program

TVA: TN Valley Authority

EPA: U.S. Environmental Protection Agency

TDEC: TN Department of Environment & Conservation

NAAQS: National Ambient Air Quality Standards

ppm: parts per million

mg/m³: milligram per cubic meter of air

µg/m³: microgram per cubic meter of air

PM: particulate matter

PM10: particles in air with a diameter equal to or less than 10 microns

2.3.1 Introduction to Air Pollution Standards

The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards (NAAQS) (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards: primary and secondary standards. Primary standards are air pollution limits set to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards are air pollution limits set to protect public welfare. These secondary standards include protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards has set NAAQS for six principal pollutants, which are called "criteria" pollutants. Units of measure for the air standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), or micrograms per cubic meter of air (µg/m^3). In this report, we will most commonly use units of µg/m^3 as a standard unit of measure.

The criteria air pollutant of concern for the TVA coal ash release is particulate matter. Particulate matter in the atmosphere varies in size, shape, composition, and density. Particulate matter is referred to as PM followed by a number, such as PM10. The number refers to the aerodynamic diameter in microns.

Aerodynamic diameter is the diameter of a unit density (1 g/cm^3) sphere that has the same gravitational settling velocity as the particle of interest. The aerodynamic diameter is used because it is a way to account for particles of different shapes and densities that behave the same way in air.

Different size particles penetrate to different parts of the respiratory tract. The terms used for this are respirable and inhalable.

EPA considers "fine particles" as particles that are 2.5 microns in diameter or less. These fine particles are referred to as PM2.5 and are considered respirable particles. This means that a large part of these particles will be deposited in the deepest area of the lungs, called the air exchange (alveolar) region. Particles that penetrate deep into the respiratory system are generally beyond the body's natural ability to remove them and are more likely to be retained. Sources of fine particles include all types of combustion: including motor vehicle exhaust, power plant emissions, residential wood burning, forest fires, agricultural burning, and some industrial processes.

EPA considers "inhalable coarse particles" as particles that are 10 microns in diameter or less. These particles are referred to as PM10 and are considered inhalable particles. These particles will reach the lungs, but only a very small portion of these particles would be deposited in the deepest, air exchange region of the lungs. Sources of coarse particles include crushing or grinding operations and dust stirred up by vehicles traveling on roads.

Other agencies may refer to PM2.5 as ultra fine particles and PM10 as fine particles.

The primary and secondary NAAQS for particulate pollution are the same. The standard for PM2.5 is 15.0 µg/m^3 for an annual arithmetic average and 35 µg/m^3 for a 24-hour average. The standard for PM10 is 150 µg/m^3 as a 24-hour average. EPA did not retain its annual arithmetic average for PM10 because available evidence does not suggest a link between long-term exposure to PM10 and health problems.

The World Health Organization (WHO) established a Working Group on Air Quality Guidelines in October 2005 that recommended concentrations of PM10 and PM2.5 that would be protective of human health. Their guidelines are 25 µg/m^3 PM2.5 and 50 µg/m^3 PM10 as 24-hour averages.

g/cm^3: gram per cubic centimeter

EPA: U.S. Environmental Protection Agency

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

PM10: particles in air with a diameter equal to or less than 10 microns

NAAQS: National Ambient Air Quality Standards

µg/m^3: microgram per cubic meter of air

WHO: World Health Organization

2.3. 2 Health Effects of Particulate Matter

Both short-term and long-term exposures to PM2.5 have been linked to cardiovascular effects, respiratory effects, and mortality. This is especially true for people with pre-existing heart and respiratory conditions. PM2.5 can aggravate existing lung disease, such as asthma and chronic bronchitis, causing more use of medications and more doctor visits. When exposed to particles, people with existing lung disease may not be able to breathe as deeply or vigorously as they normally would. They may experience symptoms such as coughing and shortness of breath. Short-term exposures may also increase susceptibility to respiratory infections.

In people with heart disease, short-term exposures to PM2.5 have been linked to heart attacks and arrhythmias.

Healthy children and adults have not been reported to suffer serious effects from short-term exposures, although they may experience temporary minor irritation of the upper airways when particle levels are elevated.

Long-term exposures, such as those experienced by people living for many years in areas with high particulate levels, have been associated with problems such as reduced lung function and the development of chronic bronchitis and even premature death.

Short-term exposure to PM10 may be linked to respiratory effects, but the link is suggestive rather than causal. Long-term exposure to PM_{10} has not been linked to health problems (EPA 2009b).

2.3.3 Introduction to Coal Fly Ash

A large percentage of coal fly ash is associated with particles larger than 2.5 microns. Typically, only about 1 to 7% of coal fly ash is associated with the PM2.5 fraction (Shoji et al. 2002, Meij and te Winkle 2001). Meij and te Winkle found that, in the Netherlands, coal fly ash generated from firing of coal blended from all over the world contains 55% PM50, 20% PM10, 5% PM4, and 1% PM2.5. Current ash generation at KIF results from burning a 50%/50% blend of Central Appalachian / Powder River Basin coal. The fly ash in the dredge cell was the product of burning different coal types over the years. Analyses by TVA of this fly ash averaged 32.7% PM10 and 8.5% PM2.5 (personal communication, Steven C. Strunk, TVA, March 17, 2009).

Because of the above size distribution, about 33% of airborne coal ash would be inhalable or respirable. TDEC captures all suspended particles (particles of all sizes) at their air monitoring site. They measure metals in these particles. Because the metals analyses that TDEC does at the spill site represent metals in particles of all sizes, rather than in PM2.5 or PM10, this method of measurement will overstate the concentration of metals that could be respired or inhaled.

Research into the chemical and toxicological nature of coal fly ash indicates that the ash can be considered a nuisance dust (Meij and te Winkel 2001; Meij 2000). This means that the fly ash would have the same potential adverse health effects as particulate matter. The metals content of the fly ash would not make the particulate matter more toxic. Ash does not appear to have greater potency to cause pulmonary effects than other ambient particulates (Smith et al. 2006).

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

PM10: particles in air with a diameter equal to or less than 10 microns

PM50: particles in air with a diameter equal to or less than 50 microns

PM4: particles in air with a diameter equal to or less than 4 microns

KIF: Kingston Fossil Plant

TVA: TN Valley Authority

TDEC: TN Department of Environment & Conservation

The material safety data sheet for class 'F' fly ash indicates that coal fly ash is about 60% silicon dioxide or silica for short. Silica is a solid and can be measured in air. The Occupational Safety and Health Administration (OSHA) and the American Conference of Industrial Hygienists (ACGIH) have set occupational standards to protect workers from exposure to silica in air in industrial situations. EPA is using a standard set by ACGIH to protect people working on the site of the coal ash release. This standard is 25 µg/m³ of respirable silica as an 8-hour time-weighted average. There is no standard for silica in ambient air. Public health should be protected from inhalation of silica at the coal ash release if PM2.5 and PM10 NAAQS are met in the monitors surrounding the coal release site.

2.3.4 Routes of Exposure

The route of exposure is breathing ambient air. If coal ash dust or metals constituents became airborne, adverse health effects would be possible for those people living near the site of the coal ash release. Three hundred twenty-four residences, with about 700 individuals, are located within 1.5 miles of the coal ash release. If the coal ash should become airborne, the airborne coal ash could affect people exposed to higher concentrations of particulate matter, especially those with pre-existing respiratory or heart conditions. Such effects could include upper airway irritation and aggravation of pre-existing conditions such as asthma, emphysema, and other respiratory conditions.

2.3.5 Summary of Air Monitoring

TVA, EPA, and TDEC have all performed air monitoring near the coal ash release. Each agency has done different types of air monitoring, at different times and at different locations. Table e below summarizes the monitoring activities by type, parameter, location, and date. See Figures 9 and 10 for locations of TVA and TDEC monitors and Figure 11 for locations of EPA monitors. TVA numbered their locations as PS05-PS09, and EPA numbered their locations as P1-P9. Details of air monitoring will be discussed by agency and type of monitoring.

OSHA: Occupational Safety and Health Administration

ACGIH: American Conference of Industrial Hygienists

EPA: U.S. Environmental Protection Agency

µg/m³: microgram per cubic meter of air

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

PM10: particles in air with a diameter equal to or less than 10 microns

NAAQS: National Ambient Air Quality Standards

TVA: TN Valley Authority

TDEC: TN Department of Environment & Conservation

Table e. Summary of air monitoring activities. Kingston Fossil Plant coal ash release, Harriman, Roane County, Tennessee.

Agency	Type	Parameters	Location	Dates
EPA	Fixed	Total Particulate	KIF property	Dec. 27, 2008 – Jan. 10, 2009
	Fixed Portable – rotating between sites	PM2.5	P1 P2 – P5 in immediate vicinity of the ash spill	Dec. 30 & 31, 2008
	Portable – rotating between sites	PM2.5	P6, P7, P8, P8.2, P9 in residential areas surrounding the ash spill	Dec. 30 & 31, 2008
	Fixed Portable – rotating between sites	PM10	P1 P2 – P5 in immediate vicinity of the ash spill	Jan. 1 - 10, 2009
	Portable – rotating between sites	PM10	P6, P7, P8, P8.2, P9 in residential areas surrounding the ash spill	Jan. 1 - 10, 2009
TVA	TEOM FRM	PM2.5 PM2.5 + metals PM10 + metals	On TVA property	Dec. 31, 2008 – Feb. 4, 2009
	Temporary, stationary	Total metals using industrial hygiene method	5 locations surrounding the ash spill; PS05-PS09	Jan. 1 – Mar. 10, 2009
	FRM	PM2.5	PS05, PS06, PS07, PS08, PS09	By March 1, 2009 - Present
	FRM	PM10	PS07, PS09	By March 1, 2009 – Present
	Portable, real-time, 1 - 3 minute samples	PM10	Many locations throughout the community	Dec. 28, 2008 – Present
TDEC	FRM (since 1999) TEOM (since 2005)	PM2.5 PM2.5	Harriman High School	Long-term ambient monitoring station
	TISCH Hi Vol	PM10, daily	PS07	Jan. 19, 2009 - Present
	TISCH TSP	Metals, daily	PS07	Jan. 19, 2009 - Present

EPA: U.S. Environmental Protection Agency

KIF: Kingston Fossil Plant

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

PM10: particles in air with a diameter equal to or less than 10 microns

TVA: TN Valley Authority

TEOM: Tapered Element Oscillating Microbalance

FRM: Federal Reference Method

TDEC: TN Department of Environment & Conservation

TISCH: a brand name

Hi-Vol: a high volume ambient air sampler

TSP: Total suspended particles

2.3.6 TVA

2.3.6.1 Sampling

2.3.6.1.1 Mobile Laboratory On-Site Monitor

TVA's mobile laboratory operated on-site at KIF from December 31, 2008, through February 4, 2009. The mobile monitor measured both PM2.5 and PM10. PM2.5 was measured with two different instruments: a Tapered Element Oscillating Microbalance (TEOM) monitor and a Federal Reference Method (FRM) sampler. The TEOM monitor measured PM2.5 continuously and recorded the hourly average concentration. The FRM instrument contained a filter that collected airborne particles for 24 hours before it was sent to a laboratory for analysis. Filters in the sampler were changed at noon each day. TVA also measured the metals content in the filters from the FRM PM2.5 monitor for the same time period. The mobile laboratory was dismantled in early February to allow the area to be prepared for on-site storage of dredged coal ash. Individual metals in PM10 air particulate samples were collected with a high volume sampler using quartz filters which were analyzed by X-ray fluorescence. See Table 38 for details.

2.3.6.1.2 TVA Temporary Stationary Monitors

During the initial ash coal spill response, TVA's ambient air monitoring contractor, Center for Toxicology and Environmental Health (CTEH), used temporary stationary monitors to collect 24-hour samples each day from five locations surrounding the coal ash spill area. Monitors were identified as PS05 through PS09. Monitor PS05 was located on Swan Pond Road; PS06 was located on Berkshire Lane; PS07 was collocated with TDEC monitors on Lakeshore Drive; PS08 was on Emory River Road; PS09 was on Windswept Lane. Figures 9 and 10 show the locations of the monitors.

The temporary monitors collected samples of all particulates for total metals analysis. They collected and analyzed for crystalline silica, total dust, and respirable dust that was 4 microns in diameter or less. Air monitoring results were available online for December 28, 2008, through March 9, 2009, on TVA's website (TVA 2009). Results from their total metals testing can be found in Table 39.

2.3.6.1.3 TVA Stationary Long-Term Monitors

TVA now has five FRM PM2.5 and two FRM PM10 stationary long-term monitors surrounding the site at the same locations as the temporary monitors. FRM PM2.5 monitors are positioned at locations PS05, PS06, PS07, PS08, and PS09. FRM PM10 monitors are positioned at locations PS07 and PS09. Most of these monitors began collecting data on February 12, 2009, and all of the new monitors were in operation by March 2009. Sampling and analysis will continue for the duration of coal ash recovery activities with samples being collected every third day or sixth day. Data from the FRM monitors analyzed between September 16, 2009, and January 13, 2010, did meet quality control parameters and are not reliable. The TEOM samples and metals sample data are reliable during that time period.

Sampling results for these monitors can be found online at TVA's website. Based on the air monitoring results of total metals up to April 2009, which did not indicate elevated levels of metals, TVA will only analyze the filters for arsenic.

FRM monitors use filter-based methods that generally produce data of good accuracy and precision. Data from FRM monitors are used for comparison with NAAQS values. However, the data are not available for some time after the measurement is made. This means that FRM data cannot be used to calculate the Air Quality Index or make rapid decisions about air quality. Continuous monitors, such as the TEOM monitor, have the advantage of providing near real-time data.

2.3.6.1.4 Real-time measurements

In addition, private contractors for TVA have taken several thousand real-time air samples for PM10 every day since December 28, 2008. The real-time

TVA: TN Valley Authority

CTEH: Center for Toxicology and Environmental Health, a contractor for TVA

TDEC: TN Department of Environment & Conservation

TVA: TN Valley Authority

FRM: Federal Reference Method

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

PM10: particles in air with a diameter equal to or less than 10 microns

TEOM: Tapered Element Oscillating Microbalance

NAAQS: National Ambient Air Quality Standards

measurements were taken initially by the contractor, CTEH, and continue to be taken every day by the contractor, Shaw Environmental. Particulate levels are measured at predetermined locations with a portable monitor to measure particulate levels for a brief time – from 1 to 3 minutes. It is not possible to use a single 1 to 3 minute average to characterize either an hourly average or a 24-hour average. However, having consistent daily elevated observations taken at the same time in the same location could indicate that an area may be seeing elevated hourly concentrations and possible elevated daily levels. See Figure 10 for representative daily sampling locations.

CTEH: Center for Toxicology and Environmental Health, a contractor for TVA

TVA: TN Valley Authority

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

NAAQS: National Ambient Air Quality Standards

μg/m³: microgram per cubic meter of air

PM10: particles in air with a diameter equal to or less than 10 microns

2.3.6.2 TVA Analytical Results

All TVA air monitoring results are summarized in Table f at the end of this TVA analytical results section.

2.3.6.2.1 Mobile Laboratory On-Site Monitor

See Table 38 for a summary of the analytical results.

TVA's PM2.5 analyses from their mobile laboratory from December 31, 2008, through February 3, 2009, were below the NAAQS level of 35 μg/m³ as a 24-hour average.

In the 35 PM2.5 samples, no cadmium, chromium, or thallium was detected. Arsenic was detected once, lead was detected in seven samples, selenium was detected in 17 samples, and vanadium was detected in two samples. These metals were detected at concentrations less than health comparison values. There are no published health comparison values for thallium or vanadium in air.

In TVA's PM10 samples, no cadmium, lead, thallium, or vanadium was detected in the 35 samples. Arsenic was detected in three of 35 samples, chromium was detected in 19 of 35 samples, and selenium was detected in four of 35 samples. Arsenic was above the health comparison value of 0.0023 μg/m³ in each of the three samples. The concentrations of arsenic found in PM10 on January 3, January 15, and January 31, 2009, were 0.0042 μg/m³, 0.0031 μg/m³, and 0.0040 μg/m³, respectively.

Chromium was above the health comparison value range of 0.001 to 0.003 μg/m³ in 14 of the 19 samples in which chromium was detected, with a maximum concentration of 0.0109 μg/m³ on January 14, 2009. The average concentration of the samples in which chromium was detected at 0.0039 μg/m³, slightly above the health comparison value range of 0.001 to 0.003 μg/m³.

Selenium in PM10 was below its health comparison value of 20 μg/m³ in all four samples in which it was detected.

2.3.6.2.2 TVA Temporary Stationary Monitors

The temporary monitors collected samples for total metals (NIOSH method 7300) from December 28, 2008, through March 10, 2009, by collecting all particulates on filters. Most samples had non-detectable concentrations of metals. The details of analytical results for those metals detected at concentrations above the minimum detection limit are presented in Table 39. The detection limits for arsenic and chromium were above the health comparison values used by EEP. The health comparison values are 0.0023 µg/m³ for arsenic and the range from 0.001 to 0.003 µg/m³ for chromium.

Four samples had detectable levels of lead on January 17, February 7, February 13, and February 24, 2009. Details are described in Table f below. These concentrations were below the NAAQS of 0.15 µg/m³ for lead.

Table f. Air concentrations of lead detected above minimum detection limits at temporary stationary monitors. Kingston Fossil Plant coal ash release, Harriman, Roane County, Tennessee.

Date	Location	Concentration, µg/m³
1/13/2009	PS07	0.051
2/07/2009	PS06	0.026
2/13/2009	PS08	0.025
2/24/2009	PS06	0.026

Cadmium was detected at 0.01 µg/m³ on January 26, 2009, at PS09. This value was above the health comparison value of 0.0056 µg/m³. These results represent total metals, including those that are not inhalable or respirable. Because the concentration of cadmium represents particulate matter of all sizes and the health comparison value is for particles of inhalable and respirable size, the health risk is likely overestimated. In addition, only one sample of 69 had any detectable cadmium.

Aluminum, copper, manganese, and zinc were detected occasionally above the minimum detection limits. No levels of these metals were above health comparison values.

2.6.3.2.3 TVA Stationary Long-Term Monitors

TVA's stationary long-term monitors measured PM2.5 at five locations and PM10 at two locations surrounding the ash release. TVA also analyzed the PM2.5 and PM10 for arsenic and thallium. From February 12, 2009, through February 24, 2009, no arsenic or thallium was detected in PM2.5 or PM10. On February 27, 2009, arsenic and thallium were below detection limits at sampling stations PS07 and PS08, but were not analyzed at sampling stations PS05, PS06, or PS09. On March 2, 2009, arsenic and thallium were below detection limits at sampling station 7, but were not analyzed at the other sampling stations. From March 5 to March 23, 2009, analysis was not done for arsenic and thallium.

TVA: TN Valley Authority
EEP: Environmental Epidemiology Program
µg/m³: microgram per cubic meter of air
NAAQS: National Ambient Air Quality Standards
PM2.5: particles in air with a diameter equal to or less than 2.5 microns

From February 12 to March 23, 2009, the detection limit for arsenic was above the health comparison value of 0.0023 μg/m³. This means that from February 12 to March 23, 2009, the actual concentration of arsenic could have been negligible or it could have been greater than the health comparison value. Beginning on March 26, 2009, the detection limit for arsenic was well below the health comparison value. No arsenic or thallium was detected from March 26 through May 13, 2009. Results can be seen on TVA's website (TVA 2009).

All particulate measurements were below the NAAQS limits.

2.3.6.2.4 Real-Time Results

From December 28, 2008, through May 31, 2009, CTEH took 47,908 real-time air samples for PM10 with hand-held meters. The current contractor is continuing to take samples every day. Of these samples, 216 (0.4%) samples were greater than 100 μg/m³ and 60 (0.1%) samples were greater than 150 μg/m³. Notations in the comment section of the CTEH spreadsheet containing these data points were used in elucidating the possible cause of the increased readings. Possible causes included fires in fireplaces, from burning of brush, or forest fires, and dust from the quarry and trucks from the quarry traveling to the site of the coal ash release. Fires of some sort were noted in the comments section for 47% of readings greater than 100 μg/m³. Truck traffic or visible dust was noted for 8% of readings greater than 100 μg/m³.

These data were used in an attempt to correlate higher real-time concentrations and residents' concerns and complaints. See the section on Public Health Implications of the Airborne Coal Ash in this section and the section on Community Concerns.

See Table g. below for a summary of TVA's analytical results.

μg/m³: microgram per cubic meter of air

TVA: TN Valley Authority

NAAQS: National Ambient Air Quality Standards

CTEH: Center for Toxicology and Environmental Health, a contractor for TVA

PM10: particles in air with a diameter equal to or less than 10 microns

Table g. TVA air monitoring data, beginning December 31, 2008. Kingston Fossil Plant, Roane County, Tennessee.

Date	Type of Monitor	Results
12/31/2008 – 2/3/2009	PM2.5 at mobile laboratory	Less than NAAQS for PM2.5 of 35 µg/m³. PM2.5 was about 28 µg/m³ on 1 day in January. All other measurements were < 25 µg/m³. No detection of cadmium, chromium, or thallium. Arsenic detected once, lead detected 7 times, selenium detected 17 times – all below health comparison values. Vanadium detected twice – no health comparison value.
12/31/2008 – 2/3/2009	PM10 at mobile laboratory	No detection of cadmium, lead, thallium, or vanadium. Arsenic was detected 3 times, at concentrations above health comparison values, but within the range found in ambient air in the U.S. Chromium was detected 19 times, at concentrations above health comparison values in 14 of 19 samples, but within the range found in ambient air in the U.S. The health comparison value is based on hexavalent chromium; 13% of chromium in coal ash is hexavalent chromium. Selenium detected 4 times at levels below health comparison values.
12/28/2008 – 3/10/2009	Temporary total metals monitors at 5 locations (these samples represent total metals, not just respirable metals)	Most samples had non-detectable metals. The detection limits for arsenic and chromium were above the health comparison values. The concentrations found were within ranges found in U.S. air. Lead was detected 4 times out of 69 samples at concentrations below the health comparison value. Cadmium was detected one time out of 69 samples at a concentration above the health comparison value.
2/12/2009 – 5/13/2009	5 Stationary FRM PM 2.5 monitors	All PM2.5 and PM10 were below NAAQS concentrations. PM10 on 2/18/09 was 53.1 µg/m³ at PS09. All others were below 50.0 µg/m³. All PM2.5 were below 25 µg/m³. Samples were analyzed for arsenic and thallium. All arsenic and thallium analysis showed no detections or were not analyzed for. The detection limit for arsenic is above the health comparison value. Concentrations of arsenic were within the ranges found in U.S. air.
12/28/2008 – 5/31/2009	Portable real-time PM10 monitors	47,908 were taken samples between January 1 and May 31, 2009. 0.1% were above 150 µg/m³, the 24-hour average NAAQS concentration.

TVA: TN Valley Authority

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

NAAQS: National Ambient Air Quality Standards

µg/m³: microgram per cubic meter of air

PM10: particles in air with a diameter equal to or less than 10 microns

FRM: Federal Reference Method

2.3.7 EPA

2.3.7.1 Sampling

From December 27, 2008, through January 10, 2009, EPA used Tetra Tech to conduct coal ash perimeter and community particulate air monitoring activities. Tetra Tech performed particulate air monitoring to assess whether air particulate concentrations were exceeding the criteria for worker safety as well as community protection. Tetra Tech conducted air monitoring activities at a total of ten locations on and off site. Each air monitoring location, designated P1 to P8, P8.2, and P9, is depicted on Figure 11.

On December 27, 2008, Tetra Tech staged a fixed total particulate monitor on KIF property near on-going response activities along Swan Pond Road. They recorded particulate concentrations in the area immediately around disturbance of the released coal ash. This air monitor was operated for approximately three to nine hours each day from December 27, 2008, through January 10, 2009.

From December 30, 2008, through January 10, 2009, Tetra Tech monitored particulate concentrations at nine additional locations. Five locations were in the immediate vicinity of the release on the Kingston Fossil Plant property (P1- P5), and five others were in surrounding residential areas near the release (P6, P7, P8, P8.2, and P9) (Tetra Tech 2009).

From December 30 to 31, 2008, monitoring was performed using portable PM2.5 monitors. From January 1 to 10, 2009, Tetra Tech replaced the PM2.5 monitors with portable PM10 monitors to validate comparable data collected by TVA. During the entire twelve-day monitoring period, up to two particulate monitors were deployed each day. One air monitor was placed at a fixed location for a continuous monitoring period. The second air monitor was rotated to all nine monitoring locations throughout the day. Each location was monitored for approximately 10 minutes, and each location was monitored several times throughout the day.

2.3.7.2 Analytical Results

Continuous air monitoring for total particulates at the fixed location (P1) on-site from December 27 to 31, 2008, indicated the average total particulate concentrations were below the OSHA permissible exposure limit of 5.0 mg/kg for nuisance dust.

Air monitoring with a portable particulate monitor equipped with a PM2.5 filter from December 30 to December 31, 2009, indicated particulate concentrations at locations on and off site (P2 to P9) were below the 24-hour average NAAQS for PM2.5 of 35 $\mu g/m^3$ and the WHO guideline of 25 $\mu g/m^3$. The concentrations ranged from 5 to 9.9 $\mu g/m^3$.

EPA: U.S. Environmental Protection Agency

Tetra Tech: Superfund Technical Assessment and Response Team (START) contractor for EPA Region 4

KIF: Kingston Fossil Plant

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

TVA: TN Valley Authority

OSHA: Occupational Safety and Health Administration

mg/kg: milligram per kilogram

NAAQS: National Ambient Air Quality Standards

$\mu g/m^3$: microgram per cubic meter of air

WHO: World Health Organization

Continuous air monitoring was performed at the fixed location (P1) on TVA property near the spill site during on-going disturbance of the coal ash. Monitoring was done with a particulate monitor equipped with a PM10 filter from January 1 to 10, 2009. Results indicated that the average particulate concentrations were below the NAAQS for PM10 of 150 µg/m³. From January 5 to 8, 2009, and on January 10, 2009, work activities at this location caused instantaneous maximum particulate concentrations to exceed 150 µg/m³. However, the average particulate concentration based on a time-weighted average did not exceed the NAAQS for PM10 of 150 µg/m³. The time-weighted average concentrations ranged from 6.1 to 55.6 µg/m³. Only one measurement was above the WHO guidance for PM10 of 50 µg/m³ as a 24-hour average.

Tetra Tech performed air monitoring onsite (P2 – P5) with a portable monitor equipped with a PM10 filter from January 1 to 10, 2009. Average particulate concentrations were below the NAAQS for PM10 of 150 µg/m3. The on-site average concentrations ranged from 7.5 to 76.2 µg/m³.

Tetra Tech performed air monitoring off-site (P6 – P9) with a portable monitor equipped with a PM10.0 filter from January 1 to 10, 2009. Average particulate concentrations were below the NAAQS for PM10 of 150 µg/m³. The off-site average concentrations ranged from 9.8 to 49.4 µg/m³.

Table h below summarizes the analytical results of EPA's air testing.

TVA: TN Valley Authority

PM10: particles in air with a diameter equal to or less than 10 microns

NAAQS: National Ambient Air Quality Standards

µg/m³: microgram per cubic meter of air

WHO: World Health Organization

Tetra Tech: Superfund Technical Assessment and Response Team (START) contractor for EPA Region 4

OSHA: Occupational Safety and Health Administration

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

Table h. Summary of EPA air monitoring data. December 27, 2008, through January 10, 2009. KIF Coal Ash Spill (TetraTech 2009).

	Date	Type of Monitor	Result
EPA	12/27 – 12/31/2008	Fixed total particulates at P1	Range: 0 to 10 µg/m³; < OSHA limit of 5.0 mg/kg for nuisance dust
	12/30 – 12/31/2008	Portable PM2.5 at P2 – P9 on- and off-site	Range: 5 to 9.9 µg/m³; < NAAQS for PM2.5 of 35 µg/m³ and WHO guideline for PM2.5 of 25 µg/m³
	1/1 – 1/10/2009	Fixed PM10 at P1 on-site, continuous	Range: 6.1 to 55.6 µg/m³ Average concentration less than 35 µg/m³; less than NAAQS for PM10 of 150 µg/m³
	1/5 – 1/8/2009 & 1/10/2009	Fixed PM10 at P1 on-site	Instantaneous maximum concentrations greater than NAAQS for PM10 of 150 µg/m³; time-weighted average ranged from 6.1 to 55.6 µg/m³
	1/1 – 1/10/2009	Portable PM10 onsite at P1-P5 on-site	Average concentration < NAAQS for PM10 of 150 µg/m³ Range: 7.5 to 76.2 µg/m³
	1/1 – 1/10/2009	Portable PM10 off-site at P6-P9 off-site	Average concentration < NAAQS for PM10 of 150 µg/m³ and WHO guideline of 50 µg/m³ Range: 9.8 to 49.4 µg/m³

2.3.8 TDEC's Air Data

2.3.8.1 Sampling

TDEC Division of Air Pollution Control (APC) began daily sampling and analysis for PM10 and for TSP plus metals on January 19, 2009, after EPA provided APC a continuous TEOM monitor for PM10 collection and a TISCH Hi-Vol monitor for collection of TSP to be analyzed for metals. The TEOM and TSP monitors are co-located with TVA's FRM PM2.5 and PM10 monitors at TVA location PS07. APC operates two monitors in Harriman, a PM2.5 TEOM installed in 2005 and a PM2.5 FRM installed in 1999. See Figures 9 and 10 for locations of monitoring activities. APC considers location PS07 to represent the location where the highest levels of particulate matter would consistently be found.

APC is measuring the metals in total suspended particles (TSP). TSP refers to all particulates in air – those too large to be inhaled, those that can be inhaled but not respired, and respirable particles. APC chose this method to ensure that they had enough particulate matter for accurate metals analyses. The level of respirable particles is lower than the levels of TSP. Because the metals are measured in all particulates (TSP), the concentration of metals that are available for respiration (about 30 percent of the ash) may be overstated in TDEC's sampling and analysis of TSP for metals.

2.3.8.2 TDEC Analytical Results

TDEC began daily monitoring for PM10 and TSP on January 19, 2009, at PS07. Beryllium, cadmium, chromium, thallium, vanadium, and mercury were not detected in any samples taken from January 19, 2009, through April 19, 2009. Arsenic was detected in five of 16 samples. The samples taken on February 24 and April 19, 2009 were estimated to be 0.0025 $\mu g/m^3$ and 0.0029 $\mu g/m^3$, respectively. These concentrations were slightly above the health comparison value of 0.0023 $\mu g/m^3$. The other 3 samples were less than the health comparison value. Selenium was detected at very low concentrations in eight of 16 samples at levels ranging from 0.001 to 0.0023 $\mu g/m^3$. The health comparison value is 20 $\mu g/m^3$. See Table 40 for details. PM10 measurements were all below the NAAQS of 150 $\mu g/m^3$ and the WHO guideline for of 50 $\mu g/m^3$ as 24-hour averages from January 19 through May 31, 2009.

PM2.5 measurements at the monitor at Harriman High School have been below the NAAQS of 35 $\mu g/m^3$ and have shown no effects from the coal ash release.

2.3.9 Toxicology of Breathing Metals and Their Health Comparison Values

As discussed in the section on Health Comparison Values in the Discussion, EEP chose ATSDR or EPA health comparison values when they were available. Table h below presents health comparison values for metals in air. These values were used in this public health assessment and by TDEC's APC

TDEC: TN Department of Environment & Conservation

APC: Division of Air Pollution Control

PM10: particles in air with a diameter equal to or less than 10 microns

TSP: Total suspended particles

EPA: U.S. Environmental Protection Agency

TEOM: Tapered Element Oscillating Microbalance

TISCH: a brand name

Hi-Vol: a high volume ambient air sampler

TVA: TN Valley Authority

FRM: Federal Reference Method

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

$\mu g/m^3$: microgram per cubic meter of air

NAAQS: National Ambient Air Quality Standards

WHO: World Health Organization

EEP: Environmental Epidemiology Program

ATSDR: Agency for Toxic Substances & Disease Registry

(Bashor 2009) and were chosen to be protective of public health for airborne coal ash at the KIF ash site. Metals detected above their respective health comparison values in air and those comparison values needing explanation will be discussed in Appendix B. See Table i below for air health comparison values used in this public health assessment.

KIF: Kingston Fossil Plant

µg/m³: microgram per cubic meter of air

EPA: U.S. Environmental Protection Agency

ATSDR: Agency for Toxic Substances & Disease Registry

EMEG: ATSDR environmental media evaluation guide

MRL: ATSDR minimal risk level

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

PM10: particles in air with a diameter equal to or less than 10 microns

°F: degrees Fahrenheit

Table i. Health comparison values to be used for metals in ambient air. Kingston Fossil Plant coal ash release, Harriman, Roane County, Tennessee.

Metal	Georgia 2008 annual average range, µg/m³	Health Comparison Value, µg/m³
Aluminum	NA	NA
Arsenic	0 – 0.001	0.0023 (ca) [1]
Barium	NA	NA
Beryllium	0.025 – 0.026	0.0042 (ca) [1]
Cadmium	0.0001 – 0.0003	0.0056 (ca) [1]
Chromium	0.001 – 0.003	0.002 [2]
Lead	0.0029 – 0.1	0.15 [3]
Manganese	0.003 – 0.011	0.04 [4]
Selenium	0	20 [1]
Thallium	NA	NA
Vanadium	NA	NA

NA = not available
[1] EPA Region IV guidance, non-carcinogens are adjusted for a hazard index of 1 and carcinogens (ca) are adjusted for 1 in 100,000 risk of excess cancer
[2] value of 0.00083 µg/m³ for a 1in 100,00 increased cancer risk and is for chromium VI; suggest using the background range for the state of Georgia
[3] National Ambient Air Quality Standard, rolling 3 month average
[4] ATSDR chronic EMEG / MRL for inhalation exposure

2.3.10 Public Health Implications of the Airborne Coal Ash

2.3.10.1 PM2.5, PM10, and Metals

No government agencies tested ambient air samples between December 22 and December 27, 2008. Therefore, it is impossible to make definitive statements about the air quality near the coal ash release before December 27, 2009.

The ambient temperature varied between a low of 12 °F on December 22, 2008, to a high of 66 °F on December 27, 2008. A trace amount of rain fell on December 23, 2008. Rain fell in the amount of 0.45 inches on December 24 and on December 26, 2008, and 0.31 inches on December 28, 2008. The ash was wet when it spilled from the holding pond. Wet weather conditions on three days after the release would have kept the coal ash from drying out and getting into the air. Average wind speeds ranged from 0.4 to 3.7 miles per hour from December 22 through December 27, 2008. Raw data from the PM2.5 monitor at Harriman High School about two miles away did not show an increase in PM2.5 concentrations at the end of December 2008. The average PM2.5 concentration in Harriman was 8.9 µg/m³ on December 2008, with range of 4.1 to 16.9 µg/m³. Concentrations PM2.5 in Harriman on December 23, 26, and 29, 2008, were 9.6, 8.6, and 5.7 µg/m³, respectively.

All sampling results following the coal ash release are summarized in Table j. The results will be discussed after the table.

µg/m³: microgram per cubic meter of air

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

NAAQS: National Ambient Air Quality Standards

PM10: particles in air with a diameter equal to or less than 10 microns

FRM: Federal Reference Method

Table j. Air monitoring data summary. December 27, 2008, through May 31, 2009. Kingston Fossil Plant, Roane County, Tennessee.

Agency	Date	Type of Monitor	Result
TVA	12/31/2008 – 2/3/2009	PM2.5 at mobile laboratory	Less than NAAQS for PM2.5 of 35 µg/m³. PM2.5 was about 28 µg/m³ on 1 day in January. All other measurements were < 25 µg/m³. No detection of cadmium, chromium, or thallium. Arsenic detected once, lead detected 7 times, selenium detected 17 times out of 35 samples– all below health comparison values. Vanadium detected twice – no health comparison value.
	12/31/2008 – 2/3/2009	PM10 at mobile laboratory	No detection of cadmium, lead, thallium, or vanadium. Arsenic detected 3 times, at concentrations above health comparison values, but within the range found in ambient air in the U.S. Chromium detected 19 times, at concentrations above health comparison values in 14 of 19 samples, but within the range found in ambient air in the U.S. The health comparison value is based on hexavalent chromium; 13% of chromium in coal ash is hexavalent chromium. Selenium detected 4 times at levels below health comparison values.
	1/1 – 3/10/2009	Temporary stationary total metals monitors at 5 locations. These samples represent total metals, not just respirable metals.	Most samples had non-detectable metals, The detection limits for arsenic and chromium were above the health comparison values. The concentrations were within ranges found in U.S. air. Lead was detected 3 times at concentrations below the health comparison value. Cadmium was detected once at a concentration above the health comparison value.
	2/12/2009 – May 13, 2009	5 Stationary FRM PM2.5 monitors	All PM2.5 and PM10 were below NAAQS concentrations. PM10 on 2/18/09 was 53.1 µg/m³ at PS09. All others were below 50.0 µg/m³. All PM2.5 were below 25 µg/m³. Samples were analyzed for arsenic and thallium. All arsenic and thallium analyses showed no detections or were not analyzed for. The detection limit for arsenic was above the health comparison value, but within the ranges found in U.S. air.
	12/28/2008 - Present	Portable real-time PM10 monitors	47,908 samples between 12/28/2008 and 5/31/2009. 0.1% were above 150 µg/m³.

Table j continued. Air monitoring data summary. December 27, 2008, through May 31, 2009. Kingston Fossil Plant, Roane County, Tennessee.			
Agency	**Date**	**Type of Monitor**	**Result**
EPA	12/27 – 12/31/2008	Fixed total particulates at P1	Range: 0 to 10 µg/m³; < OSHA limit of 5.0 mg/kg for nuisance dust
	12/30 – 12/31/2008	Portable PM2.5 at P2 – P9	Range: 5 to 9.9 µg/m³; < NAAQS for PM2.5 of 35 µg/m³ and WHO guideline for PM2.5 of 25 µg/m³
	1/1 – 1/10/2009	Fixed PM10 at P1	Range: 6.1 to 55.6 µg/m³; average concentrations < 35 µg/m³ and less than NAAQS for PM10 of 150 µg/m³
	1/5 – 1/8/2009 and 1/10/2009	Fixed PM10 at P1	Instantaneous maximum concentrations greater than NAAQS for PM10 of 150 µg/m³; time-weighted average ranged from 6.1 to 55.6 µg/m³
	1/1 – 1/10/2009	Portable PM10 onsite (P2-P5)	Range: 7.5 to 76.2 µg/m³; average concentration < NAAQS for PM10 of 150 µg/m³
	1/1 – 1/10/2009	Portable PM10 off-site (P6-P9)	Range: 9.8 to 49.5 µg/m³; average concentration < NAAQS for PM10 of 150 µg/m³ and WHO guideline of 50 µg/m³
TDEC	1/29/2009 – 5/31/2009	TEOM PM10	All results are 40 µg/m³ or less, < NAAQS for PM10 of 150 µg/m³ and WHO guideline of 50 µg/m³
	1/29 – 4/19/2009	TSP for metals	Beryllium, cadmium, chromium, thallium, vanadium, and mercury were not detected in any samples. Arsenic was detected in 5 samples. Concentrations in 3 samples were less than the health comparison value of 0.0023 µg/m³. Two samples were detected at 0.0025 and 0.0029 µg/m³, slightly above the health comparison value.

All measurements for PM2.5 and PM10 at the mobile laboratory, from TVA's temporary stationary monitors, from TVA's stationary long-term monitors, and from TDEC's monitors at sampling station 7 are well within the NAAQS for PM2.5 and PM10, as well as below the WHO guideline. Only one measurement of PM10 by TVA at one location was above the WHO guideline of 50 µg/m³. Research into the chemical and toxicological nature of coal fly ash indicates that the ash can be considered a nuisance dust (Meij and te Winkel 2001; Meij 2000). The ash does not appear to have greater potency to cause pulmonary effects than those of other ambient particulates (Smith et al. 2006).

PM2.5 is respirable and can reach deep into the lungs. No metals were detected in TVA's PM2.5 analyses for metals from December 31, 2008, through February 3, 2009, at the mobile laboratory site. EEP did not have exact detection limits for PM2.5 metals analyses at the mobile laboratory, but they were below 0.005 µg/m³ for arsenic and chromium. No arsenic or

EPA: U.S. Environmental Protection Agency

µg/m³: microgram per cubic meter of air

OSHA: Occupational Safety and Health Administration

mg/kg: milligram per kilogram

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

NAAQS: National Ambient Air Quality Standards

PM10: particles in air with a diameter equal to or less than 10 microns

WHO: World Health Organization

TEOM: Tapered Element Oscillating Microbalance

TSP: Total suspended particles

TVA: TN Valley Authority

TDEC: TN Department of Environment & Conservation

thallium was detected in PM2.5 samples from the new stationary long-term monitors from February 12, 2009, through March 2, 2009.

TVA's metals analysis results in samples from the mobile laboratory site showed some detectable levels of metals in PM10. Arsenic was detected three times out of 35 samples between December 31, 2008, and February 3, 2009, at levels slightly above the health comparison value of 0.0023 μg/m³, but within the range found in the U.S (0.00022 μg/m³ to 0.011 μg/m³). No arsenic was detected in PM10 samples from TVA's stationary long-term monitors. TDEC's analyses for arsenic in PM10 detected arsenic in three samples. Only one of these samples was slightly over the health comparison value.

In PM10 samples collected at TVA's mobile laboratory, chromium was detected at levels above the health comparison value of 0.001 μg/m³ to 0.003 μg/m³ in 14 of 19 samples. The average concentration was only slightly above the health comparison value and was within the range found at sites throughout the U.S. that monitor for metals in air (0.00036 μg/m³ to 0.011 μg/m³, with a weighted average of 0.0023 μg/m³). The maximum concentration detected was 0.01 μg/m³, representing total chromium. Hexavalent chromium is much more toxic than trivalent chromium, and the health comparison value is based on hexavalent chromium toxicity. The coal ash at KIF contains approximately 13% hexavalent chromium. The maximum concentration of total chromium would be equivalent to a maximum concentration of 0.0003 μg/m³ of hexavalent chromium. APC had not detected chromium in any of its TSP samples as of April 1, 2009. Between June 6 and August 17, 2009, APC detected chromium in seven samples, all at levels less than the health comparison value. TVA's mobile laboratory was on TVA property immediately adjacent to active disturbance of the released ash, while APC's TSP samples were collected at sampling site PS07 in the community.

Selenium was detected by TVA in PM2.5 and PM10 samples at the mobile laboratory site and by TDEC in eight of 16 TSP samples. All measurements were well below the health comparison value of 20 μg/m³.

TVA measured total metals in their samples from their temporary stationary monitors. They detected lead in three of 69 samples, all below the NAAQS limit of 0.15 μg/m³. Cadmium was detected in one sample, at a level above the health comparison value of 0.0056 μg/m³. The detection limits for arsenic and chromium were above the health comparison values. The actual concentrations of arsenic and chromium could have been greater than their health comparison values. These samples were for total metals, not just metals in PM2.5 or PM10.

Although some metals were detected in some samples, the overall results indicate that metals in airborne ash should not adversely affect public health. This reinforces the statements in the peer-reviewed literature that indicate that coal fly ash is a nuisance dust (Meij and te Winkel 2001; Meij 2000; Smith et al. 2006).

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

TVA: TN Valley Authority

PM10: particles in air with a diameter equal to or less than 10 microns

μg/m³: microgram per cubic meter of air

TDEC: TN Department of Environment & Conservation

KIF: Kingston Fossil Plant

APC: Division of Air Pollution Control

TSP: Total suspended particles

NAAQS: National Ambient Air Quality Standards

All particulate measurements for both PM2.5 and PM10 by FRM and TEOM monitoring surrounding the site are below the National Ambient Air Quality Standards and WHO guidelines and should have no adverse effect on public health.

2.3.10.2 Real-time Sampling

EEP reviewed CTEH spreadsheets containing air quality measurements of 1 to 3 minute samples of PM10. For measurements greater than 100 µg/m³, EEP analyzed and mapped results of real-time measurements. Notations in the comments section of the spreadsheets gave some insight into the cause of the higher real-time measurements. Of the 47,908 measurements from January 2 through May 31, 2009, 216 samples measured greater than or equal to 100 µg/m³ as of May 31, 2009, (0.45% of the total measurements). Of these, 47 (22%) had no dust or odor to explain the cause of the higher readings. Table k below summarizes the data by presumed cause of the higher PM10 readings.

Table k. Notations for real-time PM10 measurement that were equal to or greater than 100 µg/m³. Kingston Fossil Plant, Roane County, Tennessee. January 2, 2009, through March 31, 2009.

Notation summary	Number	Percentage
Visible fire, active fireplace, or wood burning odor	115	53
No visible dust or odor	47	22
Hazy, foggy, or high humidity conditions	34	16
Visible dust / truck traffic	18	8
In a work area	4	2
Other	4	2
More than 1 notation included with some sample results		

It is not possible to predict 24-hour average concentrations of PM10 from these real-time measurements, but it is certainly possible that at some locations PM10 was at levels greater than the NAAQS limits 24-hour average concentration of 150 µg/m³. The increased PM10 real-time measurements appear to be due to a number of sources. It is unlikely that the increased PM10 measurements are due to airborne coal fly ash. However, 22% of the increased PM10 measurements had no obvious cause. Monitors surrounding the coal ash release indicate that air quality was and is meeting all particulate standards.

2.3.10.3 Dust

Although PM10, PM2.5, and metals analysis indicate that air is meeting National Ambient Air Quality Standards, there was more than 5 million cubic yards of coal ash filling the Emory River and inlets near homes. TVA has implemented dust suppression activities, including washing wheels and underbodies of vehicles leaving the site of the ash release, vacuuming local roads, and using water trucks to wet both on-site roads and adjacent public highways. TVA spread grass seed, fertilizer, and straw over the centralized areas of displaced ash via an aerial, helicopter application within a couple of

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

PM10: particles in air with a diameter equal to or less than 10 microns

FRM: Federal Reference Method

TEOM: Tapered Element Oscillating Microbalance

WHO: World Health Organization

EEP: Environmental Epidemiology Program

CTEH: Center for Toxicology and Environmental Health, a contractor for TVA

µg/m³: microgram per cubic meter of air

NAAQS: National Ambient Air Quality Standards

weeks of the spill, but cold weather prevented germination of the winter rye grass seed. After evaluating several products, in February and March, 2009, TVA began using a liquid dust suppression agent called Flexterra flexible growth medium to cover the remaining, undisturbed portion of the ash dredge cell and other exposed areas. Spraying of Flexterra will continue as necessary to suppress dust. This product has proven to be very effective in controlling fugitive dust emissions. In addition, during the growing season grass seed is added to the mixture, providing a longer-term vegetative cover. Flexterra consists of green dyed wood fiber, synthetic fibers, and a proprietary binder. The Material Safety Data Sheet can be found at URL: http://www.profileproducts.com/erosion_control/item/browse-2-8.

The rainfall in the Harriman area has been greater than average, helping to keep the ash wet. For 2009, 69.77 inches of rain was recorded at the Kingston MRX station 404871, compared to the average yearly rainfall in Kingston of 53.23 inches (http://www.nc-climate.ncsu.edu/cronos/).

For areas of ash that will remain undisturbed for longer periods of time, TVA plans to apply either Flexterra or erosion control mulch as needed. When weather conditions optimize, TVA will further seed and fertilize if it becomes necessary. A stepped wall on the northern portion borders the remaining, undisturbed portion of the ash dredge cell. TVA plans to excavate the stepped wall and construct a flatter (~3:1) slope of ash in its place. This slope will be treated with the erosion control mulch. These dust control measures will be carried out as needed.

To rebuild destroyed roads and to build dikes to contain the ash in the river, activity at the local quarry has increased dramatically. Frequently, trucks pass by homes carrying stone to the site and returning to the quarry. TDH, TDEC, and TVA have received complaints about dust on Quarry Road and on other routes that the quarry trucks travel. While TVA has implemented dust control measures along the roads, such as using a combination of water trucks and sweeper/vacuum trucks to minimize dusting on the roads, dust still seems to present a problem for homeowners along the truck route. TDEC continues to work with the quarry owners and the truck owners to implement further dust suppression measures.

See the section, Community Concerns, for more discussion of this topic.

TVA: TN Valley Authority

TDH: Tennessee Department of Health

TDEC: TN Department of Environment & Conservation

2.4 Radiation Exposure

EEP asked for assistance from ATSDR on radiological issues. They responded with a technical assistance document. The text below is taken from that document (ATSDR 2009).

According to the TVA (TVA 2009), the Kingston Fossil Plant burns about 14,000 tons of coal per day to generate about 10 billion kilowatt-hours annually. For this production, coal is burned at high temperatures, approaching 1700°C, and the majority of the minerals in the coal are fused in an ash with glass-like properties. Included in these typical ash compounds are naturally occurring radioactive materials that are present in the coal. A small amount of minerals and the organic components are consumed during the burn (Stranden 1997, Zielinski 1998). At the Kingston location, the resulting ashes and sludges are stored on site in containment areas.

Coal ash contains both metals and naturally occurring radioactive elements. Although the actual composition of the coal and its combustion materials may be dependent on the place of origin, coal typically contains aluminum, silicon, boron, arsenic, selenium, iron, molybdenum, cadmium, mercury, and strontium (Stranden 1985, Vengosh 2009, Gabbard 2009). The radioactive substances typically include the naturally occurring uranium isotopes and their associated decay products including radium 226 (^{226}Ra) and naturally occurring thorium and its decay products including radium 228 (^{228}Ra). Of these radionuclides, those with the greatest potential of human impact are the radium isotopes radium 226 and radium 228. Both uranium and thorium have extremely long half-lives. As they transform into their respective decay products, those products also undergo decay. The decay product activity increases over time as the uranium or thorium decay until the activities of the decay products equal the activity of the uranium or thorium. This is called secular equilibrium.

Some radioactive isotopes can be difficult to measure because of interference from other non-related radioactive isotopes. For example, both Radium 226 and Radium 228 fall into this category. Secular equilibrium, however, allows for alternate methods to be used to identify these radioisotopes[9].

The data supplied to ATSDR by the TDEC included a sampling report from Duke University (Vengosh 2009). Duke analyzed three ash samples identified as TVA A, TVA B, and TVA C from the spill area. These data are given in Table 41. The results show that the concentration of both radium 226 and radium 228 are essentially identical in the three TVA ash samples.

One can also compare the Duke studies to other reports of radioactivity in coal ash. In a study of coal ash from coal plants in Germany, the concentrations of

EEP: Environmental Epidemiology Program

ATSDR: Agency for Toxic Substances & Disease Registry

TVA: TN Valley Authority

^{226}Ra: radium with an atomic weight of 226 and containing 88 protons and 138 neutrons

^{228}Ra: radium with an atomic weight of 228 and containing 88 protons and 140 neutrons

TDEC: TN Department of Environment & Conservation

[9] The concentration of Ra 226 can be determined by the concentration lead 214 (Pb 214). In a similar manner, the concentration of Radium 228 can be ascertained by the concentration of its decay product actinium 228 (Ac 228).

radium 226 and radium 228 were 6.5 pCi/g and 3.5 pCi/g, respectively (Stranden 1985). A similar study of coal ash from a Kentucky coal plant, as reported by Zielinski and Budahn, had an average radium 226 concentration of approximately 4.7 pCi/g; whereas, the average concentration of radium 228 was approximately 3.4 pCi/g2. Therefore, the Duke results are similar to other internationally reported levels of radionuclides in coal ash.

TDEC collected 10 ash samples and 13 soil samples from impacted properties. Two additional samples were collected from a nearby landfill. They also collected two background soil samples at a local park about six miles from downtown Kingston and at an embayment of Caney Creek, a tributary to the Tennessee River. All samples were collected in January 2009 and analyzed for radium 226 and radium 228 via decay products. The decay products measured by the TDEC, although different from those used by Duke University, are based on the same principle, that is, secular equilibrium. TDEC measured both lead 214 (^{214}Pb) and bismuth 214 (^{214}Bi) for radium 226. For radium 228, they measured actinium 228 (^{228}Ac), lead 212 (^{212}Pb), thallium 208 (^{208}Tl), and bismuth 212 (^{212}Bi). The results of these analyses by TDEC are shown in Table 42.

ATSDR compared the results from both the TDEC and Duke University using a t-test with unequal variances. This test is used commonly to determine if the average of two groups of data are significantly different. The result of this analysis showed there was no significant difference between the two sets of data. That is, the data collected by the state as compared to the data collected by Duke University are essentially identical.

To evaluate whether the radium radioactivity is a public health concern, ATSDR uses regulatory limits that were originally developed for uranium mill tailing sites (40 CFR 192) as screening values. These regulations require that the radioactivity concentration of Radium 226 in the top 5 centimeters of soil should not exceed 5 pCi/g above background. EPA's Office of Solid Waste and Emergency Response has also adopted a similar directive (i.e., 5 pCi/g above background), but their limit is based upon the combined Ra 226 and Ra 228 radioactivity concentration or "total radium."

The estimated total radium in the TDEC samples is approximately 3.2 pCi/g above background. The Duke University results indicate an average total radium concentration of about 7 pCi/g. After correcting for background levels (using Tennessee background data) and taking into account the potential loss of radon gas[10], the Duke University value is about 4.3 pCi/g above background. Therefore, the radium in the environment resulting from the ash spill do not exceed a health based criteria of 5 pCi/g.

Naturally occurring radioactive material present in the coal fly ash was released to the surrounding environment following the failure of the TVA containment

pCi/g: picocuries per gram

TDEC: TN Department of Environment & Conservation

^{214}Pb: lead with an atomic number of 214 and containing 82 protons and 132 neutrons

^{214}Bi: bismuth with an atomic weight of 214 and containing 80 protons and 134 neutrons

^{228}Ac: actinium with an atomic weight of 228 and containing 89 protons and 138 neutrons

^{212}Pb: lead with an atomic weight of 212 and containing 82 protons and 130 neutrons

^{208}Tl: thallium with an atomic weight of 208 and containing 81 protons and 127 neutrons

^{212} Bi: bismuth with an atomic weight of 212 and containing 80 protons and 132 neutrons

ATSDR: Agency for Toxic Substances & Disease Registry

EPA: U.S. Environmental Protection Agency

TVA: TN Valley Authority

[10] When radium decays, it forms radon gas that can escape from the soil. The radon that does not escape, decays to particulates that remain in the soil. The radon escape from coal is not significant because of the coal matrix.

structure. The radioactive materials of concern include both radium 226 and radium 228. Although the concentration of these materials exceed the average background concentrations, the levels are below the health-based directive of 5 pCi/g above background in the top 5 centimeters as used both by EPA and ATSDR. This directive was set to ensure the exposure to gamma radiation did not exceed the background ambient radiation by more than 20 microroentgens[11] per hour.

EEP appreciates the technical assistance of ATSDR's health physicists in the investigation of the radiological properties of the coal ash. Based on the evaluation of the available data that show levels of radioactivity are below the health-based limits and a review of existing Federal regulations, ATSDR concludes that the concentration of radioactive material in the coal ash is not expected to harm people's health in the area of the coal ash release.

pCi/g: picocuries per gram

EPA: U.S. Environmental Protection Agency

ATSDR: Agency for Toxic Substances & Disease Registry

EEP: Environmental Epidemiology Program

[11] The roentgen is a unit used to measure exposure. This can only be used for gamma radiation and X-rays in air. A microroentgen is one millionth of a roentgen.

2.5 Summary of Public Health Implications

TVA, EPA, and TDEC have all taken environmental samples for a variety of reasons. All agencies sampled the ash to find out what is in it. They did TCLP analysis to make sure it was not a hazardous waste as defined by EPA. TDEC sampled the municipal drinking water from the Kingston and Rockwood Water Treatment Plants every day, and they continue to sample every week. TDEC samples the river water going into the plants and the water going out for distribution to customers to make sure that the water is not affected by the coal ash. EPA and TDEC sampled well water and spring water to find out if the metals in the coal ash had gotten into the groundwater. TDEC will continue to take samples of the groundwater. TVA, EPA, and TDEC have done exhaustive sampling of the Emory, Clinch, and Tennessee Rivers to find out how the coal ash is affecting the Watts Bar Reservoir. They continue to sample the rivers. TVA, EPA, and TDEC have sampled the air for PM10, PM2.5, and metals in the air at monitors surrounding the coal ash release. TVA and TDEC continue to take air samples. TVA continues to take daily instantaneous air readings at many locations in the wider community.

Based on the sampling results by all agencies, TDH is confident that:

- No harm to health should have occurred from touching the coal ash. People had an opportunity to be exposed to the coal ash for about one month before TVA either relocated families or fenced off the coal ash. Longer-term contact would be necessary to cause any significant local skin irritation, such as coal ash that has gotten under a bandage. Casual contact with coal ash should not cause skin irritation. In addition, the metals in the coal ash are not likely to get into people's bodies from touching the ash.
- Although arsenic was found at concentrations above health comparison values for chronic exposure to children, no harm is expected from a child accidentally eating the coal ash. Chronic health effects from exposure to arsenic require exposures more long term than the type of exposure experienced in this setting. The period of exposure to the coal ash was very short. Small children had little opportunity for direct contact with the coal ash because of the cold, wet weather and the fencing of the ash to prevent contact, as well as the diligence of parents in keeping their children away from the coal ash. The exposure frequency and exposure duration were not long enough to cause harm to the health of children or adults.
- Except in the immediate vicinity of the coal ash release, the coal ash or the metals in the coal ash have not affected surface water in the Watts Bar Reservoir. TVA and TDEC have an advisory for use of the Emory River in the area near the coal ash release. The Army Corps of Engineers and the Coast Guard are patrolling this area to prevent any harm to people. The Emory River from mile marker 1.5 to mile marker 3 is closed to river traffic until February 15, 2010.

TVA: TN Valley Authority

EPA: U.S. Environmental Protection Agency

TDEC: TN Department of Environment & Conservation

TCLP: toxicity characteristic leaching procedure

PM10: particles in air with a diameter equal to or less than 10 microns

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

TDH: Tennessee Department of Health

- Municipal drinking water from the Kingston and Rockwood water treatment plants has not shown any contamination from the coal ash release since sampling began on December 23, 2008. TDEC is continuing to monitor the drinking water.
- Private well and spring water within 4 miles of the coal ash release have not shown any contamination from the coal ash. TDEC will continue to take periodic samples of private well water in the area.
- Concentrations of PM10 and PM2.5 have consistently been below EPA regulatory limits since air sampling began on December 31, 2008. Metals in air have consistently been within background levels of metals in the U.S. or below any health comparison values.
- EEP could not determine whether breathing dust near the quarry and along the routes of the quarry trucks has or will harm people's health.
- Concentrations of radionuclides are below the regulatory limits for concentrations of radionuclides in air and water that are protective of public health.

The only way people could have been exposed to the coal ash from late December 2008 through the middle of January 2009 was through direct contact with the coal ash or by accidentally eating some of the coal ash.

The airborne coal ash could affect people exposed to higher concentrations of particulate matter, especially those with pre-existing respiratory or heart conditions. Such effects could include upper airway irritation and aggravation of pre-existing conditions such as asthma, emphysema, and other respiratory conditions.

TVA, EPA, and TDEC are working to make sure that does not happen. Examples of measures that TVA is taking include:

- Applying Flexterra/hydroseed to coal ash where activity is not occurring
- Spraying of water on coal ash where activity is occurring
- Washing of cars leaving the site
- Establishing a central drop off point for delivery of materials that is off site.

TDEC: TN Department of Environment & Conservation

PM10: particles in air with a diameter equal to or less than 10 microns

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

EPA: U.S. Environmental Protection Agency

EEP: Environmental Epidemiology Program

TVA: TN Valley Authority

2.6 Non-Governmental Organizations' Response to the Coal Ash Release

EEP: Environmental Epidemiology Program
UMD: United Mountain Defense
EIP: Environmental Integrity Project
ASU: Appalachian State University
EPA: U.S. Environmental Protection Agency

EEP relies on other government agencies and their contractors for most data. EEP is not limited in which data it can use. If data are available, we will try to use them. However, since we are making decisions about public health, it is imperative that we understand: where the data came from; how samples were collected; how samples were protected; and the quality assurance and quality control measures taken when samples were collected and when the samples were analyzed.

EEP is aware of environmental sampling and analysis efforts by the following non-governmental organizations:

- Duke University
- United Mountain Defense (UMD) and the Environmental Integrity Project (EIP)
- Appalachian State University (ASU), Appalachian Voices, and the Waterkeeper Alliance's Upper Watauga Riverkeeper Program
- Appalachian State University, Appalachian Voices, and the Tennessee Aquarium

Each of these non-governmental data sets will be discussed.

2.6.1 Duke University

Staff and students at Duke University, led by Dr. Avner Vengosh, collected sixteen surface water samples on January 9–10, 2009, from four upstream river locations, four locations in the "cove", and eight downstream river locations. They also collected four groundwater samples and three solid ash samples. The water samples were analyzed for 21 inorganics, as well as for general chemistry. The solid ash samples were analyzed for radionuclides. The data were accepted for publication on April 17, 2009, by the journal, *Environmental Science and Technology*, and published online on May 4 as an article that needed immediate release (Ruhl et al. 2009). Water sampling followed U.S. Geological Survey protocol. The Division of Earth and Ocean Sciences laboratory at Duke University conducted the analyses. Inorganic elemental concentrations were determined by inductively coupled plasma mass spectrometry (ICP-MS) on a *VG Plasmaquad 3* at the Division of Earth and Ocean Sciences at Duke University. No information was given on the procedures for determining leachability of metals from the coal ash. Not enough information was provided in the report to determine whether the analytical methods conform to EPA standard methodology. Further, no information on quality assurance or quality control procedures was provided in the report.

The report by Ruhl et.al stated that, "*Results show that the tributary that was dammed by the coal ash spill and turned into a standing pond ("the Cove" in the area of Swan Pond Circle Road) has relatively high levels of leachable* *coal ash contaminants (LCAC), including arsenic, calcium, magnesium, aluminum, strontium, manganese, lithium, and boron. Some of these elements are highly enriched in coals, and are known to be highly soluble in aquatic systems. Among the LCACs, arsenic stands out with concentration of up to 86 μg/L in the Cove area."*

Sampling by EPA, TVA, and TDEC confirm that the coal ash contains higher than background levels of arsenic and that arsenic was elevated near the coal ash release in the month after the coal ash release. In a February 5, 2009, meeting held by TDEC with Dr. Vengosh, TDH, and EPA, Dr. Vengosh explained that he used a research procedure that used hydrofluoric acid for leachability rather than the EPA standard method that has proven to be accurate and reliable. TCLP analyses of ash by governmental agencies indicated that very little leaching occurred when the ash was analyzed by standard EPA TCLP methods. These methods are the only acceptable procedure for TCLP analysis for environmental regulatory agencies. The research method for leachability will cause more metals to go into solution than would happen in natural water systems. It appears that the analyses as reported used non-standard methodology for leaching of metals and that the definition of what constitutes leachability is inconsistent with normal EPA usage of the word.

Radiological data from the report (Ruhl et al. 2009) were discussed in the section above, Radiation Exposure. The radiological data for coal ash in the Duke University report are essentially the same as data measurements of coal ash taken by TDEC.

The report by Ruhl et al. expresses concern that wind-blown resuspension of fly ash could pose a threat to human health. TDEC and TDH agree that the particulate matter in airborne ash could harm people's health if it became airborne. TDH does not believe that metals in the fly would cause harm to people's health; however, TDEC and TVA continue to measure metals in particulate matter to make sure that public health is protected. Controls have been put into place to prevent resuspension of ash particles. In addition, air monitors surrounding the coal ash release are in place, measuring PM2.5, PM10, and metals content of PM10 and TSP.

2.6.2 Appalachian State University, Appalachian Voices, the Tennessee Aquarium, and Wake Forest University

ASU, Appalachian Voices, and the Tennessee Aquarium jointly collected water, sediment, and fish samples from seven locations in the Emory, Clinch, and Tennessee Rivers on January 8–9, 2009. The surface water samples were analyzed for 17 heavy metals (total and dissolved). ASU's laboratory conducted the analyses, following standard EPA methodology for sampling and analysis and for quality assurance and quality control procedures. The sampling, analysis, and results are detailed in a Preliminary Summary Report (Babyak et al. 2009).

LCAC: Leachable Coal Ash Contaminants

μg/L: microgram per liter. 1000 μg are in 1 milligram

EPA: U.S. Environmental Protection Agency

TVA: TN Valley Authority

TDEC: TN Department of Environment & Conservation

TDH: Tennessee Department of Health

TCLP: toxicity characteristic leaching procedure

PM2.5: particles in air with a diameter equal to or less than 2.5 microns

PM10: particles in air with a diameter equal to or less than 10 microns

TSP: Total suspended particles

ASU: Appalachian State University

Water was sampled and analyzed from the Emory River at miles 3.3, 2.2, 1.6, and 0.1, the Clinch River at miles 4.6, 3.3, and from the Tennessee River at mile 567. Total metals analysis for arsenic, barium, cadmium, lead, and selenium showed that levels at Emory River mile 2.2 (at the coal ash release site) were elevated when compared to water quality standards. Arsenic, barium, and cadmium were above MCLs. Lead was above the action level for drinking water, and selenium was above the Tennessee Water Quality Criteria for fish and aquatic life (continuous concentration), but below the MCL. Other sampling sites did not show any elevations of total metals. Dissolved metals were not elevated in any samples.

MCL: maximum contaminant level

TVA: TN Valley Authority

EPA: U.S. Environmental Protection Agency

TDEC: TN Department of Environment & Conservation

UMD: United Mountain Defense

EIP: Environmental Integrity Project

TDEC: TN Department of Environment & Conservation

These results generally agree with the results of TVA, EPA, TDEC, and Duke University sampling and analysis for the Emory River at the site of the ash release and in upstream and downstream locations.

The preliminary report emphasizes elevated selenium concentrations in river sediment and harm to fish. Environmental regulatory agencies are concerned with the health of the ecosystems and fish in the Emory River. The EPA Science Review Panel and the US Army Corps of Engineers have generated two reports on selenium impacts at the coal ash release site (EPA 2009e; ACOE 2009). However, as stated earlier, this public health assessment will focus only on human health.

Because no one was drinking this water or using this water for recreation, there were no public health concerns at that time. According to sampling and analysis by TDEC, the arsenic concentrations have remained below MCLs since May 28, 2009, and the barium, cadmium, lead, and selenium concentrations have never exceeded MCLs or Water Quality Criteria at the site of the spill and most arsenic concentrations have been below detection limits.

2.6.3 United Mountain Defense and the Environmental Integrity Project

UMD and EIP collected 24 river water samples from 23 locations on December 30–31, 2008, and on January 4, 2009. The locations consisted of 14 surface water samples from the Emory and Clinch Rivers, five residential well samples, one pond sample, and three upriver surface water samples. The water samples were analyzed for 30 (total) metals commonly found in coal ash as well as general chemistry. UMD/EIP reported that the sampling followed required EPA methods and procedures and the analyses were conducted by EPA-certified laboratories. The laboratory for UMD / EIP used EPA method SW-846 6010B to measure total metals, which is appropriate. Standard analytical quality assurance and quality control procedures were followed. UMD and EIP also collected solid samples; however, no information about the sample collection and analytical methods were available for the solid samples collected.

The report on the UMD website only listed those samples which had metals concentrations greater than MCLs. The raw data are, also, available on the

UMD website. Table l below summarizes the exceedances, with the MCLs and the TDEC Water Quality Criteria as references. If duplicate samples were analyzed, the average concentration was reported in Table l. Table l. United Mountain Defense and Environmental Integrity Project Data. Kingston Fossil Plant, Harriman, Roane County, Tennessee.

Sample site	Date	Analyte Result, µg/L	Analyte MCL, µg/L
Emory River, 1.3 miles upstream of the collapsed embankment (A)	December 30, 2008	Arsenic = 37.2 Lead = 16.8	Arsenic = 10 Lead = 15
Emory River, Lakeshore Drive inlet (B)	December 30, 2008	Arsenic = 84.0	Arsenic = 10
Emory River, Lakeshore Drive inlet (B)	January 4, 2009	Arsenic = 273 average Beryllium = 5.2 Lead = 36 average Antimony = 6.5	Arsenic = 10 Beryllium = 4 Lead = 15 Antimony = 6
Ash pore water Emory River, Lakeshore Drive inlet (C)	December 30, 2008	Arsenic = 478 Beryllium = 14.8 Lead = 91.8	Arsenic = 10 Beryllium = 4 Lead = 15
Clinch River, 3 miles downstream of the collapsed embankment (AB)	January 4, 2009	Arsenic = 94 average	Arsenic = 10
Clinch River, 4.5 miles downstream of the collapsed embankment (AD)	January 4, 2009	Arsenic = 20 average	Arsenic = 10
Ash pore water Swan Pond Road inlet, 0.43 miles from the collapsed embankment (AF)	January 4, 2009	Arsenic = 310 average Beryllium = 4.3 Lead = 49 average	Arsenic = 10 Beryllium = 4 Lead = 15
( ) = UMD/EIP sample number			
All other sampling results were below MCLs or water quality criteria.			

UMD's and EIP's 14 river surface water samples were collected from the Emory and Clinch Rivers or inlets feeding those rivers in the coal ash release-impacted area or downstream of the release. UMD's and EIP's sampling results appear consistent with the EPA and TDEC sampling and analysis that found arsenic in the ash and in the 'sludge'. Results, also, confirm that the coal ash has not affected groundwater.

TDEC did not detect any levels of arsenic above 10 µg/L in the Clinch River. They detected elevated arsenic in the Emory River only at miles 1.7 and 2.1, in the area of the coal ash release. UMD/EIP detected the highest concentrations in 'ash pore water'. The U.S. Geological Survey defines pore water as the water filling the spaces between grains of sediment. EEP is unsure how UMD/EIP took the samples.

µg/L: microgram per liter. 1000 µg are in 1 milligram

MCL: maximum contaminant level

UMD: United Mountain Defense

EIP: Environmental Integrity Project

EPA: U.S. Environmental Protection Agency

TDEC: TN Department of Environment & Conservation

EEP: Environmental Epidemiology Program

Because no one was drinking this water or using this water for recreation, there were no public health concerns at that time. In addition, the Emory River at the site of the coal ash release was closed for river traffic and recreation.

2.6.4 Appalachian State University and the Waterkeeper Alliance's Upper Watauga Riverkeeper Program

ASU, Appalachian Voices, and the Waterkeeper Alliance's Upper Watauga Riverkeeper Program (WAUWRP) jointly collected three water and one sediment sample from the Emory River on December 27, 2008. They reported that standard EPA methods were used to collect and analyze each field sample in triplicate for 17 heavy metals. The Environmental Toxicology and Chemistry laboratories at ASU conducted the analyses. The preliminary results were publicly available from UMD's website (ASU – WAUWRP 2009). There is no report accompanying the data, and details of sampling and analysis are not included.

EEP could not determine if the results of analysis of water samples were for total metals or for dissolved metals, although EEP assumed that the results are for total metals. Average arsenic concentration at the barge boom 0.51 miles downstream of the site of the coal ash release was reported as 3.062 mg/L (or 3,062 µg/L). This concentration is many times the arsenic concentration found by TVA and TDEC.

The site of the coal ash release is around mile 2 of the Emory River. TVA detected total arsenic above the drinking water limit in the Emory River at miles 1.75 and 2.1 the day of the ash release and one day in early January, at concentrations less than 80 µg/L on those days. On other days, concentrations of total arsenic were below the drinking water limit of 10 µg/L at these locations. EPA detected an estimated concentration of 208 mg/L of arsenic at Emory River mile 1.9 and a concentration of 1,490 µg/L of arsenic on December 23, 2008. TDEC detected arsenic in the Emory River above the drinking water limit of 10 µg/L on a few occasions. TDEC's analysis showed that arsenic concentrations ranged from non-detectable concentrations to a high of 43 µg/L near the coal ash release site.

These results are not surprising for samples at the site of the coal ash release. Because no one is drinking this water or using this water for recreation, there are no public health concerns at this time. In addition, the Emory River at the site of the coal ash release is closed for river traffic and recreation.

Waterkeeper Alliances took water samples in the "ash berg" zone, with very high turbidity. Emergency operations were ongoing at the time of their sampling event and may have stirred up the ash in the area where samples were taken. This might account for much of the difference between TDEC and Waterkeeper Alliances results.

ASU: Appalachian State University

WAUWRP: Waterkeeper Alliance's Upper Watauga Riverkeeper Program

EPA: U.S. Environmental Protection Agency

UMD: United Mountain Defense

EEP: Environmental Epidemiology Program

µg/L: microgram per liter. 1000 µg are in 1 milligram

TVA: TN Valley Authority

TDEC: TN Department of Environment & Conservation

2.7 Community Health Survey

Although initial environmental test results had been reassuring from a human health perspective, TDH wished to determine whether significant or unexpected exposures or adverse health effects were being experienced by persons in the community are the result of the coal ash release. Environmental health concerns associated with the spill prompted TDH to initiate steps for a community-based assessment.

TDH and the Centers for Disease Control and Prevention's (CDC) National Center for Environmental Health (NCEH) performed an EpiAid, the field phase of a community health survey, interviewing community members residing in the area of the ash release. TDH designed the questionnaire for use in this emergency response situation. TDH identified households within an approximate 1.5 mile radius of the coal ash spill. The 1.5 mile radius around the release encompassed all the residents who would routinely travel on the affected roads. Each accessible house within this geographic area was approached by a team and invited to participate in the voluntary survey. Using a standardized questionnaire, participating adult residents and parents of child residents were interviewed. Fact sheets about exposure and protecting themselves from ash and TDH contact information sheets inviting assessment participation were left at each unoccupied house. Follow-up visits and phone interviews were scheduled to accommodate participant needs.

From January 8-13, 2009, teams of two to three public health staff visited 324 residences within a 1.5 mile radius of the spill. Staff interviewed 368 participants representing 170 households. Results are summarized in Table m below.

The most noticeable finding was that 52% of people reported stress and anxiety after the coal ash release.

Most people (60%) did not report any change in health status since the coal ash release. Twenty-seven percent of respondents reported worsening of cough, 25% worsening of headaches, 14 % reported worsening of wheezing, and 14% reported shortness of breath.

TDH: Tennessee Department of Health

CDC: Centers for Disease Control and Prevention

NCEH: National Center for Environmental Health

Table m. Summary of results of the community health survey. Kingston Fossil Plant, Harriman, Roane County, Tennessee.

Ages	Percentage	Number
<18 years	24%	88
18-64 years	59%	216
≥65 years	17%	61
Coal ash in yard	47%	82
Involved with cleanup	4%	15
Shoes or clothing in contact with coal ash	33%	120
Direct skin contact with coal ash	13%	48
Consumption of local fish	1%	3
Aware of public health messages	83%	252
Washing hands after touching coal ash	66%	31
Increased drinking of bottled water after the spill	9% before to 25% after	16 before to 44 after
Increase in spending no time outdoors	5% before to 18% after	20 before to 66 after
Stress and anxiety	52%	186
History of:		
Asthma	18%	65
Chronic obstructive pulmonary disease	9%	33
Heart attack	5%	20
Health Status since coal ash release		
No change	60%	222
Worsening of 1 or more symptoms	40%	143
Worsening of symptoms among respondents since the coal ash release:		
Cough	27%	98
Headache	25%	91
Wheezing	14%	52
Shortness of breath	14%	52

Next, EEP determined whether or not each of these symptoms were clustered and, if so, at what distance the clustering is most significant using the Spatial Autocorrelation (Global Moran's I) tool in ArcGIS. A geographic information system integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically related information. ArcGIS is a group of geographical information system software that is used for mapping and statistical analysis of data that are geographically related.

See Tables n and o below for significant and non-significant results of the spatial autocorrelation results. Spatial autocorrelation and the Global Moran's I is based on the concept that everything is related to everything else, but nearby things are more related than far away things. It indicates whether particular values are likely to occur in one location or are equally likely to occur in any location. EEP used the Hot Spot analysis tool in ArcGIS to identify the location of clusters. It is important to note, however, that EEP was

EEP: Environmental Epidemiology Program

ArcGIS: ArcGIS is a group of geographical information system software used for mapping and statistical analysis of data that is geographically related.

dealing with very small numbers (less than 30 in each polygon). Very small numbers make any statistical analyses less reliable.

A value for Moran's I that is close to zero means that the distribution is random, with no apparent pattern. A value for I that is positive means that similar values are clustered. A value for I that is close to +1 indicates complete clustering. A value for I that is negative means similar values are dispersed. A value of I that is close to -1 indicates complete dispersion.

At a confidence level of 0.05 (95%), a Z-score less than -1.96 or greater than +1.96 indicates a statistically significant result. A Z-score in between -1.96 and +1.96, indicates a statistically non-significant result.

Table n. Statistically significant clustering of symptoms, community health survey results. Kingston Fossil Plant, Harriman, Roane County, Tennessee.

Symptom	Before			After		
	Moran's I	Z-Score	Conclusion	Moran's I	Z-Score	Conclusion
Anxiety and Stress	Not Available	Not Available	Not Available	0.35	3.7	Clustered Less than 1% likelihood pattern due to chance.
Shortness of breath	-0.15	-1.77	Dispersed	0.15	1.98	Clustered Less than 1% likelihood pattern due to chance.
Vomiting	0	0.29	Random	0.27	3.53	Clustered Less than 1% likelihood pattern due to chance.

Table o. Statistically non-significant clustering of symptoms, community health survey results. Kingston Fossil Plant, Harriman, Roane County, Tennessee.

Symptom	Before			After		
	Moran's I	Z-Score	Conclusion	Moran's I	Z-Score	Conclusion
Cough	0.01	0.52	Random	0.14	1.87	Clustered 5-10% likelihood pattern due to chance
Diarrhea	-0.18	-1.76	Dispersed	0.08	1.09	Random
Headache	0.03	0.81	Random	0.01	0.34	Random
Nausea	-0.14	-1.55	Random	0.09	1.17	Random
Wheezing	-0.16	-1.82	Dispersed	0.02	0.48	Random

See Figures 12, 13, and 14 for pictorial representations of the analyses.

These results indicate that, for anxiety and stress and for vomiting, the after scores are highly significant. The result for shortness of breath is statistically significant. Further evaluation would be needed to determine if the result for shortness of breath were clinically significant.

EEP investigated whether the 'after' symptoms had different spatial distributions than the 'before' symptoms using a Directional Distribution (Standard Ellipse) tool in ArcGIS. This tool allowed EEP to create what are called standard ellipses, which show the distribution of symptoms as well as

EEP: Environmental Epidemiology Program

ArcGIS: ArcGIS is a group of geographical information system software used for mapping and statistical analysis of data that is geographically related whether there is a directional trend or orientation in that distribution. This tool can be used to compare distributions (in this case, symptoms), examine distributions from different time periods, and show the compactness and orientation of distributions. If distributions closely resemble a circle, then there is not a strong orientation to the occurrence of the symptom. A large circle means the cases are widespread whereas a small circle means the cases are more localized (concentrated). The orientation of the circle/eclipse indicates the direction in which the cases are occurring. See Appendix C for more details about spatial analysis methodology.

Anxiety was clustered after the ash release; no questions were asked about anxiety before the ash release. Hot spots for anxiety occurred on the northwest side of the ash release area where there was much property damage. Anxiety and stress were tightly oriented around areas that were directly affected by the coal ash release, where the road was destroyed and where boats and boat docks were damaged or destroyed.

Shortness of breath was more localized after the ash release, although it was still rather widespread. Shortness of breath was clustered, with less than a 1% likelihood pattern due to chance. Hot spots for shortness of breath occurred along the southwest / northeast axis of the ash release area. The orientation of symptoms of shortness of breath changed somewhat after the coal ash release, moving closer to the spill. However, the shortness of breath was not strongly related to location and was still rather widespread.

Vomiting was more localized after the ash release and was clustered, with less than a 1% likelihood pattern due to chance. Hot spots for vomiting occurred in a very tight cluster to the northwest of the spill. Because of the tight clustering, vomiting could have been a result of a viral outbreak, which is common in winter, rather than a result of the ash release.

2.8 Physician Education

TVA: TN Valley Authority

TDH: Tennessee Department of Health

EEP: Environmental Epidemiology Program

In response to the TVA Kingston coal ash release and following the community health assessment, TDH hosted an informational meeting for local physicians and other healthcare providers. Invitations were sent by fax to approximately 100 medical practices and clinics. This represented over 250 healthcare providers from Roane County and the surrounding area. Three meetings were conducted on January 21 and 22, 2009. Presentations were given by the Deputy State Epidemiologist of TDH and an Environmental Epidemiologist of EEP. Information covered included:

- Environmental testing plan and test results
- Exposure routes and risks associated with coal ash
- Syndromic surveillance results
- Community health survey
- Recommendations that testing of people was not necessary
- Public health recommendations
- Contact information for medical toxicologists.

Attendees comprised a cross section of medical expertise. The following specialties and organizations were represented:

- Roane County Family Practices
- Individual General Practices
- Individual Internal Medicine Practices
- Roane Eye Center
- Kingston Family Practice
- Cumberland Neurology Group
- Oak Ridge Pediatric Clinic
- Chiropractic Health Center
- Roane County Medical Center including Chief Executive Officer, Directors of Nursing, Laboratory, Respiratory Care, Pathology, and Infection Control
- Roane County Public Health
- East Tennessee Regional Health Office
- Roane County Emergency Medical Staff
- Roane County Emergency Management Agency

Providers were urged to report any coal ash exposures or disease they considered associated with the coal ash release to TDH.

2.8.1 Follow up

Because TDH had received no reports of illness associated with the coal ash from healthcare providers, follow-up visits were done on March 17 and 18, 2009. The Deputy State Epidemiologist interviewed 24 healthcare providers in and around Roane County. The interviews included pediatric and family practice groups, emergency departments, and pulmonologists. No medical provider reported any illnesses that they could attribute to exposure to coal ash. Many medical providers reported they had seen a few patients with respiratory symptoms who were concerned that the symptoms might be related to the coal ash. Most medical providers commented that they could not determine if the symptoms were the result of infection, allergies, dust, or some combination. One physician, who lives in the affected area, said, "people have not stopped coughing since the spill" and expressed concern. Several providers had patients who asked for heavy metal screening. Some of the providers reassured patients about the low risk of exposure and the patients decided not to proceed with heavy metal screening. Some healthcare providers ordered heavy metal screening; none of these medical providers reported any positive heavy metal screens.

2.9 Community Concerns

2.9.1 TVA Community Involvement Center

TVA set up a Community Involvement Center in Kingston. People can go to the center in person or can telephone with any concerns about the ash release. As of June 22, 2009, 213 households had registered in writing at the center. TDH has also received calls from citizens concerned about the ash release. Many of the same people called the TVA Community Involvement Center and TDH with the same comments. Of these contacts, 36% had general health questions or concerns, 38% had respiratory complaints, 5% had complaints about rashes and itching, 7% had complaints about headaches and migraines, and 5% had other health issues. Respiratory complaints included complaints about colds, sinus conditions, congestion, cough, nosebleeds, asthma, emphysema, respiratory allergies, and chronic obstructive pulmonary disease. Some contacts were concerned about the air, water, or recreation. Of these contacts, 13% were concerned about the air, 6% were concerned with wells or springs, 10% were concerned about municipal water, and 15% were concerned about recreational use of the water. There were other non-health related reasons for why people contacted the Center.

These complaints were mapped in an attempt to determine if there was a pattern that suggested any particular exposure. See Figure 15 for a map of community concerns.

EEP used a Directional Distribution (Standard Ellipse) tool in ArcGIS to see if the complaints about dust and respiratory symptoms and real-time air measurements greater than 150 $\mu g/m^3$ were related to the truck routes. This tool allowed EEP to create what are called standard ellipses, which show the distribution of features as well as whether there is a directional trend or orientation in that distribution. This tool can be used to compare distributions, examine distributions from different time periods, and show compactness and orientation of distributions. If distributions closely resemble a circle, then there is not a strong orientation to the occurrence of the variable. A large circle means the variables are widespread whereas a small circle means the variables are more localized (concentrated). The orientation of the ellipse indicates the direction in which the cases are occurring. See Figure 16 for the results and Appendix C for more details about the methodology.

Respiratory concerns were much more widespread as indicated by the large size of the ellipse, and have the same orientation as the dust concerns that appear to run along the truck route from the quarry. It also appears as though there is a relationship between respiratory complaints and the truck route.

The ellipse representing clustering of real-time air samples greater than 150 $\mu g/m^3$ indicates that higher real-time readings are more compactly clustered than the cluster for respiratory symptoms. The ellipse for higher real-time

TVA: TN Valley Authority

TDH: Tennessee Department of Health

EEP: Environmental Epidemiology Program

ArcGIS: ArcGIS is a group of geographical information system software that is used for mapping and statistical analysis of data that is geographically related.

$\mu g/m^3$: microgram per cubic meter of air readings is not oriented with the quarry. See Figure 16 for the location of the ellipses.

Analysis of 47,908 real-time air sampling results, with 216 results greater than 100 μg/m³, reveals that 53% of results greater than 100 μg/m³ are related to fires and that 22% have an unknown cause. See Table p below. Only about 8% of higher readings can be attributed to visible dust or truck/car traffic.

Table p. Summary of notations for instantaneous reading >100 μg/m³. Kingston Fossil Plant, Harriman, Roane County, Tennessee.

Notation summary	Number >100 μg/m³	Percent
Visible fire, active fireplace, or wood-burning odor	115	53
No visible dust or odor	47	22
Hazy, foggy, or high humidity conditions	34	16
Visible dust/ truck traffic	18	8
In a work area	4	2
Other	4	2
More than 1 notation was included with some sample results		

2.9.2 Other Concerns

Immediately after the ash release a non-governmental agency, United Mountain Defense (UMD), began working in the community. UMD is an organization that works to stop mountain top removal coal mining. UMD provided bottled water to residents even though all sampling for municipal drinking water and well water have continuously met all EPA and TDEC regulations. UMD also worked to have 30 members of the community tested for heavy metals at a Tennessee company called Internal Balance. Internal Balance advocates wellness and detoxification strategies. TDH did not recommend metals testing because the community is not exposed to elevated levels of metals from coal ash.

Some community members who were tested for heavy metals are concerned about abnormal results they received, but have had no medical follow up. Some health care providers in the area are uncomfortable interpreting these test results. Several community members have reported abnormal laboratory results for porphyrins testing done through UMD. People are concerned about their health, about exposures, and about proper diagnosis and treatment.

TVA has contracted with Oak Ridge Associated Universities (ORAU) to provide services to individuals with health concerns relating to the coal ash release. ORAU has subcontracted with the Tennessee Poison Center at Vanderbilt University Medical Center (VUMC) to provide expertise in medical toxicology to area health care providers and to individuals. ORAU and VUMC medical toxicologists have prepared a protocol for acceptance into the medical program and for appropriate testing of individuals. TVA will pay the costs associated with these examinations. In addition, if an individual's health has been adversely impacted by exposure to the released coal ash, TVA will pay for treatment (personal communication, Joseph J. Hoagland, TVA, September 9, 2009).

μg/m³: microgram per cubic meter of air

UMD: United Mountain Defense

EPA: U.S. Environmental Protection Agency

TDEC: TN Department of Environment & Conservation

TDH: Tennessee Department of Health

TVA: TN Valley Authority

ORAU: Oak Ridge Associated Universities

VUMC: Vanderbilt University Medical Center

ORAU and VUMC will not share individual medical records with TVA or TDH without specific authorization from an individual patient. However, ORAU will provide information on any health trends related to exposure to the coal ash with TVA and TDH.

ORAU: Oak Ridge Associated Universities

VUMC: Vanderbilt University Medical Center

TVA: TN Valley Authority

TDH: Tennessee Department of Health

2.10 Conclusions and Recommendations

Conclusion 1

When the coal ash was released from the failed retention wall of one of the coal ash storage ponds, people in the path of the ash could have been harmed by the magnitude and suddenness of the ash release. The ash could have buried them if they had been on the portion of the Swan Pond Road that was covered. The ash could have buried them if they had been boating, swimming, or fishing in the Emory River or in the Church, Berkshire, or Swan Pond sloughs. If the release had occurred during a summer day when people were on the river or riverbanks, many people could have been harmed or killed.

An enormous amount of ash quickly filled the Emory River and two coves, moving one house from its foundation and causing two other homes to be uninhabitable. The force of the release ruptured a gas line and disrupted power, causing the evacuation of the neighborhood along Swan Pond Road and Emory River Drive. A train derailed when it ran into a portion of the huge pile of coal ash. People driving home during the night found that Swan Pond Circle Road was impassable due to the ash. Fortunately, no one on the road or river was buried by the coal ash release.

Recommendation 1

The Roane County Office of Emergency Services and Homeland Security acted immediately to protect people. The Tennessee Valley Authority, the U.S. Environmental Protection Agency, the Tennessee Department of Environment and Conservation, the Tennessee Emergency Management Agency, and the Tennessee Department of Health began to assist through a unified command structure. Although the command center was demobilized in January 2009, the response from state and federal agencies has continued, and will continue until the area is returned to the conditions existing before the coal ash release.

The Tennessee Department of Health and the Tennessee Department of Environment and Conservation will continue to widely publicize the following message: *If you do contact the ash, then practice good hygiene, especially washing your hands before eating or smoking. Wash thoroughly, including your hands, clothes and shoes if you, your children, or pets come in contact with the ash. Basically, wash the same way you would after mud exposure. Remember, the metals are bound to the ash. Occasional exposures for brief periods of time should not harm people's health.*

This coal ash release highlights the continued need for industries and federal, state, and local officials to work closely together to develop comprehensive emergency response plans and capabilities in communities where acute environmental incidents are possible.

Conclusion 2

The Tennessee Department of Health concludes that it is unlikely that harm occurred to people from touching the coal ash when they had to climb out of their damaged houses on the morning of December 22, 2008, and to those who returned to retrieve personal property.

Longer-term contact would be necessary to cause any significant local skin irritation, such as coal ash that has gotten under a bandage. Casual contact with coal ash should not cause skin irritation. In addition, the metals in the coal ash are not likely to get into people's bodies from touching the ash.

Recommendation 2

People whose homes were destroyed have been relocated. In addition, the Tennessee Valley Authority has relocated most of the families whose property was near the affected portions of the Emory River and coves.

The U.S. Environmental Protection Agency, the Tennessee Department of Environment and Conservation, and the Tennessee Valley Authority should continue to work cooperatively to clean up the ash as quickly as possible while protecting the people in the community from touching, accidentally eating, drinking, or breathing the coal ash.

Conclusion 3

The Tennessee Department of Health concludes that no harm to the community's health is expected from touching the coal ash. This includes children who might touch the ash while playing.

Longer-term contact would be necessary to cause any significant local skin irritation, such as coal ash that has gotten under a bandage. Casual contact with coal ash should not cause skin irritation. In addition, the metals in the coal ash are not likely to get into people's bodies from touching the ash. The ash has been fenced, clearly marking the areas with coal ash. The opportunity for people, especially children, to touch the ash is currently minimal.

Recommendation 3

The Tennessee Valley Authority should continue working in cooperation with the U.S. Environmental Protection Agency and the Tennessee Department of Environment and Conservation to clean up the coal ash while protecting the people in the community from touching the coal ash.

Conclusion 4

The Tennessee Department of Health concludes that no harm to people's health is expected from accidentally eating a small amount of coal ash.

The concentrations of metals in the coal ash, except arsenic, are below levels known to cause harm if eaten. Because exposure to the coal ash was brief and the arsenic in the coal ash is not completely available for absorption, no harm to health is expected even if the coal ash were accidentally eaten. The ash has been fenced, clearly marking the areas with coal ash.

Recommendation 4

The Tennessee Valley Authority should continue working in cooperation with the U.S. Environmental Protection Agency and the Tennessee Department of Environment and Conservation to clean up the coal ash while protecting the people in the community from eating the coal ash.

Conclusion 5

The Tennessee Department of Health concludes that using the Emory River at the site of the coal ash release (near Emory River mile 2) could result in harm to residents or trespassers from physical hazards associated with cleanup efforts and from the volume of ash present, if residents or trespassers entered the area.

The Tennessee Valley Authority is using heavy machinery to build dikes and weirs to contain the ash and to remove the ash. The U.S. Environmental Protection Agency and the Tennessee Valley Authority have brought in large hydraulic dredge equipment to expedite the removal of ash from the Emory River. People could be harmed if their boats became entangled in any cable or tie-offs for the dredging equipment or if any of the transport piping used to transport dredged ash were to blowout resulting in materials hitting someone nearby. In addition, boaters could hit partially submerged obstructions in the work area or have decreased visibility by not being able to see around the large equipment. By summer 2010, ash removal in the main channel of the Emory River will have been completed and all heavy equipment will be removed.

Recommendation 5

The Tennessee Valley Authority is working in cooperation with the U.S. Environmental Protection Agency and the Tennessee Department of Environment and Conservation to clean up the coal ash while protecting the people in the community. While cleanup is underway, heavy machinery will be present. The Tennessee Valley Authority should continue to actively patrol the area so that unauthorized persons cannot enter the area. The U.S. Environmental Protection Agency, in conjunction with the Tennessee Departments of Health and Environmental Conservation and the Tennessee Valley Authority, issued a Recreational Advisory for Watts Bar Reservoir in June 2009. This advisory states, in part: *The public is cautioned to avoid recreational use of the lower Emory River in the vicinity of the ash release down to the confluence of the Emory and Clinch Rivers, which includes adjacent coves, inlets, islands, and sand bars. Small vessel traffic is currently channeled through a well-marked navigational lane, but swimming, jet skiing, water skiing and tubing are not advised at this time in these areas. In addition to construction related risks, contact with submerged or floating ash should be avoided, and if ash is contacted it should be washed off with soap and water. Chronic exposure by incidental ingestion and inhalation should also be avoided.*

On August 11, 2009, the Environmental Protection Agency, in conjunction with the Tennessee Department of Environment and Conservation and the Tennessee Valley Authority, closed the Emory River from mile marker 1.5 to mile marker 3. The river closure was extended from mile marker 0.0 to mile marker 6.0. The river was closed to river traffic through May 28, 2010.

Conclusion 6

The Tennessee Department of Health concludes that using municipal drinking water from the Kingston and Rockwood water treatment plants will not harm people's health because the raw and finished water have continuously met drinking water standards.

The Environmental Protection Agency's contractor tested raw and finished drinking water for the Kingston and Rockwood water treatment plants every day between December 23, 2008, and January 5, 2009. The Tennessee Department of Environment and Conservation tested the water every day between January 2 and January 22, 2009, and continues to sample the water weekly. At no time, has the raw or finished water contained metals above primary drinking water standards. The water intake for the Kingston water treatment plant is about 6 miles downstream of the ash release site. The water intake for the Rockwood water treatment plant is about 23 miles downstream of the ash release.

Recommendation 6

The Tennessee Department of Environment and Conservation should continue to sample and analyze raw and finished water at the Kingston and Rockwood water treatment plants. If any at any time, violations of water quality are detected, the Tennessee Department of Environment and Conservation will take immediate action to protect the health of the communities using the municipal water.

Conclusion 7

The Tennessee Department of Health concludes that using well or spring water within four miles of the coal ash release will not harm people's health from exposure to coal ash or metals in the coal ash because no evidence has been found for groundwater contamination by coal ash.

Between December 30, 2008, and March 12, 2009, the U.S. Environmental Protection Agency, the Tennessee Department of Environment and Conservation, and the Tennessee Department of Health sampled and analyzed water from 102 privately owned wells and springs within a four-mile radius of the ash spill. None of the water tested had any contaminants above the national or state primary drinking water limits called Maximum Contaminant Levels (MCLs). There is no indication from groundwater sampling and analysis that coal ash has contaminated the groundwater.

Recommendation 7

The Tennessee Department of Environment and Conservation should continue to take samples of groundwater from private wells and springs for analysis periodically to make sure that the coal ash is not affecting groundwater. If elevated concentrations of any of the metals from the coal ash are found in groundwater, the Tennessee Department of Environment and Conservation will take immediate action to protect the health of the community. If site conditions at the Kingston Fossil Plant coal ash release should change, then the groundwater sampling timeframe should be re-evaluated.

Conclusion 8

The Tennessee Department of Health concludes that no harm to people's health should result from recreational use of the Emory, Clinch, and Tennessee Rivers outside the area of the lower Emory River down to the confluence of the Emory and Clinch Rivers, as specified in the recreational advisory and river closure. Previous fish advisories should be followed.

Sampling and analysis for metals associated with coal ash indicated that metals in all other areas of the Emory River and the Clinch River have remained below any health comparison values. Concentrations of total suspended solids have remained low in all areas of the Emory and Clinch Rivers except at the site of the coal ash release. The Tennessee Department of Environment and Conservation and the Tennessee Valley Authority will continue to sample and analyze surface water in the Emory, Clinch, and Tennessee Rivers. If any at any time, violations of water quality are detected, the Tennessee Department of Environment and Conservation will take immediate action to protect the health of people using the rivers for recreation.

The Tennessee Department of Environment and Conservation and the Tennessee Wildlife Resources Agency advise avoiding consumption of striped bass and limiting consumption of catfish and sauger. The pollutants of concern are polychlorinated biphenyls (PCBs) and mercury from historical activities not related to the Tennessee Valley Authority (see Appendix D).

Recommendation 8

The Tennessee Valley Authority should continue to clean up the site of the coal ash release as fast as possible while, at the same time, protecting both public health and the health of the river and its aquatic life. The Tennessee Department of Environment and Conservation should continue to monitor the Emory and Clinch Rivers to make sure they remain safe for recreational activities. The Tennessee Wildlife Resources Agency and the Tennessee Department of Environment and Conservation are sampling fish to make sure the coal ash does not affect them and indirectly harm people who eat the fish.

Cleanup of the coal ash release is being conducted in a way that will not disturb historical contamination of the river sediments with polychlorinated biphenyls (PCBs) and mercury. TVA and EPA entered into an Administrative Order and Agreement on Consent on May 6, 2009, to ensure that the environmental impacts associated with the ash spill are thoroughly assessed and that appropriate response actions are taken as necessary to protect public health, welfare of the environment, and to ensure that the response actions satisfy all federal as well as state environmental requirements. TDEC's Commissioner's Order of January 12, 2009, and TDEC's collaboration with TWRA in protecting fish are included in the TVA/EPA order.

Conclusion 9

While no air measurements were obtained during the time period between December 22 through December 27, 2008, the Tennessee Department of Health concludes that it is unlikely that any harm to public health should have resulted from breathing ambient air from December 22, 2008, through December 27, 2008. However, any dust that may have been inhaled could have aggravated symptoms in sensitive populations, that is, people with asthma, emphysema, and other respiratory or cardiovascular conditions.

The coal ash was wet when it spilled. Wet weather for three days after the spill, combined with low temperatures and slow wind speeds, would have kept the coal ash from drying out and getting into the air.

Recommendation 9

Since no air measurements were obtained during the time period between December 22 through December 27, 2008, it is not possible to know precisely what the air conditions were during this time. All emergency operations were aimed at protecting the public from released coal ash and dealing with emergency situations created by derailed trains, ruptured gas lines, destroyed homes, and destroyed roads. The U.S. Environmental Protection Agency began taking samples on site on December 27, 2008. Various types of air sampling in the community began on December 28, 2008 by the Tennessee Valley Authority, on December 30, 2008 by the U.S. Environmental Protection Agency, and on January 19, 2009, by the Tennessee Department of Environment and Conservation.

Conclusions 10a, b, c

a. The Tennessee Department of Health concludes that breathing ambient air near the coal ash release is not expected to harm people's health as long as adequate dust suppression measures are in place.

b. The Tennessee Department of Health concludes that no harm to people's health is expected from occasionally breathing coal ash if it should become airborne for short periods of time.

c. If dust suppression measures should fail and particulate matter is present in concentrations greater than National Ambient Air Quality Standards due to the coal ash becoming airborne for periods longer than one day, the Tennessee Department of Health concludes that particulate matter from airborne coal ash could harm people's health, especially for those persons with pre-existing respiratory or heart conditions. Such harm could include upper airway irritation and aggravation of pre-existing conditions such as asthma, emphysema, and other respiratory or cardiovascular conditions.

   Sampling and analysis of particulate matter by all agencies indicated that particulate matter, less than or equal to 2.5 microns in diameter (PM2.5) and less than or equal to 10 microns in diameter (PM10), in ambient air surrounding the coal ash release met all National Ambient Air Quality Standards.

Coal ash is considered a nuisance dust because of the size range of the particulate matter. Metals in the ash are not at high enough concentrations to cause harm if they are breathed. If the coal ash were breathed in for longer periods or more frequently, the particulate matter in the airborne coal ash would cause the same harm as breathing in other dusts (such as dust from a ball field or farm land). Examples of such harm are upper airway irritation and aggravation of pre-existing problems such as asthma, emphysema, and other respiratory or cardiovascular conditions.

The Tennessee Valley Authority's air monitors did not often detect metals in total particulate matter. Most measurements were below health comparison values. Arsenic and chromium detected by the Tennessee Valley Authority in total particulates on-site were within the range found in the United States for metals on particulate matter. Sampling and analysis of ambient air off-site were done by using temporary monitors that sampled total particulate matter, not just respirable or inhalable particulates. One sample taken on January 26, 2009, had cadmium in total particulates above the health comparison value. This sample represents just one sampling result within results for five sampling stations with daily sampling from January 1 through March 10, 2009 (345 samples).

Metals in total suspended particulates measured by the Tennessee Department of Environment and Conservation were all below health comparison values, except for two samples of arsenic that were slightly above the health comparison value. These two detections of arsenic should have no impact on public health because the concentrations of arsenic detected were extremely low. In addition, metals measured in total suspended particulates include metals of all sizes of particulate matter, not just particulate matter that is respirable.

Recommendation 10

The Tennessee Valley Authority and the Tennessee Department of Environment and Conservation should continue to measure particulate matter and metals in particulate matter in the air near the release until the coal ash release is cleaned up.

The Tennessee Department of Health, the Tennessee Department of Environment and Conservation, and the Tennessee Valley Authority will ensure that a system is in place to warn people if the air quality is likely to fail to meet National Ambient Air Quality Standards.

Conclusion 11

The Tennessee Department of Health cannot conclude whether breathing dust near the quarry and along the routes of the quarry trucks has or will harm people's health. Such dust can be irritating to upper airways and can aggravate pre-existing conditions such as asthma, emphysema, and other respiratory or cardiovascular conditions.

Of the 47,909 real-time measurements of particulate matter less than or equal to 10 microns in diameter (PM10) in the community near the ash release, 0.1% were above 150 micrograms per cubic meter, the 24-hour average National Ambient Air Quality Standard. Many of these samples were taken near the quarry and along the quarry truck routes. Because the samples were collected during a short time period, three to five minutes, we cannot make any predictions about the 24-hour average concentrations. We can say that the quarry dust does not typically contain heavy metals like the coal ash. Quarry dust contains chemicals present in limestone, such as calcium, magnesium, and carbonates. Such dust can be irritating to upper airways and can aggravate pre-existing conditions such as asthma, emphysema, and other respiratory or cardiovascular conditions.

Recommendation 11

If the rock dust from the quarry was a health problem, it was because it is particulate in nature. The Tennessee Department of Environment and Conservation should continue to work with the quarry and with the Tennessee Valley Authority to lessen the dust at the quarry and along the truck routes.

Conclusion 12

The Tennessee Department of Health concludes that the small amount of radiation from the coal ash is not expected to harm people's health. Any exposure to radiation from the small amount of naturally occurring radionuclides present in coal ash, even in the more concentrated forms in coal ash, would be too small to give a radiation dose to people that would be substantially greater than the normal, everyday background radiation dose to which all people are exposed.

The radioactive materials of concern in coal ash include both radium-226 and radium-228. Although the concentration of these materials in the coal ash exceeded the average regional background soil concentrations, the levels are below the health-based directive used by both the U.S. Environmental Protection Agency and the Agency for Toxic Substances and Disease Registry. This regulatory limit was set to protect the health of people, including the health of sensitive populations.

Recommendation 12

No additional public health actions are needed related to radiation from the released coal ash. The Tennessee Valley Authority, the U.S. Army Corps of Engineers, the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Tennessee Department of Environment and Conservation signed the continuing Interagency Agreement Watts Bar Reservoir Permit Coordination in February 1991. This agreement governs any activities that could result in the disturbance, resuspension, removal, and/or disposal of sediments contaminated by Oak Ridge Reservation past activities. The cleanup of ash in Watts Bar Reservoir is functioning under this agreement to prevent dredging of legacy contamination not related to the coal ash release.

Conclusion 13

The Tennessee Department of Health supports the efforts of the non-governmental organizations to collect environmental data in the days after the coal ash release. The Tennessee Department of Health concludes that data collected by non-governmental organizations confirm data collected by governmental agencies at the site of the coal ash release. Because the data were collected for a brief time immediately after the coal ash release and were collected only at the site of the release, they could not be used in establishing the long-term public health implications of the coal ash release for Watts Bar Reservoir.

Data from all agencies agree that arsenic in the coal ash was at levels above health comparison values, that arsenic in the Emory River at the site of the ash release was elevated immediately following the release. They also agree that groundwater in the vicinity of the coal ash release was not impacted by the coal ash. Non-governmental organizations, as well as the Tennessee Departments of Health and Environment and Conservation and the U.S. Environmental Protection Agency, expressed concern about the potential for harm to health from breathing airborne coal ash. See Conclusion 10 for more about this.

The data provided by non-governmental organizations about selenium in certain fish were not replicated by Tennessee Department of Environment and Conservation's, the Tennessee Wildlife Resources Agency's, or the U.S. Environmental Protection Agency's sampling and analysis. However, it has signaled the need for further investigation by government agencies. The Environmental Protection Agency's Science Review Panel and the U.S. Corps of Engineers have generated two reports on selenium impacts at the site of the coal ash release.

Non-governmental organizations (NGOs) collected most of the data in the days just after the coal ash release and in areas near the release. In some cases, the Tennessee Department of Health could not determine the exact sampling and analysis techniques or quality control and quality assurance measures. We appreciate this additional data and the concern about the environment and the health of Tennesseans by the non-governmental organizations. By working together, all governmental and non-governmental agencies can protect the environment and the health of the people who live in the area of the coal ash release.

Sampling and analysis of groundwater, surface drinking water, well water, and air continues by the Tennessee Valley Authority and the Tennessee Department of Environment and Conservation. This continuing sampling will allow the Tennessee Department of Health and the Tennessee Department of Environment and Conservation to ensure that the health of the public near the coal ash release continues to be protected.

Recommendation 13

None at this time.

Conclusion 14

Based on the Community Health Survey, the Tennessee Department of Health concludes that many residents living in the area of the coal ash spill experienced stress and anxiety. Some residents reported respiratory symptoms after the ash release.

Analysis of questions from the Community Health Survey indicated that 52 percent of the persons who answered questions for the survey experienced stress and anxiety. Symptoms of stress and anxiety are natural and to be expected since the coal ash release destroyed homes, disrupted lives, and drastically changed the landscape. Since the coal release occurred just before Christmas, even more stress was added to the lives of the people living near the coal ash release. Forty percent of the persons who answered questions for the survey reported a change in health status since the spill, primarily either worsening of cough or headaches, wheezing, or shortness of breath.

It is important to note that the survey was done soon after the spill, but was not repeated later. Therefore, the results are only applicable for the short period soon after the spill.

Recommendation 14

The Tennessee Department of Health has continually encouraged people to see their primary care provider for any health concerns. People are encouraged to contact the Oak Ridge Associated Universities to sign up for health screenings if they are concerned that their health has been harmed by the coal ash release. The health screenings will be done by medical toxicologists from the Tennessee Poison Center, Vanderbilt University Medical Center. The Department of Mental Health and the Tennessee Valley Authority worked with Ridgeview Community Mental Health Center in Oak Ridge and Harriman to provide services to people affected by the coal ash release.

Conclusion 15

Community members living near the quarry and along the routes that quarry trucks traveled made complaints specific to dust at the Tennessee Valley Authority's Community Involvement Center. Complaints about respiratory symptoms were widespread and were not oriented toward either the site of the coal ash release or the route of the quarry trucks.

The Tennessee Department of Health analyzed written complaints to the Tennessee Valley Authority's Community Involvement Center related to health concerns. The Tennessee Department of Health performed geographical analysis that indicated that dust concerns were strongly oriented to the location of the quarry and to routes traveled by the quarry trucks. Geographical analysis indicated that respiratory concerns were not geographically related to either the quarry or the coal ash release site.

Recommendation 15

The Tennessee Department of Environment and Conservation should continue to work with the quarry to control dust. TVA has implemented many dust control measures at the site of the coal ash release and for trucks leaving the site. Dust controls will continue to be required of trucks driving on county roads.

The Tennessee Department of Health has continually encouraged people to see their primary care provider for any health concerns. People are encouraged to contact the Oak Ridge Associated Universities to sign up for health screenings if they are concerned that their health has been harmed by the coal ash release. The health screenings will be done by medical toxicologists from the Tennessee Poison Center, Vanderbilt University Medical Center.

Conclusion 16

The Tennessee Department of Health concluded that screening people's blood or urine for metals would not be helpful.

Based on environmental test results, the Tennessee Department of Health does not expect harm to health from touching, eating, drinking, or breathing the metals in coal fly ash. No harm is expected from breathing the air as long as adequate dust suppression measures are in place. Any exposures would have been very brief, and any possible absorption of metals from the coal ash would have been undetectable.

Recommendation 16

If people chose to have metals' testing and they are concerned about their results, they should talk with their primary care provider or talk with a medical toxicologist at the clinics set up in the area by Oak Ridge Associated Universities and the Tennessee Poison Center at Vanderbilt University Medical Center.

Since the Public Health Assessment

All conclusions remain valid and unchanged as of July 2010. The Tennessee Department of Health has reviewed data continually as it has become available to make sure the public health of the community near the Tennessee Valley Authority spill site is protected.

2.11 Public Health Action Plan

The Tennessee Department of Health will continue to work with the Tennessee Department of Environment and Conservation and the Tennessee Valley Authority to analyze data for its public health implications. These agencies will continue to monitor the environment around the ash spill until all restoration is complete.

The Tennessee Department of Health will continue to work with the Tennessee Department of Environment and Conservation, the Tennessee Valley Authority, and the U.S. Environmental Protection Agency to involve the community in the process and to educate the community about the public health implications of the ash release and the cleanup.

The Tennessee Department of Health's Environmental Epidemiology Program will continue to work with the U.S. Environmental Protection Agency and the Tennessee Department of Environment and Conservation, if requested, as additional studies are conducted at the Tennessee Valley Authority's Kingston Fossil Plant and as the cleanup of the ash release continues.

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Figures

Figure 1. Aerial image of Kingston area prior to the ash slide. KIF coal ash spill, Harriman, Roane County, Tennessee.

Figure 2. Aerial image of Kingston ash slide. KIF coal ash spill, Harriman, Roane County, Tennessee. December 23, 2008.

Figure 3 Overview of the river systems near the KIF coal ash release, with water intakes. KIF coal ash spill, Harriman, Roane County, Tennessee

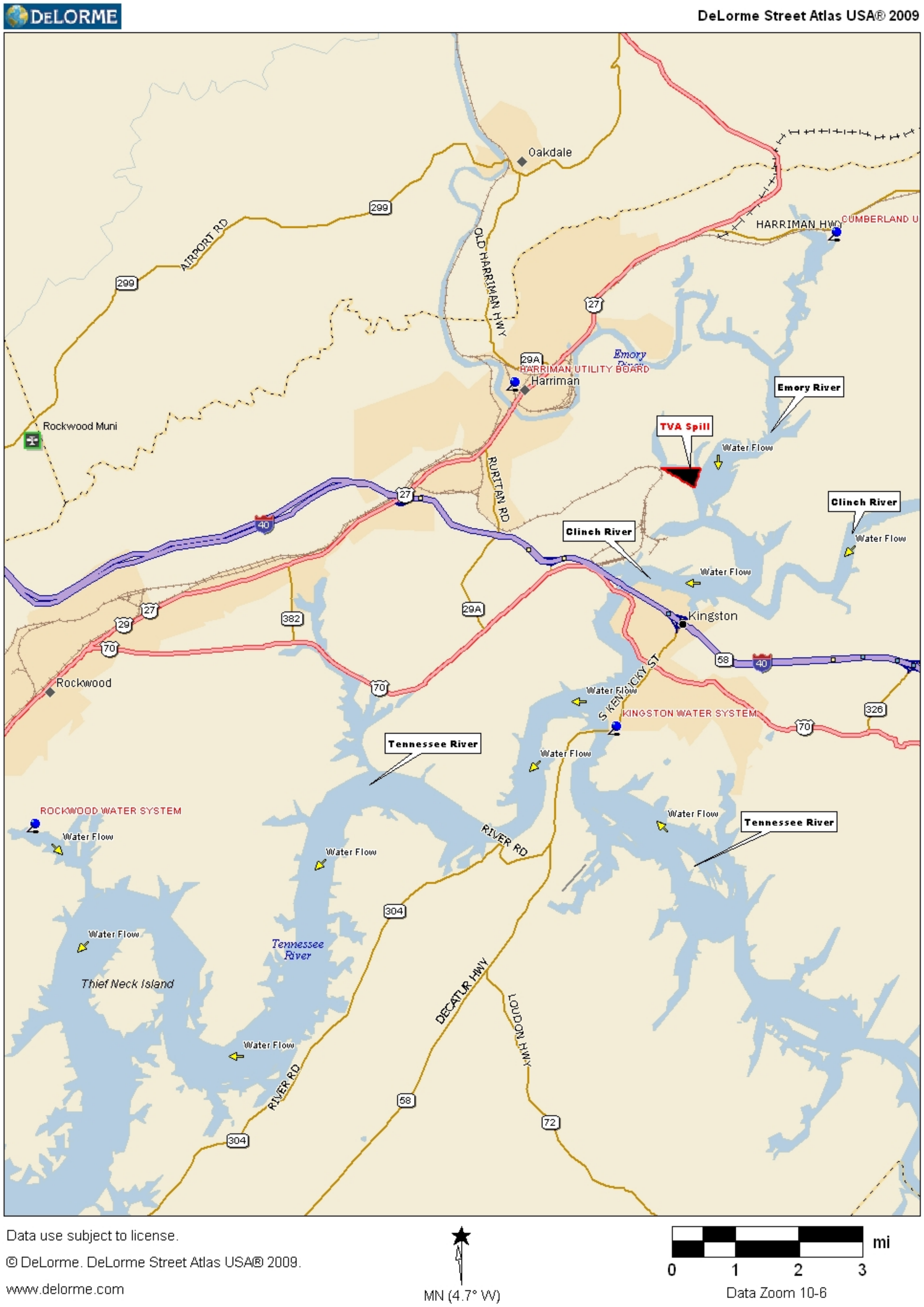


Figure 4. Soil and ash sampling locations. KIF coal ash spill, Harriman, Roane County, Tennessee.

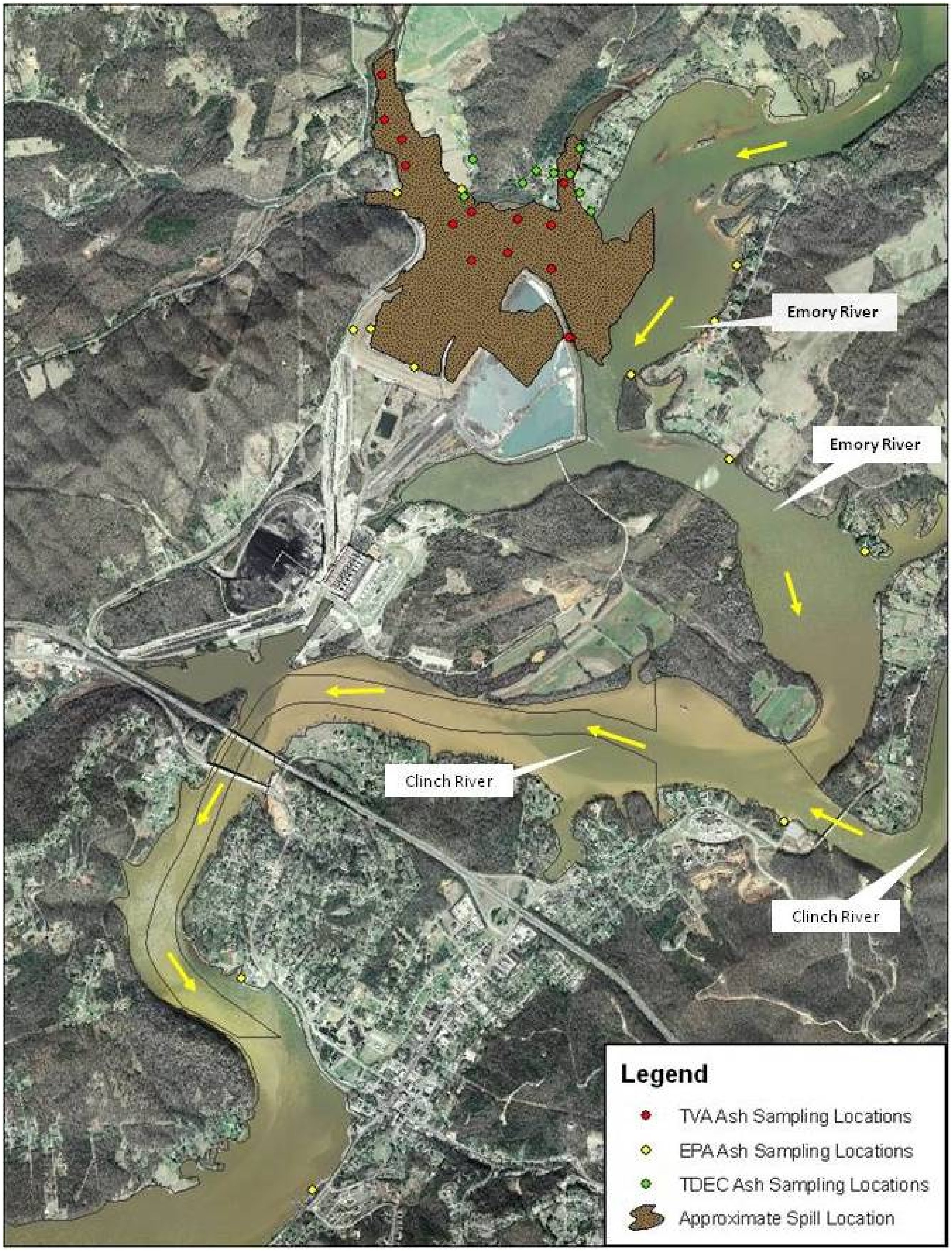


Figure 5. Tennessee Valley Authority surface water sampling locations. KIF coal ash spill, Harriman, Roane County, Tennessee.

Figure 6. Environmental Protection Agency surface water sampling locations. KIF coal ash spill, Harriman, Roane County, Tennessee.

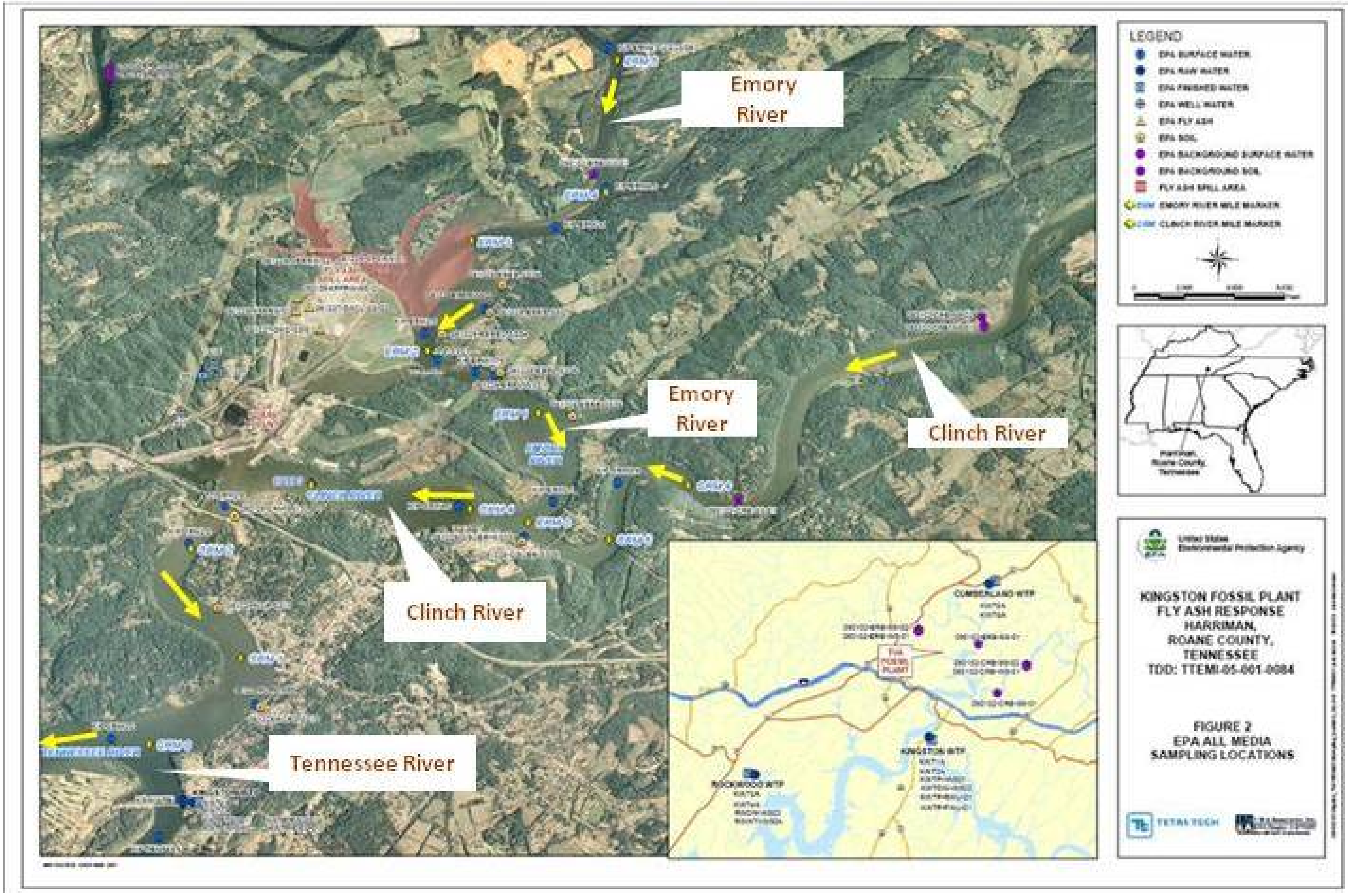


Figure 7. Tennessee Department of Environment and Conservation surface water sampling locations. KIF coal ash spill, Harriman, Roane County, Tennessee.

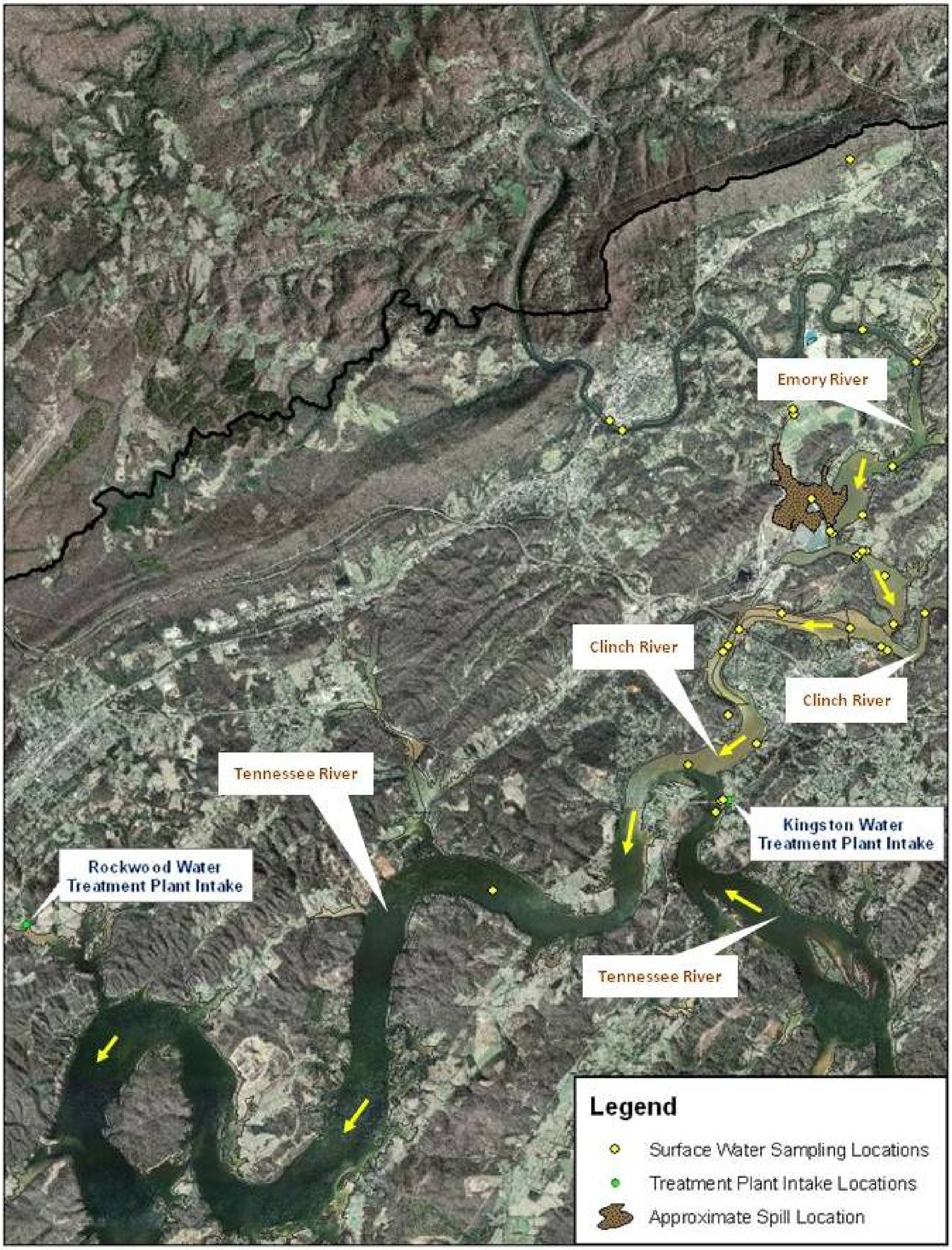


Figure 8. Tennessee Department of Environment and Conservation well and spring groundwater sampling locations. KIF coal ash spill, Harriman, Roane County, Tennessee.

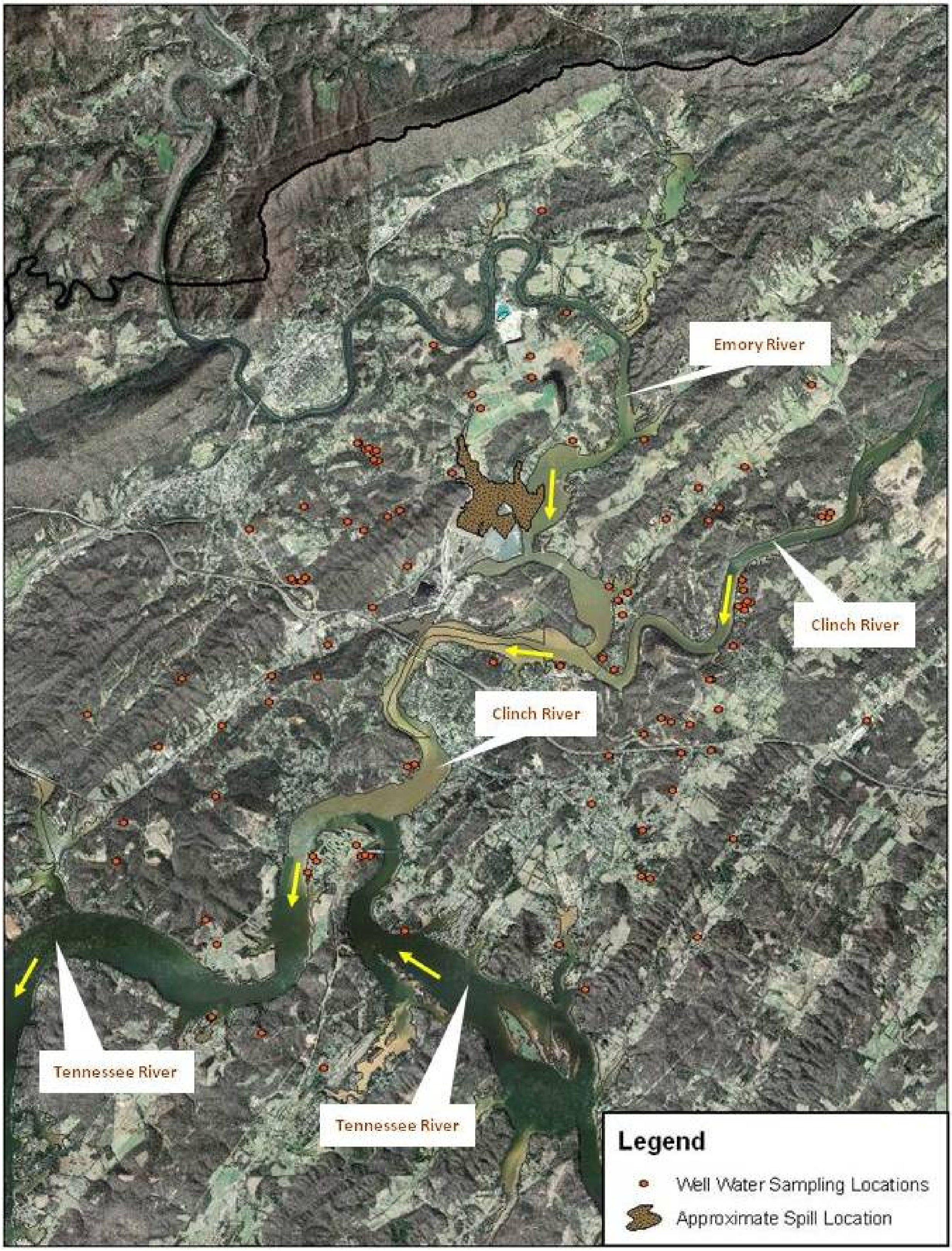


Figure 9. TVA Air monitoring locations. KIF coal ash spill, Harriman, Roane County, Tennessee.

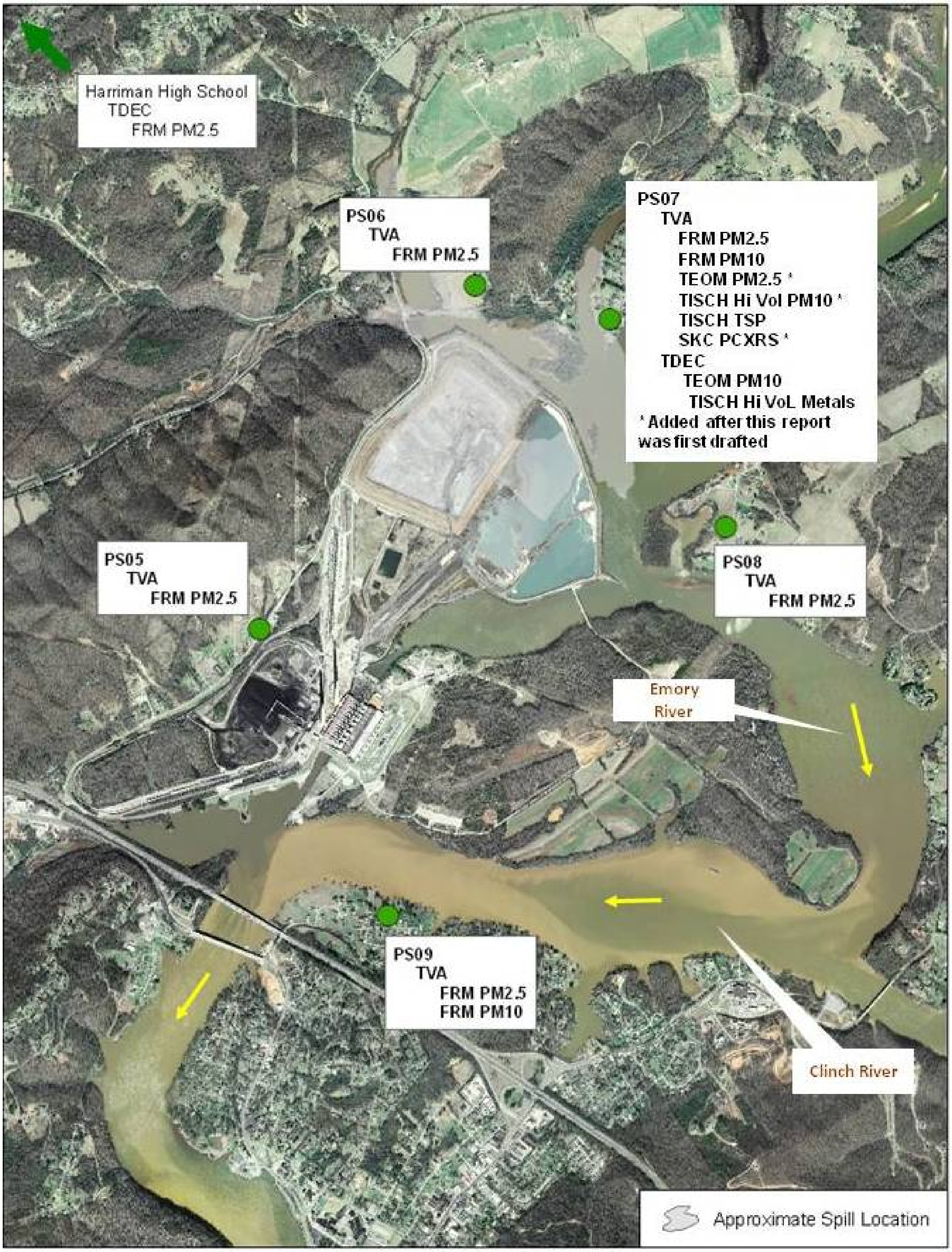


Figure 10. TVA and TDEC Air monitoring locations. KIF coal ash spill, Harriman, Roane County, Tennessee.

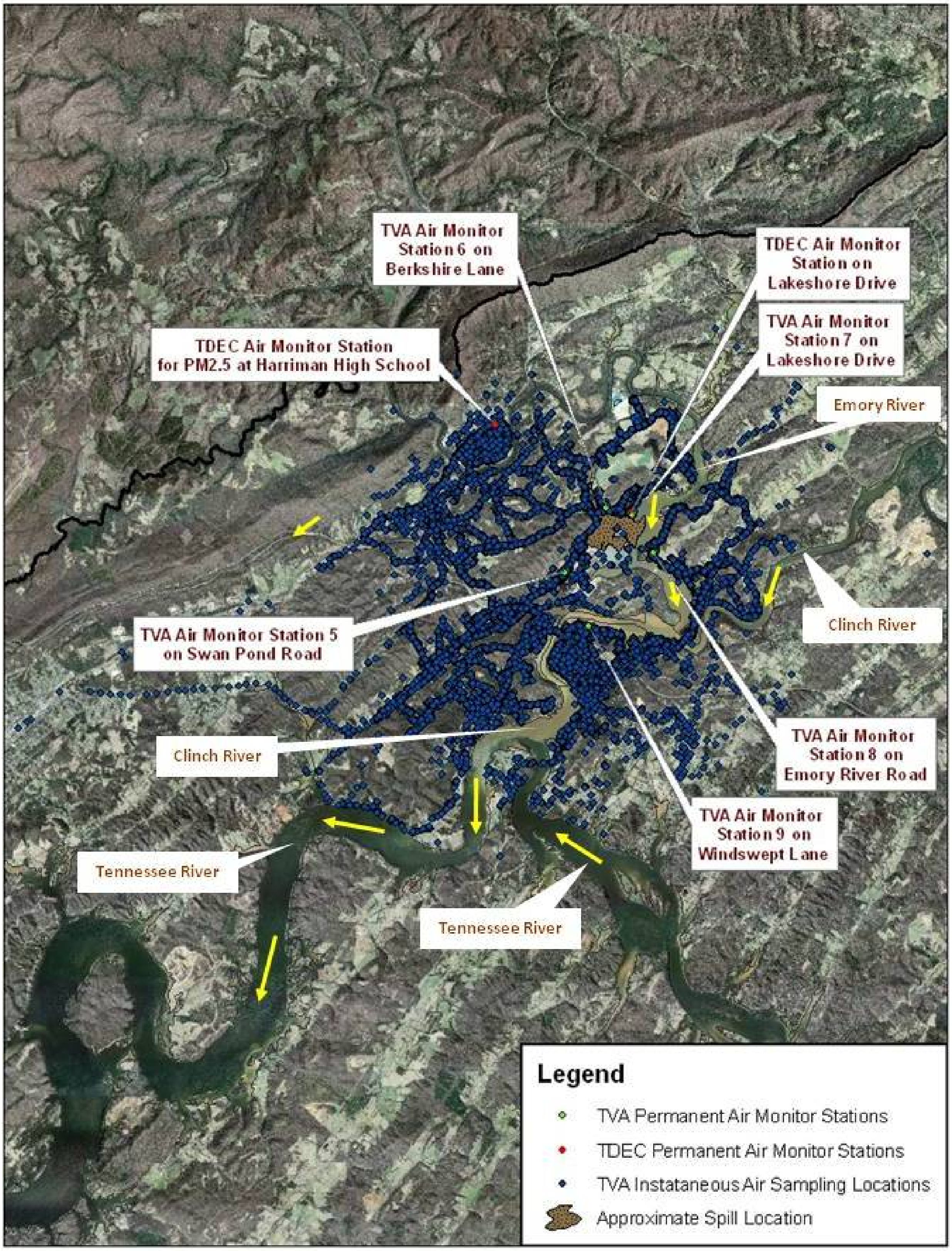


Figure 11. EPA Air monitoring locations. KIF coal ash spill, Harriman, Roane County, Tennessee.

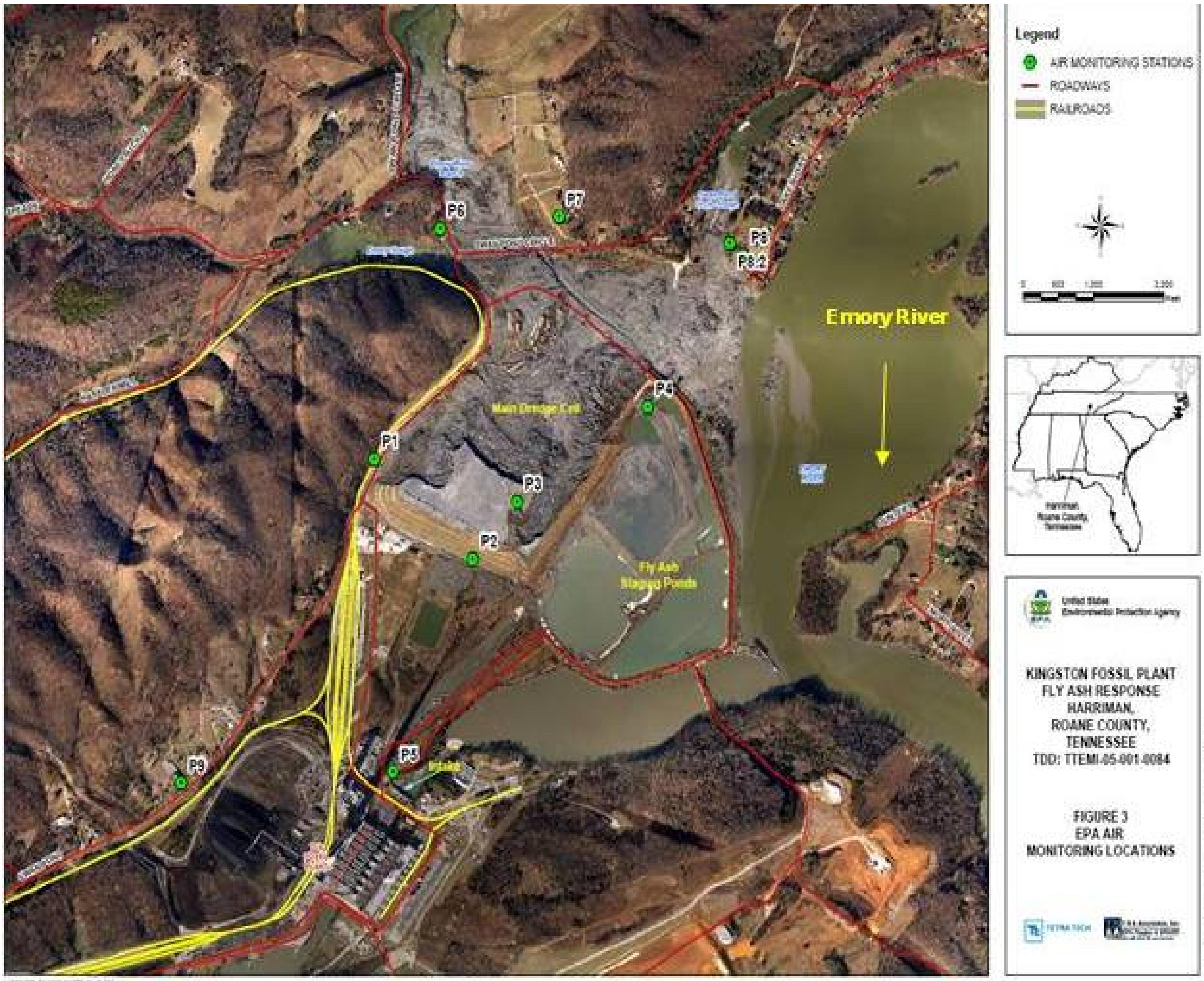
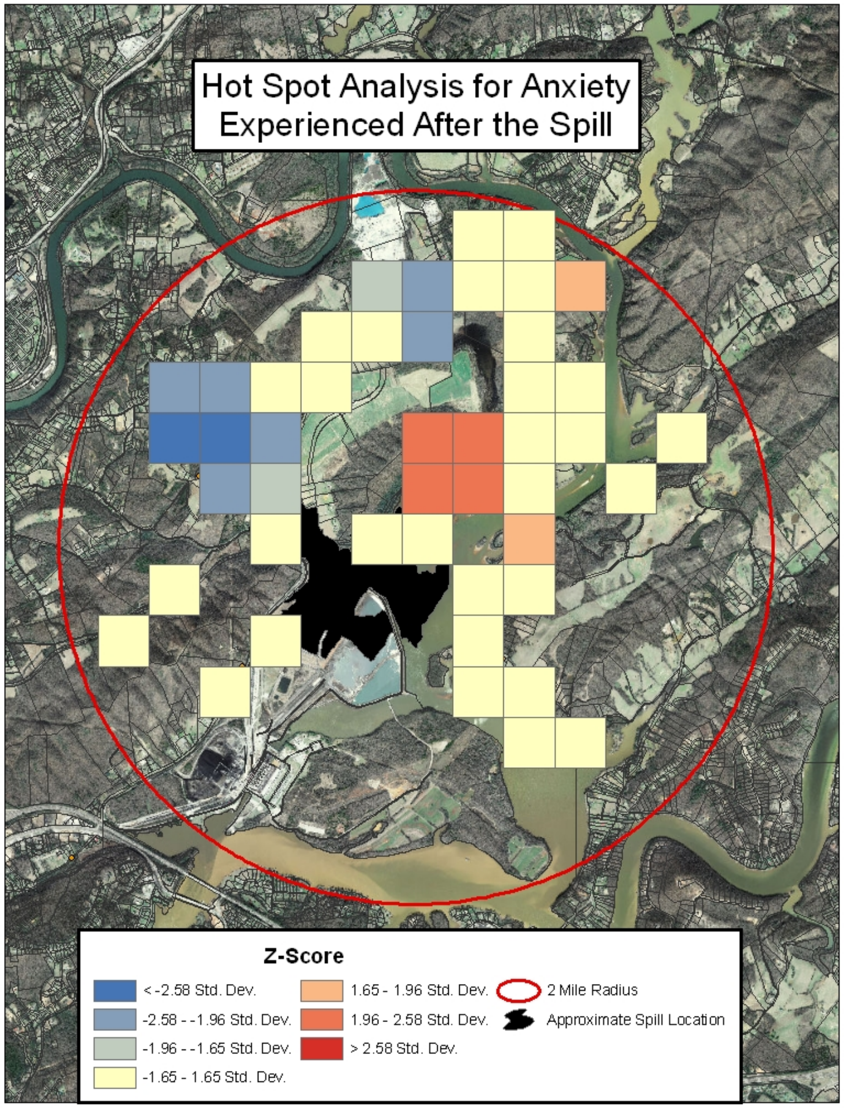


Figure 12. Hot spot analysis and directional distribution for anxiety after the ash release. KIF coal ash spill, Harriman, Roane County, Tennessee.



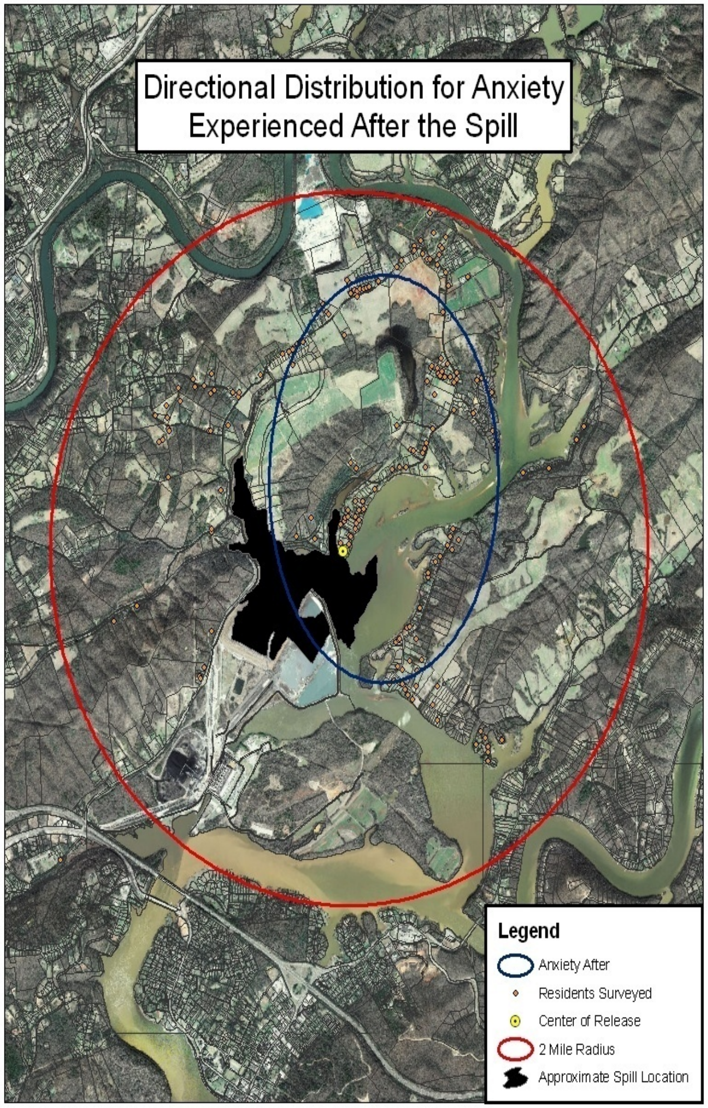
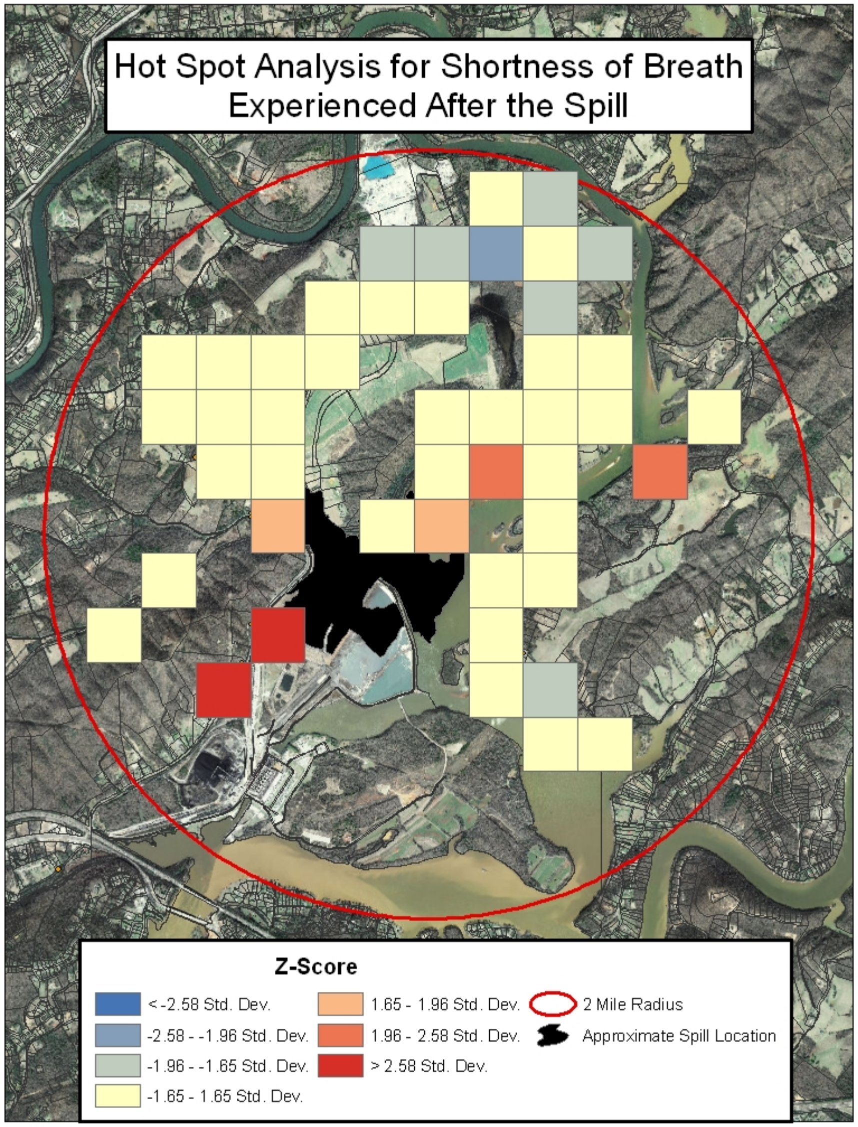


Figure 13. Hot spot analysis and directional distribution for shortness of breath experience before and after the ash release. KIF coal ash spill, Harriman, Roane County, Tennessee.



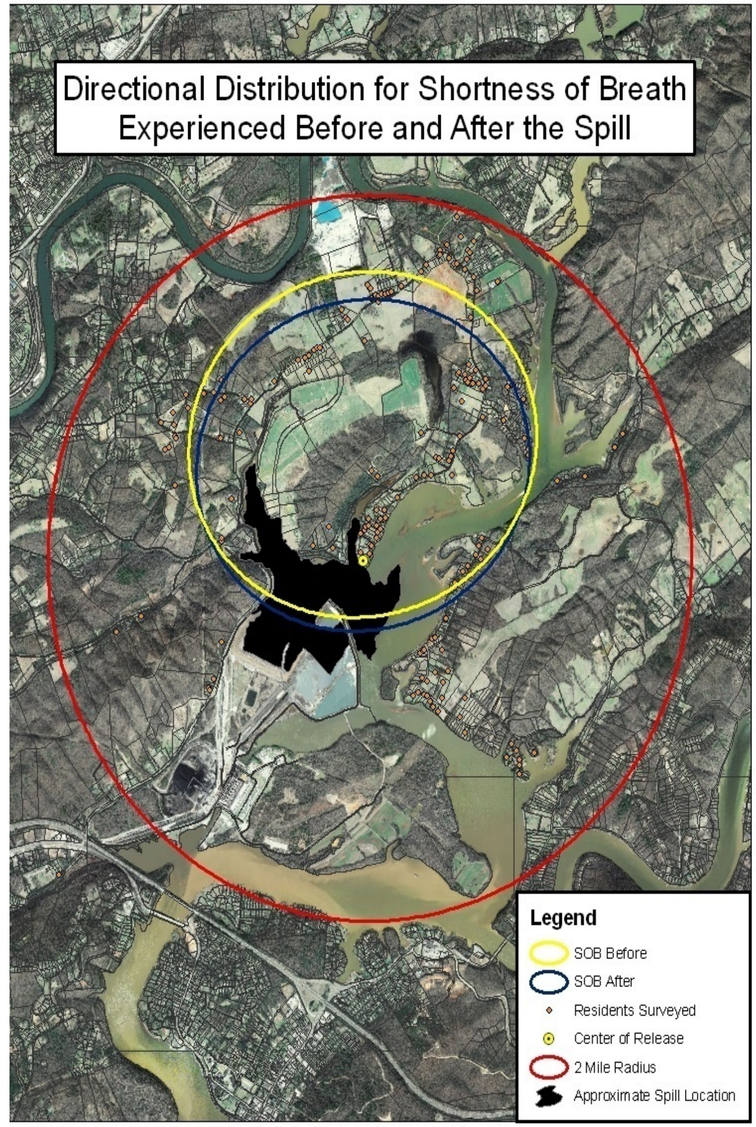
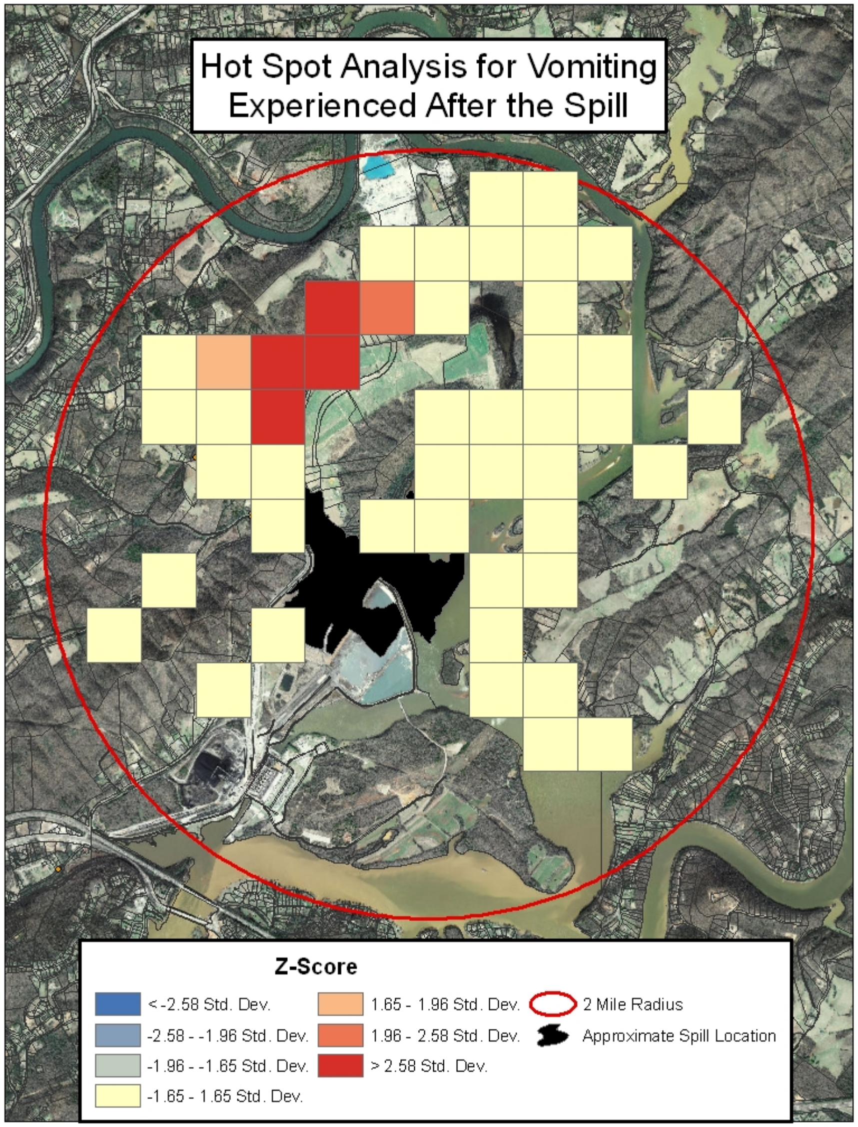


Figure 14. Hot spot analysis and directional distribution for vomiting experienced before and after the ash release. KIF coal ash spill, Harriman, Roane County, Tennessee .



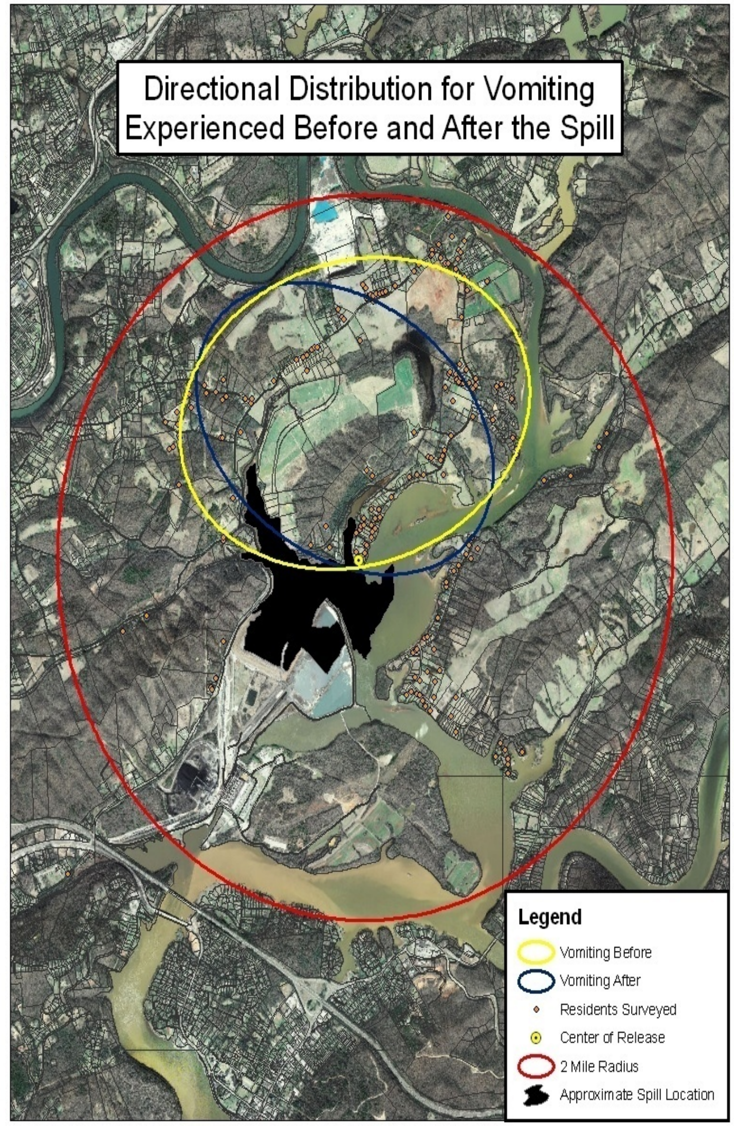


Figure 15. Locations of all health or dust complaints with the quarry truck routes. KIF coal ash spill, Harriman, Roane County, Tennessee.

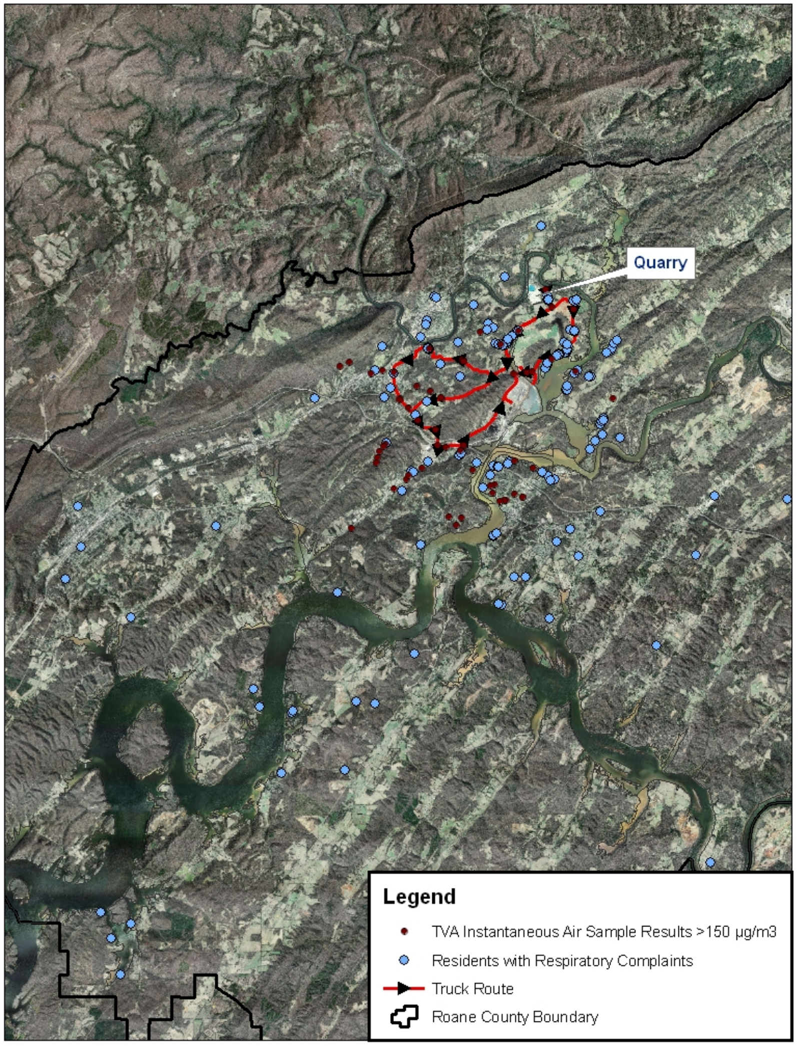
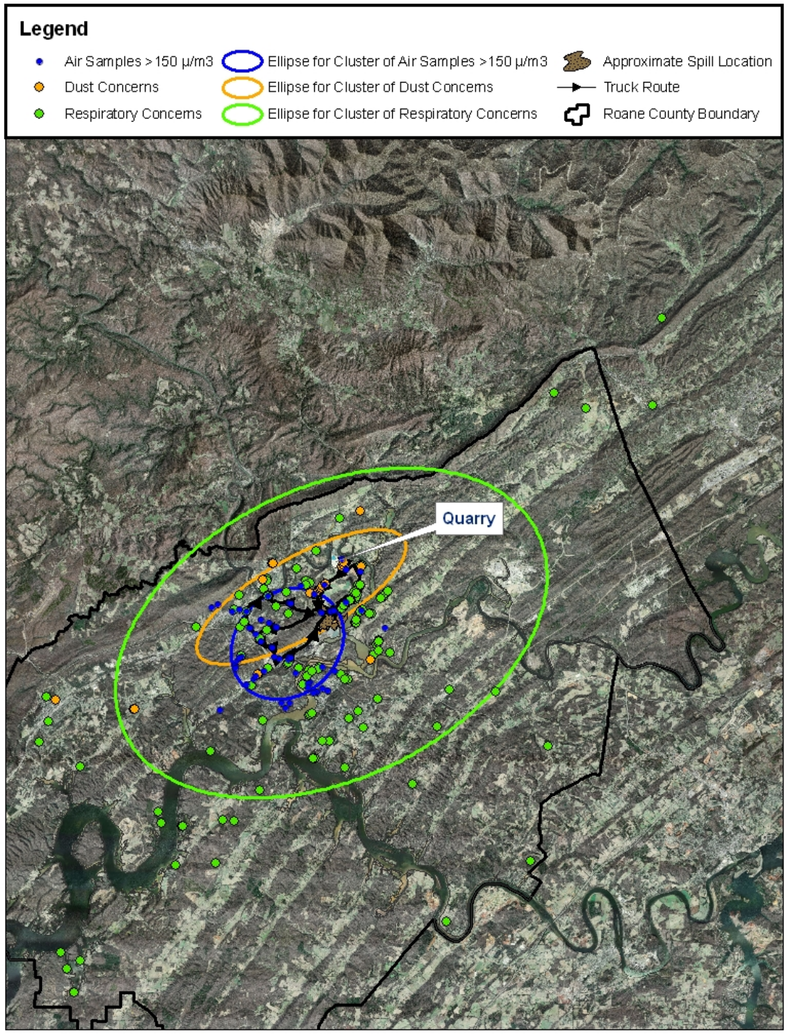


Figure 16. Directional distribution of dust and respiratory complaints. KIF coal ash spill, Harriman, Roane County, Tennessee



Tables

Table 1: TVA Ponded Fly Ash Analyses from Dredge Cell, February 5, 2002. Kingston Fossil Plant, Roane County, Tennessee.

Metal	Concentration, mg/kg	Concentration of TCLP Extract, mg/L	Health Comparison Values, Soil	
			Soil, mg/kg	TCLP, mg/L [7]
Aluminum	21,000	-----	50,000 [1]	-----
Antimony	< MDL (10.0) [2]	-----	20 [4]	-----
Arsenic	**61**	0.43 (EPA 6010B) 0.46 (EPA 7060A)	20 [1]	5
Barium	430	1.5	10,000 [1]	100
Beryllium	1.7	-----	100 [1]	-----
Cadmium	< MDL (0.5) [2]	< MDL (0.005) [2]	10 [1]	1
Chromium	27	< MDL (0.05) [2]	200 [4, 5]	5
Cobalt	18	-----	500 [4]	-----
Copper	54	-----	500 [4]	-----
Iron	21,000	-----	55,000 [9]	-----
Lead	23	< MDL (0.05) [2]	400 [6]	5
Lithium	48	-----	NA	-----
Magnesium	1,800	-----	NA [7]	-----
Manganese	96	-----	3,000 [4]	-----
Mercury, RCRA total	0.16	-----	20 [4, 10]	0.2
Molybdenum	2.0	-----	300 [4]	-----
Nickel	34	-----	1,000 [4]	-----
Selenium	< MDL (10.0) [2]	0.0219	300 [1]	1
Silver	< MDL (1.0) [2]	< MDL (0.01) [2]	300 [4]	5
Strontium	330	-----	100,000 [3]	-----
Thallium	< MDL (10.0) [2]	-----	5 – 7 [9]	-----
Tin	< MDL (5.0) [2]	-----	NA	-----
Titanium	720	-----	NA	-----
Vanadium	86	-----	2,000 [8]	-----
Zinc	75	-----	20,000 [1]	-----

NA = not available
[1] ATSDR EMEG, child, chronic exposure (≥365 days)
[2] MDL = method detection level
[3] ATSDR EMEG, child, intermediate exposure (14 – 364 days)
[4] EPA RMEG, child, derived from the Reference Dose (lifetime)
[6] Hexavalent chromium, the most toxic form
[6] Residential soil cleanup level based on interagency agreement between EPA and ATSDR
[7] Essential human nutrient, see discussion in the text
[8] Standard found in 40 CFR 261.24
[9] Risk Assessment Information System
[10] Mercuric chloride

Table 2. Analytical results, TVA residential ash sampling. December 27, 2008 – January 2, 2009. Ash results in milligrams per kilogram soil or ash (mg/kg). Kingston Fossil Plant, Roane County, Tennessee.					
	TVA				Health Comparison Values
	Mean	Minimum	Maximum	Standard Deviation	Soil (mg/kg)
Aluminum	16,616	8,710	28,500	6079	50,000 [1]
Antimony	13.5	11.8	15.6	1.2	20 [3]
Arsenic	**48.5**	**2.78**	**107**	**42.5**	**20 [1]**
Barium	170	70	323	95	10,000 [1]
Beryllium	2.0	1.2	3.8	1.0	100 [1]
Cadmium	1.35	1.18	1.56	0.1	10 [1]
Calcium	4,126	1,740	14,800	4,763	NA [6]
Chromium, total	25.8	9.64	46.5	12.6	200 [3, 4]
Cobalt	14.2	11.8	16.9	1.6	500 [3]
Copper	32.8	8.5	62.3	18.4	500 [3]
Iron	18,514	10,700	24,200	4,208	55,000 [8]
Lead	21.7	14.5	30.7	6.1	400 [5]
Magnesium	1,283	662	2,260	556	EHN [6]
Manganese	372	151	653	200	3,000 [3]
Mercury	0.172	0.0136	0.209	0.033	20 [3, 9]
Nickel	21.7	7.4	40.1	11.3	1,000 [3]
Selenium	3.9	2.7	6.7	1.8	300 [1]
Silver	1.4	1.2	1.6	0.1	300 [3]
Thallium	2.7	2.4	3.1	0.2	5 – 7 [8]
Zinc	54.0	32.1	94.7	21.4	20,000 [1]

1 ATSDR EMEG, child, chronic exposure (≥365 days)
2 ATSDR EMEG, child, intermediate exposure (14 – 364 days)
3 ATSDR RMEG, child, derived from the Reference Dose (lifetime)
4 Health Comparison Value for hexavalent chromium, the most toxic form
5 Residential soil cleanup level based on interagency agreement between EPA and ATSDR
6 Essential human nutrient, see discussion in text
7 Standard found in 40 CFR 261.24
8 Risk Assessment Information System
9 Mercuric chloride

Table 3. Analytical results, EPA soil sampling. December 23, 2008 – January 5, 2009. Soil results in milligrams per kilogram ash (mg/kg). Kingston Fossil Plant, Roane County, Tennessee.

	EPA				Health Comparison Values
	Mean	**Minimum**	**Maximum**	**Standard Deviation**	**Soil (mg/kg)**
Aluminum	9,683	2,170	22,600	5,767	50,000 [1]
Antimony	0.7	0	1.9	0.5	20 [2]
Arsenic	12	1.1	34	10	20 [1]
Barium	56	18	174	44	10,000 [1]
Beryllium	0.3	0	0.7	0.2	100 [1]
Cadmium	0.1	0	0.4	0.1	10 [1]
Calcium	1,321	348	2,310	612	NA [3]
Chromium, total	26	4.2	87	23	200 [2, 4]
Cobalt	8.9	2.3	34	10	500 [2]
Copper	14	4.3	36	8.4	500 [2]
Iron	20,622	2,800	40,800	12,384	55,000 [6]
Lead	28	6.6	72	21	400 [5]
Magnesium	862	240	2,530	707	NA [3]
Manganese	701	61	4,160	1,051	3,000 [2]
Mercury	0.04	0	0.2	0.06	20 [2, 7]
Nickel	10	0	24	6.3	1,000 [2]
Selenium	2.5	1.0	4.3	1.0	300 [1]
Silver	0	0	0	0	300 [2]
Thallium	0	0	0	0	5 – 7 [6]
Vanadium	31	5.0	82	25	200 [2]
Zinc	38	18	84	20	20,000 [1]

[1] ATSDR EMEG, child, chronic exposure (≥365 days)
[2] ATSDR RMEG, child, derived from the EPA Reference Dose (lifetime)
[3] Essential human nutrient, see discussion in text
[4] Health Comparison Value for hexavalent chromium, the most toxic form
[5] Residential soil cleanup level based on interagency agreement between EPA and ATSDR
[6] Risk Assessment Information System
[7] Mercuric chloride

Table 4. Analytical results, EPA ash sampling, with TCLP results for applicable metals. December 23, 2008 – January 5, 2009. Ash results in milligrams per kilogram ash (mg/kg). *TCLP results in milligrams per liter (mg/L).* Kingston Fossil Plant, Roane County, Tennessee.

	EPA				Health Comparison Values	
	Mean	Minimum	Maximum	Standard Deviation	Soil (mg/kg)	TCLP [6] (mg/L)
Aluminum	16,712	10,500	28,900	7,290	50,000 [1]	-----
Antimony	1.2	0.9	1.6	0.2	20 [2]	-----
Arsenic	**61**	**45**	**81**	**13**	**20 [1]**	-----
Arsenic, TCLP	*0.03*	*0*	*0.1*	*0.05*	-----	*5*
Barium	368	179	864	295	10,000 [1]	-----
Barium, TCLP	*1.4*	*0.7*	*4.7*	*1.5*	-----	*100*
Beryllium	1.4	0.1	6.3	2.0	100 [1]	-----
Cadmium	0.8	0.6	1.2	0.2	10 [1]	-----
Cadmium, TCLP	*0*	*0*	*0*	*0*	-----	*1*
Calcium	8262	2190	19,500	7,120	NA [3]	-----
Chromium, total	27	18	41	8.8	200 [2, 4]	-----
Chromium, TCLP	*0.01*	*0*	*0.05*	*0.02*	-----	*5*
Cobalt	12	7.9	19	4.4	500 [2]	-----
Copper	46	30	69	15	500 [2]	-----
Iron	13,961	9,590	19,300	2,954	55,000 [7]	-----
Lead	25	15	57	13	400 [5]	-----
Lead, TCLP	*0.01*	*0*	*0.05*	*0.02*	-----	*5*
Magnesium	1,861	713	4,300	1,415	NA [3]	-----
Manganese	141	46	447	140	3,000 [2]	-----
Mercury	0.1	0.06	0.12	0.02	20 [2, 8]	-----
Mercury, TCLP	*0*	*0*	*0*	*0*	-----	*0.2*
Nickel	24	17	32	6.0	1,000 [2]	-----
Selenium	5.9	3.1	7.2	1.3	300 [1]	-----
Selenium, TCLP	*0*	*0*	*0*	*0*	-----	*1*
Silver	2.1	0.0	3.5	1.5	300 [2]	-----
Silver, TCLP	*0*	*0*	*0*	*0*	-----	*5*
Thallium	0.5	0	4.4	1.5	5 – 7 [7]	-----
Vanadium	70	45	121	29	200 [2]	-----
Zinc	40	24	56	11	20,000 [1]	-----

[1] ATSDR EMEG, child, chronic exposure (≥365 days)
[2] ATSDR RMEG, child, derived from the EPA Reference Dose (lifetime)
[3] Essential human nutrient, see discussion in text
[4] Health Comparison Value for hexavalent chromium, the most toxic form
[5] Residential soil cleanup level based on interagency agreement between EPA and ATSDR
[6] Standard found in 40 CFR 261.24
[7] Risk Assessment Information System
[8] Mercuric chloride

Table 5. Analytical results, TDEC soil sampling. January 6, 7, 2009. Soil results in milligrams per kilogram soil (mg/kg). Kingston Fossil Plant, Roane County, Tennessee.

	TDEC				Health Comparison Values
	Mean	Minimum	Maximum	Standard Deviation	Soil (mg/kg)
Aluminum	8,419	1,300	17,000	4031	50,000 [1]
Antimony	0	0	0	0	20 [2]
Arsenic	2	0	6.4	2.4	20 [1]
Barium	79	21	180	52	10,000 [1]
Beryllium	0	0	1.1	0.3	100 [1]
Cadmium	0	0	0.7	0.2	10 [1]
Calcium	1,378	210	3,700	913	NA [2]
Chromium, total	15	8	33	8.4	200 [2, 4]
Cobalt	9	0.9	29	7.4	500 [2]
Copper	11	0	120	29	500 [2]
Iron	16,050	4,000	41,000	9,251	55,000 [6]
Lead	14	4.4	33	8.1	400 [5]
Magnesium	2,530	300	19,000	4,695	NA [3]
Manganese	879	52	2,900	877	3,000 [2]
Mercury	0	0	0	0	20 [2, 7]
Nickel	6	0	22	7.0	1,000 [2]
Selenium	1	0	5.3	1.5	300 [1]
Silver	0	0	0	0	300 [2]
Thallium	7	2.3	18	4.7	5 – 7 [6]
Uranium	0.7	0.4	0.9	0.19	NA
Vanadium	21	15	28	4.6	200 [2]
Zinc	31	9.7	57	15	20,000 [1]

NA = not available
[1] ATSDR EMEG, child, chronic exposure (≥365 days)
[2] ATSDR RMEG, child, derived from the EPA Reference Dose (lifetime)
[3] Essential human nutrient, see discussion in text
[4] Health Comparison Value for hexavalent chromium, the most toxic form
[5] Residential soil cleanup level based on interagency agreement between EPA and ATSDR
[6] EPA Region III Regional Screening Table
[7] Mercuric chloride

These samples were taken to determine if coal ash had impacted natural soil at residences affected by the coal ash release. Since no impact of coal ash on natural soil was demonstrated, these values could be considered background values for soil in this area, although some concentrations are somewhat different from TDEC's statistical summary of inorganics in their soil background survey.

Table 6. Analytical results, TDEC ash sampling, with TCLP results for applicable metals. January 6,7, 2009. Ash results in milligrams per kilogram ash (mg/kg). *TCLP results in milligrams per liter (mg/L).* Kingston Fossil Plant, Roane County, Tennessee.

	TDEC				Health Comparison Values	
	Mean	**Minimum**	**Maximum**	**Standard Deviation**	**Soil (mg/kg)**	**TCLP [6] (mg/L)**
Aluminum	14,267	1000	22,000	6,939	50,000 [1]	-----
Antimony	0	0	0	0	20 [2]	-----
Arsenic	**78**	**56**	**100**	**14**	**20 [1]**	-----
Arsenic, TCLP	*0.18*	*0.002*	*0.15*	-----		*5*
Barium	287	180	330	47	10,000 [1]	-----
Barium, TCLP	*0.05*	*0.05*	*1.4*	-----		*100*
Beryllium	3	1.5	3.6	0.7	100 [1]	-----
Cadmium	0.03	0	0.2	0.1	10 [1]	-----
Cadmium, TCLP	*0.001*	*0*	*0.009*	-----		*1*
Calcium	3,308	2,000	4,600	783	NA [2]	-----
Chromium, total	23	16	31	4.6	200 [2, 4]	-----
Chromium, TCLP	*0.001*	*0*	*0.004*	-----		*5*
Cobalt	12	6.7	18	3.6	500 [2]	-----
Copper	43	25	58	10	500 [2]	-----
Iron	13,000	10,000	21,000	3,027	55,000 [7]	-----
Lead	18	9.8	29	6.3	400 [5]	-----
Lead, TCLP	*0*	*0*	*0*			*5*
Magnesium	1,153	730	1,600	291	NA [3]	-----
Manganese	102	56	260	54	3,000 [2]	-----
Mercury	0	0	0	0	20 [2, 8]	-----
Mercury, TCLP	*0*	*0*	*0*	-----		*0.2*
Nickel	21	13	32	6.7	1,000 [2]	-----
Selenium	0.2	0	2.2	0.7	300 [1]	-----
Selenium, TCLP	*0.003*	*0*	*0.012*	-----		*1*
Silver	0	0	0	0	300 [2]	-----
Silver, TCLP	*0*	*0*	*0.001*	-----		*5*
Thallium	0.15	0	1.8	0.5	5 – 7 [7]	-----
Uranium	2.89	2.3	3.8	0.59	NA	-----
Vanadium	70	42	94	16	200 [2]	-----
Zinc	37	25	54	10	20,000 [1]	-----

[1] ATSDR EMEG, child, chronic exposure (≥365 days)
[2] ATSDR RMEG, child, derived from the EPA Reference Dose (lifetime)
[3] Essential human nutrient, see discussion in text
[4] Health Comparison Value for hexavalent chromium, the most toxic form
[5] Residential soil cleanup level based on interagency agreement between EPA and ATS DR
[6] Standard found in 40 CFR 261.24
[7] Risk Assessment Information System
[8] Mercuric chloride

Table 7. TVA surface water data, Clinch River mile 0.0. December 23, 2008 - May 8, 2009. Units in mg/L. TVA Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
12/23/2008																	
Dissolved	ND	ND	0.003	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.63	ND	0.003	ND	ND	ND	ND	ND	0.036	NA	ND	ND	ND	ND	NA	0.004	ND
12/26/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.209	ND	ND	ND	ND	ND	ND	ND	0.042	NA	ND	ND	ND	ND	NA	ND	ND
12/29/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.229	ND	ND	ND	ND	ND	ND	ND	0.054	NA	ND	ND	ND	ND	NA	ND	ND
1/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.812	ND	ND	ND	ND	ND	ND	ND	0.037	NA	ND	ND	ND	ND	NA	ND	ND
1/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.444	ND	ND	ND	ND	ND	ND	ND	0.046	NA	ND	ND	ND	ND	NA	ND	ND
1/7/2009																	
Dissolved	0.156	ND	0.007	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	0.004	ND
Total	7.56	ND	0.014	ND	ND	0.006	0.004	0.01	0.068	NA	0.009	ND	ND	ND	NA	0.025	ND
1/9/2009																	
Dissolved	ND	ND	0.003	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	5.47	ND	0.005	ND	ND	0.004	0.003	0.006	0.084	NA	0.007	ND	ND	ND	NA	0.013	ND
1/11/2009																	
Dissolved	ND	ND	0.002	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	1.42	ND	0.002	ND	ND	ND	ND	ND	0.063	NA	ND	ND	ND	ND	NA	0.005	ND
1/12/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.816	ND	ND	ND	ND	ND	ND	ND	0.053	NA	ND	ND	ND	ND	NA	ND	ND
1/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.418	ND	ND	ND	ND	ND	ND	ND	0.040	NA	ND	ND	ND	ND	NA	ND	ND
1/21/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.276	ND	ND	ND	ND	ND	ND	ND	0.036	NA	ND	ND	ND	ND	NA	ND	ND
1/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.2175	ND	ND	ND	ND	ND	ND	ND	0.035	NA	ND	ND	ND	ND	NA	ND	ND
1/26/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND

Table 7. TVA surface water data, Clinch River mile 0.0. December 23, 2008 - May 8, 2009. Units in mg/L. TVA Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.344	ND	ND	ND	ND	ND	ND	ND	0.041	NA	ND	ND	ND	ND	NA	ND	ND
1/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.168	ND	ND	ND	ND	ND	ND	ND	0.037	NA	ND	ND	ND	ND	NA	ND	ND
1/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.317	ND	ND	ND	ND	ND	ND	ND	0.046	NA	ND	ND	ND	ND	NA	ND	ND
1/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.31	ND	ND	ND	ND	ND	ND	ND	0.047	NA	ND	ND	ND	ND	NA	ND	ND
2/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.229	ND	ND	ND	ND	ND	ND	ND	0.031	NA	ND	ND	ND	ND	NA	ND	ND
2/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.26	ND	ND	ND	ND	ND	ND	ND	0.032	NA	ND	ND	ND	ND	NA	ND	ND
2/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.184	ND	ND	ND	ND	ND	ND	ND	0.029	NA	ND	ND	ND	ND	NA	ND	ND
2/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.1625	ND	ND	ND	ND	ND	ND	ND	0.043	NA	ND	ND	ND	ND	NA	ND	ND
2/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.151	ND	ND	ND	ND	ND	ND	ND	0.036	NA	ND	ND	ND	ND	NA	ND	ND
2/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.010	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.163	ND	ND	ND	ND	ND	ND	ND	0.033	NA	ND	ND	ND	ND	NA	ND	ND
2/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.010	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.195	ND	ND	ND	ND	ND	ND	ND	0.035	NA	ND	ND	ND	ND	NA	ND	ND
2/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.023	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.622	ND	ND	ND	ND	ND	ND	ND	0.055	NA	ND	ND	ND	ND	NA	ND	ND
2/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.008	ND	ND	ND	ND	ND		NA	ND
Not applicable															7.1		
Total	0.196	ND	ND	ND	ND	ND	ND	ND	0.040	ND	ND	ND	ND	ND		NA	ND

Table 7. TVA surface water data, Clinch River mile 0.0. December 23, 2008 - May 8, 2009. Units in mg/L. TVA Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
2/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.008	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.1		
Total	0.118	ND	ND	ND	ND	ND	ND		0.038	ND	ND	ND	ND	ND		NA	ND
2/28/2009								NA									
Dissolved	ND	ND	ND	ND	ND	ND	ND		0.008	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.4		
Total	0.136	ND	ND	ND	ND	ND	ND	ND	0.039	ND	ND	ND	ND	ND		NA	ND
3/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.008	ND	ND	ND	ND	ND		NA	ND
Not applicable															8.5		
Total	0.241	ND	ND	ND	ND	ND	ND	ND	0.039	ND	ND	ND	ND	ND		NA	ND
3/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.008	ND	ND	ND	ND	ND		NA	ND
Not applicable															6.7		
Total	0.19	ND	ND	ND	ND	ND	ND	NA	0.031	ND	ND	ND	ND	ND		NA	ND
3/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.008	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.5		
Total	0.2	ND	ND	ND	ND	ND	ND	NA	0.037	ND	ND	ND	ND	ND		NA	ND
3/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.008	ND	ND	ND	ND	ND		NA	ND
Not applicable															6		
Total	0.131	ND	ND	ND	ND	ND	ND	NA	0.032	ND	ND	ND	ND	ND		NA	ND
3/11/2009																	
Dissolved	ND	ND	ND	0.002	ND	ND	ND	NA	0.008	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.1		
Total	0.122	ND	ND	0.002	ND	ND	ND	ND	0.039	ND	ND	ND	ND	ND		NA	ND
3/13/2009																	
Dissolved	ND	ND	ND	0.002	ND	ND	ND	ND	0.008	ND	ND	ND	ND	ND		NA	ND
Not applicable															7.3		
Total	0.205	ND	ND	0.002	ND	ND	ND		0.035	ND	ND	ND	ND	ND		NA	ND

Table 7. TVA surface water data, Clinch River mile 0.0. December 23, 2008 - May 8, 2009. Units in mg/L. TVA Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
3/14/2009																	
Dissolved	ND	ND	ND	0.002	ND	ND	ND	ND	0.008	ND	ND	ND	ND	ND		NA	ND
Not applicable															6.6		
Total	0.123	ND	ND	0.002	ND	ND	ND		0.042	ND	ND	ND	ND	ND		NA	ND
3/16/2009																	
Dissolved	ND	ND	ND	0.002	ND	ND	ND	ND	0.008	ND	ND	ND	ND	ND	56.7	NA	ND
Total	0.756	ND	0.007	0.002	ND	ND	ND	NA	0.044	ND	ND	ND	ND	ND			ND
3/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.012	ND	ND	ND	ND	ND		ND	ND
Not applicable															12.3		
Total	0.689	ND	ND	ND	ND	ND	ND	NA	0.038	ND	ND	ND	ND	ND		ND	ND
3/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.006	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.93		
Total	0.212	ND	ND	ND	ND	ND	ND	ND	0.034	ND	ND	ND	ND	ND		ND	ND
3/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0063	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.5		
Total	0.284	ND	ND	ND	ND	ND	ND	NA	0.0327	ND	ND	ND	ND	ND		ND	ND
3/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.003	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.6		
Total	0.13	ND	ND	ND	ND	ND	ND	NA	0.040	ND	ND	ND	ND	ND		ND	ND
3/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.035	ND	ND	ND	ND	ND		ND	ND
Not applicable															55.1		
Total	2.58	ND	0.008	ND	ND	0.003	ND	NA	0.063	ND	ND	ND	ND	ND		0.010	ND
3/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.007	ND	ND	ND	ND	ND		ND	ND
Not applicable															9.7		
Total	0.239	ND	ND	ND	ND	ND	ND	NA	0.038	ND	ND	ND	ND	ND		ND	ND
4/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.014	ND	ND	ND	ND	ND		ND	ND

Table 7. TVA surface water data, Clinch River mile 0.0. December 23, 2008 - May 8, 2009. Units in mg/L. TVA Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Not applicable															11.4		
Total	0.365	ND	ND	ND	ND	ND	ND	NA	0.038	ND	ND	ND	ND	ND		ND	ND
4/3/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.013	ND	ND	ND	ND	ND		ND	ND
Not applicable															9		
Total	0.322	ND	ND	ND	ND	ND	ND	NA	0.035	ND	ND	ND	ND	ND		ND	ND
4/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.009	ND	ND	ND	ND	ND		ND	ND
Not applicable															11		
Total	0.137	ND	ND	ND	ND	ND	ND	NA	0.038	ND	ND	ND	ND	ND		ND	ND
4/8/2009																	
Dissolved	0.15	0.001	0.001	0.001	ND	0.001	0.001	NA	0.010	ND	0.002	0.001	0.001	0.001		0.001	0.014
Not applicable															9.8		
Total	0.562	0.001	0.002	0.001	ND	ND	0.001	NA	0.038	ND	0.002	0.001	0.001	0.001		0.002	0.014
4/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.014	ND	ND	ND	ND	ND		ND	ND
Not applicable															10.1		
Total	0.381	ND	ND	ND	ND	ND	ND	NA	0.038	ND	ND	ND	ND	ND		ND	ND
4/13/2009																	
Dissolved	ND	NA	ND	ND	ND	ND	ND	NA	0.015	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.6		
Total	0.118	NA	ND	ND	ND	ND	ND	NA	0.038	ND	ND	ND	ND	ND		ND	ND
4/15/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.012	ND	ND	ND	ND	ND		ND	ND
Not applicable															0.5		
Total	0.565	ND	ND	ND	ND	ND	ND	NA	0.041	ND	ND	ND	ND	ND		ND	ND
4/17/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.006	ND	ND	ND	ND	ND		ND	ND
Not applicable															13.1		
Total	0.278	ND	ND	ND	ND	ND	ND	ND	0.028	ND	ND	ND	ND	ND		ND	ND
4/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND		ND	ND

Table 7. TVA surface water data, Clinch River mile 0.0. December 23, 2008 - May 8, 2009. Units in mg/L. TVA Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Not applicable															7.5		
Total	0.221	ND	ND	ND	ND	ND	ND	ND	0.027	ND	ND	ND	ND	ND		ND	ND
4/22/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.7		
Total	0.152	ND	ND	ND	ND	ND	ND	ND	0.027	ND	ND	ND	ND	ND		ND	ND
4/24/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.4		
Total	0.342	ND	ND	ND	ND	ND	ND	ND	0.027	ND	ND	ND	ND	ND		ND	ND
4/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.4		
Total	0.234	ND	ND	ND	ND	ND	ND	ND	0.027	ND	ND	ND	ND	ND		ND	ND
4/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.3		
Total	0.181	ND	ND	ND	ND	ND	ND	ND	0.022	ND	ND	ND	ND	ND		ND	ND
5/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.3		
Total	0.148	ND	ND	ND	ND	ND	ND	ND	0.011	ND	ND	ND	ND	ND		ND	ND
5/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND		ND	ND
Not applicable															11.8		
Total	0.357	ND	ND	ND	ND	ND	ND	ND	0.036	ND	ND	ND	ND	ND		ND	ND

Concentrations reported are the average of duplicates taken at each site.
ND = not detected
NA = not available

Table 8. TVA surface water data, Clinch River mile 2.0. December 23, 2008 - May 8, 2009. Units in mg/L. TVA Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
12/23/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
12/26/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.536	ND	ND	ND	ND	ND	ND	ND	0.051	NA	ND	ND	ND	ND	NA	ND	ND
12/29/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.534	ND	ND	ND	ND	ND	ND	ND	0.0489	NA	ND	ND	ND	ND	NA	ND	ND
1/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.661	ND	ND	ND	ND	ND	ND	ND	0.0409	NA	ND	ND	ND	ND	NA	ND	ND
1/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.476	ND	ND	ND	ND	ND	ND	ND	0.0449	NA	ND	ND	ND	ND	NA	ND	ND
1/7/2009																	
Dissolved	0.378	ND	0.0242	ND	ND	ND	ND	ND	0.005	NA	ND	0.00302	ND	ND	NA	0.0231	ND
Total	41.5	0.00347	0.0937	0.00614	0.01	0.0283	0.025	0.050	0.129	NA	0.042	0.02	0.02	0.00277	NA	0.114	0.08
1/9/2009																	
Dissolved	ND	ND	0.003	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	2.59	ND	0.0039	ND	ND	0.00203	ND	0.003	0.0675	NA	ND	ND	ND	ND	NA	0.00789	ND
1/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	1.11	ND	ND	ND	ND	ND	ND	ND	0.0608	NA	ND	ND	ND	ND	NA	ND	ND
1/12/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.98	ND	ND	ND	ND	ND	ND	ND	0.0591	NA	ND	ND	ND	ND	NA	ND	ND
1/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.35	ND	ND	ND	ND	ND	ND	ND	0.0414	NA	ND	ND	ND	ND	NA	ND	ND
1/21/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.22	ND	ND	ND	ND	ND	ND	ND	0.0383	NA	ND	ND	ND	ND	NA	ND	ND
1/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.34	ND	ND	ND	ND	ND	ND	ND	0.0396	NA	ND	ND	ND	ND	NA	ND	ND
1/26/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.268	ND	ND	ND	ND	ND	ND	ND	0.037	NA	ND	ND	ND	ND	NA	ND	ND
1/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND22	ND	ND	ND	ND	ND	ND	ND	0.0358	NA	ND	ND	ND	ND	NA	ND	ND
1/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.249	ND	ND	ND	ND	ND	ND	ND	0.0542	NA	ND	ND	ND	ND	NA	ND	ND
1/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND

Table 8. TVA surface water data, Clinch River mile 2.0. December 23, 2008 - May 8, 2009. Units in mg/L. TVA Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.384	ND	ND	ND	ND	ND	ND	ND	0.0436	NA	ND	ND	ND	ND	NA	ND	ND
2/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.21	ND	ND	ND	ND	ND	ND	ND	0.0315	NA	ND	ND	ND	ND	NA	ND	ND
2/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND46	ND	ND	ND	ND	ND	ND	ND	0.0296	NA	ND	ND	ND	ND	NA	ND	ND
2/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.272	ND	ND	ND	ND	ND	ND	ND	0.0352	NA	ND	ND	ND	ND	NA	ND	ND
2/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND72	ND	ND	ND	ND	ND	ND	ND	0.0325	NA	ND	ND	ND	ND	NA	ND	ND
2/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.149	ND	ND	ND	ND	ND	ND	ND	0.031	NA	ND	ND	ND	ND	NA	ND	ND
2/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0136	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.2	ND	ND	ND	ND	ND	ND	ND	0.0361	NA	ND	ND	ND	ND	NA	ND	ND
2/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00552	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.219	ND	ND	ND	ND	ND	ND	ND	0.0318	NA	ND	ND	ND	ND	NA	ND	ND
2/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0328	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.518	ND	ND	ND	ND	ND	ND	ND	0.0555	NA	ND	ND	ND	ND	NA	ND	ND
2/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0233	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.569	ND	ND	ND	ND	ND	ND	ND	0.0539	NA	ND	ND	ND	ND	NA	ND	ND
2/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not Applicable															8		
Total	0.23	ND	ND	ND	ND	ND	ND	ND	0.0343	ND	ND	ND	ND	ND		NA	ND
2/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.015	ND	ND	ND	ND	ND		NA	ND
Not Applicable															5.8		
Total	0.129	ND	ND	ND	ND	ND	ND	NA	0.032	ND	ND	ND	ND	ND		NA	ND
2/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not Applicable															7.4		
Total	0.161	ND	ND	ND	ND	ND	ND	NA	0.0373	ND	ND	ND	ND	ND		NA	ND
3/2/2009																	
Dissolved	0.155	ND	ND	ND	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not Applicable															9.3		

Table 8. TVA surface water data, Clinch River mile 2.0. December 23, 2008 - May 8, 2009. Units in mg/L. TVA Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.277	ND	ND	ND	ND	ND	ND	ND	0.0387	ND	ND	ND	ND	ND		NA	ND
3/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not Applicable															7.6		
Total	0.207	ND	ND	ND	ND	ND	ND	NA	0.033	ND	ND	ND	ND	ND		NA	ND
3/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not Applicable															5.9		
Total	0.236	ND	ND	ND	ND	ND	ND	NA	0.0322	ND	ND	ND	ND	ND		NA	ND
3/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.015	ND	ND	ND	ND	ND		NA	ND
Not Applicable															6.3		
Total	0.148	ND	ND	ND	ND	ND	ND	NA	0.0317	ND	ND	ND	ND	ND		NA	ND
3/11/2009																	
Dissolved	ND	ND	ND	0.004	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not Applicable															7.2		
Total	0.234	ND	ND	0.004	ND	ND	ND	ND	0.034	ND	ND	ND	ND	ND		NA	ND
3/13/2009																	
Dissolved	ND	ND	ND	0.004	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not Applicable															9.8		
Total	0.232	ND	ND	0.004	ND	ND	ND	ND	0.0355	ND	ND	ND	ND	ND		NA	ND
3/14/2009																	
Dissolved	ND	ND	ND	0.004	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not Applicable															9		
Total	0.156	ND	ND	0.004	ND	ND	ND	ND	0.0402	ND	ND	ND	ND	ND		NA	ND
3/16/2009																	
Dissolved	ND	ND	ND	0.004	ND	ND	ND	ND	0.0263	ND	ND	ND	ND	ND	80.6	NA	ND
Total	0.812	ND	0.007	0.004	ND	ND	ND	NA	0.0459	ND	ND	ND	ND	ND		NA	ND
3/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.011	ND	ND	ND	ND	ND		ND	ND
Not Applicable															11.9		
Total	0.34	ND	ND	ND	ND	ND	ND	ND	0.0345	ND	ND	ND	ND	ND		ND	ND
3/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.00767	ND	ND	ND	ND	ND		ND	ND
Not Applicable															8.4		
Total	0.22	ND	ND	ND	ND	ND	ND	ND	0.0354	ND	ND	ND	ND	ND		ND	ND
3/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00683	ND	ND	ND	ND	ND		ND	ND
Not Applicable															8.8		

Table 8. TVA surface water data, Clinch River mile 2.0. December 23, 2008 - May 8, 2009. Units in mg/L. TVA Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.208	ND	ND	ND	ND	ND	ND	NA	0.0348	ND	ND	ND	ND	ND		ND	ND
3/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0146	ND	ND	ND	ND	ND		ND	ND
Not Applicable															9.5		
Total	0.208	ND	ND	ND	ND	ND	ND	NA	0.0371	ND	ND	ND	ND	ND		ND	ND
3/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0214	ND	ND	ND	ND	ND		ND	ND
Not Applicable															35.9		
Total	1.59	ND	0.0043	ND	ND	ND	ND	NA	0.054	ND	ND	ND	ND	ND		0.00558	ND
3/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0169	ND	ND	ND	ND	ND		ND	ND
Not Applicable															11.4		
Total	0.235	ND	ND	ND	ND	ND	ND	ND	0.0396	ND	ND	ND	ND	ND		ND	ND
4/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.011	ND	ND	ND	ND	ND		ND	ND
Not Applicable															10.7		
Total	0.319	ND	ND	ND	ND	ND	ND	ND	0.0353	ND	ND	ND	ND	ND		ND	ND
4/3/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00951	ND	ND	ND	ND	ND		ND	ND
Not Applicable															9.3		
Total	0.319	ND	ND	ND	ND	ND	ND	NA	0.0355	ND	ND	ND	ND	ND		ND	ND
4/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.018	ND	ND	ND	ND	ND		ND	ND
Not Applicable															10.9		
Total	0.23	ND	ND	ND	ND	ND	ND	ND	0.0362	ND	ND	ND	ND	ND		ND	ND
4/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0122	ND	ND	ND	ND	ND		ND	ND
Not Applicable															13.9		
Total	0.225	ND	ND	ND	ND	ND	ND	ND	0.043	ND	ND	ND	ND	ND		ND	ND
4/11/2009																	
Dissolved	0.5	ND	ND	ND	ND	ND	ND	ND	0.0163	ND	ND	ND	ND	ND		ND	ND
Not Applicable															10.2		
Total	0.5	ND	ND	ND	ND	ND	ND	ND	0.038	ND	ND	ND	ND	ND		ND	ND
4/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00949	ND	ND	ND	ND	ND		ND	ND
Not Applicable															7		
Total	0.128	ND	ND	ND	ND	ND	ND	ND	0.0374	ND	ND	ND	ND	ND		ND	ND
4/15/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0287	ND	ND	ND	ND	ND		ND	ND

Table 8. TVA surface water data, Clinch River mile 2.0. December 23, 2008 - May 8, 2009. Units in mg/L. TVA Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Not Applicable															19.7		
Total	0.561	ND	0.0021	ND	ND	ND	ND	ND	0.0456	ND	ND	ND	ND	ND		ND	ND
4/17/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	ND	ND	ND	ND	ND		ND	ND
Not Applicable															12.3		
Total	0.381	ND	ND	ND	ND	ND	ND	ND	0.0307	ND	ND	ND	ND	ND		ND	ND
4/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0136	ND	ND	ND	ND	ND		ND	ND
Not Applicable															9.2		
Total	0.3	ND	ND	ND	ND	ND	ND	ND	0.0333	ND	ND	ND	ND	ND		ND	ND
4/22/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00605	ND	ND	ND	ND	ND		ND	ND
Not Applicable															14.6		
Total	0.379	ND	ND	ND	ND	ND	ND	ND	0.0444	ND	ND	ND	ND	ND		ND	ND
4/24/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00578	ND	ND	ND	ND	ND		ND	ND
Not Applicable															10.2		
Total	0.428	ND	ND	ND	ND	ND	ND	ND	0.0323	ND	ND	ND	ND	ND		ND	ND
4/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0117	ND	ND	ND	ND	ND		ND	ND
Not Applicable															8.8		
Total	0.289	ND	ND	ND	ND	ND	ND	ND	0.035	ND	ND	ND	ND	ND		ND	ND
4/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	ND	ND	ND	ND	ND		ND	ND
Not Applicable															12.6		
Total	0.398	ND	0.0026	ND	ND	ND	ND	ND	0.0298	ND	ND	ND	ND	ND		ND	ND
5/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.005	ND	ND	ND	ND	ND		ND	ND
Not Applicable															6.8		
Total	0.261	ND	0.00226	ND	ND	ND	ND	ND	0.0223	ND	ND	ND	ND	ND		ND	ND
5/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.007	ND	ND	ND	ND	ND		ND	ND
Not Applicable															21.4		
Total	0.545	ND	ND	ND	ND	ND	ND	ND	0.0491	ND	ND	ND	ND	ND		ND	ND

ND = not detected
NA = not available

Table 9. TVA surface water data, Clinch River mile 4.0. December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release. Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
12/23/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.401	ND	ND	ND	ND	ND	ND	ND	0.0198	NA	ND	ND	ND	ND	NA	ND	ND
12/26/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.417	ND	ND	ND	ND	ND	ND	ND	0.0452	NA	ND	ND	ND	ND	NA	ND	ND
12/29/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.33	ND	ND	ND	ND	ND	ND	ND	0.0478	NA	ND	ND	ND	ND	NA	ND	ND
1/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.226	ND	ND	ND	ND	ND	ND	ND	0.039	NA	ND	ND	ND	ND	NA	ND	ND
1/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.304	ND	ND	ND	ND	ND	ND	ND	0.0446	NA	ND	ND	ND	ND	NA	ND	ND
1/7/2009																	
Dissolved	0.351	ND	0.0216	ND	ND	ND	ND	ND	ND	NA	ND	0.00264	ND	ND	NA	0.0205	ND
Total	57.8	0.00347	0.109	0.0076	0.01	0.0352	0.0321	0.065	0.175	NA	0.053	0.02	0.02	0.00316	NA	0.143	0.09
1/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA		ND	ND	ND	NA	ND	ND
Total	0.982	ND	ND	ND	ND	ND	ND	ND	0.0674	NA	ND	ND	ND	ND	NA	ND	ND
1/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.556	ND	ND	ND	ND	ND	ND	ND	0.0666	NA	ND	ND	ND	ND	NA	ND	ND
1/12/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.476	ND	ND	ND	ND	ND	ND	ND	0.0527	NA	ND	ND	ND	ND	NA	ND	ND
1/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.186	ND	ND	ND	ND	ND	ND	ND	0.0446	NA	ND	ND	ND	ND	NA	ND	ND
1/21/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.167	ND	ND	ND	ND	ND	ND	ND	0.0415	NA	ND	ND	ND	ND	NA	ND	ND
1/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.164	ND	ND	ND	ND	ND	ND	ND	0.0417	NA	ND	ND	ND	ND	NA	ND	ND
1/26/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND

Table 9. TVA surface water data, Clinch River mile 4.0. December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release. Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.166	ND	ND	ND	ND	ND	ND	ND	0.0373	NA	ND	ND	ND	ND	NA	ND	ND
1/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.124	ND	0.00325	ND	ND	ND	ND	ND	0.0407	NA	ND	ND	ND	ND	NA	ND	ND
1/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.295	ND	ND	ND	ND	ND	ND	ND	0.0632	NA	ND	ND	ND	ND	NA	ND	ND
1/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.236	ND	ND	ND	ND	ND	ND	ND	0.0481	NA	ND	ND	ND	ND	NA	ND	ND
2/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.215	ND	ND	ND	ND	ND	ND	ND	0.0332	NA	ND	ND	ND	ND	NA	ND	ND
2/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.215	ND	ND	ND	ND	ND	ND	ND	0.0322	NA	ND	ND	ND	ND	NA	ND	ND
2/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.156	ND	ND	ND	ND	ND	ND	ND	0.0331	NA	ND	ND	ND	ND	NA	ND	ND
2/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.182	ND	ND	ND	ND	ND	ND	ND	0.0495	NA	ND	ND	ND	ND	NA	ND	ND
2/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0274	NA	ND	ND	ND	ND	NA	ND	ND
2/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.029	NA	ND	ND	ND	ND	NA	ND	ND
2/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.156	ND	ND	ND	ND	ND	ND	ND	0.0284	NA	ND	ND	ND	ND	NA	ND	ND
2/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.49	ND	ND	ND	ND	ND	ND		0.059	NA	ND	ND	ND	ND	NA	ND	ND
2/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0134	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.342	ND	ND	ND	ND	ND	ND	NA	0.0423	NA	ND	ND	ND	ND	NA	ND	ND
2/23/2009																	

Table 9. TVA surface water data, Clinch River mile 4.0. December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release. Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.015	ND	ND	ND	ND	ND		NA	ND
Not applicable															7.7		
Total	0.174	ND	ND	ND	ND	ND	ND	NA	0.0354	ND	ND	ND	ND	ND		NA	ND
2/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.015	ND	ND	ND	ND	ND		NA	ND
Not applicable															6		
Total	0.131	ND	ND	ND	ND	ND	ND	NA	0.0333	ND	ND	ND	ND	ND		NA	ND
2/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.015	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.6		
Total	0.148	ND	ND	ND	ND	ND	ND	NA	0.0323	ND	ND	ND	ND	ND		NA	ND
3/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not applicable															8.7		
Total	0.224	ND	ND	ND	ND	ND	ND	ND	0.0366	ND	ND	ND	ND	ND		NA	ND
3/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not applicable															6.5		
Total	0.142	ND	ND	ND	ND	ND	ND	ND	0.0307	ND	ND	ND	ND	ND		NA	ND
3/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.5		
Total	0.15	ND	ND	ND	ND	ND	ND	NA	0.0302	ND	ND	ND	ND	ND		NA	ND
3/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.015	ND	ND	ND	ND	ND		NA	ND
Not applicable															6.9		
Total	0.198	ND	ND	ND	ND	ND	ND	NA	0.0349	ND	ND	ND	ND	ND		NA	ND
3/11/2009																	
Dissolved	ND	ND	ND	0.004	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not applicable															9.4		
Total	0.246	ND	ND	0.004	ND	ND	ND	ND	0.0406	ND	ND	ND	ND	ND		NA	ND
3/13/2009																	

Table 9. TVA surface water data, Clinch River mile 4.0. December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release. Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Dissolved	ND	ND	ND	0.004	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not applicable															8.3		
Total	0.182	ND	ND	0.004	ND	ND	ND	NA	0.0395	ND	ND	ND	ND	ND		NA	ND
3/14/2009																	
Dissolved	ND	ND	ND	0.004	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND		NA	ND
Not applicable															8.1		
Total	0.112	ND	ND	0.004	ND	ND	ND	ND	0.0359	ND	ND	ND	ND	ND		NA	ND
3/16/2009																	
Dissolved	ND	ND	ND	0.004	ND	ND	ND	ND	0.0174	ND	ND	ND	ND	ND	42.4	NA	ND
Total	0.474	ND	0.00335	0.004	ND	ND	ND	ND	0.0386	ND	ND	ND	ND	ND		NA	ND
3/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															11.6		
Total	0.232	ND	ND	ND	ND	ND	ND	NA	0.0404	ND	ND	ND	ND	ND		ND	ND
3/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.13		
Total	0.153	ND	ND	ND	ND	ND	ND	NA	0.0387	ND	ND	ND	ND	ND		ND	ND
3/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															9.1		
Total	0.131	ND	ND	ND	ND	ND	ND	NA	0.0374	ND	ND	ND	ND	ND		ND	ND
3/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.5		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0381	ND	ND	ND	ND	ND		ND	ND
3/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00721	ND	ND	ND	ND	ND		ND	ND
Not applicable															13		
Total	0.448	ND	ND	ND	ND	ND	ND	ND	0.0432	ND	ND	ND	ND	ND		ND	ND
3/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00574	ND	ND	ND	ND	ND		ND	ND
Not															11.1		

Table 9. TVA surface water data, Clinch River mile 4.0. December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release. Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
applicable																	
Total	0.212	ND	ND	ND	ND	ND	ND	NA	0.0375	ND	ND	ND	ND	ND		ND	ND
4/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.4		
Total	0.136	ND	ND	ND	ND	ND	ND	NA	0.0314	ND	ND	ND	ND	ND		ND	ND
4/3/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0176	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.8		
Total	0.283	ND	ND	ND	ND	ND	ND	NA	0.039	ND	ND	ND	ND	ND		ND	ND
4/6/2009																	
Dissolved	0.5	ND	ND	ND	ND	ND	ND	ND	0.026	ND	ND	ND	ND	ND		ND	ND
Not applicable															11.6		
Total	0.77	ND	ND	ND	ND	0.00547	ND	NA	0.042	ND	ND	ND	ND	ND		ND	ND
4/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															10.1		
Total	0.142	ND	ND	ND	ND	ND	ND	ND	0.035	ND	ND	ND	ND	ND		ND	ND
4/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00942	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.4		
Total	0.273	ND	ND	ND	ND	ND	ND	ND	0.0326	ND	ND	ND	ND	ND		ND	ND
4/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00638	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.5		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0363	ND	ND	ND	ND	ND		ND	ND
4/15/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00958	ND	ND	ND	ND	ND		ND	ND
Not applicable															13.4		
Total	0.328	ND	ND	ND	ND	ND	ND	ND	0.0404	ND	ND	ND	ND	ND		ND	ND
4/17/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not															10.3		

Table 9. TVA surface water data, Clinch River mile 4.0. December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release. Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
applicable																	
Total	0.119	ND	ND	ND	ND	ND	ND	ND	0.0359	ND	ND	ND	ND	ND		ND	ND
4/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.017	ND	ND	ND	ND	ND		ND	ND
Not applicable															7		
Total	0.299	ND	ND	ND	ND	ND	ND	ND	0.0366	ND	ND	ND	ND	ND		ND	ND
4/22/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															13.3		
Total	0.2	ND	ND	ND	ND	ND	ND	ND	0.0424	ND	ND	ND	ND	ND		ND	ND
4/24/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															9.8		
Total	0.248	ND	ND	ND	ND	ND	ND	ND	0.0344	ND	ND	ND	ND	ND		ND	ND
4/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.1		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.024	ND	ND	ND	ND	ND		ND	ND
4/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.1		
Total	0.126	ND	ND	ND	ND	ND	ND	ND	0.0216	ND	ND	ND	ND	ND		ND	ND
5/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.2		
Total	0.152	ND	ND	ND	ND	ND	ND	ND	0.0288	ND	ND	ND	ND	ND		ND	ND
5/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															20.1		
Total	0.432	ND	ND	ND	ND	ND	ND	ND	0.0513	ND	ND	ND	ND	ND		ND	ND

ND = not detected
NA = not available

Table 10. TVA surface water data, Clinch River mile 5.5, December 22, 2008 – May 8, 2009. Units in mg/L. Kinston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
12/22/2008																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.689	ND	ND	ND	ND	ND	ND	ND	0.0443	NA	ND	ND	ND	ND	NA	ND	ND
12/23/2008																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.173	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
12/26/2008																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.263	ND	ND	ND	ND	ND	ND	ND	0.0431	NA	ND	ND	ND	ND	NA	ND	ND
12/29/2008																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.264	ND	ND	ND	ND	ND	ND	ND	0.0464	NA	ND	ND	ND	ND	NA	ND	ND
1/2/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.236	ND	ND	ND	ND	ND	ND	ND	0.0399	NA	ND	ND	ND	ND	NA	ND	ND
1/6/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.276	ND	ND	ND	ND	ND	ND	ND	0.0472	NA	ND	ND	ND	ND	NA	ND	ND
1/7/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.524	ND	ND	ND	ND	ND	ND	ND	0.0519	NA	ND	ND	ND	ND	NA	ND	ND
1/9/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.354	ND	ND	ND	ND	ND	ND	ND	0.0555	NA	ND	ND	ND	ND	NA	ND	ND
1/11/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.354	ND	ND	ND	ND	ND	ND	ND	0.0647	NA	ND	ND	ND	ND	NA	ND	ND
1/12/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.604	ND	ND	ND	ND	ND	ND	ND	0.0741	NA	ND	ND	ND	ND	NA	ND	ND
1/19/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.202	ND	ND	ND	ND	ND	ND	ND	0.0453	NA	ND	ND	ND	ND	NA	ND	ND
1/21/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.178	ND	ND	ND	ND	ND	ND	ND	0.0404	NA	ND	ND	ND	ND	NA	ND	ND
1/23/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.145	ND	ND	ND	ND	ND	ND	ND	0.0444	NA	ND	ND	ND	ND	NA	ND	ND
1/26/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.197	ND	ND	ND	ND	ND	ND	ND	0.0407	NA	ND	ND	ND	ND	NA	ND	ND
1/28/2009																	

Table 10. TVA surface water data, Clinch River mile 5.5, December 22, 2008 – May 8, 2009. Units in mg/L. Kinston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.256	ND	ND	ND	ND	ND	ND	ND	0.0488	NA	ND	ND	ND	ND	NA	ND	ND
1/29/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.184	ND	ND	ND	ND	ND	ND	ND	0.0408	NA	ND	ND	ND	ND	NA	ND	ND
1/30/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.166	ND	ND	ND	ND	ND	ND	ND	0.0423	NA	ND	ND	ND	ND	NA	ND	ND
2/2/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.174	ND	ND	ND	ND	ND	ND	ND	0.0342	NA	ND	ND	ND	ND	NA	ND	ND
2/4/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.215	ND	ND	ND	ND	ND	ND	ND	0.0358	NA	ND	ND	ND	ND	NA	ND	ND
2/6/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.177	ND	ND	ND	ND	ND	ND	ND	0.0337	NA	ND	ND	ND	ND	NA	ND	ND
2/9/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.126	ND	ND	ND	ND	ND	ND	ND	0.0318	NA	ND	ND	ND	ND	NA	ND	ND
2/13/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.1	ND	ND	ND	ND	ND	ND	ND	0.0332	NA	ND	ND	ND	ND	NA	ND	ND
2/16/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	0.00592	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.1	ND	ND	ND	ND	ND	ND	ND	0.0273	NA	ND	ND	ND	ND	NA	ND	ND
2/18/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.152	ND	ND	ND	ND	ND	ND	ND	0.0307	NA	ND	ND	ND	ND	NA	ND	ND
2/19/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	0.00866	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.517	ND	ND	ND	ND	ND	ND	NA	0.0412	NA	ND	ND	ND	ND	NA	ND	ND
2/20/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	NA	0.00818	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.29	ND	ND	ND	ND	ND	ND	NA	0.0359	NA	ND	ND	ND	ND	NA	ND	ND
2/23/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	0.02	NA	0.015	0.0002	0.01	ND	ND	ND		NA	ND
Not applicable															5.7		
Total	0.134	ND	ND	ND	ND	ND	0.02	NA	0.0313	0.0002	0.01	ND	ND	ND		NA	ND
2/25/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	0.02	NA	0.015	0.0002	0.01	ND	ND	ND		NA	ND
Not															5.4		

Table 10. TVA surface water data, Clinch River mile 5.5, December 22, 2008 – May 8, 2009. Units in mg/L. Kinston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
applicable																	
Total	0.1	ND	ND	ND	ND	ND	0.02	NA	0.032	0.0002	0.01	ND	ND	ND		NA	ND
2/28/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	0.02	NA	0.015	0.0002	0.01	ND	ND	ND		NA	ND
Not applicable															5.8		
Total	0.15	ND	ND	ND	ND	ND	0.02	NA	0.0312	0.0002	0.01	ND	ND	ND		NA	ND
3/2/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	0.02	ND	0.015	0.0002	0.01	ND	ND	ND		NA	ND
Not applicable															6.6		
Total	0.208	ND	ND	ND	ND	ND	0.02	NA	0.0323	0.0002	0.01	ND	ND	ND		NA	ND
3/4/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	0.02	ND	0.015	0.0002	0.01	ND	ND	ND		NA	ND
Not applicable															5.9		
Total	0.138	ND	ND	ND	ND	ND	0.02	NA	0.0292	0.0002	0.01	ND	ND	ND		NA	ND
3/6/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	0.02	ND	0.015	0.0002	0.01	ND	ND	ND		NA	ND
Not applicable															5.7		
Total	0.163	ND	ND	ND	ND	ND	0.02	NA	0.0311	0.0002	0.01	ND	ND	ND		NA	ND
3/9/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	0.02	NA	0.015	0.0002	0.01	ND	ND	ND		NA	ND
Not applicable															6.3		
Total	0.109	ND	ND	ND	ND	ND	0.02	NA	0.0344	0.0002	0.01	ND	ND	ND		NA	ND
3/11/2009																	
Dissolved	0.1	ND	ND	0.004	ND	ND	0.02	ND	0.015	0.0002	ND	ND	ND	ND		NA	ND
Not applicable															5.9		
Total	0.198	ND	ND	0.004	ND	ND	0.02	ND	0.0345	0.0002	ND	ND	ND	ND		NA	ND
3/13/2009																	
Dissolved	0.1	ND	ND	0.004	ND	ND	0.02	ND	0.015	0.0002	ND	ND	ND	ND		NA	ND
Not applicable															7.6		
Total	0.168	ND	ND	0.004	ND	ND	0.02	ND	0.0375	0.0002	ND	ND	ND	ND		NA	ND
3/14/2009																	
Dissolved	0.1	ND	ND	0.004	ND	ND	0.02	ND	0.015	0.0002	ND	ND	ND	ND		NA	ND
Not applicable															6.4		
Total	0.11	ND	ND	0.004	ND	ND	0.02	ND	0.0354	0.0002	ND	ND	ND	ND		NA	ND
3/16/2009																	

Table 10. TVA surface water data, Clinch River mile 5.5, December 22, 2008 – May 8, 2009. Units in mg/L. Kinston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Dissolved	0.1	ND	ND	0.004	ND	ND	0.02	ND	0.015	0.0002	ND	ND	ND	ND	7.5	NA	ND
Total	0.103	ND	ND	0.004	ND	ND	0.02	ND	0.0377	0.0002	ND	ND	ND	ND		NA	ND
3/18/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															10		
Total	0.19	ND	ND	ND	ND	ND	ND	NA	0.0397	0.0002	ND	ND	ND	ND		ND	ND
3/20/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															10		
Total	0.156	ND	ND	ND	ND	ND	ND	ND	0.0415	0.0002	ND	ND	ND	ND		ND	ND
3/23/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															9.1		
Total	0.141	ND	ND	ND	ND	ND	ND	NA	0.0393	0.0002	ND	ND	ND	ND		ND	ND
3/25/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															7.5		
Total	0.1	ND	ND	ND	ND	ND	ND	ND	0.0336	0.0002	ND	ND	ND	ND		ND	ND
3/27/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	0.00588	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															8.6		
Total	0.267	ND	ND	ND	ND	ND	ND	ND	0.0404	0.0002	ND	ND	ND	ND		ND	ND
3/30/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															10.2		
Total	0.162	ND	ND	ND	ND	ND	ND	ND	0.0379	0.0002	ND	ND	ND	ND		ND	ND
4/1/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															8		
Total	0.136	ND	ND	ND	ND	ND	ND	ND	0.032	0.0002	ND	ND	ND	ND		ND	ND
4/3/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															8.2		
Total	0.207	ND	ND	ND	ND	ND	ND	ND	0.0346	0.0002	ND	ND	ND	ND		ND	ND
4/6/2009																	

Table 10. TVA surface water data, Clinch River mile 5.5, December 22, 2008 – May 8, 2009. Units in mg/L. Kinston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															9.3		
Total	0.22	ND	ND	ND	ND	ND	ND	ND	0.0305	0.0002	ND	ND	ND	ND		ND	ND
4/8/2009																	
Dissolved	0.5	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															8.3		
Total	0.5	ND	ND	ND	ND	ND	ND	ND	0.0351	0.0002	ND	ND	ND	ND		ND	ND
4/11/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	NA	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															9.6		
Total	0.225	ND	ND	ND	ND	ND	ND	NA	0.0316	0.0002	ND	ND	ND	ND		ND	ND
4/13/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															9.9		
Total	0.122	ND	ND	ND	ND	ND	ND	ND	0.0395	0.0002	ND	ND	ND	ND		ND	ND
4/15/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															11.2		
Total	0.224	ND	ND	ND	ND	ND	ND	ND	0.038	0.0002	ND	ND	ND	ND		ND	ND
4/17/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															9.9		
Total	0.172	ND	ND	ND	ND	ND	ND	ND	0.0336	0.0002	ND	ND	ND	ND		ND	ND
4/20/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															8.3		
Total	0.131	ND	ND	ND	ND	ND	ND	ND	0.0346	0.0002	ND	ND	ND	ND		ND	ND
4/22/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															12.9		
Total	0.262	ND	ND	ND	ND	ND	ND	ND	0.0381	0.0002	ND	ND	ND	ND		ND	ND
4/24/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															8.3		

Table 10. TVA surface water data, Clinch River mile 5.5, December 22, 2008 – May 8, 2009. Units in mg/L. Kinston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.162	ND	ND	ND	ND	ND	ND	ND	0.0305	0.0002	ND	ND	ND	ND		ND	ND
4/27/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															8		
Total	0.103	ND	ND	ND	ND	ND	ND	ND	0.028	0.0002	ND	ND	ND	ND		ND	ND
4/29/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															6.8		
Total	0.1	ND	ND	ND	ND	ND	ND	ND	0.0276	0.0002	ND	ND	ND	ND		ND	ND
5/1/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															6.6		
Total	0.1	ND	ND	ND	ND	ND	ND	ND	0.0271	0.0002	ND	ND	ND	ND		ND	ND
5/8/2009																	
Dissolved	0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.0002	ND	ND	ND	ND		ND	ND
Not applicable															14.3		
Total	0.265	ND	ND	ND	ND	ND	ND	ND	0.0498	0.0002	ND	ND	ND	ND		ND	ND

ND = not detected
NA = not available

Table 11. TVA surface water data, Emory River mile 0.1, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
12/23/2008																	
Dissolved	ND	ND	0.011	0.00546	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	0.00604	ND
Total	5.41	ND	0.0202	0.00316	ND	0.00546	0.00316	0.008	0.284	NA	0.0074	ND	ND	ND	NA	0.0213	ND
12/26/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.618	ND	ND	ND	ND	ND	ND	ND	0.0322	NA	ND	ND	ND	ND	NA	ND	ND
12/29/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.42	ND	ND	ND	ND	ND	ND	ND	0.0439	NA	ND	ND	ND	ND	NA	ND	ND
1/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.354	ND	ND	ND	ND	ND	ND	ND	0.0384	NA	ND	ND	ND	ND	NA	ND	ND
1/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.338	ND	ND	ND	ND	ND	ND	ND	0.0413	NA	ND	ND	ND	ND	NA	ND	ND
1/7/2009																	
Dissolved	0.191	ND	0.0273	ND	ND	ND	ND	ND	ND	NA	ND	0.00335	ND	ND	NA	0.0262	ND
Total	63.9	0.00364	0.132	0.00878	ND	0.0408	0.0356	0.073	0.2	NA	0.0586	ND	ND	0.00403	NA	0.162	0.1
1/9/2009																	
Dissolved	ND	ND	0.00218	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total		ND	0.00254	ND	ND	ND	ND	ND	0.0412	NA	ND	ND	ND	ND	NA	0.00476	ND
1/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.47	ND	ND	ND	ND	ND	ND	ND	0.0355	NA	ND	ND	ND	ND	NA	ND	ND
1/12/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.35	ND	ND	ND	ND	ND	ND	ND	0.0329	NA	ND	ND	ND	ND	NA	ND	ND
1/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.249	ND	ND	ND	ND	ND	ND	ND	0.0359	NA	ND	ND	ND	ND	NA	ND	ND
1/21/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.252	ND	ND	ND	ND	ND	ND	ND	0.0363	NA	ND	ND	ND	ND	NA	ND	ND
1/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.206	ND	ND	ND	ND	ND	ND	ND	0.0384	NA	ND	ND	ND	ND	NA	ND	ND
1/26/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND

Table 11. TVA surface water data, Emory River mile 0.1, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.235	ND	ND	ND	ND	ND	ND	ND	0.0382	NA	ND	ND	ND	ND	NA	ND	ND
1/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.45	ND	ND	ND	ND	ND	ND	ND	0.0341	NA	ND	ND	ND	ND	NA	ND	ND
1/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.383	ND	ND	ND	ND	ND	ND	ND	0.0843	NA	ND	ND	ND	ND	NA	ND	ND
1/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.207	ND	ND	ND	ND	ND	ND	ND	0.0496	NA	ND	ND	ND	ND	NA	ND	ND
2/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.377	ND	ND	ND	ND	ND	ND	ND	0.0335	NA	ND	ND	ND	ND	NA	ND	ND
2/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.312	ND	ND	ND	ND	ND	ND	ND	0.0333	NA	ND	ND	ND	ND	NA	ND	ND
2/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.23	ND	ND	ND	ND	ND	ND	ND	0.0304	NA	ND	ND	ND	ND	NA	ND	ND
2/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.165	ND	ND	ND	ND	ND	ND	ND	0.0332	NA	ND	ND	ND	ND	NA	ND	ND
2/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.184	ND	ND	ND	ND	ND	ND	ND	0.0307	NA	ND	ND	ND	ND	NA	ND	ND
2/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.00517	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.148	ND	ND	ND	ND	ND	ND	NA	0.0313	NA	ND	ND	ND	ND	NA	ND	ND
2/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.202	ND	ND	ND	ND	ND	ND	NA	0.0275	NA	ND	ND	ND	ND	NA	ND	ND
2/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0528	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.414	ND	ND	ND	ND	ND	ND	NA	0.0664	NA	ND	ND	ND	ND	NA	ND	ND
2/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0474	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.741	ND	ND	ND	ND	ND	ND	ND	0.061	NA	ND	ND	ND	ND	NA	ND	ND
2/23/2009																	

Table 11. TVA surface water data, Emory River mile 0.1, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0216	ND	ND	ND	ND	ND		NA	ND
Not applicable															8.4		
Total	0.347	ND	ND	ND	ND	ND	ND	NA	0.0362	ND	ND	ND	ND	ND		NA	ND
2/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.2		
Total	0.124	ND	ND	ND	ND	ND	ND	NA	0.031	ND	ND	ND	ND	ND		NA	ND
2/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															6.9		
Total	0.274	ND	ND	ND	ND	ND	ND	NA	0.0321	ND	ND	ND	ND	ND		NA	ND
3/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0275	ND	ND	ND	ND	ND		NA	ND
Not applicable															6.3		
Total	0.206	ND	ND	ND	ND	ND	ND	NA	0.0371	ND	ND	ND	ND	ND		NA	ND
3/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															6		
Total	0.168	ND	ND	ND	ND	ND	ND	NA	0.0306	ND	ND	ND	ND	ND		NA	ND
3/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															4.5		
Total	0.186	ND	ND	ND	ND	ND	ND	NA	0.0279	ND	ND	ND	ND	ND		NA	ND
3/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															6.1		
Total	0.121	ND	ND	ND	ND	ND	ND	NA	0.0296	ND	ND	ND	ND	ND		NA	ND
3/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															6		
Total	0.155	ND	ND	ND	ND	ND	ND	ND	0.0326	ND	ND	ND	ND	ND		NA	ND
3/13/2009																	

Table 11. TVA surface water data, Emory River mile 0.1, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															9.8		
Total	0.211	ND	ND	ND	ND	ND	ND		0.039	ND	ND	ND	ND	ND		NA	ND
3/14/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		NA	0.23
Not applicable															6.3		
Total	0.141	ND	ND	ND	ND	ND	ND	ND	0.0301	ND	ND	ND	ND	ND		NA	ND
3/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.022	ND	ND	ND	ND	ND	44.5	NA	ND
Total	0.489	ND	0.00344	ND	ND	ND	ND	ND	0.0395	ND	ND	ND	ND	ND		NA	ND
3/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.018	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.6		
Total	0.369	ND	ND	ND	ND	ND	ND	NA	0.0285	ND	ND	ND	ND	ND		ND	ND
3/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0176	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.07		
Total	0.28	ND	ND	ND	ND	ND	ND	NA	0.0284	ND	ND	ND	ND	ND		ND	ND
3/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.00618	ND	ND	ND	ND	ND		ND	ND
Not applicable															8		
Total	NA	ND	ND	ND	ND	ND	ND	NA	0.0342	ND	ND	ND	ND	ND		ND	ND
3/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.9		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0306	ND	ND	ND	ND	ND		ND	ND
3/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0254	ND	ND	ND	ND	ND		ND	ND
Not applicable															29.1		
Total	1.14	ND	0.00241	ND	ND	ND	ND	NA	0.046	ND	ND	ND	ND	ND		ND	ND
3/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0288	ND	ND	ND	ND	ND		ND	ND
Not															14.3		

Table 11. TVA surface water data, Emory River mile 0.1, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
applicable																	
Total	0.342	ND	ND	ND	ND	ND	ND	NA	0.0421	ND	ND	ND	ND	ND		ND	ND
4/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0289	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.1		
Total		ND	ND	ND	ND	ND	ND	NA	0.0377	ND	ND	ND	ND	ND		ND	ND
4/3/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	NA	NA	0.029	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.7		
Total	0.324	ND	ND	ND	ND	ND	ND	NA	0.0418	ND	ND	ND	ND	ND		ND	ND
4/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0268	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.4		
Total	0.249	ND	ND	ND	ND	ND	ND	NA	0.0386	ND	ND	ND	ND	ND		ND	ND
4/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0258	ND	ND	ND	ND	ND		ND	ND
Not applicable															9.7		
Total	0.391	ND	ND	ND	ND	ND	ND	NA	0.0403	ND	ND	ND	ND	ND		ND	ND
4/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0202	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.3		
Total	0.29	ND	ND	ND	ND	ND	ND	NA	0.04	ND	0.0012	ND	ND	ND		ND	ND
4/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0419	ND	ND	ND	ND	ND		ND	ND
Not applicable															6		
Total	NA	ND	ND	ND	ND	ND	ND	ND	0.0502	ND	ND	ND	ND	ND		ND	ND
4/15/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0264	ND	ND	ND	ND	ND		ND	ND
Not applicable															10.7		
Total	0.315	ND	ND	ND	ND	ND	ND	ND	0.0358	ND	ND	ND	ND	ND		ND	ND
4/17/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0123	ND	ND	ND	ND	ND		ND	ND
Not															9.4		

Table 11. TVA surface water data, Emory River mile 0.1, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
applicable																	
Total	0.341	ND	ND	ND	ND	ND	ND	ND	0.0244	ND	ND	ND	ND	ND		ND	ND
4/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0209	ND	ND	ND	ND	ND		ND	ND
Not applicable															3.9		
Total	0.191	ND	ND	ND	ND	ND	ND	ND	0.0354	ND	ND	ND	ND	ND		ND	ND
4/22/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0208	ND	ND	ND	ND	ND		ND	ND
Not applicable															9.8		
Total	0.336	ND	ND	ND	ND	ND	ND	ND	0.0322	ND	ND	ND	ND	ND		ND	ND
4/24/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0189	ND	ND	ND	ND	ND		ND	ND
Not applicable															4.5		
Total	0.248	ND	ND	ND	ND	ND	ND	ND	0.0305	ND	ND	ND	ND	ND		ND	ND
4/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.7		
Total	0.137	ND	ND	ND	ND	ND	ND	ND	0.0255	ND	ND	ND	ND	ND		ND	ND
4/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.7		
Total	0.166	ND	ND	ND	ND	ND	ND	ND	0.0296	ND	ND	ND	ND	ND		ND	ND
5/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.3		
Total	0.186	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
5/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0233	ND	ND	ND	ND	ND		ND	ND
Not applicable															11.1		
Total	0.448	ND	ND	ND	ND	ND	ND	ND	0.0366	ND	ND	ND	ND	ND		ND	ND

ND = not detected
NA = not available

Table 12. TVA surface water data, Emory River mile 1.0, December 22, 2008, & Emory River mile 1.7, December 25, 2009. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Row Labels	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
12/22/2008																	
ERM1.0																	
Dissolved	ND	ND	0.0145	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	0.00895	ND
Total	16.1	0.00225	0.0386	0.00208	ND	0.0126	0.00774	0.02	0.277	NA	0.0181	ND	ND	ND	NA	0.0479	0.053
2/25/2009																	
ERM1.7																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.6		
Total	0.197	ND	ND	ND	ND	ND	ND	ND	0.0264	ND	ND	ND	ND	ND		NA	ND

ND = not detected
NA = not available

Table 13. TVA surface water data, Emory River mile 1.75, December 22, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
12/22/2008																	
Dissolved	ND	ND	0.0151	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	0.00989	ND
Total	22.5	0.00236	0.0589	0.00256	ND	0.0164	0.0112	0.0242	0.235	NA	ND	ND	ND	ND	NA	0.0616	ND
12/23/2008																	
Dissolved	ND	ND	0.00725	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	2.97	ND	0.0124	ND	ND	0.00322	ND	0.00439	0.137	NA	ND	ND	ND	ND	NA	0.0123	ND
12/26/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.29	ND	ND	ND	ND	ND	ND	ND	0.0253	NA	ND	ND	ND	ND	NA	ND	ND
12/29/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.65	ND	ND	ND	ND	ND	ND	ND	0.0393	NA	ND	ND	ND	ND	NA	ND	ND
1/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.526	ND	ND	ND	ND	ND	ND	ND	0.0365	NA	ND	ND	ND	ND	NA	ND	ND
1/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND

Table 13. TVA surface water data, Emory River mile 1.75, December 22, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.436	ND	ND	ND	ND	ND	ND	ND	0.0393	NA	ND	ND	ND	ND	NA	ND	ND
1/7/2009																	
Dissolved	0.144	ND	0.0281	ND	ND	ND	ND	ND	ND	NA	ND	0.00512	ND	ND	NA	0.0265	ND
Total	96	0.00313	0.189	ND	ND	0.0829	0.0546	0.104	0.558	NA	0.126	ND	ND	0.00491	NA	0.339	ND
1/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.714	ND	ND	ND	ND	ND	ND	ND	0.0427	NA	ND	ND	ND	ND	NA	ND	ND
1/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.485	ND	ND	ND	ND	ND	ND	ND	0.0406	NA	ND	ND	ND	ND	NA	ND	ND
1/12/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.325	ND	ND	ND	ND	ND	ND	ND	0.036	NA	ND	ND	ND	ND	NA	ND	ND
1/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.42	ND	ND	ND	ND	ND	ND	ND	0.0374	NA	ND	ND	ND	ND	NA	ND	ND
1/21/2009																	
Dissolved	0.1	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.005	NA	0.005	0.002	0.002	0.002	NA	0.004	0.05
Total	0.33	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.02955	NA	0.005	0.002	0.002	0.002	NA	0.004	0.05
1/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.204	ND	ND	ND	ND	ND	ND	ND	0.0313	NA	ND	ND	ND	ND	NA	ND	ND
1/26/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.202	ND	ND	ND	ND	ND	ND	ND	0.02775	NA	ND	ND	ND	ND	NA	ND	ND
1/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.3	ND	ND	ND	ND	ND	ND	ND	0.0296	NA	ND	ND	ND	ND	NA	ND	ND
1/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.368	ND	ND	ND	ND	ND	ND	ND	0.0657	NA	ND	ND	ND	ND	NA	ND	ND
1/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.199	ND	ND	ND	ND	ND	ND	ND	0.038	NA	ND	ND	ND	ND	NA	ND	ND
2/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.292	ND	ND	ND	ND	ND	ND	ND	0.0309	NA	ND	ND	ND	ND	NA	ND	ND
2/4/2009																	

Table 13. TVA surface water data, Emory River mile 1.75, December 22, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.21	ND	ND	ND	ND	ND	ND	ND	0.0321	NA	ND	ND	ND	ND	NA	ND	ND
2/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.31	ND	ND	ND	ND	ND	ND	ND	0.0296	NA	ND	ND	ND	ND	NA	ND	ND
2/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.195	ND	ND	ND	ND	ND	ND	ND	0.0278	NA	ND	ND	ND	ND	NA	ND	ND
2/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.176	ND	ND	ND	ND	ND	ND	ND	0.0258	NA	ND	ND	ND	ND	NA	ND	ND
2/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0107	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.182	ND	ND	ND	ND	ND	ND	ND	0.0306	NA	ND	ND	ND	ND	NA	ND	ND
2/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.193	ND	ND	ND	ND	ND	ND	ND	0.0271	NA	ND	ND	ND	ND	NA	ND	ND
2/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0429	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.783	ND	ND	ND	ND	ND	ND	ND	0.0583	NA	ND	ND	ND	ND	NA	ND	ND
2/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0289	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.462	ND	ND	ND	ND	ND	ND		0.0414	NA	ND	ND	ND	ND	NA	ND	ND
2/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0254	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.6		
Total	0.241	ND	ND	ND	ND	ND	ND	ND	0.0325	ND	ND	ND	ND	ND		NA	ND
2/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															4.9		
Total	0.164	ND	ND	ND	ND	ND	ND	ND	0.0298	ND	ND	ND	ND	ND		NA	ND
3/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0323	ND	ND	ND	ND	ND		NA	ND
Not applicable															8.1		
Total	0.234	ND	ND	ND	ND	ND	ND	ND	0.0382	ND	ND	ND	ND	ND		NA	ND
3/4/2009																	

Table 13. TVA surface water data, Emory River mile 1.75, December 22, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0243	ND	ND	ND	ND	ND		NA	ND
Not applicable															4.9		
Total	0.207	ND	ND	ND	ND	ND	ND	ND	0.0297	ND	ND	ND	ND	ND		NA	ND
3/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0236	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.2		
Total	0.308	ND	ND	ND	ND	ND	ND	ND	0.0323	ND	ND	ND	ND	ND		NA	ND
3/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															5		
Total	0.125	ND	ND	ND	ND	ND	ND	ND	0.0269	ND	ND	ND	ND	ND		NA	ND
3/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.8		
Total	0.14	ND	ND	ND	ND	ND	ND	ND	0.0275	ND	ND	ND	ND	ND		NA	ND
3/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															7.9		
Total	0.257	ND	ND	ND	ND	ND	ND	ND	0.0312	ND	ND	ND	ND	ND		NA	ND
3/14/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															6.1		
Total	0.126	ND	ND	ND	ND	ND	ND	ND	0.0266	ND	ND	ND	ND	ND		NA	ND
3/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0188	ND	ND	ND	ND	ND	52	NA	ND
Total	0.534	ND	0.00293	ND	ND	ND	ND	ND	0.0439	ND	ND	ND	ND	ND		NA	ND
3/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0208	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.3		
Total	0.374	ND	ND	ND	ND	ND	ND	ND	0.0296	ND	ND	ND	ND	ND		ND	ND
3/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0233	ND	ND	ND	ND	ND		ND	ND
Not															5.07		

Table 13. TVA surface water data, Emory River mile 1.75, December 22, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
applicable																	
Total	0.242	ND	ND	ND	ND	ND	ND	ND	0.0328	ND	ND	ND	ND	ND		ND	ND
3/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0285	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.2		
Total	0.189	ND	ND	ND	ND	ND	ND	ND	0.0393	ND	ND	ND	ND	ND		ND	ND
3/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00732	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.6		
Total	0.145	ND	ND	ND	ND	ND	ND	ND	0.0306	ND	ND	ND	ND	ND		ND	ND
3/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0224	ND	ND	ND	ND	ND		ND	ND
Not applicable															32.2		
Total	1.08	ND	0.00228	ND	ND	ND	ND	ND	0.0484	ND	ND	ND	ND	ND		ND	ND
3/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0301	ND	ND	ND	ND	ND		ND	ND
Not applicable															12.4		
Total	0.318	ND	ND	ND	ND	ND	ND	ND	0.0424	ND	ND	ND	ND	ND		ND	ND
4/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0312	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.9		
Total	0.19	ND	ND	ND	ND	ND	ND	ND	0.0384	ND	ND	ND	ND	ND		ND	ND
4/3/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0404	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.2		
Total	0.216	ND	ND	ND	ND	ND	ND	ND	0.0483	ND	ND	ND	ND	ND		ND	ND
4/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0264	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.9		
Total	0.529	ND	ND	ND	ND	ND	ND	ND	0.03795	ND	0.0015	ND	ND	ND		0.0012	ND
4/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0359	ND	ND	ND	ND	ND		ND	ND
Not															7.9		

Table 13. TVA surface water data, Emory River mile 1.75, December 22, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
applicable																	
Total	0.208	ND	ND	ND	ND	ND	ND	ND	0.0496	ND	ND	ND	ND	ND		ND	ND
4/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0402	ND	ND	ND	ND	ND		ND	ND
Not applicable															3.5		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.049	ND	ND	ND	ND	ND		ND	ND
4/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0372	ND	ND	ND	ND	ND		ND	ND
Not applicable															20.1		
Total	0.446	ND	ND	ND	ND	ND	ND	ND	0.0509	ND	ND	ND	ND	ND		ND	ND
4/15/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.014	ND	ND	ND	ND	ND		ND	ND
Not applicable															15		
Total	0.612	ND	ND	ND	ND	ND	ND	ND	0.0313	ND	ND	ND	ND	ND		ND	ND
4/17/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0154	ND	ND	ND	ND	ND		ND	ND
Not applicable															9.4		
Total	0.377	ND	ND	ND	ND	ND	ND	ND	0.0268	ND	ND	ND	ND	ND		ND	ND
4/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0393	ND	ND	ND	ND	ND		ND	ND
Not applicable															10.2		
Total	0.242	ND	ND	ND	ND	ND	ND	ND	0.0565	ND	ND	ND	ND	ND		ND	ND
4/22/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0204	ND	ND	ND	ND	ND		ND	ND
Not applicable															13.3		
Total	0.39	ND	ND	ND	ND	ND	ND	ND	0.0328	ND	ND	ND	ND	ND		ND	ND
4/24/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0276	ND	ND	ND	ND	ND		ND	ND
Not applicable															3.4		
Total	0.171	ND	ND	ND	ND	ND	ND	ND	0.0357	ND	ND	ND	ND	ND		ND	ND
4/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0131	ND	ND	ND	ND	ND		ND	ND
Not															6.3		

Table 13. TVA surface water data, Emory River mile 1.75, December 22, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
applicable																	
Total	0.177	ND	ND	ND	ND	ND	ND	ND	0.0362	ND	ND	ND	ND	ND		ND	ND
4/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.7		
Total	0.188	ND	ND	ND	ND	ND	ND	ND	0.0238	ND	ND	ND	ND	ND		ND	ND
5/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.8		
Total	0.191	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
5/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0222	ND	ND	ND	ND	ND		ND	ND
Not applicable															21.3		
Total	0.805	ND	ND	ND	ND	ND	ND	ND	0.0383	ND	ND	ND	ND	ND		ND	ND
Total	0.805	ND	ND	ND	ND	ND	ND	ND	0.0383	ND	ND	ND	ND	ND		ND	ND

Concentrations reported are the reported value or the maximum value reported if duplicates were taken.
ND = not detected
NA = not available

Table 14. TVA surface water data, Emory River mile 2.0, December 29, 2008, and Emory River mile 2.1, December 23, 2008, - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
12/23/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.81	ND	0.00277	ND	ND	ND	ND	ND	0.0576	NA	ND	ND	ND	ND	NA	ND	ND
12/26/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.229	ND	ND	ND	ND	ND	ND	ND	0.0213	NA	ND	ND	ND	ND	NA	ND	ND
12/29/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.62	ND	ND	ND	ND	ND	ND	ND	0.0405	NA	ND	ND	ND	ND	NA	ND	ND
1/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.685	ND	ND	ND	ND	ND	ND	ND	0.0468	NA	ND	ND	ND	ND	NA	ND	ND
1/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.233	ND	ND	ND	ND	ND	ND	ND	0.0466	NA	ND	ND	ND	ND	NA	ND	ND
1/7/2009																	
Dissolved	ND	ND	0.0193	ND	ND	ND	ND	ND	ND	NA	ND	0.00233	ND	ND	NA	0.0131	ND
Total	65.6	0.00279	0.131	ND	ND	0.0547	0.0344	0.0686	0.445	NA	0.0818	ND	ND	0.0033	NA	0.206	ND
1/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.63	ND	ND	ND	ND	ND	ND	ND	0.0381	NA	ND	ND	ND	ND	NA	ND	ND
1/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.322	ND	ND	ND	ND	ND	ND	ND	0.038	NA	ND	ND	ND	ND	NA	ND	ND
1/12/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.284	ND	ND	ND	ND	ND	ND	ND	0.0388	NA	ND	ND	ND	ND	NA	ND	ND
1/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.134	ND	ND	ND	ND	ND	ND	ND	0.0444	NA	ND	ND	ND	ND	NA	ND	ND
1/21/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.104	ND	ND	ND	ND	ND	ND	ND	0.0473	NA	ND	ND	ND	ND	NA	ND	ND
1/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.322	ND	ND	ND	ND	ND	ND	ND	0.0628	NA	ND	ND	ND	ND	NA	ND	ND
1/26/2009																	

Table 14. TVA surface water data, Emory River mile 2.0, December 29, 2008, and Emory River mile 2.1, December 23, 2008, - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.105	ND	ND	ND	ND	ND	ND	ND	0.0734	NA	ND	ND	ND	ND	NA	ND	ND
1/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.23	ND	ND	ND	ND	ND	ND	ND	0.0755	NA	ND	ND	ND	ND	NA	ND	ND
1/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.548	ND	ND	ND	ND	ND	ND	ND	0.089	NA	ND	ND	ND	ND	NA	ND	ND
1/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.54	ND	ND	ND	ND	ND	ND	ND	0.0373	NA	ND	ND	ND	ND	NA	ND	ND
2/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.228	ND	ND	ND	ND	ND	ND	ND	0.0306	NA	ND	ND	ND	ND	NA	ND	ND
2/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0336	NA	ND	ND	ND	ND	NA	ND	ND
2/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.103	ND	ND	ND	ND	ND	ND	ND	0.0396	NA	ND	ND	ND	ND	NA	ND	ND
2/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0483	NA	ND	ND	ND	ND	NA	ND	ND
2/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.064	NA	ND	ND	ND	ND	NA	ND	ND
2/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0523	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.147	ND	ND	ND	ND	ND	ND	ND	0.0567	NA	ND	ND	ND	ND	NA	ND	ND
2/18/2009																	
Dissolved	ND	ND	0.00293	ND	ND	ND	ND	ND	0.0533	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.786	ND	0.00477	ND	ND	ND	ND		0.0646	NA	ND	ND	ND	ND	NA	0.00545	ND
2/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0507	NA	ND	ND	ND	ND	NA	ND	ND
Total	1.6	ND	ND	ND	ND	ND	0.0022		0.102	NA	ND	ND	ND	ND	NA	ND	ND
2/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.029	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.417	ND	ND	ND	ND	ND	ND	ND	0.0392	NA	ND	ND	ND	ND	NA	ND	ND
2/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.027	ND	ND	ND	ND	ND		NA	ND

Table 14. TVA surface water data, Emory River mile 2.0, December 29, 2008, and Emory River mile 2.1, December 23, 2008, - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Not applicable															4.8		
Total	0.243	ND	ND	ND	ND	ND	ND	NA	0.032	ND	ND	ND	ND	ND		NA	ND
2/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0288	ND	ND	ND	ND	ND		NA	ND
Not applicable															2.2		
Total	0.143	ND	ND	ND	ND	ND	ND	ND	0.0323	ND	ND	ND	ND	ND		NA	ND
2/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0351	ND	ND	ND	ND	ND		NA	ND
Not applicable															2.9		
Total	0.172	ND	ND	ND	ND	ND	ND	NA	0.0411	ND	ND	ND	ND	ND		NA	ND
3/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0321	ND	ND	ND	ND	ND		NA	ND
Not applicable															9.3		
Total	0.222	ND	ND	ND	ND	ND	ND	ND	0.0388	ND	ND	ND	ND	ND		NA	ND
3/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0241	ND	ND	ND	ND	ND		NA	ND
Not applicable															3.8		
Total	0.206	ND	ND	ND	ND	ND	ND	ND	0.0279	ND	ND	ND	ND	ND		NA	ND
3/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0261	ND	ND	ND	ND	ND		NA	ND
Not applicable															2.3		
Total	0.101	ND	ND	ND	ND	ND	ND	NA	0.0308	ND	ND	ND	ND	ND		NA	ND
3/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0323	ND	ND	ND	ND	ND		NA	ND
Not applicable															3.1		
Total	0.118	ND	ND	ND	ND	ND	ND	NA	0.0366	ND	ND	ND	ND	ND		NA	ND
3/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0357	ND	ND	ND	ND	ND		NA	ND
Not applicable															9		
Total	0.321	ND	ND	ND	ND	ND	ND	ND	0.0435	ND	ND	ND	ND	ND		NA	ND
3/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0434	ND	ND	ND	ND	ND		NA	ND
Not applicable															9.4		

Table 14. TVA surface water data, Emory River mile 2.0, December 29, 2008, and Emory River mile 2.1, December 23, 2008, - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.351	ND	ND	ND	ND	ND	ND	ND	0.0571	ND	ND	ND	ND	ND		NA	ND
3/14/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0487	ND	ND	ND	ND	ND		NA	ND
Not applicable															6		
Total	0.121	ND	ND	ND	ND	ND	ND	ND	0.0581	ND	ND	ND	ND	ND		NA	ND
3/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.017	ND	ND	ND	ND	ND	40.1	NA	ND
Total	0.458	ND	ND	ND	ND	ND	ND	ND	0.0405	ND	ND	ND	ND	ND		NA	ND
3/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0201	ND	ND	ND	ND	ND		ND	ND
Not applicable															4.1		
Total	0.303	ND	ND	ND	ND	ND	ND	ND	0.0269	ND	ND	ND	ND	ND		ND	ND
3/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.026	ND	ND	ND	ND	ND		ND	ND
Not applicable															4.4		
Total	0.246	ND	ND	ND	ND	ND	ND	ND	0.0328	ND	ND	ND	ND	ND		ND	ND
3/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0356	ND	ND	ND	ND	ND		ND	ND
Not applicable															4.3		
Total	0.281	ND	ND	ND	ND	ND	ND	NA	0.0421	ND	ND	ND	ND	ND		ND	ND
3/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0392	ND	ND	ND	ND	ND		ND	ND
Not applicable															10.6		
Total	0.217	ND	0.00279	ND	ND	ND	ND	ND	0.0468	ND	ND	ND	ND	ND		ND	ND
3/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0181	ND	ND	ND	ND	ND		ND	ND
Not applicable															30.4		
Total	0.866	ND	ND	ND	ND	ND	ND	NA	0.044	ND	ND	ND	ND	ND		ND	ND
4/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0399	ND	ND	ND	ND	ND		ND	ND
Not applicable															2.9		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0491	ND	ND	ND	ND	ND		ND	ND
4/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0411	ND	ND	ND	ND	ND		ND	ND

Table 14. TVA surface water data, Emory River mile 2.0, December 29, 2008, and Emory River mile 2.1, December 23, 2008, - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Not applicable															8.2		
Total	0.187	ND	ND	ND	ND	ND	ND	ND	0.0534	ND	ND	ND	ND	ND		ND	ND
4/22/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0213	ND	ND	ND	ND	ND		ND	ND
Not applicable															9.1		
Total	0.286	ND	ND	ND	ND	ND	ND	ND	0.0329	ND	ND	ND	ND	ND		ND	ND
4/24/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0297	ND	ND	ND	ND	ND		ND	ND
Not applicable															3.6		
Total	0.131	ND	ND	ND	ND	ND	ND	ND	0.0393	ND	ND	ND	ND	ND		ND	ND
4/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0316	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.2		
Total	0.136	ND	ND	ND	ND	ND	ND	ND	0.0453	ND	ND	ND	ND	ND		ND	ND
4/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0267	ND	ND	ND	ND	ND		ND	ND
Not applicable															3.6		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0444	ND	ND	ND	ND	ND		ND	ND
5/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00961	ND	ND	ND	ND	ND		ND	ND
Not applicable															9.7		
Total	0.274	ND	ND	ND	ND	ND	ND	ND	0.0409	ND	ND	ND	ND	ND		ND	ND
5/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0205	ND	ND	ND	ND	ND		ND	ND
Not applicable															10.6		
Total	0.426	ND	ND	ND	ND	ND	ND	ND	0.0341	ND	ND	ND	ND	ND		ND	ND

Concentrations reported are the reported value or the maximum value reported if duplicates were taken.
ND = not detected
NA = not available

Table 15. TVA surface water data, Emory River Mile 4.0, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
12/23/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.229	ND	ND	ND	ND	ND	ND	ND	0.027	NA	ND	ND	ND	ND	NA	ND	ND
12/26/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.298	ND	ND	ND	ND	ND	ND	ND	0.0268	NA	ND	ND	ND	ND	NA	ND	ND
12/29/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.575	ND	ND	ND	ND	ND	ND	ND	0.0403	NA	ND	ND	ND	ND	NA	ND	ND
1/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.502	ND	ND	ND	ND	ND	ND	ND	0.0471	NA	ND	ND	ND	ND	NA	ND	ND
1/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.134	ND	ND	ND	ND	ND	ND	ND	0.0477	NA	ND	ND	ND	ND	NA	ND	ND
1/7/2009																	
Dissolved	ND	ND	0.00477	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	10.1	ND	0.0163	ND	ND	0.00854	0.00664	0.0122	0.278	NA	0.0146	ND	ND	ND	NA	0.0277	ND
1/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.669	ND	ND	ND	ND	ND	ND	ND	0.0427	NA	ND	ND	ND	ND	NA	ND	ND
1/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.301	ND	ND	ND	ND	ND	ND	ND	0.038	NA	ND	ND	ND	ND	NA	ND	ND
1/12/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.34	ND	ND	ND	ND	ND	ND	ND	0.0355	NA	ND	ND	ND	ND	NA	ND	ND
1/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0478	NA	ND	ND	ND	ND	NA	ND	ND
1/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0752	NA	ND	ND	ND	ND	NA	ND	ND
1/26/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0749	NA	ND	ND	ND	ND	NA	ND	ND
1/28/2009																	
Dissolved	0.702	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND

Table 15. TVA surface water data, Emory River Mile 4.0, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0853	NA	ND	ND	ND	ND	NA	ND	ND
1/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.124	ND	ND	ND	ND	ND	ND	ND	0.0436	NA	ND	ND	ND	ND	NA	ND	ND
1/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.155	ND	ND	ND	ND	ND	ND	ND	0.0344	NA	ND	ND	ND	ND	NA	ND	ND
2/2/2009																	
Dissolved	0.125	ND	ND	ND	ND	ND	ND	ND	0.0342	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.186	ND	ND	ND	ND	ND	ND	ND	0.0309	NA	ND	ND	ND	ND	NA	ND	ND
2/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0343	NA	ND	ND	ND	ND	NA	ND	ND
2/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.104	ND	ND	ND	ND	ND	ND	ND	0.0431	NA	ND	ND	ND	ND	NA	ND	ND
2/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0544	NA	ND	ND	ND	ND	NA	ND	ND
2/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0591	NA	ND	ND	ND	ND	NA	ND	ND
2/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0543	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.061	NA	ND	ND	ND	ND	NA	ND	ND
2/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0572	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.113	ND	ND	ND	ND	ND	ND	ND	0.0622	NA	ND	ND	ND	ND	NA	ND	ND
2/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0444	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.245	ND	ND	ND	ND	ND	ND	ND	0.0514	NA	ND	ND	ND	ND	NA	ND	ND
2/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.027	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.206	ND	ND	ND	ND	ND	ND	ND	0.0372	NA	ND	ND	ND	ND	NA	ND	ND
2/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0278	ND	ND	ND	ND	ND		NA	ND
NA															3.6		
Total	0.169	ND	ND	ND	ND	ND	ND	ND	0.0331	ND	ND	ND	ND	ND		NA	ND

Table 15. TVA surface water data, Emory River Mile 4.0, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
2/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND		0.0321	ND	ND	ND	ND	ND		NA	ND
NA															2.4		
Total	0.154	ND	ND	ND	ND	ND	ND	ND	0.0361	ND	ND	ND	ND	ND		NA	ND
2/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0386	ND	ND	ND	ND	ND		NA	ND
NA															1.8		
Total	0.137	ND	ND	ND	ND	ND	ND	ND	0.0429	ND	ND	ND	ND	ND		NA	ND
3/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0337	ND	ND	ND	ND	ND		NA	ND
NA															5.2		
Total	0.173	ND	ND	ND	ND	ND	ND	ND	0.0375	0.000245	ND	ND	ND	ND		NA	ND
3/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0251	ND	ND	ND	ND	ND		NA	ND
Not applicable															4.3		
Total	0.214	ND	ND	ND	ND	ND	ND	ND	0.0306	ND	ND	ND	ND	ND		NA	ND
3/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0278	ND	ND	ND	ND	ND		NA	ND
NA															1.8		
Total	0.128	ND	ND	ND	ND	ND	ND	ND	0.0316	ND	ND	ND	ND	ND		NA	ND
3/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0313	ND	ND	ND	ND	ND		NA	ND
NA															1.7		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0352	ND	ND	ND	ND	ND		NA	ND
3/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0382	ND	ND	ND	ND	ND		NA	ND
NA															3.6		
Total	0.118	ND	ND	ND	ND	ND	ND	ND	0.0446	ND	ND	ND	ND	ND		NA	ND
3/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0468	ND	ND	ND	ND	ND		NA	ND
NA															3.5		
Total	0.135	ND	ND	ND	ND	ND	ND	ND	0.058	ND	ND	ND	ND	ND		NA	ND
3/14/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0543	ND	ND	ND	ND	ND		NA	ND
NA															3		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0633	ND	ND	ND	ND	ND		NA	ND
3/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.015	ND	ND	ND	ND	ND	14.9	NA	ND

Table 15. TVA surface water data, Emory River Mile 4.0, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.324	ND	ND	ND	ND	ND	ND	ND	0.033	ND	ND	ND	ND	ND		NA	ND
3/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0245	ND	ND	ND	ND	ND		ND	ND
NA															5		
Total	0.336	ND	ND	ND	ND	ND	ND	NA	0.0314	ND	ND	ND	ND	ND		ND	ND
3/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0361	ND	ND	ND	ND	ND		ND	ND
NA															7.1		
Total	0.303	ND	ND	ND	ND	ND	ND	NA	0.0414	ND	ND	ND	ND	ND		ND	ND
3/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0371	ND	ND	ND	ND	ND		ND	ND
NA															3		
Total	0.2	ND	ND	ND	ND	ND	ND		0.0461	ND	ND	ND	ND	ND		ND	ND
3/25/2009								NA									
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0442	ND	ND	ND	ND	ND		ND	ND
NA															3.8		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0522	ND	ND	ND	ND	ND		ND	ND
3/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0189	ND	ND	ND	ND	ND		ND	ND
Not applicable															25.1		
Total	0.752	ND	ND	ND	ND	ND	ND	NA	0.0444	ND	ND	ND	ND	ND		ND	ND
3/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.031	ND	ND	ND	ND	ND		ND	ND
NA															10.7		
Total	0.236	ND	ND	ND	ND	ND	ND	ND	0.045	ND	ND	ND	ND	ND		ND	ND
4/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0354	ND	ND	ND	ND	ND		ND	ND
NA															5.6		
Total	0.228	ND	ND	ND	ND	ND	ND	ND	0.0423	ND	ND	ND	ND	ND		ND	ND
4/3/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.04	ND	ND	ND	ND	ND		ND	ND
NA															3.6		
Total	0.213	ND	ND	ND	ND	ND	ND	ND	0.0471	ND	ND	ND	ND	ND		ND	ND
4/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0422	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.9		
Total	0.174	ND	ND	ND	ND	ND	ND	ND	0.0532	ND	ND	ND	ND	ND		ND	ND

Table 15. TVA surface water data, Emory River Mile 4.0, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
4/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	0.0014	NA	0.0415	ND	ND	ND	ND	ND		ND	ND
NA															3.3		
Total	0.146	ND	ND	ND	ND	ND	ND	NA	0.052	ND	0.0011	ND	ND	ND		ND	ND
4/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0339	ND	ND	ND	ND	ND		ND	ND
NA															8.7		
Total	0.261	ND	ND	ND	ND	ND	ND	ND	0.0416	ND	ND	ND	ND	ND		ND	ND
4/15/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00859	ND	ND	ND	ND	ND		ND	ND
NA															18		
Total	0.571	ND	ND	ND	ND	ND	ND	ND	0.0333	ND	ND	ND	ND	ND		ND	ND
4/17/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0174	ND	ND	ND	ND	ND		ND	ND
NA															6.6		
Total	0.254	ND	ND	ND	ND	ND	ND	ND	0.0288	ND	ND	ND	ND	ND		ND	ND
4/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0402	ND	ND	ND	ND	ND		ND	ND
Not applicable															4.5		
Total	0.134	ND	ND	ND	ND	ND	ND	ND	0.0541	ND	ND	ND	ND	ND		ND	ND
4/22/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0215	ND	ND	ND	ND	ND		ND	ND
NA															7.4		
Total	0.296	ND	ND	ND	ND	ND	ND	ND	0.0337	ND	ND	ND	ND	ND		ND	ND
4/24/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0281	ND	ND	ND	ND	ND		ND	ND
NA															4.1		
Total	0.171	ND	ND	ND	ND	ND	ND	ND	0.0387	ND	ND	ND	ND	ND		ND	ND
4/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0442	ND	ND	ND	ND	ND		ND	ND
NA															2.9		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0534	ND	ND	ND	ND	ND		ND	ND
4/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0383	ND	ND	ND	ND	ND		ND	ND
NA															2.2		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0552	ND	ND	ND	ND	ND		ND	ND
5/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0141	ND	ND	ND	ND	ND		ND	ND

Table 15. TVA surface water data, Emory River Mile 4.0, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.																	
Date	**Aluminum**	**Antimony**	**Arsenic**	**Beryllium**	**Cadmium**	**Chromium**	**Cobalt**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Silver**	**Thallium**	**TSS**	**Vanadium**	**Zinc**
NA															3.7		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0436	ND	ND	ND	ND	ND		ND	ND
5/5/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00947	ND	ND	ND	ND	ND		ND	ND
NA															23.7		
Total	0.786	ND	ND	ND	ND	ND	ND	ND	0.0522	ND	ND	ND	ND	ND		ND	ND
5/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0236	ND	ND	ND	ND	ND		ND	ND
NA															9.1		
Total	0.314	ND	ND	ND	ND	ND	ND	ND	0.0371	ND	ND	ND	ND	ND		ND	ND

Concentrations reported are the reported value or the maximum value reported if duplicates were taken.
ND = not detected
NA = not available

Table 16. TVA surface water data, Emory River mile 12.2, December 26, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
1/26/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0428	NA	ND	ND	ND	ND	NA	ND	ND
1/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0594	NA	ND	ND	ND	ND	NA	ND	ND
1/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.28	ND	ND	ND	ND	ND	ND	ND	0.0316	NA	ND	ND	ND	ND	NA	ND	ND
1/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.214	ND	ND	ND	ND	ND	ND	ND	0.0247	NA	ND	ND	ND	ND	NA	ND	ND
2/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0255	NA	ND	ND	ND	ND	NA	ND	ND
2/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.108	ND	ND	ND	ND	ND	ND	ND	0.0348	NA	ND	ND	ND	ND	NA	ND	ND
2/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.034	NA	ND	ND	ND	ND	NA	ND	ND
2/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.116	ND	ND	ND	ND	ND	ND	ND	0.0426	NA	ND	ND	ND	ND	NA	ND	ND
2/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0383	NA	ND	ND	ND	ND	NA	ND	ND
2/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0367	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.252	ND	ND	ND	ND	ND	ND	NA	0.0387	NA	ND	ND	ND	ND	NA	ND	ND
2/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0335	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.102	ND	ND	ND	ND	ND	ND	NA	0.0352	NA	ND	ND	ND	ND	NA	ND	ND
2/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0191	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.154	ND	ND	ND	ND	ND	ND	NA	0.0239	NA	ND	ND	ND	ND	NA	ND	ND
2/23/2009																	
Dissolved	ND	0.00273	ND	ND	ND	ND	ND	NA	0.0233	ND	ND	ND	ND	ND		NA	ND

Table 16. TVA surface water data, Emory River mile 12.2, December 26, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Not applicable															ND		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0239	ND	ND	ND	ND	ND		NA	ND
2/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0297	ND	ND	ND	ND	ND		NA	ND
Not applicable															ND		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0312	ND	ND	ND	ND	ND		NA	ND
2/28/2009																	
Dissolved	ND	0.00318	ND	ND	ND	ND	ND	NA	0.0326	ND	ND	ND	ND	ND		NA	ND
Not applicable															10.3		
Total	0.347	ND	ND	ND	ND	ND	ND	NA	0.0403	ND	ND	ND	ND	ND		NA	ND
3/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0184	ND	ND	ND	ND	ND		NA	ND
Not applicable															2.5		
Total	0.161	ND	ND	ND	ND	ND	ND	NA	0.0219	ND	ND	ND	ND	ND		NA	ND
3/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0213	ND	ND	ND	ND	ND		NA	ND
Not applicable															1.1		
Total	0.134	ND	ND	ND	ND	ND	ND	ND	0.0226	ND	ND	ND	ND	ND		NA	ND
3/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0245	ND	ND	ND	ND	ND		NA	ND
Not applicable															1		
Total	ND	0.00599	ND	ND	ND	ND	ND	NA	0.0274	ND	ND	ND	ND	ND		NA	ND
3/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0297	ND	ND	ND	ND	ND		NA	ND
Not applicable															1.2		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0319	ND	ND	ND	ND	ND		NA	ND
3/11/2009																	
Dissolved	ND	0.00222	ND	ND	ND	ND	ND	NA	0.0354	ND	ND	ND	ND	ND		NA	ND
Not applicable															4.4		
Total	0.174	ND	ND	ND	ND	ND	ND	NA	0.0387	ND	ND	ND	ND	ND		NA	ND
3/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0201	ND	ND	ND	ND	ND		NA	ND

Table 16. TVA surface water data, Emory River mile 12.2, December 26, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Not applicable															1.6		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0237	ND	ND	ND	ND	ND		NA	ND
3/14/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0188	ND	ND	ND	ND	ND		NA	ND
Not applicable															2.4		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0233	ND	ND	ND	ND	ND		NA	ND
3/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12.9	NA	ND
Total	0.229	ND	ND	ND	ND	ND	ND	NA	0.0326	ND	ND	ND	ND	ND		NA	ND
3/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0179	ND	ND	ND	ND	ND		ND	ND
Not applicable															4		
Total	0.221	ND	ND	ND	ND	ND	ND	NA	0.0282	ND	ND	ND	ND	ND		ND	ND
3/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0203	ND	ND	ND	ND	ND		ND	ND
Not applicable															2.6		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0251	ND	ND	ND	ND	ND		ND	ND
3/23/2009																	
Dissolved	ND	0.00269	ND	ND	ND	ND	0.0039	NA	0.0379	ND	ND	ND	ND	ND		ND	ND
Not applicable															1.6		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0376	ND	ND	ND	ND	ND		ND	ND
3/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0467	ND	ND	ND	ND	ND		ND	ND
Not applicable															2.9		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0551	ND	ND	ND	ND	ND		ND	ND
3/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0147	ND	ND	ND	ND	ND		ND	ND
Not applicable															23.7		
Total	0.798	ND	ND	ND	ND	ND	ND	NA	0.0716	ND	ND	ND	ND	ND		ND	ND
3/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.024	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.4		

Table 16. TVA surface water data, Emory River mile 12.2, December 26, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.258	ND	ND	ND	ND	ND	ND	NA	0.039	ND	ND	ND	ND	ND		ND	ND
4/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0318	ND	ND	ND	ND	ND		ND	ND
Not applicable															4.1		
Total	0.143	ND	ND	ND	ND	ND	ND	ND	0.0392	ND	ND	ND	ND	ND		ND	ND
4/3/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0319	ND	ND	ND	ND	ND		ND	ND
Not applicable															3.8		
Total	0.208	ND	ND	ND	ND	ND	ND	NA	0.0381	ND	ND	ND	ND	ND		ND	ND
4/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0249	ND	ND	ND	ND	ND		ND	ND
Not applicable															3.8		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.031	ND	ND	ND	ND	ND		ND	ND
4/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0319	ND	ND	ND	ND	ND		ND	ND
Not applicable															3.2		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0396	ND	0.0012	ND	ND	ND		ND	ND
4/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0405	ND	ND	ND	ND	ND		ND	ND
Not applicable															14.4		
Total	0.391	ND	ND	ND	ND	ND	ND	NA	0.0569	ND	ND	ND	ND	ND		ND	ND
4/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.0294	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.6		
Total	0.267	ND	ND	ND	ND	ND	ND	ND	0.0369	ND	ND	ND	ND	ND		ND	ND
4/15/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.00827	ND	ND	ND	ND	ND		ND	ND
Not applicable															19.9		
Total	0.474	ND	ND	ND	ND	ND	ND	NA	0.0451	ND	ND	ND	ND	ND		ND	ND
4/17/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0262	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.2		

Table 16. TVA surface water data, Emory River mile 12.2, December 26, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.2	ND	ND	ND	ND	ND	ND	ND	0.0369	ND	ND	ND	ND	ND		ND	ND
4/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0287	ND	ND	ND	ND	ND		ND	ND
Not applicable															16.2		
Total	0.36	ND	ND	ND	ND	ND	ND	ND	0.0543	ND	ND	ND	ND	ND		ND	ND
4/22/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0216	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.1		
Total	0.166	ND	ND	ND	ND	ND	ND	ND	0.0352	ND	ND	ND	ND	ND		ND	ND
4/24/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0421	ND	ND	ND	ND	ND		ND	ND
Not applicable															2.9		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0437	ND	ND	ND	ND	ND		ND	ND
4/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0354	ND	ND	ND	ND	ND		ND	ND
Not applicable															2		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0441	ND	ND	ND	ND	ND		ND	ND
4/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0313	ND	ND	ND	ND	ND		ND	ND
Not applicable															2.3		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0423	ND	ND	ND	ND	ND		ND	ND
5/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0193	ND	ND	ND	ND	ND		ND	ND
Not applicable															3		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0513	ND	ND	ND	ND	ND		ND	ND
5/5/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0152	ND	ND	ND	ND	ND		ND	ND
Not applicable															21.7		
Total	0.643	ND	ND	ND	ND	ND	ND	ND	0.0612	ND	ND	ND	ND	ND		ND	ND
5/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.0238	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.3		

Table 16. TVA surface water data, Emory River mile 12.2, December 26, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.249	ND	ND	ND	ND	ND	ND	ND	0.0376	ND	ND	ND	ND	ND		ND	ND

Concentrations reported are the reported value or the maximum value reported if duplicates were taken.
ND = not detected
NA = not available

Table 17. TVA surface water data, Emory River mile 6.0, January 19 and 23, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
1/19/2009															
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0503	ND	ND	ND	ND	ND	ND
1/23/2009															
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.073	ND	ND	ND	ND	ND	ND

Concentrations reported are the reported value or the maximum value reported if duplicates were taken.
ND = not detected

Table 18. TVA surface water data, Tennessee River mile 563.5, January 12 - April 17, 2009. Results in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
1/12/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.808	ND	ND	ND	ND	ND	ND	ND	0.0862	NA	ND	ND	ND	ND	NA	ND	ND
3/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.8		
Total	0.36	ND	ND	ND	ND	ND	ND	NA	0.0365	ND	ND	ND	ND	ND		ND	ND
3/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.8		
Total	0.284	ND	ND	ND	ND	ND	ND	NA	0.038	ND	ND	ND	ND	ND		ND	ND
4/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	0.00533	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.2		
Total	0.256	ND	ND	ND	ND	ND	ND	ND	0.0307	ND	ND	ND	ND	ND		ND	ND
4/3/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.6		
Total	0.235	ND	ND	ND	ND	ND	ND	ND	0.0322	ND	ND	ND	ND	ND		ND	ND
4/15/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.8		
Total	0.23	ND	ND	ND	ND	ND	ND	ND	0.0318	ND	ND	ND	ND	ND		ND	ND
4/17/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.6		
Total	0.158	ND	ND	ND	ND	ND	ND	ND	0.0227	ND	ND	ND	ND	ND		ND	ND

Concentrations reported are the reported value or the maximum value reported if duplicates were taken.
ND = not detected
NA = not available

Table 19. TVA surface water data, Tennessee River mile 568.5, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
12/23/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.242	ND	ND	ND	ND	ND	ND	ND	0.0446	NA	ND	ND	ND	ND	NA	ND	ND
12/26/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.202	ND	ND	ND	ND	ND	ND	ND	0.0409	NA	ND	ND	ND	ND	NA	ND	ND
12/29/2008																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.221	ND	ND	ND	ND	ND	ND	ND	0.0477	NA	ND	ND	ND	ND	NA	ND	ND
1/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.191	ND	ND	ND	ND	ND	ND	ND	0.0377	NA	ND	ND	ND	ND	NA	ND	ND
1/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.185	ND	ND	ND	ND	ND	ND	ND	0.0451	NA	ND	ND	ND	ND	NA	ND	ND
1/7/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.23	ND	ND	ND	ND	ND	ND	ND	0.0532	NA	ND	ND	ND	ND	NA	ND	ND
1/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.826	ND	ND	ND	ND	ND	ND	ND	0.14	NA	ND	ND	ND	ND	NA	ND	ND
1/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.5	ND	ND	ND	ND	ND	ND	ND	0.0939	NA	ND	ND	ND	ND	NA	ND	ND
1/12/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.759	ND	ND	ND	ND	ND	ND	ND	0.0837	NA	ND	ND	ND	ND	NA	ND	ND
1/19/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.238	ND	ND	ND	ND	ND	ND	ND	0.0437	NA	ND	ND	ND	ND	NA	ND	ND
1/21/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.228	ND	ND	ND	ND	ND	ND	ND	0.0369	NA	ND	ND	ND	ND	NA	ND	ND
1/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.177	ND	ND	ND	ND	ND	ND	ND	0.0399	NA	ND	ND	ND	ND	NA	ND	ND
1/26/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND

Table 19. TVA surface water data, Tennessee River mile 568.5, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.171	ND	ND	ND	ND	ND	ND	ND	0.0404	NA	ND	ND	ND	ND	NA	ND	ND
1/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.2	ND	ND	ND	ND	ND	ND	ND	0.0392	NA	ND	ND	ND	ND	NA	ND	ND
1/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.134	ND	ND	ND	ND	ND	ND	ND	0.0376	NA	ND	ND	ND	ND	NA	ND	ND
1/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.175	ND	ND	ND	ND	ND	ND	ND	0.0401	NA	ND	ND	ND	ND	NA	ND	ND
2/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.205	ND	ND	ND	ND	ND	ND	ND	0.0399	NA	ND	ND	ND	ND	NA	ND	ND
2/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.143	ND	ND	ND	ND	ND	ND	ND	0.0415	NA	ND	ND	ND	ND	NA	ND	ND
2/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.167	ND	ND	ND	ND	ND	ND	ND	0.0414	NA	ND	ND	ND	ND	NA	ND	ND
2/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.136	ND	ND	ND	ND	ND	ND	ND	0.0424	NA	ND	ND	ND	ND	NA	ND	ND
2/13/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.147	ND	ND	ND	ND	ND	ND	ND	0.0451	NA	ND	ND	ND	ND	NA	ND	ND
2/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	0.00767	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.155	ND	ND	ND	ND	ND	ND	NA	0.051	NA	ND	ND	ND	ND	NA	ND	ND
2/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.174	ND	ND	ND	ND	ND	ND		0.0432	NA	ND	ND	ND	ND	NA	ND	ND
2/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	NA	ND	ND	ND	ND	NA	ND	ND
Total	0.171	ND	ND	ND	ND	ND	ND	NA	0.042	NA	ND	ND	ND	ND	NA	ND	ND
2/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															6.5		
Total	0.152	ND	ND	ND	ND	ND	ND	NA	0.045	ND	ND	ND	ND	ND		NA	ND

Table 19. TVA surface water data, Tennessee River mile 568.5, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
2/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.1		
Total	0.133	ND	ND	ND	ND	ND	ND	NA	0.0413	ND	ND	ND	ND	ND		NA	ND
2/28/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.7		
Total	0.149	ND	ND	ND	ND	ND	ND	NA	0.0437	ND	ND	ND	ND	ND		NA	ND
3/2/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															7		
Total	0.164	ND	ND	ND	ND	ND	ND	NA	0.0503	ND	ND	ND	ND	ND		NA	ND
3/4/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.7		
Total	0.145	ND	ND	ND	ND	ND	ND	NA	0.0447	ND	ND	ND	ND	ND		NA	ND
3/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															6.4		
Total	0.217	ND	ND	ND	ND	ND	ND	NA	0.0451	ND	ND	ND	ND	ND		NA	ND
3/9/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.8		
Total	0.11	ND	ND	ND	ND	ND	ND	NA	0.0436	ND	ND	ND	ND	ND		NA	ND
3/11/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															5.8		
Total	0.188	ND	ND	ND	ND	ND	ND	NA	0.042	ND	ND	ND	ND	ND		NA	ND
3/14/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		NA	ND
Not applicable															6.9		
Total	0.156	ND	ND	ND	ND	ND	ND	ND	0.0477	ND	ND	ND	ND	ND		NA	ND
3/16/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	5.9	NA	ND
Total	0.113	ND	ND	ND	ND	ND	ND	NA	0.0371	ND	ND	ND	ND	ND		NA	ND
3/18/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.1		

Table 19. TVA surface water data, Tennessee River mile 568.5, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	0.195	ND	ND	ND	ND	ND	ND	NA	0.0372	ND	ND	ND	ND	ND		ND	ND
3/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0334	ND	ND	ND	ND	ND		ND	ND
3/23/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	0.00025	ND	ND	ND	ND		ND	ND
Not applicable															6.4		
Total	0.16	ND	ND	ND	ND	ND	ND	NA	0.0343	ND	ND	ND	ND	ND		ND	ND
3/25/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.8		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0398	ND	ND	ND	ND	ND		ND	ND
3/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.7		
Total	0.167	0.00206	ND	ND	ND	ND	ND	NA	0.0356	ND	ND	ND	ND	ND		ND	ND
3/30/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															8		
Total	0.128	ND	ND	ND	ND	ND	ND	NA	0.04	ND	ND	ND	ND	ND		ND	ND
4/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.5		
Total	ND		ND	ND	ND	ND	ND	NA	0.0325	ND	ND	ND	ND	ND		ND	ND
4/3/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.2		
Total	ND	0.00307	ND	ND	ND	ND	ND	NA	0.0335	ND	ND	ND	ND	ND		ND	ND
4/6/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															8.3		
Total	0.101	ND	ND	ND	ND	ND	ND	NA	0.033	ND	ND	ND	ND	ND		ND	ND
4/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															10.6		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0455	ND	ND	ND	ND	ND		ND	ND
4/11/2009																	

Table 19. TVA surface water data, Tennessee River mile 568.5, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.5		
Total	ND	ND	ND	ND	ND	ND	ND	NA	0.0292	ND	ND	ND	ND	ND		ND	ND
4/13/2009																	
Dissolved	ND	0.0025	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															8		
Total	0.119	ND	ND	ND	ND	ND	ND	NA	0.0353	ND	ND	ND	ND	ND		ND	ND
4/15/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															7.4		
Total	0.186	ND	ND	ND	ND	ND	ND	NA	0.0391	ND	ND	ND	ND	ND		ND	ND
4/17/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.3		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0259	ND	ND	ND	ND	ND		ND	ND
4/20/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															4.4		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0203	ND	ND	ND	ND	ND		ND	ND
4/22/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.8		
Total	0.131	ND	ND	ND	ND	ND	ND	ND	0.0282	ND	ND	ND	ND	ND		ND	ND
4/24/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.1		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0203	ND	ND	ND	ND	ND		ND	ND
4/27/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															5.8		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0164	ND	ND	ND	ND	ND		ND	ND
4/29/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.7		
Total	ND	ND	ND	ND	ND	ND	ND	ND	0.0213	ND	ND	ND	ND	ND		ND	ND
5/1/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.4		

Table 19. TVA surface water data, Tennessee River mile 568.5, December 23, 2008 - May 8, 2009. Units in mg/L. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	TSS	Vanadium	Zinc
Total	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
5/8/2009																	
Dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Not applicable															6.1		
Total	0.112	ND	ND	ND	ND	ND	ND	ND	0.0363	ND	ND	ND	ND	ND		ND	ND

Concentrations reported are the reported value or the maximum value reported if duplicates were taken.
ND = not detected
NA = not available

Table 20. EPA dissolved metals surface water sampling, Emory River, December 23, December 28, December 29, 2008, and January 2, 2009. Kingston Fossil Plant, Roane County, Tennessee. Units in mg/L.

	23-Dec-08					12/28/2008			12/29/2008				1/2/2009	
Dissolved Metals	ERM0.1	ERM1.9	ERM1.9dup	ERM2.1	ERM4.0	ERPL	ERER	ERERdup	ERM0.1	ERM1.75	ERM2.0	ERM2.0dup	ERM4.0	ERB
Aluminum	0.164 J	NA	NA	NA	NA	0.152 J	0.0680 J	0.0643 J	0.0265 J	0.0439 J	0.0411 J	0.0420 J	0.0441 J	0.0336
Antimony	0.02 U	NA	NA	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.005 U
Arsenic	0.0116 J	NA	NA	NA	NA	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.005 U
Barium	0.0345	NA	NA	NA	NA	0.0171 J	0.0205	0.0205	0.0240	0.0223	0.0219	0.0218	0.0226	0.0252
Berylliuim	0.01 U	NA	NA	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.0001 U
Cadmium	0.005 U	NA	NA	NA	NA	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0007 U
Chromium	0.01 U	NA	NA	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.005 U
Cobalt	0.02 U	NA	NA	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.005 U
Copper	0.00170 J	NA	NA	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.002 U
Iron	0.187	NA	NA	NA	NA	0.155	0.0832 J	0.0832 J	0.0376 J	0.0569 J	0.0598 J	0.0583 J	0.0621 J	39.8 J
Lead	0.01 U	NA	NA	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.001 U
Manganese	0.153	NA	NA	NA	NA	0.0155	0.0120 J	0.0120 J	0.0126 J	0.0221	0.0227	0.0238	0.0275	0.00569
Mercury	0.0002 U	NA	NA	NA	NA	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.00021	0.0002 U
Nickel	0.02 U	NA	NA	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.00109 J
Selenium	0.00749 J	NA	NA	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.005 U
Silver	0.01 U	NA	NA	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.001 U
Thallium	0.00774 J	NA	NA	NA	NA	0.02 U	0.0047 J	0.0047 J	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.001 U
Vanadium	0.00341 J	NA	NA	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.005 U
Zinc	0.00772 J	NA	NA	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.0067 J	0.02 U	0.00252 J+

J= The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample.
J+ = The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and is possibly biased high.
J- = The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and is possibly biased low.
mg/L = milligrams per liter
NA = The sample was not analyzed for this analyte.
U – The analyte was analyzed for, but was not detected at or above the detection limit shown.

Table 21. EPA Total suspended solids and total metals surface water sampling, Emory River, December 23, December 28, December 29, 2008, and January 2, 2009. Kingston Fossil Plant, Roane County, Tennessee. Units in mg/L.

	23-Dec-08					12/28/2008			12/29/2008				1/2/2009	
	ERM0.1	ERM1.9	ERM1.9dup	ERM2.1	ERM4.0	ERPL	ERER	ERERdup	ERM0.1	ERM1.75	ERM2.0	ERM2.0dup	ERM4.0	ERB
Total Suspended Solids	14,700	NA	NA	NA	NA	58	161	186	9	13	22	17	10	6J
Total Metals														
Aluminum	121	2.58	2.58	1.13	0.338	5.84	1.85	1.85	0.400	0.587	0.995	0.998	0.02 U	0.132
Antimony	0.00655 J	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.005 U
Arsenic	1.49	0.0208 J	0.0337 J	0.05 U	0.05 U	0.00629 J	0.0106 J	0.0106 J	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.005 U
Barium	1.47	0.0643	0.0643	0.0405	0.0304	0.0389	0.0434	0.0434	0.0320	0.0328	0.0377	0.0375	0.0325	0.0293
Berylliuim	0.0119	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.001 U
Cadmium	0.0155	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0007 U
Chromium	0.127	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.005 U
Cobalt	0.0768	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.005 U
Copper	0.225	0.00406 J	0.00508 J	0.01 U	0.01 U	0.00536 J	0.00331 J	0.00331 J	0.01 U	0.01 U	0.01 U	0.00198 J	0.01 U	0.000819 J
Iron	67.0	1.37	1.77	0.660	0.262	6.22	1.49	1.49	0.323	0.414	0.643	0.625	0.397	0.195
Lead	0.0754	0.00625 J	0.00492 J	0.01 U	0.01 U	0.00886 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.000237 J
Manganese	1.89	0.0898	0.0970	0.0738	0.0368	0.0921	0.0585	0.0585	0.0427	0.0408	0.0446	0.0437	0.0442	0.0345
Mercury	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	0.103	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	NL	0.00134 J
Selenium	0.0180 J	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.05	0.005 U
Silver	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	NL	0.001 U
Thallium	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.002	0.001 U
Vanadium	0.465	0.00741 J	0.0108	0.00255 J	0.01 U	0.0150	0.00593 J	0.00505 J	0.01 U	0.01 U	0.00230 J	0.00218 J	NL	0.005 U
Zinc	0.266	0.0371	0.050	0.00461 J	0.02 U	0.0125 J	0.0473	0.00719 J	0.02 U	0.02 U	0.00467 J	0.00409 J	NL	0.0136

J= The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample.
J+ = The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and is possibly biased high.
J- = The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and is possibly biased low.
mg/L = milligrams per liter
NA = The sample was not analyzed for this analyte.
U – The analyte was analyzed for, but was not detected at or above the detection limit shown.

Table 22. EPA dissolved metals surface water sampling, Clinch River, December 23, December 28, December 29, 2008, and January 2, 2009. Kingston Fossil Plant, Roane County, Tennessee. Units in mg/L.

	23-Dec-08				12/28/2008		12/29/2008					1/2/2009
Dissolved Metals	CRM0.0	CRM2.0	CRM4.0	CRM5.5	SGUBR	KCPS	CRM0.0	CRM2.0	CRM2.5	CRM4.0	CRM5.5	CRB
Aluminum	0.0268 J	0.0302 J	NA	NA	0.02 U	0.0361 J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.0306
Antimony	0.02 U	0.02 U	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.005 U
Arsenic	0.05 U	0.05 U	NA	NA	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.005 U
Barium	0.0189 J	0.0311	NA	NA	0.0319	0.0276	0.0172 J	0.0288	0.028	0.286	0.0292	0.0322
Berylliuim	0.01 U	0.01 U	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Cadmium	0.005 U	0.005 U	NA	NA	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0007 U
Chromium	0.01 U	0.01 U	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Cobalt	0.02 U	0.02 U	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.005 U
Copper	0.01 U	0.01 U	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.00204
Iron	0.1 U	0.0481 J	NA	NA	0.01 U	0.0398 J	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	18.7 J
Lead	0.01 U	0.01 U	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.000262J
Manganese	0.00944 J	0.0149 J	NA	NA	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.0307
Mercury	0.0002 U	0.0002 U	NA	NA	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.002 U	0.0002 U	0.00023	0.0002 U
Nickel	0.02 U	0.02 U	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.00128J
Selenium	0.02 U	0.02 U	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.005 U
Silver	0.01 U	0.01 U	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.001 U
Thallium	0.00463 J	0.02 U	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.000108 J
Vanadium	0.01 U	0.01 U	NA	NA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.005 U
Zinc	0.02 U	0.02 U	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.018

J = The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample.
J+ = The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and is possibly biased high.
J- = The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and is possibly biased low.
mg/L = milligrams per liter
NA = The sample was not analyzed for this analyte.
U – The analyte was analyzed for, but was not detected at or above the detection limit shown.

Table 23. EPA total suspended solids and total metals surface water sampling, Clinch River, December 23, December 28, December 29, 2008, and January 2, 2009. Kingston Fossil Plant, Roane County, Tennessee. Units in mg/L.

	23-Dec-08				12/28/2008		12/29/2008					1/2/2009
	CRM0.0	CRM2.0	CRM4.0	CRM5.5	SGUBR	KCPS	CRM0.0	CRM2.0	CRM2.5	CRM4.0	CRM5.5	CRB
Total Suspended Solids	15	80	NA	NA	68	969	46	15	13	10	9	7J
Total Metals												
aluminum	0.265	0.905	1.53	0.986	2.27	8.20	0.751	0.516	0.355	0.355	0.308	0.12
antimony	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.005 U
arsenic	0.00351 J	0.00310 J	0.00392 J	0.00501 J	0.00773 J	0.0480 J	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.005 U
barium	0.0215	0.0436	0.0430	0.0385	0.0514	0.142	0.0311	0.0411	0.0384	0.0374	0.0379	0.0348
berylliuim	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.001 U
cadmium	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0007 U
chromium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.005 U
cobalt	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.00219 J	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.005 U
copper	0.01 U	0.01 U	0.01 U	0.01 U	0.00282 J	0.0141	0.00168 J	0.01 U	0.01 U	0.01 U	0.01 U	0.00118 J
iron	0.234	0.607	1.08	0.733	2.51	3.99	1.12	0.466	0.328	0.335	0.294	0.121
lead	0.01 U	0.01 U	0.00461 J	0.01 U	0.01 U	0.00589 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.000237 J
manganese	0.0248	0.0512	0.0938	0.0453	0.0715	0.0816	0.159	0.0507	0.0495	0.0473	0.0518	0.0345
mercury	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.00188	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
nickel	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.00604 J	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.00134 J
selenium	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.005 U
silver	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.00038 J	0.01 U	0.01 U	0.001 U
thallium	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.000107J
vanadium	0.01 U	0.00237 J	0.00243 J	0.01 U	0.00625 J	0.0261	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.005 U
zinc	0.02 U	0.02 U	0.00404 J	0.02 U	0.00777 J	0.0333	0.00634 J	0.02 U	0.02 U	0.02 U	0.02 U	0.0136

J= The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample.
J+ = The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and is possibly biased high.
J- = The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample and is possibly biased low.
mg/L = milligrams per liter
NA = The sample was not analyzed for this analyte.
U – The analyte was analyzed for, but was not detected at or above the detection limit shown.

Table 24. TDEC surface water data, Clinch River mile 2.3. January 8 - May 14, 2009. Units in µg/L; TSS in mg/L.

	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	TSS	Thallium	Vanadium	Zinc
1/8/2009	NA	NA	4.8	0.36	ND	3.2	1.8	3.7	70	ND	NA	ND	NA	93	0.19	11	NA
1/13/2009	410	ND	1.1	ND	ND	ND	0.37	0.7	57	ND	1.3	ND	ND	ND	ND	5.5	4.6
1/15/2009	250	ND	ND	ND	ND	ND	0.27	0.5	46	ND	0.61	ND	ND	13	0.03	ND	2.9
1/20/2009	130	ND	ND	ND	ND	ND	0.22	0.36	39	ND	0.87	ND	ND	ND	0.12	ND	2.6
1/22/2009	170	ND	ND	ND	ND	ND	0.28	0.33	36	ND	1.2	ND	ND	ND	0.1	ND	2.6
1/27/2009	130	ND	ND	ND	ND	ND	0.21	0.31	32	ND	1.1	ND	ND	ND	0.05	7.9	2.8
1/29/2009	390	ND	ND	ND	ND	ND	0.43	0.62	53	ND	1.5	ND	ND	13	0.07	5.1	3.4
2/4/2009	260	ND	ND	ND	ND	ND	0.29	0.41	34	ND	1.4	1.7	ND	ND	0.11	6	5
2/5/2009	120	ND	1.2	ND	ND	ND	0.2	0.58	31	ND	1.2	ND	ND	ND	0.04	ND	2.8
2/10/2009	140	ND	ND	ND	ND	ND	0.2	0.3	30	ND	1.3	1.7	ND	ND	0.05	ND	2.8
2/10/2009	150	ND	ND	ND	ND	ND	0.2	0.25	30	ND	1.2	1.7	ND	ND	0.03	ND	2.2
2/12/2009	230	0.37	ND	ND	ND	3	0.26	0.32	32	ND	1.3	ND	ND	ND	0.1	7.4	2.4
2/17/2009	180	ND	ND	ND	ND	ND	0.23	0.23	29	ND	1.8	ND	ND	ND	0.12	7.4	2.9
2/19/2009	120	0.33U	1.1	ND	ND	ND	0.24	0.25	40	ND	1.4	3.6	ND	ND	0.05	ND	2.3
2/24/2009	190	ND	ND	ND	ND	ND	0.24	0.28	32	ND	1.3	ND	ND	ND	0.05	ND	2.9
2/26/2009	94	ND	ND	ND	ND	ND	0.25	0.27	30	ND	1.3	ND	ND	ND	0.05	ND	13
3/3/2009	180	ND	ND	ND	ND	ND	0.29	0.35	37	ND	1.4	ND	ND	ND	0.06	3.6	4.1
3/5/2009	120	ND	ND	ND	ND	ND	0.22	0.25	30	ND	1.4	ND	ND	ND	0.03	ND	2.6
3/11/2009	130	ND	ND	ND	ND	ND	0.19	0.23	30	ND	1.3	ND	ND	ND	0.05	8.8	2.7
3/12/2009	120	ND	ND	ND	ND	ND	0.21	0.28	33	NA	1.7	ND	ND	ND	0.08	8.5	ND
3/17/2009	370	ND	1.3	ND	ND	ND	0.35	0.51	34	NA	0.82	ND	ND	17	ND	ND	4.5
3/19/2009	290	ND	ND	ND	ND	ND	0.36	0.41	34	NA	1.1	ND	ND	12	0.11	ND	4.2
3/24/2009	170	ND	ND	ND	ND	ND	0.23	0.39	29	ND	1.8	ND	ND	ND	0.06	ND	4.8
3/26/2009	490	ND	ND	ND	ND	2	0.3	0.48	39	NA	1.5	ND	ND	ND	0.054	ND	10
3/31/2009	370	3.2	ND	ND	ND	ND	0.41	0.42	45	NA	1.7	ND	ND	ND	ND	14	5.4
4/2/2009	350	3.1	1.5	ND	ND	ND	0.35	0.37	32	NA	1.8	ND	ND	ND	ND	14	3.9
4/7/2009	280	ND	4.3	ND	ND	ND	0.32	0.42	34	0.06	1.8	ND	ND	14	ND	19	4
4/8/2009	420	ND	8.5	ND	ND	ND	0.37	0.54	34	0.062	1.7	ND	ND	12	ND	16	4.2
4/14/2009	240	ND	ND	ND	ND	ND	0.37	0.66	44	0.073	1.4	ND	ND	13	ND	ND	4.9
4/16/2009	700	ND	ND	ND	ND	ND	0.45	0.9	37	NA	1.6	ND	ND	18	ND	ND	6.2
4/22/2009	280	ND	ND	ND	ND	2.1	0.35	0.43	40	ND	1.6	ND	ND	10	0.07	10	2.8
4/22/2009	310	ND	ND	ND	ND	2.1	0.37	0.54	41	ND	1.9	ND	ND	14	0.07	ND	3.9
4/23/2009	340	ND	ND	ND	ND	ND	0.36	0.49	36	0.044	1.8	ND	ND	15	0.09	ND	3.7
4/28/2009	590	ND	ND	ND	ND	2.4	0.43	0.73	39	0.04	1.1	ND	ND	10	0.048	ND	4
4/30/2009	390	ND	1.5	ND	ND	ND	0.36	0.56	29	0.08	1.5	2.6	ND	14	0.043	ND	ND
5/5/2009	3200	ND	3.8	0.31	ND	5.3	1.6	3.3	52	0.04	3.5	ND	ND	52	0.15	ND	6.9
5/7/2009	690	ND	ND	ND	ND	ND	0.59	0.89	40	0.06	1.8	ND	ND	20	0.053	ND	3.8
5/12/2009	680	ND	1.2	ND	ND	ND	0.52	0.86	58	0.06	1.7	ND	ND	20	0.057	ND	3.7
5/14/2009	250	ND	ND	ND	ND	ND	0.29	0.41	36	ND	1.4	ND	ND	ND	0.06	ND	3.2

January 8 sample taken at mid-depth; other samples taken at the surface. ND = not detected. NA = not available

Table 25. TDEC surface water data, Clinch River mile 4.0, January 2, 2009, and Clinch River mile 4.5, January 8 - May 14, 2009. Units in µg/L; TSS in mg/L.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	TSS	Thallium	Vanadium	Zinc
1/2/2009	NA	NA	ND	ND	ND	ND	0.21	0.31	35	ND	NA	ND	NA	ND	ND	ND	NA
1/8/2009	NA	NA	3.5	0.21	ND	ND	0.95	1.8	40	ND	NA	ND	NA	45	0.15	ND	NA
1/13/2009	250	NA	ND	ND	ND	ND	0.35	0.28	37	ND	1.4	ND	ND	ND	ND	6.6	3.4
1/15/2009	820	ND	4.7	0.2	ND	2.8	1	1.3	77	ND	1.6	ND	ND	150	0.12	3.5	7.5
1/20/2009	980	ND	3.3	0.21	ND	2	1	1.7	78	ND	2.1	ND	ND	190	0.25	4	7
1/22/2009	130	ND	ND	ND	ND	ND	0.19	0.32	30	0.17	0.99	ND	ND	66	0.13	ND	2.5
1/27/2009	130	ND	ND	ND	ND	ND	0.18	0.31	30	ND	0.96	ND	ND	24	0.05	4.8	2
1/29/2009	420	0.4	ND	ND	ND	ND	0.63	0.76	98	ND	1.6	ND	ND	18	0.08	7	6.1
2/4/2009	340	ND	ND	ND	ND	ND	0.33	0.43	36	ND	1.4	1.5	ND	ND	0.03	5.6	5.2
2/5/2009	3900	ND	10	0.73	ND	4.4	4.1	6.6	320	ND	7.3	ND	ND	24	0.31	16	16
2/7/2009	370	1.4	1	ND	ND	ND	0.31	0.47	34	ND	1.5	1.7	ND	ND	0.31	6.8	4.9
2/10/2009	140	ND	ND	ND	ND	ND	0.19	0.31	29	ND	1.2	1.8	ND	ND	0.07	ND	5.4
2/12/2009	130	1.8	ND	ND	ND	3	0.19	0.28	28	ND	1.1	ND	ND	ND	0.13	8.4	2
2/17/2009	170	ND	ND	ND	ND	ND	0.21	0.22	30	ND	1.6	ND	ND	ND	0.2	ND	3
2/19/2009	210	ND	1.3	ND	ND	ND	0.47	0.55	75	ND	1.5	3.3	ND	24	0.07	5.4	4.5
2/24/2009	340	ND	ND	ND	ND	ND	0.29	0.44	34	ND	6.6	ND	ND	ND	0.06	ND	33
2/26/2009	110	ND	ND	ND	ND	ND	0.19	0.25	30	ND	1.3	ND	ND	ND	0.05	ND	8.4
3/3/2009	150	ND	ND	ND	ND	ND	0.31	0.28	38	ND	1.2	ND	ND	ND	0.05	ND	6.4
3/5/2009	120	ND	ND	ND	ND	ND	0.21	0.22	30	0.14	1.1	ND	ND	ND	0.03	ND	3.2
3/11/2009	130	ND	ND	ND	ND	ND	0.19	0.24	29	ND	1.3	ND	ND	ND	0.11	ND	1.9
3/11/2009	120	ND	ND	ND	ND	ND	0.19	0.26	34	ND	1.4	ND	ND	ND	0.08	11	4.3
3/12/2009	180	ND	ND	ND	ND	ND	0.28	0.35	40	NA	1.7	ND	ND	22	0.11	ND	ND
3/17/2009	310	ND	ND	ND	ND	ND	0.32	0.39	27	NA	0.52	ND	ND	11	ND	ND	3.7
3/19/2009	270	ND	ND	ND	ND	2.1	0.35	0.37	31	NA	0.82	ND	ND	ND	0.15	ND	7.3
3/24/2009	130	ND	ND	ND	ND	ND	0.19	0.28	28	ND	1.6	ND	ND	ND	0.07	ND	3.5
3/26/2009	170	ND	ND	ND	ND	ND	0.22	0.33	35	NA	1.4	ND	ND	ND	0.056	ND	8.9
3/31/2009	920	3.3	2.8	0.28	ND	ND	1.6	2.6	91	NA	3.8	ND	0.03	80	0.08	22	12
4/2/2009	300	3.1	1.5	ND	ND	ND	0.37	0.32	37	NA	1.6	1.4	ND	ND	ND	14	4.3
4/7/2009	310	ND	4.8	ND	ND	ND	0.34	0.42	37	0.054	1.7	ND	ND	11	ND	15	8.4
4/8/2009	280	ND	8.2	ND	ND	ND	0.3	0.4	38	0.07	1.3	ND	ND	ND	ND	17	5.1
4/14/2009	240	ND	ND	ND	ND	2.4	0.38	0.41	47	ND	1.2	ND	ND	10	ND	ND	3.7
4/14/2009	250	ND	ND	ND	ND	ND	0.4	0.85	47	0.063	1.4	ND	ND	11	ND	ND	10
4/16/2009	600	ND	ND	ND	ND	ND	0.35	0.76	30	NA	1.3	ND	ND	15	ND	ND	5.1
4/22/2009	380	ND	ND	ND	ND	2.4	0.38	0.52	36	ND	1.4	1.3	ND	10	0.09	ND	4.4
4/23/2009	320	ND	ND	ND	ND	ND	0.33	0.42	35	ND	1.3	ND	ND	10	0.1	ND	3.1
4/28/2009	420	ND	ND	ND	ND	ND	0.27	0.42	32	ND	0.82	ND	ND	12	ND	ND	2.6
4/30/2009	220	ND	ND	ND	ND	ND	0.26	0.38	34	0.06	1.3	ND	ND	ND	0.038	ND	ND
5/5/2009	1800	ND	1.1	0.14	ND	3.9	0.81	1.5	45	0.04	2.2	ND	ND	27	0.058	ND	4.9
5/7/2009	460	0.017	ND	ND	ND	ND	0.43	0.62	36	0.06	1.6	ND	ND	10	0.033	ND	5.1
5/12/2009	870	0.86	1.7	0.16	ND	ND	0.84	1.3	71	0.07	2.2	ND	0.05	21	0.18	4.6	5.3

January 2 samples taken at 15 feet; January 8 sample taken at mid-depth; other samples taken at the surface. ND= not detected. NA = not available

Table 26. TDEC surface water data, Emory River mile 0.1, January 2 - May 12, 2009. Units in µg/L; TSS units in mg/L.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	TSS	Thallium	Vanadium	Zinc
1/2/2009	NA	NA	ND	ND	ND	ND	0.21	0.31	35	ND	NA	ND	NA	ND	ND	ND	NA
1/8/2009	NA	NA	3.5	0.21	ND	ND	0.95	1.8	40	ND	NA	ND	NA	45	0.15	ND	NA
1/13/2009	250	NA	ND	ND	ND	ND	0.35	0.28	37	ND	1.4	ND	ND	ND	ND	6.6	3.4
1/15/2009	820	ND	4.7	0.2	ND	2.8	1	1.3	77	ND	1.6	ND	ND	150	0.12	3.5	7.5
1/20/2009	980	ND	3.3	0.21	ND	2	1	1.7	78	ND	2.1	ND	ND	190	0.25	4	7
1/22/2009	130	ND	ND	ND	ND	ND	0.19	0.32	30	0.17	0.99	ND	ND	66	0.13	ND	2.5
1/27/2009	130	ND	ND	ND	ND	ND	0.18	0.31	30	ND	0.96	ND	ND	24	0.05	4.8	2
1/29/2009	420	0.4	ND	ND	ND	ND	0.63	0.76	98	ND	1.6	ND	ND	18	0.08	7	6.1
2/4/2009	340	ND	ND	ND	ND	ND	0.33	0.43	36	ND	1.4	1.5	ND	ND	0.03	5.6	5.2
2/5/2009	3900	ND	10	0.73	ND	4.4	4.1	6.6	320	ND	7.3	ND	ND	24	0.31	16	16
2/7/2009	370	1.4	1	ND	ND	ND	0.31	0.47	34	ND	1.5	1.7	ND	ND	0.31	6.8	4.9
2/10/2009	140	ND	ND	ND	ND	ND	0.19	0.31	29	ND	1.2	1.8	ND	ND	0.07	ND	5.4
2/12/2009	130	1.8	ND	ND	ND	3	0.19	0.28	28	ND	1.1	ND	ND	ND	0.13	8.4	2
2/17/2009	170	ND	ND	ND	ND	ND	0.21	0.22	30	ND	1.6	ND	ND	ND	0.2	ND	3
2/19/2009	210	ND	1.3	ND	ND	ND	0.47	0.55	75	ND	1.5	3.3	ND	24	0.07	5.4	4.5
2/24/2009	340	ND	ND	ND	ND	ND	0.29	0.44	34	ND	6.6	ND	ND	ND	0.06	ND	33
2/26/2009	110	ND	ND	ND	ND	ND	0.19	0.25	30	ND	1.3	ND	ND	ND	0.05	ND	8.4
3/3/2009	150	ND	ND	ND	ND	ND	0.31	0.28	38	ND	1.2	ND	ND	ND	0.05	ND	6.4
3/5/2009	120	ND	ND	ND	ND	ND	0.21	0.22	30	0.14	1.1	ND	ND	ND	0.03	ND	3.2
3/11/2009	130	ND	ND	ND	ND	ND	0.19	0.24	29	ND	1.3	ND	ND	ND	0.11	ND	1.9
3/11/2009	120	ND	ND	ND	ND	ND	0.19	0.26	34	ND	1.4	ND	ND	ND	0.08	11	4.3
3/12/2009	180	ND	ND	ND	ND	ND	0.28	0.35	40	NA	1.7	ND	ND	22	0.11	ND	ND
3/17/2009	310	ND	ND	ND	ND	ND	0.32	0.39	27	NA	0.52	ND	ND	11	ND	ND	3.7
3/19/2009	270	ND	ND	ND	ND	2.1	0.35	0.37	31	NA	0.82	ND	ND	ND	0.15	ND	7.3
3/24/2009	130	ND	ND	ND	ND	ND	0.19	0.28	28	ND	1.6	ND	ND	ND	0.07	ND	3.5
3/26/2009	170	ND	ND	ND	ND	ND	0.22	0.33	35	NA	1.4	ND	ND	ND	0.056	ND	8.9
3/31/2009	920	3.3	2.8	0.28	ND	ND	1.6	2.6	91	NA	3.8	ND	0.03	80	0.08	22	12
4/2/2009	300	3.1	1.5	ND	ND	ND	0.37	0.32	37	NA	1.6	1.4	ND	ND	ND	14	4.3
4/7/2009	310	ND	4.8	ND	ND	ND	0.34	0.42	37	0.054	1.7	ND	ND	11	ND	15	8.4
4/8/2009	280	ND	8.2	ND	ND	ND	0.3	0.4	38	0.07	1.3	ND	ND	ND	ND	17	5.1
4/14/2009	240	ND	ND	ND	ND	2.4	0.38	0.41	47	ND	1.2	ND	ND	10	ND	ND	3.7
4/14/2009	250	ND	ND	ND	ND	ND	0.4	0.85	47	0.063	1.4	ND	ND	11	ND	ND	10
4/16/2009	600	ND	ND	ND	ND	ND	0.35	0.76	30	NA	1.3	ND	ND	15	ND	ND	5.1
4/22/2009	380	ND	ND	ND	ND	2.4	0.38	0.52	36	ND	1.4	1.3	ND	10	0.09	ND	4.4
4/23/2009	320	ND	ND	ND	ND	ND	0.33	0.42	35	ND	1.3	ND	ND	10	0.1	ND	3.1
4/28/2009	420	ND	ND	ND	ND	ND	0.27	0.42	32	ND	0.82	ND	ND	12	ND	ND	2.6
4/30/2009	220	ND	ND	ND	ND	ND	0.26	0.38	34	0.06	1.3	ND	ND	ND	0.038	ND	ND
5/5/2009	1800	ND	1.1	0.14	ND	3.9	0.81	1.5	45	0.04	2.2	ND	ND	27	0.058	ND	4.9
5/7/2009	460	0.017	ND	ND	ND	ND	0.43	0.62	36	0.06	1.6	ND	ND	10	0.033	ND	5.1
5/12/2009	870	0.86	1.7	0.16	ND	ND	0.84	1.3	71	0.07	2.2	ND	0.05	21	0.18	4.6	5.3

Samples taken January 2 at 15 feet; samples taken January 8 at mid-depth; other samples taken at the surface. ND = not detected. NA = not available.

Table 27. TDEC surface water data, Emory River mile 1.7, January 8 - May 14, 2009. Units in µg/L; TSS units in mg/L.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	TSS	Thallium	Vanadium	Zinc
1/8/2009	NA	NA	2.6	0.15	ND	ND	0.92	1.6	48	ND	NA	ND	NA	59	0.09	4.5	NA
1/13/2009	300	ND	ND	ND	ND	ND	0.33	0.33	34	ND	1.3	ND	ND	ND	ND	6.3	3.3
1/15/2009	240	ND	ND	ND	ND	ND	0.29	0.42	32	ND	0.68	ND	ND	ND	0.04	ND	5.7
1/20/2009	220	1.1	1.4	ND	ND	ND	0.36	0.65	40	ND	1.1	ND	0.03	32	0.47	ND	3.6
1/22/2009	15000	1.2	19	1.6	0.6	8	7.8	16	330	ND	13	ND	0.1	1200	1.1	43	21
1/27/2009	170	ND	ND	ND	ND	ND	0.21	0.44	28	ND	1	ND	ND	ND	0.1	ND	3.8
1/27/2009	300	ND	ND	ND	ND	ND	0.3	0.51	31	ND	1.2	ND	ND	ND	0.09	ND	4
1/29/2009	590	2	ND	ND	ND	3.2	0.9	1.1	93	ND	2.1	ND	0.04	41	0.2	9.5	9
2/4/2009	260	ND	ND	ND	ND	ND	0.29	0.29	34	ND	1.2	1.5	ND	ND	0.03	6.1	4.2
2/5/2009	5800	ND	17	1.2	ND	6.6	6.4	11	330	ND	10	ND	ND	ND	0.57	25	23
2/10/2009	160	ND	ND	ND	ND	ND	0.2	0.63	27	ND	1.3	1.7	ND	ND	0.12	ND	7
2/12/2009	190	ND	ND	ND	ND	2.8	0.21	0.29	26	ND	1.1	ND	ND	ND	0.21	7.1	2.5
2/17/2009	180	ND	ND	ND	ND	ND	0.21	0.27	28	ND	1.6	ND	ND	ND	0.31	4.4	3.6
2/19/2009	270	ND	3.3	ND	ND	ND	0.64	1	73	ND	2.2	3.3	ND	40	0.05	ND	11
2/24/2009	300	0.38	ND	ND	ND	ND	0.27	0.35	29	ND	1.4	ND	ND	ND	0.07	ND	3.6
2/26/2009	190	ND	ND	ND	ND	ND	0.24	0.26	31	ND	1.2	ND	ND	ND	0.06	ND	4.9
3/3/2009	190	ND	ND	ND	ND	2.3	0.34	0.3	34	ND	1.2	ND	ND	ND	0.09	ND	3
3/3/2009	190	ND	ND	ND	ND	2	0.34	0.35	33	ND	1.3	ND	ND	ND	0.08	ND	6.9
3/5/2009	120	ND	ND	ND	ND	ND	0.23	0.21	29	ND	0.93	ND	ND	ND	0.04	ND	3.9
3/11/2009	110	ND	ND	ND	ND	ND	0.16	0.29	28	ND	1.3	ND	ND	ND	0.18	ND	4.3
3/12/2009	170	ND	1.4	ND	ND	ND	0.31	0.39	35	NA	1.7	ND	ND	31	0.15	ND	2.7
3/17/2009	280	ND	ND	ND	ND	ND	0.32	0.39	27	NA	0.47	ND	ND	13	ND	ND	4.3
3/19/2009	270	ND	ND	ND	ND	ND	0.38	0.37	32	NA	0.8	ND	ND	ND	0.27	ND	6.3
3/24/2009	130	ND	ND	ND	ND	ND	0.19	0.23	24	ND	1.5	ND	ND	ND	0.09	ND	2.8
3/26/2009	160	ND	ND	ND	ND	ND	0.27	0.25	52	NA	1	ND	ND	ND	0.05	ND	4.5
3/31/2009	190	3.1	1.2	ND	ND	ND	0.33	0.39	35	NA	1.4	2	0.03	ND	ND	16	6.9
4/2/2009	320	3.1	ND	ND	ND	ND	0.37	0.27	41	NA	1.5	ND	ND	ND	ND	17	3.4
4/7/2009	430	ND	4.7	ND	ND	ND	0.46	0.71	41	0.058	1.7	ND	ND	12	0.05	17	8.4
4/7/2009	400	ND	4.9	ND	ND	ND	0.44	0.53	39	0.042	1.6	ND	ND	14	0.03	16	6.1
4/8/2009	660	ND	8.3	ND	ND	ND	0.59	0.81	45	0.078	1.8	ND	ND	52	ND	18	11
4/14/2009	310	ND	ND	ND	ND	3.3	0.41	0.78	44	0.069	1.6	ND	ND	13	ND	ND	11
4/16/2009	800	ND	ND	ND	ND	ND	0.4	0.81	31	NA	1.5	ND	ND	13	ND	ND	7.6
4/22/2009	310	ND	ND	ND	ND	2.2	0.36	0.43	33	ND	1.3	ND	ND	ND	0.11	ND	3.1
4/23/2009	400	ND	ND	ND	ND	ND	0.39	0.56	34	0.041	1.2	ND	ND	11	0.11	ND	3.1
4/28/2009	370	ND	ND	ND	ND	ND	0.29	0.41	38	ND	0.75	ND	ND	ND	ND	ND	3.2
4/30/2009	130	ND	ND	ND	ND	ND	0.19	0.29	24	0.08	1.1	ND	ND	ND	0.034	ND	ND
5/5/2009	1500	ND	ND	0.12	ND	4.3	0.84	1.4	50	0.12	2.3	ND	ND	26	0.06	ND	8.9
5/7/2009	450	ND	0.94	ND	ND	ND	0.51	0.77	40	0.06	1.7	ND	ND	11	0.038	4.1	4.9
5/12/2009	460	ND	ND	ND	ND	ND	0.46	0.78	47	0.06	1.5	ND	ND	ND	0.052	ND	3.9
5/14/2009	305	ND	ND	ND	ND	ND	0.4	0.55	51	ND	1.6	ND	ND	ND	0.36	ND	6.3

Sample taken January 8 at mid-depth; other samples taken at the surface. ND = not detected. NA = not available.

Table 28. TDEC surface water data, Emory River mile 2.1, January 2 - May 14, 2009. Units in µg/L; TSS units in mg/L.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	TSS	Thallium	Vanadium	Zinc
1/2/2009	NA	NA	0.93U	0.11U	0.41U	2.0U	0.36J	0.46J	48	0.13U	NA	1.3U	NA	10	0.10J	3.4U	NA
1/8/2009	NA	NA	8.6	0.62J	0.41U	3.7J	2.6	5.3	61	0.13U	NA	1.3U	NA	48	0.29J	14	NA
1/13/2009	790	0.83J	14	0.17J	0.41U	2.6J	0.70J	1.1	51	0.13U	1.9	3.3J	0.03U	48	0.14J	16	3.6J
1/15/2009	5600	1.2	43	1.2	0.41U	12	2.9	6	56	0.13U	5.4	1.3U	0.03U	610	0.88J	45	10
1/15/2009	4000	1.4	43	0.99J	0.41U	11	2.2	4.3	53	0.13U	4	1.3U	0.03U	610	0.79J	42	8.8
1/20/2009	2800	0.34J	8.8	0.56J	0.41U	3.7J	2.1	3.8	61	0.13U	4.4	1.3U	0.03U	77	0.55J	11	8.4
1/22/2009	130	0.37J	0.93U	0.11U	0.41U	2.0U	0.35J	0.22J	51	0.13U	1.3	1.3U	0.03U	10U	0.17J	3.4U	3.2J
1/27/2009	600	0.33U	4.4J	0.11U	0.41U	2.0U	0.62J	0.94J	61	0.13U	1.8	1.3U	0.03U	18	0.18J	3.4U	5
1/29/2009	970	0.33U	0.93U	0.14J	0.41U	2.7J	1.3	1.7	97	0.13U	2.8	1.3U	0.03U	53	0.08J	10	7.9
2/4/2009	290	0.33U	1.3J	0.11U	0.41U	2.0U	0.37J	0.41J	41	0.15J	1.3	1.6J	0.03U	10U	0.05J	5.9	3.6J
2/5/2009	180	0.33U	1.4J	0.11U	0.41U	2.0U	0.32J	0.58J	39	0.13U	1.2	1.3U	0.03U	10U	0.07J	3.4U	4.0J
2/10/2009	2800	0.33U	6.9	0.43J	0.41U	3.2J	2.1	3.7	84	0.13U	4.4	1.6J	0.03U	31	0.37J	9.1	11
2/12/2009	310	0.33U	1.7J	0.11U	0.41U	3.1J	0.42J	0.53J	59	0.13U	1.1	1.3U	0.03U	10U	0.38J	9.2	5
2/17/2009	180	0.33U	0.93U	0.11U	0.41U	2.4J	0.32J	0.20J	61	0.13U	1.3	1.3U	0.03U	10U	0.54J	9.8	4.7J
2/19/2009	340	0.33U	1.3J	0.11U	0.41U	3.0J	1.5	2	98	0.13U	2.5	3.0J	0.03U	130	0.17J	4.8J	7.3
2/24/2009	350	3.1	2.3J	0.11U	0.41U	2.0U	0.34J	0.39J	37	0.13U	1.2	1.3U	0.03U	10U	0.18J	3.4U	3.1J
2/24/2009	360	0.89J	2.1J	0.11U	0.41U	2.0U	0.38J	0.50J	37	0.13U	1.3	1.3U	0.03U	10U	0.10J	3.4U	3.5J
2/26/2009	160	0.37J	0.93U	0.11U	0.41U	2.0U	0.27J	0.32J	39	0.13U	1.9	1.3U	0.03U	10U	0.07J	3.4U	12
3/3/2009	200	0.33U	0.93U	0.11U	0.41U	2.5J	0.34J	0.39J	38	0.13U	1.3	1.3U	0.03U	10U	0.15J	3.4U	9.8
3/5/2009	130	0.33U	0.93U	0.11U	0.41U	2.0U	0.23J	0.17J	29	0.13U	0.96J	1.3U	0.03U	10U	0.07J	3.4U	2.8J
3/11/2009	120	0.48J	0.93U	0.11U	0.41U	2.0U	0.26J	0.15J	37	0.13U	0.96J	1.3U	0.03U	10U	0.54J	3.4U	4.5J
3/12/2009	220	0.33U	1.3J	0.11U	0.41U	2.0U	0.31J	0.31J	49	NA	1.1	1.3U	0.03U	10U	0.20J	3.4U	1.9J
3/17/2009	630	0.33U	6.8	0.15J	0.41U	2.0U	0.57J	0.82J	40	NA	0.98J	1.3U	0.03U	51	0.09J	3.4U	16
3/19/2009	2100	0.51J	10	0.39J	0.41U	2.8J	1.7	3.1	73	NA	3.3	1.3U	0.03U	57	0.28J	11	11
3/19/2009	1800	0.46J	9.1	0.31J	0.41U	2.6J	1.5	2.9	70	NA	3	1.3U	0.03U	45	0.26J	11	9.2
3/24/2009	420	0.33U	4.0J	0.11U	0.41U	2.0U	0.44J	0.59J	58	0.13U	1.5	1.3U	0.03U	20	0.22J	4.3J	3.7J
3/26/2009	6200	1	17	0.77J	0.41U	4.8J	2.6	6.1	59	NA	5.3	1.3U	0.051J	130	0.43J	21	15
3/31/2009	4100	3.8	11	0.63	.41U	2.0U	2.6	5.7	62	NA	5.9	1.3U	0.09J	110	0.38J	32	12
3/31/2009	3600	4.2	10	0.69J	0.41U	2.0U	2.7	5.5	61	NA	5.7	1.3U	0.07J	99	0.64J	33	11
4/2/2009	290	3.6	0.94J	0.11U	0.41U	2.0U	0.43J	0.31J	43	NA	1.6	1.3U	0.03J	10U	0.33J	14	3.7J
4/7/2009	420	0.33U	4.1J	0.11U	0.41U	2.0U	0.43J	0.53J	40	0.025U	1.6	1.3U	0.03U	13	0.11J	14	5.8
4/8/2009	1600	0.49J	13	0.23J	0.41U	2.0U	1	1.9	89	0.025J	2.6	1.3U	0.03J	34	0.14J	21	8.1
4/14/2009	320	0.33U	0.93U	0.11U	0.41U	4.5J	0.44J	0.63J	47	0.025U	1.4	1.3U	0.03U	11	0.03J	3.4U	5.1
4/16/2009	3600	0.33U	11	0.46J	0.41U	3.6J	1.8	4.3	36	NA	4.1	1.3U	0.03U	70	0.24J	8.7	11
4/22/2009	970	0.33U	4.6J	0.19J	0.41U	2.7J	0.77J	1.4	35	0.029U	2.1	1.3U	0.07J	39	0.59J	6.5	5.3
4/23/2009	1200	0.33U	3.4J	0.22J	0.41U	2.0U	0.98J	1.9	36	0.029J	2.3	1.3U	0.03U	28	0.33J	3.9J	4.7J
4/28/2009	640	0.33U	1.8J	0.11U	0.41U	2.5J	0.48J	0.75J	46	0.029U	1.1	1.3U	0.03U	13	0.072J	3.4U	3.2J
4/30/2009	250	0.33U	0.93U	0.11U	0.41U	2.0U	0.27J	0.41J	43	0.03J	0.98J	1.3U	0.03U	10U	0.037J	3.4U	1.9U
5/5/2009	1500	0.94J	1.6J	0.20J	0.41U	4.2J	0.87J	1.4	63	0.03J	2.1	1.3U	0.035J	58	0.12J	3.4U	5.2
5/7/2009	640	0.33U	1.1J	0.11U	0.41U	2.0U	0.59J	0.82J	50	0.029U	1.8	1.3U	0.03U	11	0.053J	3.4U	4.7J
5/12/2009	200	0.64J	1.8J	0.11U	0.41U	2.0U	0.37J	0.38J	64	0.029U	1.2	1.3U	0.046J	10U	0.17J	7	2.4J
5/12/2009	530	0.33U	0.93U	0.11U	0.41U	2.0U	0.37J	0.46J	63	0.029U	1.3	1.3U	0.03U	10U	0.040J	3.4U	3.1J
5/14/2009	180	0.33U	0.93U	0.11U	0.41U	2.0U	0.27J	0.27J	60	0.029U	1	1.3U	0.03U	10U	0.040J	3.4U	3.9J

Samples taken on January 2 at 3.5 feet; samples taken on January 8 at mid-depth; other samples taken at the surface. ND = not detected. NA = not available.

Table 29. TDEC surface water data, Emory River mile 12.1. January 2 - May 14, 2009. Units in µg/L; TSS units in mg/L.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Sus Res	Thallium	Vanadium	Zinc
1/27/2009	56	ND	ND	ND	ND	ND	0.28	0.12	35	ND	1.3	ND	ND	ND	0.18	ND	15
1/29/2009	520	ND	ND	ND	ND	2.7	0.56	0.66	36	ND	1.8	ND	ND	20	0.05	10	10
2/4/2009	71	ND	ND	ND	ND	ND	0.26	0.11	25	0.15	1.4	1.7	ND	ND	0.03	8.1	6.1
2/5/2009	43	ND	ND	ND	ND	ND	0.24	0.33	24	ND	1.1	ND	ND	ND	0.07	ND	4.5
2/10/2009	42	0.98	0.97	ND	ND	ND	0.25	0.11	28	ND	1.1	1.7	ND	ND	0.57	ND	5
2/12/2009	52	ND	ND	ND	ND	2.8	0.2	0.11	26	ND	0.9	ND	ND	ND	1	5.4	5.4
2/17/2009	55	ND	ND	ND	ND	2.7	0.21	0.11	25	ND	1.3	ND	ND	ND	1.5	ND	6.1
2/19/2009	280	ND	0.96	ND	ND	ND	0.42	0.32	35	ND	1.3	3.4	ND	10	0.41	ND	3.9
2/24/2009	91	ND	ND	ND	ND	ND	0.23	0.11	26	ND	0.98	ND	ND	ND	0.03	ND	7.5
2/26/2009	58	0.58	ND	ND	ND	ND	0.25	0.16	26	ND	1.2	ND	ND	ND	0.09	ND	14
3/3/2009	100	ND	ND	ND	ND	2.7	0.23	0.18	21	ND	1	ND	ND	ND	0.2	ND	6.8
3/5/2009	62	ND	ND	ND	ND	ND	0.22	0.11	21	ND	0.93	ND	ND	ND	0.12	ND	4.1
3/11/2009	75	ND	ND	ND	ND	ND	0.18	0.16	23	ND	0.86	ND	ND	ND	0.13	ND	4.7
3/12/2009	71	ND	ND	ND	ND	ND	0.19	0.19	25	NA	1.2	ND	ND	ND	0.45	ND	3.9
3/17/2009	200	ND	ND	ND	ND	ND	0.32	0.26	28	NA	0.43	ND	ND	ND	0.04	ND	3.3
3/19/2009	110	ND	ND	ND	ND	ND	0.3	0.15	26	NA	0.66	ND	ND	ND	0.11	ND	7
3/24/2009	74	ND	ND	ND	ND	ND	0.21	0.2	25	ND	1.2	ND	ND	ND	0.45	ND	5.2
3/26/2009	260	1.5	ND	ND	ND	ND	0.41	0.32	42	NA	1.6	ND	ND	ND	0.088	ND	14
3/31/2009	200	3.2	ND	ND	ND	ND	0.44	0.21	33	NA	1.6	ND	ND	ND	0.41	14	6.1
4/2/2009	150	3.1	ND	ND	ND	ND	0.33	0.85	32	NA	1.5	ND	ND	ND	ND	13	4.4
4/7/2009	100	ND	3.3	ND	ND	ND	0.27	0.11	25	ND	1.3	ND	ND	ND	0.19	15	5.5
4/8/2009	86	0.65	5.9	ND	ND	ND	0.27	0.13	25	0.08	1.2	ND	0.04	ND	0.06	17	4.8
4/14/2009	140	0.72	ND	ND	ND	4.1	0.32	0.29	30	0.049	2.1	ND	ND	ND	0.04	ND	7.1
4/16/2009	340	ND	ND	ND	ND	ND	0.39	0.39	37	NA	1.3	ND	ND	ND	0.07	ND	7.7
4/22/2009	154	ND	ND	ND	ND	ND	0.35	0.28	28	0.068	1.2	ND	ND	ND	0.87	ND	3.4
4/23/2009	110	ND	ND	ND	ND	ND	0.31	0.19	29	0.051	1	ND	0.05	ND	0.65	ND	3.4
4/28/2009	93	ND	ND	ND	ND	ND	0.22	0.31	41	0.12	0.61	ND	ND	ND	ND	ND	4.9
4/30/2009	48	ND	ND	ND	ND	ND	0.27	0.14	139	0.22	0.98	ND	ND	ND	ND	ND	ND
5/5/2009	590	ND	ND	ND	ND	ND	0.85	0.89	78	0.09	1.8	ND	ND	25	0.037	3.5	4.4
5/7/2009	390	ND	ND	ND	ND	ND	0.55	0.52	47	0.08	1.7	ND	ND	ND	ND	ND	6.4
5/12/2009	97	ND	ND	ND	ND	ND	0.23	0.2	28	0.05	0.91	ND	ND	ND	0.14	4	3
5/14/2009	74	ND	ND	ND	ND	ND	0.19	0.19	24	0.04	0.86	ND	ND	ND	0.071	ND	4.7

All samples taken at the surface. ND = not detected. NA = not available.

Table 30. TDEC surface water data, Emory River mile 1.9. April 22 - May 14, 2009. Units in µg/L; TSS units in mg/L.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	TSS	Thallium	Vanadium	Zinc
4/22/2009	320	ND	ND	ND	ND	2	0.29	0.38	33	ND	1.3	ND	ND	ND	0.14	ND	4.1
4/23/2009	187	ND	ND	ND	ND	ND	0.28	0.23	37	ND	1	ND	ND	ND	0.11	ND	2.9
4/28/2009	450	ND	ND	ND	ND	2.6	0.39	0.62	45	ND	0.96	ND	ND	10	0.046	ND	4.3
4/30/2009	170	ND	ND	ND	ND	ND	0.26	0.37	45	0.07	0.95	ND	ND	ND	ND	ND	ND
5/5/2009	1500	ND	ND	ND	ND	3.9	0.67	0.99	50	0.07	1.7	1.3	ND	21	0.036	ND	4.3
5/7/2009	450	ND	ND	ND	ND	ND	0.39	0.57	35	0.07	1.3	ND	ND	13	0.033	ND	5.4
5/12/2009	270	ND	ND	ND	ND	ND	0.28	0.41	39	0.05	1.1	ND	ND	ND	ND	ND	4
5/14/2009	180	ND	ND	ND	ND	ND	0.3	0.32	55	ND	1.1	ND	0.041	ND	ND	ND	3.9

All samples taken at the surface. ND = not detectable. NA = not available.

Table 31. TDEC surface water sampling, Emory River mile 4.0. January 2 - January 22, 2009. Units in µg/L; TSS units in mg/L.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	TSS	Thallium	Vanadium	Zinc
1/2/2009	NA	NA	ND	ND	ND	ND	0.31	0.43	47	ND	NA	ND	NA	ND	ND	3.8	NA
1/8/2009	NA	NA	ND	ND	ND	ND	0.63	1	49	0.17	NA	ND	NA	28	0.06	ND	NA
1/8/2009	NA	NA	ND	ND	ND	ND	0.62	0.87	47	ND	NA	ND	NA	18	0.05	ND	NA
1/13/2009	430	0.44	ND	ND	ND	ND	0.33	0.46	36	ND	1.2	ND	ND	ND	ND	8.3	4.6
1/15/2009	150	2	ND	ND	ND	ND	0.28	0.33	33	ND	0.74	ND	ND	ND	0.2	ND	6.4
1/20/2009	ND	ND	ND	ND	ND	ND	0.34	0.34	48	ND	1.3	ND	ND	ND	1.2	ND	6.2
1/22/2009	120	2.2	ND	ND	ND	ND	0.32	0.24	54	ND	1.3	ND	0.03	ND	0.32	ND	3.9

Samples taken January 2 at a5 feet; samples taken January 8 at mid-depth; other samples taken at the surface. ND = not detected. NA = not available.

Table 32. TDEC surface water sampling, Tennessee River mile 568.2. January 22, 2009. Units in µg/L; TSS units in mg/L.

Date	Aluminum	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Manganese	Mercury	Nickel	Selenium	Silver	TSS	Thallium	Vanadium	Zinc
1/2/2009 s	NA	NA	ND	ND	ND	ND	0.15	0.23	42	ND	NA	ND	NA	ND	ND	ND	NA
1/2/2009	NA	NA	ND	ND	ND	ND	0.16	0.29	38	ND	NA	ND	NA	ND	0.51	ND	NA

Sample taken on 1/2/2009 s was taken at the surface; the other sample was taken at 15 feet. ND = not detected. NA = not available.

Table 33. Laboratory results for untreated (raw) water samples taken at the intake of the Kingston Water Treatment Plant before water processing. December 31, 2008 – May 18, 2009. Units in µg/L Kingston Fossil Plant, Roane County, Tennessee.

Compound	Range of Results		Primary Drinking Water Standard (MCL)	Secondary Drinking Water Standard (MCL)	Above Primary Standard?	Above Secondary Standard?
	Minimum (µg/L)	Maximum (µg/L)				
Aluminum	140	1100	NE	-----		
Antimony	<0.33	2	6	-----	No	
Arsenic	<0.93	2.8J	10	-----	No	
Barium	17	37	2000	-----	No	
Beryllium	<0.11	0.35J	4	-----	No	
Cadmium	<0.41	<0.41	5	-----	No	
Calcium	16000	19000	NE	-----		
Calcium Hardness	34000	63000	NE	-----		
Chloride	7500	9400	NE	-----		
Chromium	<2	2.1J	100	-----	No	
Cobalt	0.1J	0.6J	NE	-----		
Copper	3.6	4.1	1300	1000	No	No
Fluoride	84	86	4000	2000	No	No
Iron	150	920	NE	300		Yes
Lead	<0.1	1.4	15	-----	No	
Magnesium	3900	4800	NE	50000		No
Manganese	<0.42	160	NE	50		Yes
Mercury	<0.13	<0.13	2	-----	No	
Molybdenum	0.45J	1	NE	-----		
Nickel	0.71J	1.2	100	-----	No	
Potassium	1900	2100	NE	-----		
Selenium	<1.3	1.7J	50	-----	No	
Silver	<0.03	0.04J	NE	100		No
Sodium	8100	10000	NE	-----		
Strontium	54	73	NE	-----		
Sulfate	12000	17000	NE	250000		No
Thallium	<0.03	1.7	2	-----	No	
Total Alkalinity	42000	72000	NE	-----		
Uranium	0.07J	0.24J	NE	-----		
Vanadium	<3.4	12	NE	-----		
Zinc	34	51	NE	5000		No

Notes:
J = Laboratory estimated concentration. Concentration is below the quantitation limit for compound.
MCL = EPA Primary Drinking Water Standard Maximum Contaminant Level
SDWG = EPA Secondary Drinking Water Guideline value
NE = Not Established
----- = No secondary drinking water guideline established for metal (has primary standard).

Table 34. Laboratory results for untreated (raw) water samples taken at the intake of the Rockwood Water Treatment Plant before water processing. December 31, 2008 – May 18, 2009. Units in µg/L. Kingston Fossil Plant, Roane County, Tennessee.

Compound	Range of Results		Primary Drinking Water Standard (MCL)	Secondary Drinking Water Standard (MCL)	Above Primary Standard?	Above Secondary Standard?
	Minimum (µg/L)	Maximum (µg/L)				
Aluminum	39	74	NE	-----		
Antimony	<0.33	<0.33	6	-----	No	
Arsenic	<0.93	<0.93	10	-----	No	
Barium	21	36	2000	-----	No	
Beryllium	<0.11	<0.11	4	-----	No	
Cadmium	<0.41	<0.41	5	-----	No	
Calcium	21000	22000	NE	-----		
Calcium Hardness	46000	89000	NE	-----		
Chloride	5700	7400	NE	-----		
Chromium	<2	2.7J	100	-----	No	
Cobalt	0.04J	0.21J	NE	-----		
Copper	1.3	2.1	1300	1000	No	No
Fluoride	69	83	4000	2000	No	No
Iron	47	66	NE	300		No
Lead	<0.1	4.6	15	-----	No	
Magnesium	6000	7300	NE	50000		No
Manganese	5.6	43	NE	50		No
Mercury	<0.13	<0.13	2	-----	No	
Molybdenum	0.47J	0.53J	NE	-----		
Nickel	0.54J	1.1	100	-----	No	
Potassium	1500	1800	NE	-----		
Selenium	<1.3	1.5J	50	-----	No	
Silver	<0.03	<0.03	NE	100		No
Sodium	5500	8000	NE	-----		
Strontium	52	67	NE	-----		
Sulfate	11000	15000	NE	250000		No
Thallium	<0.03	0.77J	2	-----	No	
Total Alkalinity	64000	110000	NE	-----		
Uranium	0.1J	0.18J	NE	-----		
Vanadium	<3.4	12	NE	-----		
Zinc	18	52	NE	5000		No

Notes:
J = Laboratory estimated concentration. Concentration is below the quantitation limit for compound.
MCL = EPA Primary Drinking Water Standard Maximum Contaminant Level
SDWG = EPA Secondary Drinking Water Guideline value
NE = Not Established
----- = No secondary drinking water guideline established for metal (has primary standard).

Table 35. Laboratory results for treated (finished) water samples taken at the Kingston Water Treatment Plant after water processing. December 31, 2008 – May 18, 2009. Units in µg/L. Kingston Fossil Plant, Roane County, Tennessee.

Compound	Range of Results		Primary Drinking Water Standard (MCL)	Secondary Drinking Water Standard (MCL)	Above Primary Standard?	Above Secondary Standard?
	Minimum (µg/L)	Maximum (µg/L)				
Aluminum	31	45	NE	-----		
Antimony	<0.33	0.62J	6	-----	No	
Arsenic	<0.93	1.9J	10	-----	No	
Barium	16	27	2000	-----	No	
Beryllium	<0.11	<0.11	4	-----	No	
Cadmium	<0.41	<0.41	5	-----	No	
Calcium	16000	19000	NE	-----		
Calcium Hardness	35000	63000	NE	-----		
Chloride	15000	17000	NE	-----		
Chromium	<2	<2	100	-----	No	
Cobalt	<0.04	0.13J	NE	-----		
Copper	6	7.7	1300	1000	No	No
Fluoride	1100	1100	4000	2000	No	No
Iron	4.4J	8J	NE	300		No
Lead	<0.1	2.9	15	-----	No	
Magnesium	3900	4700	NE	50000		No
Manganese	<0.42	36	NE	50		No
Mercury	<0.13	<0.13	2	-----	No	
Molybdenum	0.37J	1.2	NE	-----		
Nickel	0.64J	0.87	100	-----	No	
Potassium	1900	2000	NE	-----		
Selenium	<1.3	5.5	50	-----	No	
Silver	<0.03	<0.03	NE	100		No
Sodium	13000	14000	NE	-----		
Strontium	54	72	NE	-----		
Sulfate	13000	17000	NE	250000		No
Thallium	<0.03	1.1	2	-----	No	
Total Alkalinity	39000	73000	NE	-----		
Uranium	<0.01	0.02J	NE	-----		
Vanadium	<3.4	12	NE	-----		
Zinc	3.4J	4.8J	NE	5000		No

Notes:
J = Laboratory estimated concentration. Concentration is below the quantitation limit for compound.
MCL = EPA Primary Drinking Water Standard Maximum Contaminant Level
SDWG = EPA Secondary Drinking Water Guideline value
NE = Not Established
----- = No secondary drinking water guideline established for metal (has primary standard).

Table 36. Laboratory results for treated (finished) water samples taken at the Rockwood Water Treatment Plant after water processing. December 31, 2008 – May 18, 2009. Units in µg/L. Kingston Fossil Plant, Roane County, Tennessee.

Compound	Range of Results		Primary Drinking Water Standard (MCL)	Secondary Drinking Water Standard (MCL)	Above Primary Standard?	Above Secondary Standard?
	Minimum (µg/L)	Maximum (µg/L)				
Aluminum	19	31	NE	-----		
Antimony	<0.33	<0.33	6	-----	No	
Arsenic	<0.93	<0.93	10	-----	No	
Barium	<2.5	34	2000	-----	No	
Beryllium	<0.11	<0.11	4	-----	No	
Cadmium	<0.41	<0.41	5	-----	No	
Calcium	20000	23000	NE	-----		
Calcium Hardness	46000	75000	NE	-----		
Chloride	12000	15000	NE	-----		
Chromium	<2	3.3J	100	-----	No	
Cobalt	<0.04	0.16J	NE	-----		
Copper	<0.38	0.56J	1300	1000	No	No
Fluoride	1100	1200	4000	2000	No	No
Iron	<2.9	<2.9	NE	300		No
Lead	<0.1	<0.1	15	-----	No	
Magnesium	6000	8200	NE	50000		No
Manganese	<0.42	22	NE	50		No
Mercury	<0.13	<0.13	2	-----	No	
Molybdenum	0.39J	0.57J	NE	-----		
Nickel	0.74J	0.85J	100	-----	No	
Potassium	1600	1900	NE	-----		
Selenium	<1.3	2.2J	50	-----	No	
Silver	<0.03	<0.03	NE	100		No
Sodium	6200	9000	NE	-----		
Strontium	50	72	NE	-----		
Sulfate	11000	15000	NE	250000		No
Thallium	<0.03	0.94J	2	-----	No	
Total Alkalinity	53000	84000	NE	-----		
Uranium	<0.01	0.11J	NE	-----		
Vanadium	<3.4	14	NE	-----		
Zinc	21	23	NE	5000		No

Notes:
J = Laboratory estimated concentration. Concentration is below the quantitation limit for compound.
MCL = EPA Primary Drinking Water Standard Maximum Contaminant Level
SDWG = EPA Secondary Drinking Water Guideline value
NE = Not Established
----- = No secondary drinking water guideline established for metal (has primary standard).

Table 37. Groundwater concentration ranges for fourteen metals in drinking water wells and springs within a four-mile radius of the TVA Kingston Fossil Plant, Roane County, TN. Data compiled from TDEC laboratory analysis results. Samples analyzed for TDEC by Microbac Laboratories, Inc. Maryville, TN (for samples collected on 12/30/08, 12/31/08, and 01/05/09). Samples collected from 01/05/09 to 03/12/09 were analyzed by the State of Tennessee Department of Health Environmental Laboratory in Nashville, TN. All results are reported in mg/L, which is equivalent to parts per million (ppm).

Compound	Range of Results		Primary Drinking Water Standard (MCL)	Secondary Drinking Water Standard	Above Primary Standard (MCL)?	Above Secondary Standard?
	Minimum	Maximum				
Arsenic (As)	<0.00025	0.0031J+	0.010	—	No	
Barium (Ba)	<0.010	0.71	2	—	No	
Beryllium (Be)	<0.00005	0.0003	0.004	—	No	
Cadmium (Cd)	<0.00005	0.00070J	0.005	—	No	
Chromium (Cr)	<0.001	0.0042J	0.1	—	No	
Cobalt (Co)	<0.00025	0.001	NE	—		
Lead (Pb)	<0.0001	0.0098	0.015	—	No	
Manganese (Mn)	<0.00005	0.845+	NE	0.05 *		Yes
Mercury (Hg)	<0.0002	0.00016J	0.002	—	No	
Selenium (Se)	<0.00013	0.0019J	0.05	—	No	
Strontium (St)	<0.00025	1.6	NE	—		
Thallium (Tl)	<0.00003	0.0019	0.002	—	No	
Vanadium (Va)	<0.0007	0.012	NE	—		

Notes:
All results are reported in milligrams per liter (mg/L) and are equivalent to parts per million (ppm).
<0.00025 = Detection limit of analysis
0.71 = Highest value reported for wells sampled within 4-mile radius of KIF.
J = Laboratory estimated concentration. Concentration is below the quantitation limit for compound.
MCL = EPA Primary Drinking Water Standard Maximum Contaminant Level
SDWG = EPA Secondary Drinking Water Guideline value
NE = Not Established
+ = Well was sampled twice. Concentrations are average of results and is highest concentration observed in wells and springs sampled for this metals

Table 38. TVA 24-hr Concentration of Metals in Airborne Particles (PM2.5 and PM10) with a chart of PM2.5 measurements. Sampled On-Site at Kingston Plant from Dec 31, 2008 through Feb 3, 2009. Kingston Fossil Plant, Roane County, Tennessee. Units in µg/m^3.

	PM 2.5			PM 10			
Metal	**Minimum**	**Maximum**	**Number Of Samples in Which Detected**	**Minimum**	**Maximum**	**Number Of Samples in Which Detected**	**Health comparison value [1]**
Arsenic	ND	0.0018	1/35	ND	0.0042	3/35	0.0023 [2]
Cadmium	ND	ND	0/35	ND	ND	0/35	0.0056 [2]
Chromium	ND	ND	0/35	ND	0.000019	19/35	0.001 – 0.003 [3, 4]
Lead	ND	0.0056	7/35	ND	ND	0/35	0.15 [5]
Manganese	NA	NA	NA	NA	NA	NA	0.05 – 0.3 [6]
Selenium	ND	0.0037	17/35	ND	0.0043	4/35	20 [7]
Thallium	ND	ND	0/35	ND	ND	0/19	NA
Vanadium	ND	0.001	2/35	ND	ND	0/25	NA

ND = non-detected
[1] Bashor 2009
[2] EPA IRIS, for a risk of 1x10^{-5} risk of excess cancer
[3] health comparison value is for hexavalent chromium; KIF coal ash is less than 13% hexavalent chromium
[5] National Ambient Air Quality Standard
[4] average background in Georgia
[6] range of values from ATSDR and EPA
[7] EPA Region IV screening value adjusted for a hazard index of 1.0

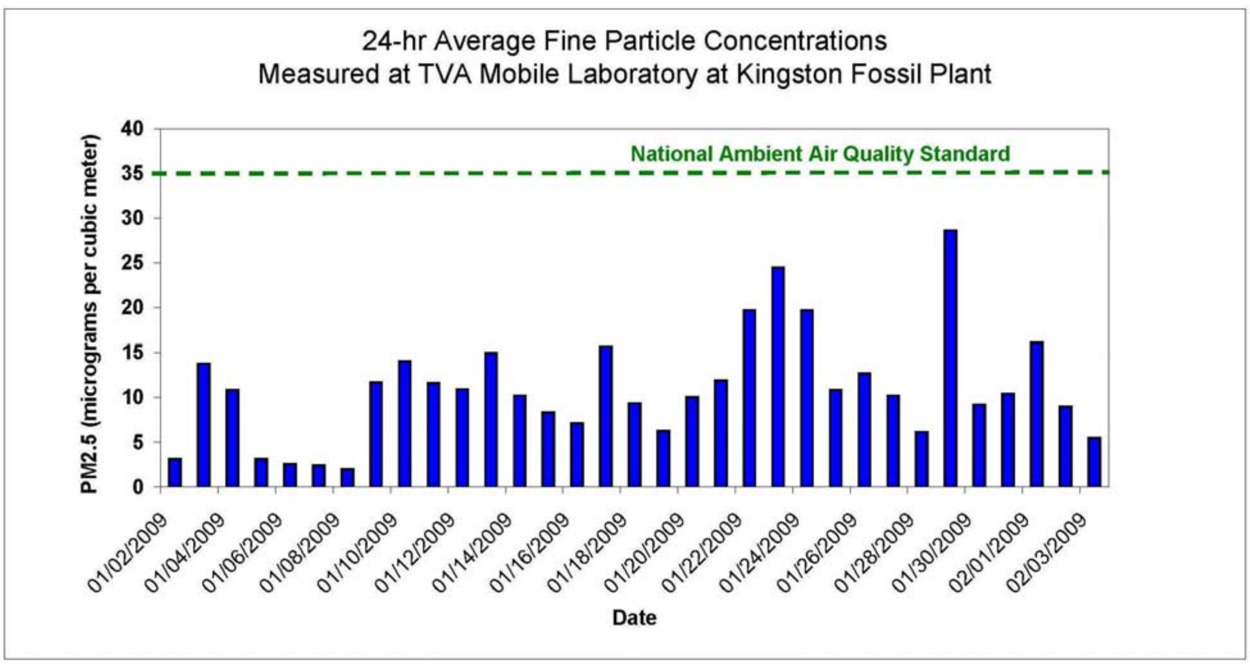


Table 39. TVA air sampling data at temporary permanent monitoring stations for those metals detected above the minimum detection limit, December 28, 2008 – March 9, 2009. Units in µg/m³. Kingston Fossil Plant Coal Ash Release, Harriman, Roane County, Tennessee.

Date	Aluminum	Cadmium	Copper	Lead	Manganese	Zinc
12/28/2008						
PS02	67	-----	-----	-----	0.11	16
PS03	67	-----	-----	-----	0.11	18
PS04	79	-----	-----	-----	0.13	20
1/13/2009						
`PS07	-----	-----	-----	0.051	-----	-----
1/17/2009						
PS07	5.2	-----	-----	-----	-----	-----
1/26/2009						
PS09	-----	0.01	-----	-----	-----	-----
2/7/2009						
PS06	-----	-----	-----	0.026	-----	-----
2/10/2009						
PS06	2.8	-----	-----	-----	-----	-----
2/13/2009						
PS08	-----	-----	-----	0.025	-----	-----
2/17/2009						
PS06	-----	-----	0.15	-----	-----	-----
PS07	-----	-----	0.33	-----	-----	-----
PS09	-----	-----	0.12	-----	-----	-----
2/18/2009						
PS05	-----	-----	0.1	-----	-----	-----
2/24/2009						
PS06	-----	-----	-----	0.026	-----	-----
PS07	-----	-----	0.1	-----	-----	-----
3/4/2009						
PS06	-----	-----	-----	-----	0.054	-----
3/8/2009						
PS06	5.5	-----	-----	-----	-----	-----
PS07	5.6	-----	-----	-----	-----	-----
PS08	5.2	-----	-----	-----	-----	-----
PS09	5.5	-----	-----	-----	-----	-----
3/9/2009						
PS05	2.7	-----	-----	-----	-----	-----

Cells with ----- indicate that either samples were not analyzed for the particular metal or the concentration was less than the minimum detection limit.

Table 40. TDEC 24-hr Concentration of Metals in Airborne Particles (TSP). January 19, 2009 through May 31, 2009. Kingston Fossil Plant, Roane County, Tennessee. Units in μg/m^3.

Date	TSP	Aluminum	Arsenic	Barium	Lead	Manganese	Selenium
1/19/2009	24	ND	ND	ND	0.0027	0.0036	0.001
1/25.2009	17	ND	ND	ND	0.0035	0.006	0.0016
1/31/2009	15	ND	ND	ND	0.0039	0.0048	ND
2/6/2009	64	0.099	0.0017	ND	0.0044	0.011	0.0023
2/12/2009	15	0.087	ND	0.0041	0.0016	0.004	ND
2/18/2009	18	0.11	ND	0.00590	0.00220	0.00390	0.00160
2/24/2009	42	0.11	0.0025	0.0074	0.0035	0.014	0.0022
3/2/2009	20	0.16	ND	0.0042	0.0017	0.0017	ND
3/8/2009	37	0.12	0.0019	0.0051	0.0026	0.0041	ND
3/14/2009	11	0.043	ND	ND	0.0016	0.0012	0.0019
3/20/2009	24	0.11	ND	0.0039	0.0026	0.0057	ND
3/26/2009	12	0.043	ND	0.0018	0.0016	0.0025	ND
4/1/2009	15	0.11	ND	0.0043	0.0025	0.0058	0.0021
4/7/2009	15	0.064	ND	0.0024	0.0013	0.0043	ND
4/13/2009	32	0.045	0.0008	0.0031	0.0022	0.0009	ND
4/19/2009	29	ND	0.0029	0.0025	0.0029	0.0029	0.0021
4/25/2009	63	NA	NA	NA	NA	NA	NA
5/1/2009	32	NA	NA	NA	NA	NA	NA
5/7/2009	26	NA	NA	NA	NA	NA	NA
5/13/2009	42	NA	NA	NA	NA	NA	NA
5/19/2009	28	NA	NA	NA	NA	NA	NA
5/25/2009	12	NA	NA	NA	NA	NA	NA
5/31/2009	28	NA	NA	NA	NA	NA	NA
Health Comparison Value[1]	NA	5.2[2]	0.0023[3]	0.52[2]	0.15[4]	0.04[5]	20[6]

ND = not detected
NA = not available
[1] Bashor 2009
[2] EPA Region 3 Screening Tables
[3] EPA IRIS, for a risk of 1 x 10^{-5} risk of excess cancer
[4] NAAQS
[5] comparison values from ATSDR and EPA range between 0.04 μg/m³ to 0.3 μg/m³
[6] EPA Region 4 screening value adjusted for a hazard index of 1

Beryllium, cadmium, chromium, thallium, and mercury were not detected in any of the sample analysis results.

Table 41. Radioactivity in ash samples analyzed by Duke University. Kingston Fossil Plant, Roane County, Tennessee. Units in pCi/g of ash material.

Sample	^{226}Ra	^{228}Ra	^{210}Pb	Total Radium	$^{228/226}Ra$ ratio [2]
TVA A	4.9	3.2	3.57	8.11	0.65
TVA B	2.6	2.1	3.54	4.65	0.79
TVA C	4.9	3.1	5.01	7.94	0.63
Average [1]	4.12	2.78	4.04	6.90	0.69
Standard Deviation	1.08	0.51	0.69	1.59	0.07

[1] The average and standard deviation were calculated by ATSDR. The standard deviation used was the population standard deviation.

[2] A ratio of 1.0 indicates that the radionuclides are in secular equilibrium. The standard deviation indicates that the samples are essentially the equal.

Table 42. Radioactivity in soil and ash samples analyzed by the Tennessee Department of Environment and Conservation. Kingston Fossil Plant, Roane County, Tennessee. Units in pCi/g of soil / ash material.

	^{214}Pb	^{214}Bi	^{228}Ac	^{212}Pb	^{208}Tl	^{212}Bi
Average background	1.234	1.230	1.840	1.671	0.671	1.080
Soil average	1.161	1.060	1.353	1.225	0.438	1.204
Net soil average [1]	-0.073	-0.170	-0.487	-0.446	-0.233	0.124
Ash average	4.305	3.884	3.003	2.944	0.978	2.133
Net ash average [1]	3.071	2.654	1.163	1.273	0.307	1.053
Nearby landfill average	5.050	4.540	3.335	3.197	1.160	3.080

[1] The net averages were determined by subtracting the background concentration from the reported soil or ash sample. A value less than zero is an artifact; the reported value is within the variability of background.

Appendix A: Health Comparison Values

ATSDR is charged by Congress with providing support in the assessment of any health hazard posed by Superfund or other hazardous waste sites. Part of that charge is to thoroughly research what is known about toxic and hazardous chemicals. The purpose of the research is to establish health comparison values. These health comparison values are used by ATSDR and TDH so that when toxic or hazardous substances are found in the environment, we can understand the public health implications using the best science available.

If the chemical concentrations are below health guidance values, then environmental scientists can be reasonably certain that no adverse health effects will occur in people who are exposed. If concentrations are above the guidance values (ATSDR 2007a, 2008) for a particular chemical, then further evaluation is needed. In this public health assessment, we will do further evaluation for arsenic in coal ash for the ingestion route of exposure.

ATSDR's health comparison values for chemicals that do not cause cancer are called Minimal Risk Levels (MRLs). MRLs represent doses that a person could receive without adverse health effects for a lifetime. The unit of measurement for MRLs is milligram of chemical per kilogram of body weight per day, written as mg/kg·day.

MRLs are derived from 'no observed adverse effect levels' (NOAELs) or from lowest observed adverse effect levels (LOAELs). A NOAEL is the highest tested dose of a chemical that has been reported to have no harmful health effects on people or animals. A LOAEL is the lowest tested dose of a chemical that has been reported to cause harmful health effects in people or animals. LOAELs are based on less serious, subtle effects rather than on obvious toxic effects.

To be more useful as a screening tool, MRLs are mathematically converted to Environmental Media Evaluation Guidelines (EMEGs). EMEGs represent concentrations of chemicals in an environmental media, such as soil, air, or water, that people could be exposed to for varying amounts of time without adverse health effects. The units of measurement for EMEGs are milligrams of chemical per kilogram of soil (mg/kg), milligrams of chemical per liter of water (mg/L), or milligrams of chemical per cubic meter of air (mg/m^3).

ATSDR used conservative assumptions about chemical exposure when developing its EMEGs and minimum risk levels MRLs. EMEGs and MRLs consider non-cancer adverse health effects. Exposure durations are defined as acute (14 days or less), intermediate (15–364 days), and chronic (365 days or more) exposures. For most chemicals, EMEGs have been derived for children and adults.

EMEGs serve as screening guidance to help scientists look more closely at the people who might be exposed to harmful levels of chemicals. To use these screening levels we must know how much of a chemical someone is exposed to

ATSDR: Agency for Toxic Substances & Disease Registry

TDH: Tennessee Department of Health

MRL: ATSDR minimal risk level

mg/kg·day: milligram of substance per kilogram body weight per day

NOAEL: No observed adverse effect level

LOAEL: Lowest observed adverse effect level

EMEG: ATSDR environmental media evaluation guide

mg/kg: milligram per kilogram

mg/L: milligram per liter

mg/m^3: milligram per cubic meter of air (dose), how long that exposure has been or will be occurring (duration of exposure), how frequent the exposure is or will be (frequency of exposure), and the age of the exposed person. If concentrations are below the chronic EMEG for a particular chemical, scientists can be reasonably certain that no adverse health effects will occur in people who are exposed.

EMEGs are not action or trigger levels. Concentrations above the chronic EMEG do not mean that adverse health effects would occur. The health assessor would need to look more closely at exposure routes, duration of exposure, frequency of exposure, and dose. In addition, the health assessor needs to look more closely at the toxicity of the chemical and how much confidence we have in the MRL.

The EPA is also mandated to publish toxicity information. EPA's values are very similar to ATSDR's MRLs and EMEGs. EPA's reference dose (RfD) and reference concentration (RfC) are analogous to ATSDR's chronic exposure MRL. RfDs are used in cases of oral exposure (eating or drinking) to the chemical in question. RfC's are used for inhalation exposure (breathing) to the chemical in question.

Policy decisions at each agency may result in ATSDR and EPA deriving different MRLs, RfDs, and RfCs for the same chemical. In addition, ATSDR derives EMEGs for varying chronic, intermediate, and acute exposure frequencies. Chronic exposure is defined as one year or more. Intermediate exposure is defined as 15 – 364 days. Acute exposure is defined as fourteen days or less. EPA-derived RfDs and RfCs are for chronic or lifetime exposure. If ATSDR has not derived an MRL for a chemical, then it sometimes uses EPA's RfD to derive a Reference Dose Media Evaluation Guide (RMEG). ATSDR usually considers RMEGs to represent an intermediate exposure.

For cancer effects, ATSDR uses EPA information to set their cancer risk evaluation guidelines (CREGs) for lifetime exposure.

If a chemical is a probable or known human carcinogen, EPA derives a cancer risk value for that chemical. EPA uses data from animal studies and human epidemiology studies, if they are available, to extrapolate from high doses with known carcinogenic end points to very low doses using complex models. Often EPA assumes there is no threshold; that is, any exposure will result in some risk of cancer. This is an assumption that is valid in some cases and not in others, but for most chemicals we lack sufficient data to know the validity of the assumption. EPA then uses one of several models to determine the slope of the 95% upper confidence level of the extrapolated response at low concentrations. This derived slope factor is the number that represents the theoretical risk of excess cancer from exposure to the chemical in question (EPA 2005).

EMEG: ATSDR environmental media evaluation guide

MRL: ATSDR minimal risk level

EPA: U.S. Environmental Protection Agency

RfD: EPA Reference Dose

RfC: EPA Reference Concentration

ATSDR: Agency for Toxic Substances & Disease Registry

RMEG: ATSDR-derived reference dose media evaluation guide

It is important to note that the cancer risk value is a statistically derived number representing an upper 95% confidence level of a theoretical straight line predicting one extra cancer per unit increase in exposure. The use of such toxicity values in combination with estimates of exposure result in estimates of "excess lifetime cancer risks" from the exposure in question. This extra or "excess" risk is in addition to the risk people already have for any number of other reasons (e.g., genetic predisposition, lifestyle factors, etc.). In the US, men have slightly less than a 1 in 2 lifetime risk of developing cancer. For women, the lifetime excess risk is a little more than 1 in 3 (Cancer Facts and Figures 2008).

ATSDR does not publish a comparable cancer guidance value; they use EPA's slope factor. EPA regulates chemicals in the environment which may cause cancer, when their presence could result in the range of one excess cancer in 1,000,000 people to one excess cancer in 10,000 people (EPA 1991).

Health comparison values will change periodically as scientists discover more about how a particular chemical does or does not cause harm to people. Thus, MRLs and slope factors can get higher or lower.

EEP used comparison values for chronic exposures to children whenever possible. This means that EEP assumed that all exposures would last more than one year and could last for a lifetime. This is cautious way to look at possible risks from exposures to chemicals in the environment. People are seldom exposed to an environmental contaminant constantly for over a year. Details for each exposure pathway will be discussed in each section of the public health assessment.

If concentrations are below the chronic EMEG for a particular chemical, the health assessor can be reasonably certain that no adverse health effects will occur in people who are exposed. Stated another way, the health assessor can be very sure that even long-term, continuous exposure to a chemical at concentrations below its chronic EMEG will not harm people's health.

EEP used ATSDR's MRLs and EMEGs for chronic exposure to children whenever possible. For certain metals, ATSDR used an EPA value comparable to their MRLs to calculate a Reference Dose Media Evaluation Guide (RMEG). If ATSDR's EMEGs or RMEGs were unavailable, EEP used comparison values developed by regional EPA offices or EEP developed comparison values for use at this ash release site.

ATSDR: Agency for Toxic Substances & Disease Registry

EPA: U.S. Environmental Protection Agency

MRL: ATSDR minimal risk level

EEP: Environmental Epidemiology Program

EMEG: ATSDR environmental media evaluation guide

RMEG: ATSDR-derived reference dose media evaluation guide

Appendix B. Toxicological Discussion of Metals in Air

mg/kg: milligram per kilogram

EEP: Environmental Epidemiology Program

μg/m³: microgram per cubic meter of air

EPA: U.S. Environmental Protection Agency

Arsenic

Arsenic is widely distributed in the Earth's crust. In Tennessee, soils contain a range of arsenic concentrations, with an average of 10 mg/kg (TDEC 2001). In the U.S., soils have an average arsenic value of 20 mg/kg (ATSDR 2007). In nature, arsenic is mostly found in minerals and only to a small extent in its elemental form. In coal fly ash, arsenic is in an inorganic form, mostly as an arsenate (Shoji et al. 2002).

Workers exposed to arsenic dusts in an occupational setting often experience irritation to the mucous membranes of the nose and throat. This may lead to laryngitis, bronchitis, or rhinitis, and very high exposures (characteristic of workplace exposures in the past) can cause perforation of the nasal septum. Despite the known respiratory irritant effects of arsenic, there have been few systematic investigations of respiratory effects in humans exposed to arsenic. There is some evidence from epidemiological studies that inhaled inorganic arsenic can produce effects on the cardiovascular system. Dermatitis has frequently been observed in industrial workers exposed to inorganic arsenic in the air, with the highest rates occurring in the workers with the greatest arsenic exposure. There is evidence from epidemiological studies that inhaled inorganic arsenic can produce neurological effects (ATSDR 2007).

There is convincing evidence from a large number of epidemiological studies that breathing inorganic arsenic increases the risk of lung cancer. Most studies involved workers exposed primarily to arsenic trioxide dust in air at copper smelters and mines, but increased incidence of lung cancer has also been observed at chemical plants where exposure was primarily to arsenate. In addition, several studies suggest that residents living near smelters or arsenical chemical plants may also have increased risk of lung cancer, although the increases are small and are not clearly detectable in all cases. The strongest evidence that arsenic is responsible for the observed lung cancers comes from quantitative dose-response data relating specific arsenic exposure levels to lung cancer risk. These data are available for arsenic-exposed workers at the ASARCO copper smelter in Tacoma, Washington, the Anaconda copper smelter in Montana, eight other U.S. copper smelters, and the Ronnskar copper smelter in Sweden. A common limitation of these studies is confounding exposure to other chemicals, such as sulfur dioxide, and cigarette smoking (ATSDR, 2007).

EEP chose a health comparison value for arsenic of 0.0023 μg/m³. This exposure would represent a risk of one excess cancer in a 100,000 people with continuous lifetime exposure to 0.0023 μg/m³ of airborne arsenic. EEP used the risk values from EPA's Integrated Risk Information System (IRIS). The respirable portion of the coal ash is less than 30%, and, with dust suppression measures in place, actual exposure to airborne ash should be infrequent and for short periods of time.

Chromium

µg/kg: microgram per kilogram

mg/kg: milligram per kilogram

TVA: TN Valley Authority

Chromium is a naturally-occurring element found in rocks, animals, plants, and soil. The three main forms of chromium are elemental chromium (valence state 0), trivalent chromium (valence state +3), and hexavalent chromium (valence state +6). Small amounts of trivalent chromium are considered to be a necessity for human health. The primary route of exposure for the general population is food ingestion. Chromium content in foods varies greatly and depends on the processing and preparation. In general, most fresh foods typically contain chromium levels ranging from <10 to 1,300 µg/kg (<0.01 to 1.3 mg/kg) (ATSDR, 2008a).

Hexavalent chromium compounds are more toxic than trivalent chromium compounds. The most common health problem experienced by workers exposed to airborne chromium involves the respiratory tract. These health effects include irritation of the lining of the nose, runny nose, and breathing problems (asthma, cough, shortness of breath, wheezing). Workers have also developed allergies to chromium compounds, which can cause breathing difficulties and skin rashes (ATSDR 2008a).

The concentrations of chromium in air that can cause these effects may be different for different types of chromium compounds, with effects occurring at much lower concentrations for hexavalent chromium compared to trivalent chromium. However, the concentrations causing respiratory problems in workers are at least 60 times higher than levels normally found in the environment (ATSDR 2008a).

The International Agency for Research on Cancer has determined that hexavalent chromium compounds are carcinogenic to humans. The National Toxicology Program's 11th Report on Carcinogens classified hexavalent chromium compounds as known human carcinogens. In workers, inhalation of hexavalent chromium has been shown to cause lung cancer. In laboratory animals, hexavalent chromium compounds have been shown to cause tumors to the stomach, intestinal tract, and lung (ATSDR 2008a).

Researchers have performed spectral analysis of coal fly ash that was experimentally generated by combustion of three high-volatile bituminous coals from the eastern United States and four coals from the western United States. Results indicated that fly ash from western coals contained significant amounts of hexavalent chromium (9% to 26% of all chromium in fly ash), while fly ash from eastern coals contained no hexavalent chromium (Shoji et al 2002). Researchers in the Netherlands found that hexavalent chromium accounts for an average of 6 percent of all chromium in coal ash. In the Netherlands, coal from all over the world is burned to generate electricity (Meij and te Winkel 2001). TVA blends central Appalachian coal (eastern) and Powder River Basin coal (western) in a 50/50 ratio to meet their sulfur dioxide limits (personal communication, Jeryl Stewart, TDEC, through Quincy Styke, TDEC, March 12, 2009, and Steven C. Strunk, TVA, March 17, 2009). In the past, it is likely that eastern coal was burned exclusively, resulting in lower levels of hexavalent chromium in mixed coal ash. EEP conservatively assumed that the ash that spilled would have 13 percent hexavalent chromium (based on a 50/50 mixture of coal containing no hexavalent chromium and coal containing 26% hexavalent chromium).

Hexavalent chromium is carcinogenic, and there are no health comparison values for trivalent chromium. The concentration that corresponds to one excess cancer in 100,000 people ($1x10^{-5}$ risk of excess cancer) is 0.00083 $\mu g/m^3$. This level is lower than the 2008 average concentration of 0.004 $\mu g/m^3$ and maximum concentration of 0.02 $\mu g/m^3$ in the U.S. The level representing one excess cancer in 100,000 people is also less than the 2008 average concentration of 0.002 to 0.003 $\mu g/m^3$ and maximum concentration of 0.02 $\mu g/m^3$ in the State of Georgia, the nearest state with metals monitoring (EPA 2009c).

EEP chose to use background concentrations found in Georgia (0.002 to 0.003 $\mu g/m^3$) for comparison purposes pertaining to the KIF release. The calculated theoretical risk of one excess cancer in 100,000 people ($1x10^{-5}$) is below background levels found in the U.S. Because only about 13% of chromium in the KIF coal ash is in the hexavalent form of chromium, the actual risk from breathing KIF coal ash is less than would be mathematically calculated. In addition, the respirable portion of the ash is small. With dust suppressions measures in place, actual exposure to airborne ash should be infrequent and for short periods.

Manganese

Manganese is a naturally-occurring substance found in many types of rocks and soil. Pure manganese is a silver-colored metal. Manganese does not occur in the environment as a pure metal. Rather, it occurs combined with other substances such as oxygen, sulfur, and chlorine. Manganese is a trace element and some is necessary for good health (ATSDR 2008b).

The most common health problems in workers occupationally exposed to high levels of manganese involve the nervous system. These health effects include behavioral changes and other nervous system effects, which include movements that may become slow and clumsy. This combination of symptoms when sufficiently severe is referred to as “manganism.” Other less severe nervous system effects such as slowed hand movements have been observed in some workers exposed to lower concentrations of manganese in the work place.

The health comparison values for manganese in air are undergoing review by EPA and ATSDR. The ATSDR Draft Toxicological Profile for Manganese released in September 2008 included a health comparison value of 0.3 $\mu g/m^3$ for chronic exposure to manganese in air (ATSDR 2008b). The currently listed health comparison value from ATSDR’s Air Comparison Values Table is 0.04 $\mu g/m^3$. The comparison value from EPA that represents hazard index of 1 is

TDEC: TN Department of Environment & Conservation

TVA: TN Valley Authority

$\mu g/m^3$: microgram per cubic meter of air

KIF: Kingston Fossil Plant

EPA: U.S. Environmental Protection Agency

ATSDR: Agency for Toxic Substances & Disease Registry

0.05 μg/m³ (IRIS 2009). EEP chose to use ATSDR's value from their Air Comparison Values Table of 0.04 μg/m³ as its health comparison value for this public health assessment.

Other Metals

The health comparison values for airborne aluminum and barium were taken from EPA Region 3's Regional Screening Tables. The health comparison value for aluminum is 5.2 μg/m³ and for barium is 0.52 μg/m³.

The health comparison value for selenium was taken from EPA Region 4's chronic inhalation screening values, adjusted for a hazard index of 1. This value is 20 μg/m³.

No health comparison values for inhalation are available for thallium and vanadium in air. Sufficient information about the human toxicology of thallium and vanadium could not be identified to derive health screening values.

μg/m³: microgram per cubic meter of air

ATSDR: Agency for Toxic Substances & Disease Registry

EPA: U.S. Environmental Protection Agency

EEP: Environmental Epidemiology Program

Appendix C: Spatial Analysis with ArcGIS

EEP did spatial analysis using ESRI's ArcGIS Version 9.3. In order to do the analysis, incident data were aggregated based on 1,500 foot by 1,500-foot grid cells. Census block groups could not be used for aggregation because the area around the TVA spill site is very rural; therefore, census block groups were too large. Due to the relatively low incidence of symptoms, it is important to note that EEP was dealing with very small numbers (less than 30 in each cell). As a result, a small change in symptom occurrence can lead to a large change in the symptom proportion.

To discern any temporal trends in symptom occurrence, EEP investigated whether the 'after' symptoms had different spatial distributions than the 'before' symptoms using the Directional Distribution (Standard Ellipse) tool in ArcGIS. This tool allowed EEP to create standard ellipses, which show the distribution of features as well as whether there is a directional trend or orientation in that distribution. It does so by calculating the standard distance between each feature to the mean center of the distribution separately for the x and y coordinates. These two measures define the axis of an ellipse, which encompasses the distribution of the features. The length of the x-axis is calculated in the east-west direction and the length of the y-axis is calculated in the north-south direction. Because the standard deviation is measured in each direction from the mean center, the total length of each axis is twice its standard deviation. To determine the orientation of the ellipse, ArcGIS calculates an angle of rotation from 0^{o} due north for the y-axis so that the sum of the squares of the distance between the features and the axes is minimized. It then rotates each axis by this angle, ultimately finding the best fit of both axes among the features in which the distance of the features to the axes is minimized (Mitchell 2005).

The Directional Distribution (Standard Ellipse) tool can be used to compare distributions, examine distributions from different time periods, and show compactness and orientation of distributions. If distributions closely resemble a circle, then there is not a strong orientation to the occurrence of the symptom. A large circle means the cases are widespread whereas a small circle means the cases are more localized (concentrated). The orientation of the circle/eclipse indicates the direction in which the cases are occurring (ESRI 2006).

Next, EEP determined whether or not each of these symptoms were clustered and, if so, at what distance the clustering is most significant using the Spatial Autocorrelation (Global Moran's I) tool in ArcGIS. This tool is based on the concept that everything is related to everything else, but nearby things are more related than far away things. It indicates whether particular values are likely to occur in one location or are equally likely to occur at any location (ESRI 2006). It does so by calculating a Moran's I statistic. This statistic calculates the difference between each feature and the difference between each neighboring feature to the mean value for all features in the study area. It then compares

EEP: Environmental Epidemiology Program

ESRI: Environmental Systems Research Institute

ArcGIS: ArcGIS is a group of geographical information system software that is used for mapping and statistical analysis of data that is geographically related.

TVA: TN Valley Authority

these two differences. The values for Moran's I range from -1 to +1. The closer Moran's I is to +1, the greater the clustering of similar features. Conversely, the closer Moran's I is to -1, the greater the dispersion of similar features. An I close to 0 indicates that the features are random and there is no apparent pattern (Mitchell 2005).

The Spatial Autocorrelation (Global Moran's I) tool also calculates a Z-score which indicates statistical significance. For this analysis, EEP used a significance level of 0.05, or 95%. Therefore, a Z-score greater than +1.96 or a Z-score less than -1.96 is a significant result. A positive Z-score above the significant value of +1.96 would thus indicate that similar values tend to be found together and you can be 95% confident that the clustered pattern is not due to chance. A negative Z-score below the significant value of -1.96 would indicate that high and low values are interspersed and you can be 95% confident that the dispersed pattern is not due to chance (Mitchell 2005).

Once significant clustering of symptoms was recognized, EEP used the Hot Spot Analysis with Rendering tool in ArcGIS to identify the location of these clusters. Using a distance-based neighborhood, this tool calculates a Getis-Ord Gi* statistic for each feature by summing the values of the neighboring features within a specific distance and dividing this sum by the sum of the values of all the features in the study area. A group of features with high Gi* values indicates a hot spot. A hot spot is an area where there is an unexpectedly high number of symptoms given the number of people. Equally, a group of features with low Gi* values indicates a cold spot which is an area where there is an unexpectedly low number of symptoms given the number of people. A Gi* near 0 indicates an area where there is neither a high nor a low concentration of symptoms (Mitchell 2005).

As with Moran's I, the Hot Spot Analysis with Rendering tool also calculates a Z-score to test statistical significance. A high Z-score for a feature indicates its neighbors have high attribute values and a low Z-score for a feature indicates its neighbors have low attribute values. As such, with a significance level of 0.05, a Z-score greater than +1.96 indicates that the identified hot spot is statistically significant. A Z-score less than -1.96 indicates that the identified cold spot is statically significant. A Z-score near 0 indicates no apparent concentration of similar values (Mitchell 2005). The greater the Z-score, whether it be negative or positive, the more intense the clustering (ESRI 2008).

EEP: Environmental Epidemiology Program

ArcGIS: ArcGIS is a group of geographical information system software that is used for mapping and statistical analysis of data that is geographically related.

References for Appendix C

ESRI. 2006. Understanding Spatial Statistics in ArcGIS 9 Transcript. Available from: http://www.utsa.edu/lrsg/Teaching/EES6513/ESRI_ws_SpatialStatsSlides.pdf. Last accessed: January 21, 2009.

ESRI. 2008. ArcGIS Desktop 9.3 Help. Available from: http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=welcome. Last accessed: April 2, 2009.

Mitchell. 2005. The ESRI Guide to GIS Analysis, Volume 2: Spatial Measurements & Statistics. ESRI Press. Redlands, California

Appendix D: Excerpt from Fishing and Biological Advisories in Tennessee

Fishing and Bacteriological Advisories in Tennessee can be found at URL:
http://www.state.tn.us/environment/wpc/publications/pdf/advisories.pdf

Fish Tissue Contamination

Fish are an important part of a balanced diet and a good source of low fat protein. They also provide essential fatty acids that are crucial for the proper functioning of the nervous system and help prevent heart disease. The Department recommends that residents and visitors continue to eat fish from Tennessee rivers and reservoirs, but they should also follow the published advisories on consumption hazards in individual reservoirs.

Approximately 94,400 reservoir acres and 119 river miles are currently posted due to contaminated fish. The contaminants most frequently found at dangerous levels in fish tissue are PCBs, mercury, chlordane, and other organics.

Organic substances and mercury tend to bind with the sediment, settle out of the water, and persist for a very long time. In the sediment, they become part of the aquatic food chain and, over time, concentrate in fish tissue. Contaminants can be found in fish tissue even if the substance has not been used or manufactured in decades.

Waterbodies where fish tissue has levels of contamination that pose a higher than acceptable risk to the public are posted and the public is advised of the danger. Signs are placed at main public access points and a press release is submitted to local newspapers. The list of advisories is also published in TWRA's annual fishing regulations. If needed, TWRA can enforce a fishing ban.

Where contaminants are elevated in fish, they may also be present in other aquatic life as well. Therefore, the public is advised to limit or avoid consumption of other animals such as turtles, crayfish and mussels in waterbodies with a fishing advisory.

In March 2004, the U.S. Department of Health and Human Services, in conjunction with the U.S. Environment Protection Agency, issued a mercury advisory for the consumption of fish and shellfish by pregnant women, nursing mothers, young children, and women who might become pregnant. The advisor specifically warns this sensitive sub-population to avoid eating fish with elevated mercury levels: Shark, Swordfish, King Mackerel, and Tilefish. For more information see EPA's website: http://www.epa.gov/waterscience/fishadvice/advice.html

Reducing Risks from Contaminated Fish

The best way to protect yourself and your family from eating contaminated fish is by following the advice provided by the Department of Environment and Conservation. Cancer risk is accumulated over a lifetime of exposure to a carcinogen (cancer-causing agent). For that reason, eating an occasional fish, even from an area with a fishing advisory, will not measurably increase your cancer risk.

At greatest risk are people who eat contaminated fish for years, such as recreational or subsistence fishermen. Some groups of people like children or people with a previous occupational exposure to a contaminant are more sensitive to that pollutant. Studies have shown that contaminants can cross the placental barrier in pregnant women to enter the baby's body, thereby increasing the risk of developmental problems. These substances are also concentrated in breast milk.

The Division's goal in issuing fishing advisories is to provide the information necessary for people to make **informed choices** about their health. People concerned about their health will likely choose not to eat fish from contaminated sites.

If you choose to eat fish in areas with elevated contaminant levels, here is some advice on how to reduce this risk:

1. Throw back the big ones. Smaller fish generally have lower concentrations of contaminants.
2. Avoid fatty fish. Organic carcinogens such as DDT, PCBs, and dioxin accumulate in fatty tissue. Large carp and catfish tend to have more fat than gamefish. Moreover, the feeding habits of carp, sucker, buffalo, and catfish tend to expose them to the sediments, where contaminants are concentrated. In contrast, however, mercury tends to accumulate in muscle tissue and will tend to concentrate in higher levels in gamefish.
3. Wash fish before cleaning. Some contaminants are concentrated in the mucus, so fish should be washed before they are skinned and filleted.
4. Broil or grill your fish. These cooking techniques allow the fat to drip away. Frying seals the fat and contaminants into the food.
5. Throw away the fat if the pollutant is PCBs, dioxin, chlordane or other organic contaminants. Organic pesticides tend to accumulate in fat tissue, so cleaning the fish so the fat is discarded will provide some protection from these contaminants.

Stream	County	Portion	Pollutant	Comments
Emory River	Roane, Morgan	From Highway 27 near Harriman (Mile 12.4) upstream to Camp Austin Road Bridge (Mile 21.8)	Mercury	Precautionary advisory for all fish
Watts Bar Reservoir	Roane, Meigs, Rhea, Loudon	Tennessee River portion (38,000 acres)	PCBs	Catfish, striped bass, & hybrid (striped bass-white bass) should not be eaten. Precautionary advisory for white bass, sauger, carp, smallmouth buffalo and largemouth bass.
Watts Bar Reservoir	Roane, Anderson	Clinch River arm (1,000 acres)	PCBs	Striped bass should not be eaten. Precautionary advisory for catfish and sauger.
*Precautionary Advisory - Children, pregnant women, and nursing mothers should not consume the fish species named. All other persons should limit consumption of the named species to one meal per month.				

Additional national fish tissue advisories have been issued for the most sensitive sub-populations: pregnant women, nursing mothers, children, and women who could become pregnant. See the attached joint EPA and FDA advisory.

Where contaminants are elevated in fish, they may also be present in other aquatic life as well. Therefore, the public is advised to limit or avoid consumption of other animals such as turtles, crayfish and mussels in waterbodies with a fishing advisory.

Appendix E. Peer Review Comments and Response to Comments

Peer Reviewer 1

Peer Review Comment Form

Tennessee Valley Authority (TVA) Kingston Fossil Plant

Coal Ash Release

Public Health Assessment

December 2009

Guide to Reviewers:

The objective of peer review conducted by the Office of Science is to ensure the highest quality of science for NCEH/ATSDR studies and results of research; therefore, your comments should be provided with this goal in mind. Unlike other peer review processes in which you may have participated, the questions to be addressed for NCEH/ATSDR are broadly based so that each reviewer may have a wide latitude in providing his/her comments. Any remarks you wish to make that have not been specifically covered by the General Questions Section may be included under question # 2 in the Additional Questions Section. Please note that your unaltered comments will be sent to the investigator for a response. You should receive a copy of the response to the peer review comments when they are available.

Tennessee Department of Health's and ATSDR's responses to comments are in italics following the comment.

General Questions:

Does the public health assessment adequately describe the nature and extent of contamination?

The Public Health Assessment thoroughly and completely describes, in appropriate scientific terms and by appropriate technical analyses, the environmental contamination that resulted from the December 22, 2008 release of coal ash and water from the TVA Fossil Plant holding pond. The Health Assessment correctly applies scientific methods by comparing measured values of potentially harmful components in the coal ash to known limits and standard values applicable to well-established measures used for public and occupational health protection. This reviewer did not find fault with the methods or approach used by the authors. The results and findings presented in the Health Assessment are highly credible and show careful attention to the scientific method, appropriate methods of analysis, and correct interpretation of results.

No response needed. Thank you.

2. Does the public health assessment adequately describe the existence of potential pathways of human exposure?

This Public Health Assessment describes each of the major pathways for human exposure applicable to the accident and long-term consequences, including but not limited to: direct skin contact with coal ash, drinking home water from well and municipal sources, breathing air containing coal ash dusts, and ingesting contaminated soils. The Assessment correctly identifies each of the primary contaminants (metals and radionuclides), their chemical forms, pathways for human intake, and known toxicities.

Specific comments in detail:

a. In Conclusion 12, no specific values of radiation dose to members of the general public are given for comparison to normal background levels.

This reviewer made a suggestion under question 5 for rewording this conclusion. It has been so reworded. Because of this rewording and because it is nearly impossible to make radiation and health comprehensible to those who are not health physicists, it seemed best to leave the conclusion as suggested in the rewording.

b. On page 15, the chemical form (molecular structure) of arsenate should be added.

Added

c. On page 17, the text states that no ATSDR derived health comparison values are available for thallium. Indicate whether thallium is considered to be a toxic metal. Thallium is indeed a toxic metal (Handbook on Toxicity of Inorganic Compounds). However, all people are daily exposed to normal environmental levels (about 2 micrograms per day as a daily intake). The threshold limit value-time weighted average for thallium in workplace air is 0.1 mg/m^3. Clarify that 1) the EPA screening values are for thallium per kg of coal ash,

Done

and 2) that the airborne levels of thallium to which people are exposed from environmental sources, including aerosols from the coal ash release, are substantially less than this EPA threshold limit value.

Because no thallium has been detected in air at the monitors, this suggestion was not done. The air chapter is already so complex that any additional complexity would not be helpful.

d. On page 20, section on "Water," the authors need to more clearly define what they mean by "a mix of obvious and more subtle impacts." This review recommends deleting that statement.

Done

e. On page 31, add that water moving through underground rocks and soils may pick up soluble radium as well as magnesium, calcium, and chlorides (salts of radium, calcium, and magnesium).

Done

f. On what basis is the statement made on page 34, bottom, that "private well and spring water monitoring may be necessary for several years to assure that there is no impact from the coal ash release? Other places in the text suggest that a long-term impact of the release on wells and spring water is not possible (and this reviewer agrees).

The text was changed to reflect the reviewer's comment.

g. The statement at the bottom of page 35 is not correct. A high-quality light microscope can obtain a diffraction limit of resolution of as little as 0.2 micrometers.

This has been corrected.

h. The entire section of the text on "Introduction to Airborne Coal Ash," comprising pages 35 to 42, is not very well written, and needs some work. The section describing fine particles is poorly written.

Agreed. The section has been extensively rewritten. This section has been very difficult to write.

Course particles are not 2.5 to 10 micrometers.

While many organizations do not define 10 micrometer particles as 'coarse', EPA defines PM10 as coarse particles.

Particles do not cause deaths from heart and lung disease (this needs to be clarified and put in context because everyone breathes in such particles in normal breathing air). You have a gap between 24 hour exposures and long-term exposures over many years. Particulate air pollution does not immediately cause heart disease.

This has been clarified in the text in accordance with EPA's Integrated Science Assessment for Particulate Matter, 2009.

What is meant by "there is no arithmetic average for PM10"? and why is that relevant?

Another reviewer wanted to know why I did not specify a PM10 arithmetic average. I added that statement to make it clear that PM10 standards did not have an arithmetic average because EPA had not found correlations between long-term exposure to PM10 and adverse health effects.

> The section describing WHO working group guidelines seems out of place.

The WHO paragraph is in a new place. I hope the whole section is now clearer.

> Overall, there is not a good description of the concepts of "respirable" and "non-respirable" in terms of aerodynamic diameter and lung function. Differences between physical diameters and aerodynamic diameters are not explained or clarified.

I have tried to clarify respirable and inhalable. I added a little bit about aerodynamic diameter, but, since any valid discussion would include things like Stoke's diameter, density, and aerodynamic drag, I did not add any detailed discussion. The PHA is not the place for such a discussion.

> The concept of "nuisance dust" needs explanation.

A sentence has been added for clarification.

> This reviewer does not agree with the statement on page 37 that "the metals analyses based on total suspended particulates will overstate the concentration of metals that could be respired".

I disagree with the comment. Total suspended solids measure all particulate matter, up to about 45 µm, well outside the range for inhalability. There is no reason to believe that metals would only be in or on the inhalable and respirable particles; therefore, the concentration of metals measured would overstate the concentrations that matter biologically.

> The section under "routes of exposure" on page 37 seems to be overstated (that if the coal ash should become airborne, the coal ash dust and metals constituents could impact all of these people". How and why would this be the case. Why make that case if it is not realistic? What are the adverse health effects that are being described here?

This has been reworded.

i. At the bottom of page 41, the detection limit for arsenic is not given. Rephrase the statement pertaining to the time period from February 12 to March 23, which could have as easily been negligible as "greater than the health comparison value."

Done.

j. Under the section on dust, first sentence, page 51, give numerical values to the "huge amount" of coal ash.

Done

k. Page 57, restate the bullet that "concentration of radionuclides are below the regulatory limits for concentrations or radionuclides in air and water (not "radiation").

Done

l. Bottom of page 57, if exposure to particulate matter in air could result, what kind of harm to health would result?

This has been clarified.

3. Are all relevant environmental and toxicological data (i.e., hazard identification, exposure assessment) being appropriately used?

The Health Assessment provides data from a large number of different types of environmental measurements. Health comparison values are also given for comparison, including the ATSDR minimal risk level, the environmental media evaluation guide, the cancer risk evaluation guide, and the ATSDR-derived reference dose media evaluation guide. Also presented are the Environmental Protection Agency's Reference Dose guides, maximum contaminant level guides, National Ambient Air Quality Standards reference values, and the State of Tennessee water quality criteria. All the environmental measurement and referenced toxicological standards appear to have been obtained and applied correctly and seem to meet a high standard of scientific rigor.

No response needed.

4. Does the public health assessment accurately and clearly communicate the health threat posed by the site?

The Health Assessment does accurately and clear communicate the details of the holding pond failure, the flood of water and coal ash that dispersed along its pathway and flowed into adjacent rivers, the short-term and long-term impacts on the environment, and all actions taken to mitigate and characterize the release. The Assessment carefully documents all health risks associated with contaminants in the coal ash, their environmental pathways, risks to human health, and implications of exposure. Minor corrections and suggestions for improvement are given above in this reviewer's response to question 2. This Public Health Assessment is quite thorough, and has not omitted critical details. It appears to be an honest and thorough scientific analysis of all the health threats involved and the likelihood that any of these might have risen to a level of concern for health effects in the exposed human population. The language used in the Assessment is clear, albeit rather lengthy and detailed for the average reader.

Thank you. I have tried to make the report easier to read. I hope I have hit the compromise between simplicity and putting in enough details to explain the reasoning used.

5. Are the conclusions and recommendations appropriate in view of the site's condition as described in the public health assessment?

This Health Assessment provides a comprehensive set of conclusions and recommendations. The Summary, Introduction, and Overview provide the main conclusions concerning the overall impact of this environmental event, the steps taken to mitigate the spread of coal ash contaminants. These are summarized as 16 main conclusions with a statement on Future sampling and analysis activities to ensure the health, safety, and welfare of the affected public.

Conclusion 1 could be clarified and strengthened by stating precisely how people in the path of the coal ash release could have been harmed (for example, by burial under the mud flow), to ensure that this statement is not confused with potential harm from low-level environmental exposures to the metal contaminants in the coal ash.

Done

Appertaining to Conclusion 2, this reviewer does not believe that the evidence is strong that casual touching the coal ash could cause local skin irritation. Rather, it would require a long-term dermal contact (for example, entrapment under a bandage) to result in any significant localized skin irritation. Certainly, the Assessment should not infer that skin irritation could result from casual touching of the coal ash.

This has been clarified.

Conclusion 5 could be clarified and strengthened by stating precisely how people could be harmed by using the Emory river at the site of the coal ash release (for example, by trespassing and being crushed by a front-end loader), to ensure that this statement is not confused with the potential effects of low-level exposure to coal ash metals.

Done

Conclusion 9 states that the Tennessee Department of Health cannot conclude whether breathing coal ash from December 22 through December 27, 2008, harmed people's health. However, the local weather conditions and the high moisture content of the coal ash would have precluded airborne exposure to nearby residents, as explained in the report. This conclusion could be restated in such as way as to explain that conditions were such during that period to preclude any significant airborne exposure levels that could have harmed people's health.

The conclusion has been restated.

Conclusion 12 describes the small amount of radiation from the coal ash that would not be expected to harm people's health. This reviewer suggests alternative wording, as follows: "The Tennessee Department of Health concludes that any exposure to radiation from the small amount of naturally occurring radionuclides present in coal ash, even in the more concentrated forms characteristic of coal ash, would be too small to impart a radiation dose to people that would be significantly greater than the normal, everyday background exposure radiation to which all people are exposed."

Done

6. Are there any other comments about the public health assessment that you would like to make?

The Health Assessment provides a second column of text to the right of the main text. This second column explains all acronyms and abbreviations used in the accompanying main text. While the second column is a helpful feature, this reviewer would prefer a simple correction:

simply spell out all acronyms in the main text, and eliminate the extra column of acronym explanation. That change would simplify reading and review.

I gave chapters to people who had not seen the public health assessment and asked if the column with explanations or spelling out all the acronyms would be better. They all said that spelling out the acronyms made the sentences too long and cumbersome so that they forgot the purpose of the sentence after wading through the long names. So, I think the column to the right of the text is the better way to deal with the issue, although it is not perfect.

Are there any other comments?

Overall, the Health Assessment is well written. Exceptions are stated under Question 2.

Additional Questions:

1. Are there any comments on ATSDR's peer review process?

The ATSDR peer review process is excellent. ATSDR works hard to identify well-qualified reviewers.

Peer Reviewer 2

PEER REVIEW COMMENT FORM

Tennessee Valley Authority (TVA) Kingston Fossil Plant Coal Ash Release

PUBLIC HEALTH ASSESSMENT

DECEMBER 2009

GUIDE TO REVIEWERS:

The objective of peer review conducted by the Office of Science is to ensure the highest quality of science for NCEH/ATSDR studies and results of research; therefore, your comments should be provided with this goal in mind. Unlike other peer review processes in which you may have participated, the questions to be addressed for NCEH/ATSDR are broadly based so that each reviewer may have a wide latitude in providing his/her comments. Any remarks you wish to make that have not been specifically covered by the General Questions Section may be included under question # 2 in the Additional Questions Section. Please note that your unaltered comments will be sent to the investigator for a response. You should receive a copy of the response to the peer review comments when they are available.

Tennessee Department of Health's and ATSDR's responses to comments are in italics following the comment.

GENERAL QUESTIONS:

1. Does the public health assessment adequately describe the nature and extent of contamination?

Yes for the most part. Overall the report is a thoughtful presentation of existing data collected by a variety of agencies and NGOs.

Some of the information could be presented more clearly using figures and graphical methods to present the data and give readers a clearer picture of the contamination over time.

In particular it would help if the scales on the aerial photos and maps were consistent across figures: for example while Figures 1 and 2 show more or less the same area, it is difficult to put see how these relate to Figure 3, for example, which does a poor job of showing where the spill is in relation to these previous figures. The scale changes again slightly when one gets to Figures 4 through 11 also have the same issue: pick one scale that fits the information and then use it consistently. For water sampling also show the direction that the Rivers flow with arrows: it is not at all clear to the naïve reader looking at these. This is especially important if and when rivers might flow backwards (as mentioned in the report) and if the ash flow is not all in the direction of the river. Labeling of the individual rivers is also needed: I've never managed to figure out which was which. This hinders the understanding of the extent of the contamination.

For the first two figures, we used aerial photographs supplied by TVA. There is really nothing I can do about the scales being different, although I know it would be better if they were identical. For Figure 3, I have tried to emphasize the spill area so it can be easily seen. The purpose of Figure 3 is to show how all the rivers interrelate to form Watts Bar Reservoir. I found the water flow to be very confusing, too. The other figures have different scales because the sampling locations for the different types of samples and for different agencies cover widely different geographic areas, even though they all center on the spill area. I have added river names and flow directions to the river maps. Many of the maps came from other agencies so there is little I can do about the scales.

The report does not make effective use of graphical methods to display, in particular, the water quality data over time. There are small and hard to read graphs on page 25, for example, that try to do this by displaying trends in concentration of pollutants relative to health-based standards. Most of the data in the multiple tables in the appendices should be given this treatment as well, as most of them will likely show the bolus effect during the release and subsequent fall in concentrations over time as pollutants are diluted. This would also allow the report authors to summarize the quantitative uncertainties through use of error bars and/or coefficients of variation on various analytical methods, to the extent that this information is available.

I have added text to reinforce the fact that concentrations of metals other than arsenic and lead near the spill site early on never were elevated or were elevated for a brief time. I have enlarged the 3 figures to make them more friendly. I have added background concentrations to these figures, as well as the health comparison values. I have added two figures for selenium in the Emory and Clinch Rivers and one for iron in the Emory River as examples of concentrations not changing much through time. Historically, no one has sampled selenium in the water column anywhere in Watts Bar Reservoir or outside its area of influence in the Emory River. Therefore, I was not able to show normal background for selenium.

2. Does the public health assessment adequately describe the existence of potential pathways of human exposure?

Yes, though it seems more focused on cold weather pathways and does not mention extensively pathways that can occur in warmer weather as the site is/has been cleaned up over time. I realize that the report is focused on the immediate aftermath of the spill and likely exposures around the time of event. It should mention if these events are likely to be addressed in future reports, and the long term controls monitoring data that might be used to address these issues. Clearly no one is going to be fishing around the spill any time soon, but as the cleanup proceeds what might reasonably be expected to happy seems germane to the report.

The report is looking at short-term and long-term potential health effects. Of course, for surface water more people will have exposure in the summer when they can swim and ski. Fishing goes on all year. The introductory comments about the spill were talking about winter because that is when the spill happened. However, the discussion for surface water was geared toward protecting people for recreational use of Watts Bar Reservoir, which is more prevalent in *summer. All the conclusions were based on year-round exposure potential. Air concentrations are independent of the temperature, but could be related to dry conditions. The discussion of air is appropriate for any season – TVA needs to keep ash particulate out of the air. This will be the final Public Health Assessment. Other reports will be written in the event something goes badly wrong during the final stages of cleanup. Most of the ash is out of the Emory River itself. It will take several years for all the ash to be removed from the inlets. We will keep a watch on all sampling data until everything is back to way it was before the spill.*

3. Are all relevant environmental and toxicological data (i.e., hazard identification, exposure assessment) being appropriately used?

Yes, and for the most part these are carefully documented. It would be useful to mention in the summary on page 7 how much ash ingestion is being assumed and put that 200 mg number in context for those readers who are not familiar with SI units. But the HID and tox values are from peer reviewed sources and the standard equations used are applied appropriately.

Done

4. Does the public health assessment accurately and clearly communicate the health threat posed by the site?

Yes. But I also think it would be useful to do some of the data presentation I mentioned under answer 1 above, which would allow comparison to background levels over time (as opposed to health/based standards). Since there are few acute health-based standards this would help readers picture the relatively rapid short term changes in environmental concentrations relative to typical concentrations in water and air over time. This exercise is separate from figures that compare concentrations to health based standards.

I have added background concentrations to three figures about TDEC's monitoring of arsenic and lead in surface water. I have added two representative figures for selenium and iron.

5. Are the conclusions and recommendations appropriate in view of the site's condition as described in the public health assessment?

My main quibble is that the conclusions and recommendations should follow one another in series: i.e., Conclusion 1, recommendation 1, etc. Both conclusions are recommendations are clear for the most part, though the section on "The Future" is just a list of all the involved agencies and does not provide much detail on the sort of long term environmental quality monitoring and assessments that will be done. This reviewer concurs that biomonitoring of residents is unlikely to be useful and that resources and energy should be on dust suppression, environmental quality monitoring, and exploration of potential warm weather pathways of exposure that might result form fugitive dust release or the continued presence of ash in the river.

I have reformatted the conclusions and recommendations to be in series. ATSDR usually requests that the two sections be separate, but in this case having two sections only confuses things.

6. Are there any other comments about the public health assessment that you would like to make?

No.

7. Are there any other comments?

No.

Additional Questions:

1. Are there any comments on ATSDR's peer review process?

It would be easier for reviewers if you provided both a hard copy and a PDF or some other searchable document type.

I am sorry that you did not know about our website: http://health.state.tn.us/coalashspill.htm.

Peer Reviewer 3

Peer Review Comment Form

Tennessee Valley Authority (TVA) Kingston Fossil Plant Coal Ash Release

Public Health Assessment
December 2009

Guide to Reviewers:

The objective of peer review conducted by the Office of Science is to ensure the highest quality of science for NCEH/ATSDR studies and results of research; therefore, your comments should be provided with this goal in mind. Unlike other peer review processes in which you may have participated, the questions to be addressed for NCEH/ATSDR are broadly based so that each reviewer may have a wide latitude in providing his/her comments. Any remarks you wish to make that have not been specifically covered by the General Questions Section may be included under question # 2 in the Additional Questions Section. Please note that your unaltered comments will be sent to the investigator for a response. You should receive a copy of the response to the peer review comments when they are available.

Tennessee Department of Health's and ATSD's responses to comments are in italics following the comment.

General Questions:

1. **Does the public health assessment adequately describe the nature and extent of contamination?**
The sampling and analytical results obtained in and around the site are adequate for the development of remediation and restoration protocols. The problem for the public is that the results are primarily located in the tables. The tables should be recast into figures to establish a spatial record for the community that is easier to understand and then linked to standards (e.g. areas above a standard, & which appear to be few. The results are summarized within text; these are useful in evaluating the environmental risks.

   The routes of potential exposure are identified, but there should be a separate discussion in the conclusion section on the impacts of each. This will provide an overall understanding of the known and potential impact.

   There should be a firm statement about what can and can not be done in this evaluation and in the future and analyses because of the lack of data during the initial phase of response after the spill.

The purpose for TDH/ATSDR in writing the Public Health Assessment (PHA) is to draw conclusions about past, present, and future public health implications of the spill, not for remediation or environmental restoration protocols. I agree that the tables are cumbersome. However, the actual data needs to be in the PHA so that people can see what the data are and make comparisons across agencies if they wish to. For the surface water section, I have amended the three little figures for arsenic and lead by making them bigger and adding background information to the figures. I have also added two figures for iron and selenium as representative of concentrations of metals not being increased over time or only increased for a short period of time.

The conclusion section is organized by route of exposure and has a brief discussion of associated with each conclusion. The conclusion section and the conclusions in the summary need to be concise, with detailed discussion of how we came to the conclusion in the Discussion section.

2. Does the public health assessment adequately describe the existence of potential pathways of human exposure?

The document provides some information on potential pathways. However, the discussion is located throughout the document. Thus, for clarity there should be a separate section that integrates the results such as those found in tables on pages 13, 48 and 49. They are very useful for evaluation

The discussion of pathways of exposure is by section: ingestion and dermal contact with ash, exposure to surface water, groundwater, municipal water, air, radiation. There is a summary of public health implications that summarizes conclusions based on route of exposure on pages 56 and 57.

3. Are all relevant environmental and toxicological data (i.e., hazard identification, exposure assessment) being appropriately used?

The data bases are reasonable for the compounds considered, the standards used are also reasonable. One major issue with the outcome data is the graph of the distribution of anxiety? The results are based upon a subjective questionnaire which has not been thoroughly tested for bias, and there is no control population. I am not sure about the value of the outcome data on vomiting, but since there is a before and after graphic it does appear reasonable as a screening tool.

The survey used soon after the release was an emergency response effort with the purposes of finding out if anyone had unusual symptoms and to make contact with people. The emergency use of such a survey is not meant to be objective and scientifically rigorous. Just making contact with the people affected was just as important as the questions asked. We have had conflicting comments from reviewers about the vomiting data, so I will live it as is.

4. Does the public health assessment accurately and clearly communicate the health threat posed by the site?

No. The document especially the conclusion section is poorly written. Further, some of the comments are pure speculation. For example conclusion #1 does not focus on the facts. The second half of this conclusion is pure speculation. Even the beginning sentence of conclusion is a partial speculative comment.

Please base conclusions on the facts; it is the only way to help the public to understand the true nature of the situation that actually was evolved at the time of the event.

The overall conclusion is that the exposures were low. Further, the proper remediation efforts should be employed and the population reevaluated for exposure over a reasonable time to in sure background levels do not spike to levels of concern.

The conclusion section is written in accordance with the latest ATSDR guidance. Conclusions 9, 10c, and 11 are not speculative in a public health sense. In most scientific fields, data is rigorously obtained and conclusions from individual research efforts are clearly drawn from the experiments. In environmental public health, toxicological experiments and epidemiologic studies are probably the most scientifically rigorous areas. Each toxicology experiment and each epidemiologic study have exact data and fairly exact conclusions. However, when we put all the experiments and epidemiological studies together to figure out the public health impact of exposure, we lose the precision and accuracy. For the sake of protecting public health, we are forced to make decisions and draw conclusions that are not firm and can be seen as speculative by practitioners of more exact sciences. In other words, we have to make decisions even when data is less than desirable. Risk assessment is not an exact science even though it uses the scientific method.

We recognize that Conclusion 1 is not based on a rigorous scientific review. In dealing with communities affected by events such as this, we feel it is important to acknowledge and emphasize that the community has experienced something big, scary, and unexpected, and that could have been life-threatening.

The practice of public health is about more than data and facts. Any report written for the public has to acknowledge that people are impacted – bodies, minds, and emotions. The reports must have some soul, otherwise they are purely academic exercises.

TDH has and continues to follow the results of all environmental sampling and analysis done at the spill site. All data continue to support our conclusions.

5. **Are the conclusions and recommendations appropriate in view of the site's condition as described in the public health assessment?**
Partially. Conclusions that involve speculation must be eliminated. Those that fall into that category are: conclusion #1, conclusion #9, conclusion #10c, and conclusion #11. However, conclusions 9, 10c and 11 can be rephrased into acceptable statements to abort the situation. For instance conclusion #9, can be rephrased to indicate that although no conclusion can be made at this time, ER records could be a source of information to achieve some level of understanding about any acute effects that may have resulted from the spill.

Finally, conclusion #14 should be separated into two separate conclusions.

6. **Are there any other comments about the public health assessment that you would like to make?**
The authors must base there conclusions on the facts of the actual spill. This is a significant environmental event, but there have been many more serious disasters, natural and human environmental disasters, e.g., Valdez and or Mt. St. Helens.

7. **Are there any other comments?**
The revisions need a thorough final review of the facts, and the report needs justifiable conclusions.

Comments 5., 6., and 7. It would not be good environmental public health practice to eliminate conclusions 1, 9, 10c, and 11. The conclusions are based on facts and are justifiable. Conclusion 14 is about the community survey, so I think leaving the conclusion as is would be better.

Appendix F: Comments from the public and responses

Public Commenter 1

Public Comments

TO: Agency for Toxic Substances and Disease Registry
ATTN: Records Center
1600 Clifton Road, NE, MS F-09
Atlanta, GA 30333

FROM: (Citizen)

RE: Public Health Assessment, Public Comment Release
For TVA Kingston Fossil Plant Coal Ash Release
Harriman, Roane County, TN
EPA Facility ID: TN8640006682

Date: January 15, 2010

Even with limitations on current knowledge, we are fortunate to have reached a point that we can rapidly assess the quality of air, soil, and water to intervene quickly to protect people. This report is a remarkable piece of work given the magnitude of the spill; the multiplicity of agencies, organization and residents involved; and the number of data sets analyzed. The reading level is satisfactory though the complexity of the problem situation makes reading a challenge. I don't know how you can simplify it without abdicating your obligation to science and the public. The following comments are meant to raise questions and suggestion improvements to strengthen the report.

At the beginning of the report (e.g., in the introduction on p.xvi) include the timeframe covered by the report (e.g. from the time of the spill through so many months). In this way, it will be clear to the reader that this report addresses the acute and intermediate phase of potential contaminant exposure; and the understanding the impact of the spill on wildlife, workers, and people remaining in the area will require long term study. This may help alleviate disappointment among those who are looking for a more holistic view of the situation. If it is possible to identify who will be responsible for producing a report that synthesizes all relevant analyses, please do so.

Tennessee Department's of Health and ATSDR's responses to comments are in italics.

<u>Page</u> <u>Comment</u>

xxxi Conclusion #13. Please provide the URL links for the two reports on selenium (EPA Science Review Panel and the US Corps of Engineers). [This also applies to page 60, paragraph 3 and page 77, paragraph 1]

Done

6 Paragraph 3, line 3. Replace the words <u>controlled by</u> with the words <u>depends on.</u>

Done

8 Paragraph 2, line 3. Change the words <u>can get</u> to <u>can be reset.</u> [Also, page 193, paragraph 3, line 3].

Done

16-17 Other health comparison values. I do not disagree with the exclusion of the elements iron, calcium, magnesium, potassium and sodium from the review. (I have no opinion on thallium.) However, the reasoning needs to be updated to reflect current nutritional guidelines from the

National Academy of Sciences (NAS), Institute of Medicine. Cite the following National Academy Press references for the reader:

Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc (2000)

Dietary Reference Intakes of Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride (1997)

Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate (2005)

IRON. Although ATSDR and EPA have not published toxicity for iron, NAS has addressed questions pertaining to its role in nutrition and human health that includes estimated tolerable upper intake levels (UL) of 40 mg/day for children and 45 mg/day for adults. Also, please make clear that the EPA health comparison value is based on the quantity of iron in soil. Would the read "55,000 mg/kg of soil?"

CALIUM. Pica (eating dirt) is characteristic of the young child. Contrasting the "estimated intake from soil accidently consumed" with the recommended dietary allowance for an adolescent is not a valid comparison. Also, the current dietary reference intake for calcium is 500 mg/day for the child 1-3 years, 800 mg/day for child 4-8, and 1300 mg/day for adolescent. The tolerable upper intake (UL) for children from 1-18 yrs. And adults (all ages) is 2500 mg/day.

MAGNESIUM. Likewise, there are new values for magnesium intake. NAS does discuss the magnesium (65 mg of supplementary magnesium a day for children 1 through 3 years of age).

POTASSIUM and SODIUM. The fact that potassium and sodium are essential nutrients that ubiquitous in foods and salts is not an acceptable reason to exclude them from this review. Find another reason. Are the levels of potassium and sodium in ash, surface water, and groundwater similar to background levels in soil and the Tennessee River? This might be an acceptable reason.

Done

18 Paragraph 2, line 5. please cite a reference/link for the EPA estimate for accidental ingestion of dust/dirt.

Done

24 Paragraph 3. What does this mean? "Concentrations of dissolved antimony and beryllium were below the detection limits at all sampling points on each date sampled, but it is impossible to know if they were above the criteria."

This has been clarified in the text. The detection limit was higher than the water quality criteria. So we cannot know if the true concentrations were insignificant or if they were above the water quality criteria.

26 Paragraph 3. In reference to the sentence "…historical contamination with PCBs and mercury (not related to TVA activities)." Do we really know that TVA activities did not contribute to observed PCB and mercury contamination? Cite a source.

Done

Please cite relevant ATSDR reports that speak to legacy contamination in this area (e.g., reports on White Oak Creek radionuclides and PCBs). This has implications for future dredging activities that should be clearly acknowledge in this report. [These comments also apply to page xxv, paragraphs 3 and 4; page 74, conclusion number 8, paragraph 3; and page 80, number 8, paragraph 2].

I cited the TDH dose reconstruction reports that ATSDR used in their assessments.

30-31.1 Do you have data that demonstrate that “iron levels were at levels normally present in the Tennessee River?” Refer reader to appropriate tables (e.g. Tables 33-37).

Those sources are cited in the text, with the ranges found.

51 In the last section on dust: This would be a good place to mention the above average rainfall that occurred this year (approximately 12 inches) as a boon to dust suppression. Also, provide a link for the composition and safety of vinyl acrylic emulsion.

Done

62 Paragraph 1, lines 2-3 and paragraph 5, lines 3-4 are incomplete sentences, and the meaning is not clear.

This has been corrected

63 Syndromic surveillance. This analysis is misleading. It suggest that there was no change in health status. This study does not prove it. It only demonstrates that this method does not show it. Speculation about concurrent infectious diseases provides interesting context. However, the large number of people with infectious diseases would overwhelm the relatively small number of people showing up from Swan Pond especially those who were forced to relocate and sought health care in disparate locations.

This section has been removed since it added no useful information.

65 Table I: Please add a column with numbers of people and overall N. This will help overcome the omission of a demographic analysis of Swan Pond community in this report.

Done

74 Number 8, paragraph 3. Please include a reference/link to fish advisories with cooking tips to lower contaminant levels. It is imperative to include specific information especially for women who are pregnant or breastfeeding babies. Perhaps this information should be included in an appendix.

Done

76 Number 13. Although I do not belong to any NGOs, I find it quite comforting to see independent confirmation of findings. Omit the words “limited usefulness.” Your appraisal of NGO methods, results, and reports is sensitively worded and may help build trust and goodwill among people in the NGOs and the community.

This has been reworded.

77 Number 14. The Community Health Survey was done soon after the spill (thank you!) It would be appropriate to note this was monitored over time. I venture to say that as reality set in more people experienced stress and anxiety both in Swan Pond and the community at large. It was not pretty! We have much to learn about the impact of environmental catastrophes on mental health and well-being.

This was a one-time event done as part of the emergency response. I have clarified the wording in the PHA. TVA had a contract with Ridgeview Community Mental Health Center to assist people with these kinds of issues.

79-82 The section on recommendations is really rough. Recommendations do not have to correspond one on one with conclusions.
I have incorporated the conclusions and recommendations into one section. I hope this makes it all read better.

79 Combine paragraph 2 of recommendations #2 with recommendations #3 and #4.
I have incorporated the conclusions and recommendations into one section. I hope this makes it all read better.

81 Recommendation #12. Mention that monitoring of radionuclides will be stepped up when dredging occurs. A clear statement about the interagency agreement that governs this activity would be good.
I added information about the interagency agreement.

Recommendation #15. Combine paragraph 1 with recommendation #11. Paragraph 2 duplicates recommendation #14.

Recommendation #16 duplicates #14 and #15, paragraph 2.
I have incorporated the conclusions and recommendations into one section. I hope this makes it all read better.

82 Will TDH also work with TWRA? See htt://tn.gov/twra/Kingston.html. This website indicates that "assessment of the impact of this release on wildlife resources and habitat will require repeated sampling and evaluation over the next three to five years. TWRA will coordinate with the U.S. Fish and Wildlife Service (USFWS) and other resource agencies to assess the long-term impact of contaminants on other wildlife resources in the area including mammals, bird life, and aquatic species."
TWRA coordinates their fish sampling with TDEC. TDH will work with both agencies as needed.

Are there other cooperative agreements that should be acknowledge in this report? Will NIOSH report on workers' health? What is the ongoing role for ATSDR? We need ATSDR!
We will continue to be a cooperative agreement state with ATSDR. As such, we will continue to do environmental health investigations and write the reports. ATSDR will review all our work to make sure it is scientifically sound. ATSDR also is a resource for TDH. Their expertise in environmental toxicology is absolutely vital to us.

I do not believe that NIOSH has been called in so they are unlikely to make a report. EPA has mandated that the site and site-workers meet all OSHA regulations and standards. All workers have had the 40-hour HAZWOPER Training. Air monitoring on-site has demonstrated that OSHA requirements for silica are being met. The Site Worker Safety and Health Plan was revised on February 10, 2010. This revision as well as subsequent revisions of the SWSHP incorporates the specific requirements of 29 Code of Federal Regulations (CFR) 1910.120; Hazardous Waste Operations and Emergency Response (HAZWOPER). Plans written prior to this revision were not required to address the HAZWOPER requirements; however they were adequately protective of employee safety and health. The major changes in this and future revisions primarily address terminology, work zones, worker training and medical monitoring requirements as required by HAZWOPER.

89-103 Figures 1-16: Nice photographs! Light dots show up better than dark dots.

105-110 In Tables 1 through 6, health comparison values for calcium and magnesium are given as EHN (essential human nutrient). If you are not able to derive an appropriate comparison value from National Academy of Sciences publication (1997), it would be better to use NA (not available). Also, a sampling date needs to be added to the header of these tables.
I used NA in the tables with a footnote to see the text.

183 Please check the values for sodium in Table 34. Is the order of magnitude off? Do you need to move the decimal point?
You are correct. Thank you for finding the error.

COMMENTS on the 4 page Summary:

2 The write up of "What do the environmental data indicate?" Does not say that the spill occurred in the middle of the night in the dead of winter. That would make the summer scenario more meaningful.

3-4 The conclusions section needs synthesis. A narrative would be better—or at least fewer enumerated conclusions. Abbreviating the conclusion statements diminished the author's sensitivity to the reader (e.g., number 13). This list has no soul.

Conclusion #16. Why even mention this type of routine screening when ORAU-Vanderbilt screening activities have been made available?
The summary has been redone. I hope it is better and has some soul.

Copy to EEP-TDH
1/15/10

Public Commenter 2

Comments on the **Public Health Assessment** for Tennessee Valley Authority (TVA) Kingston Fossil Plant Coal Ash Release.

1. The title to the document needs to be more descriptive than Public Health Assessment- the exact title of the document is unclear.

Response: The title is set by ATSDR. All their public health assessments are named in this way.

2. The sections and subsections of the document need to be numbered for quick reference.

Response: Done

3. There is a continued repetition of the phrase "no continued contact with ash" within the document- how true is this assumption?

Response: TDH based the validity of the phrase on personal observation, reports from TDH's regional environmental epidemiologist, EPA, and TDEC. All agencies are reinvestigating this in light of the approaching summer season and the opening of the Emory River to make sure that people using the rivers for recreation will not have any harmful exposures.

4. Clearly explain the relationship between the Environmental Epidemiology Program (Tennessee Department of Health) and the ATSDR. How does the funding flow for the work of this report?

Response: ATSDR currently funds 29 states and 1 Indian Community through competitive cooperative agreement applications. TDH is in its 5th year of its second round of funding for the cooperative agreement for site-specific activities. These activities include public health consultations, public health assessments, and education/community involvement. Currently ATSDR provides funding for two health assessors in TDH. Other staff in EEP are funded through CDC Public Health Emergency Preparedness funds (2 positions), CDC's Environmental Health Specialist Network (1 position), National Toxic Substances Incidents Program (2 positions), and the State (1 position). The money flows from ATSDR to TDH just like other grant-funded programs. The money is drawn down as it is used in accordance with the yearly budget. ATSDR has not provided Tennessee with any extra funds to work on the TVA ash spill. As a cooperative agreement state, TDH and EEP do environmental investigations and write the reports, which are reviewed and certified by ATSDR, before they are released to the public.

5. Provide a chart (in addition to text) providing the following information: sampling agency, media, sampling dates (span of dates discussed in the report), number of samples, standards used (TVA vs. EPA vs. TDEC), etc.

Response: Done. It is at the end of the introduction in the Discussion.

6. What is the latest data used in this particular report? It should be noted in a prominent place for each agency.

Response: The latest data is detailed in the summary table discussed in comment 5 and specified in the text and on the data tables. The dates are generally from the time of the spill through spring of 2009. An addendum at the end of the main report will summarize data findings through spring 2010.

7. There is an excessive use of acronyms (see page 8 paragraph 4). Side bars are extremely useful and well done.

Response: There are a lot of acronyms. When we tried writing out everything in full, the sentences were so long and complex that they were not intelligible. We are glad you found the sidebars helpful.

8. Why were PM 10 monitors used instead of PM 2.5 monitors (pages 41 and 44) from January 1st forward?

Response: EPA began testing with portable PM2.5 monitors. TVA was using portable PM10 monitors to take instantaneous readings throughout the community, in addition to its FRM and TEOM monitors. EPA switched to the portable PM10 monitors so it could validate comparable TVA data.

9. In the summary introduction and conclusions (pages xvi to xxxvi) the **Basis for decision** for each conclusion does not always provide evidence, proof, or documentation as a basis; often the conclusion is just re-stated.

Response: I have tried to clarify the basis for decision for several conclusions.

10. The **Next Steps** sections often do not list any steps and do not indicate how the agencies will proceed. Sometimes this section lists what has been done which are not "next steps." This is frustrating to the public because this is a section the public is particularly interested in.

Response: I apologize. ATSDR has set the format for the overview section of public health assessments after a good deal of research. The layout and formatting are done from their guidance. For some conclusions, such as Conclusion 1, in which everything to do with that conclusion has already been done, there are no Next Steps. In those cases, I have changed Next Steps to What Was Done. I hope that makes the document less frustrating.

11. Much of the information in the document is too general and self evident to be very useful to the community.

Response: TDH has tried very hard to make the document specific to the situation near KIF. We did not want the document to be generic. The data discussions were quite detailed. It is true that some conclusions are self-evident after looking at the data. For instance, air data from all the agencies indicated that particulate matter was not elevated in the ambient air surrounding the ash spill. The obvious conclusion is that public health was not harmed from exposure to particulate matter. The conclusion is obvious, but the analysis that led to the conclusion was not obvious, simple, or general.

12. Clearly define the purpose and limitations of the document toward the beginning of the document; e.g., immediate harm assessed vs. long term hazard; human health only; for purposes of screening only vs. a detailed health study. What the public needs and wants from a public health study is clearly different from what is provided in this public health screening/assessment.

Response: I have attempted to clarify the purposes by addition of a paragraph in the Summary and the Background sections. The purposes of an ATSDR Public Health Assessment were explained at a public meeting held for that intention on June 11, 2009. The purpose of Public Health Assessment is different from the purpose of a health study. This difference is not a limitation, just a difference. At the meeting, differences in a Public Health Assessment and the clinical examinations of ORAU and Vanderbilt were explained.

13. Are any additional, more detailed ATSDR studies expected?

Response: At this time, no ATSDR studies are expected. If the situation changes, of course, ATSDR and TDH will respond in an appropriate way.

14. Page 12, Calcium is listed as a metal with concentrations higher in ash than soil; however calcium is not listed in the preceding paragraph listing the metals found in coal ash (inconsistent presentation of data).

Response: The list of metals in the first paragraph under Discussion, Coal Ash, Introduction, is a list of what toxicologists call heavy metals. These are the metals that are toxic at certain concentrations. When TVA analyzed the coal ash, they also did analysis for some metals that are not considered toxic and are not termed, heavy metals. Calcium was one these metals.

15. Page 15, the 4^{th} sentence on in the first paragraph repeats verbatim a paragraph on page 9

Response: This is true. We thought it was worded well the first time, so we repeated it when the subject of TCLP was brought up again.

16. In drinking water, surface water and groundwater sections mention the times required for migration can vary greatly and may require years. Sampling in the short term provides very little information for long term impacts.

Response: In surface water, it takes some time for metals to leach out of the coal ash. The time it takes is dependent upon the characteristics of the particular coal ash. Sampling now assures us that metals in Watts Bar Reservoir from the coal ash spill are not at elevated levels. It is important to remember that mercury in sediments and fish are elevated from past activities at the Oak Ridge Reservation. The ash is being removed from the river at a very fast rate. It will be out of the Emory River by this summer. It may take two-to-four years to remove all the ash from the three impacted sloughs. Monitoring on a regular, frequent basis will continue in Watts Bar Reservoir until all the ash is removed and the area restored as specified in TDEC's and EPA's Administrative Order and Agreement on Consent of May 6, 2009.

The wells and springs within 4 miles of the ash spill have not been impacted by leaching of metals from coal ash, even though the dredge cells have been in existence for years. TDEC will take regular samples from groundwater to make sure that they are not being affected by coal ash.

17. Page 44, 2nd paragraph, explain why the air monitor was operated between 3 and 9 hours and not the same amount of time each day.

Response: EPA wanted to monitor the air in as many places as they could with a limited number of monitors.

18. Page 14, last 3 paragraphs, how were the averages calculated for arsenic (TVA, EPA, and TDEC)?

Response: In answering this question, I looked at the raw data in Excel spreadsheets. In looking at it with fresh eyes, I noticed that various kinds of ash sampling were included in the dataset. I calculated new statistics based on ash samples taken in residential areas. The numbers changed, but the impact of the data did not change. The newly calculated numbers are now represented in the paragraph and in Table 2 at the end of the document. The averages were calculated the usual way, adding the values and dividing by the number of values. This was done in Excel using the formula for average over a range of cell. Concentrations of all arsenic samples were above the method detection limit, so the issue of using one-half the limit of detection did not arise.

19. There is some question about the adequacy of sampling for the Community Health survey.

– *Response: TDH and NCEH staff members tried to reach each home within an approximate 1.5 mile radius of the spill. The survey was not a scientific study, but an emergency response. The table within the discussion of the survey now includes numbers of people in addition to the percentages.*

Public Commenter 3

Comments on the Public Health Assessment. Tennessee Valley Authority (TVA) Kingston Fossil Plant Coal

1. Page xx, Conclusion 3, Basis for Decision, second sentence " The ash has been fenced, clearly marking the areas with coal ash." This statement does not address the coal ash that contaminated the shore lines and was washed on land during the initial tsunami, and the coal ash that is commingled with the native soil and river sediment.

Response: The data indicate that there was very little comingling of ash and native soil except right along the shoreline. The initial wave of ash filled part of the Emory River, three sloughs and the lower-lying land with the road, railroad tract, Church Slough, and the peninsula between Berkshire and Swan pond Sloughs. I observed orange fencing in all these areas in January 2009.

2. Page xxii, second to last sentence, and last sentence needs to be updated to reflect the closing of the Emory River from mile marker 0 to 6.

Response: This has been done.

3. Page xxiii, Conclusion 6 states "water from the Kingston and Rockwood water treatment plants will not harm people's health because the raw and finished water have continuously met drinking water standards." However, in the Next Steps section, the recommendation is for TDEC to continue to sample and analyze raw and finished water. Why does this need to be done if the water has been good so far, what is the basis for continued sampling? What is the possibility of the samples not being good at some point in the future?

Response: The drinking water has been free of coal ash contaminants. It is highly unlikely that this will change. The recommendation for continued sampling is probably overly cautious, but it is prudent to make sure that nothing changes and so that we can know for sure that the water remains safe.

4. Page xxiv, Conclusion 7, "using wells or spring water within four miles of the coal ash release will not harm people's health." The Next Step section recommends TDEC continue to take samples of ground water from private wells and springs for analysis periodically.." How long will samples continue to be taken? What private wells are on a long term sampling plan? Page 34 states "It sometimes takes days, months or years for an outside influence to show up in the groundwater of an area." TDEC is only sampling wells two times a year for several years. This does not seem adequate. Residents within the spill area should be included on the sampling plan if requested by the resident.

Response: The wells and springs within 4 miles of the ash spill have not been impacted by leaching of metals from coal ash, even though the dredge cells have been in existence for years. TDEC will take regular samples from groundwater to make sure that they are not being affected by coal ash. TDEC would be amenable to requests from residents. TDEC will determine how many years to continue to take samples in collaboration with other agencies to make sure that the public is protected.

5. Page xxvi, Conclusion 9, Basis for Decision, and Next Steps indicates "No agencies took air samples in this period" and "since no air measurements were obtained during the time period between December 22 and December 27, 2008. However, the statement on page 3, 2nd paragraph, contradicts this statement by stating "On December 22, 2008, government agencies …. Began collecting samples of soil, ash, and drinking water. TVA began daily real time air sampling at many locations."

Response: I clarified both the conclusion and the text on page 3. The list of the types of environmental sampling was deleted from page 3, paragraph 2. Ash sampling began immediately, but there was a delay for TVA in beginning air sampling until December 28. EPA began some air monitoring on-site, but not off-site, on December 27, 2008.

6. Page xxvii, Conclusion 10b, "The TDEH concludes that no harm to people's health is expected from occasionally breathing coal ash if it should become airborne for short periods of time." What is the definition of "short period of time"?

Response: I have not found a precise definition for 'short-term' in any references, including <u>Integrated Science Assessment for Particulate Matter</u> authored by the National Center for Environmental Assessment – RTP, Division of Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, NC. I have inferred that, for particulate matter, short-term refers to exposures of an hour or two to one day to peak concentrations. Extremely high levels of air pollution, such as the London fog of 1952 or the episode in Donora, Pennsylvania, in the mid-1950s, can have very quick effects. Those most at risk from short-term exposures are the elderly and those persons with pre-existing cardiovascular or respiratory illness. It is thought that long-term exposure to less than peak concentrations have the most potential for harm.

These are the definitions associated with the EPA NAAQS: The annual average standard for PM2.5 is the 3-year average of the weighted annual mean PM2.5 concentrations from single or multiple community-oriented monitors that must not exceed 15.0 $\mu g/m^3$. The 24-hour average for PM2.5 is the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area that must not exceed 35$\mu g/m^3$.

There will be times in most areas in which the reading for one day is over the 24-hour average of 35 $\mu g/m^3$, but the area meets the standard in terms of the different kinds of averages. EPA's National Ambient Air Quality Standards and the World Health Organization's guideline were set to be protective of public health.

7. Page 16, Conclusion 16, Basis for Decision, "No harm is expected from breathing the air as long as adequate dust suppression measures are in place." What happens when "adequate" dust suppression is not in place?

Response: TDEC has in place a system to notify people if concentrations of particulate matter are elevated so that people can stay indoors or leave the area temporarily. The health impacts would be the same as when particulate matter is elevated for any other reason. TVA, EPA, and TDEC are taking every known precaution to keep the ash from getting air-borne.

8. Page 60, 4th paragraph, "Because no one is drinking this water or using this water for recreation, there are no public health concerns at this time." What specific area does this statement refer to? Parts of the Emory River outside of the closed area (1.5 to 3.0 mile marker) as well as the Clinch and Tennessee Rivers were used for recreation last summer. What are the concerns since the water was used for recreation, and will be used for recreation this summer too?

Response: That paragraph refers to the site of the spill. Last summer, Watts Bar Reservoir was safe for recreation except in the closed area. This summer the river may be open because the ash will have been removed from the Emory River and the heavy equipment will be gone. EPA, TDEC, and TDH are currently revising last year's advisory to reflect the new conditions.

9. Page 64, Community Health Survey, "324 residences within a 1.5 mile radius of the spill" were visited. How many homes are located in a 1.5 mile radius of the spill? I know of many families who were not contacted who live in this area.

Response: I regret that not all families were able to be contacted. Efforts were made to administer the survey to everyone within the 1.5 mile radius of the spill. This survey was a part of the emergency response and was not intended to be a scientific study. We identified 324 homes within 1.5 miles and visited each one. We were able to interview 368 people in 170 of those homes.

March 8, 2010

Public Commenter 4

From:

To: EEP Health

Date: 1/4/2010 9:29 AM

Subject: Re: Coal Ash question

1/4/2010 5:58 PM >>>

I have a question regarding the health effects related to coal ash. Has there been a documented occurrence where exposure to coal ash has had negative health effects? If so, could you give me details? I lived near the TVA spill and have participated in the ORAU study. I assume there has been a review of research and related health studies on this subject. Looking over the PHA draft I have not seen a reference to this type of review.

Thanks,

Response (1/22/2010): I have spoken with several experts in epidemiology and medical toxicology. We can find no documented negative health effects related to coal ash in any situation like that in Harriman. Occupational exposure to coal dust while mining it, of course, has adverse effects. If the coal ash should become air-borne so that ambient air standards are violated, we would expect negative health effects from the particulate matter, such as upper airway irritation and aggravation of pre-existing conditions such as asthma, emphysema, and other respiratory conditions.

Public Commenter 5

NATURAL RESOURCES DEFENSE COUNCIL · EARTHJUSTICE · ENVIRONMENTAL INTEGRITY PROJECT · SIERRA CLUB

March 9, 2010

Environmental Epidemiology Program
Tennessee Department of Health
1st Floor Cordell Hull Building
425 5th Avenue North
Nashville TN 37243

Re: Comments on the Public Health Assessment of the Kingston Fossil Plant coal ash release

To Whom It May Concern,

The Natural Resources Defense Council, Earthjustice, The Environmental Integrity Project, and the Sierra Club submit these comments on the Tennessee Department of Health *Public Health Assessment of the Tennessee Valley Authority Kingston Fossil Plant Coal Ash Release*.

I. Introduction

Coal combustion ash contains heavy metals such as arsenic, cadmium, chromium, lead, mercury and other toxic elements such as selenium that may leach out of the ash when it comes into contact with water.[1] The toxic health effects of these substances are well known. Arsenic increases the risk of cancer of the bladder, liver, lungs and skin, while cadmium may cause kidney damage. Inhalation of hexavalent chromium is associated with an increased risk of cancer, and its ingestion may increase the risk of stomach tumors. Elevated exposure to lead, mercury or selenium may cause neurological problems.[2]

Fly ash, the lighter ash residue that enters a power plant's smokestacks, typically leaches metals at higher rates than the bottom ash that clings to the walls and bottom of the furnace. The coal ash impoundment that ruptured on December 22, 2008 at the Tennessee Valley Authority (TVA) Kingston Fossil Plant in Harriman, Tennessee, contained almost exclusively wet fly ash. Because the coal ash was stored in a wet impoundment, and because it subsequently spilled into the Clinch and Emory Rivers, there is concern over potential human exposures through drinking

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[1] U.S. Department of Energy and U.S. Environmental Protection Agency. (2006) *Coal Combustion Waste Management at Landfills and Surface Impoundments, 1994 – 2004*. Document No. DOE/PI-0004. Available at: http://www.fossil.energy.gov/programs/powersystems/pollutioncontrols/coal_waste_report.pdf.
[2] Agency for Toxic Substances and Disease Registry (ATSDR). *ToxFAQs*. Available at: http://www.atsdr.cdc.gov/toxfaq.html

water caused by the leaching of contaminants into ground and surface water. Risks also exist for people who use the river recreationally, including those who engage in sports or subsistence fishing who may ingest contaminated fish. Ingestion through eating other contaminated food or through hand-to-mouth behavior may increase these risks. Furthermore, ash that dried after the spill may become airborne, increasing levels of respirable particulate matter in air and aggravating respiratory problems in the exposed population. Dermal exposure to coal ash may also result in skin irritation.

Response:

Yes, TDH agrees that coal ash contains heavy metals that may leach into water and that can be toxic. We stated such in the PHA in unambiguous language. Whether or not the ash spilled at the Kingston site leaches or is toxic is specific to this site and its coal ash characteristics. The potential for toxicity depends upon the concentrations of metals that are available for intake and absorption and how long people were exposed. All of this was carefully considered in the PHA. The PHA is a site-specific document. The conclusions expressed in it may not apply at other locations. It would be a disservice to the community to make generic statements about the potential for public health impacts when it is possible to do site-specific analysis.

Of course, there were and are potential human exposures through drinking water. That is why both raw and finished water at the two closest water treatment plants were tested immediately and everyday by TDEC until January 20. TDEC continued to sample weekly, while the Kingston WTP retained the daily sampling and analysis. At no time since the spill has municipal drinking water violated any water quality regulations.

People use the Watts Bar Reservoir recreationally. It is beautiful and pleasant waterway. EPA, TDEC, and TDH were and have been concerned about any potential effects from fishing and other recreational activities on the Reservoir. That is why TVA and TDEC have sampled and are continuing to sample long stretches of the Reservoir, from upstream on the Emory River, the Clinch River, and the Tennessee River. These thoughts were also expressed unambiguously in the PHA. After sampling and analysis and before the start of summer activities, a recreational advisory was published stating that Watts Bar Reservoir was safe for recreation and fishing except in the vicinity of the spill. Later, as larger equipment was brought in to remove ash, the river was closed for a few miles on either side of the spill site.

Unfortunately for such a beautiful reservoir, legacy contamination from mercury and PCBs have necessitated fish advisories in the Reservoir. These advisories have been in place for many years. EPA, TDEC, and TWRA began fish sampling soon after the incident, and are continuing to watch the situation closely.

Ingestion of ash could result in harm. Incidental ingestion was carefully considered. Information contained in the ATSDR Toxicological Profiles and obtained from consultation with expert medical toxicologists, assure us that the potential short-term, minimal exposure at this site would not result in harm.

EPA, TVA, TDEC, and TDH are aware of the potential for harm to public health from exposure to inhaled particulates from air-borne coal ash. Again, this was stated unambiguously in the PHA. Air sampling began very quickly. The types of sampling changed with time as more FRM and TEOM samplers became available for use around the site. TVA and TDEC operate air samplers at the point that best professional judgement indicated as the point of maximum exposure, based on the nature of the ash on the ground and prevailing wind direction . In addition, there are other air monitors surrounding the site and on the site. Air sampling surrounding the site indicates no violation of either National Ambient Air Quality Standards or World Health Organization guidelines. Air sampling on-site indicates no violation of OSHA standards.

Contaminant leaching from coal ash is known to have polluted many sites across the United States. The U.S. Environmental Protection Agency has acknowledged the existence of sites in 23 states where coal ash is known or suspected to have caused environmental damage.[1] The sites reviewed by EPA primarily involved the leaching of contaminants from intentionally placed coal ash, not massive accidental ash releases such as the one at the TVA Kingston plant. A release of such magnitude as the one in Kingston carries the potential to cause much more widespread contamination.

Response:

TDH, TDEC, and EPA have never denied that the potential for widespread contamination. That is why so many environmental samples have been and are being taken. To reiterate, all agencies are investigating potential environmental and human health harms not as generic possibilities, but as site-specific actualities.

The Tennessee Department of Health (TDH), under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR) of the U.S. Department of Health, conducted a Public Health Assessment (PHA) of the coal ash release at the TVA Kingston Plant. While we welcome the fact that TDH has collected and analyzed data on the effects of the spill, a number of unsupported assumptions and data limitations call into question some of the conclusions presented in the PHA.

- TDH did not conduct blood tests or other forms of biomonitoring to assess exposures to metals in coal ash among the population affected by the Kingston disaster.

Response:

TDH did not conduct blood tests or other forms of biomonitoring. Any exposure from any route or any media would have been very brief. The weather and the wetness of the ash precluded it from becoming air-borne. Any dermal exposure or incidental ingestion would have been possible only for a very few days. Any such exposures would have been impossible to detect with any type of biomonitoring. A central tenet of health assessments is that somehow enough of the

[1] U.S. Environmental Protection Agency (U.S. EPA). *Coal Combustion Waste Damage Case Assessments.* July 9, 2007. Available at www.regulations.gov (Document ID No. EPA-HQ-RCRA-2006-0796-0015).

chemicals of concern have to get inside someone for a long enough time before they can do harm.

TVA has arranged, through ORAU, for medical examinations, including blood testing, of anyone living near the spill who wants it. The protocol for the examinations was carefully developed by occupational and environmental physicians from the University of Colorado School of Public Health, Vanderbilt Medical Center medical toxicologists, and ORAU scientists. The protocol includes blood testing.

- By overestimating children's body weight, the assessment underestimates arsenic doses in children from incidental ingestion of ash-contaminated soil.

Response:

TDH did not overestimate children's body weight. ATSDR's Public Health Assessment Manual specified 16 kg as the appropriate value to use in exposure dose calculations for children aged 1 through 6 years. The 200 mg/day ingestion rate used in the PHA is 2 times the central tendency ingestion rate for children from 1 year to less than 6 years of age (100 mg/day) for incidental ingestion of soil and outdoor settled dust (EPA 2008). People with the potential for actual exposure to the ash were moved quickly. Infants aged from 6 months to 11 months old would not have been left to play unattended along the shoreline where ash was deposited. In addition, in the rare instance when a child might have gotten to the shoreline and eaten ash, the length of exposure would have been very short (a matter of minutes) and the possibility for exposure would have lasted at most a few days.

Because the ash was wet and stayed wet and because ash was deposited only along the shoreline except for three properties, it its highly unlikely that any ash was deposited on clothes. Sampling of soil in yards showed a clear demarcation between ash and soil. The ash was only along the shoreline except in the three houses from which people were relocated immediately. It is highly unrealistic to assume that people could have ingested or inhaled enough ash from yards or clothes to have caused any harm.

- Drinking water (municipal, spring and well) has not been tested for boron, a constituent of coal ash that may cause harm to the male reproductive system, low birth weight, and birth defects.

Response:

TVA has 1,216 sample results for boron between December 22, 2009, and the end of May 2009. Only 1.6% of those sample results were above the detection limit (usually 50 µg/L, occasionally 100 µg/L). The highest concentration found was 227 µg/L. No samples taken in the Tennessee River upstream of the water treatment plants were above the detection limit of 50 µg/L.

Boron is considered in the WHO Guidelines for Drinking-Water Quality. The Drinking-water Quality Committee, at its meeting of 9-13 November 2009, recommended revising the Boron Guideline Value to 2.4 mg/L. The revised Guideline Value and Summary Statement will be *incorporated into the Guidelines. This health-based value for drinking water is well above any concentrations found in Watts Bar Reservoir in the spill area.*

- Arsenic and selenium levels in surface water have exceeded EPA water quality criteria. Therefore, the PHA should not conclude that no harm will come to people's health from recreational river use, since fish may be bioaccumulating selenium. Fish tissue testing by Appalachian State University and others in January 2009 found high levels of selenium in fish that highlight the need for further biomonitoring.

Response:

TDEC, TWRA, and EPA began testing fish for selenium uptake soon after the spill. They were unable to duplicate Appalachian State University's results; the EPA Science Review Panel and the U.S. Army Corps of Engineers have generated two reports on selenium impacts at the coal ash release site [1]*. TDEC and TWRA are continuing to test fish to make sure that they are not bioaccumulating coal ash constituents. Current fish advisories for Watts Bar Reservoir, that have been in place for many years for mercury and PCB contamination from historical activities upstream of the ash spill, will continue to protect public health. If selenium is found to be bioaccumulating in fish tissue, then TDEC and TWRA will amend the existing advisory to protect people from selenium in fish. The ash is being removed from the river at a very fast rate. Over two-thirds of the ash is now out of the river; the ash will be out of the embayments and inlets in two to four years. Selenium would not bioaccumulate enough in one season to present a problem.*

- TDH should not conclude that breathing coal ash will not harm people's health, since available evidence points to the existence of elevated health risks. Particulate matter has exceeded levels known from scientific studies to aggravate asthma symptoms in children. Arsenic has exceeded health comparison values in some air samples. Furthermore, TDH found statistically significant clustering of respiratory symptoms near the area of the spill.

Response:

TDH did not conclude that breathing coal ash will not harm people's health. Conclusion 10b states: "The Tennessee Department of Health concludes that no harm to people's health is expected from occasionally breathing coal ash if it should become airborne for short periods of

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[1] (ACOE 2009) U.S. Army Corps of Engineers, Environmental Laboratory, Engineer Research and Development Center. Final Draft: Evaluation of metals release from oxidation of fly ash during dredging of the Emory River, prepared for Paul E. Davis, Director, Division of Water Pollution Control, Tennessee Department of Environment and Conservation. October 9, 2009. Vicksburg, Mississippi. URL: http://www.state.tn.us/environment/kingston/emory_metals.shtml.

(EPA 2009e) An EPA Science Panel Review Paper prepared at the request of the Senate Committee on Environment and Public Work Staff. December 2009. URL: http://www.epakingstontva.com.

time." TDH stands by this conclusion. This conclusion was supported by medical toxicologists and outside peer reviewers.

PM10 and PM2.5 have not been measured at levels above either EPA NAAQS nor WHO recommendations in off-site monitors. Instantaneous readings for PM10 in a large area around the spill area have shown higher 3- to 5- minutes concentrations. It is not possible to predict 24-hour average concentrations of PM10 from these real-time measurements, but it is certainly possible that at some locations PM10 was at levels greater than the NAAQS limits 24-hour average concentration of 150 μg/m³. The increased PM10 real-time measurements appear to be due to a number of sources, including fires in fireplaces, localized forest fires, or dust from the local quarry. It is extremely unlikely that the increased PM10 measurements are due to airborne coal fly ash because monitors surrounding the coal ash release indicate that air quality was and is meeting all particulate standards.

Arsenic in air was fully discussed in the PHA. In off-site monitors surrounding the ash spill, TDEC had 2 measurements for arsenic slightly above the health comparison value – 0.0025 and 0.0029 μg/m³ compared to the comparison value of 0.0023 μg/m³. The detection limit for TVA's measurements for arsenic was above 0.0023 μg/m³, but well within normal concentrations of arsenic found in the U.S. ambient air (0.00022 to 0.011 μg/m³). Arsenic in air does not pose a human health threat around ash spill.

Scientists continue to look at health effects from air pollution. There has been and will continue to be discussion about how to synthesize protective standards from academic research findings. This PHA is not the place for that kind of discussion. We can confidently say that monitoring by TEOM and FRM monitors surrounding the ash spill have not shown any levels of particulates above EPA regulations or World Health Organization recommendations.

The survey conducted by TDH and NCEH was not a scientific study, but an emergency response. The data can only be used to suggest hypotheses. The Tennessee Poison Center is conducting evaluations of the health status and blood levels of certain heavy metals in all community members who desire it. The air data taken by EPA, TVA, and TDEC do not indicate that coal ash constituents are getting into the ambient air.

- It would be in the best interest of the community affected by the Kingston coal ash spill for TDH and ATSDR to address these serious shortcomings in the PHA.

Response:

ATSDR sent the draft PHA to three outside peer reviewers to make sure that the scientific methods used were robust and the conclusions were drawn correctly from the data. TDH has worked diligently to analyze data for site-specific conclusions relevant and helpful to the community. In the words of outside peer Reviewer 1, "It [the PHA] appears to be an honest and thorough scientific analysis of all the health threats involved and the likelihood that any of these might have risen to a level of concern for health effects in the exposed human population" and "The results and findings presented in the Health Assessment are highly credible and show *careful attention to the scientific method, appropriate methods of analysis, and correct interpretation of results."*

II. Discussion

This document will discuss the Conclusions of the *Public Health Assessment* (PHA), as enumerated below.

CONCLUSION 1:

"When the coal ash was released from the failed retention wall of one of the coal ash storage ponds, people in the path of the ash could have been harmed by the magnitude and suddenness of the ash release. If the release had occurred during a summer day when people were on the river or riverbanks, many people could have been harmed or killed."[1]

Comment: We agree that the amount of ash and the force of the release could have added loss of life to this environmental and economic catastrophe. However, we understand the term "harmed" here to mean only "immediate physical injury", since there is not enough data in the PHA to reliably conclude that the coal ash release has not negatively affected the health of the community, particularly in the absence of biomonitoring by TDH.

Response:

We consider the data to be sufficient to evaluate each route of exposure. We conclude that we should not expect negative impacts to public health.

Comment: This first conclusion is followed in the PHA by a message to be publicized by TDH and the Tennessee Department of Environment and Conservation (TDEC), recommending the practice of good hygiene by washing hands, clothes and shoes if people come into contact with the ash. This is a useful recommendation; however, its effectiveness may be undermined by the statement that follows it: "Remember, the metals are bound to the ash. Occasional exposures for brief periods of time should not harm people's health."[2] Metals may leach from the ash when it comes into contact with moisture, which would occur if the ash were ingested, or breathed into the lungs. Arsenic and lead leaching at the pH in the human stomach (pH 2) are likely to be higher than predicted by Toxic Characteristic Leaching Procedure (TCLP) tests, which are carried out in a solution buffered to pH 5.[3, 4] In fact, a recent report by the EPA's Office of Research and Development determined that variable pH has a dramatic effect on the leaching of

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[1] Tennessee Department of Health (TDH). (2009) *Public Health Assessment; Tennessee Valley Authority (TVA) Kingston Fossil Plant Coal Ash Release* (Public Comment Release), at xviii.
[2] *Id.*
[3] Mercier, G; Duchesne, J; Carles-Ciberges, A. (2002) A simple and fast screening test to detect soils polluted by lead. *Environmental Pollution* 118: 285-96.
[4] Wang, T; Wang, J; Tang,Y; Shi, H; Ladwig, K. (2009) Leaching characteristics of arsenic and selenium from coal fly ash: the role of calcium. *Energy & Fuels* 23:2959-66.

metals from coal ash, particularly for arsenic.[1] Using a new and more reliable leach test, the EPA determined that arsenic leaching from fly ash reached levels up to 18,000 ug/L or 3.5 times the toxicity characteristic (hazardous waste level) of arsenic.[2]

Since it is not possible for either health agencies or exposed individuals to pinpoint the precise threshold of exposure time at which a person may begin to suffer adverse effects from exposure to the coal ash, this last statement regarding metals being bound to the ash and not causing harm through occasional exposures should not be included in public messages.

Response:

TDH stands by its conclusion. For arsenic to leach from ingested ash and harm someone, it would be necessary for someone to ingest it in a large enough amount and for long enough. People, whose homes were impacted, were evacuated very quickly after the ash spill. Any exposures would have been very brief – a matter of hours. Use of risk equations indicated that a child could possibly ingest 0.0002 mg/kg·day of arsenic. This oral dose is much less than ATSDR's acute MRL of 0.005 mg/kg·day.

We agree that the TCLP method is not useful for predicting absorption of metals in the GI tract. However, real life data indicates that absorption of arsenic would not likely exceed 50%. See our response to the last comment under Conclusion 4 for more details.

CONCLUSION 2:
"The Tennessee Department of Health concludes that it is unlikely that harm occurred to people from touching the coal ash when they had to climb out of their damaged houses on the morning of December 22, 2008, and to those who returned to retrieve personal property."[3]

Comment: TDH based this conclusion on the argument that metals would not enter people's bodies from touching the ash. However, coming into contact with the ash may have led to incidental ingestion, or inhalation once portions of the ash on people's clothes or property became dry. Furthermore, TDH did not conduct blood tests or other forms of biomonitoring to determine people's levels of exposure to metals in the coal ash.

Response:

Long-term contact would be necessary to cause any significant local skin irritation. In addition, the metals in the coal ash are not likely to get into people's bodies from touching the ash. This statement is correct. Even if the metals could get from skin into the blood stream, the extremely short exposure period would preclude measurable amounts from getting into blood. The extremely short exposure period and the small amount of ash that could have gotten onto

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[1] U.S. EPA, (2009) *Characterization of Coal Combustion Residues from Electric Utilities Using Multi-Pollutant Control Technology – Leaching and Characterization Data (EPA-600/R-09/151).* Available at: http://www.epa.gov/nrmrl/pubs/600r09151/600r09151.html
[2] *Id.*, at xiv.
[3] TDH (2009) at xix.

people's clothes would not result in measurable or harmful exposures. TVA personnel and contractors removed clothes and other possessions from the three houses that were irreparably damaged and cleaned them before returning them to the owners.

Potential risks from ingestion of coal ash and from inhalation of air borne coal ash are discussed in conclusions 4, 9, and 11. Exposure to coal ash while escaping from impacted homes was brief. Any exposure to ash on clothing was of short duration (hours at most). TVA hired contractors to retrieve and clean possessions so that residents would not have any additional exposure. It is our understanding that ash did not get inside any of the homes – three homes were damaged by the ash flow, but they were not flooded with ash.

Outside peer reviewer 1 states, "this reviewer does not believe that the evidence is strong that casual touching the coal ash could cause local skin irritation Rather, it would require a long-term dermal contact (for example, entrapment under a bandage) to result in any significant localized skin irritation. Certainly, the Assessment should not infer that skin irritation could result from casual touching of the coal ash."

Blood testing was not necessary for the reasons already stated. In the words of outside peer reviewer 1, "The results and findings presented in the Health Assessment are highly credible and show careful attention to the scientific method, appropriate methods of analysis, and correct interpretation of results." Outside peer reviewer 2 states, "This reviewer concurs that biomonitoring of residents is unlikely to be useful and that resources and energy should be on dust suppression, environmental quality monitoring, . . ."

CONCLUSION 3:

"The Tennessee Department of Health concludes that no harm to the community's health is expected from touching the coal ash. This includes children who might touch the ash while playing."[1]

Comment: Touching the ash while playing may lead to its inhalation and ingestion, since small children are prone to engage in frequent hand-to-mouth behavior. Since TDH did not test the exposed population for levels of metals or their health effects, it has no data to support its conclusion that no harm to the community's health is expected from touching the ash.

Response:

The conclusion follows from a scientific analysis of the data. ATSDR sent the draft PHA to three outside peer reviewers to make sure that the scientific methods used were robust and the conclusions were drawn correctly from the data. Outside peer reviewer 2 states, "This reviewer concurs that biomonitoring of residents is unlikely to be useful and that resources and energy should be on dust suppression, environmental quality monitoring, . . ."
Any exposure of young children to the coal ash would have been short and extremely infrequent due to where the ash was (along the shoreline), the ability of parents to clearly see the ash, the excellent work of emergency response personnel, and the weather – cold and wet.

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[1] *Id.*, at xx.

Outside peer reviewer 1 states, "this reviewer does not believe that the evidence is strong that casual touching the coal ash could cause local skin irritation Rather, it would require a long-term dermal contact (for example, entrapment under a bandage) to result in any significant localized skin irritation. Certainly, the Assessment should not infer that skin irritation could result from casual touching of the coal ash."

See the response to comments on conclusion 4 for a discussion of issues surrounding incidental ingestion of coal ash.

CONCLUSION 4:
"The Tennessee Department of Health concludes that no harm to people's health is expected from eating a small amount of coal ash."[1]

Comment: TDH goes on to acknowledge that arsenic was found in the coal ash at levels above health criteria. Its claim of no harm being expected rests on assumptions such as only 50 percent of the arsenic being bioavailable, and that coal ash would represent 50 percent of daily contaminated soil ingestion.[2] In the case of a child, TDH assumed the age of the child to be 2 years, and his/her weight to be 16 kg, or 35 pounds. However, the ATSDR *Public Health Assessment Guidance Manual* states that "ATSDR calculates an EMEG for a child using a daily soil ingestion rate of 200 mg/day for a 10-kg child." This body weight value corresponds to the weight of an infant 6- to 11-months of age.[3]

TDH used the following equation to calculate the oral dose of arsenic a child would receive from ingesting coal ash in contaminated soil:[4]

$$\text{Oral dose} = \frac{CA \times abs \times IR \times CF \times FI}{BW}$$

Where:
CA = concentration of arsenic in ash; 78 mg/kg, the highest mean concentration
abs = percent likely to be absorbable, 50% (0.5)
IR = ingestion rate, 200 mg/day for a child
CF = conversion factor, 10^{-6} kg/mg or 1 kg/1,000,000 mg
FI = fraction ingested, assuming 0.5 (half) of the incidental ingestion is ash
BW = body weight

When the oral dose is calculated using the ATSDR-recommended body weight value of 10 kg instead of the 16 kg wrongly used in the PHA, the result is:

$$\text{Oral dose} = \frac{78\text{ mg/kg} \times 0.5 \times 200\text{ mg/day} \times 1\text{ kg} \times 0.5}{10\text{ kg} \times 1{,}000{,}000\text{ mg}} = 0.00039\text{ mg/kg} \cdot \text{day}$$

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[1] *Id.*, at xxi.
[2] *Id*. at xxi; 18.
[3] ATSDR (2005) *ATSDR Public Health Assessment Guidance Manual*, Appendix F. Available at: http://www.atsdr.cdc.gov/HAC/PHAmanual/appf.html
[4] TDH (2009), at 18-19.

The resulting dose is 0.00039 mg/kg · day, which exceeds the ATSDR MRL and the EPA Reference Dose (RfD) of 0.0003 mg/kg · day. Furthermore, contrary to TDH's assertion, the assumptions used in the PHA arsenic dose calculations do not represent a worst-case scenario. The 78 mg/kg arsenic concentration in coal ash is the highest mean, but the maximum concentration was 166 mg/kg, which was found in the TVA samples. Calculating the oral dose using the maximum concentration of 166 mg/kg yields a result of 0.00083 mg/L, or over 2.5 times the MRL. Therefore, children may be exposed to arsenic concentrations that are substantially higher than ATSDR or EPA health criteria. The estimated arsenic dose indicates that the health of children in the area of the coal ash spill may be at risk from ingesting unsafe levels of arsenic.

Response:

TDH's methodology is correct. An infant would not be in a situation in which he would be eating ash. A child might have been in such a situation for a short period of time. Using variables for a reasonable worst-case scenario (which is what TDH used) is appropriate. The soil ingestion rate is double the central tendency ingestion rate for children aged 1 through 6 years. The use of the highest mean arsenic concentration is appropriate. Assuming that half of the consumption is ash that a child would consume in a day is an overestimate of exposure. Assuming that 50% of the arsenic in coal ash is bioavailable is also a conservative estimate based on real-world data.

The ATSDR and EPA health comparison values are for long-term exposures. Any exposure in this situation would have been extremely short-term. It is improper to compare this one time unlikely event dosage with a long-term health comparison value. Even using the variables suggested by the reviewers, the calculated dose of 0.00083 mg/kg·day is well below the acute exposure MRL of 0.005 mg/kg·day.

CONCLUSION 5:

"The Tennessee Department of Health concludes that using the Emory River at the site of the coal ash release (near Emory River mile 2) could result in harm to residents or trespassers from physical hazards associated with cleanup efforts and from the volume of ash present, if residents or trespassers entered the area."[1]

Comment: We agree with this conclusion and with the recreational advisories issued by the U.S. EPA, TDH, TDEC and TVA, which caution the public to avoid the use of the lower Emory River in the vicinity of the coal ash spill, and to avoid chronic exposure to the ash.

No response necessary.

[1] TDH (2009), at xxii.

CONCLUSION 6:
"The Tennessee Department of Health concludes that using municipal drinking water from the Kingston and Rockwood water treatment plants will not harm people's health because the raw and finished water have continuously met drinking water standards."[1]

Comment: While the water from these two treatment plants does not appear to have exceeded primary drinking water standards in tests performed by TDEC and the EPA contractor, it is necessary to test the water for boron, which is enriched in coal ash[2] and is an indicator element of coal ash contamination of water. According to the ATSDR, animal studies have indicated that boron affects the male reproductive organs, and may lead to low birth weight and birth defects. The EPA has not set a primary drinking water standard for boron, but it has issued a Longer Term Health Advisory for boron in drinking water consumed by children of 2.0 mg/L, while the European Union has adopted a standard of 1.0 mg/L[3, 4]

We agree with TDEC that the agency should continue monitoring municipal drinking water as well as private wells and springs, but future drinking water testing should include boron tests to determine whether it may pose a risk to communities relying on drinking water from the Kingston and Rockwood water treatment, since conventional drinking water treatment methods do not remove boron.[5]

Response:

TDH will pass this comment to TDEC so that they can make the decision whether or not to test for boron in municipal water. TVA's sampling, as discussed above, does not indicate that boron in Watts Bar Reservoir is elevated.

TVA has 1,216 sample results for boron between December 22, 2009, and the end of May 2009. Only 1.6% of those sample results were above the detection limit (usually 50 µg/L, occasionally 100 µg/L). The highest concentration found was 227 µg/L. No samples taken in the Tennessee River upstream of the water treatment plants were above the detection limit of 50 µg/L.

Boron is considered in the WHO Guidelines for Drinking-water Quality. The Drinking-water Quality Committee, at its meeting of 9-13 November 2009, recommended revising the Boron Guideline Value to 2.4 mg/L. The revised Guideline Value and Summary Statement will be

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[1] TDH (2009), at xxiii.

[2] Goodarzi, F; Swaine, DJ. (1994) Paleoenvironmental and environmental aspects of boron in coal. *Geological Survey of Canada Bulletin* 471. 76 pp.

[3] U.S. EPA. (2008) *Summary Document from the Health Advisory for Boron and Compounds*. Available at: http://www.epa.gov/ogwdw000/ccl/pdfs/reg_determine2/healthadvisory_ccl2-reg2_boron_summary.pdf

[4] Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption. *Official Journal of the European Communities*, Volume 41, 5.12.2998, L 330, 32-54.

[5] WHO (1998) *Boron*. Geneva, World Health Organization, International Programme on Chemical

Safety (Environmental Health Criteria 204). Available at: http://www.inchem.org/documents/ehc/ehc/ehc204.htm.

incorporated into the Guidelines. This value for drinking water is well above any concentrations found in Watts Bar Reservoir in the spill area.

CONCLUSION 7:
"The Tennessee Department of Health concludes that using well or spring water within four miles of the coal ash release will not harm people's health from exposure to coal ash or metals in the coal ash because no evidence has been found for groundwater contamination by coal ash."[1]

Comment: As in the case of municipal drinking water, well and spring water did not appear to contain concentrations of coal ash contaminants in excess of primary drinking water standards. However, there has been as of yet, no comprehensive hydrogeologic study of groundwater or karst water movement under the Kingston plant or the release site and thus primary flow paths and rates and directions of water flow have not been definitively established. Even if such work had been done at the release site, the limited, mostly one-time sampling of offsite wells and springs that has occurred has not been sufficient to definitively support a conclusion of no harm to human health, particularly given the admission in TVA's draft Engineering Evaluation and Cost Analyses (EE/CA) for the Embayment/Dredge Cell and River that arsenic has very recently been found above the MCL and historic levels in groundwater downgradient from the dredge cell at the Kingston site.[2] Finally spring and well water may also be subject to contamination with boron, which has no primary drinking water standard and which was not included in chemical tests. Given the reproductive and developmental health risks posed by boron, spring and well water should also be tested for this contaminant.

Response:

There is no evidence that boron is elevated in surface water near the site. Sampling and analysis of wells and springs did not show any effects from the coal ash. The dredge cell has been in existence for many years, so if it were affecting wells and springs we would expect the effects to be evident. TDEC will continue to sample well water periodically to determine if coal ash constituents are getting into groundwater.

CONCLUSION 8:
"The Tennessee Department of Health concludes that no harm to people's health should result from recreational use of the Emory, Clinch and Tennessee Rivers outside the area of the lower Emory River down to the confluence of the Emory and Clinch Rivers, as specified in the recreational advisory and river closure. Previous fish advisories should be followed."[3]

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[1] TDH (2009), at xxiv.
[2] TVA, *Kingston Fly Ash Recovery Project Non-Time Critical Action Scope and EE/CA Work Plan for Public Review* (Prepared by Jacob Engineering), vii (2009).
[3] TDH (2009) at xxv.

Comment: Water testing results from TVA indicate that arsenic concentrations have exceeded the EPA water quality criterion for human health for carcinogens (fish consumption), which is 0.14 ug/L:[1, 2]

- 7 times at Clinch River mile 0.0 (maximum total: 14 ug/L; maximum dissolved: 7 ug/L)
- 7 times at Clinch River mile 2.0 (maximum total: 93.7 ug/L; maximum dissolved: 24.2 ug/L)
- 3 times at Clinch River mile 4.0 (maximum total: 109 ug/L; maximum dissolved: 21.6 ug/L)
- 5 times at Emory River mile 0.1 (maximum total: 132 ug/L; maximum dissolved: 27.3 ug/L)
- 1 time at Emory River mile 1.0 (maximum total: 38.6 ug/L; maximum dissolved: 14.5 ug/L)
- 5 times at Emory River mile 1.75 (maximum total: 189 ug/L; maximum dissolved: 28.1 ug/L)
- 3 times at Emory River mile 2.0 (maximum total: 131 ug/L; maximum dissolved: 19.3 ug/L)
- 1 time at Emory River mile 4.0 (maximum total: 16.3 ug/L; maximum dissolved: 4.77 ug/L)

All exceedances of the arsenic criterion in TVA samples are shown in Appendix Table 1. TVA sampling was conducted between December 23 and May 8, 2009. Concentrations have been converted in this document from mg/L to ug/L.

More exceedances of the 0.14 ug/L arsenic criterion were recorded by EPA and TDEC sampling.[3] Detection limits for antimony, arsenic, and beryllium for certain EPA surface water samples were higher than the water quality criteria, so it is not possible to determine from those results whether additional exceedances occurred.[4] Testing by Vengosh et al. (2009) found high concentrations of arsenic in the Emory and Clinch Rivers in excess of the arsenic criterion, with all 14 samples at or downstream of the ash spill exceeding the criterion. Dissolved arsenic concentrations ranged from 0.3 to 69.6 ug/L (497 times the criterion); total arsenic ranged from 0.3 to 95.2 ug/L. The highest levels were found in the dammed tributary.[5, 6] Sampling conducted by Appalachian State University, Appalachian Voices, Tennessee Aquarium and Wake Forest University of Emory River mile 2.2 in the area of the spill found a total recoverable arsenic concentration of 2,667 ug/L.[7]

Elevated selenium levels have also been measured in surface water. Although according to TDH "levels of selenium are well below EPA's proposed toxicity standards for protection of fish and other aquatic life",[8] selenium concentrations reached or exceeded the EPA freshwater quality criterion of 20 ug/L three times between December 23 and May 8, 2009:[9, 1]

[1] *Id.,* at 111-70.
[2] 40 CFR 131.36. This criterion was set for inorganic arsenic.
[3] TDH (2009) at 171-80.
[4] *Id.,* at 24.
[5] Vengosh, A; Ruhl, L;, Dwyer, GS. (2008) *Possible environmental effects of the coal ash spill at Kingston, Tennessee. Phase I: Preliminary Results.* Nicholas School of the Environment and Earth Sciences, Duke University.
[6] Ruhl, L, Vengosh. A, Dwyer, GS, Hsu-Kim, H, Deonarine, A, Bergin, M, Kravchenko, J. (2009) Survey of the potential environmental and health impacts in the immediate aftermath of the coal ash spill in Kingston, Tennessee, *Environmental Science & Technology* 43:6326–6333.
[7] *Preliminary Summary Report from Water, Sediment and Fish Samples Collected at the TVA Ash Spill by Appalachian State University, Appalachian Voices, Tennessee Aquarium, and Wake Forest University.* Available at: http://www.appvoices.org/resources/AppVoices_TVA_Ash_Spill_Report_May15.pdf.
[8] TDH (2009) at 21.
[9] *Id.,* at 111-70.

- January 2, 2009 at Emory River mile 4.0 (50 ug/L; EPA data)
- January 7, 2009 at Clinch River mile 2.0 (20 ug/L; TVA data)
- January 7, 2009 at Clinch River mile 4.0 (20 ug/L; TVA data)

Since fish are mobile, fish affected by arsenic, selenium and other contaminants in the area of the coal ash spill may be caught by recreational and subsistence fishers outside of the areas included in the recreational advisory and river closure. While TDH simply recommends following pre-existing fish consumption advisories issued for PCBs and mercury that are unrelated to the coal ash release, the arsenic and selenium levels detected indicate the need for a more cautious approach when reaching conclusions about possible harm from and recreational use of the river, including fishing, and when issuing recommendations to the public. Fish testing by Appalachian State University, Appalachian Voices, Tennessee Aquarium and Wake Forest University found elevated selenium concentrations in fish muscle of 3.19 to 5.17 parts per million (ppm).[2] While these did not exceed the EPA draft health guidance, selenium levels in fish should continue to be monitored closely, as bioaccumulation may lead to increased concentrations in tissue over time.

Given the data presented in the PHA, TDH cannot conclude that use of the river will not result in harm to people's health. Fish monitoring should continue in the Emory and Clinch Rivers, the community should be informed of the exceedances of water quality criteria, and new advisories should be issued (and/or existing advisories strengthened) if fish tissues exceed health comparison values for any contaminants.

Response:

The commenters are correct that the number 0.14 ug/L appears for arsenic in the national criteria table found on the EPA website. It should be noted that EPA has withdrawn support for this criterion due to concerns about its accuracy. A footnote to this criterion states that it is being reconsidered.

EPA has approved the existing Tennessee arsenic criterion of 10 ug/L, which is the water quality standard which properly applies to the Emory and Clinch.

The 10 ug/L arsenic criterion is not an acute criterion as suggested by the commenters - rather it is based on arsenic levels over time and chronic exposures.

TDEC and TDH agree with the commenters that arsenic levels in the lower Emory have exceeded this 10 ug/L criterion with enough frequency, duration, and magnitude that the classified use of domestic water supply has been impacted in this specific area. In other words, arsenic levels documented in 2009 would present an obstacle to the lower Emory being used as a

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[1] 40 CFR 131.36. Criterion expressed as total recoverable selenium.

[2] Appalachian State University, Appalachian Voices, Tennessee Aquarium and Wake Forest University. (2009) *Preliminary Summary Report from Water, Sediment and Fish samples collected at the TVA Ash Spill by Appalachian State University, Appalachian Voices, Tennessee Aquarium and Wake Forest University.*

Available at http://www.appvoices.org/resources/AppVoices_TVA_Ash_Spill_Report_May15.pdf.

water supply during the duration of the ash spill. However, we do not agree that this leads to a conclusion that public health is at risk. The lower Emory, although classified for domestic water supply, is not being used for this purpose.

When the proper arsenic criterion of 10 µg/L is used, TDEC shows exceedances in 4% of their samples, all at the site of the ash spill. TVA shows exceedances in 0.06% of 30,781 analyses for arsenic. These exceedances are as follows:

Exceedances of Arsenic water quality criterion approved by EPA (10 µg/L)			
River Mile	***Arsenic Concentration, µg/L***	***Dissolved (D) or Total (T)***	***Date***
TDEC			
ERM 1.7	*19*	*T*	*1/22/09*
ERM1.7	*17*	*T*	*2/5/09*
ERM 2.1	*14*	*T*	*1/13/09*
ERM2.1	*43*	*T*	*1/15/09*
ERM2.1	*17*	*T*	*3/26/09*
ERM2.1	*11*	*T*	*3/31/09*
ERM2.1	*13*	*T*	*4/8/09*
TVA			
CRM0.0	*14*	*T*	*1/7/09*
CRM2.0	*24*	*D*	*1/7/09*
CRM2.0	*94*	*T*	*1/7/09*
CRM4.0	*22*	*D*	*1/7/09*
CRM4.0	*109*	*T*	*1/7/09*
ERM0.1	*20*	*T*	*12/23/08*
ERM0.1	*11*	*D*	*12/23/08*
ERM0.1	*27*	*D*	*1/7/09*
ERM0.1	*132*	*T*	*1/7/09*
ERM1.0	*39*	*T*	*12/22/08*
ERM1.0	*14*	*D*	*12/22/08*
ERM1.75	*59*	*T*	*12/22/08*
ERM1.75	*59*	*T*	*12/22/08*
ERM1.75	*15*	*D*	*12/22/08*
ERM1.75	*12*	*T*	*12/23/08*
ERM1.75	*28*	*D*	*1/7/09*
ERM1.75	*189*	*T*	*1/7/09*
ERM2.1	*19*	*D*	*1/7/09*
ERM2.1	*131*	*T*	*1/7/09*

All exceedances outside the area of the spill occurred on January 7, 2009, and have not recurred since then.

TDH does not agree with the commenters that a significant issue with arsenic is found outside the lower Emory. TDH did not use data from NGOs for the reasons stated in the PHA. Most sampling was done at the site of the spill and in dammed tributaries in the earliest days after the spill. This data confirmed elevated levels of arsenic at the site of the spill. However, the data were not particularly useful for determining effects of chronic exposures to the Watts Bar Reservoir.

Reaching EPA's Water Quality Criterion for selenium twice and exceeding it once in more than 5 months of sampling does not constitute a reason to say that recreation if unsafe. Water Quality Criteria are based on long-term exposures. In addition, fish are being monitored to detect any bioaccumulation, if it should occur.

CONCLUSION 9:

"The Tennessee Department of Health cannot conclude whether breathing coal ash from December 22, 2008, through December 27, 2008, harmed people's health. However, any dust that may have been inhaled could have aggravated symptoms in sensitive populations, that is, people with asthma, emphysema, and other respiratory conditions."[1]

Comment: TDH cannot draw this conclusion. As TDH acknowledges, no agencies took air samples from December 22, 2008, through December 27, 2008. Although TDH believes that it is unlikely that the wet ash released from the failed impoundment dried enough to become airborne during this period,[2] thinner layers of ash on the property or clothes of people who came into contact with the ash may have posed an inhalation risk during the period in question.

Response: After comments from outside peer reviewers, EEP has changed conclusion 9 to read, "While no air measurements were obtained during the time period between December 22 and December 27, 2008, the Tennessee Department of Health concludes that it is unlikely that any harm to public health should have resulted from breathing ambient air from December 22, 2008, through December 27, 2008. However, any dust that may have been inhaled could have aggravated symptoms in sensitive populations, that is, people with asthma, emphysema, and other respiratory conditions."

The coal ash, which was wet and remained wet in that time period, did not get into yards or on clothes except for 3 homes that were evacuated. Data support our conclusion. In fact, we state in the conclusion that if a person with pre-existing respiratory conditions breathed the coal ash, then this could have aggravated their symptoms.

CONCLUSION 10a:

"The Tennessee Department of Health concludes that breathing ambient air near the coal ash release is not expected to harm people's health as long as adequate dust suppression measures are in place."

CONCLUSION 10b:

"The Tennessee Department of Health concludes that no harm to people's health is expected from occasionally breathing coal ash if it should become airborne for short periods of time."

CONCLUSION 10c:

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[1] TDH (2009) at xxvi.

[2] *Id*.

"If dust suppression measures should fail and particulate matter is present in concentrations greater than National Ambient Air Quality Standards due to the coal ash becoming airborne for periods longer than one day, the Tennessee Department of Health concludes that particulate matter from airborne coal ash could harm people's health, especially for those persons with preexisting respiratory or heart conditions. Such harm could include upper airway irritation and aggravation of pre-existing conditions such as asthma, emphysema, and other respiratory conditions."[1]

Comment, 10a – 10c: TDH has stated that despite TVA's dust suppression measures, dust still appears to be a problem for homeowners along the truck route, and that there appears to be a relationship between respiratory complaints and the truck route.[2, 3] We strongly agree on the need to have adequate dust suppression measures in place, and that the failure of such could cause harm to people suffering from respiratory or cardiac conditions.

Response: The dust referred to is not dust from the coal ash, but dust from the quarry.

Comment: However, we strongly disagree with Conclusion 10b, which states that "no harm to people's health is expected from occasionally breathing coal ash if it should become airborne for short periods of time." Studies have shown that exposure to fine particulate matter (PM2.5) of just a few hours may aggravate airway inflammation and asthma symptoms in children. Rabinovitch et al. (2006) found a statistically significant association between morning peak PM 2.5 concentrations (but not 24-hour averages) and increased bronchodilator use at school and urinary leukotriene E_4 – a biomarker for airway inflammation – during school hours among children with moderate and severe asthma. These effects were observed despite the fact that the morning means were ≤30.2 ug/m^3 and the 24-hour averages were ≤11.8 ug/m^3, both below the 24-hour National Ambient Air Quality Standard (NAAQS) of 35 ug/m^3 .[4] Delfino et al. (2002) also found an association between short exposures to elevated PM10 concentrations (1-hour and 8-hour maxima) and asthma symptoms in children, even though the 24-hour PM10 NAAQS of 150 ug/m3 was not exceeded. The 1-hour maximum was 51 ug/m^3; the 8-hour and 24-hour maxima were 38 ug/m^3 and 25 ug/m^3, respectively.[5] These studies indicate that children may be at greater risk of asthma symptoms from short-term exposure to elevated levels of PM2.5 and PM10, even if the 24-hour NAAQS are not exceeded. EPA sampling has detected average PM10 concentrations on- and off TVA property that are within the range associated with the aggravation of asthma symptoms in children in the referenced studies (76.2 ug/m^3 on-site and 49.4 ug/m^3 off-site.).[6]

Response:

[1] *Id*., at xxvii.
[2] *Id*., at 52.
[3] *Id*., at 70.
[4] Rabinovitch N, Strand M, Gelfand EW (2006) Particulate levels are associated with early asthma worsening in children with persistent disease. *American Journal of Respiratory and Critical Care Medicine* 173:1098–1105
[5] Delfino RJ, Zeiger RS, Seltzer JM, Street DH, McLaren C. (2002) Association of asthma symptoms with peak particulate air pollution and effect modification by anti-inflammatory medication use. *Environmental Health Perspectives* 110:A607–A617.
[6] TDH (2009) at 45.

This same comment was discussed at length in section I. It is repeated here. TDH did not conclude that breathing coal ash will not harm people's health. Conclusion 10b states: "The Tennessee Department of Health concludes that no harm to people's health is expected from occasionally breathing coal ash if it should become airborne for short periods of time." TDH stands by this conclusion. This conclusion was supported by medical toxicologists and outside peer reviewers.

PM10 and PM2.5 have not been measured at levels above either EPA NAAQS nor WHO recommendations in off-site monitors. Instantaneous readings for PM10 in a large area around the spill area have shown higher 3- to 5- minutes concentrations. It is not possible to predict 24-hour average concentrations of PM10 from these real-time measurements, but it is certainly possible that at some locations PM10 was at levels greater than the NAAQS limits 24-hour average concentration of 150 μg/m³. The increased PM10 real-time measurements appear to be due to a number of sources, including fires in fireplaces, localized forest fires, or dust from the local quarry. It is extremely unlikely that the increased PM10 measurements are due to airborne coal fly ash because monitors surrounding the coal ash release indicate that air quality was and is meeting all particulate standards.

Scientists continue to look at health effects from air pollution. There has been and will continue to be discussion about how to synthesize protective standards from academic research findings. This PHA is not the place for that kind of discussion. We can confidently say that monitoring by TEOM and FRM monitors surrounding the ash spill have not shown any levels of particulates above EPA regulations or World Health Organization recommendations.

Comment: Other testing results also raise concern about possible health risks from breathing airborne ash. Levels of arsenic and chromium in some PM10 samples obtained by a TVA mobile on-site monitor from December 31 2008 through February 3, 2009 were above health comparison values (arsenic was above its health comparison value in three of 35 samples, and chromium in 14 of 35 samples.)[1] TDEC also found exceedances for arsenic in 2 of 16 samples.[2] Other exceedances may have occurred, since detection limits for arsenic and chromium at TVA stationary monitors were at times above health comparison values.[3]

Response:

This was also discussed in Section I and is repeated here. Arsenic in air was fully discussed in the PHA. In off-site monitors surrounding the ash spill, TDEC had 2 measurements for arsenic slightly above the health comparison value – 0.0025 and 0.0029 μg/m³ compared to the comparison value of 0.0023 μg/m³. The detection limit for TVA's measurements for arsenic was above 0.0023 μg/m³, but well within normal concentrations of arsenic found in the U.S. ambient air (0.00022 to 0.011 μg/m³). Arsenic in air does not pose a human health threat around the ash spill.

[1] *Id.,* at 40.
[2] *Id.,* at 46.
[3] *Id.,* at 41-2.

Health agencies and TVA must ensure that dust suppression measures are strengthened to reduce the risk of respiratory health problems in surrounding communities. They must also ensure that meaningful monitoring, with appropriate detection limits below health comparison values for arsenic and chromium, be consistently instituted.

Response:

EPA and TDEC are doing an excellent job in overseeing TVA's work and monitoring activities. TDEC continues to monitor the air in the community at the point that models predict would have the highest concentrations of air pollutants originating from the site of the spill. TDH will continue to follow all activities at the site.

CONCLUSION 11:
"The Tennessee Department of Health cannot conclude whether breathing dust near the quarry and along the routes of the quarry trucks has or will harm people's health. Such dust can be irritating to upper airways and can aggravate pre-existing conditions such as asthma, emphysema, and other respiratory conditions."[1]

Comment: According to TDH, 0.1% of real-time 3-to-5-minute measurements in the community near the ash release, many of which were taken near the quarry truck routes, have exceeded the 150 ug/m^3 PM10 NAAQS. Short exposures to PM2.5 and PM10 at elevated levels below the NAAQS may aggravate asthma symptoms in people with respiratory conditions, especially children. *See* Comment on Conclusions 10a – 10c, above. Breathing dust near the quarry may aggravate respiratory symptoms in the exposed population. TDH should continue to monitor for increases in hospital treatment and admissions for asthma and other respiratory conditions among the community. The need for health monitoring is supported by the findings of the *Community Health Survey* conducted by TDH and the Centers for Disease Control and Prevention, which found a statistically significant clustering of shortness of breath, with hot spots occurring along the southwest/northeast axis of the ash release area.[2] As previously mentioned, TDH has also stated that dust still appears to be a problem for homeowners along the truck route, and that there appears to be a relationship between respiratory complaints and the truck route.[3, 4]

Response:

TDH did not say that 0.1% of real-time 3-to-5-minute measurements in the community near the ash release, many of which were taken near the quarry truck routes, have exceeded the 150 ug/m^3 PM10 NAAQS. TDH said that instantaneous readings for PM10 in a large area around the spill area have shown 3- to 5- minutes concentrations greater than 150 $\mu g/m^3$. It is not possible to predict 24-hour average concentrations of PM10 from these real-time measurements, but it is certainly possible that at some locations PM10 was at levels greater than the NAAQS limits 24-hour average concentration of 150 $\mu g/m^3$. The increased PM10 real-time measurements appear to be due to a number of sources, including fires in fireplaces, localized

[1] *Id.,* at xxix.
[2] *Id.,* at 66-7.
[3] *Id.*, at 52.
[4] *Id.*, at 70.

forest fires, or dust from the local quarry. It is extremely unlikely that the increased PM10 measurements are due to airborne coal fly ash because monitors surrounding the coal ash release indicate that air quality was and is meeting all particulate standards. 0.1% of samples represents less than 50 readings.

As we stated, we cannot draw any conclusions about harm to public health from breathing dust near the quarry or along the truck routes. TVA has arranged, through ORAU, for medical examinations, including blood testing, of anyone living near the spill who wants it. The protocol for the examinations was carefully developed by occupational and environmental physicians from the University of Colorado School of Public Health, Vanderbilt Medical Center medical toxicologists, and ORAU scientists. These organizations are better able to do this type of medical screening than is TDH.

CONCLUSION 12:
"The Tennessee Department of Health concludes that the small amount of radiation from the coal ash is not expected to harm people's health."[1]

Comment: Radium-226 and radium-228 were found in the coal ash at concentrations above background soil levels. The estimated total radium in the TDEC samples is approximately 3.2 pCi/g above background; in Duke University samples, it is 4.3 pCi/g above background (the EPA regulatory level is 5 pCi/g above background).[2] Even though these concentrations were below regulatory limits, the fact that they are enriched above background levels adds to the existing background health risks and should be of concern for people chronically exposed to coal ash aerosols.[3]

Response: People are not being chronically exposed to coal ash aerosols.

CONCLUSION 13:
"…The Tennessee Department of Health concludes that data collected by non-governmental organizations were of limited usefulness in establishing the long-term public health implications of the coal ash release. However, the non-governmental organizations' data confirm data collected by governmental agencies… Data from all agencies agree that arsenic in the coal ash was at levels above health comparison values, that arsenic in the Emory River at the site of the ash release was elevated immediately following the release… The data provided by non-governmental organizations about selenium in certain fish were not replicated by Tennessee Department of Environment and Conservation's, the Tennessee Wildlife Resources Agency's, or the U.S. Environmental Protection Agency's sampling and analysis. However, it has signaled the need for further investigation by government agencies…"[4]

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[1] *Id.,* at xxx.
[2] *Id.,* at 54.
[3] Vengosh, A; Ruhl, L;, Dwyer, GS. (2008) *Possible environmental effects of the coal ash spill at Kingston, Tennessee. Phase I: Preliminary Results*. Nicholas School of the Environment and Earth Sciences, Duke University.
[4] TDH (2009) at xxxi.

Comment: We disagree with this conclusion. Both the arsenic and selenium data demonstrate the need for additional monitoring of surface water and fish to determine whether existing fish consumption advisories need to be strengthened, or new advisories issued. Arsenic and selenium concentrations have exceeded water quality criteria in TVA, EPA and/or TDEC sampling. *See* Comment on Conclusion 8, above.

Response:

TDEC, TWRA, and EPA have explored and are continuing to explore the selenium issue. They have not ignored selenium issues. TDEC and TDH acknowledge that arsenic is above water quality criteria at the site of the ash spill. This is issue has been explained earlier in the comments.

CONCLUSION 14:
"Based on the Community Health Survey, the Tennessee Department of Health concludes that many residents living in the area of the coal ash release experienced stress and anxiety. Some residents reported respiratory symptoms after the ash release."[1]

Comment: As stated earlier in the *Comment* to Conclusion 11 above, the findings of the *Community Health Survey* conducted by TDH and the Centers for Disease Control and Prevention support the need for continued monitoring of respiratory symptoms among the community. The *Survey* found a statistically significant clustering of shortness of breath, with hot spots occurring along the southwest/northeast axis of the ash release area, in addition to the significant clustering of stress and anxiety symptoms.[2]

Response: Tennessee Poison Center medical toxicologists are medically evaluating members of the community. They are better able to do this type of medical screening than is TDH.

CONCLUSION 15:
"Community members living near the quarry and along the routes that quarry trucks traveled made complaints specific to dust at the Tennessee Valley Authority's Community Involvement Center. Complaints about respiratory symptoms were widespread and were not oriented toward either the site of the coal ash release or the route of the quarry trucks."[3]

Comment: The statistically significant clustering of respiratory symptoms along the southwest/northeast axis of the coal ash release area, and the change in orientation of the symptoms, which move closer to the spill area after the coal ash release, indicate that people in the community may have been experiencing respiratory symptoms related to the coal ash release. Respiratory symptoms may have been widespread, but TDH's own analysis has indicated that

[1] *Id.,* at xxxiii.
[2] *Id.,* at 66-7.
[3] *Id.,* at xxxiv.

respiratory symptoms were clustered near the spill area,[1] and that there appears to be a relationship between respiratory complaints and dust along the truck route.[2, 3]

Response:

The truck route referred to is the route that the quarry trucks take. Any dust generated by the trucks would come from the quarry, not the ash spill site. TVA has very stringent controls in place to keep coal ash out of the community. Again ORAU and the TN Poison Center are doing medical examinations using a protocol developed by experts in medical toxicology and environmental medicine.

CONCLUSION 16:
"The Tennessee Department of Health concluded that screening people's blood or urine for metals would not be helpful."[4]

Comment: We strongly disagree. TDH asserts that "based on environmental test results, the Tennessee Department of Health does not expect harm to health from touching, eating, drinking, or breathing the metals in coal fly ash. No harm is expected from breathing the air as long as adequate dust suppression measures are in place." However, TDH has acknowledged that the maximum concentration of arsenic in soil exceeded the health comparison value for chronic exposure of a child.[5] Also, as noted above, our arsenic ingestion estimate indicates that risks may exist for children who may ingest coal ash or ash-contaminated soil (see *Comment* on Conclusion 4, above, adjusting TDH calculations by using the correct child body weight value). Biomonitoring is necessary to determine whether children are or have been exposed to excessive levels of arsenic.

TDH has acknowledged the health concerns of community members following abnormal results for heavy metals in biomonitoring testing made possible by the non-governmental organization United Mountain Defense. TDH has also stated that TVA will make resources available for further testing of individuals.[6] Data obtained from such testing should be incorporated into the PHA.

Response:

All these comments have been fully discussed.

Data from the medical exams will not be available in time for incorporation into the PHA. This PHA is based on currently available data and the proper use of risk assessment methodology. If medical evaluation shows that people were harmed by exposure to coal ash, then we would take

[1] *Id.,* at 66-7; 101.
[2] *Id.*, at 52.
[3] *Id.*, at 70.
[4] *Id.,* at 35.
[5] *Id.,* at 14.
[6] *Id.,* at 71.

further action to explore the issue. It is inappropriate to wait until data resulting from the medical evaluations are available to publish the PHA.

III. Miscellaneous comments

Discussion of EMEGs , page 8: According to the PHA, "If concentrations are below the chronic EMEG [Environmental Media Evaluation Guideline] for a particular chemical, the health assessor can be reasonably certain that no adverse health effects will occur in people who are exposed. Stated another way, the health assessor can be very sure that even long-term, continuous exposure to a chemical at concentrations below its chronic EMEG will not harm people's health." This statement is misleading. In its discussion of EMEGs, the ATSDR *Public Health Assessment Guidance Manual* states that "before excluding all substances detected at concentrations below environmental guidelines from further consideration in a public health assessment, you need to consider the factors described in Section 7.4." Section 7.4 of the *Public Health Assessment Guidance Manual* enumerates these factors as:

- Community concerns
- Specific populations (Particularly sensitive populations, or populations exposed at higher rates than the average population, e.g. subsistence fishers)
- Multiple pathways of exposure
- Multiple-chemical exposures

Response: TDH used health comparison values correctly. Outside peer reviewers agree. In addition, ATSDR reviews and approves all methodologies and conclusions.

TDH did not consider contaminant exposure among subsistence fishers, who may be exposed to higher doses of contaminants than recreational fishers. Furthermore, EMEGs do not account for carcinogenic effects. According to the ATSDR Public Health Assessment Guidance Manual "EMEGs are based on toxicity information (MRLs), which consider noncarcinogenic toxic effects of chemicals, including their developmental and reproductive toxicity. MRLs do not consider potential genotoxic or carcinogenic effects of a substance. Because some substances have both noncarcinogenic and carcinogenic effects, ATSDR has derived CREGs [Cancer Risk Evaluation Guides] to consider potential carcinogenic effects of a substance."[1] These CREGs are "media-specific comparison values that are used to identify concentrations of cancer-causing substances that are unlikely to result in an increase of cancer rates in an exposed population. ATSDR develops CREGs using EPA's cancer slope factor (CSF) or inhalation unit risk (IUR), a target risk level (10^{-6}), and default exposure assumptions."[2]

Response:

We know of no populations of subsistence fishers in this area. The current fish advisories have been in place for many years. If someone is a subsistence fisher using the Watts Bar Reservoir, they are at much greater risk from mercury and PCBs than from a theoretical bioaccumulation of metals from the coal ash. TDEC and TWRA are sampling fish and will continue to sample

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[1] ATSDR (2005) *ATSDR Public Health Assessment Guidance Manual*, Appendix F. Available at: http://www.atsdr.cdc.gov/HAC/PHAmanual/appf.html

[2] *Id.*

fish. TDH used all health comparison values correctly, for carcinogenic and non-carcinogenic effects.

Simply stated, a health assessor cannot be "very sure that even long-term, continuous exposure to a chemical… will not harm people's health" simply because the concentrations detected were below the EMEG without first having considered whether the chemical in question may produce carcinogenic effects, which are not accounted for by the EMEGs. Arsenic, a carcinogenic element, is present in the ash from the Kingston ash spill. As stated on pages 4 and 5 of these comments, children may be receiving doses of arsenic that are higher than TDH estimated, and in excess of the ATSDR MRL and the EPA Reference Dose. However, TDH did not derive a CREG for arsenic when evaluating exposures to this substance among children or other subpopulations. This oversight should be corrected.

Response:

TDH did not derive a carcinogenic value for arsenic, although EPA has done so. The health comparison values used in this PHA for arsenic, beryllium, and cadmium in air are based on carcinogenic potential risk.

Definition of TCLP test; page 14: According to TDH, Toxicity Characteristic Leaching Procedure (TCLP) testing of coal ash samples "gives a good indication if the metals would be absorbed from the gastrointestinal tract when ingested."[1] In the TCLP tests, about 0.5 percent of the arsenic present in the EPA-collected samples leached, and about 0.7 percent from TDH-collected samples.[2] However, contrary to the TDH statement, the TCLP test is not a good or reliable indicator of how much leaching of metals would occur in the gastrointestinal tract. Metals leaching is pH-dependent. While the test solution in the TCLP test is buffered to pH 5, the pH in the human stomach is approximately 2. Wang et al. (2009) tested Appalachian bituminous coal samples and found that arsenic leaching was greatest at pH <3 and pH >7.[3] The pH in the human stomach falls within the range of greatest arsenic leaching (pH <3), while the pH of the solution in TCLP tests falls within the range of lowest leaching (3<pH<7). In the Wang et al. (2009) study, arsenic leaching at pH 2 exceeded 800 ug/L, but was <10 ug/L at pH 5.[4] Mercier et al. (2002) also found that the TCLP test leached less lead than a gastric juice simulation test conducted at pH 2,[5] providing further evidence that the TCLP test is inadequate when determining how much of a metal would leach out of coal ash in the gastrointestinal tract.

Furthermore, the latest report on coal ash leaching by the EPA's Office of Research and Development provides additional definitive evidence that metal leaching is pH-dependent and the TCLP test is not a reliable test. This report determined that variable pH greatly affects the

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[1] TDH (2009), at xiv.
[2] *Id.*, at 15.
[3] Wang, T; Wang, J; Tang,Y; Shi, H; Ladwig, K. (2009) Leaching characteristics of arsenic and selenium from coal fly ash: the role of calcium. *Energy & Fuels* 23:2959-66.
[4] *Id.*
[5] Mercier, G; Duchesne, J; Carles-Ciberges, A. (2002) A simple and fast screening test to detect soils polluted by lead. *Environmental Pollution* 118: 285-96.

leaching of metals from coal ash, particularly for arsenic.[1] Using a new and more reliable leach test, the EPA determined that arsenic leaching from fly ash reached levels up to 18,000 ug/L or 3.5 times the toxicity characteristic (hazardous waste level) of arsenic.[2]

Response: Including the statement in the definition was an oversight and has been corrected.

CONCLUSIONS

Based on our review of the *Public Health Assessment* (PHA) of the Kingston Fossil Plant coal ash release, we conclude the following:

- The lack of biomonitoring data in the Public Health Assessment undermines the conclusions by TDH concerning health risks from exposure to coal ash, particularly to children. Data from any future biomonitoring tests should be incorporated into the PHA.
- TDH has underestimated arsenic doses in children from incidental ingestion of ash-contaminated soil by overestimating a reference child's body weight in a manner inconsistent with the ATSDR *Public Health Assessment Guidance Manual*. TDH must recalculate the dose by using the correct body weight.
- The Environmental Media Evaluation Guidelines (EMEGs) TDH used in its health assessment do not account for carcinogenic risks from arsenic. TDH should have considered, in addition to the EMEGs, appropriate Cancer Risk Evaluation Guides (CREGs) that would account for these risks.
- TDH has not conducted a comprehensive hydrogeologic study of groundwater or karst water movement under the Kingston plan or the spill site. Thus primary flow paths and rates and directions of water flow have not been definitively established. Such analyses should be completed, followed by comprehensive testing of groundwater for contaminants, including boron. These results must be analyzed before a conclusion is drawn that groundwater is safe for human consumption in the area near the plant and spill site.
- Drinking water municipal systems, springs and wells should be tested for boron, a leachable constituent of coal ash. While there is no EPA drinking water standard for boron, animal studies indicate that boron may cause harm to the male reproductive system, low birth weight, and birth defects. The U.S. EPA has set a Longer Term Health Advisory for boron in drinking water consumed by children of 2.0 mg/L, while the European Union has adopted a standard of 1.0 mg/L[3, 4]
- Based on water and fish testing results, it is premature for TDH to conclude that no harm will come to people's health from recreational river use, since fish may be

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[1] U.S. EPA, (2009) *Characterization of Coal Combustion Residues from Electric Utilities Using Multi-Pollutant Control Technology – Leaching and Characterization Data (EPA-600/R-09/151).* Available at: http://www.epa.gov/nrmrl/pubs/600r09151/600r09151.html

[2] *Id.*, at xiv.

[3] U.S. EPA. (2008) *Summary Document from the Health Advisory for Boron and Compounds*. Available at: http://www.epa.gov/ogwdw000/ccl/pdfs/reg_determine2/healthadvisory_ccl2-reg2_boron_summary.pdf

[4] Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption. *Official Journal of the European Communities*, Volume 41, 5.12.2998, L 330, 32-54.

bioaccumulating contaminants. The full extent of this bioaccumulation will only be known by continued monitoring. TDH should consider risks to subsistence fishers in its health assessment.

- TDH should not conclude that breathing coal ash will not harm people's health, since available evidence points to the existence of elevated health risks. Particulate matter has exceeded levels known from scientific studies to aggravate asthma symptoms in children. Furthermore, TDH found statistically significant clustering of respiratory symptoms near the area of the spill, and of respiratory complaints near the truck route. Therefore, dust control measures along the quarry truck route and in the spill area should be improved.

We urge TDH to address the issues identified in these comments on the *Public Health Assessment* (PHA) to protect the community residents from the health risks posed by coal ash exposure.

Response:

The final conclusions have been thoroughly discussed.

Respectfully submitted,

/s/

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APPENDIX

Table 1. Exceedances of the EPA water quality criterion for human health for fish consumption for arsenic (0.14 ug/L), according to TVA surface water data, December 23, 2008 – May 8, 2009[1]

Date	Site	Type	Concentration , ug/L*
12/23/2008	Clinch River mile 0.0	Dissolved	3
		Total	3
1/7/2009	Clinch River mile 0.0	Dissolved	7
		Total	14
1/9/2009	Clinch River mile 0.0	Dissolved	3
		Total	5
1/11/2009	Clinch River mile 0.0	Dissolved	2
		Total	2
3/16/2009	Clinch River mile 0.0	Dissolved	ND
		Total	7
3/27/2009	Clinch River mile 0.0	Dissolved	ND
		Total	8
4/8/2009	Clinch River mile 0.0	Dissolved	1
		Total	2
1/7/2009	Clinch River mile 2.0	Dissolved	24.2
		Total	93.7
1/9/2009	Clinch River mile 2.0	Dissolved	3
		Total	3.9
3/16/2009	Clinch River mile 2.0	Dissolved	ND
		Total	7
3/27/2009	Clinch River mile 2.0	Dissolved	ND
		Total	4.3
4/15/2009	Clinch River mile 2.0	Dissolved	ND
		Total	2.1
4/29/2009	Clinch River mile 2.0	Dissolved	ND
		Total	2.6
5/1/2009	Clinch River mile 2.0	Dissolved	ND
		Total	2.26
1/7/2009	Clinch River mile 4.0	Dissolved	21.6
		Total	109
1/28/2009	Clinch River mile 4.0	Dissolved	ND
		Total	3.25
3/16/2009	Clinch River mile 4.0	Dissolved	ND
		Total	3.35
12/23/2008	Emory River mile 0.1	Dissolved	11
		Total	20.2
1/7/2009	Emory River mile 0.1	Dissolved	27.3
		Total	132
1/9/2009	Emory River mile 0.1	Dissolved	2.18
		Total	2.54
3/16/2009	Emory River mile 0.1	Dissolved	ND
		Total	3.44
3/27/2009	Emory River mile 0.1	Dissolved	ND
		Total	2.41
12/22/2008	Emory River mile 1.0	Dissolved	14.5
		Total	38.6
12/22/2008	Emory River mile 1.75	Dissolved	15.1
		Total	58.9
12/23/2008	Emory River mile 1.75	Dissolved	7.25
		Total	12.4
1/7/2009	Emory River mile 1.75	Dissolved	28.1
		Total	189
1/21/2009	Emory River mile 1.75	Dissolved	2
		Total	2
3/16/2009	Emory River mile 1.75	Dissolved	ND
		Total	2.93
1/7/2009	Emory River mile 2.0	Dissolved	19.3
		Total	131
2/18/2009	Emory River mile 2.0	Dissolved	2.93
		Total	4.77
3./25/2009	Emory River mile 2.0	Dissolved	ND
		Total	2.79
1/7/2009	Emory River mile 4.0	Dissolved	4.77
		Total	16.3

*Concentrations have been converted from mg/L to ug/L.

[1] TDH (2009) at 111-70.

Public Commenter 6

From: >
To: <EEP.Health@tn.gov>
Date: 2/6/2010 9:49 AM
Subject: Comments on Exposure to Coal Ash

Sirs,

I am submitting comments the draft Public Health Assessment on exposure to coal ash. The draft assessment of no health danger to humans lacks significant evidence of determination of what are the potential long term effects of exposure to coal ash on humans. Long term health concerns have been raise at locations in other states on the long term human health effects to human exposure. It is my concerns that discounting these findings would be a serious mistake by the TN Department of Health. Especially with the lack of knowledge of studying the exposure impacts on children. The placement of schedule screening on impacted children must be done. The priority is to assure citizens of efforts to catch health problems before they are untreatable.

The present assessment does nit take into account long term exposure and the procedures needed to catch health exposure problems before they are untreatable. The implementing of screening assures citizens that they concerns are being address. Prior long term exposure health problems have been documented in other states. A screening programs of resident should be implemented to over the long term concerns over the next 5 to ten years to catch health concerns before they are untreatable. It would be a serious mistake to determine "No health danger" based upon present health status of residents and their children.

I thank you for this opportunity to submit comments if the draft.

Sincerely,

Response: The Public Health Assessment looked at long-term chronic effects of exposure to coal ash. TDH did not conduct blood tests or other forms of biomonitoring. Any exposure from any route or any media would have been very brief. The weather and the wetness of the ash precluded it from becoming air-borne. Any dermal exposure or incidental ingestion would have been possible only for a very few days. Any such exposures would have been impossible to detect with any type of biomonitoring. A central tenet of health assessments is that somehow enough of the chemicals of concern have to get inside someone for a long enough time before they can do harm.

TVA has arranged, through Oak Ridge Associated Universities (ORAU), for medical examinations, including blood testing, of anyone living near the spill who wants it. The protocol for the examinations was carefully developed by occupational and environmental physicians from the University of Colorado School of Public Health, Vanderbilt Medical Center medical toxicologists, and ORAU scientists. The protocol includes blood testing.

Public Commenter 7

From:	>
To:	<EEP.Health@tn.gov>
Date:	2/8/2010 8:15 AM
Subject:	Regarding TDH's PHA for Kingston ash spill

Dear Sir or Madam:

The implication in the recently published assessment that the Kingston coal ash spill poses little public health threat is ridiculous knowing what we know about the human health impacts of aerial and waterborne ash. Furthermore, it contradicts the experiences of a number of residents of the affected region.

The report states that ash and the toxic metals contained within have not "gotten into private well or spring water". But, what of the massive contamination of the Clinch and Emory rivers, and seepage into groundwater?

The report states that the coal ash did not "increase particulate matter [...] in the ambient air around the site". Some of it may have blown away, but the impacts of inhaling toxic particulates within the first several weeks after the spill (when poor air quality was independently documented by citizen monitors) must not be underestimated.

Finally, it states: "Screening people's blood or urine for metals would not be helpful." Right. Not helpful to TVA's mounting liability for this catastrophe.

Frankly, this report smells like a cover-up. An independent (out-of-state experts with a citizen review board) investigation should be conducted. Unless the true magnitude of what happened last December in Kingston comes to light, negligent utilities and coal companies will continue to allow these things to happen.

Sincerely,

Response: This Public Health Assessment was reviewed by three outside peer reviewers who are experts in their fields. Two of the three reviewers fully support the conclusions and discussion and conclude that the report is valid. One reviewer had issues with how the conclusions were worded, but not with how the environmental sampling data was interpreted. All possible routes of exposure were discussed in the report: groundwater, surface drinking water, surface recreational water, the ash itself, and air. The report looked at site-specific data and drew conclusions based on actual data rather than generic information about coal ash.

TDH did not conduct blood tests or other forms of biomonitoring. Any exposure from any route or any media would have been very brief for this particular spill. The weather and the wetness of the ash precluded it from becoming air-borne. Any dermal exposure or incidental ingestion would have been possible only for a very few days. Any such exposures would have been impossible to detect with any type of biomonitoring. A central tenet of health assessments is that *somehow enough of the chemicals of concern have to get inside someone for a long enough time before they can do harm.*

TVA has arranged, through ORAU, for medical examinations, including blood testing, of anyone living near the spill who wants it. The protocol for the examinations was carefully developed by occupational and environmental physicians from the University of Colorado School of Public Health, Vanderbilt Medical Center medical toxicologists, and ORAU scientists. The protocol includes blood testing.

Public Commenter 8

From: >
To: <EEP.Health@tn.gov>
Date: 2/8/2010 7:09 AM
Subject: Long term Effects

I definitely think that screening for toxic heavy metals should be conducted on residents in the surrounding area of the coal ash spill. My husband grew up in Herculaneum, MO and was exposed to lead in air and water for approximately 18 years until he left for college. The lead smelter was then called St. Joe Lead Company, which is now listed as Doe Run Lead. When growing up, he had chronic GI pains, fatigue, and low weight. The St. Joe doctor, the only MD in area, never addressed the lead poisoning or analyzed his blood for lead. Fifty years later he and his 2 sisters all have neuropathies in hands and feet and neurological damage. This damage is just from lead exposure, who knows the potential health risks from the combined effects of arsenic, beryllium, cadmium, chromium, lead, selenium, thallium, and vanadium. Children are more affected and at risk; this fact cannot be ignored.

Response: I am sorry that your husband did not have anyone to protect him from lead exposure at Herculaneum. We did not ignore any potential risks to children or adults at the ash spill. The Public Health Assessment is a site-specific analysis of the spill and its potential for harm to people.

TDH did not conduct blood tests or other forms of biomonitoring. Any exposure from any route or any media would have been very brief for this particular spill. The weather and the wetness of the ash precluded it from becoming air-borne. Any dermal exposure or incidental ingestion would have been possible only for a very few days. Any such exposures would have been impossible to detect with any type of biomonitoring. A central tenet of health assessments is that somehow enough of the chemicals of concern have to get inside someone for a long enough time before they can do harm.

TVA has arranged, through ORAU, for medical examinations, including blood testing, of anyone living near the spill who wants it. The protocol for the examinations was carefully developed by occupational and environmental physicians from the University of Colorado School of Public Health, Vanderbilt Medical Center medical toxicologists, and ORAU scientists. The protocol includes blood testing.

Public Commenter 9

From: >
To: <EEP.Health@tn.gov>
Date: 2/6/2010 1:25 PM
Subject: TDA is denying their responsibility.

The TVA spill Toxic Coal Ash Threatens the Health and Environment and is a human carcinogen (based on occupational exposure studies) associated with increased risks of skin, lung, and bladder cancers" Additionally, those same scientists strongly recommend "long-term follow-ups of various population groups, including children and adolescents, pregnant women, persons exposed in utero, and individuals with pre-existing broncho-pulmonary diseases and diabetes mellitus" because of the ash's radioactive and heavy metal content, and because of the likelihood of fine particles becoming resuspended in the air.

It's outrageous for TDH to state "screening people's blood or urine for metals would not be helpful". These people have been poisoned and TDA is denying their responsibility.

Sincerely,

Response: TDH did not conduct blood tests or other forms of biomonitoring. Any exposure from any route or any media would have been very brief for this particular spill. The weather and the wetness of the ash precluded it from becoming air-borne. Any dermal exposure or incidental ingestion would have been possible only for a very few days. Any such exposures would have been impossible to detect with any type of biomonitoring. A central tenet of health assessments is that somehow enough of the chemicals of concern have to get inside someone for a long enough time before they can do harm.

TVA has arranged, through ORAU, for medical examinations, including blood testing, of anyone living near the spill who wants it. The protocol for the examinations was carefully developed by occupational and environmental physicians from the University of Colorado School of Public Health, Vanderbilt Medical Center medical toxicologists, and ORAU scientists. The protocol includes blood testing.

Certification

This Tennessee Valley Authority (TVA) Kingston Fossil Plant Coal Ash Release Public Health Assessment was prepared by the Tennessee Department of Health's Environmental Epidemiology Program under a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was prepared in accordance with the approved methodology and procedures that existed at the time the health assessment was begun. The editorial was completed by the cooperative agreement partner.

Technical Project Officer, CAT, SPAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with the findings.

Team Leader, CAT, SPAB, DHAC, ATSDR