Tennessee Valley Authority
Regulatory Submittal for Kingston Fossil Plant

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TVA Kingston Fossil Plant Release Site On-Scene Coordinator Report Addendum for the Time-Critical Removal Action
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Submitted to whom
Leo Francendese, EPA

Concurrence

Received	Not Applicable	TVA	Initials	Date
☒	☐	Steve McCracken	SAM.	12/8/11
☒	☐	Kathryn Nash	KAN	12/8/11
☒	☐	Dennis Yankee	via e-mail	12/8/11
☒	☐	Michelle Cagley	mmc	12/8/11
☒	☐	Mark Hastings	DMH	12/8/2011
☒	☐	Neil Carriker	via e-mail	12/8/11
☒	☐	Tom Heffernan	[illegible]	12/8/11

Received	Not Applicable	Jacobs	Initials	Date
☒	☐	Jack Howard		
☒	☐	Bruce Haas		

Approvals

Leo Francendese OSC
Digitally signed by Leo Francendese OSC
DN: cn=Leo Francendese OSC, c=US, o=USEPA, ou=R4 ERRB, email=francendese.leo@epa.gov
Reason: I am approving this document as the EPA OSC per the TVA Kingston AOC
Date: 2012.01.30 20:03:13 -05'00'

EPA ____________________ Date ________

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TVA Kingston Fossil Fuel Plant Release Site On-Scene Coordinator Report Addendum for the Time-Critical Removal Action

Addendum No. 01

Harriman, Roane County, Tennessee

Tennessee Valley Authority

Revision	Description	Date
00	OSC Report Addendum for TVA Review	November 11, 2011
01	OSC Report Addendum for Regulator Review	December 7, 2011
02	OSC Report Addendum Final	January 30, 2012

Additional information regarding the TVA Kingston Fossil Fuel Plant Release Site and the time-critical removal action can be found on the following websites:

U.S. Environmental Protection Agency (EPA) website:
www.epakingstontva.com/

Tennessee Department of Environmental Conservation (TDEC) website:
http://tennessee.gov/environment/kingston/

Tennessee Valley Authority (TVA) website:
www.tva.gov/kingston

Tennessee Department of Public Health (TDPH) website:
http://health.state.tn.us/coalashspill.htm

Roane County Community Advisory Group (CAG) website:
www.roanecag.org/

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References (on CD)

List of Acronyms

AECOM	AECOM Technology Corporation
BOR	U.S. Department of the Interior's Bureau of Reclamation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cy	cubic yard
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ERM	Emory River Mile
FS	factor of safety
ICS	Incident Command System
Jacobs	Jacobs Engineering Group Inc.
mg/L	milligram per liter
msl	mean sea level
NEF	no erosion filter
NPDES	National Pollution Discharge Elimination System
OIG	TVA Office of the Inspector General
STA	station
Stantec	Stantec Consulting Services, Inc.
SWSHP	Site Wide Safety and Health Plan
TDEC	Tennessee Department of Environment and Conservation
TRM	Tennessee River Mile
TSS	total suspended solid
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USACE	U.S. Army Corps of Engineers
WBS	work breakdown structure

ACKNOWLEDGEMENT

Under penalty of law, I certify that to the best of my knowledge, after appropriate inquiries of all relevant parties involved in the preparation of the report, the information submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Steve McCracken, TVA General Manager, TVA Kingston Fossil Fuel Plant Release Site

Signature [signature] Date 12/7/011

EXECUTIVE SUMMARY

On December 22, 2008, approximately 5.4 million cubic yards of ash material were released into the environment from the Tennessee Valley Authority (TVA) Kingston Fossil Fuel Plant (plant) in Harriman, Roane County, Tennessee. In response to this release, TVA undertook immediate response actions and worked in close coordination with the U.S. Environmental Protection Agency (EPA) Region 4, the Tennessee Department of Environment and Conservation (TDEC), and other agencies to provide for the safety of area residents, to contain released ash and minimize its downriver migration, and to monitor and assess air and water quality. Following the initial response actions, EPA issued a Transfer of Federal Lead Agency Authority memorandum, transferring lead agency authority from EPA to TVA on January 11, 2009. On January 12, 2009, TDEC issued a Commissioner's Order to TVA requiring the comprehensive assessment, cleanup and restoration of areas impacted by the release. On May 11, 2009, an Administrative Order and Agreement on Consent (EPA Order) was signed between EPA and TVA providing the regulatory framework for the cleanup efforts under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). TVA undertook response actions to achieve short-term strategic Site objectives defined in the EPA Order as time-critical removal actions. These removal actions were executed within the framework of the Incident Command System Unified Command; TVA was the lead agency for the time-critical removal action; the EPA On-Scene Coordinator (OSC) approved all actions in consultation with TDEC.

The U.S. Bureau of Reclamation (BOR) provided particular support to the EPA OSC during the Dike C reinforcement in engineering consultation and review. To expedite work and improve technical effectiveness of the action, the EPA assigned a fulltime onsite BOR representative to oversee construction activities. This allowed for quicker turn-around times on ash removal concurrences and improved the communication process.

An OSC Report (Ref. 13.1) was prepared to summarize the time-critical removal actions taken to comply with the EPA Order through December 2010. The OSC Report was approved by the EPA OSC on March 31, 2011. This OSC Report Addendum summarizes the time-critical actions that were completed between December 2010 and October 2011, which included in particular the reinforcement of Dike C surrounding the Ash Pond and Stilling Pond. Approved work plans and/or reports are available at www.epakingstontva.com.

SUMMARY OF EVENTS

Ash, a by-product of burning coal in power generation plants, contains naturally-occurring metals and radionuclides that are hazardous substances as defined by CERCLA. At the Kingston plant, ash had been washed out of the power generation facilities and sluiced in a water-based slurry to an Ash Pond for settling. Prior to the release, the ash was then dredged from the Ash Pond and piped to long-term unlined storage ponds, also known as dredge cells. The dredge cells were permitted by TDEC as a Class II Solid Waste Landfill under state regulations. When the release occurred, a section of the Dike C containment dike surrounding the Class II landfill collapsed, releasing the ash. The wet ash material flowed into area waters, including the Emory River, adjacent tributaries and sloughs, and adjoining shorelines. The material covered approximately 300 acres of Watts Bar Reservoir, including most of the Swan Pond Embayment north of the former Dredge Cell. The area affected by the released ash is known as the TVA Kingston Fossil Fuel Plant Release Site (the Site). The ash deposits filled the navigation channel and affected flood levels by obstructing river flow.

Emergency response actions were taken immediately after the release happened and continued until EPA transferred lead agency authority to TVA. Thereafter, TVA continued to respond under the approval authority of TDEC as specified in the January 12, 2009, Commissioner's Order. Time-critical actions under the EPA Order began immediately following issuance of that order on May 11, 2009. These actions included dredging, mechanical excavation, dewatering/ash processing, loading/transport/disposal, and other related actions.

A Structural Integrity Evaluation, completed in August 2009, recommended a rock buttress along the remaining sections of Dike C to reinforce the dike against shallow surface slumping in accordance with dam safety guidelines.

Construction of the rock buttress reinforcement along Dike C was begun on December 7, 2009, and was completed on August 6, 2011. In association with the Dike C reinforcement, a bridge and a portion of the causeway were removed from the Kingston plant's Intake Channel to allow placement of the rock buttress. The bridge and causeway removal was completed on July 7, 2011. In addition, the plant's effluent discharge diffusers located on Dike C near the bridge were replaced with temporary siphons, which began operating on June 7, 2011; the diffusers were subsequently replaced by October 14, 2011. Dike stability evaluations and inspections were routinely conducted throughout the time-critical removal action.

EFFECTIVENESS OF REMOVAL ACTIONS

Details of the removal actions, and improvements approved by the EPA OSC to increase their productivity and effectiveness, are described below and in further detail in Section 2 of this OSC Report Addendum.

Effectiveness of Dike C Reinforcement. Buttress construction along Dike C increased the factor of safety and reduced the potential for a deep-seated slope failure. Reinforcement consisted of a graded filter (sand and stone aggregate) covered with riprap. Improvements to buttress construction included use of a rock slinger to place filter materials in the flatter slope sections along the Emory River, and revisions to filter material gradation specifications to match materials available from local sources.

Effectiveness of Removal of Bridge/Causeway. An existing bridge structure was removed to expedite the construction of the full buttress through the bridge area. In addition, a portion of the adjoining causeway was removed to widen the flow channel and maintain hydraulic capacity of the Intake Channel. Removal of the bridge and causeway improved safety by eliminating the potentially unstable bridge piers and expedited construction by removing the bridge as an obstacle to placing filter and buttress materials.

Effectiveness of Siphon Installation and Diffuser Replacement. Existing diffusers were removed to facilitate construction of the full buttress in the area of the diffusers. Removal of the diffusers improved effectiveness of the buttress construction by avoiding interruption to the plant effluent discharge from the Stilling Pond while the buttress materials were being placed.

MONITORING AND ANALYTICAL RESULTS

Dike Instrumentation Monitoring. A network of inclinometers and piezometers were installed along Dike C to monitor dike stability. One inclinometer, Station 34 near the bridge, indicated a slope creep toward the Intake Channel over a 12-month period. Measurements taken after the buttress was completed indicated that the slope creep had stopped.

Turbidity Monitoring. Turbidity monitoring included Hydrolabs stationed in the Emory River and Intake Channel during time-critical removal action dredging operations and visual observations of water quality during the Dike C reinforcement. These observations indicated no adverse impact to water quality outside the turbidity curtains.

Material Sampling. Material testing included gradation testing to verify that materials placed in the completed buttress provided adequate filter to ensure integrity of the dike due to seepage from the Ash Pond and Stilling Pond. Difficulties were encountered in meeting strict specification requirements. Through further design analysis and filter testing, material specifications were reevaluated in two design addendums to allow use of materials available from local sources.

Stilling Pond Monitoring. Monitoring of plant effluent from the Stilling Pond continued throughout the buttress construction, including sampling from the temporary siphons. Results verified no exceedance of permitted discharge requirements.

SAFETY AND HEALTH

Details of the safety and health program are provided in Section 4 of the OSC Report, including safety and health incidents through December 2010. There were no additional safety and health incidents or reportable environmental events associated with the Dike C reinforcement activities.

PUBLIC INFORMATION AND COMMUNITY RELATIONS ACTIVITIES

EPA and TVA established community involvement programs to facilitate communication with the surrounding community. Communication tools were used to interact with the community and expand understanding about the Site. These communication tools included establishing an Administrative Record and Information Repository, websites and electronic media, a Community Outreach and Learning Center, and a Community Advisory Group. TVA established an Economic Development Foundation to provide more than $40 million in economic development funds for locally identified projects. TVA placed public notices announcing public comment periods in the local newspaper and by email, held availability sessions and public meetings, prepared responsiveness summaries for each public comment period, issued fact sheets, newsletters, and handouts, and erected road signs and electronic message boards. EPA and TVA maintained active media relations and identified opportunities to speak to local government bodies, schools, and civic/community organizations.

RESOURCES COMMITTED

TVA has recorded an estimate in the amount of $1.2 billion for the total cost of cleanup related to the release. Costs incurred since the event, through the time-critical removal action, totaled $589 million, which includes $16.9 million for the Dike C reinforcement and associated activities. EPA costs incurred have totaled $5 million.

DIFFICULTIES ENCOUNTERED, MEASURES TAKEN, AND CONCLUSIONS

Operational Difficulties. Measures were taken during the time-critical removal action to expedite ash removal and mitigate other operational difficulties, as described in Section 7 of this OSC Report Addendum. The following summarizes the conclusions.

- Measures to maintain the quality of in-place manufactured sand improved constructability and expedited material approval. A source of quartz-based sand was located to replace limestone-based sand that had been found to degrade during material handling, which in turn resulted in a higher fines content in the material. Rubber-tired equipment was used to replace tracked equipment and material handling protocols were revised to limit material stockpile rework and avoid degradation of the fines content. Gradation specifications were revised to allow use of an averaging methodology, broader gradation bandwidths, and increased frequency of sampling of the stockpiled sand material. Laboratory filter tests, conforming to a No Erosion Filter, were completed to verify acceptability of the revised bandwidths. EPA OSC approval to use the quartz-based sand based on results of NEF testing expedited construction by preventing costly delays in the supply of material of suitable quality. This allowed buttress construction to proceed using the available sand material without delaying the December 2010 restart of the Dike C reinforcement.

- Measures to mitigate a collapsed bridge pier successfully avoided restriction of flow in the Intake Channel. Cooperative efforts of project stakeholders, including EPA, BOR, construction operators, and design engineers, were critical in providing expeditious repair of the collapsed pier.

1 SUMMARY OF EVENTS

1.1 SITE CONDITIONS AND BACKGROUND

On December 22, 2008, approximately 5.4 million cubic yards (cy) of ash material were released into the environment from the Tennessee Valley Authority (TVA) Kingston Fossil Plant (plant) in Harriman, Roane County, Tennessee. In response to this release, an Incident Command System (ICS) Unified Command structure was implemented consisting of the U.S. Environmental Protection Agency (EPA) Region 4 as the lead agency, the Tennessee Department of Environment and Conservation (TDEC), and TVA. TVA undertook immediate response actions and worked in close coordination with the EPA, TDEC, and other agencies to provide for the safety of area residents, to contain released ash and minimize its downriver migration, and to monitor and assess air and water quality. Following the initial response actions, EPA issued a *Transfer of Federal Lead Agency Authority* memorandum, transferring lead agency authority from EPA to TVA on January 11, 2009 (Ref. 2.1). On January 12, 2009, TDEC issued a Commissioner's Order to TVA requiring the comprehensive assessment, cleanup and restoration of areas impacted by the release (Ref. 7.1). On May 11, 2009, an Administrative Order and Agreement on Consent (EPA Order) (Ref. 8.1) was signed between EPA and TVA providing the regulatory framework for the removal actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Ref. 8.1). TVA undertook time-critical actions to achieve short-term strategic Site objectives defined in the EPA Order. The *TVA Kingston Fossil Fuel Plant Release Site On-Scene Coordinator Report for the Time-Critical Removal Action, May 11, 2009 through December 2011*, Document No. EPA-AP-030 (Ref. 13.1), was prepared to summarize the time-critical removal actions taken to comply with the EPA Order through December 2010. The OSC Report was approved by the EPA OSC on March 31, 2011. This OSC Report Addendum summarizes the time-critical actions that were completed between December 2010 and October 2011, which included in particular the reinforcement of Dike C surrounding the Ash Pond and Stilling Pond. This report addendum has been prepared in conformance with the requirements of EPA's Office of Solid Waste and Emergency Response Directive No. 9360.3-03 (Ref. 6.1 and Ref. 6.2).

The TVA Kingston Fossil Plant (plant) is located just off Swan Pond Road in Harriman, Roane County, Tennessee, near the city of Kingston (Figure 1). The plant typically generates 10 billion kilowatt-hours of electric power each year, consuming approximately 14,000 tons of coal per day and generating approximately 1,000 dry tons, or approximately 1,200 cy, of ash per day as a by-product when operating at full power. Prior to the release, the ash had been sluiced as a water-based slurry to a pond for settling. Prior to the release, the ash was then dredged from the ash settling pond and piped to long-term unlined storage ponds, also known as dredge cells.

The ash settling pond was constructed in 1961, and consists of areas referred to as the Lateral Expansion, Stilling Pond, and Ash Pond (Figure 2). The intermediate dike separating the Ash Pond and Stilling Pond was installed between 1976 and 1984. The Lateral Expansion remained part of the Ash Pond until 2008 when TDEC permitted the northern half of the Ash Pond as a storage area. The "Stilling Pond" is a triangular-shaped area located immediately east of the Ash Pond and Lateral Expansion area. The Stilling Pond is used for final treatment of plant wastewaters prior to discharge under the Kingston plant's National Pollutant Discharge Elimination System (NPDES) permit. The Ash Pond and Stilling Pond have approximately 40 ft of underlying ash deposits.

Dike C was initially constructed in 1961 as the perimeter dike separating the ash settling pond from Swan Pond Embayment to the north, the Emory River to the east, and the Kingston plant Intake Channel to the south (Figure 3). Subsequent modifications raised the top crest of the dike to approximately elevation 765 ft mean sea level (msl). The section of Dike C north of the former Dredge Cell was destroyed during the ash release. The remaining sections of Dike C extend along the northern boundary of the Lateral

Expansion, the eastern and southern boundaries of the Stilling Pond, and the southern boundary of the Ash Pond. Dike C is used to contain both pond water and ash deposited within the ponds.

The plant is located on the Emory River close to the confluence of the Clinch and Tennessee Rivers. The Emory River at the plant is impounded by Watts Bar Dam. The normal summer and winter pool levels of Watts Bar Reservoir in the vicinity of the plant are 741 and 735 feet msl, respectively.

1.1.1 Initial Situation

On Monday, December 22, 2008, a containment dike surrounding a portion of the Class II landfill collapsed, releasing approximately 5.4 million cy of fly ash and bottom ash. The initial situation is further described in the EPA-approved OSC Report, Document No. EPA-AP-030 (Ref. 13.1).

1.1.2 Location of Hazardous Substance(s)

The ash material contains naturally-occurring metals and radionuclides that are hazardous substances as defined by CERCLA Section 101(14). The released ash extended through several miles of riverways. Initially, the ash may have traveled upriver as far as Emory River Mile (ERM) 5.75 and as far downriver as Tennessee River Mile (TRM) 564. During the time-critical removal action, further downriver migration of ash occurred into the Clinch and Tennessee Rivers in response to large rainfall and high river flow events. Dredging of the Emory River during the time-critical removal action removed approximately 3,511,000 cy of released ash and sediment, but not all ash was retrieved. Approximately 532,000 cy of ash was estimated to remain in the river system, as described in the EPA-approved OSC Report (Ref. 13.1). That remaining material is being addressed under a subsequent non-time-critical removal action.

1.1.3 Cause of Release or Discharge

TVA hired AECOM Technology Corporation (AECOM) to determine the most probable cause(s) and location of failure at the Site. AECOM published a Root Cause Analysis Report where more information can be found (Ref. 9.1). AECOM concluded that rapid failure of the active Dredge Cell 2 was progressive in nature due to four concurrent factors: (1) fill geometry, (2) increased fill rates, (3) soft foundation soils, and (4) loose wet ash (Ref. 13.1).

The TVA Office of the Inspector General (OIG) hired Marshall Miller & Associates to conduct an independent peer review of AECOM's root cause analysis and a review of TVA's ash management practices. The TVA OIG published an Inspection Report where more information can be found (Ref. 9.2). The OIG Inspection Report concluded that management practices or policies and procedures contributed to the release by allowing conditions to advance to the critical stage that precipitated the release. In response, TVA management reassessed its management program and undertook several actions to improve its organizational effectiveness, including: organizational changes to address management and accountability issues; changes designed to alter the corporate culture which had de-emphasized the importance of ash management; and steps to assess ash storage facilities against dam safety guidelines.

In November 2009, a TDEC Advisory Board published its report of lessons learned from the Dredge Cell failure (Ref. 9.3). The TDEC Advisory Board concluded that emphasis should be on improved life-cycle design requirements by employing: thorough engineering design principles; effective engineering safety monitoring, inspection, and follow-up maintenance; and an engineering philosophy and long-term plan that can be safely followed and modified as needed, as these types of facilities evolve.

1.1.4 Injury/Possible Injury to Natural Resources

Possible injury to natural resources were described in the EPA-approved OSC Report (Ref. 13.1). The ash released into the Swan Pond Embayment and Emory River covered aquatic habitats in this portion of Watts Bar Reservoir. Bottom-dwelling animals (mussels, snails, insects, crayfish, etc.) in areas where large amounts (>6 inches) of ash were deposited were likely unable to escape the release and were smothered by ash deposits. Subsequent surveys indicate that the release appears to have had minimal long-term impacts on the numbers and species of aquatic and terrestrial organisms present. These surveys will continue to be addressed under the *Non-Time-Critical Removal Action for the River System, Sampling and Analysis Plan (SAP), Revision 3*, Document No. EPA-AO-021 (Ref. 4.1).

1.1.5 Efforts to Obtain Response by Responsible Parties

Initial responses to the release are described in the EPA-approved OSC Report (Ref. 13.1). Considerable activity occurred at the Site immediately after the release. These activities occurred under the ICS, Unified Command structure. EPA was the lead agency, which included approval authority, until January 11, 2009. TDEC then became the approval authority until May 11, 2009, when the EPA Order was issued. The TDEC Commissioner's Order remained in effect, but TDEC agreed that work performed under the EPA Order, in consultation with TDEC, would satisfy portions of the TDEC Order.

Immediate actions included: (1) closure of the river to boats not associated with the removal action, (2) management of flows of the Clinch and Tennessee Rivers by controlling the releases from area dams, (3) ash migration control by installing weirs and dikes to reduce downriver migration of ash, (3) repair of the railroad, roadways, and utilities; (4) containment and removal of cenospheres and debris in the river; (5) construction of storm water management systems, including clean water diversion ditches and ash water collection and settling basins, (6) control of dust to reduce air-borne silica, (7) monitoring of river water, drinking water, and air quality; (8) stabilization of the failed Dredge Cell through dike reinforcement; (9) a pilot dredging program; and (10) extensive community outreach activities.

On May 11, 2009, an EPA Administrative Order and Agreement on Consent (EPA Order) was signed between EPA and TVA providing the regulatory framework for the removal actions under CERCLA (Ref. 5.2.1). The parties agreed to expeditiously and efficiently prioritize and conduct response actions.

An Action Memorandum for the time-critical removal action was approved on August 4, 2009, which outlined the dredging of ash from the river to meet the requirements of the EPA Order (Ref. 8.1). The Action Memorandum also required completion of a Structural Integrity Evaluation, including developing recommendations and a maintenance plan for existing Site dikes/berms being used to contain spilled ash. The reinforcement of Dike C was undertaken in response to this need to maintain the structural integrity of existing Site dikes/berms.

1.2 ORGANIZATION OF THE RESPONSE

The organization of the time-critical removal action was via the ICS under a Unified Command, as shown on the EPA website located at http://www.epakingstontva.com and Ref. 1.2. While TVA retained responsibility as the lead Federal agency, EPA retained approval authority over the actions taken to clean up the Site in consultation with TDEC. TDEC also retained authority in specific areas, such as final closure of the failed Dredge Cell. In addition, other agencies were involved such as the U.S. Coast Guard, Bureau of Reclamation (BOR), the Agency for Toxic Substances and Disease Registry, U.S. Army Corps of Engineers (USACE), and the Tennessee Department of Health.

1.3 CHRONOLOGICAL NARRATIVE OF RESPONSE ACTIONS

Time-critical actions began following issuance of the EPA Order on May 11, 2009. The time-critical actions were taken for threat abatement to meet the short-term strategic objectives for the Site, and are described in the EPA-approved OSC Report (Ref. 13.1). These actions included dredging, mechanical excavation, dewatering/ash processing, loading/transport/disposal, and other related actions.

A Structural Integrity Evaluation, as required by the EPA Order was completed by Stantec Consulting Services, Inc. (Stantec) on August 3, 2009, and presented in the *Report of Geotechnical Exploration and Slope Stability for Dike C* (Ref. 5.2.2). As a result of that evaluation, Stantec recommended a rock buttress along Dike C to reinforce the dike stability against shallow surface slumping.

Construction of the rock buttress reinforcement along Dike C was begun on December 7, 2009, and was completed on August 6, 2011. In association with the Dike C reinforcement, a bridge and a portion of the causeway were removed from the plant's Intake Channel to allow placement of the rock buttress. The bridge and causeway removal was completed on May 31, 2011. In addition, the plant's effluent discharge diffusers located on Dike C near the bridge were reconfigured to accommodate the longer slope of the buttress (see Figure 6). During construction of the buttress, temporary siphons were installed to maintain the Stilling Pond level while the discharge diffusers were removed to allow the buttress to be completed in that area. The discharge diffusers were reinstalled on September 26, 2011. Final work on the diffusers and buttress was completed October 14, 2011. Dike stability evaluations and inspections were routinely conducted throughout the time-critical removal action.

2 EFFECTIVENESS OF REMOVAL ACTIONS

2.1 ACTIONS TAKEN BY TVA

Comprehensive operations conducted by TVA under the time-critical removal action are summarized in the EPA-approved OSC Report (Ref. 13.1). The following sections describe the effectiveness of the actions taken to reinforce Dike C, as well as the associated actions taken to remove the bridge and causeway and install temporary siphons for plant effluent discharge.

2.1.1 Facility Assessments

In accordance with the EPA Order (Section XI, Paragraph 33) and the January 12, 2009, TDEC Commissioner's Order, Stantec conducted structural integrity assessments of existing coal ash impoundments and landfills at TVA's eleven coal-fired power plants. Results of those assessments were documented in the EPA-approved *Phase 1 Facility Assessment for Coal Combustion Product Impoundments and Disposal Facilities in AL, KY, and TN,* Document No. EPA-AO-004 (Ref. 3.1). The results were presented in a series of three separate reports, one for Alabama facilities, one for Kentucky facilities, and one for Tennessee facilities.

Subsequent evaluations are being performed at these facilities to implement recommended dike reinforcement activities. At the Kingston plant, these evaluations comprise the design and construction activities discussed below for Dike C (Sections 2.1.2.1 and 2.1.3).

In October 2010, Stantec prepared an *Instrumentation Monitoring and Reporting Plan* (Ref. 5.2.4), which formed a portion of the EPA-approved *Dike C Risk Mitigation Work Plan,* Document No. EPA-AWP-035 (Ref. 5.1.1). As follow-on to the facility assessments and monitoring, EPA conducted an inspection of the Ash Pond and Stilling Pond dikes on September 21, 2011 (Ref. 5.2.14). The EPA inspectors classified the dikes as having "significant hazard potential," based on the size and location of the impoundment. EPA inspectors stated that a release due to embankment failure or misoperation could cause economic loss and environmental damage, as the impoundment is adjacent to the Emory River, but would not cause probable loss of human life.

Stantec conducted a subsequent hydrologic analysis based on this classification (Ref. 5.2.15). Results of that reanalysis determined that the Ash Pond would reach a peak water elevation of 764.4 ft msl during a designated design storm of one-half the Probable Maximum Precipitation event. This peak water elevation is below the crest of Dike C (elevation 765.0 ft msl). Therefore, the Ash Pond would be able to pass the design rainfall event through the existing outlet structures without overtopping the dikes, which complies with Tennessee Dam Safety regulations.

2.1.2 Structural Integrity of Dikes

As required by the EPA Order, TVA evaluated the structural integrity of the existing dikes and berms and developed recommendations for dike improvement, maintenance, and inspection. Inspections were conducted in response to the National Incident Management System ICS Unified Command. The EPA OSC relied heavily on consultation with the BOR on reviewing the dike structural integrity evaluations. Four separate dikes were evaluated; additional information is presented in the EPA-approved OSC Report.

1. Dike D, which separates the failed Dredge Cell from the Ash Pond and Lateral Expansion area. Evaluations of Dike D concluded that an emergency buttress system built on Dike D achieved short-term stabilization of the structure, and that adequate Factors of Safety (FS) were provided for slope

stability and steady state seepage under static loading conditions. Dike D will be fully encapsulated as part of the landfill closure under the non-time-critical removal action for the Dredge Cell.

2. Dike 2, which divides the Swan Pond Embayment from the Emory River, was built to prevent further migration of ash into the river from the Site. Evaluations of Dike 2 have concluded that static and seismic conditions are acceptable for water elevations exceeding the 1,000-year design storm event. As directed by the EPA OSC, the outboard slope of Dike 2 was armored to prevent erosion and further evaluation of Dike 2 was referred to the non-time-critical removal action. Dike 2 will be removed near the completion of the non-time-critical removal action for the Dredge Cell.

3. East Dike, which separates the Sluice Trench from the plant Intake Channel. Evaluations of the East Dike concluded that calculated FSs were adequate for both seepage and slope stability considering a deep-seated failure mechanism under long term conditions. The seismic stability analysis concluded that deformations during the design earthquake would be acceptable. The EPA OSC and BOR questioned those conclusions, commenting that (1) specific discussion of the seismic conditions (presence of loose sands) should be added; and (2) recommendations should include improvement to a minimum FS of 4.0 for heave or "blowout" conditions. Resolution of these comments is ongoing; the EPA OSC has referred the East Dike study to the non-time-critical removal action (Ref. 5.2.16).

4. Dike C, which surrounds the Ash Pond and Stilling Pond adjacent to the river. Dike C is the focus of this OSC Report Addendum and is discussed in detail below.

2.1.2.1 Dike C Evaluation

Following the failure of Dike C during the release, TVA contracted with Stantec to perform a stability analysis of the remaining dikes at the Site (Ref. 5.2.2). This analysis was reviewed by the EPA OSC with technical consultation provided by the BOR. Stantec advanced 74 borings at 54 locations and installed instrumentation to monitor conditions potentially affecting the FS of Dike C (see Figure 4). An additional 10 borings were completed in June and July 2010, with piezometers installed to measure water levels, as described in the *Design Report for Segment B of the Dike C Buttress Project* (Ref. 5.2.13). Stantec analyzed five representative cross sections through Dike C.

Results of the seepage analysis (Table 2-1) indicated that upward vertical gradients at the dike toe created the potential for soil piping, as seepage water could erode materials from the interior of the dike. Based on USACE design criteria for dams, a target FS against piping of three was used. The computed FS against piping ranged from 1.3 to 2.7. Therefore, Dike C did not meet acceptable criteria for soil piping due to seepage (Ref. 5.2.2).

Table 2-1. Summary of Computed Exit Gradients and Factors of Safety Against Piping

Cross Section Location	Material	Critical Exit Point	Vertical Gradient (i_v) at Critical Exit Point	Critical Gradient (i_{crit})	Factor of Safety Against Piping (FS_{piping})
108+93	Silty Sand to Sandy Silt	Toe	0.15-0.38	1.03	2.7
119+69	Lean Clay	Toe	0.70-0.74	1.05	1.4
132+37	Clay Starter Dike	Toe	0.73-0.84	1.05	1.3
138+27	Constructed Ash	Toe	0.30-0.42	0.71	1.7
149+14	Silty Sand to Sandy Silt	Toe	0.45-0.50	1.03	2.1

Slope stability analysis evaluated four types of conditions: a deep-seated failure, a shallow failure in the lower "starter" dike, a shallow failure in the upper "raised" dike, and a shallow failure on the upstream (interior pond-side) slope. Based on USACE design criteria for dams, a target FS against slope failure of 1.5 for static, long-term, steady state seepage conditions was used. Results of the analysis (Table 2-2) indicated that although Dike C met acceptable criteria for a deep seated failure, it did not meet criteria for shallow failures. The computed FS against shallow slope failure ranged from 1.13 to 1.42 on the downstream face of Dike C (Ref. 5.2.2).

Table 2-2. Summary of Computed Factors of Safety for Slope Stability

Cross Section Location	Deep Seated Slide	Shallow Slide in Starter Dike	Shallow Slide in Raised Dike	Shallow Slide in Upstream Dike
108+93	1.66	1.42	1.39	not applicable
119+69	1.48	1.25	1.39	1.738
132+37	1.47	1.24	1.22	1.33
138+27	1.52	1.13	1.38	not applicable
149+14	1.49	1.15	1.35	not applicable

In accordance with the EPA Order, the EPA OSC directed TVA to reinforce Dike C so as to meet the minimum required FS against slope failure of 1.5. Stantec recommended the construction of a rock buttress reinforcement of Dike C to achieve an acceptable FS against both soil piping and shallow failures.

2.1.3 Dike C Reinforcement

The Dike C buttress design was begun in August 2009. The length to be buttressed was approximately 5,700 ft. To facilitate design and to address the most urgent hazard potential, Dike C was broken into two phases: Phase 1 focused on the "starter" dike (or lower portion of the dike). The Phase 1 work was then broken into four segments (A through D). Segment A is from the southeastern Redwater Pond Area to the bridge over the plant Intake Channel; Segment B is from the bridge to the skimmer wall; Segment C is from the skimmer wall to the intermediate "divider" dike; and Segment D is from the divider dike to the intersection of Dike D. Each segment had its own design and constructability constraints. Figure 4 is a layout of the Dike C segments, and Figure 5 is a typical cross section of the buttress. Design of the Dike C buttress is further described in the *Design Report for Dike C Buttress* (Ref. 5.2.7), and the supplemental *Design Report for Segment B of the Dike C Buttress Project* (Ref. 5.2.13).

Phase 2 dike reinforcement was originally planned to focus on the "raised" dike (or upper portion of the dike). The *Non-Time Critical Removal Action Embayment/ Dredge Cell Action Memorandum*, Document No. EPA-AO-024 proposed construction of a perimeter containment system encompassing the failed Dredge Cell, Lateral Expansion area, and Ash Pond, which would further stabilize Segments A and D of Dike C. As a result, Phase 2 dike reinforcement is no longer needed in those areas. The EPA OSC concluded that further evaluation of Phase 2 of the Dike C reinforcement should be referred to the non-time-critical removal action. Phase 2 dike reinforcement around the Stilling Pond is being addressed as part of plant operations.

Dike C also suffered from poor maintenance practices which allowed the establishment of mature trees and other vegetation on the embankment slopes. The tree roots penetrated the dike material and the retained ash, which are fine-grained soils that can be eroded by seepage. The tree root penetration could shorten the seepage pathways and a seepage-related internal erosion failure could occur. Scouring of the

Emory River bank along Dike C was also identified as a concern for the stability of the dike. To mitigate this concern, in May 2009, the existing riprap was removed, trees and associated rootballs were removed, and the resulting divot hole was backfilled with clay and compacted. Removal of an initial section of trees was approved by the OSC consultation with the BOR provided that as a safety precaution, road base material (a mixture of gravel, sand, and silt) be stockpiled at the dike for use in seepage control. The initial tree removal resulted in several of the rootball excavations showing the initiation of seepage flow. The road base was immediately placed into the rootball excavations. This action, along with daily visual monitoring provided temporary control of the seepage. A layer of gravel was placed as bedding material, and riprap was placed as a temporary measure until the Dike C buttress could be constructed. An engineered sand filter was incorporated into the design of the Dike C buttress to provide additional protection against the possibility of a seepage-related failure. It was decided that further tree removal would be delayed until shortly before buttress construction in a given location. Excavation and filling of the rootball was subsequently performed just prior to installation of the buttress with filter sand being used to fill the rootball excavation.

Buttress construction proceeded along Dike C in a series of individual panels. Each panel was approximately 20- to 30-ft wide, a distance that could typically be excavated and backfilled within one or two days. The first step consisted of removing any residual ash or vegetation on the surface of the Dike C slope. A graded filter was then constructed by placing aggregate materials in each of three layers: a 6-inch layer of manufactured sand, a 6-inch layer of No. 57 stone, and a 6-inch layer of No. 2 stone. The final step consisted of placing a minimum 3-ft layer of riprap over the graded filter to finish grade, which varied between 6:1 (horizontal:vertical) to 4:1 slope, depending on the segment. Photographs showing the sequence of panel construction are included in Appendix A.

As-built records of the Dike C reinforcement were prepared by Stantec in the *Construction Certification Report, Dike C Buttress Construction, Work Plans 1 to 5* (Ref. 5.2.17). These records provide detailed documentation of the design and design changes, requests for information and non-conformance reports, quality control laboratory testing, daily field reports and weekly meeting minutes, instrumentation details, and record drawings. A summary log of the daily buttress production is presented in Appendix B.

2.1.3.1 <u>Segment D Construction</u>

Dike C buttress construction began in Segment D. Segment D extends from the divider dike to the intersection of Dike D, STA 138+00 to STA 160+00. Construction started on Phase 1, Segment D, on December 7, 2009, which allowed a portion of the buttress to be constructed above the water line, but also required the removal of approximately 6,000 tons of ash, as described in the EPA-approved OSC Report. Initial work consisted of installing an access road and removing surface materials; placement of buttress materials in the first panel began at Station 159+40 on December 21, 2009. Reinforcement of Dike C was implemented in accordance with the EPA OSC-approved *Dike C Risk Mitigation Work Plan*, Document No. EPA-AWP-035 (Ref. 5.1.1). Construction advanced southward from the Dike D intersection toward the Emory River. Segment D was substantially completed on June 4, 2010, and work moved on to Segment C. A 14-ft section of Segment D that had been skipped to allow for removal of dredge piping was completed the week ending June 18, 2010.

During the construction of Segment D, manufactured sand material for construction of the filter consisted of limestone-based sand obtained from Roger's quarries in Roane and Rhea County. Difficulties were frequently encountered in meeting very strict gradation requirements; the need to handle the sand multiple times onsite during placement caused the sand to degrade and increased the amount of fines in the material. These difficulties are discussed further in Section 7.1. To improve sand quality, a source of quartz-based manufactured sand was found from a Crab Orchard quarry that didn't degrade as easily during material handling. The quartz-based sand was then used in the Dike C buttress construction when work resumed in November 2010, as described below.

A total length of 2,140 lin. ft. was constructed for the Segment D buttress, for an average of 90 ft/week while work was ongoing. Work was temporarily slowed between March 22 and April 4, 2010 so that ash could be removed from the adjacent rookery area east of Dike 2. Total quantities of materials placed in Segment D included 11,594 tons of sand, 15,264 tons of No. 57 stone, 13,158 tons of No. 2 stone, and 39,752 tons of riprap.

2.1.3.2 Segment C Construction

Segment C extends along the Emory River from the skimmer wall to the divider dike, STA 128+00 to STA 138+00. Segment C construction was implemented in accordance with the EPA OSC-approved *Dike C Buttress Work Plan - Section C,* Document No. EPA-RAWP-067 (Ref. 5.1.2). Approximately 100 ft of Phase 1 buttress was completed on Segment C by June 22, 2010, when the decision was made to suspend construction until November 2010. That decision was documented in an EPA OSC memorandum, *Request for Temporary Suspension of Dike C Buttress Construction Activity* (Ref. 5.2.3). The decision was made to allow the water level in the river to return to winter pool. Conducting the work during summer pool would potentially have inhibited compaction, caused greater loss of materials, and impeded the visual observations and judgment of the Quality Control Manager. Constructing the buttress during winter pool improved construction because more of the buttress could be constructed above water. Construction of the buttress in Segment C resumed at STA 137+00 on November 2, 2010, and progressed south along the Emory River toward the skimmer wall.

As described above, to improve sand quality, a source of quartz-based manufactured sand was found from a Crab Orchard quarry that didn't degrade as easily during material handling. The quartz-based sand was used in the Dike C buttress construction when work resumed in November 2010.

Segment C was designed at a 6:1 outboard slope, which was flatter than the 4:1 outboard slope for the northern section of Segment D. Originally, TVA used conventional excavator equipment to place the materials; however, due to the flatter slope and longer slope length, the excavator reach was limited, which slowed production. TVA, in consultation with the BOR, evaluated alternate excavation equipment. In November 2010, TVA's Civil Projects construction division began using a rock slinger to place the sand, the No. 57 stone, and the No. 2 stone. Use of the rock slinger equipment improved the removal action by facilitating placement on the flatter 6:1 slope constructed for Segment C. Improvement in productivity resulted from not having to build an access pad for the excavator to reach the far toe at the bottom of the 6:1 slope. Lift thickness was verified by a survey team using a small boat to measure elevations at the top of each material lift. Segment C was completed on January 18, 2011 at STA 128+00, located just before the skimmer wall peninsula. Construction then moved to Segment A in the Intake Channel.

A total length of 1,000 lin. ft. was constructed for the Segment C buttress, for an average of 70 ft/week while work was ongoing. Total quantities of materials placed in Segment C included 5,852 tons of sand, 9,310 tons of No. 57 stone, 8,512 tons of No. 2 stone, and 26,600 tons of riprap.

2.1.3.3 Segment A Construction

Segment A extends from the southern Redwater Pond Area to the bridge over the plant Intake Channel, STA 107+00 to STA 120+00. Segment A construction was implemented in accordance with the EPA OSC-approved *Dike C Buttress Work Plan - Segment A,* Document No. RAWP-086 (Ref. 5.1.3). The initial conceptual design for Segment A did not include the Redwater Pond (wetland) area located southwest of the Ash Pond at the East Dike. Based on analysis of seepage flow through Dike C from the Ash Pond in July 2010, Stantec determined that the FS against piping was below the required value of 3.0 and the FS against sliding was below the required value of 1.5. As a result, the draft design for Segment A, as documented in *Dike C Buttress Work Plan - Segment A*, extended the buttress through the Redwater Pond area to STA 103+80. In December 2010, Stantec again reviewed the stability analysis for this area using detailed survey information as described in the *Redwater Ponds Area Phase 1 Buttress Construction - Slope Stability Review* (Ref. 5.2.5). Stantec recommended the buttress not extend through the Redwater Pond area, but terminate near STA 107+00, tying into the existing East Dike that contains the Redwater Pond.

The EPA OSC approved the Segment A drawings (*Dike C Buttress Work Plan - Segment A*), with modifications for the Redwater Pond wetland area noted above, on January 27, 2011. Work began on the western end of Segment A on January 20, 2011, in the area of the Redwater Pond. An access ramp was constructed to tie into the buttress at STA 107+20. Construction of the first panel began on January 31, 2011. Work progressed east toward the Intake Channel bridge.

The rock slinger was not used for buttress construction in Segment A because of concerns that water current velocities within the Intake Channel would create excessive turbidity. Therefore, an excavator was used to place the buttress material. Turbidity curtains and booms were deployed during the construction to protect water quality by preventing migration of material out of the work area and by deflecting the current away from the work area. No adverse water quality conditions were observed during the construction (see Section 3).

To construct the buttress using conventional excavator equipment, an access road was built into the Intake Channel at the toe of the buttress, which allowed the excavator to reach the buttress slope to place material. The access road was constructed predominately with riprap approved for buttress construction; more riprap was used than needed for buttress construction in order to raise the height of the road and keep it out of the water. As a result, Segment A used substantially more riprap than Segments C or D. Once the access road was no longer needed, the riprap was spread out to complete the lower toe of the buttress.

Between STA 107+20 and STA 113+50, the buttress was located directly within the current of the Intake Channel. To better control placement of the sand and prevent the current from washing away the material, the construction was improved by sequencing the access road construction with the buttress placement. The access road was extended incrementally along the toe of the slope, forming a slackwater area between it and the slope surface. The buttress materials were then placed within this slackwater area from the end of the access road. The road was then extended to allow another increment of construction. Although a slow process, this sequence improved the ability to control the material placement within the current of the Intake Channel. Turbidity curtains were also installed as a further means to prevent the current from washing away the material.

In March 2011, a brown substance was found to be released from the manufactured filter sand as it was being placed in water in the Intake Channel. The area where work was occurring was a slackwater area with little or no flow. Based on observation of this unknown brown substance, work was stopped until an investigation could be conducted. An additional turbidity curtain was installed to contain the material, which was subsequently removed using a vacuum truck. After discussions with the Crab Orchard quarry, which supplied the manufactured sand, and total organic carbon tests on the material (Ref. 5.2.9), it was determined that the brown substance was naturally-occurring coal dust entrained in the quartz-based sand material. The coal dust did not impact water quality nor buttress operations. Use of the quartz-based sand was preferred over limestone-based sand, which had been difficult to keep within specifications. A technical memorandum was provided to the EPA OSC in March 2011 (Ref. 5.2.8) that identified the following benefits to the project for continuing to use quartz-based manufactured sand from the Crab Orchard quarry:

- Quartz sand would not break down mechanically as easily as limestone-based material during the required onsite handling, thus allowing for more consistent gradation test results of placed material.
- The supply of the quartz-based sand material, especially sand meeting gradation requirements for the finer sieve sizes, would be more consistent, which was very important for filter construction.
- Placing the quartz-based sand material in the water would have lesser impact on turbidity within the slackwater area than the limestone-based sand.

Based on these considerations, the EPA OSC approved the sand to be incorporated into the work (Ref. 5.2.13), which allowed the work to progress in a timely manner and prevented the need to discard any stockpiled sand material.

Segment A filter placement was completed to STA 120+00 by April 19, 2011; the remaining riprap placement was completed by April 26, 2011, and work moved on to Segment B.

A total length of 1,280 lin. ft. was constructed for the Segment A buttress, for an average of 100 ft/week while work was ongoing. Productivity was improved in Segment A over Segment C due to the use of the faster excavator rather than rock slinger equipment, despite placing higher volume of riprap and building the access road. Total quantities of materials placed in Segment A included 8,030 tons of sand, 12,760 tons of No. 57 stone, 13,354 tons of No. 2 stone, and 66,264 tons of riprap.

2.1.3.4 Segment B Construction

Segment B extended from the bridge and diffuser area to the skimmer wall peninsula, STA 120+00 to STA 128+00. In the initial design, the bridge and diffusers were to remain in place, and riprap was to be placed as added weight at the dike toe. Design for Segment B was modified in early January 2011 when it was decided to remove the bridge and diffusers and install a full filter buttress consistent with the remainder of Dike C. For further details on the bridge and diffuser removal actions, see Sections 2.1.4 and 2.1.5, respectively.

Design for Segment B was issued for approval in two parts which allowed time to make design changes pertaining to the bridge and diffuser removal. Part 1 included the section east of the diffuser area, extending across the skimmer wall peninsula and connecting to the termination of Segment C. Part 2 included the section encompassing the bridge and diffusers. The EPA OSC and the BOR expressed concern with the design of Part 1 through the skimmer wall peninsula area and recommended providing seepage protection for the skimmer wall peninsula area (Ref. 5.1.8). To expedite work and allow design modifications to be made to the peninsula area, the EPA OSC approved work in the areas not in question. The approval was documented in an email from the EPA OSC on April 13, 2011 (Ref. 5.1.8). A revised Segment B Part 1 design, incorporating BoR design changes for the skimmer wall peninsula area, was approved by the EPA OSC on May 26, 2011 (*Dike C Buttress Work Plan - Segment B Part 1 of 2,* Document No. RAWP-092 (Ref. 5.1.7). The design for Part 2 was approved by the EPA OSC on May 31, 2011 (*Dike C Buttress Work Plan - Segment B Part 2 of 2,* Document No. RAWP-095 (Ref. 5.1.9).

Buttress construction on Segment B began on April 28, 2011. Work began in the approved areas along the Intake Channel and the Emory River. Completion of the Intake Channel side allowed temporary siphons to be installed so that the diffusers could be removed. Once approval of Part 1 was obtained, buttress construction began on the skimmer wall peninsula area.

While work was being completed on Segment B Part 1, the bridge and causeway removal and the diffuser removal actions were being implemented. Construction work on Segment B Part 2 began on June 29, 2011, once the diffusers and causeway were removed. Work progressed from the bridge on the western end of Segment B Part 2 toward the skimmer wall, and tied into Segment B Part 1 just east of the diffuser headwall. Buttress construction was completed on Segment B on August 5, 2011.

A total length of 800 lin. ft. was constructed for the Segment B buttress, for an average of 70 ft/week while work was ongoing. Productivity was slower in Segment B over other segments because of the confined work areas and extra buttressing required around the skimmer wall peninsula, which lowered the efficiency of operations. Total quantities of materials placed in Segment B included 4,268 tons of sand, 7,414 tons of No. 57 stone, 9,262 tons of No. 2 stone, and 62,194 tons of riprap. Similar to Segment A, more riprap was used in Segment B than Segment C or D due to the construction of the access road and extra riprap placed along the skimmer wall peninsula.

2.1.3.5 Dike Inspections

Dike inspections were completed daily throughout the time-critical removal action to monitor Dike C conditions (e.g., signs of seepage, cracks, vegetation stress, erosion, etc.). Dike inspection reports were prepared to document those inspections and can be found in Ref. 5.2.17. Repairs, predominantly filling of erosion rills, were undertaken promptly in response to any inspection findings. Dike inspections continue to be performed under the non-time-critical removal action.

2.1.3.6 Concurrence Process

The EPA OSC implemented a concurrence process for approval of ash removal from each panel prior to construction of the buttress. The process consisted of the BOR onsite representative inspecting the excavation surface, and giving verbal field approval to proceed. Excavated panels were photographed and a concurrence form was sent to the EPA OSC for review. The EPA OSC indicated final approval by signing the concurrence form, indicating that the panel, or section of buttress, had been reviewed by the EPA and that ash had been removed to levels acceptable to allow for the placement of Dike C buttress construction materials. A total of 236 panel concurrence forms were approved by the EPA OSC based on field approval of the onsite BOR representative. The panel concurrences are provided in (Ref. 5.3). This concurrence process expedited buttress construction by providing real-time field inspection of the panel excavation, allowing subsequent buttress material placement to proceed without delay and minimizing the time the dike surface was exposed. This improved productivity by avoiding delays in buttress placement that could have resulted while waiting for final approval.

2.1.4 Bridge and Causeway Removal

The buttressing for reinforcement of Dike C extended through an area of Segment B where an existing bridge and causeway crossed the Intake Channel, connecting the Stilling Pond with a peninsula area east of the plant. During a bridge inspection by Kingston plant personnel (unrelated to Dike C) in January 2010, it was determined that the bridge was no longer stable due to erosion around its foundation (Ref. 5.2.7). In addition, inclinometer monitoring indicated minor, but continuous, slope creep was occurring near the bridge. Therefore, Stantec recommended a full buttress, consistent with the remainder of Dike C, be installed in the bridge area.

Because of the challenges of constructing a buttress around the existing bridge structure and the structural instability of the bridge, it was decided to remove the bridge structure so as to expedite the construction of the full buttress. Removal of the bridge and causeway improved safety by eliminating the potentially unstable bridge piers and expedited construction by removing the bridge as an obstacle to placing filter and buttress materials. In addition, because the full buttress would extend into the Intake Channel and restrict flow, it was decided to remove a portion of the adjoining causeway so as to widen the flow channel and maintain hydraulic capacity through the Intake Channel to the plant intakes.

Bridge removal was implemented in accordance with the EPA OSC-approved *Intake Channel Bridge Removal Work Plan*, Document No. RAWP-087 (Ref. 5.1.4). Demolition of the bridge was contracted to DEMCO, Inc., a decommissioning and environmental management company. Award of the demolition contract was delayed while decisions were being made on how the existing bridge piers should be removed. It was ultimately decided that the pier closest to the causeway (Pier A) should be removed and the others left in place. Demolition began on May 6, 2011 and was completed on May 31, 2011.

While attempting to prepare Pier A for removal, the pier collapsed into the water. Although no injuries or damage occurred, a report of the incident was prepared to identify the collapse as a near miss and document lessons learned (Ref. 5.2.12). The near miss incident is discussed further in Section 7.2. After consulting with the onsite BOR representative and Stantec as the Engineer of Record, the EPA OSC determined that the pier could be left in place as long as it could be pushed to the bottom of the Intake Channel. Surveys completed during causeway excavation showed that Pier A was at the bottom of the channel and not in the way of construction or Intake Channel flow.

Removal of the causeway was implemented in accordance with the EPA OSC-approved *Intake Channel Causeway Removal Work Plan*, Document No. RAWP-094 (Ref. 5.1.6). Work on removing the causeway was begun on June 2, 2011. Appropriate sediment and turbidity control measures, including turbidity curtains, were installed prior to beginning excavation and maintained throughout the duration of the causeway removal to control sediment movement in the Intake Channel. Water quality was monitored for turbidity or color change. The clayey nature of the excavated material caused more discoloration of the water in the Intake Channel than was anticipated. However, turbidity measurements at the plant discharge showed no significant increase in turbidity levels. As a result, there were no delays encountered during causeway removal. Water quality monitoring is further discussed in Section 3.

At the request of EPA and TDEC, sediment samples were collected prior to the excavation to determine the potential for the excavation to mobilize legacy contaminants, particularly cesium-137. Sediment samples were collected using vibracore methods upstream and downstream of the causeway. Results (presented in the *Intake Channel Causeway Removal Work Plan*) indicated cesium-137 was not present above the interagency work group action level of 11 picocuries per gram. Some ash mixed with sediment was found to be present both upstream and downstream of the causeway; ash movement was contained by the use of turbidity curtains.

The excavation was performed from land, accessing the causeway from the peninsula area to the south. The initial approach was to use an excavator to remove the material. However, because the material was found to contain more clay than rock, concerns arose about the stability of the excavation slope; therefore, a crane equipped with a clam shell bucket was used so that the equipment could be setup further from the working edge. Once survey results indicated a section of the causeway had been removed to the design depth, riprap was placed to prevent scour, and the crane was moved backwards to start on the next section. The causeway was cut back far enough by June 21, 2011, to allow buttress construction to begin on Segment B Part 2. The remaining causeway removal was completed by July 7, 2011. Approximately 3,500 cy of material were removed from the causeway. Excavated material was loaded into articulating haul trucks and transported to an area on the plant peninsula area uphill from the causeway. The material was spread out to allow positive drainage to the existing stormwater retention pond on the plant peninsula area.

2.1.5 Diffuser Removal and Installation

Removal and replacement of the plant discharge diffusers was performed in accordance with the EPA OSC-approved *Siphon Installation/Diffuser Removal Work Plan,* Document No. RAWP-093 (Ref. 5.1.5). The diffusers were removed to allow proper installation of the buttress in the area of the diffusers. Prior to the removal of the diffusers, temporary siphons were installed just east of the diffuser headwall, which allowed the plant discharge from the Stilling Pond to continue to operate while the diffusers were offline. Siphon installation began on May 20, 2011, and the siphons became operational on June 7, 2011. Subsequent diffuser removal began on June 10, 2011, and was completed June 16, 2011.

During siphon operation, Stilling Pond water level and discharge were monitored and reported to the plant. Daily total suspended solids (TSS) samples were collected from the siphon discharge. As reported in the OSC Report, the EPA OSC used the plant's NPDES permit levels that are required for its coal combustion activities as performance criteria for removal action operations. No daily or monthly TSS limits were exceeded during siphon operations, although a slight increase in TSS was observed compared to prior diffuser operations.

Replacement of the diffusers began September 12, 2011. The diffusers were assembled on the causeway and dragged into position by pulling them from Dike C. The diffusers were then sunk into position by filling them with water. The siphons were turned off and the diffusers placed back in operation on September 26, 2011. A survey and visual inspection of the diffuser openings was completed by divers on September 29, 2011. Final valve installation on the diffusers was completed on October 14, 2011.

2.2 LISTING OF QUANTITIES AND TYPES OF MATERIALS ADDRESSED

The quantities of ash removed during the time-critical removal action and ultimate destinations of materials disposed are presented in the EPA-approved OSC Report (Ref. 13.1). No additional volumes of ash-related materials were removed during the reinforcement of the remainder of Dike C, bridge/causeway removal, or siphon installation. The topsoil scrapings were removed from the surface of the slope and hauled away from Dike C for use as fill on the Site to patch berms, roads, erosion gullies, and similar applications. Approximately 3,500 cy of clayey material were removed from the causeway excavation and placed in the plant peninsula area.

Table 2-3 lists the total length of buttress constructed in each segment, and the quantities and types of materials placed during the Dike C reinforcement action.

Table 2-3. Listing of Quantities and Types of Materials Addressed

Segment	Length (linear feet)	Sand (tons)	No. 57 Stone (tons)	No. 2 Stone (tons)	Riprap (tons)
A	1,280	8,030	12,760	13,354	66,264
B	800	4,268	7,414	9,262	62,194
C	1,000	5,852	9,310	8,512	26,600
D	2,140	11,594	15,264	13,158	39,752
Total	5,220	29,744	44,748	44,246	194,810

2.3 ACTIONS TAKEN BY STATE AND LOCAL FORCES

TDEC has been actively engaged in the actions associated with remedying the release since it occurred. On January 12, 2009, TDEC issued a Commissioner's Order which remains in effect, although TDEC has agreed that work performed under the EPA Order, in consultation with TDEC, would satisfy portions of the TDEC Order. As part of the ICS Unified Command, which included EPA and TVA, TDEC personnel have been onsite as part of a coordinated effort to contain the immediate threat to human health and the environment. Their efforts included sampling and analysis for public drinking water systems to assess whether the raw water entering and the finished water produced by the Kingston Water Treatment Plant meets public health standards. Work also included ongoing water quality monitoring and assessment within the major waterways impacted by the ash release including the Emory, Clinch, and Tennessee Rivers. TDEC and the Tennessee Department of Health provided public health guidance and recommended precautions for citizens that came in contact with the ash; they had major involvement in completing a public health assessment, available at http://health.state.tn.us/Environmental/list.htm and included in Ref. 2.1.

TDEC provided resources to review regulatory documents produced by TVA. EPA consulted with TDEC prior to EPA approving any work. Actions taken by TDEC during the time-critical removal action are presented in detail on their website, available at http://tennessee.gov/environment/kingston/.

2.4 ACTIONS TAKEN BY OTHER AGENCIES AND SPECIAL TEAMS

The following groups supported EPA time-critical response actions, as described in the EPA-approved OSC Report (Ref. 13.1):

- EPA START contractors (Tetra Tech and OTIE)
- EPA Region 4 Air, Pesticides and Toxics Division
- EPA Region 4 Office of External Affairs
- EPA Region 4 TSS of the Superfund Division
- EPA Region 4 Science and Ecosystems Support Division
- EPA Region 4 Resource Conservation and Recovery Act Division
- EPA Region 4 Office of Environmental Accountability
- EPA Region 4 Water Protection Division
- EPA Region 4 Office of Congressional and Intergovernmental Affairs
- EPA Region 4 Federal Facilities Branch
- EPA Emergency Response Team of Edison, New Jersey
- EPA Science Advisory Board, Washington, DC
- U. S. Coast Guard Gulf Strike Team
- BOR
- Agency for Toxic Substances and Disease Registry
- USACE

The BOR provided particular support during the Dike C reinforcement. BOR assisted EPA in providing engineering consultation and review. Engineering technical assistance was provided for a variety of issues, including dike evaluations, design reviews, and work plan reviews for the reinforcement of Dike C. BOR also provided engineering oversight and review of construction activities. To expedite work and improve technical effectiveness of the action, EPA assigned a fulltime onsite BOR representative to oversee construction activities. This allowed for quicker turn-around times on requests and improved the communication process. The onsite BOR representative was integrated into the Dike C buttress team, attended weekly meetings, and observed construction activities on a daily basis. The BOR was designated by the EPA OSC to inspect the panel excavation surface, and give verbal field approval to proceed with subsequent buttress construction. BOR field approvals are documented in emails to the EPA OSC (Ref. 5.3.3 and Ref. 5.3.4).

EPA Office of Resource Conservation and Recovery conducted an inspection of the Ash Pond and Stilling Pond dikes on September 21, 2011 (Ref. 5.2.14). EPA inspectors classified the dikes as having "significant hazard potential", based on the size and location of the impoundment. EPA inspectors stated that a release due to embankment failure or misoperation could cause economic loss and environmental damage, as the impoundment is adjacent to the Emory River, but would not cause probable loss of human life. Stantec conducted a subsequent hydrologic analysis based on this classification (Ref. 5.2.15), and determined that the Ash Pond would be able to pass the design rainfall event through the existing outlet structures without overtopping the dikes, which complies with Tennessee Dam Safety regulations.

3 MONITORING AND ANALYTICAL RESULTS

Monitoring during the Dike C reinforcement included dike instrumentation monitoring and turbidity monitoring. Material sampling and analysis was conducted in accordance with the Quality Control Plan. Monitoring of the Stilling Pond effluent at Outfall 1 continued throughout the diffuser removal and temporary siphon operations.

3.1 DIKE INSTRUMENTATION MONITORING

A network of inclinometers and piezometers were installed along Dike C to monitor dike stability, as described in *Geotechnical Exploration and Slope Stability for Dike C* (Ref. 5.2.2). In addition, a detailed *Instrumentation Monitoring and Reporting Plan* (Ref. 5.2.4) was prepared, which formed a portion of the EPA-approved *Dike C Risk Mitigation Work Plan,* Document No. EPA-AWP-035 (Ref. 5.1.1). Additional piezometers were installed in 2010, as described in the *Segment B Buttress Design Report* (Ref. 5.2.13).

Water levels in the piezometers and movement in the inclinometers were monitored during construction to determine if operations were impacting the dike stability. Weekly reports were prepared to document the instrumentation monitoring (Ref. 5.2.14). One inclinometer, STA 34+00 near the intake bridge, was the only instrument that showed any pattern of movement. Over a 12-month period that inclinometer indicated a slope creep toward the Intake Channel. This creep was one of the main factors that drove the decision to remove the Intake Channel bridge and diffusers and install a full buttress in this area. Measurements taken after the buttress was completed indicate that the slope creep had stopped.

3.2 TURBIDITY MONITORING

Turbidity monitoring during time-critical ash dredging was performed in conjunction with dredging operations, and was also used to monitor Dike C operations. Visual observations of water quality outside of turbidity curtains were also made during the Dike C reinforcement.

Water quality parameters were measured in the Emory River (ERM 2.0), at the Stilling Pond discharge, plant Intake Channel, and plant effluent channel using multi-analyte programmable data loggers (Hydrolab®). The water quality parameters measured included temperature, dissolved oxygen, saturated oxygen, pH, conductivity, and turbidity, with turbidity being the primary measurement of interest. During Dike C buttress construction along the Emory River, these Hydrolabs stationed in the river and Intake Channel were used to confirm visual observations that buttress material placement was not impacting water quality in the river. Results, reported in the EPA-approved OSC Report, showed no adverse impact to water quality. The 200 nephelometric turbidity unit target was not exceeded during Dike C construction activities.

Once Dike C construction resumed in November 2010, only visual observations were used to monitor turbidity. These observations indicated no adverse impact water quality outside the turbidity curtains; conditions were similar to those observed while dredging was being monitored.

3.3 MATERIAL SAMPLING

Material testing as required by the technical specifications was performed by MACTEC Engineering and Consulting, Inc. Sampling of materials (sand, No. 57 stone, No. 2 stone, and riprap) was conducted at a predetermined frequency detailed in the specifications. Results of quality control testing of materials incorporated into the Dike C reinforcement are presented in the *Construction Certification Report, Dike C Buttress Construction, Work Plans 1 to 5* (Ref. 5.2.17).

As discussed in Section 2.1.3, material sampling requirements were revised to expedite construction and allow use of available materials with consistent quality. Revisions to the specifications were documented in the EPA OSC-approved Addendum 001 and Addendum 002 to the specifications. Addendum 001 revised the allowable gradation limits (bandwidths) of the granular filter materials along with the material testing protocols (running average) included within the Quality Control Plan. Addendum 002 revised the allowable gradation limits (bandwidth) of the manufactured sand filter material for the percent passing the No. 30 sieve. To ensure integrity of the dike due to seepage from the Ash Pond and Stilling Pond, the EPA OSC required a filter test be performed on the manufactured sand as part of the approval for Addendum 002. Results of the filter test are also included in the *Construction Certification Report, Dike C Buttress Construction, Work Plans 1 to 5* (Ref. 5.2.17).

3.4 STILLING POND MONITORING

During the temporary siphon operation, TVA continued sampling the NPDES permitted outfall at the Stilling Pond discharge, KIF 001, daily to track effects of operations to maintain compliance with NPDES permit limits, and apply appropriate controls when results approached permit limits. The Stilling Pond is the final solids settling location. KIF 001 is the final point of discharge for water from plant operations and dredging operations. The sampling point was moved from the diffusers to the temporary siphons.

During the period when the temporary siphons were in operation (June 7 through September 26, 2011), the TSS monitoring within the Stilling Pond did not exceed the plant permit limits. The maximum TSS value (51.50 milligrams per liter [mg/L]) reported on July 18, 2011, was below the maximum daily allowable TSS limit of 92.2 mg/L. The average monthly TSS values ranged from 13.31 to 19.89 mg/L over the four-month period, below the average monthly allowable TSS limit of 29.9 mg/L. Table 3-1 summarizes the TSS monitoring data for June through September. Operation of the temporary siphons did not adversely affect effluent water quality.

Table 3-1. Total Suspended Solids Operational Monitoring of Stilling Pond Effluent (June-September 2011)

	Daily Maximum (mg/L)	Monthly Average (mg/L)
Permit Limit	**92.20**	**29.90**
June 2011	30.40	13.39
July 2011	51.50	19.89
August 2011	24.10	16.59
September 2011	22.90	13.31

4 SAFETY AND HEALTH

The EPA Order, Article XIII, paragraph 35, required TVA to submit for EPA review and approval a plan to ensure the protection of the public health and safety during performance of onsite work, in accordance with EPA's *Standard Operating Safety Guide* and consistent with Occupational Safety and Health Administration provisions for response action worker safety and health found in the U.S. Code of Federal Regulations, Title 29, Part 1910. A comprehensive Site Wide Safety and Health Plan (SWSHP) (Ref. 12.1, Ref, 12.2, Ref. 12.3, Ref. 12.4) was developed for the Site, which governed the overall health and safety program. The SWSHP was written to comply with the EPA Order, Article XIII, paragraph 35. The SWSHP was approved by the EPA OSC in consultation with TDEC, as presented in the EPA-approved OSC Report (Ref. 13.1). Dike C reinforcement activities were conducted in accordance with the approved SWSHP.

No safety and health incidents occurred during the Dike C construction. There was one near miss that occurred on June 2, 2011 during the bridge removal resulting in damage to the left boom stop on a LinkBelt 418A crane. No injuries were associated with the near miss as documented in the incident report (PER 375195) included in Ref. 5.2.12.

No reportable environmental events occurred during the Dike C construction.

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5 PUBLIC INFORMATION AND COMMUNITY RELATIONS ACTIVITIES

EPA, TVA, and TDEC functioned under a Unified Command as part of the National Incident Management System ICS structure during the time-critical removal action. During this period, community relations activities were performed to promote open communication among citizens, TVA, EPA, TDEC, and other agencies, and provide opportunities to the community for meaningful and active involvement in the cleanup process. Members of the Unified Command endeavored to promote accurate, fact-based public information while maintaining separate information outlets such as independent fact sheets, websites, and press releases. In addition, the Unified Command communicated to the public together and in separate venues.

Public information and community relations activities conducted both by EPA and TVA during the time-critical removal action are described in the EPA-approved OSC Report (Ref. 13.1). Activities continue under the ongoing non-time-critical removal action.

There have been no community relations activities unique to the Dike C reinforcement. River closings and No Wake zone restrictions were issued through an emergency rule by the Tennessee Wildlife Resources Agency (TWRA) in conjunction with dredging and skimmer wall construction activities and communicated to the public during the time-critical removal action. These remained in effect during much of the Dike C reinforcement activities. No Wake Zone restrictions adopted by the TWRA remained in effect until July 14, 2011, at which time the emergency rule expired and the rule reverted to its previous status.

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6 RESOURCES COMMITTED

6.1 TENNESSEE VALLEY AUTHORITY COSTS

Costs incurred since the event through the time-critical removal action totaled $589 million. Actual costs of the work performed have been captured in accordance with the project Work Breakdown Structure (WBS). Table 6-1 lists the WBS elements associated with the time-critical removal action, and the costs incurred. These costs, originally reported in the EPA-approved OSC Report, have been updated to reflect total costs for the WBS 01.10, Dike Reinforcement.

Table 6-1. TVA Costs Incurred During the Time-Critical Removal Action

Work Breakdown Structure Element	Costs Incurred
WBS 01.01 - Program Management	$28,800,000 [a]
WBS 01.02 - Government Relations, Legal, Health	$29,000,000 [a]
WBS 01.03 - Community Outreach	$42,200,000 [a]
WBS 01.04 - Infrastructure	$108,200,000 [a]
WBS 01.05 - Ash Dredging & Processing	$106,200,000 [b]
WBS 01.06 - Cenosphere Removal	$22,000,000 [c]
WBS 01.07 - Skimmer Wall (Debris Removal)	$2,300,000 [c]
WBS 01.08 - Ash Disposition (Long-Term Disposal)	$179,500,000 [b]
WBS 01.09 - Peninsula Ash Processing Area	$500,000 [a]
WBS 01.10 - Dike Reinforcement	$16,900,000 [d]
WBS 01.11 - Environmental Management	$26,300,000 [a]
WBS 01.12 - Embayment Restoration	$3,300,000 [a]
WBS 01.13 - Failed Dredge Cell	$8,900,000 [a]
WBS 01.98 - Fuel Related Contract Settlements	$15,300,000 [a]
Project Total	**$589,400,000**

Notes:

[a] Actual Cost of Work Performed through June 30, 2010 completion of the time-critical removal action phase.

[b] Actual Cost of Work Performed through December 31, 2010 completion of offsite disposal.

[c] Actual Cost of Work Performed through September 30, 2010, completion of cenospheres removal and debris removal.

[d] Actual Cost of Work Performed through September 30, 2011, completion of Dike C reinforcement and associated activities.

6.2 U.S. ENVIRONMENTAL PROTECTION AGENCY COSTS

Approximate EPA costs incurred are reported in the EPA-approved OSC Report (Ref. 13.1).

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7 DIFFICULTIES ENCOUNTERED, MEASURES TAKEN, AND CONCLUSIONS

This section of the OSC Report records the problems encountered in implementing the time-critical removal action, the measures taken, and conclusions as they relate to compliance with the EPA Order. Operational difficulties during the Dike C reinforcement included maintaining the quality of in-place manufactured sand.

7.1 MAINTAINING THE QUALITY OF IN-PLACE MANUFACTURED SAND

The primary issue encountered during the Dike C buttress construction was the ability to maintain consistent quality of in-place material, especially the manufactured sand, within strict specification requirements. The specifications required a narrow range of acceptable gradation (percentage of material passing various sieve sizes). Samples of the limestone-based manufactured sand typically met specification requirements at the quarry; however, the need to handle the sand multiple times onsite during placement caused the sand to degrade and increased the amount of fines in the material.

Measures Taken. The following measures were taken to achieve acceptable material quality:

- To improve in-place quality, greater emphasis was placed on limiting the amount of movement of the sand. Construction supervisors provided additional instruction and training of equipment operators working in the stockpile area to avoid continual reshaping of the material stockpile. Equipment was changed from a dozer to use of a rubber-tired loader. By limiting the stockpile rework and using rubber tired equipment, degradation of the material affecting the fines content was minimized.

- To improve constructability and expedite material approval, Stantec reviewed the specifications and determined that a running average of the sand gradation could be used, rather than independent gradation testing results for individual samples. Addendum 001 to the specifications was approved by the EPA OSC, which revised the gradation specification and allowed the use of an averaging methodology.

- To expedite material approval prior to placement, sampling protocols were revised to provide for increased frequency of sampling of the stockpiled sand material.

- To improve consistency in material quality from the supplier, alternative sources of manufactured sand materials were investigated that contained less initial fines. One alternative was the Rogers Quarry in Rhea County, Tennessee. However, that quarry was unable to produce a consistent supply of sand having a gradation within the narrow limits (<5%) required by the specifications. Another alternative was the Crab Orchard quarry in Cumberland County, Tennessee. That quarry produced a quartz-based (sandstone) material that met the 5% requirement. However, the material gradually displayed a higher bandwidth for the percent passing the No. 30 sieve (as high as 65%) which consistently exceeded the specified band width of 15 to 60%. Steps taken to modify the band width for manufactured sand are described in *Dike C Buttress Revised Band Width for Manufactured Sand Technical Memorandum,* Document No. KRP-DOC-003 (Ref. 5.2.11). Following reevaluation, Stantec recommended expanding the band width to 15 to 70%. The EPA OSC, based on recommendations by the BOR, approved the Crab Orchard material for use, provided that laboratory filter tests be completed on the material conforming to a No Erosion Filter (NEF). Results of the filter testing are documented in an EPA-approved memorandum dated April 18, 2011 (Ref. 5.2.10). Finally, upon EPA approval, the specifications were changed on June 8, 2011.

Conclusions. The EPA OSC approval to use the quartz-based sand based on results of NEF testing expedited construction by preventing costly delays in the supply of material of suitable quality. This allowed buttress construction to proceed using the available sand material without delaying the November 2010 restart of the Dike C reinforcement.

7.2 DIFFICULTIES IN REMOVING BRIDGE PIER

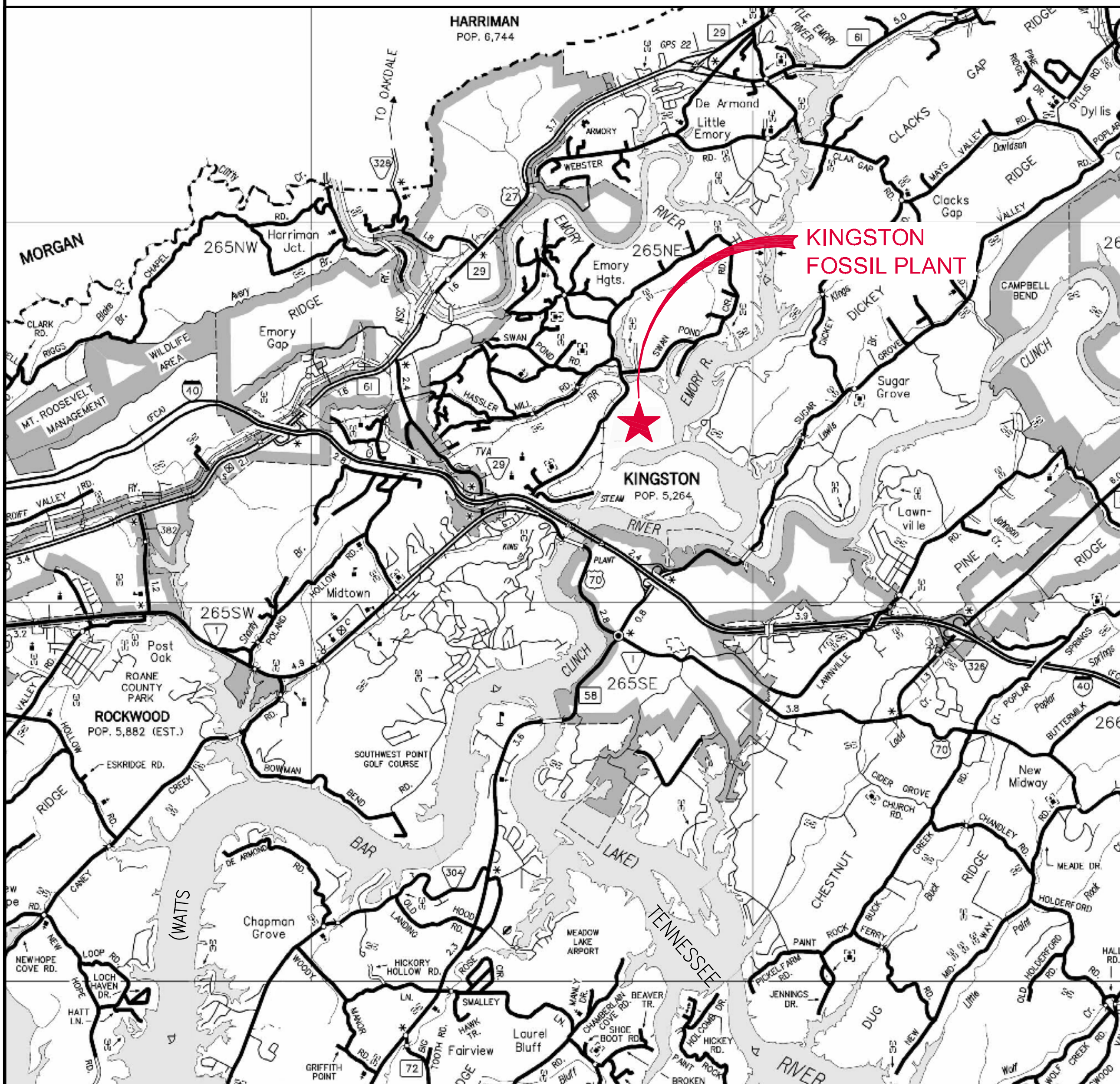
During plant inspections, the existing bridge over the Intake Channel was found to be unstable due to erosion (scour) around its footings. During the demolition of the bridge, one of its piers, Pier A, collapsed. The pier consisted of three piles connected with metal cross-bracing. The bridge demolition work plan included use of an excavator to rip the cross-bracing off of the piles so that each pile could be pulled independently. While attempting to remove the cross-bracing, the pier collapsed into the water and came to rest on the slope of the existing causeway.

Measures Taken. The pier needed to be moved out of the way to avoid restricting flow in the Intake Channel. Several unsuccessful attempts were made to remove the pier by dragging it up the slope. Attempts to use divers were eliminated for safety reasons due to the unknown stability of the piers. After consulting the operators, engineers, and the onsite BOR representative, it was decided to excavate around the pier and push the pier down to the bottom of the Intake Channel, which proved successful.

Conclusions. Cooperative efforts of project stakeholders, including EPA, BOR, construction operators, and design engineers were critical in providing expeditious repair of the collapsed pier. As a result, construction resumed less than two days following the pier collapse, and bridge removal was completed on schedule.

Figures

LOCATION MAP



SOURCE:
GENERAL HIGHWAY MAP, ROANE COUNTY, TENNESSEE
TENNESSEE DEPARTMENT OF TRANSPORTATION, 2006

0 1 2 4
SCALE IN MILES

FIGURE 1
LOCATION OF THE KINGSTON FOSSIL PLANT

KINGSTON ASH RECOVERY PROJECT

DATE:	PHASE:
5 Dec. 2011	OSC Report Addendum

I:\0002 ENGINEERING\Civil\Report Graphics\OSC Final Report_Report Addendum\Fig 01 Location of the KIF.dwg Dec 05,2011 -bperatro

I:\0002 ENGINEERING\Civil\Report Graphics\OSC Final Report_Report Addendum\Fig 02 KIF Pre-Spill Conditions.dwg Dec 05,2011 -bperatro

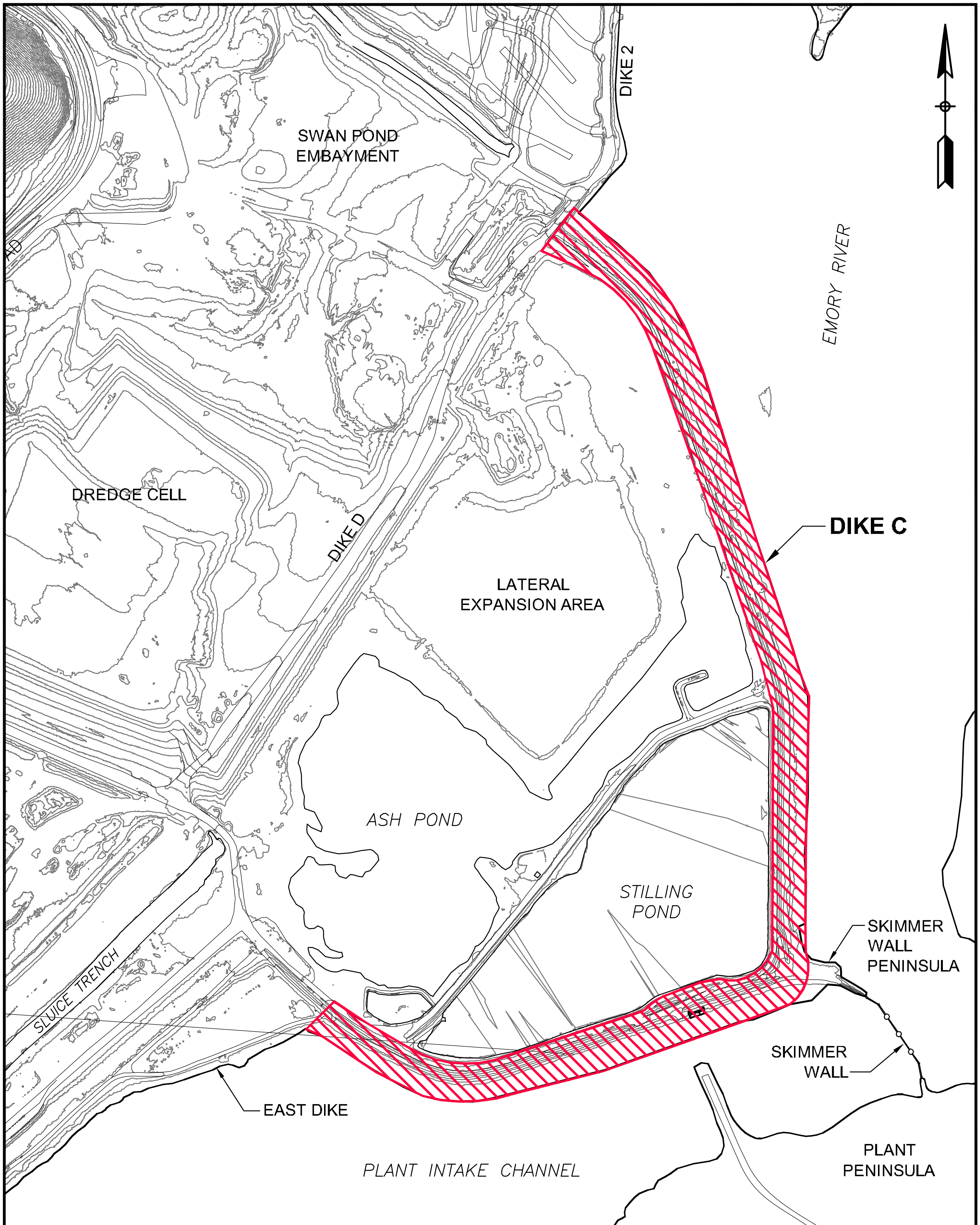
DATE OF PHOTO: APRIL 5, 2005

0 500 1000 2000
SCALE IN FEET

FIGURE 2
KINGSTON FOSSIL PLANT PRE-SPILL CONDITIONS

KINGSTON ASH RECOVERY PROJECT

DATE:	PHASE:
5 Dec. 2011	OSC Report Addendum



NOTE: TOPO INFORMATION FROM
TVA'S MAY 19, 2010 SURVEY

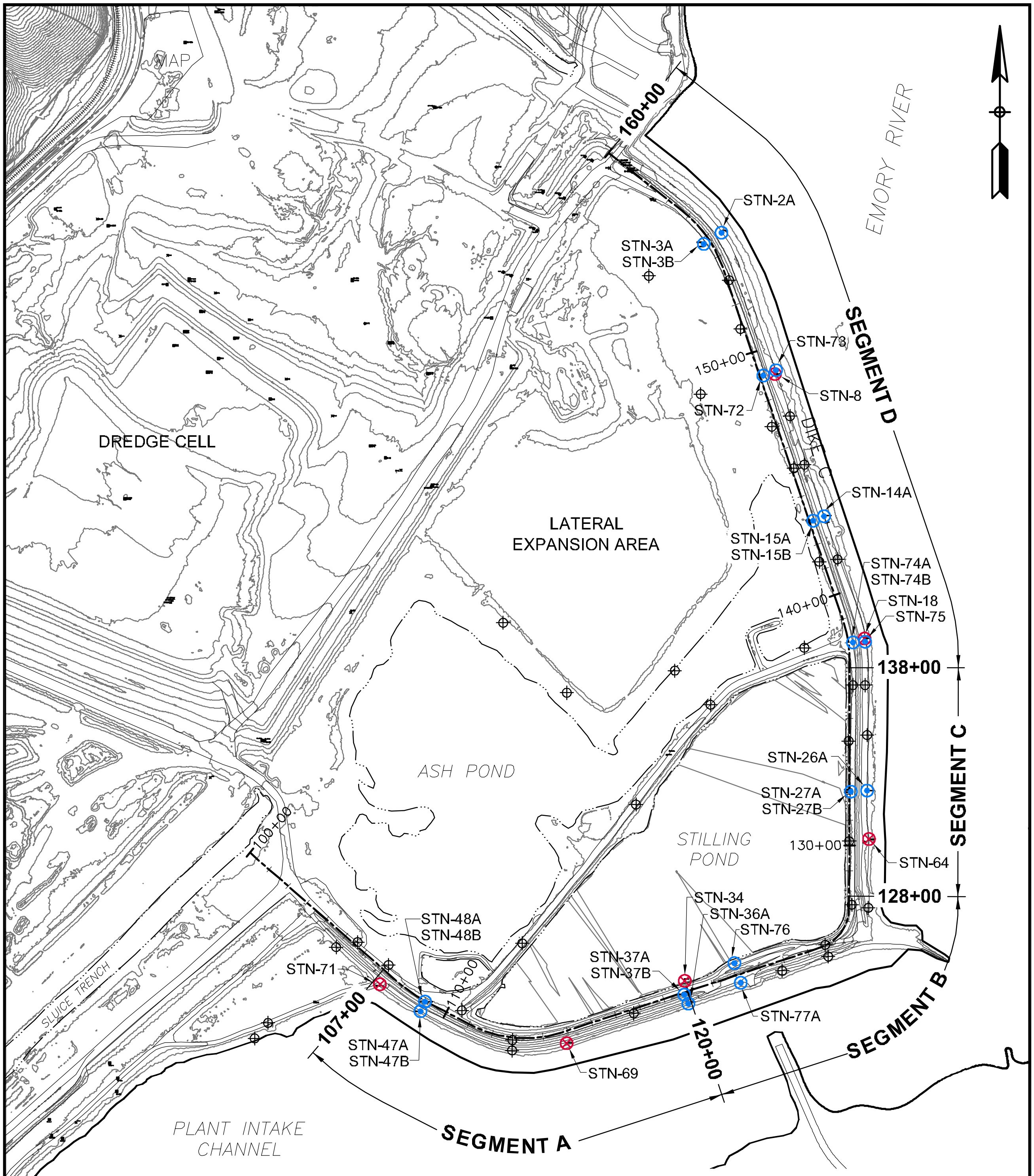
0 300 600 1200
SCALE IN FEET

FIGURE 3
LOCATION OF DIKE C

KINGSTON ASH RECOVERY PROJECT

DATE:	PHASE:
5 Dec. 2011	OSC Report Addendum

I:\0002 ENGINEERING\Civil\Report Graphics\OSC Final Report_Report Addendum\Fig 03 Dike C Location.dwg Dec 05,2011 -bperatro



LEGEND:

- SOIL BORING
- PIEZOMETER
- SLOPE INCLINOMETER

NOTES:

LAYOUT AND BORING LOCATIONS BASED ON STANTEC'S "GEOTECHNICAL EXPLORATION ASH POND BORING PLAN AND BASELINE LAYOUT" DRAWING NO. 10W229-01

TOPO INFORMATON FROM TVA'S MAY 19, 2010 SURVEY

0 300 600 1,200

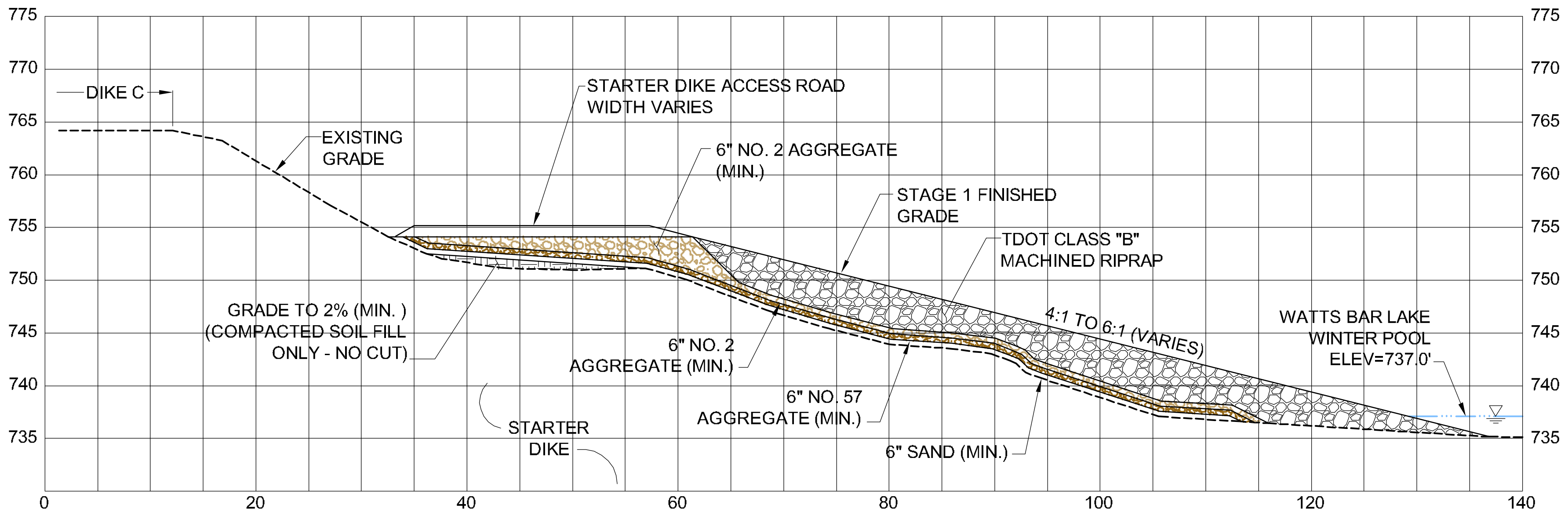
SCALE IN FEET

FIGURE 4
DIKE C REINFORCEMENT LAYOUT OF SEGMENTS

KINGSTON ASH RECOVERY PROJECT

DATE:	PHASE:
5 Dec. 2011	OSC Report Addendum

I:\0002 ENGINEERING\Civil\Report Graphics\OSC Final Report_Report Addendum\Fig 04 Dike C Layout of Segments.dwg Dec 05,2011 -bperatro



NOTE:

1. FIGURE BASED ON STANTEC'S "DIKE C BUTTRESS, STAGE 1 CONSTRUCTION TYPICAL SECTIONS AND DETAILS" DRAWING 10W229-53.

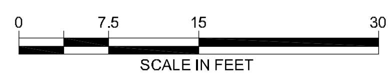
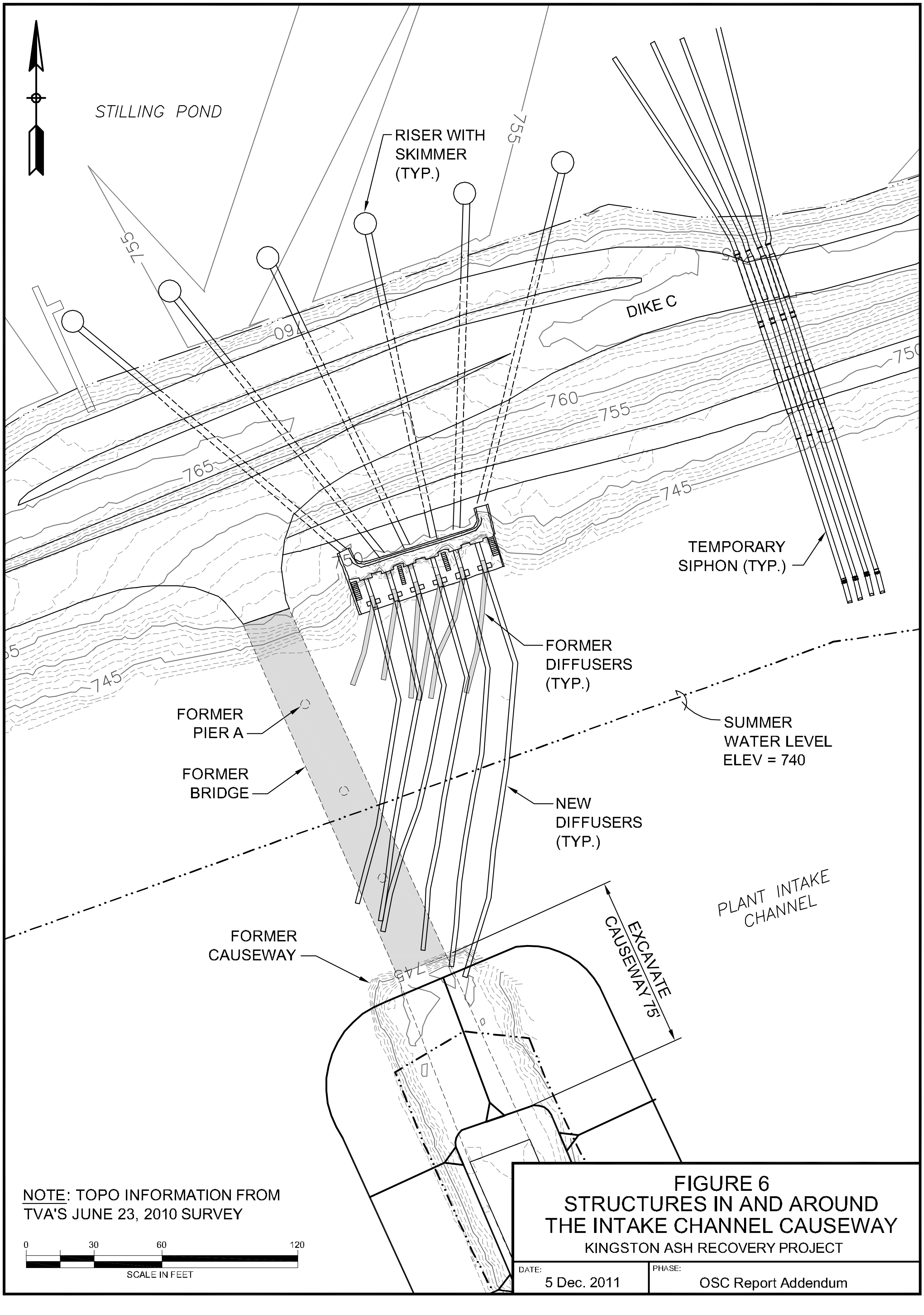


FIGURE 5
DIKE C REINFORCEMENT BUTTRESS TYPICAL SECTION

KINGSTON ASH RECOVERY PROJECT

DATE:	PHASE:
5 Dec. 2011	OSC Report Addendum



NOTE: TOPO INFORMATION FROM TVA'S JUNE 23, 2010 SURVEY

FIGURE 6
STRUCTURES IN AND AROUND THE INTAKE CHANNEL CAUSEWAY
KINGSTON ASH RECOVERY PROJECT

DATE:	PHASE:
5 Dec. 2011	OSC Report Addendum

APPENDIX A

Photo Log

APPENDIX A PHOTO LOG
Dike C Reinforcement

Excavating ash in “panels” from outboard slope of Dike C to expose dike material. June 5, 2010.

Placing layer of sand on top of dike material in panel. December 29, 2009.

Placing layer of gravel on top of sand material in panel. December 27, 2009.

Placing riprap on top of gravel material. December 27, 2009.

Excavation of subsequent panel next to a completed panel. February 12, 2010.

Progress of overall Dike C reinforcement work as viewed from top of Dike C.
February 24, 2010.

Below water excavation and sand, gravel, and riprap placement. April 23, 2010.

Equipment used in placing sand, gravel, and riprap during Dike C reinforcement.
April 29, 2010.

Below water excavation and sand, gravel, and riprap placement. April 23, 2010.

Equipment used in placing sand, gravel, and riprap during Dike C reinforcement.
April 29, 2010.

Below water excavation and sand, gravel, and riprap placement. April 23, 2010.

Equipment used in placing sand, gravel, and riprap during Dike C reinforcement.
April 29, 2010.

Bridge removal. May 6, 2011.

Bridge removal. May 2011.

New siphon installation. June 7, 2011.

New siphon installation. June 7, 2011.

Causeway removal. June 10, 2011.

Causeway removal. July 5, 2011.

Old diffuser removal. June 11, 2011.

Old diffuser removal. July 19, 2011.

New diffuser installation. September 16, 2011.

New diffuser installation. September 18, 2011.

APPENDIX B

Buttress Production Quantities

APPENDIX B
BUTTRESS PRODUCTION QUANTITIES

Segment	Week Ending	Cumulative Footage	Weekly Footage	Remarks
D	12/11/2009	0	0	Work began 12/7/2011
D	12/18/2009	0	0	
D	12/25/2009	20	20	
D	01/01/2010	60	40	
D	01/08/2010	120	60	
D	01/15/2010	120	0	
D	01/22/2010	260	140	
D	01/29/2010	320	60	
D	02/05/2010	430	110	
D	02/12/2010	530	100	
D	02/19/2010	610	80	Addendum 001 - Change in specification
D	02/26/2010	718	108	
D	03/05/2010	860	142	
D	03/12/2010	1040	180	BOR onsite fulltime
D	03/19/2010	1200	160	
D	03/26/2010	1200	0	Work on removing ash from rookery
D	04/02/2010	1200	0	Work on removing ash from rookery
D	04/09/2010	1250	50	BOR gives Assistance with 6:1 Slope
D	04/16/2010	1260	10	
D	04/23/2010	1288	28	Working in open water
D	04/30/2010	1344	56	Segment C approved by EPA
D	05/07/2010	1456	112	BOR agrees to leave temporary gap for dredge pipe
D	05/14/2010	1512	56	
D	05/21/2010	1792	280	Civil Projects crosses dredge pipeline
D	05/28/2010	2082	290	BOR agrees to stop work at Station 137
D	06/04/2010	2200	118	Segment D Complete. Segment C begins
C	06/11/2010	2250	50	
C	06/18/2010	2280	30	Work stopped at Station 137
C	06/25/2010	2280	0	Work was suspended from 6/18/2010 to 11/02/2010
C	10/29/2011	2280	0	
C	11/02/2010	2280	0	Work resumes
C	11/09/2010	2280	0	
C	11/16/2010	2300	20	
C	11/23/2010	2340	40	
C	11/30/2010	2430	90	
C	12/07/2010	2565	135	
C	12/14/2010	2655	90	
C	12/21/2010	2745	90	
C	12/28/2010	2830	85	

APPENDIX B
BUTTRESS PRODUCTION QUANTITIES

Segment	Week Ending	Cumulative Footage	Weekly Footage	Remarks
C	01/04/2011	2945	115	
C	01/11/2011	3015	70	
C	01/18/2011	3080	65	
C	01/25/2011	3100	20	Segment C completed 01/23/2011
A	02/01/2011	3100	0	Segment A begins 01/28/2011. Begin preparing Segment A.
A	02/08/2011	3100	0	Building access point at Redwater Wetlands
A	02/15/2011	3332	232	
A	02/22/2011	3332	0	Building toe road
A	03/01/2011	3612	280	
A	03/08/2011	3717	105	
A	03/15/2011	3892	175	
A	03/22/2011	3948	56	Focus on extending toe road
A	03/29/2011	4028	80	Focus on extending toe road
A	04/05/2011	4196	168	
A	04/12/2011	4331	135	
A	04/19/2011	4395	64	Working into Intake Channel current
A	04/26/2011	4440	45	Working into Intake Channel current
A	05/03/2011	4500	60	Segment A complete 5/1/2011. Work begins on preparing Segment B.
B1	05/10/2011	4500	0	Work on building access ramp to Segment B
B1	05/17/2011	4624	124	
B1	05/24/2011	4761	137	
B1	05/31/2011	4761	0	Worked in skimmer wall peninsula area. Work was not part of the earned base line because it was agreed upon addition to better buttress the dike in this area. Work included ~160 ft of filter and buttress, trench, and top layer construction.
B1	06/07/2011	4761	0	
B1	06/14/2011	4761	0	
B1	06/21/2011	4803	42	
B2	06/28/2011	4825	22	
B2	07/05/2011	4866	41	
B2	07/12/2011	4972	106	
B2	07/19/2011	5114	142	
B2	07/26/2011	5178	64	
B2	08/02/2011	5261	83	
B2	08/09/2011	5288	27	Buttress construction complete 8/6/2011.

List of References (on Disk)

TVA Kingston Fossil Fuel Plant Release Site
Time-Critical Removal Action
On-Scene Coordinator Final Report Addendum Reference Documents

1 INCIDENT COMMAND SYSTEM UNIFIED COMMAND

1.1 Memorandum: *Transfer of Federal Lead Agency Authority*. From Steve Spurlin (EPA) to Tim Hope (TVA). January 10, 2009.

1.2 Incident Organization Charts June 9, 2009 through July 13, 2010

2 PUBLIC HEALTH ASSESSMENT

2.1 *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.

3 OTHER TVA FACILITY ASSESSMENTS

3.1 *Phase 1 Facility Assessments for Coal Combustion Product Impoundments and Disposal Facilities in AL. KY, and TN*. Document No. EPA-AO-004. Prepared by Stantec. July 20, 2009 (EPA approval).

4 EAST OF DIKE 2 DREDGING

4.1 *Non-Time-Critical Removal Action for the River System, Sampling and Analysis Plan (SAP). Revision 3*. Document No. EPA-AO-021. Prepared by Jacobs. June 1, 2010 (EPA approval).

5 KINGSTON DIKE EVALUATIONS AND MAINTENANCE

5.1 Kingston Dike Plans and Work Plans

5.1.1 *Dike C Risk Mitigation Work Plan*. Document No. EPA-AWP-035. Prepared by Jacobs. December 2, 2009 (EPA approval).

5.1.2 *Dike C Buttress Work Plan - Section C*. Document No. EPA-RAWP-067. Prepared by Jacobs. April 24, 2010 (EPA approval).

5.1.3 *Dike C Buttress Work Plan - Segment A*. Document No. RAWP-086. Prepared by Jacobs. January 27, 2011 (EPA approval).

5.1.4 *Intake Channel Bridge Removal Work Plan*. Document No. RAWP-087. Prepared by Jacobs. April 7, 2011 (EPA approval).

5.1.5 *Siphon Installation/Diffuser Removal Work Plan.* Document No. RAWP-093. Prepared by Jacobs. May 19, 2011 (EPA approval).

5.1.6 *Intake Channel Causeway Removal Work Plan.* Document No. RAWP-094. Prepared by Jacobs. May 25, 2011 (EPA approval).

5.1.7 *Dike C Buttress Work Plan* - Segment B, Part 1 of 2. Document No. RAWP-092. Prepared by Jacobs. May 26, 2011 (EPA approval).

5.1.8 Memo to Leo Francendesce, OSC: *Response to Bureau of Reclamation Review Comments Dated March 30, 2011, Dike C Buttress Work Plan - Segment B (Part 1 of 2) dated March 11, 2010*. EPA email reply dated April 13, 2011.

5.1.9 *Dike C Buttress Work Plan* - Segment B, Part 2 of 2. Document No. RAWP-095. Prepared by Jacobs. May 31, 2011 (EPA approval).

5.2 Kingston Dike Support Documentation

5.2.1 *Environmental Assessment, Initial Emergency Response Actions for the Kingston Fossil Plant Ash Dike Failure, Roane County, Tennessee*. Prepared by TVA. February 2009.

5.2.2 *Report of Geotechnical Exploration and Slope Stability for Dike C*. Prepared by Stantec. August 3, 2009.

5.2.3 Memorandum: *Request for Temporary Suspension of Dike C Buttress Construction Activity*. From Leo Francendese (EPA) to Steve McCracken (TVA). June 21, 2010.

5.2.4 *Instrumentation Monitoring and Reporting Plan, Kingston Fossil Plant, Harriman, Tennessee*. Prepared by Stantec. October 28, 2010.

5.2.5 *Kingston Fossil Plant Bridge Underwater Inspection Report*. Prepared by TVA Facilities Projects. December 8, 2010.

5.2.6 Letter: *Redwater Ponds Area Phase 1 Buttress Construction Slope Stability Review*. Prepared by Stantec. December 22, 2010.

5.2.7 *Design Report for Dike C Buttress, Kingston Fossil Plant, Harriman, Tennessee*. Prepared by Stantec. March 1, 2011.

5.2.8 Technical Memorandum: *Organic Material in Buttress Sand*. From Steve McCracken (TVA) to Leo Francendese (EPA). March 7, 2011.

5.2.9 Analytical Report for Segment A Brown Material. Prepared by TestAmerica. March 9, 2011.

5.2.10 Memo: *TVA Kingston Site Dike C Buttress Construction NEF Filter Test Results.* Prepared by Stantec. April 18, 2011.

5.2.11 *Dike C Buttress Revised Band Width for Manufactured Sand Technical Memorandum.* Document No. KRP-DOC-003. Prepared by Jacobs. April 26, 2011 (issued date).

5.2.12 Kingston Construction Bridge Demolition - TCM's Post Mortem Review. Prepared by S. E. Gaines, P.E., Technical Contract Manager, Civil Projects Engineering. May 18, 2011.

5.2.13 *Design Report for Segment B of the Dike C Buttress Project, Kingston Fossil Plant, Harriman, Tennessee*. Prepared by Stantec. September 1, 2011.

5.2.14 Ash Pond and Stilling Pond Inspection at the Kingston Steam Plant. Prepared by EPA. September 21, 2011.

5.2.15 Letter: *Addendum, September 30, 2010 H&H Report - KIF Ash Pond/Stilling Basin, Dam Safety Regulation-Spillway Capacity Evaluation.* Prepared by Stantec. October 11, 2011.

5.2.16 Memorandum: *TVA Kingston Fossil Fuel Plant Release Site and the Referral of the East Dike Evaluation and Potential Future Maintenance and Repair from the Time Critical Removal Action scope to the Non Time Critical Removal Action*

Scope. To Steve McCracken (TVA) from Craig Zeller (EPA). November 3, 2011 (Draft).

5.2.17 *Construction Certification Report, Dike C Buttress Construction, Work Plans 1 to 5*. Prepared by Stantec. November 18, 2011.

5.3 Concurrence Forms

5.3.1 Removal Action Concurrence Form - Dike C Buttress Construction - Geotechnical Testing Interval Change. Document No. KRP-10-0001. April 15, 2010 (submittal date).

5.3.2 Dike C Buttress Construction Ash Removal Sign Off Forms-2009

5.3.3 Dike C Buttress Construction Ash Removal Sign Off Forms-2010

5.3.4 Dike C Buttress Construction Ash Removal Sign Off Forms-2011

6 GUIDANCE DOCUMENTS

6.1 *Superfund Removal Procedures, Removal Response Reporting: POLREPs and OSC Reports*. Publication 9360.0-03. Prepared by EPA. June 1994.

6.2 *Guidance for Preparing POLREPs/SITREPs*, Office of Solid Waste and Emergency Response (OSWER) Directive No. 9360.3-03. Prepared EPA. December 2007.

7 TDEC COMMISSIONER'S ORDER – EMERGENCY RESPONSE

7.1 Commissioner's Order, Case No. OGC09-0001 In the Matter of: Tennessee Valley Authority. Prepared by TDEC. January 12, 2009.

8 SITE SUPPORT DOCUMENTS

8.1 Administrative Order and Agreement on Consent. In the Matter of: TVA Kingston Fossil Fuel Plant Release Site, Roane, County, Tennessee. Tennessee Valley Authority, Respondent. Prepared by EPA. May 11, 2009.

9 ROOT CAUSE ANALYSIS

9.1 *Root Cause Analysis of TVA Kingston Dredge Pond Failure on December 22, 2008, Kingston Fossil Plant, Harriman, Tennessee*. Prepared by AECOM. June 25, 2009.

9.2 *Inspection Report, Review of the Kingston Fossil Plant Ash Spill Root Cause Study and Observations About Ash Management*. 2009-12283-02. Prepared by TVA Office of the Inspector General. July 23, 2009.

9.3 *Lessons Learned from the TVA Kingston Dredge Cell Containment Facility Failure TDEC Advisory Board Recommendations for Safe Performance*. Prepared by TDEC. November 30, 2009.

10 PROGRESS REPORTS

10.1 Kingston Ash Recovery Project Daily Reports

10.2 KIF Fly Ash Pond Incident Daily Situation Reports

10.3 Kingston Ash Recovery Project Weekly Reports

10.4 Kingston Ash Recovery Project Dike C Weekly Reports

11 CONTRACTOR DAILY REPORTS

11.1 Jacobs Dike C Buttress Construction Daily Reports

11.2 Jacobs QA Daily Reports

11.3 Civil Projects Daily Dike Inspection Reports

12 HEALTH AND SAFETY

12.1 *Site Wide Safety and Health Plan for the TVA Kingston Fossil Plant Ash Release Response, Revision 2.* Document No. EPA-AO-003. Prepared by Jacobs. April 6, 2009.

12.2 *Site Wide Safety and Health Plan for the TVA Kingston Fossil Plant Ash Release Response, Revision 3*. Document No. EPA-AO-003. Prepared by Jacobs. June 30, 2009 (EPA approval).

12.3 *Site Wide Safety and Health Plan for the TVA Kingston Fossil Plant Ash Release Response, Revision 4*. Document No. EPA-AO-003. Prepared by Jacobs. February 26, 2010 (EPA approval).

12.4 *Site Wide Safety and Health Plan for the TVA Kingston Fossil Plant Ash Release Response, Revision 5*. Document No. EPA-AO-003. Prepared by Jacobs. October 21, 2010 (EPA approval).

13 OSC FINAL REPORT

13.1 *TVA Kingston Fossil Fuel Plant Release Site On-Scene Coordinator Report for the Time-Critical Removal Action, May 11, 2009 through December 2011*. Document No. EPA-AP-030. Prepared by Jacobs. March 31, 2011 (EPA approval). Available online at http://www.epakingstontva.com.