Tennessee Valley Authority
Regulatory Submittal for Kingston Fossil Plant

Documents submitted:
Dredge Plan Addendum – Completion of Time Critical Removal Action, Revision 10

Date Submitted:
4/9/2010

Submitted to whom
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DREDGE PLAN ADDENDUM-COMPLETION OF TIME-CRITICAL REMOVAL ACTION

1. Purpose

The initial dredge plan (TVA 2009) was written before significant production dredging occurred and did not define how completion decisions would be made. The plan was based on the pilot study conducted from March through July 2009 and lacked details for how and when the final dredging would occur. In addition, the plan only addressed ash removal from the river. On March 5, 2010, the Environmental Protection Agency (EPA) On-Scene Coordinator (OSC) issued a memorandum documenting the final dredge depth defined by the time-critical removal action (see attachment). There are three primary purposes to this addendum to the dredge plan.

- To document the objectives of the time-critical removal action and define the completion of the action in the river (as outlined in the OSC's memorandum) and the embayments east of Dike 2.
- To provide a decision-making process for reaching agreement where no further time-critical action is required or where the time-critical removal action is complete.
- To describe the ash removal operations including the remaining tasks, equipment, and schedule required to complete the time-critical removal action in the Emory River and east of Dike 2 (including the East Embayment).

2. Objective of the Time-Critical Removal Action

On May 11, 2009, the EPA and the Tennessee Valley Authority (TVA) entered into an Administrative Order and Agreement on Consent (AOC) which included definition of the following short-term, or "time critical" objectives:

1. Prevention of the release from negatively impacting public health and the environment,
2. Containment and removal from the Emory River and the area east of Dike 2 as appropriate, to restore flow and minimize further downstream migration of the ash material, and
3. Ensure that coal ash recovered is properly managed pending ultimate disposal decision or to the extent required by limited storage, properly disposed.

Mid-term, or non-time critical removal objectives included removing any remaining coal ash from the Emory River and the area east of Dike 2 to the maximum extent practicable, as determined by EPA in consult with the Tennessee Department of Environment and Conservation (TDEC) and TVA, pending further site assessment.

An action memorandum for the time-critical removal action was approved on August 4, 2009 and notes that dredging will take place in two programs or phases. "The initial dredging program covered under this Action Memorandum, which is intended to address the time critical actions under the EPA AOC, will focus on reopening the original Emory River navigation channel. Currently, nearly one mile of the channel is blocked by the ash material and debris. Opening the channel reduces the potential for upstream flooding. It may also reduce the potential for downstream ash migration as the flow channel widens, reducing the potential for scouring. This initial phase of dredging is anticipated to recover around 1.5 million cy of ash. As a second priority, the river channel will be recontoured, removing additional ash down to native sediment where practicable."

Phase 1 dredging was completed on February 1, 2010. Phase 2 or final time-critical contouring dredging began on February 2, 2010. As of March 30, 2010, TVA has removed over 2.9 million cy of coal ash from the Emory River and adjoining areas east of Dike 2. Over 1.4 million cy of ash has been disposed of in a Subtitle D Order compliant facility and the rest of the on-site material is being managed properly as per approved work plans.

3. Overview of Approach

Figure 1 provides an overview of the approach taken to complete river dredging, showing two phases of work. First, the action memorandum required development of a dredge plan. This plan was revised in July of 2009 and is now being modified by this addendum. Following the July 2009 plan, production dredging was conducted (Phase 1). Production dredging focused on removing the most amount of ash in the quickest time frame to reduce the potential for upstream flooding by opening the river channel and to minimize downgradient migration risk.

To conduct production dredging, a grid-based dredge plan was developed with the elevation of the final dredge cut in each 125 ft by 125 ft grid being an average of the pre-spill river bottom contour. The average final contour best represented the native sediment location. It provided a balance between dredging non-ash material and leaving ash behind. The concept of a flat bottom grid set at the average river bottom was used from early November 2009 through January 2010. Figure 2 illustrates the flat bottom elevations that were used for production dredging for Segments 1, 2, and 3. This flat bottom elevation allowed the quickest removal of the greatest volume of ash with the equipment onsite. Once the initial 1.5 million cy of ash was removed by Sevenson from the river to open the channel and minimize downgradient migration, the dredging plan changed to dredging to original river contours to further minimize the potential for future ash transport down river. Most of this dredging is considered precision dredging (or Phase 2) as shallower depths of ash remain and the dredging is conducted with specialized equipment.

Following the grid-based production dredge plan left ash behind in portions of most of the grids. In some areas of the river, additional data collection in the form of surveys or vibracore samples was necessary to better define the extent of ash remaining. This information has been collected and the results are considered in this final form of the dredge plan addendum.

In those areas where ash remains at a significant quantity in a location where additional dredging is feasible, precision dredging will occur behind the production dredging. Precision dredging will also focus further up and down river where lesser depths of ash were deposited.

It is recognized that due to challenges in accurately identifying the river bottom contour and the imprecision of dredges that some ash may be left behind in some segments at the end of the time critical removal action. The extent of this ash and potential human health and ecological risks from the ash will be assessed as part of future non-time critical actions.

Please refer to the OSC's memorandum for further discussion concerning time critical dredging objectives and limitations.

4. Data Collection

There are two types of data collection needed to support time critical removal actions:

- Data to demonstrate completion of ash removal east of Dike 2.
- Data to optimize the dredge plan and schedule (locate remaining ash).

To complete the ash removal east of Dike 2 (including the east embayment), samples are only needed in areas below water or areas with extensive river bottom sediment (visually similar to ash) to demonstrate completion. Where the cleaned area is above the water level, a visual examination will be used.

To determine the extent of ash removal needed both to complete this final dredge plan addendum and in the future to refine locations to place dredges, bathymetric data compiled post-slide were compared to pre-slide bathymetric data where a survey exists. Where pre-slide data exist but no post-slide data exist, a new survey was completed. Where no pre-slide data exists, a technique such as a vibracoring was used to collect samples for visual analysis.

A sampling and analysis plan for collecting initial samples for visual analysis to determine the extent of ash present was written for this effort. Visual analysis of vibracore samples were used to estimate the amount of residual ash to determine the depth, thickness, and location of ash. Additional surveys and investigation results will be submitted to the EPA OSC and reported through the Time-Critical Phase 2 Nature and Extent Report.

The data collected were used to determine the areas to dredge that are presented in this final dredge plan.

5. Decision-Making Process

The primary mechanism to facilitate decision-making is the concurrence form which is used to record agreement on changes to the dredge plan addendum and to be used after dredging to record concurrence that the dredging activities are complete. Appropriate technical information will be attached to each concurrence form to support the agreement. A sample concurrence form and the concurrence log are attached.

6. Dredging Approach

The following description of dredging equipment, schedule, projected production rates, and ash processing operation illustrates that the completion objective can be met. Production rates of 10,000 to 12,000 cy/d will be achieved initially when all five dredges are on line and then will decline in the latter part of April as dredge cuts get shallower and the dredges have to cover more length of river to remove ash, around 4,000-6,000 cy/d. To facilitate the use of five dredges in the river, the entire river will be closed, from river mile 0.0 to the upper limits of the ash, around river mile 6.0.

The following equipment will support completion of the dredging activity. The production daily volumes are based on 80% productivity.

- 16” cutter head dredge (with Hypack software and GPS to control operation) operated from February 1st to May 1st.
    - 3,500 cy/d (250 cy/hr)

- 14” cutter head dredge (with Hypack software and GPS to control operation modified to include an automation and mechanical control software package) operated from February 1st to May 1st.
    - 2,800 cy/d (150 cy/hr)
- 16” cutter head dredge (with automation and mechanical control software) operated from February 1st to May 1st.
    - 3,500 cy/d (175 cy/hr)
- Two 14” cutter head dredges (with automation and mechanical control software) operated from February 15th and March 5th to May 1st.
    - 2,800 cy/d (140 cy/hr)
- Komatsu PC 800 mechanical dredge (with automation and mechanical control software) from March 8th to May 1st
    - 500-1000 cy/d

The dredge plan uses two hydraulic dredging approach components: 1) high-rate production dredging for remaining large deposits of ash following a dredge grid with a single bottom elevation (Phase 1); and 2) precision-controlled dredging to river bottom to accomplish attainment of final contours (Phase 2).

High-rate production dredging occurred through January with the grid elevations providing the initial target contours. Figures 3, 4, 5, and 6 illustrate the estimated depth of ash remaining in various priority segments after production dredging. The areas that are planned to be dredged in order to complete the time critical work are outlined.

This time-critical dredging will focus on removing remaining material from the main channel to meet the goals of the action memorandum. In parallel with, or subsequent to this time critical dredging, work may be conducted east of Segment 1 and in the shallow areas outside the main channel.

One portion of the main channel of the river is not being dredged under the time-critical removal action. Cs-137 has been found at low levels in underlying sediment samples taken from ERM 1.8 to 0.0. In addition, Cs-137 has been found in the sediments in the intake channel. The Cs-137 is a result of historical releases from the Oak Ridge Reservation Department of Energy facilities. Although the levels are low, the impact from having sediment with radiological contamination mixed with the ash requires further analysis. Therefore, these areas have been deferred from the time-critical removal action portion of the project.

It is important to note that the original river bottom contours are defined by the pre-slide bathymetric survey which is not complete in all areas. Therefore, despite a computerized file being available to the dredge operators of the anticipated river bottom, they may frequently reach river bottom at a higher elevation. Efforts have been and will continue to be made through visual observations of dredge effluent to not excessively overdredge. When it appears that conditions in the river result in a final elevation that is higher than originally anticipated, a change to the dredge plan will be documented through the concurrence form.

The river is divided into multiple segments as shown on Figure 7. In general, several segments will be dredged concurrently. The river is segmented to track progress and allow communication on the location of dredge activities.

There are a couple of the work elements that are unique enough to warrant a more detailed discussion. These include the following:

- The ash berm along the area east of Dike 2 is being removed by hydraulic dredges with excavation occurring first above the water line. Once completed, the area inside the berm will be dredged to complete the work begun as mechanical removal. The first ash berm dredging began as part of the first phase of Sevenson's contract.
- The rock and associated ash of Weir 1 will be removed by mechanical excavation. This effort was described more fully in a separate work plan (approved Weir 1 Removal Work Plan).

7. Storage and Processing

The high ash volume production by dredging and the need to complete the ash movement east of Dike 2 at the same time results in a greater need for storage and disposal. Wet ash storage is discouraged on site because of the potential for underlying ash stability issues. Therefore, dry ash storage requiring the least amount of pre-storage construction is the preferred method, as written in several already approved work plans. There is dry storage available in the Peninsula area and in the West Storage Area. There are smaller areas within the dredge cell that are also available such as the Valley area. Operation of these storage areas are all conducted under separate work plans. Volumes placed in these storage or processing areas are tracked daily by the operating organization.

Lime is used, as needed, on the Sluice Trench material and on the ash east of Dike 2 as well as on any other wet ash encountered during the removal action. The purpose is to dry material sufficiently for loading into the trains or into dry storage. Treatment will remove some of the capacity requirements for Ball Field processing. The lime treatment has been described and approved under a separate work plan.

8. Evaluation of Alternative Technologies and Approaches

There are several technologies that have been evaluated for removing ash from the river. Suction hydraulic dredging from the water surface with cutter heads is the method selected for use on the Emory River. Other suction dredges include a plain suction dredger (no tool on the end of the suction pipe to disturb the material), a trailing suction hopper dredge which loads the dredge spoils into a hopper on the vessel, an auger suction (like the cutter head but with a Archimedean screw as the cutting tool), and an air-lift (air blown into the pipe rises, dragging water with it). These technologies have varying challenges. A cutting device is necessary to disturb the ash or the suction will not be sufficient to lift the ash. The air lift dredge is unlikely to have enough power to disturb the ash and is typically a smaller type of dredge. Using a hopper dredge requires bringing new equipment onsite and developing a different ash handling system than the current Rim Ditch/Sluice Trench operation. The auger suction dredge is most similar and can use the existing system but does not introduce any benefit over the cutter head dredges. Suction dredging is considered to be the most effective and cutter head suction dredging has been in use at Kingston since dredging began.

Other technologies than suction surface dredges were evaluated as to their effectiveness in meeting the goal of ash removal to the river bottom by spring, ease of implementability including availability in the time frame required, and cost. Cost is a qualitative evaluation.

Bottom-crawling dredging devices: These dredges are designed to surgically remove thin layers of fine-grained materials with an accuracy of 2 to 4 in. The machine can move forward, backward, and sideways using a screw propulsion technology. They are remotely controlled. They have two dredge hoods, located at each end of the dredge. The dredge fluidizes the bottom material with a low-pressure supply pump. This allows selective removal of fine-grained sediments into an enclosed hood for slurry pipeline transport to shore. The hoods are designed to allow sand material to fall back to the bottom and only fine-

grained sediment is removed. These devices have been employed and can remove up to 100 cy per hour effectively. They could be used to separate sand from ash. Other than separation, there is no real advantage in these devices over more traditional dredges except for small areas. They will be less productive in larger areas than the hydraulic dredges. Their availability is uncertain. They are comparable in price to the hydraulic dredges planned. Between the time required to access this equipment, the potentially lower productivity, and no real advantage, these devices were not considered further.

Mechanical dredging: The use of clamshells or excavators on barges could remove ash from the river. A less applicable mechanical technology includes circulating buckets attached to a wheel or chain. There is much less water captured that must be removed. This lower hydraulic requirement would lessen the dependency of the project on the Rim Ditch/Sluice Trench/Ash Pond system. There are excavators onsite that could reach the required depth in the river. However, mechanical dredging may increase the rates of suspension of ash and resultant turbidity in the river. Because barges are required to move the recovered ash to shore, the limiting factor in production is the ash movement to shore. As the barges move into the upper and lower reaches of the river, this production will be lowered. Once the ash is moved to the shore, it needs to be moved into the Ball Field by truck, increasing the need and cost for off-road trucks. Equipped with the same depth finding system as the hydraulic dredges, mechanical dredges could be just as accurate.

Mechanical dredging from a barge mounted crane or hydraulic hoe can be effective in removing fly ash. The equipment may be fitted with instruments and differential global positioning that will allow removal of controlled areas within a general survey accuracy of ± 6-inches. Removal on flatter areas is usually by use of a clamshell bucket that may be sealed to prevent the loss of fly ash upon lifting the bucket. On steeper slopes a backhoe bucket is usually more effective and can make a more precise cut by operating perpendicular to the slope. In deep water a hydraulic hoe may be limited and have to use a spindle extension to reach the bottom. The use of a spindle reduces some of the maneuvering flexibility inherent in a backhoe and thus slows production rate. Mechanical dredging equipment is able to handle debris (i.e., trees) as they are encountered and does not have to wait for debris handling.

Mechanical excavation requires a crane or backhoe setting on a barge and the draft under the barge limits work in very shallow water. More importantly, if the fly ash is placed on a flat deck barge with combing the draft of the material barge will likely prevent work in areas with less than 5-feet of water. The barge must then be moved to an unloading facility that can draft a full barge. At the unloading facility the free water that is loaded with the fly ash (likely to be 40-50% of the volume) must be removed prior to moving the fly ash. To avoid this issue the free water could be allowed to overflow the barge, however, the total suspended solids downstream of the barge would likely be found unacceptable. On some sites in very shallow water a mechanical dredging option has been used with the dredge material moved away from the dredge using a floating pump hopper (pump and hopper on a barge deck). With this approach the mechanical dredge may access shallower water. However, there is still a need to remove debris from the pumping barge, since it cannot pass through the pump. If hydraulic lines are present in the work area, it will be difficult to move a mechanical system and its material barges around the floating obstructions. The equipment usually used for mechanical dredging with precision accuracy is not common equipment and the time frame to obtain the equipment for a major operation and get it operational could be two months or more.

As with all dredging operations, the unit cost to complete both hydraulic dredging and mechanical dredging is dependent on the size of the dredging unit (i.e., the cost of labor per day is somewhat constant as equipment size increases). Generally if keeping the removal rates comparable, mechanical dredging is approximately twice the cost of hydraulic dredging going after the same material. If the dewatering cost is high then the mechanical dredge may gain some of the differential back. At the Kingston Ash

Recovery project the dewatering means and methods are cost effective and it is unlikely that the gains in reduced water handling apparent from mechanical dredging would tip the scale in favor of mechanical dredging. (For example conventional hydraulic dredging is $5-10 per cubic yard and mechanical would be $15-20 per cubic yard).

Mechanical dredging is used in the final plan for specialized removals.

Vacuuming: Current activities to collect cenospheres from the river use vacuum trucks. These trucks have been placed on barges to allow access to the center of the river. The hoses are flexible and therefore must either be used in shallow areas where personnel can guide them, or the personnel will need to don scuba equipment to guide the hoses. In either case, the production is low. Significant trips would be required from barge to shore to offload the trucks. A larger system could be designed but there is still the issue that the ash is so hard in areas that a cutting device is necessary to first break the ash to allow suction to work. Vacuuming is not effective as it would not remove the ash and because of the low production, could not remove the ash in the time frame required. The cost would also be very high per volume of ash removed. Vacuuming is not considered further due to these issues.

9. Ash Removal East of Dike 2

The activities associated with removing ash east of Dike 2 have been identified in an approved work plan and will not be repeated here. The only significant modification is the use of lime as a drying agent for the wet ash generated during excavation, also approved under separate cover. A test was conducted using road stabilization equipment to add lime to wet ash, some from the Sluice Trench and some from areas east of Dike 2. Various quantities of lime, between 6 and 9% by weight, were added to varying types of wet ash. In all cases, the resultant ash was of sufficiently low moisture content to be loaded directly into trains for transport to Alabama. A request was made of the disposal facility to accept 6% lime in the disposed ash and the request was granted. Stantec has also agreed that the lime-treated ash can be used in dry ash stacking locations, including the test embankment.

Much of the ash that remains in the areas east of Dike 2, including the east embayment, is too wet to dry at the point of generation to a condition suitable for loading or dry stacking. A vendor has been selected to dry the ash with lime kiln dust. The actual quantities added varies with the condition of the ash but the additive must allow the ash to reach loadable quality within a few hours, not set up to conditions that would cause a rail car to be unloadable and also to be acceptable to the landfill. It is anticipated that a worse case need would be up to 150,000 cy of wet ash will require treatment. The treated material would then be taken to dry ash storage or to the trains for disposal.

Another 75,000 cy of ash that is under water or part of an ash berm also must be removed. A combination of excavation and hydraulic dredging has been selected to remove this material. The dredged material will be processed through the Rim Ditch/Sluice Trench and Ball Field to dry sufficiently to load on trains.

10. Schedule

Activities to complete the time-critical removal action have been scheduled and this action will be completed May 01, 2010. Figure 8 is a schedule showing the two major components of the action; dredging and ash removal east of Dike 2.

Three new dredges were brought on site to work with the existing 14 and 16 inch dredges. The new dredges are fitted with a precision system for guiding the cutterhead to cut to the river bottom.

One of the dredges was deployed to Segment 4 to dredge the northern portion of it to original contours. Meanwhile, the other new dredge along with one of the original dredges moved into Segment 5 and above Segment 5 to complete those areas. The remaining two dredges continue dredging in Segments 1, 2, and 3.

The major assumptions relevant for each segment are included in Table 1. The daily production presented above was reduced to 80% to reflect actual productivity on the river. Each dredge is assumed to work 6 days a week with one day for routine maintenance. The dredges used in each segment may change as conditions change.

Table 1. Planned dredge volumes and equipment

Area	Volume (cy)	Dredge
Post Phase 1 Segments 1-5	530,000	16" at 3500 cy/d 14" at 2800 cy/d
North of Phase 1 Segments to ERM 6.0	250,000	Mechanical-50,000 cy at 2000 cy/d 16" at 3500 cy/d 14" at 2800 cy/d

Ash removal and treatment from the areas east of Dike 2 should be completed by mid-April with another 75,000 cy of ash removed from the berms and below water by hydraulic dredging completed by May 1.

FIGURES

Figure 1. River Dredging Activities
Figure 2. Emory River TVA Dredge Plan; Target Elevations Segments 1, 2, and 3
Figure 3. Ash Remaining to Pre-Spill Surface Above Above Segment 5
Figure 4. Ash Remaining to Pre-Spill Surface Above Segment 5
Figure 5. Ash Remaining to Pre-Spill Surface Segments 1, 2, 3, and 5
Figure 6. Ash Remaining to Pre-Spill Surface in Segment 4
Figure 7. Dredge Segments
Figure 8. Schedule

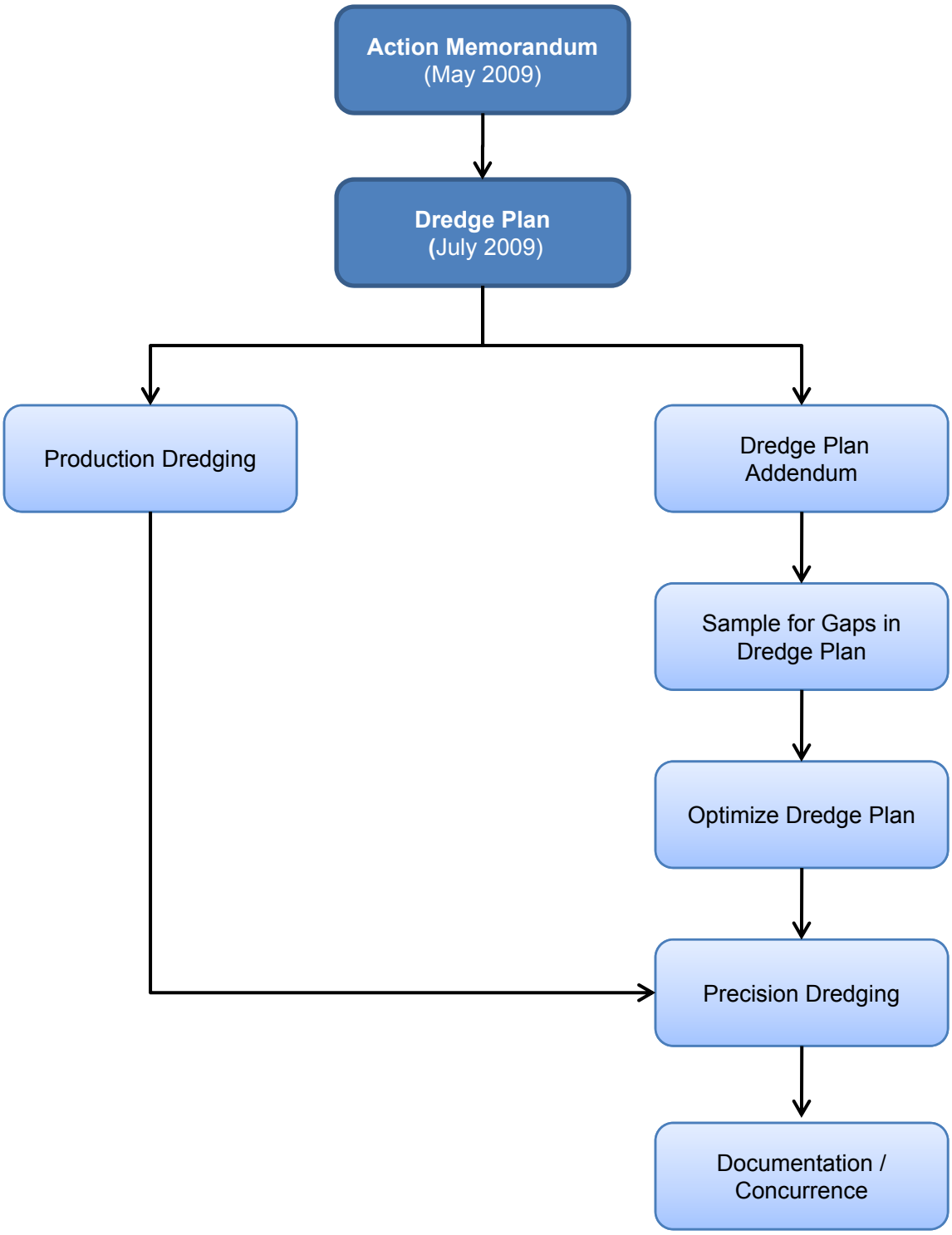
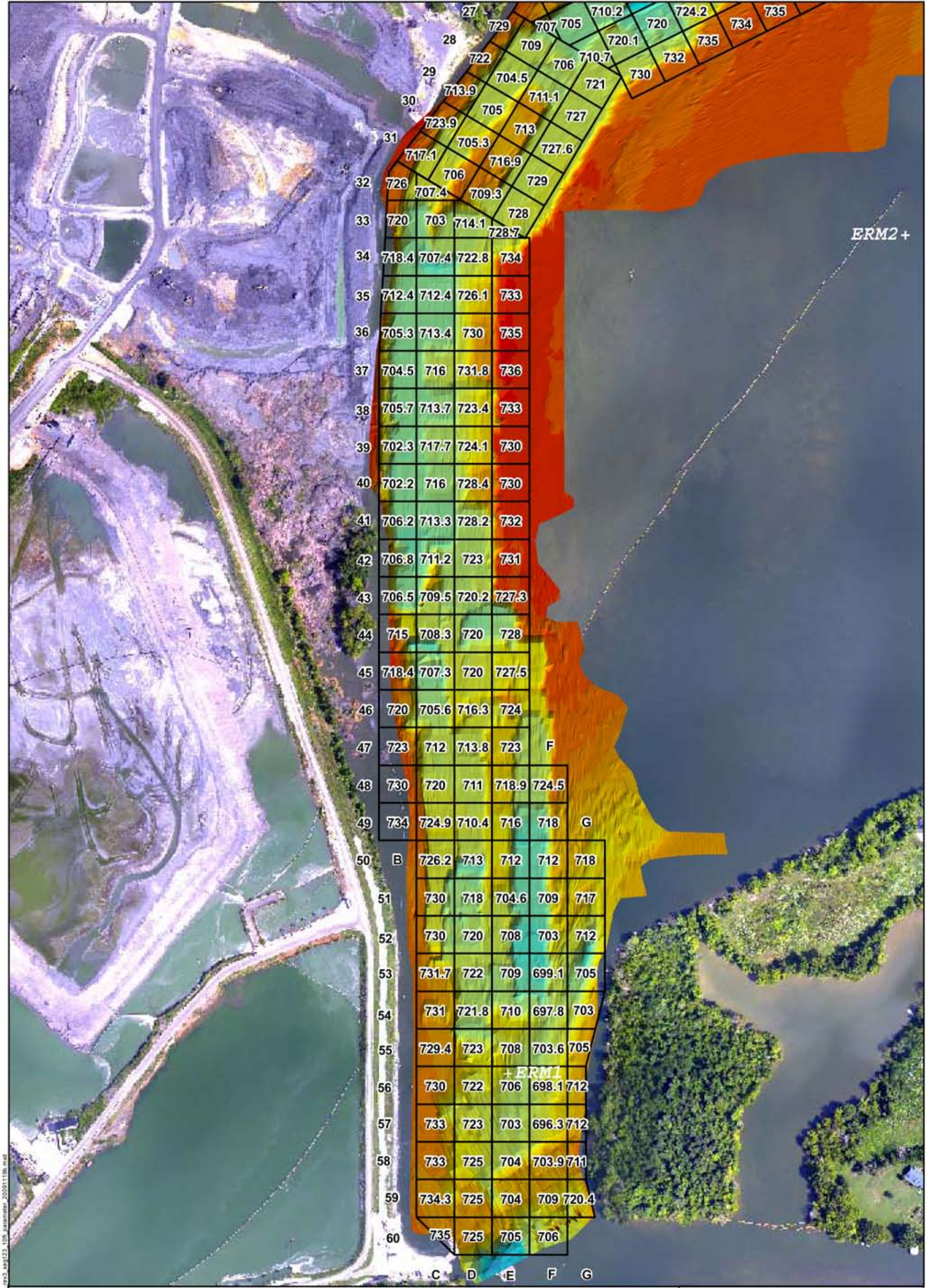


Fig. 1. River Dredging Activities



Legend

Emory River Bathymetry; Elevation, feet
Dredging Activities through 11/17/09 for the Sandpiper, 11/18/09 for the McKenzie, and 11/17/09 for the Kylee

740 - 742
738 - 740
736 - 738
734 - 736
732 - 734
730 - 732
728 - 730
726 - 728
724 - 726
722 - 724
720 - 722
718 - 720
716 - 718
714 - 716
712 - 714
710 - 712
708 - 710
706 - 708
704.88 - 706

719.1 ← Target Elevation with 10 ft parameter

0 150 300 Feet 1:3,600

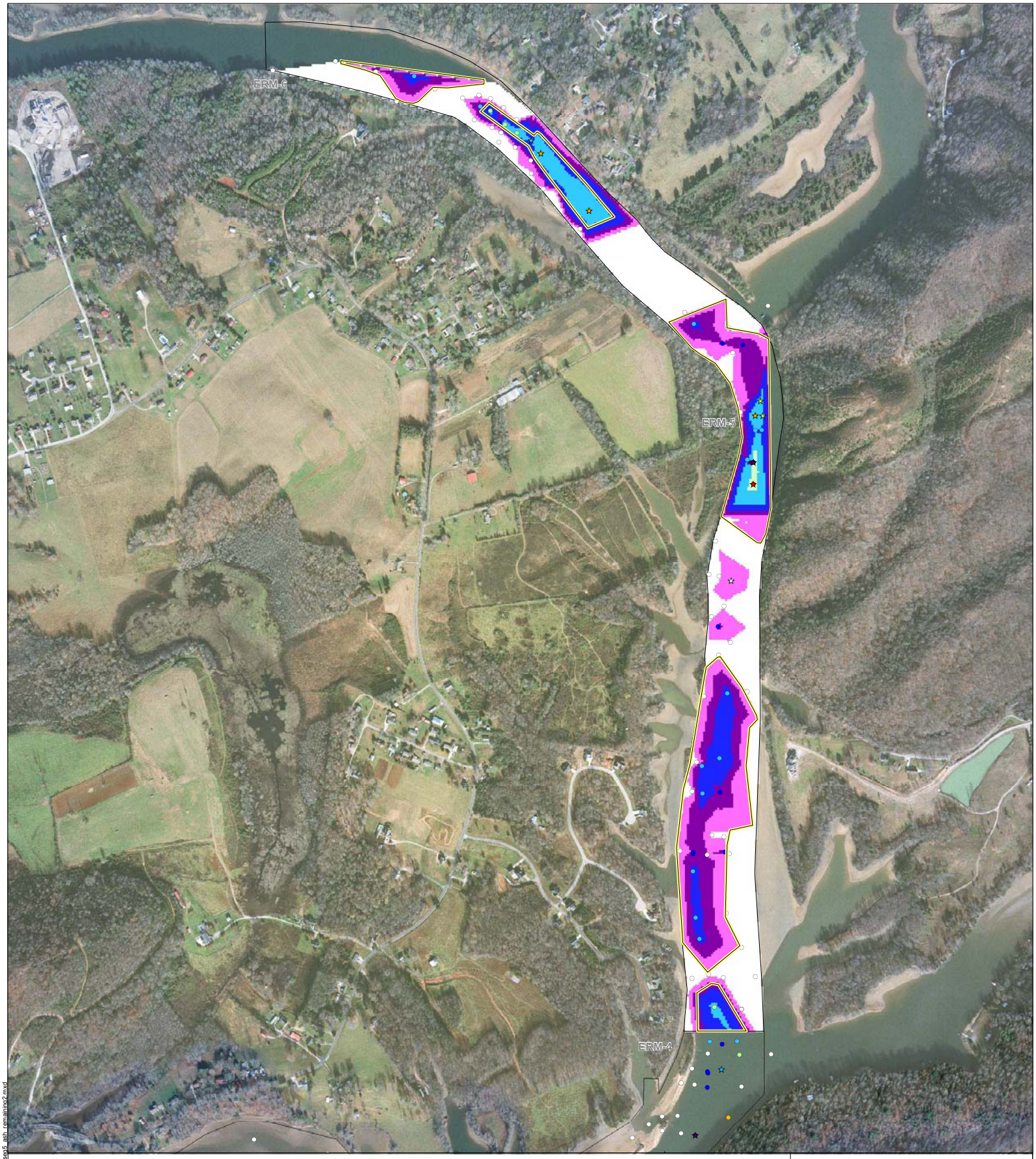
N

JACOBS

Emory River TVA Dredge Plan; Target Elevations Segments 1, 2, and 3

NAME: croberts DATE: 11/20/2009

Figure 2



Legend

Ash Remaining: ~67,803 cy

- 0 - 1 inch; ~335 cy
- 1 - 6 inches; ~9,370 cy
- 6 inches - 1 ft; ~19,592 cy
- 1 - 2 ft; ~ 26,766 cy
- 2 - 4 ft; ~8,838 cy
- 4 - 6 ft; ~2,902 cy

Proposed Dredge Area

Vibecores Collected as of 02/25/2010; Thickness of Ash (ft)

- 0.00 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00

Vibecores Collected as of 02/25/2010; Minimum Thickness of Ash (ft) (Bottom of Ash is unknown.)

- 0.40 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00

DRAFT

0 500 1,000 Feet

1:3,000

N

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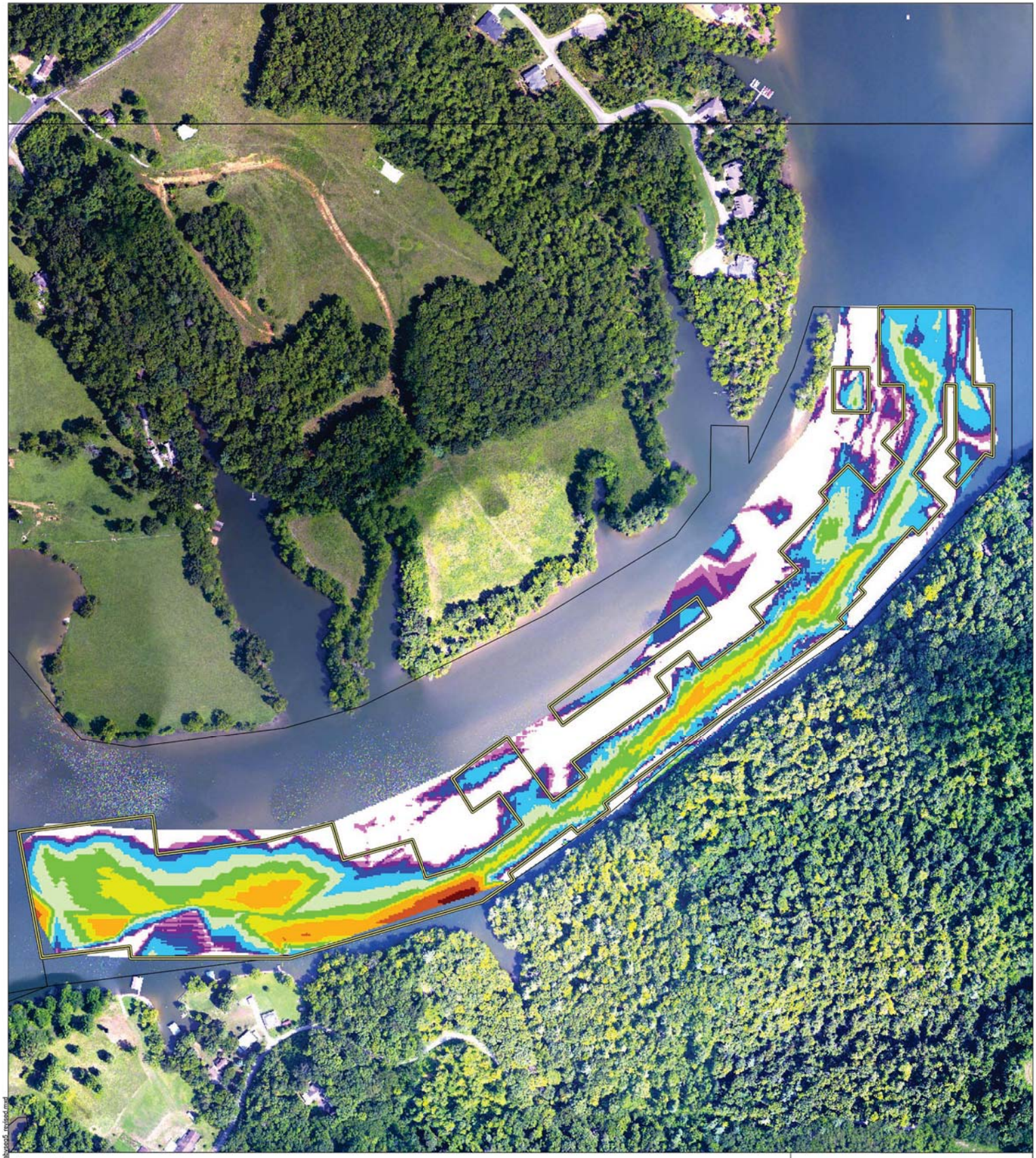
Ash Remaining to Pre-Spill Surface Above Above Segment 5

NAME: croberts DATE: 03/15/2010

Figure 3

Y:\TVA\Projects\05DJ5400\20100315\ArcGIS\above_above_seg5_ash_remaining2.mxd



Legend

Ash Remaining; ~184,467 cy

- 0 - 1 inch; ~23 cy
- 1 - 6 inches; ~903 cy
- 6 inches - 1 ft; ~2,432 cy
- 1 - 2 ft; ~ 7,804 cy
- 2 - 4 ft; ~25,576 cy
- 4 - 6 ft; ~34,111 cy
- 6 - 8 ft; ~41,299 cy
- 8 - 10 ft; ~34,748 cy
- 10 - 15 ft; ~28,775 cy
- 15 - 20 ft; ~6,673 cy
- > 20 ft; ~2,123 cy

Proposed Dredge Area

DRAFT

0 200 400 Feet

N

1:1,200

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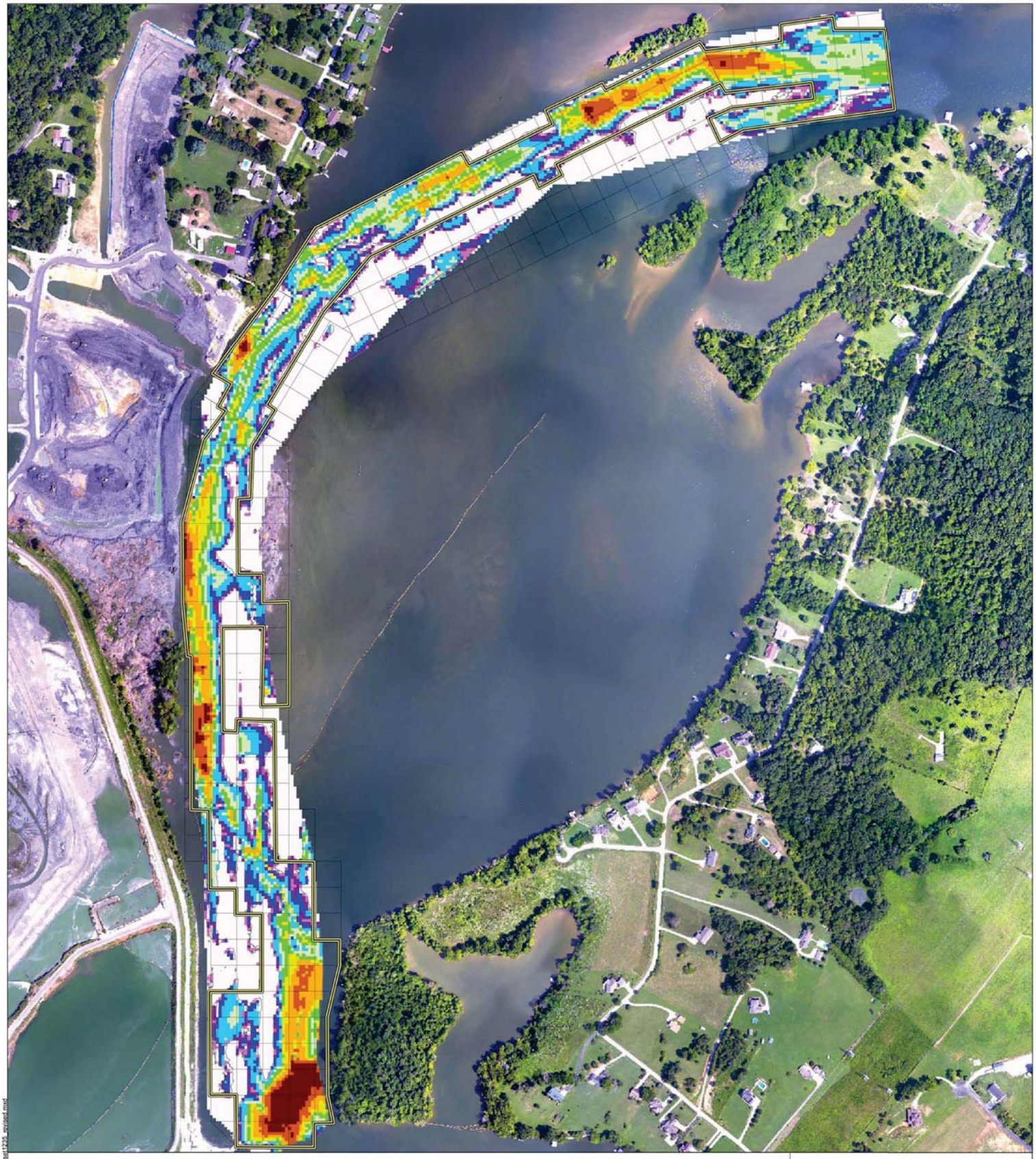
Ash Remaining to Pre-Spill Surface Above Segment 5

NAME: croberts DATE: 02/25/2010

Figure 4

Y:\TVA\Projects\05DJ5400\20100215\ArcGIS\ashremaining_abyscoff_revised.mxd



Legend

Ash Remaining; ~438,592 cy

- 0 - 1 inch; ~32 cy
- 1 - 6 inches; ~1,315 cy
- 6 inches - 1 ft; ~3,802 cy
- 1 - 2 ft; ~ 14,177 cy
- 2 - 4 ft; ~45,426 cy
- 4 - 6 ft; ~57,924 cy
- 6 - 8 ft; ~57,980 cy
- 8 - 10 ft; ~46,704 cy
- 10 - 15 ft; ~91,783 cy
- 15 - 20 ft; ~62,820 cy
- > 20 ft; ~56,629 cy

Proposed Dredge Area

DRAFT

0 300 600 Feet

N

1:1,800

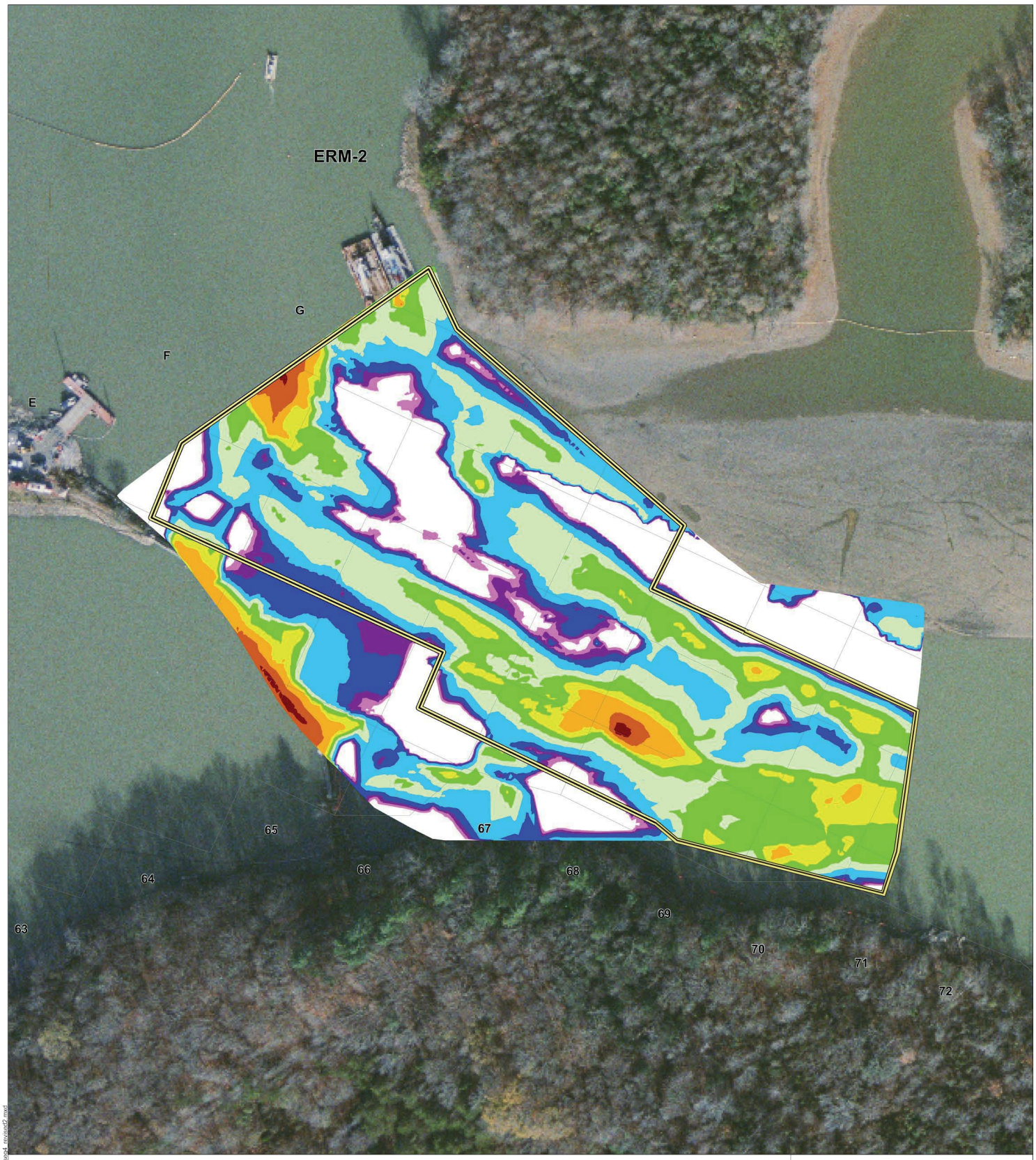
JACOBS

Ash Remaining to Pre-Spill Surface Segments 1, 2, 3, and 5

NAME: croberts DATE: 02/25/2010

Figure 5

Y:\TVA\Projects\05DJ5400\20100225\ArcGIS\ashremaining_set1235_rev\cad.mxd



Legend

Ash Remaining; ~62,899 cy

- 0 - 1 inch; ~4 cy
- 1 - 6 inches; ~141 cy
- 6 inches - 1 ft; ~495 cy
- 1 - 2 ft; ~ 2,280 cy
- 2 - 4 ft; ~8,919 cy
- 4 - 6 ft; ~15,347 cy
- 6 - 8 ft; ~16,651 cy
- 8 - 10 ft; ~7,927 cy
- 10 - 15 ft; ~6,504 cy
- 15 - 20 ft; ~3,752 cy
- > 20 ft; ~879 cy

Proposed Dredge Area

DRAFT

0 80 160 Feet

1:480

N

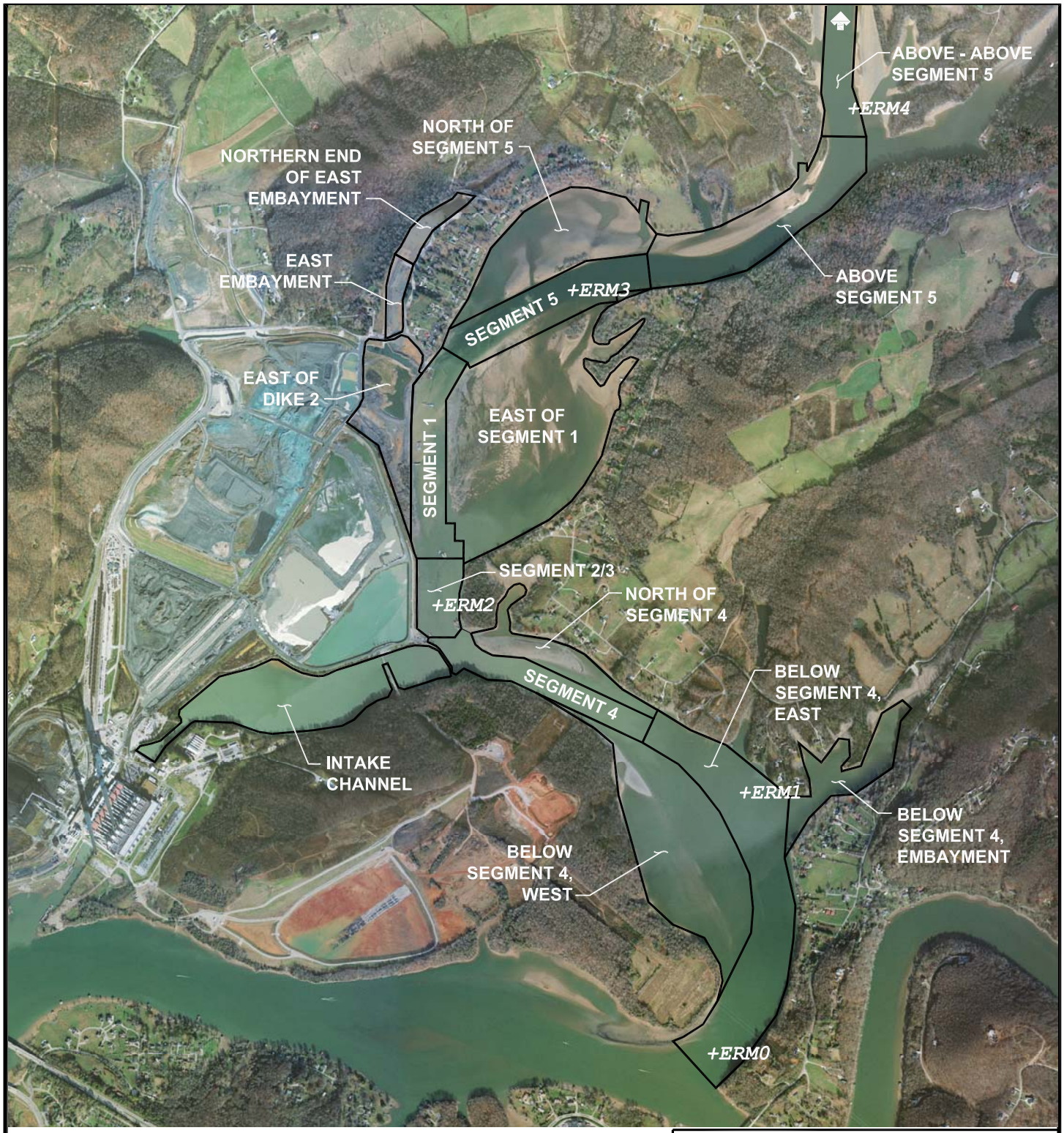
JACOBS™

Ash Remaining to Pre-Spill Surface in Segment 4

NAME: croberts DATE: 03/24/2010

Figure 6

Y:\TVA\Projects\05DJ5400\20100324\ArcGIS\sebremaining_seg4_revised2.mxd



0 1000 2000

Feet 1:2000

JACOBS™

Dredge Segments

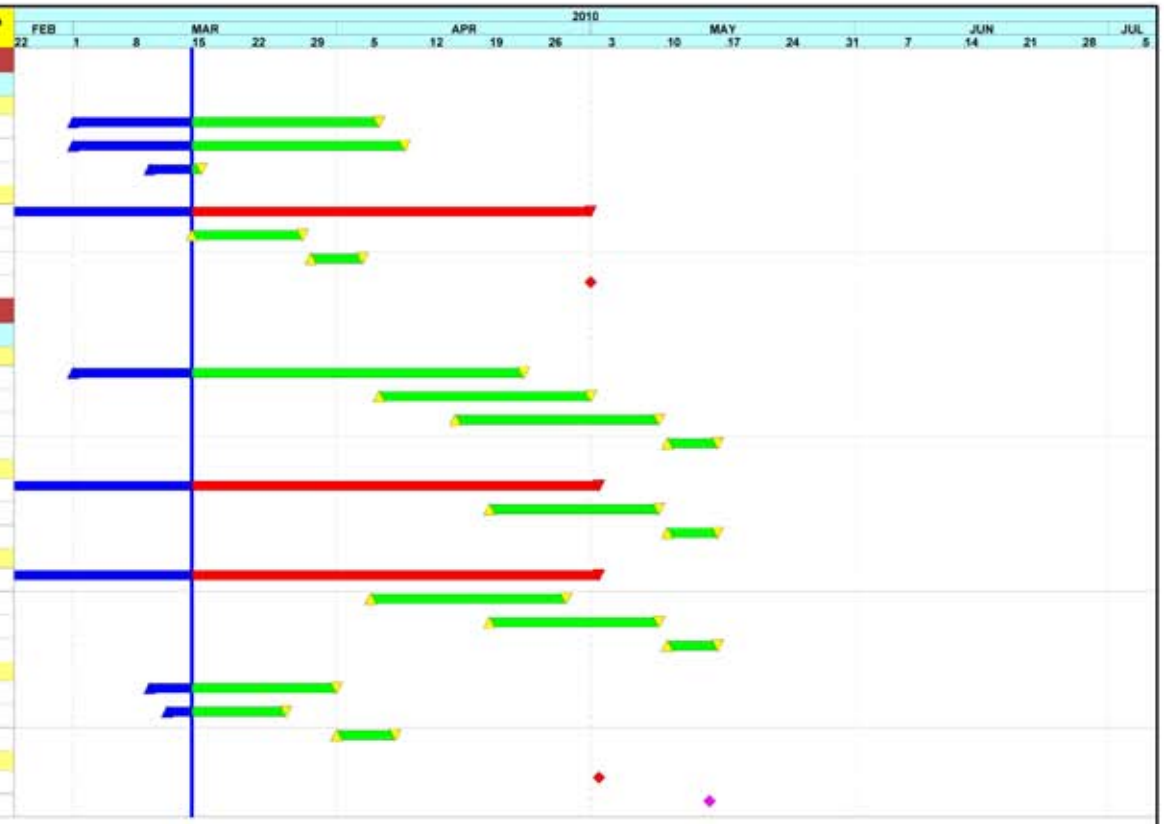
NAME: Jacobs DATE: 01/26/10

Figure 7

T:\0002 ENGINEERING\Civil\Drawing\Dredging\Dredge Plan\New Revised Dredge Grid.dwg Mar 01,2010 -bperatro

Figure 8. Schedule

Activity ID	Activity Description	Orig Dur	Rem Dur	Early Start	Early Finish	Total Float	Accountable Name
04 Infrastructure							
0413 Ash Removal East of Dike-2							
D11 East Embayment							
CH2000680	Excavate & Haul Ash from East Embayment	32	19	01MAR10A	05APR10	4	CIVIL PROJ
EAST0410	CR00015 - Use Lime Technology to Support Excav	36	22	01MAR10A	08APR10	19	
EAST1040	Document - North Portion of East Embayment	5	1	10MAR10A	15MAR10	34	JACOBS
D15 Ash Removal East of Dike 2							
EAST1000	Mechanical Removal of Ash	60	41	01FEB10A	30APR10	0	
EAST1070	Final Survey	12	12	15MAR10	27MAR10	23	
EAST1080	Documentation - East of Dike 2	6	6	29MAR10	03APR10	23	TVA
EAST0900	Ash Removal East of Dike 2 Complete	0	0		30APR10	0	TVA
05 Ash Dredging & Processing							
0508 Dredging Optional Scope							
E71 Dredging Upstream of Segment 5							
RIVR0010	Dredge - Abv Segment 5	36	34	01MAR10A	22APR10	8	SEVENSON
RIVR0060	Mechanical Excavation - Abv Abv Segment 5	22	22	06APR10*	30APR10	1	SEVENSON
RIVR0020	Final Survey - Abv Segment 5	21	21	15APR10	06MAY10	30	
RIVR0030	Documentation - Abv Segment 5	6	6	10MAY10	15MAY10	30	
E72 Dredging Segment 5							
RIVR0110	Dredge - Segment 5	54	42	01FEB10A	01MAY10	0	SEVENSON
RIVR0120	Final Survey - Segment 5	18	18	19APR10	06MAY10	30	
RIVR0130	Documentation - Segment 5	6	6	10MAY10	15MAY10	30	
E73 Dredging Segments 1/2/3 & East of Dike 2							
RIVR0210	Dredge - Segment 1 & 2 & 3	54	42	01FEB10A	01MAY10	0	SEVENSON
RIVR0215	Dredge - East of Dike 2 - N & S Berms	20	20	05APR10*	27APR10	40	SEVENSON
RIVR0220	Final Survey - Segment 1/2/3	18	18	19APR10	06MAY10	30	
RIVR0230	Documentation - Segment 1/2/3	6	6	10MAY10	15MAY10	30	
E75 Dredging Segment 4							
RIVR0420	Final Survey - Segment 4	18	15	10MAR10A	31MAR10	63	
BASE0020	Remove Weir #1 from River	12	10	12MAR10A	25MAR10	10	SEVENSON
RIVR0430	Documentation - Segment 4	6	6	01APR10	07APR10	63	
DRG000200	All Time Critical Dredging Complete	0	0		01MAY10	0	TVA
MS1001000	Time-Critical Removal Actions Complete	0	0		14MAY10	24	TVA



Start Date 01APR09
Finish Date 29APR15
Data Date 15MAR10
Run Date 16MAR15 16:29

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ASH1

Sheet 1 of 1

Tennessee Valley Authority

TVA Kingston Ash Recovery Project

Time Critical Actions

Early Bar
Progress Bar
Critical Activity

ATTACHMENTS

Memorandum: EPA Approval of the Final Dredge Depth Determination; March 5, 2010

Time-Critical Concurrence Log

Time-Critical Concurrence

MEMORANDUM

Date: March 5, 2010

From: Leo Francendese, EPA OSC
TVA Kingston Site

To: Steve McCracken, TVA Project Manager
TVA Kingston Site

Thru: Craig Zeller, EPA RPM
TVA Kingston Site

The purpose of the memorandum is to document the decision process for U.S. Environmental Protection Agency (EPA) approval of the final dredge depth determination under the time critical removal action for the TVA Kingston Fossil Fuel Plant Coal Ash Release Site (the Site). Specifically, the dredge depth will be set at the 2007 bathymetry estimate of the Emory River channel bottom. Dredging operations will be conducted in a manner that seeks to maximize coal ash removal while simultaneously minimizing disturbance to native sediments of the river.

BACKGROUND

The following is a description of the status provided by the EPA OSC for background. EPA is acting as the approving official for the CERCLA Administrative Order and Agreement on Consent (AOC) at the Site. The EPA approving official for time critical work plans is the EPA OSC.

On May 11, 2009, EPA and the Tennessee Valley Authority (TVA) entered into an AOC, which included definition of the following short term, or "time critical" objectives:

1. prevention of the release from negatively impacting public health and the environment
2. containment and removal from the Emory River and the area east of Dike 2 as appropriate to restore flow and minimize further downstream migration of the ash material and
3. ensure that coal ash recovered is properly managed pending ultimate disposal decisions or to the extent required by limited storage, properly disposed.

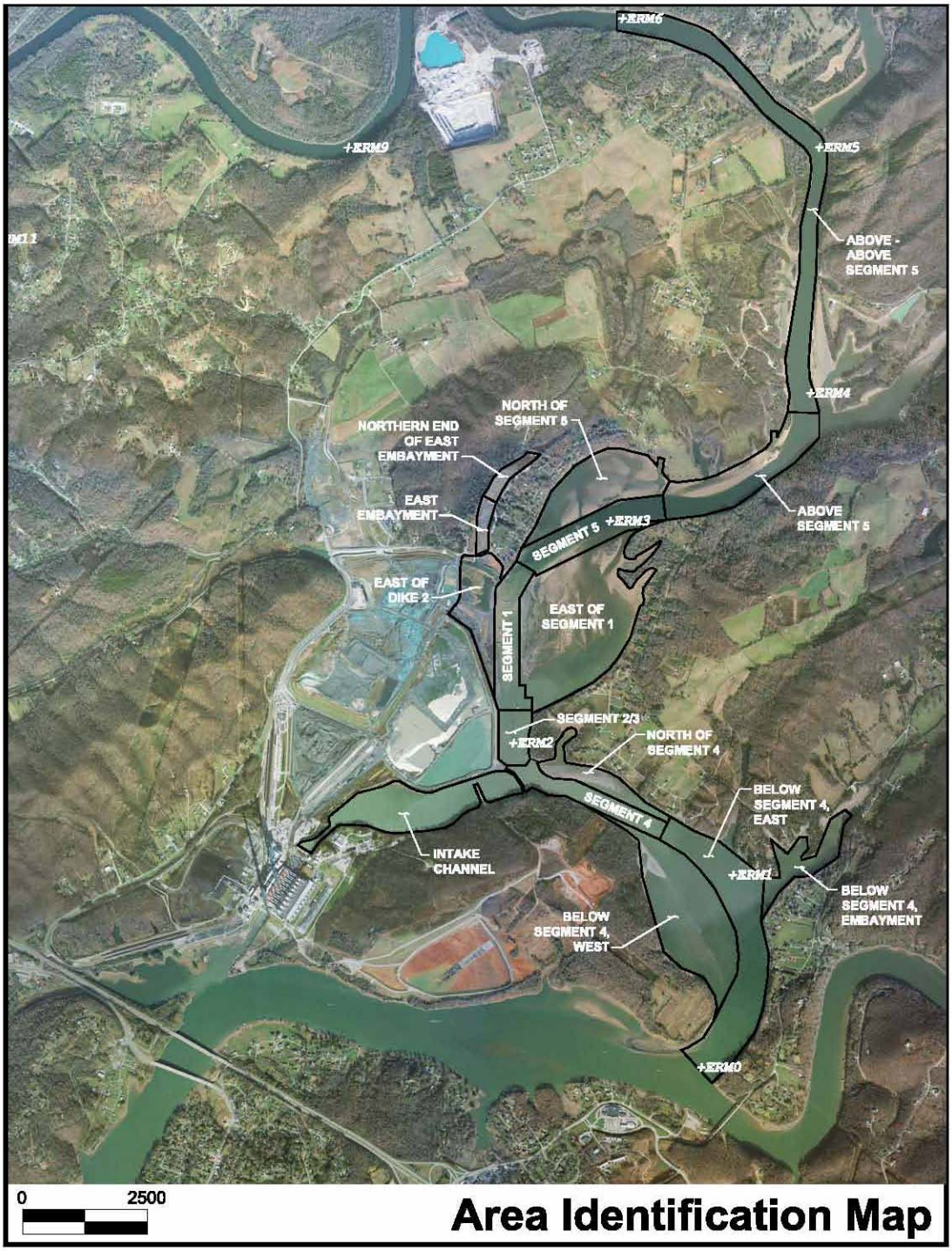
Mid term, or non-time critical objectives included removing any remaining coal ash from the Emory River and the area east of Dike 2 to the maximum extent practicable, as determined by EPA in consult with TDEC and TVA, pending further Site assessment.

An Action Memorandum for the time critical removal action was approved on August 4, 2009 and notes that dredging will take place in two programs or phases:

> "The initial dredging program covered under this Action Memorandum, which is intended to address the time critical actions under the EPA AOC, will focus on reopening the original Emory River navigation channel. Currently, nearly one mile of the channel is blocked by the ash material and debris. Opening the channel reduces the potential for upstream flooding. It may also reduce the potential for downstream ash migration as the flow channel widens, reducing the potential for scouring. This initial phase of dredging is anticipated to recover around 1.5 million cubic yards of ash. As a second priority, the river channel will be recontoured, removing additional ash down to native sediment where practicable."

Phase 1 dredging was completed on February 1, 2010. Phase 2 or final time-critical contouring dredging began on February 2, 2010. As of February 16, 2010, TVA has removed over 2.6 million cubic yards (CYS) of coal ash from the Emory River and adjoining areas east of Dike 2. Over 1 million CYS has been disposed of in a Subtitle D Order compliant facility and the rest of the on-site material is being managed properly as per approved work plans.

Figure 1. The following image is meant to assist in identifying areas to be discussed.



ESTIMATE OF VOLUME OF COAL ASH REMAINING IN EMORY RIVER

A large number of factors create uncertainty in estimating the volume of coal ash remaining in the Emory/Clinch river system east of Dike 2. These factors include: estimating underwater volumes and inherent uncertainty of sediment coring and bathymetry investigations. However, several lines of evidence can be used to provide a reasonable working estimate for this value:

1. Bathymetry within the channel Segments 1, 2, 3, 4, and 5 post Phase 1 execution indicate approximately 580,000 CYS remaining.
2. Bathymetry and sediment coring data gathered north of Segment 5 result in additional estimates of 250,000 CYS to ERM 6.0.
3. Bathymetry and sediment coring south of Segment 4 result in additional estimates of 120,000 CYS to the confluence of the Clinch.
4. Sediment coring within the KIF Intake Channel estimates approximately 75,000 CYS.
5. Shallow zones, including sand bars outside the channel appear to have relatively minor total mass as compared to the main channel and are estimated to contain an additional 125,000 CYS.
6. Approximately 50,000 CYS remains to be removed from the East Embayment via excavation.

To summarize:

1.	Post Phase 1 Segments 1 thru 5	580,000 CYS
2.	North of Phase 1 Segments to ERM 6.0	250,000 CYS
3.	South of Phase 1 Segments to ERM 0	120,000 CYS
4.	Shallow zones, sand bars	125,000 CYS
5.	KIF Intake Channel	75,000 CYS
6.	East Embayment	50,000 CYS
TOTAL		**1,200,000 CYS**

- Coal ash residing in Items 1 thru 3 is subject to migration because it resides in the main channel of the river. These areas are to be addressed as priority areas. (Please note rationale on page 8 for exclusions within these items)
- Coal ash under Item 4 rests in shallow zones or sand bars and is not as subject to migration therefore resulting in lesser priority.
- Coal ash under Item 5 is not subject to migration as long as the coal plant remains idle. The coal plant is being run as part of a system reliability decision matrix and thus results in a lesser priority as frequency of use is significantly diminished.
- Coal ash removal under Item 6 is on track for April 2010 completion.

Figure 2. This image represents coal ash remaining in channel Segments 1, 2, 3, 5 post Phase 1.

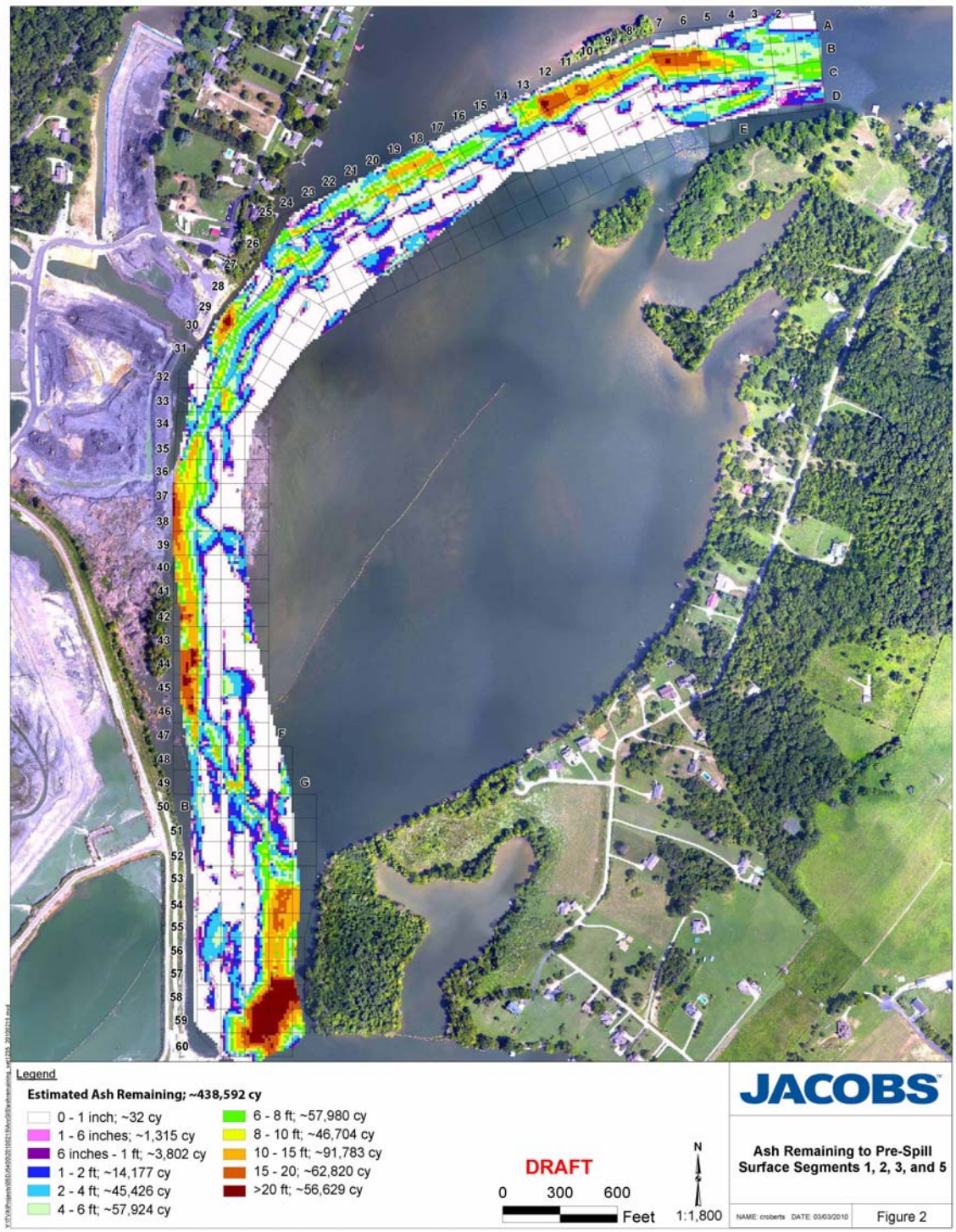


Figure 3. This image represents coal ash remaining in channel Segment 4 post Phase 1.

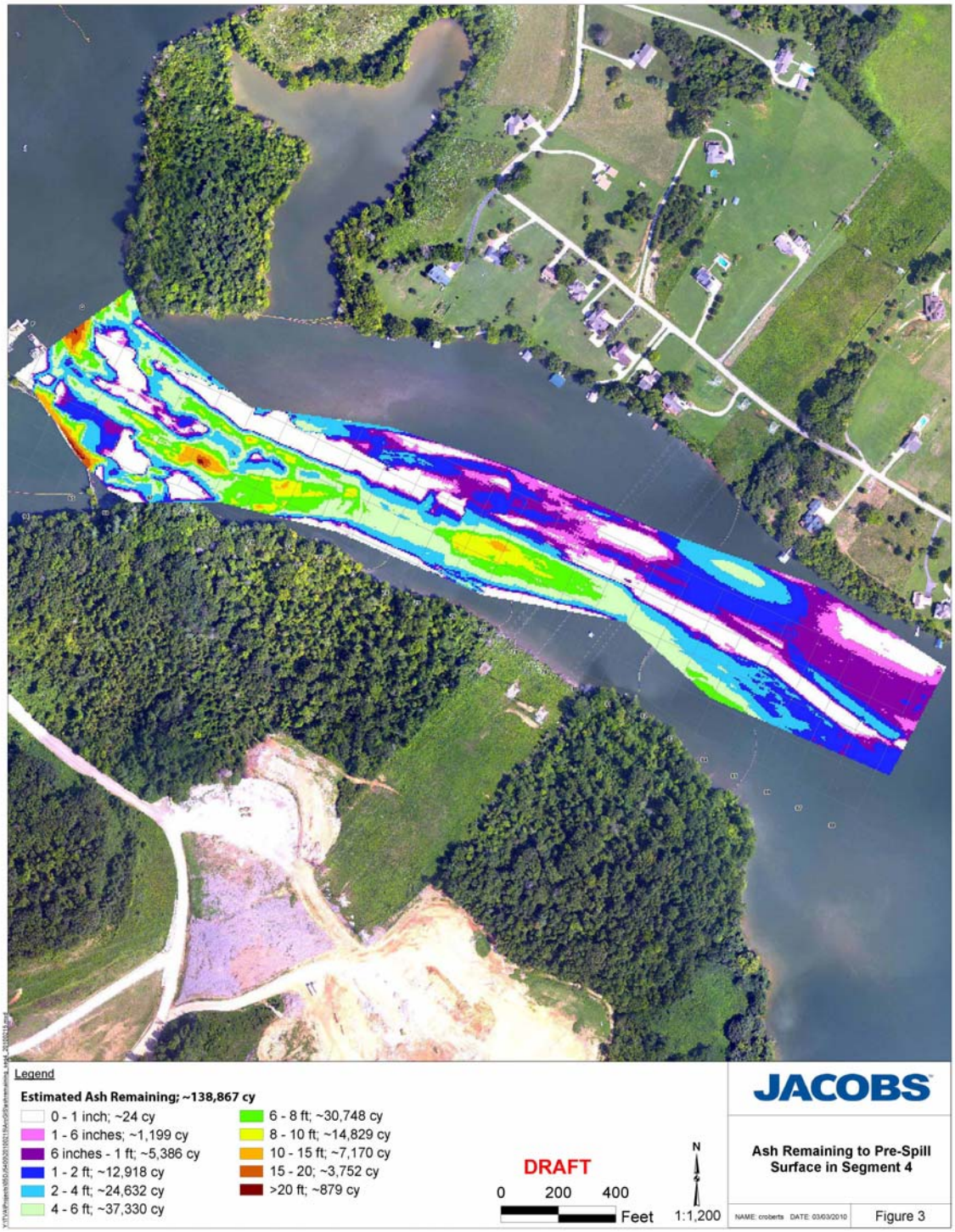


Figure 4. This image represents coal ash remaining in the channel Below Segment 4.

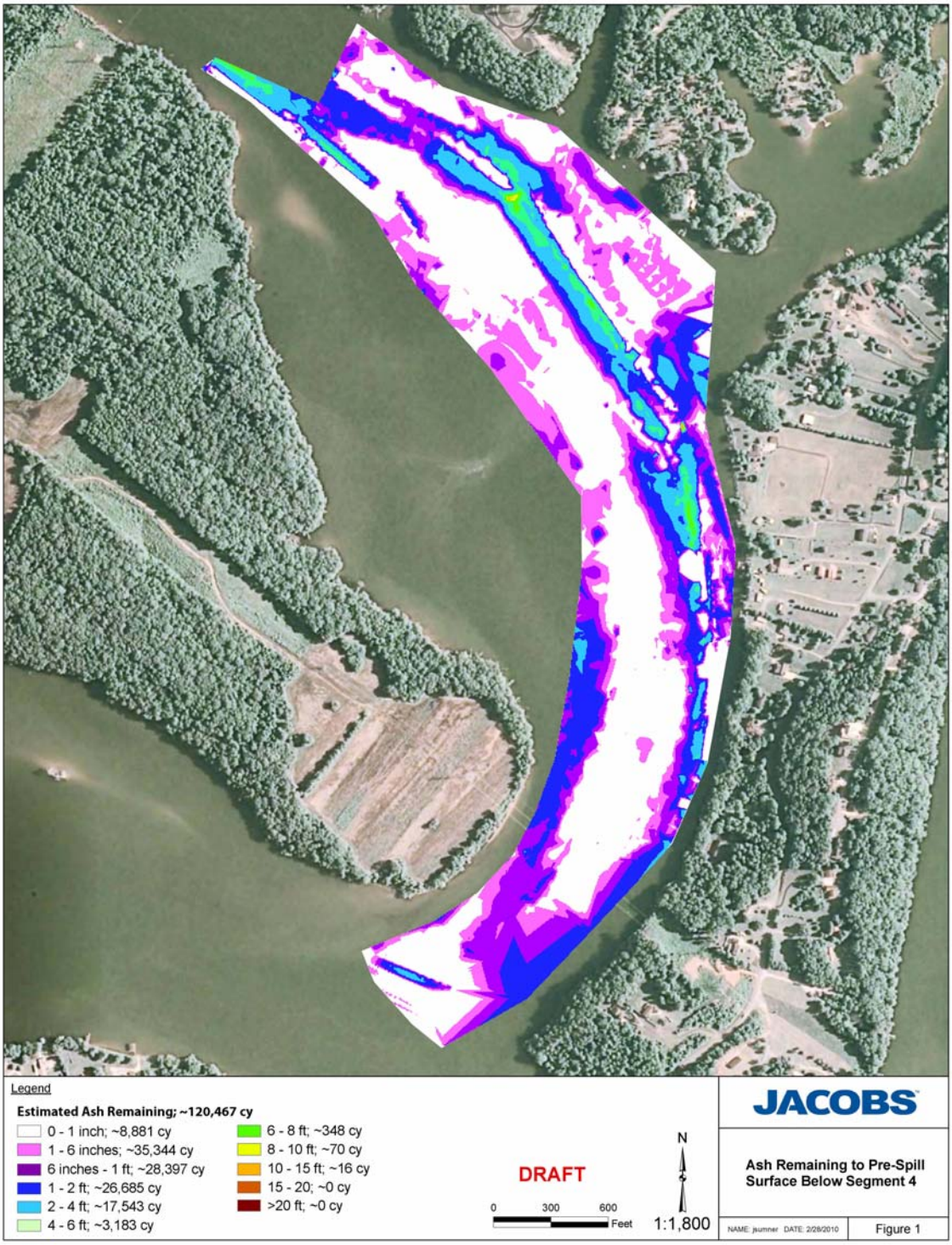


Figure 5. This image represents coal ash remaining in the channel Above Segment 5.

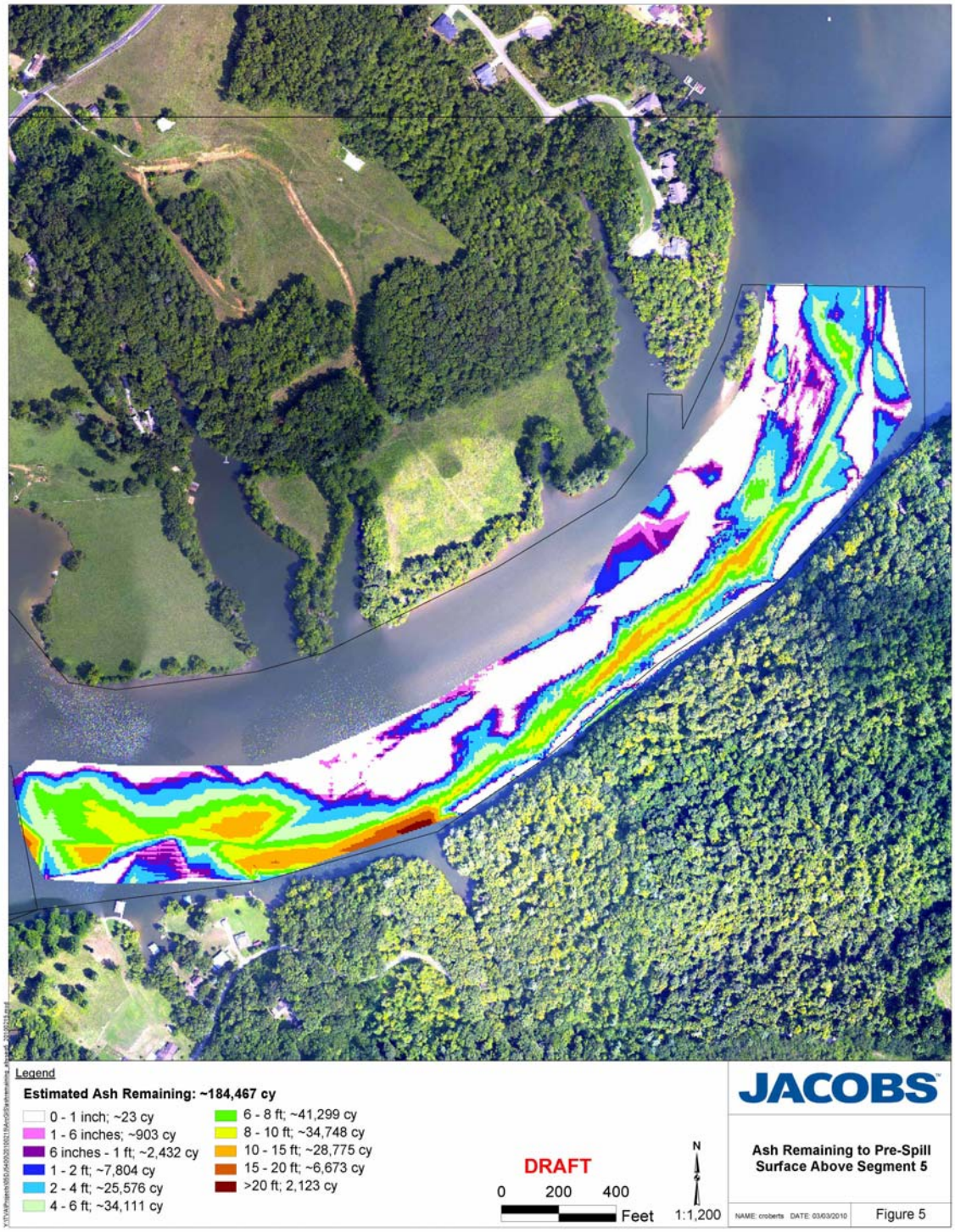
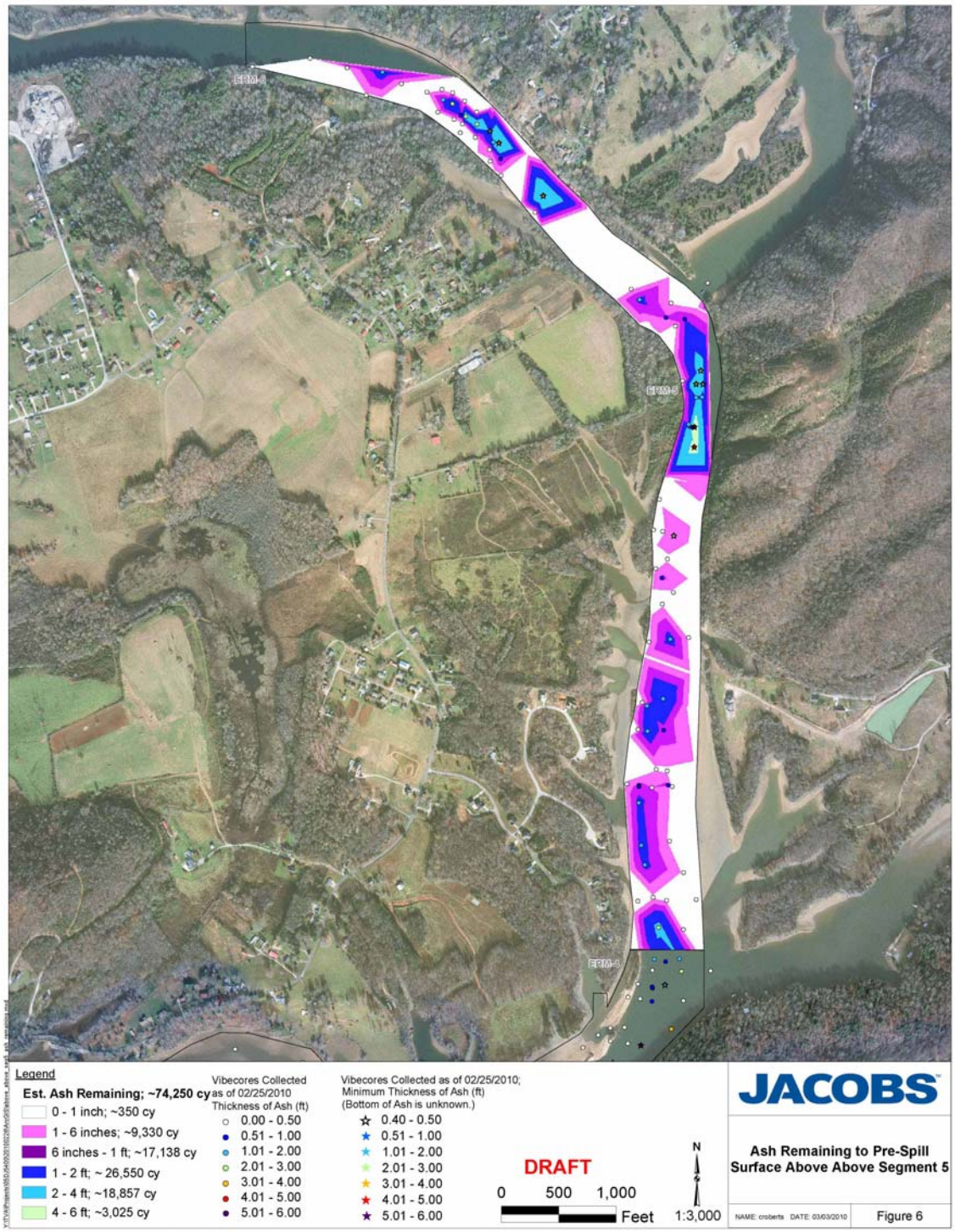


Figure 6. This image represents coal ash remaining in the reach identified as Above Above Segment 5.



CESIUM IMPACTED AREAS

Recent data indicates that cesium 137 (^{137}Cs) exists in native sediments below approximately ERM 1.8 to ERM 0 (Figure 7). This area will require further evaluation before dredging ensues. Using the current nomenclature, this area resides in part of Segment 4 and Below Segment 4 East. Current estimates for this combined region are 120,000 CYS for Below Segment 4 East and 50,000 CYS within Segment 4 for a total of 170,000 CYS of coal ash. The presence of ^{137}Cs and the further evaluation it requires precludes item 3 and a part of Segment 4 from inclusion into the time critical removal action. This evaluation will take place as part of future evaluations under the CERCLA non-time critical removal action, specifically the River System Sampling and Analysis Plan (SAP).

To summarize the remaining priority time critical channel dredge volumes:

1.	Post Phase 1 Segments 1 thru 5 less 50,000 CYS from Segment 4	530,000 CYS
2.	North of Phase 1 Segments to ERM 6.0	250,000 CYS
	TOTAL	**780,000 CYS**

Items 1 (minus the ^{137}Cs affected section of segment 4) and 2 are priority areas for this ext phase of dredging. They amount to an estimated total of 780,000 CYS.

Figure 7. This image represents ^{137}Cs concentrations below ERM 1.8 to ERM 0.0

DETERMINATION OF DREDGE DEPTH

The EPA OSC, in coordination with the EPA RPM, TDEC and TVA has requested technical assistance from the USACE in attempting to define a maximum practicable extent of dredge depth achieved during this time-critical removal action. EPA, TVA and TDEC have expressed the desire to remove as much coal ash as possible during this phase of the cleanup, particularly while dredges are mobilized and site operations remain in place to handle the ash recovery and potential off-site disposal.

It is the understanding of all parties that the potential human health and ecological risks posed by residual ash remaining after Phase 2 time critical dredging work will be assessed by the River System Sampling and Analysis Plan (SAP) process. The parties understand that under any reasonable circumstance, some ash will remain. With that understanding and with the stated time-critical objective of minimizing migration, the OSC has requested that the USACE provide technical consult relative to:

- the balance between native sediment removal versus ash removal, and
- a status on the reduction in threat of migration.

The USACE memorandum (see attachment) dated March 2, 2010 notes the following in its technical memorandum generated pursuant to the EPA OSC request:

- Current accomplishments under the time-critical removal action have significantly decreased threat of migration of coal ash downstream.
- Negative effects of over-dredging include the loss of native sediment and an unintended influence on river morphology and/or stability.
- The vertical accuracy of the dredge cutterhead is +/- 1 foot.
- Resuspension and resettling is likely to range from 5 to 20% of the mass of the material cut.
- Over time residual ash will blend with the native sediment load, reducing net metals loading.
- USACE ERDC lab tests of coal ash conclude low risk of heavy metal disassociation.

When taking these facts into consideration and balancing them with the intentions of creating a transition between time-critical and non time-critical objectives, the EPA OSC has made the following operational determination concerning the removal of coal ash down to native sediment in the river channel where practicable as described in the time critical Action Memorandum.

The contouring phase of hydraulic dredging will use the 2007 river channel bottom as the reference elevation, that is, the cutterhead on the dredge will be set at this level and continue to remove as much ash as practical while minimizing disturbance to native sediments. It is assumed that as the cutterhead on the dredge moves along the river channel bottom it is likely to remove some sediment while simultaneously removing coal ash and resuspending some percentage of material that then resettles. Figure 8

demonstrates percent ash recovery of the final foot of ash with the cutterhead set at different depths and moving forward through a full cycle. Unadjusted for resuspension and resettlement, the locations remove 29, 71, and 100 percent respectively. Each location is represented as a range to show the influence of resuspension and resettlement. It is worth noting, that 100 percent removal is never achieved due to the resuspension and resettlement effect. Figure 8 inserts represent the movement of a 2 ft diameter cutterhead through a typical dredging cycle with the head moving vertically through the expected range of motion +/- 1 ft. Each insert represents the elevation setting of the bottom of the cutterhead; +1 ft for one foot above the pre-spill bed elevation, 0 feet for the pre-spill bed elevation setting, and -1.0 ft one foot below the pre-spill bed elevation. The color areas depicted on the figure represent the material area occupied by the cutterhead through the cycle (gray for ash and tan for native bed sediments). The percent ash or native bed sediment entrained by the cutterhead is represented by the fraction of the total area occupied by either the fly ash (gray) or native sediment (tan). A comparison of the three locations on the graph shows that positioning the cutterhead at the pre-spill bed elevation will entrain the highest percentage of fly ash, while minimizing the uptake of native sediment.

In order to further minimize removal of native sediments while maximizing coal ash removal, best management practices will be implemented which will include in the field evaluations that may result in the incremental elevation or lowering of the cutterhead. These in the field adjustments will be subject to EPA OSC approval with TDEC consult.

Executing the above strategy will minimize the disturbance of native sediment, maximize the removal of coal ash and provide for a transition between time-critical and non-time-critical removal actions.

Figure 8. This graph illustrates percent ash recovery of final foot of ash.

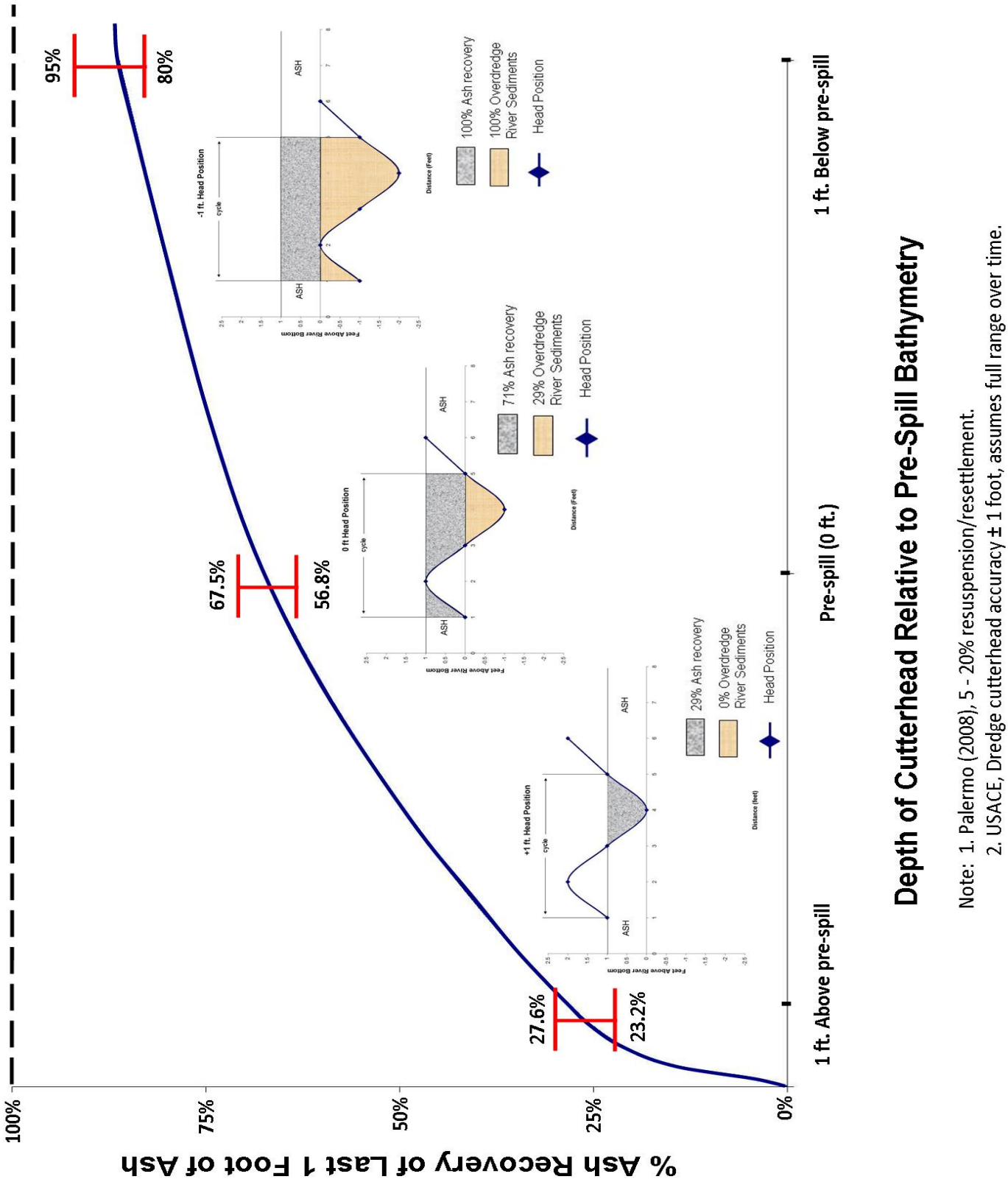
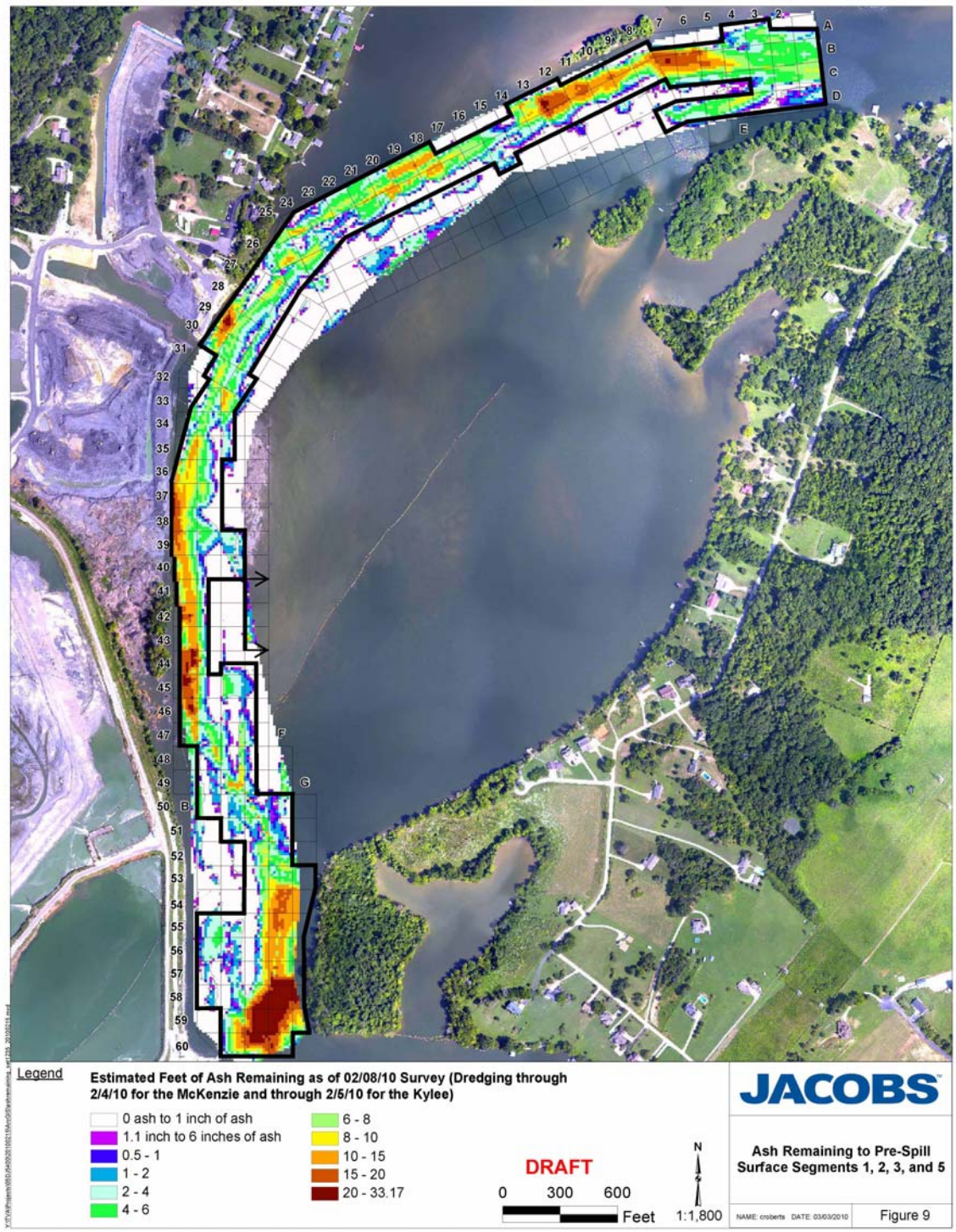


Figure 9. The following graphic demonstrates the proposed grid based execution for Segments 1, 2, 3, and 5. Similar grid patterns will be created for the other areas of concern.



Phase 2 has removed approximately 100,000 CYS in this time-critical contouring dredge phase since the latest rounds of bathymetry and sediment coring. It is estimated that approximately 780,000 CYS of coal ash existed in the Emory River channel between ERM 1.8 and 6.0 prior to Phase 2. Approximately 680,000 CYS remains to be removed from the channel.

TDEC, TVA and EPA are aware that some residual ash will remain in the Emory River between ERM 1.8 and 6.0 after time critical removal actions are complete. The potential human health and ecological risks posed by residual ash will be comprehensively assessed by the River System SAP non-time critical removal action that includes the Emory, Clinch and Tennessee Rivers. A Draft SAP is currently under review by the regulatory stakeholders and technical review comments are due by March 17, 2010. Initial field sampling under this SAP is anticipated in April/May 2010. Future remedy decisions regarding residual ash in the River System will be made at a later date, and will be based on the results of the risk assessment process.

Cc:

Paul Davis, TDEC
Barbara Scott, TDEC
Jim Webster, EPA R4

ATTACHMENT

MEMORANDUM

To: Leo Francendese EPA OSC

Thru: Craig Zeller EPA RPM

From: Steve Scott USACE ERDC

Re: Technical Consult as it Relates to the Addendum to the Time Critical Dredge Plan at the TVA Kingston Fossil Fuel Plant Release Site

Date: March 2, 2010

The following technical review from the USACE outlines a review of the operational limitations and related findings pertaining to the addendum to the time critical dredge workplan.

The vertical dredging accuracy of a cutter-head dredge is considered to be about + /- 1.0 foot (Palermo 1991). The removal of fly ash residuals less than 12 inches thick with a cutter-head dredge will impact native sediments. Attempting to dredge fly ash deposits with a thickness less than the dredging accuracy will potentially remove quantities of the underlying native sediment. In addition to the destruction of native material, the natural morphology and stability of the river may be impacted.

Figure 1 below shows a simplified approximate relationship between the depth of the residual on the river bed and the risk of fly ash removal based on a vertical dredging accuracy of + / - 1.0 foot.

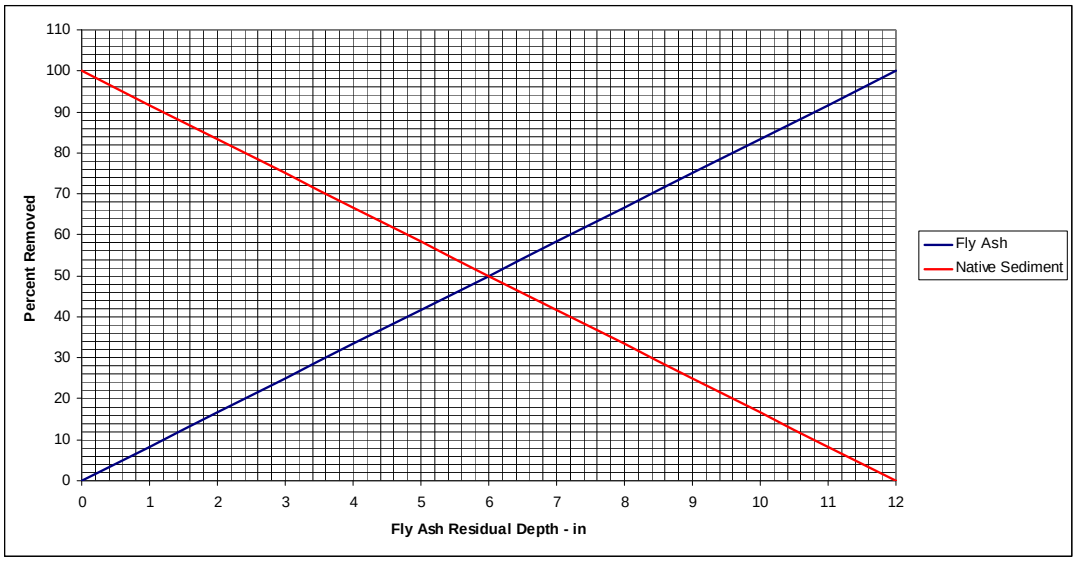


Figure1. Percent of native sediment and fly ash removed as a function of fly ash depth
In addition, Palermo et al. (2008) suggests that a residual volume of any material entrained by the cutterhead is subject to re-suspension and resettlement of between 5 and 20 percent.

The EPA OSC has requested an evaluation of the risk of migration presented by the remaining volumes. Over time, there is a potential for the residual fly ash to mix with native sediments, as well as transport to both the Clinch and Tennessee River (Watts Bar Reservoir). The risk for fly ash migration was very high prior to dredging. The fly ash filled the main channel, significantly increasing the bed slope between the upstream fly ash deposits and the relatively unaffected channel downstream. For this condition, even moderate flows resulted in higher velocities and bed shear stress, particularly in the river reach adjacent to weir 1. This resulted in a significant fly ash discharge from the site during May 2009 (70,000 cfs peak flow event). The dredging operations cleared the main channel, and effectively returned the channel slope to pre-spill conditions, thus significantly reducing the erosion potential. The end result is a lower fly ash erosion and transport potential for similar sized storms for residual fly ash deposits. Similar size storms in December 2009 and January 2010 resulted in an estimated order of magnitude reduction from 150,000 CYS migration in May to 15,000 CYS in December and January. Significant reduction is expected as ash is continued to be removed from the channel. Currently, the highest risk for residual fly ash transport resides in the main channel. The sediments found in areas outside of the main channel have a reduced potential for erosion due to low specific discharge (Figure 2 below).

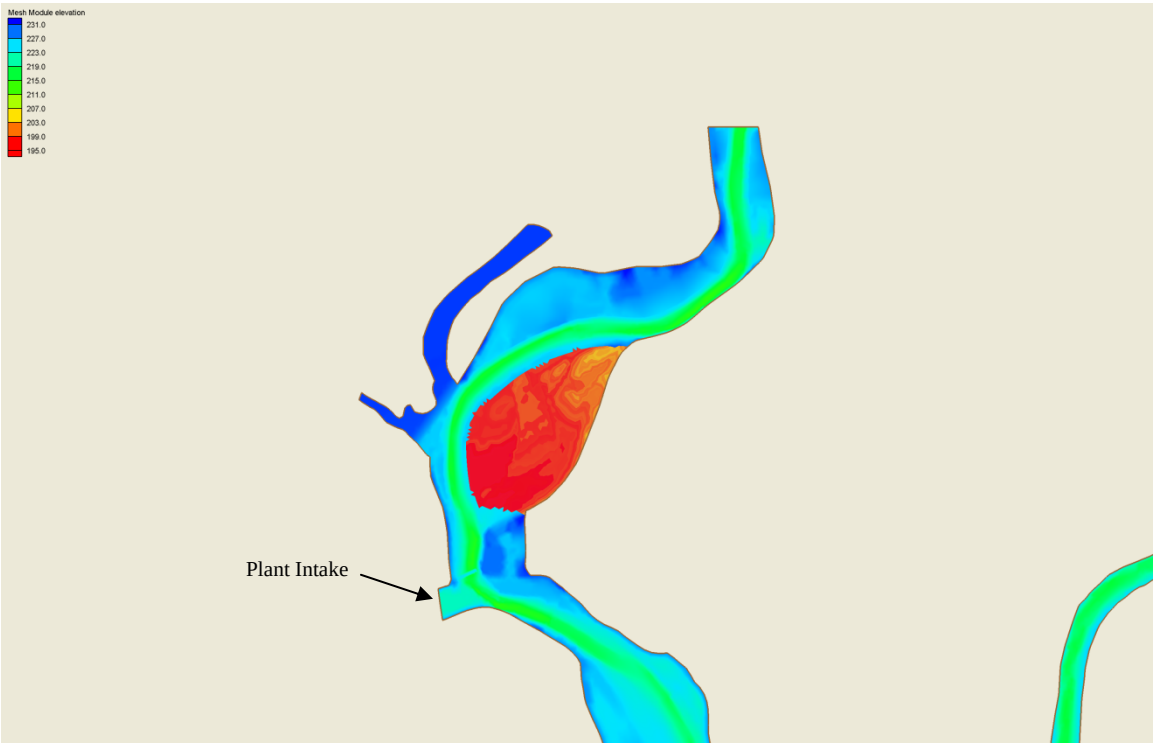


Figure 2. Area for low potential for transport (in red).

Residual quantities of fly ash that do transport from the site to the lower river reaches will be diluted by the annual native sediment load in the Emory River and the native sediment accumulation in Watts Bar Reservoir. The annual native sediment yield from the Emory River is estimated to be approximately 84,000 tons (USGS 1984). The TVA estimates the annual native sediment yield for Watts Bar Reservoir to be approximately 346,000 tons (TVA 1993). The estimated discharge of fly ash from the May 2009 event from the Emory River was approximately 150,000 cubic yards or 201,165 tons of fly ash solids. Preliminary modeling results indicate that up to 50 percent of the ash may have deposited in the upper to mid Watts Bar Reservoir (100,000 tons). The arsenic content of fly ash and native sediments is estimated to be 66 mg/kg and 24 mg/kg respectively. If the incoming native sediment load into Watts Bar Reservoir (346,000 tons) mixes with the fly ash deposits, the total average arsenic content of the mixture will be diluted. If it can be assumed that both the fly ash and natural sediment depositional areas are common to both the fly ash and incoming natural sediment load, the following dilution scenario may apply. For the first year, the dilution will be 3.5 to 1, the second year 7:1, and the fifth year 17:1. Thus the average mixed bed arsenic concentration would range from 33 mg/kg after the first year to 26 mg/kg after the fifth year, assuming a complete mixing of fly ash and natural sediment. Therefore after approximately 5 years, the fly ash residuals that transport below the site will potentially be diluted to background levels due to mixing and burial with inflowing native sediments. Preliminary sediment transport modeling results from the ERDC indicate fly ash deposition depths of 0.05 to 0.25 inches in Watts Bar reservoir (TRM 550 – 566) after the May 2009 flow event. Figure 3 shows modeling results plotted along with the estimated annual sediment deposition depth in Watts Bar reservoir as presented in a previous model study of the reservoir (Ziegler 1995). This plot indicates the potential annual burial of fly ash deposits by natural sediments over time.

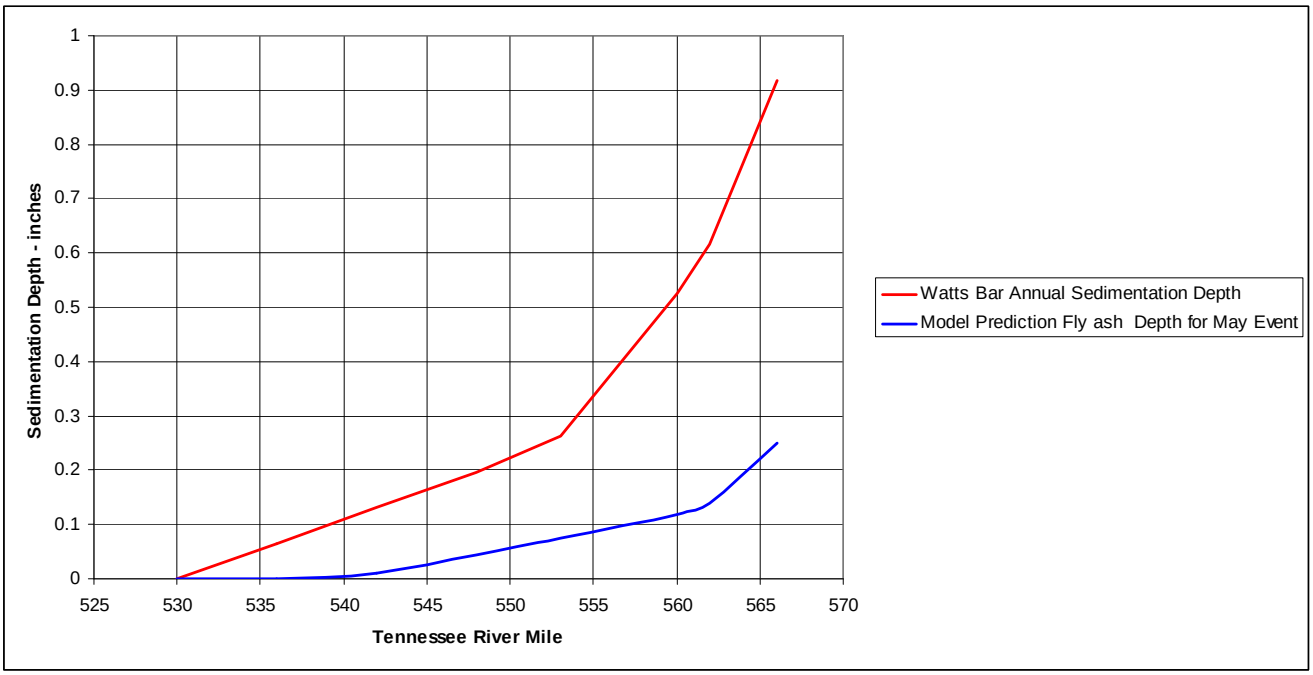


Figure 3. Natural sediment and fly ash depth in Watts Bar Reservoir

In addition to the dilution factor, laboratory tests of fly ash at the ERDC WES have concluded that there is a low risk for heavy metals to disassociate from the fly ash deposits and enter the water column. However, the long term stability of fly ash and associated constituents is relatively unknown at this time.

The above facts are summarized below:

- The vertical accuracy of the dredge cutterhead is +/- 1 foot.
- Negative effects of over-dredging include loss of native sediment and unintended effects on river morphology and stability.
- Re-suspension and resettlement is likely to range from 5 to 20% of the mass of the material cut.
- Significantly decreased threat of migration has been documented
- Residual ash will blend with the native sediment load, reducing net metals loading over a measured period of time.
- USACE ERDC lab tests of fly ash conclude low risk of heavy metal disassociation.

References

1. Palermo, M.R., "Equipment Choices for Dredging Contaminated Sediments", Remediation, 1991

2. Ewing, L.K, "Suspended Sediment Inflows to Watts Bar Reservoir", TVA Resource Group, Engineering Services, Report No. WR28-3-14-105, September 1993

3. U.S Geological Survey, "Sediment Characteristics of Tennessee Streams and Rivers", Open File Report 84-749, 1984.

4. Ziegler, C.K., "Long-Term Simulation of Fine-Grained Sediment Transport in Large Reservoir, Journal of Hydraulic Engineering, November 1995, p. 773 – 781.

Cc:

Jeff Steevens USACE ERDC

Time-Critical Concurrence Log

Agreement No.	CONTACT	Area	ISSUED DATE	Agreement	COMMENTS
KIF-10-001					

Agreement Log #: KIF-10-_____

Time-Critical Concurrence

Area:
Agreement:
Concurrence:

_____ _____
Jacobs Project Manager Date

_____ _____
Tennessee Valley Authority Date

_____ _____
Tennessee Department of Environment and Conservation Date

_____ _____
U. S. Environmental Protection Agency Date