Waugh Chapel Evaluation Plan

Paragraph 34 of the Consent Decree dated October 1, 2007, requires the submittal of a Waugh Chapel Evaluation Plan for the evaluation of remedial options to both prevent further off-site migration of contaminants into groundwater and to address existing groundwater impacts. The plan shall:

> (a) Provide for the identification and evaluation of the feasibility and effectiveness of potential remedial options for Waugh Chapel Pit. This evaluation shall include consideration of both source controls and plume controls. The evaluation shall also perform preliminary engineering of a groundwater collection system to determine the feasibility of treatment and discharge options.
> (b) Include a proposed schedule for all tasks, culminating in a Waugh Chapel Proposed Remediation Report that will propose remedial alternative(s) for approval by the Department.

This document was prepared to meet the requirements of Paragraph 34 of the Consent Decree.

Introduction & Background

Coal ash from Constellation Energy's electric generation facilities was used as a structural fill to reclaim portions of the Waugh Chapel Pit (WCP) sand and gravel mine between the years 2000-2004. The fill was placed at least 4 feet above the water table, and consists of a 2-foot or thicker layer of bottom ash or other natural porous soil overlain by 30 to 70 feet of compacted fly ash. Completed portions of the site are capped with 18 inches of 10^{-7} cm/sec permeability compacted clay covered by 12 inches of vegetated top soil. The fill area covers approximately 17 acres.

Elevated concentrations of sulfate and other constituents in groundwater downgradient of the fill area triggered a source investigation. Soil borings and wells drilled through the fill revealed isolated areas of wet ash near the base of the fill. Ponding water near the edges of the ash fill was found to be a potential, unanticipated source of infiltration into the ash that may be causing generation of leachate. A pond located at the base of the ash fill was eliminated and extensive stormwater management and capping improvements were completed in early 2007 to largely address potential sources of infiltration into the sides of the fill. A second potential source of groundwater quality degradation is the black soil present throughout the area where the site is located, that can generate an acidic leachate containing sulfate and metals when weathered. The reclamation activities included a large deposit of this soil in the northern area of the fill and it was also used in the early reclamation period as backfill in the pit to prepare it for the placement of coal ash.

Testing of private wells downgradient of the Waugh Chapel Pit identified some wells that were impacted by groundwater contamination from the site. Bottled water was immediately supplied to the affected locations and temporary public water supplies were provided in September and October 2007. Permanent public water supply to this area should be completed in early 2008. These actions were taken to address the existing groundwater impacts from this area. The remedial options evaluation described in this document will determine additional corrective actions needed to prevent additional off-site migration of contaminants.

Constellation Energy and the Electric Power Research Institute (EPRI) conducted research to determine the leachate characteristics of coal ash and black soil. The leachate characteristics data developed by EPRI will be combined with site-specific and regional data to calibrate a groundwater flow and transport model. This calibrated model will provide a tool that will be used to test, optimize, and demonstrate the effectiveness of

proposed source and groundwater plume controls on downgradient groundwater quality. Natural Resource Technology (NRT) will be performing the remedial options study for the WCP area.

Objectives of the Remedial Options Study

- Calibrate a groundwater flow and transport model to observed conditions at WCP.
- Use the calibrated model to test source control alternatives (such as an upgraded cap and/or barrier walls) and plume control alternatives (such as groundwater extraction, and/or barrier walls) to determine their effectiveness in preventing off-site migration of contaminants both individually and in combination.
- Once a preferred source/plume control strategy is selected, use the model to optimize the design from a cost and performance perspective.
- Demonstrate that the final optimized design will provide an effective long-term remedy for any groundwater quality issues associated with the coal ash fill.

Scope of Work/Task Descriptions

Task 1. Data Assembly

The first task involves assembly of site-specific and regional data available from the Maryland Geological Survey publications web page. NRT was able to obtain an advance copy of a recently updated report (RI 54, *Simulated Hydrologic Effects Of The Development Of The Patapsco Aquifer System In Glen Burnie, Anne Arundel County, Maryland,* Achmad, G., 1991) that describes the recent groundwater flow model update for Anne Arundel County. This information will provide a regional hydrogeologic framework for groundwater flow in the county. NRT will also closely review previous studies performed for the site. Site specific data to be assembled for the modeling will include:

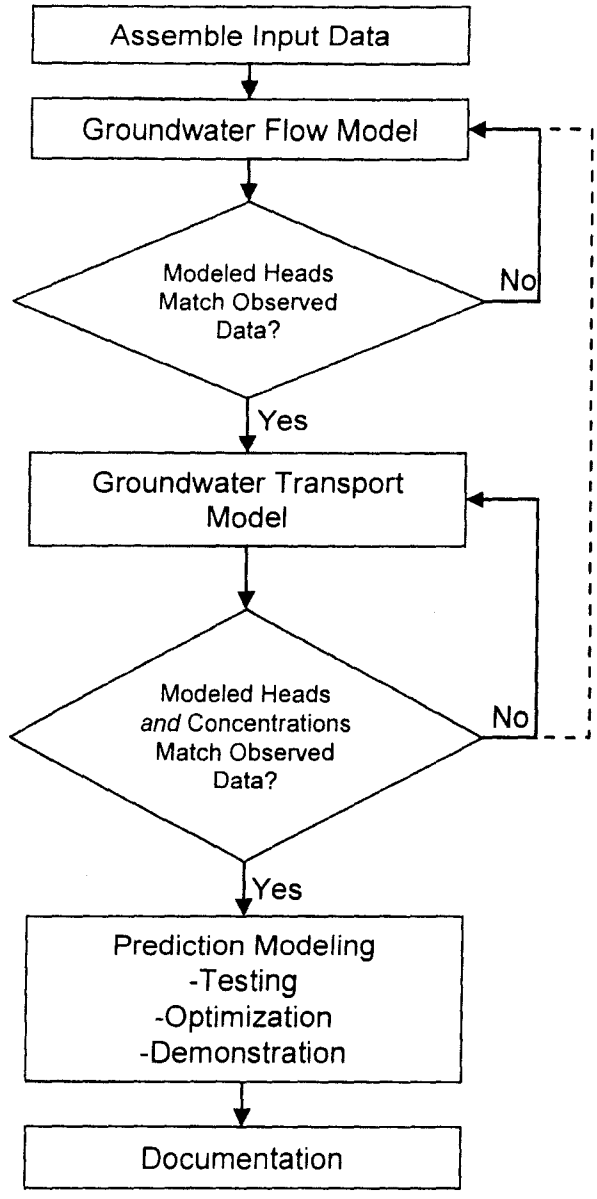
- Delineation of ash fill and wet ash areas in WCP
- Delineation of known areas of black soil
- Geologic logs of all site borings
- Well logs for water supply wells within the model domain
- Pumping records for public water supply wells, if any and if available, within the model domain
- Hydraulic conductivity data obtained from testing of site monitoring and recovery wells
- Leachate concentration data for the ash fill and black soils

Other model input data, such as recharge rates, effective porosity, dispersivity, and retardation factors, will be obtained from published data and through model calibration.

Task 2. Flow and Transport Modeling

Flow and transport modeling will be an iterative process as illustrated to the right and described below.

- Calibrate the flow model to match current groundwater flow conditions (hydraulic head).
- Calibrate the transport model to match current groundwater concentration trends (which may require multiple recalibrations of the flow model).
- Perform prediction modeling to test alternatives for source and plume control.
- Perform prediction modeling to optimize the selected source and/or plume control strategy.
- Perform prediction modeling to demonstrate the long-term effectiveness of the optimized source and/or plume control strategy.
- Perform sensitivity testing to evaluate the effects of model uncertainty on predicted results.



Two sources will be considered, ash fill in WCP and black soil. In addition, two constituents will be modeled, one as a tracer for ash leachate (boron), and one that may originate from both the coal ash and the black soil (sulfate). The groundwater extraction system at Turner pit will be represented in the model.

Groundwater flow will be modeled using the USGS MODFLOW code. Transport will be modeled using MT3DMS coupled to the flow results of MODFLOW. Additional modeling to estimate the effect of various ash fill capping options on leachate percolation will be performed using the HELP model.

Prediction scenarios will be developed to simulate proposed source control and plume control alternatives. Physical alternatives that affect the rate of leachate percolation and groundwater flow such as capping, barrier walls, in-situ stabilization, and groundwater extraction can be readily modeled because their effect on groundwater flow is directly calculated by the models. Sensitivity testing will be performed on selected prediction scenarios to evaluate the effect of model uncertainty on predicted plume migration.

Preliminary Engineering of a Groundwater Collection System

Preliminary engineering of a groundwater collection system will be done concurrently with the remedial options modeling to determine the feasibility of treatment and discharge options. This effort will determine maximum groundwater extraction rates needed to capture affected groundwater leaving the site without the use of barrier walls to determine worst case treatment and discharge options. This information will be used to evaluate the feasibility of discharge options including discharge of treated effluent to Towsers Branch, discharge to a sanitary sewer line (with pretreatment if needed), etc.

Waugh Chapel Proposed Remediation Report

This remedial options modeling effort will culminate in a Waugh Chapel Proposed Remediation Report that will identify the selected remedy and will include the modeling results demonstrating its predicted effectiveness. The modeling results for the various source and plume control alternatives will also be presented in the report. The report will document model input data, as well as calibration and prediction results, to document development of the final remedy. Design and development of an implementation schedule of the chosen remedy will begin upon approval by the Department.

Schedule

A draft report describing the modeled effectiveness of proposed remedial alternatives for Constellation's and BBSS's review and selection of a remedy is anticipated in February. The final Waugh Chapel Proposed Remediation Report as described above will be submitted to MDE by April 30, 2008.