

## EXECUTIVE SUMMARY

This executive summary is presented for convenience only. While the executive summary is an integral part of the report, it should not be used in lieu of reading the entire report, including the appendices.

The Battlefield Golf Club (the 'Site') is an 18-hole golf course located southeast of the intersection of Whittamore Road and Centerville Turnpike South in Chesapeake, Virginia. Approximately 1.5 million tons of fly ash (Type F Coal Combustion By-Products [CCB]) generated from coal-fired power generating units at the Chesapeake Energy Center (CEC) was provided for beneficial use in structural fill subsoil (amended ash) during construction of the golf course from approximately April 2002 through March 2007.

MACTEC Engineering and Consulting, Inc. (MACTEC) performed field activities for a Post-Construction Ash Fill, Soil Cover and Groundwater Evaluation at the Site in November and December 2008 and June 2009. In general, field activities included; installation of 19 groundwater monitoring wells, 33 hand auger borings, 3 test pits, 14 test borings, collection of surface water, groundwater, and soil samples, gauging, and surveying of streams and ponds at the Site.

The following conclusions were developed based on the results of post-construction assessment activities at the Site:

- Proper development of monitoring wells installed by Kimley-Horn (MW-KH-1, -2 and -3), followed by low-flow sampling to produce non-turbid samples resulted in substantially reduced metals concentrations for the wells compared to previous sampling performed by Kimley-Horne. Observations made by MACTEC personnel during sampling indicate that the screen interval for these wells may be too close to the surface (within 2 feet or less) to have allowed for installation of a proper sand pack above the top of the screen and installation of a proper bentonite well seal above the sand pack. Due to the location of these wells within the ash fill area of the Site, improper well construction may allow for ash to enter the well. MACTEC recommends that these wells be properly abandoned. If wells are considered necessary within this area of the Site, then replacement with properly constructed wells is recommended to prevent possible cross-contamination from ash intrusion.
- The Virginia Groundwater Standards indicates a pH range for groundwater in the Coastal Plain Physiographic Province of 6.5 to 9. Comparatively low pH (<6.5) was measured in groundwater samples collected from 19 of 23 monitoring wells at the Site, including groundwater samples collected from 2 of 3 wells sampled by URS during their pre-construction assessment. Potential Peroxide Acidity (PPA) results for soil samples collected from various depth intervals at the Site indicate that acid sulfate soils are present that have the potential to produce acid runoff when exposed to weathering (a naturally occurring condition documented for this region of Virginia). As potential acid-producing soils have been identified at the site, low pH measurements identified in groundwater samples collected prior to construction and during this investigation appear to be naturally occurring. The most notable low pH (<4) measurements were identified in shallow groundwater samples collected from monitoring well MW-BGC-8A (screened from 10 to 20 feet below grade) and in proximal surface water (Pond SG12 near the southwest quadrant of the Site and a stream that flows north into the southern boundary drainage ditch from the off-site residential development). A relatively low pH of 5.2 was measured in a groundwater sample collected from monitoring well MW-BGC-13, which is also in the southwest quadrant of the Site.

- Beryllium was detected in groundwater samples collected from two monitoring wells (MW-BGC-8A and MW-BGC-13) at concentrations exceeding the MCL. Arsenic was detected at concentrations exceeding the MCL in groundwater samples collected from monitoring well MW-BGC-12A during the Phase I sampling event in December 2008, but was less than the laboratory reporting limit during the Phase II sampling event in June 2009. Arsenic was detected at concentrations exceeding the MCL in the groundwater samples collected from monitoring well MW-BGC-15 during the Phase II sampling event in June 2009. Although fly ash is known to be a potential source for heavy metals such as arsenic and beryllium, elevated concentrations of these and other heavy metals were generally absent from groundwater samples collected from monitoring wells throughout the Site.
- The elevated arsenic and beryllium concentrations detected in groundwater samples collected from monitoring wells MW-BGC-8A and MW-BGC-13 are not suspected to indicate impact from ash fill at the Site, but may be related to acid producing soils resulting in relatively low pH groundwater conditions in the southwest quadrant of the Site. However, further groundwater sampling would be necessary to confirm the results for wells installed during Phase II and evaluate potential trends in groundwater conditions throughout the Site.
- Groundwater flow beneath the Site is generally to the east-southeast, toward or in the direction of the nearest drainage ditch. Based on slug test data, groundwater level data obtained during this investigation and soil types encountered within the water table aquifer, the groundwater velocity across the Site is estimated to range from approximately 16 to 23 feet per year (although fluctuations in the groundwater gradient due to natural and man-made influences may occur to alter these velocity estimates). Transport velocities of potential contaminants would be substantially slower than groundwater velocity due to the effects of dilution and retardation (sorption, dissolution, and precipitation). Supplementary water-level gauging would be necessary to further evaluate seasonal variations in the groundwater gradient and flow direction at the Site.
- In general, metal concentrations in road bed, soil stockpile and pond sediment samples were less than (up to one order of magnitude) the average corresponding metal concentrations in ash fill samples. These results indicate that road bed, soil stockpile and pond sediment samples do not consist of ash.

The following conclusions were developed based on our review of construction documents and our geotechnical investigation at the Site:

- The ash fill thickness was observed ranging 15.2 feet to 17.2 feet in the 3 test borings. Relative compaction results for ash fill at the three test pit locations ranged from 84 to 92%.
- Based on the tests MACTEC performed on the ash fill and our review of the construction documents, it can generally be confirmed that compactive energy was applied to the ash fill when placed. The degree of compaction at placement was not quantified from the results of this assessment due to potential post-placement expansion and changes in moisture content.
- Soil cover thicknesses of less than 18 inches were encountered in two general areas of the Site. MACTEC understands that cover in these areas will be restored to a minimum of 18 inches. Soil cover generally consisted of clayey silt and clayey, fine-grained sand.

- Ash fill analyses were reportedly inconclusive in determining the kiln dust (amending agent) content in the three ash fill samples collected from the Site. The laboratory results indicated evidence of higher calcium oxide concentrations by weight in the ash fill samples than in the ash standard, which may indicate the presence of a calcium amendment, although the percentage of kiln dust was not confirmed.
- In general, and subject to additional confirmatory sampling, our findings at the Site do not presently indicate adverse impact to groundwater from the placement of ash.