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FINAL NO ACTION TECHNICAL MEMORANDUM FOR SOIL AND GROUNDWATER AT THE  
WASTE SLAG SUBAREA OF AREA OF CONCERN 6 NWS YORKTOWN VA

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CH2M HILL

# Final No Action Technical Memorandum for Soil and Groundwater at the Waste Slag Subarea of AOC 6, Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

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This Technical Memorandum (Tech Memo) summarizes site history, presents and evaluates recently collected soil data, assesses human health and ecological risks, and provides the rationale for no further action (NFA) for soil and groundwater at the Waste Slag subarea of Area of Concern (AOC) 6, located at Naval Weapons Station (WPNSTA) Yorktown Cheatham Annex (CAX). A human health risk screening (HRS) and screening-level ecological risk assessment (SERA) were conducted to support the NFA decision for soil and groundwater at the Waste Slag subarea of AOC 6. The Waste Slag Material subarea is the only subarea being evaluated in this Tech Memo; the other four AOC 6 subareas will be evaluated separately. In addition, soil and groundwater were the only media evaluated in this Tech Memo, as surface water and sediment are not associated with the Waste Slag Material subarea of AOC 6. The CAX Partnering team has agreed that the waste slag pile will be removed from the site, the details of which will be presented under a separate cover.

## Background

CAX is located in Williamsburg, Virginia, on the York-James Peninsula (**Figure 1**). The peninsula trends northwest-southeast and is bordered to the southwest by the James River, to the northeast by the York River, and to the southeast by the confluence of the James River and the Chesapeake Bay. CAX was established in June 1943 as a satellite unit of the Navy Supply Depot to provide bulk storage facilities. Prior to 1943, CAX had been the location of the Penniman Shell Loading Plant (PSLP), a large powder and shell loading facility operated by DuPont during World War I. Today the mission of CAX is supplying Atlantic Fleet ships and providing recreational opportunities to military and civilian personnel.

The Waste Slag Material subarea is one of five subareas that comprise AOC 6 (Penniman AOC). It consists of a pile of metallic slag material that was identified and sampled during a 1999 Site Inspection (SI) of the former PSLP (described in more detail below) (Weston, 1999). The waste slag pile was measured in November 2012 and is approximately 25 feet long by 20 feet wide by 1.5 feet high, and located in the southern portion of the base (**Figure 2**).

## Previous Investigations

In January 2001, CAX was placed on the National Priorities List (NPL), which required all subsequent activities for Navy Environmental Restoration (ER) sites be conducted under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) procedures. The United States Environmental Protection Agency (USEPA) included the Waste Slag Material subarea as a source area for the CAX Hazard Ranking System (HRS) scoring, although the Navy considered it to be associated with former railroad activities and not a CERCLA-regulated release. The Waste Slag material subarea was one of eight source areas evaluated as part of the CAX

HRS, and had no impact on the overall HRS score that placed CAX on the NPL. However, it was included as one of five AOC 6 subareas in the CAX Federal Facilities Agreement (FFA) (USEPA et al., 2005); as a result, the Navy has agreed to address this subarea as part of ER activities.

Previous investigations that helped characterize potential contamination and contaminant sources at the AOC 6 Waste Slag Material subarea are the 1999 PSLP SI (Weston, 1999) and site visits.

### 1999 Site Inspection, Penniman Shell Loading Plant

The purpose of this USEPA-directed SI was to collect information concerning conditions at the former PSLP sufficient to assess potential contamination sources and to determine the need for additional investigation under CERCLA or other authority, and, if appropriate, support site evaluation using the HRS for proposal to the NPL. The investigation included reviewing background information, sampling waste and environmental media, evaluating and documenting HRS factors, and collecting additional non-sampling information (Weston, 1999).

As part of the SI, one waste source sample was collected from the Waste Slag Material subarea (PEN1-SO-07) and analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, and nitroaromatic (explosive) compounds. The description of this waste source sample in Table 1 and Attachment 1 of the SI seems to indicate the slag itself was sampled and analyzed (Weston, 1999). No sample depth information or a description of the exact sample location (e.g., beside the pile, within the pile, under the pile) is provided in the document. The sample results were compared to SI-specific background soil concentrations and USEPA Region 3 Risk-Based Concentrations (RBCs). The Waste Slag Material subarea sample results that exceeded Region 3 RBCs are presented in **Table 1** below.

TABLE 1  
1999 SI Waste Slag Material Subarea Sample  
*Results Exceeding USEPA Region 3 RBCs for Residential Soil*

Area	Sample ID	Analytical Results <sup>1</sup>
Waste Slag Material Subarea	PEN1-SO-07	Antimony – 4.6 L mg/kg Arsenic – 33.4 mg/kg Chromium – 32.9 mg/kg Lead – 2,600 mg/kg Manganese – 2,070 J mg/kg

**Notes:**

<sup>1</sup>Analytical results lists all compounds exceeding the USEPA Region 3 RBCs for Residential Soil in waste samples

L = Analyte present. Reported value may be biased low. Actual value is expected to be higher.

J = Analyte present. Reported value may or may not be accurate or precise.

mg/kg = milligrams per kilogram

The SI concluded that the slag material is contaminated with antimony, arsenic, chromium, lead, and manganese, and of these, arsenic and lead were of particular concern. In addition, visual inspection of the slag material indicated that it was an “intact, relatively hard, rock-like material” that had a relatively low potential to migrate as particulates (Weston, 1999). However, further investigation was recommended to determine if contaminants are leaching from the slag material and impacting the site.

The SI presented a list of areas recommended for further investigation, and five of these areas, including the Waste Slag Material, were chosen to comprise AOC 6, Penniman AOC. These five subareas are listed in the CAX FFA.

### AOC 6 SI

Although part of AOC 6, Penniman AOC, the Waste Slag Material subarea was not included in the recent SI for AOC 6 (CH2M HILL, 2012a) because the Navy’s position has been that the waste slag is associated with former railroad activities (or “rolling stock”) and is, therefore, not considered a CERCLA-regulated release. However, after several Partnering Team discussions, the Navy has agreed to regulatory agency requests to address this one pile of waste slag as part of CAX’s ER Program since the Waste Slag Material subarea is included as an AOC 6 subarea in the CAX FFA.

## Site Visits

The 1999 SI provided a general location of the Waste Slag Material subarea (i.e., a dot on a drawing indicating the location of PEN1-SO-07), but the area was not surveyed and no sample coordinates were provided. The Navy Remedial Project Manager (RPM), along with Navy contractor personnel (either from Shaw Environmental or CH2M HILL), conducted three separate site visits (August 2009, December 2009, and February 2010) that attempted, unsuccessfully, to locate the Waste Slag Material subarea. In May 2010, the Navy RPM conducted a fourth site visit with the USEPA and Virginia Department of Environmental Quality (VDEQ) RPMs. The Navy RPM showed the USEPA and VDEQ RPMs the general area where the waste slag was reported to be located and noted that the environment was not stressed, but thriving. The Navy proposed no action for the Waste Slag Material subarea; however, the USEPA requested an additional site visit to look for it again. As part of the January 2011 Partnering Meeting, a site visit was conducted and the waste slag pile was found (**Figure 2**). The Partnering Team subsequently formulated a path forward to address the Waste Slag Material subarea of AOC 6 (CH2M HILL, 2012b), which involved the collection of surface and subsurface soil samples adjacent to and underneath the waste slag pile to assess if there had been leaching of the material to soil.

## Investigation Methodology

This section summarizes the field investigation procedures of the soil sample collection conducted at the Waste Slag Material subarea of AOC 6 in November 2012. The field activities were conducted in accordance with the approved Uniform Federal Policy (UFP) Sampling Analysis Plan (SAP) Addendum (CH2M HILL, 2012b).

### Pre-Investigation Activities

Prior to the soil sampling activities, an underground utility clearance was conducted at the Waste Slag Material subarea of AOC 6 by Accumark of Chesapeake, Virginia.

### Soil Sampling

Five co-located surface and subsurface soil samples were collected from as close to the perimeter of the waste slag pile as possible on November 2, 2012 (SO23 could not be collected immediately adjacent to the perimeter of waste slag pile due to several fallen trees in the area; therefore, it was collected from a low-lying natural drainage channel to be representative of surface runoff from the waste slag pile). In addition, one surface and subsurface soil sample was collected from underneath the waste slag material (**Figure 3**). The soil samples were collected in order to determine if metals, potentially attributable to the waste slag pile, have leached to soil (CH2M HILL, 2012b) and to be used as pre-waste slag removal characterization samples. Preliminary sample locations were agreed upon by the Partnering Team prior to mobilization; however, the exact sample locations were field-determined based on the observed perimeter of the waste slag pile. All soil sampling activities were conducted in accordance with the SOP entitled *Shallow Soil Sampling* (CH2M HILL, 2012b).

Soil samples were collected using a hand auger. In accordance with the approved UPF-SAP Addendum, surface soil samples were collected from 0 to 0.5 feet below ground surface (bgs), while subsurface samples were collected from 0.5 to 2 feet bgs. All soil samples were analyzed for total metals. Directly following the collection of the soil core by hand auger, the collected soil was homogenized in a stainless steel bowl and then transferred to the appropriate laboratory-provided sample containers. After preparation, samples were packed on ice and shipped to the laboratory for analysis in accordance with the SOP entitled *Sample Preservation* (CH2M HILL, 2012b).

### Surveying Activities

Following the completion of sampling activities, global positioning system (GPS) coordinates were collected with a hand-held global positioning system to record sample locations.

### Decontamination Procedures

All decontamination activities were conducted in accordance with the SOP entitled *Decontamination of Personnel and Equipment*, as applicable (CH2M HILL, 2012b). Personal protective equipment (PPE), such as nitrile gloves, were treated as non-hazardous solid waste. After use, PPE was placed in plastic bags and disposed of in an onsite

trash dumpster. Non-disposable sampling equipment (e.g., the hand auger, sampling trowels, etc.) was decontaminated prior to each use.

Water generated during decontamination of sampling equipment was collected and transferred to a 55-gallon drum to be disposed of with investigation derived waste (IDW) generated as part of other environmental investigations being conducted at CAX.

## Conceptual Site Model

The Conceptual Site Model (CSM) for the Waste Slag Material subarea of AOC 6 is based on the historical data and information summarized above, and interprets the physical setting, distribution of contamination, potential migration pathways, and potential exposure receptor pathways.

### Physical Setting

The area surrounding the Waste Slag Material subarea is heavily vegetated and is relatively flat. The waste slag pile itself is within a wooded area near Garrison Road (**Figure 3**). Immediately north and northwest of the waste slag pile is an open area, cleared of large trees and covered with small shrubs, grasses, and greenbriers. King Creek is located about 400 feet southeast of the waste slag pile; however, Garrison Road is located between the site and King Creek, with the topography of the southern side of Garrison Road being at a higher elevation than the north side of the road (i.e., Garrison Road slopes down toward the site). Ground elevations at CAX vary from sea level along the eastern boundary, which borders the York River, to a maximum elevation of approximately 50 feet above mean sea level on a few scattered hills in the western portion of the base. At the Waste Slag Material subarea, the approximate ground elevation is 30 feet above mean sea level.

The Yorktown-Eastover aquifer is the uppermost aquifer unit beneath AOC 6, and extends beneath all of CAX with a thickness ranging from 60 to 100 feet. Transmissivity of the aquifer ranges from 0.5 to 40 square feet per day (ft<sup>2</sup>/day). At CAX, groundwater flow within the Yorktown-Eastover aquifer is locally controlled by topography, with discharge to nearby surface water bodies and a primary flow and discharge direction towards the York River. The depth to groundwater in the Yorktown-Eastover aquifer is likely relatively shallow (i.e., < 30 feet below ground surface [bgs]) and is anticipated to flow towards King Creek. At the Waste Slag Material subarea, depth to groundwater is expected to be around 28 feet bgs, based on groundwater collection via temporary wells at nearby AOC 2 and the relatively flat topography between the two AOCs.

The Waste Slag Material subarea is located in a sparsely wooded area with no specified designated use. While the Waste Slag Material subarea is not surrounded by a gate or fencing, it is within the confines of CAX and access to it is restricted for the general public. Navy and Department of Defense (DoD) personnel do have access to the area, and several nearby tree stands are used for hunting. Future land use at the Waste Slag Material subarea is not expected to change and will likely continue as wooded/ green space for the foreseeable future.

### Distribution of Contamination

Five surface and five subsurface soil samples were collected from the perimeter of the waste slag pile. In addition, one surface and subsurface soil sample was collected from underneath the waste slag material. Based on the size of the waste slag pile (25 feet by 20 feet by 1.5 feet), six surface and six subsurface soil samples are adequate to determine if metals attributed to the waste slag pile have leached to soil. All surface and subsurface soil samples were analyzed for total metals and pH in accordance with the approved UFP-SAP Addendum (CH2M HILL, 2012b). Analyses for VOCs, SVOCs, pesticides, PCBs, and explosives were not conducted during the November 2012 sampling event, as analyses for these constituents were included for the sample conducted during the 1999 SI and were not found to be chemicals of potential concern (COPCs).

Analytical results from the November 2012 sampling event are summarized in **Tables 2** and **3**; the full laboratory analytical report is provided in **Attachment A**. **Figure 4** shows the sample locations and exceedances of screening criteria for the soil samples.

The results were screened against approved base background soil values (95% upper tolerance limits [UTLs]) for metals (CH2M HILL, 2011) and conservative screening values as follows:

- USEPA Regional Soil Screening Levels (SSLs) for protection of groundwater (November 2012)
- USEPA Regional Screening Levels (RSLs) for residential soil, adjusted as appropriate (for non-carcinogenic effects) (November 2012)
- Site-specific ecological screening values (ESVs)

### Surface Soil

Four metals (aluminum, chromium, selenium, and thallium) exceeded the approved base background values and at least one screening criterion (SSLs, adjusted residential RSLs, and/or ESVs) in surface soil (**Figure 4**).

- Aluminum concentration exceeded the base background 95% UTL concentration (12,200 mg/kg) and adjusted residential RSL (7,700 mg/kg) in one surface soil sample (CAA06-SS25), at a concentration of 14,900 mg/kg.
- Chromium concentration exceeded the base background 95% UTL concentration (18.2 mg/kg), the SSL (0.00059 mg/kg), and the adjusted residential RSL (0.29 mg/kg), in one surface soil sample (CAA06-SS25), at a concentration of 20.6 mg/kg.
- Selenium concentrations exceed the base background 95% UTL concentration (0.51 mg/kg) and the ESV (0.52 mg/kg) in several surface soil samples, at a maximum concentration of 0.67 mg/kg.
- Thallium concentrations exceeded the SSL (0.011 mg/kg) and the adjusted residential RSL (0.078 mg/kg) in all surface soil samples, at a maximum concentration of 0.22 mg/kg (CAS06-SS23). There is no base background 95% UTL concentration for thallium.

### Subsurface Soil

Two metals (aluminum and thallium) exceeded the approved background values and at least one screening criterion (SSLs, adjusted residential RSLs, and/or ESVs) (**Figure 4**).

- Aluminum concentration exceeded the base background 95% UTL concentration (13,000 mg/kg), the adjusted residential RSL (7,700 mg/kg), and the ESV (pH < 5.5) in one subsurface soil sample (CAA06-SB23), at a concentration of 16,100 mg/kg and a pH of 5.0.
- Thallium concentrations exceeded the SSL (0.011 mg/kg) and the adjusted residential RSL (0.078 mg/kg) in all subsurface soil samples, at a maximum concentration of 0.18 mg/kg (CAS06-SB23). There is no base background 95% UTL concentration for thallium.

### Potential Migration Pathways

The results indicate that metals may have leached from the waste slag pile to the adjacent soil. The principal contaminant release and transport mechanisms from the waste slag pile are deterioration of the waste slag itself and leaching from the slag to adjacent soil as a result of rainwater infiltration. Contaminants leached from the slag into soil have the potential to further migrate to the underlying groundwater. Contaminant transport could also occur through surface water runoff carrying contaminated particulate matter; however, the transport of surface soil by surface runoff or wind dispersion is unlikely to be significant because the area is relatively flat and heavily vegetated. King Creek is located about 400 feet southeast of the waste slag pile; however, Garrison Road is located between the site and King Creek, with the topography of the southern side of Garrison Road being at a higher elevation than the north side of the road (i.e., Garrison Road slopes down toward the site). No perennial surface water bodies or sediment are present within the site boundary. Surface water (i.e., standing water) is only present in low-lying areas during and immediately following precipitation events.

### Receptors

Actual or potential exposures of human and ecological receptors to contaminants associated with a site are determined by identifying the most likely and most important mechanisms and pathways of contaminant release and transport. A complete exposure pathway has three components: (1) a source or sources of contamination that results in a release to the environment; (2) a pathway and mechanism of chemical transport through an environmental medium; and (3) an exposure or contact point for a receptor.

Potential human receptors exposed to the Waste Slag Material subarea are:

- Current and future recreational users/visitors, trespassers, and maintenance workers (surface soil)
- Future industrial workers and construction workers (surface and subsurface soil)
- Future residents (surface and subsurface soil and groundwater)

These potential receptors may be exposed to site-related contaminants through:

- Incidental ingestion of and dermal contact with the surface soil, and inhalation of particulate emissions from the surface soil
- Ingestion of and dermal contact with groundwater

Potential ecological receptors exposed to soil at the Waste Slag Material subarea include lower trophic-level terrestrial receptors (plants and soil invertebrates). Due to the small size of the Waste Slag Material subarea (approximately 600 square feet), exposures to upper trophic-level receptors (i.e., birds and mammals) are not considered significant. The lower trophic-level receptors may be exposed to site-related contaminants through root uptake from the soil (plants) and through direct exposure with soil (plants and soil invertebrates).

## Risk Screenings

Metals detected in the soil at the Waste Slag Material subarea of AOC 6 were compared to the conservative screening criteria described above and identified on the detection tables (**Tables 2 and 3**). Those constituents that exceeded the base background 95% UTL and one or more criteria are depicted on **Figure 4**. An HHRS and SERA were completed to determine if any potential unacceptable risks associated with soil are present at the Waste Slag Material subarea of AOC 6.

### Human Health Risk Screening

A conservative HHRS was performed to determine the potential for unacceptable human health risks associated with exposure to surface and subsurface soil at the slag pile area within AOC 6. The results of the human health risk screening provide a preliminary indication of potential risks from exposure to COPCs identified for the site, and are used to help determine whether the site may require further evaluation (e.g., a baseline risk assessment or additional data collection) or if future unrestricted use of the site is acceptable.

### Human Health Conceptual Site Model

The human health CSM presents an overview of site conditions, potential contaminant migration pathways, and exposure pathways to potential receptors. The human health CSM for soil at the slag pile area is presented in **Figure 5**. The *Background* section above presents the site background, and the *Physical Setting* section presents a brief overview of the land use at CAX and the site.

#### Potential Human Receptors and Exposure Scenarios

Potential current receptors at the Waste Slag Material subarea include recreational users/visitors, trespassers, and maintenance workers. The potential current receptors may come in contact with surface soil; exposure routes may include incidental ingestion of and dermal contact with the surface soil, and inhalation of particulate emissions from the surface soil. Since VOCs are not associated with the waste slag material, inhalation of volatile emissions from the soil is not a potential exposure pathway.

Potential future receptors include the current receptors and future residents, industrial workers, and construction workers. Future receptors could be exposed to surface soil and to subsurface soil if future recreational facilities, piping/utilities, industrial buildings, or residential houses are constructed at the site. Exposure routes for future exposure to the surface soil and the subsurface soil are the same as those for current exposure to surface soil - incidental ingestion of and dermal contact with the soil and inhalation of particulate emissions from the soil.

Potable water supplies for CAX are provided by the City of Newport News Water Works. Groundwater is not used as a source of water on the base. However, leaching from soil beneath and around the waste slag material to the groundwater is a potential contaminant transport pathway. It was conservatively assumed that if future

residential development of the site occurs, the residents could use the groundwater as a potable water supply. The residents would be exposed through ingestion and dermal contact while bathing. Since VOCs are not associated with the waste slag material, inhalation of VOCs while showering is not a complete exposure pathway. Due to the anticipated depth of groundwater (estimated to be around 28 feet below ground surface) construction workers are not expected to be exposed to the groundwater through dermal contact in an excavation during construction activities.

### Human Health Risk Screening Methodology

The human health risk screening was conducted in three steps using a risk ratio technique (U.S. Navy, 2000). If COPCs were identified after Step 1, the COPCs were evaluated in Step 2. If COPCs were identified after Step 2, the COPCs were evaluated in Step 3. The risk screening evaluation is presented in the Table 2 series in **Attachment B**. The three-step screening process is described below:

#### Step 1

The maximum detected constituent concentrations in surface and subsurface soil were compared to the base background 95% UTL concentrations for surface and subsurface soil, respectively. If the constituent concentration was below background, it was not considered a COPC.

If there were no background data or the constituent concentration was greater than the base background 95% UTL concentration, it was compared to the USEPA human health RSL for residential soil (USEPA, 2012a) and the USEPA risk-based SSL for protection of groundwater (USEPA, 2012a). The RSLs based on noncarcinogenic effects were adjusted by dividing the RSL by 10 to account for exposure to multiple constituents (i.e., were adjusted to a hazard quotient of 0.1, from the hazard quotient of 1 used on the USEPA RSL table). The RSLs based on carcinogenic endpoints were used, as presented in the RSL table, and are based on a carcinogenic risk of  $1 \times 10^{-6}$ . The SSLs were not adjusted.

The residential soil RSLs were used for the screening level risk assessment, as they are more conservative (i.e., lower) than industrial soil RSLs, and are protective of all potential receptors (e.g., recreational users, visitors, trespassers, residents, industrial workers, and construction workers).

If the maximum detected concentration of an analyte in surface soil or subsurface soil exceeded the base background 95% UTL concentration and the residential soil RSL, the analyte was identified as a COPC based on direct exposure with the soil (ingestion, dermal contact, and inhalation of particulates) and the screening level risk evaluation proceeded to Step 2. If the maximum detected concentration of an analyte exceeded the base background 95% UTL concentration and the SSL, the analyte was identified as a COPC based on potential leaching to groundwater, but was not carried forward to Step 2 for direct contact with the soil.

#### Step 2

For constituents identified as COPCs in Step 1 for direct contact with soil (exceeding base background 95% UTL concentration and the residential soil RSL), a corresponding risk level was calculated using the following equation:

$$\text{corresponding risk level} = \frac{\text{concentration} \times \text{acceptable risk level}}{\text{RSL}}$$

The concentration is the maximum detected concentration (the same concentration that was used in Step 1). The acceptable risk level is 1 for noncarcinogens and  $10^{-6}$  for carcinogens. The RSLs for noncarcinogenic effects are not adjusted by 10 as was done in Step 1; they are used as presented in the RSL table. All of the corresponding risk levels for each constituent within a medium are summed to calculate the cumulative corresponding hazard index (for noncarcinogens) and cumulative corresponding carcinogenic risk (for carcinogens). A cumulative corresponding hazard index is also calculated for each target organ/effect. If the cumulative corresponding hazard index for a target organ/effect is greater than the risk-ratio screening benchmark of 0.5, or the cumulative corresponding carcinogenic risk is greater than the  $5 \times 10^{-5}$  risk-ratio screening benchmark, the chemicals contributing to these values are retained as COPCs and carried forward to Step 3.

### Step 3

A corresponding risk level was calculated as discussed above for Step 2. However, the 95 percent upper confidence limit (UCL) was used in place of the maximum detected concentration, to obtain a more site-specific risk ratio. If the cumulative corresponding HI by target organ/effect is greater than the risk-ratio screening benchmark of 0.5, or the cumulative corresponding carcinogenic risk is greater than the  $5 \times 10^{-5}$  risk-ratio screening benchmark, then chemicals contributing to these values are considered COPCs.

The most current version of the ProUCL software program (USEPA, 2011) was used to test the data distribution and calculate 95 percent UCL exposure point concentrations (EPCs) used for the Step 3 risk ratio calculations.

### Human Health Risk Screening Results

The results of the risk evaluation for AOC 6 waste slag pile subarea are presented in Tables 2.1 through 2.2a, **Attachment B**.

### Surface Soil

Tables 2.1 through 2.1b in **Attachment B** present the risk-based screening evaluation for surface soil. The maximum detected concentrations of aluminum, chromium, and thallium exceeded the base background 95% UTL concentration and residential soil RSL, and were retained for evaluation in Step 2. Based on Step 2 (risk ratio using maximum detected concentrations), chromium was carried forward to Step 3. Based on Step 3 (risk ratio using 95% UCLs), chromium was retained as a COPC for surface soil.

In the absence of chromium speciation information, the residential soil RSL for hexavalent chromium, the more toxic (and carcinogenic) form of chromium, was used as the screening value for total chromium. It was assumed that all of the chromium detected in the surface soil is hexavalent chromium. Chromium is generally found in soil in the trivalent form, unless activities at the site have resulted in the release or formation of hexavalent chromium. Any hexavalent chromium in soil is expected to be reduced over time to trivalent chromium by organic matter (USEPA, 1998). Additionally, hexavalent chromium is unstable in the body (in biological tissues) and is ultimately reduced to trivalent chromium by a variety of reducing agents, including ascorbate and glutathione (ATSDR, 2008; USEPA, 2012b). Therefore, the assumption that all of the chromium is hexavalent chromium likely over-estimates the risk associated with chromium in the soil. In the past, prior to including the New Jersey Department of Environmental Protection oral Cancer Slope Factor (CSF) for hexavalent chromium in the USEPA RSL table, the RSL presented a residential soil RSL for total chromium assuming a 1:6 ratio of Cr(VI) to Cr(III). Assuming this ratio applies to surface soil at the site, the concentration of hexavalent chromium (the maximum detected chromium concentration multiplied by 1/6) would not result in an unacceptable risk (the corresponding cancer risk would be below the  $5 \times 10^{-5}$  risk-ratio screening benchmark).

The maximum detected concentrations of chromium, selenium, and thallium exceeded the base background 95% UTL concentration and the SSL. Therefore, these constituents may be leaching to groundwater at concentrations of potential concern to human health if the groundwater is used as a potable water supply. The SSLs from the RSL table are extremely conservative and based on a dilution and attenuation factor (DAF) of 1 (i.e., no dilution or attenuation). The RSL table users guide (USEPA, 2012a) indicates that "if one wishes to use the calculator to calculate screening levels using the SSL guidance for a source up to 0.5 acres, then a dilution factor of 20 can be used." Therefore, as the site is less than 0.5 acres, it is appropriate to multiply the SSLs presented on Table 2.1, **Attachment B** by 20, to adjust to a DAF of 20 instead of the default DAF of 1. In this case, the maximum detected concentrations of selenium and thallium do not exceed the SSL based on a DAF of 20. As discussed in the preceding paragraph, the chromium screening was conducted by conservatively assuming that all of the detected chromium was hexavalent chromium. The total chromium concentration exceeds the SSL for hexavalent chromium; however, it is much lower than the SSL for trivalent chromium, the more likely form of chromium in the soil.

Therefore, based on the risk screening evaluation and additional considerations presented above, exposure to surface soil would not be expected to result in any unacceptable human health risks based direct contact with the soil or leaching to the groundwater.

## Subsurface Soil

Tables 2.2 and 2.2a in **Attachment B** present the risk-based screening evaluation for subsurface soil. The maximum detected concentrations of aluminum and thallium exceeded the base background 95% UTL concentration and residential soil RSL, and were retained for evaluation in Step 2. Based on Step 2 (risk ratio using maximum detected concentrations), neither of these COPCs were carried forward to Step 3. Therefore, there are no COPCs for direct contact with subsurface soil.

The maximum detected concentrations of thallium exceeded the base background 95% UTL concentration and the SSL. Therefore, thallium may be leaching to groundwater at concentrations of potential concern to human health if the groundwater is used as a potable water supply. The SSLs from the RSL table are extremely conservative and based on a DAF of 1. The RSL table users guide (USEPA, 2012a) indicates that “if one wishes to use the calculator to calculate screening levels using the SSL guidance for a source up to 0.5 acres, then a dilution factor of 20 can be used.” Therefore, as the site is less than 0.5 acres, it is appropriate to multiply the SSLs presented on Table 2.1, **Attachment B** by 20, to adjust to a DAF of 20 instead of the default DAF of 1. In this case, the maximum detected concentration of thallium would be below the SSL based on a DAF of 20.

Therefore, exposure to subsurface soil would not be expected to result in any unacceptable human health risks based on direct contact with the soil or leaching to the groundwater.

### Risk Screening Summary

Based on the HHRS evaluation and the additional considerations presented above, exposure to surface soil or subsurface soil would not be expected to result in any unacceptable human health risks based on direct contact with the soil or leaching to the groundwater.

## Ecological Risk Screening

An ecological risk screening was performed to determine the potential for ecological risks associated with direct exposure to site surface soil (0 to 6 inches) and subsurface soil (6 to 24 inches) at the AOC 6 Waste Slag Material subarea. The results of the ecological risk screening provide a preliminary indication of potential risks from exposure to COPCs identified for this subarea, and are used to help determine whether the site requires further evaluation (e.g., a baseline risk assessment or additional data collection) or if risks are acceptable.

### Ecological Conceptual Site Model

The ecological CSM provides a brief summary of site conditions, potential contaminant migration pathways, and exposure pathways to potential receptors. The *Physical Setting*, *Potential Contaminant Migration Pathways*, and *Exposure Pathways* sections above include a summary of the CSM.

### Ecological Risk Screening Methodology

The ecological risk screening was conducted using a two step process within the overall decision analysis process, which is comprised of three steps as described in the Final SI report (CH2M HILL, 2012a) that included AOC 6 (but did not include the waste slag pile). The ERA process falls within Steps 2a and 2b of this overall process.

If a CERCLA-related release is suspected (Step 1 of the overall decision process), site-specific analytical data for detected constituents in soil are compared to conservative ecological screening values and approved base background 95% UTL concentrations, where available (Step 2a). Ecological screening values used in the assessment (including sources), which are based upon lower trophic-level exposures per the CSM (see the *Conceptual Site Model* section above), are listed in **Attachment C, Table 1**. Soil screenings were conducted for both surface samples (0 to 6 inches) and subsurface samples (6 to 24 inches) since ecological exposures are generally considered to be confined to the top two feet of the soil column.

The base background 95% UTL concentrations are facility-specific values derived for Yorktown/CAX (CH2M HILL, 2011). Soil UTL values have been developed separately for surface and subsurface soils.

If the maximum detected concentration exceeded both ecological screening values and base background 95% UTL concentrations, exceeded either screening values or base background 95% UTL concentrations if only one of the two were available for a constituent, or neither a screening value or base background 95% UTL concentration was

available, the constituent was retained as an initial COPC for that medium. This constituted Step 2a of the decision process and also corresponds to a screening level ERA (which is Step 2 of the ERA process outlined in USEPA [1997] and NAVFAC [2003]).

For the screening value and base background 95% UTL concentration exceedances that are likely attributable to a historic CERCLA-related release, an evaluation of the data using more realistic assumptions was performed. This more realistic evaluation (Step 2b of the decision process) was performed to help ensure appropriate perspective is considered regarding the release such that informed decisions on the need for further investigation or action can be made (which is Step 3 of the decision process). Step 2b of the decision process corresponds to the first step of a baseline ERA (which is Step 3A of the ERA process outlined in NAVFAC [2003]).

Where there are exceedances of the ecological screening values and base background 95% UTL concentrations, more realistic assumption evaluations consider the following types of information:

- The size of the site
- The type and quality of the habitat present on the site and in surrounding areas, and the potential receptors likely to be present
- The frequency and magnitude of screening value and background exceedances
- Average exposure concentrations
- The spatial pattern of exceedances
- Additional screening values from the literature, where applicable
- Other site-specific factors that might be relevant to assessing potential exposures (e.g., soil type, bioavailability, fate, transport properties)

This additional risk evaluation provides another line of evidence that, when considered with all other site-specific information and evaluations, increases the level of confidence by which conclusions for the site are drawn.

### Ecological Risk Screening Results

The ecological risk screening was performed separately for surface soil and subsurface soil.

#### Surface Soil

Three metals (manganese, mercury, and selenium) equaled or exceeded soil screening values based on maximum detected concentrations. However, only selenium also exceeded the base background 95% UTL concentration (**Attachment C, Tables 2 and 3**). Therefore, selenium was identified as an initial (Step 2) COPC in surface soil.

The initial COPCs were then evaluated to select refined COPCs, as follows:

- Selenium exceeded the ecological screening value for soil organisms (0.52 mg/kg) in 3 of 6 samples at a maximum HQ of 1.29. The mean HQ for selenium was slightly less than one (**Attachment C, Table 2**). Selenium exceeded the base background 95% UTL concentration in 4 of 6 samples at a maximum ratio of 1.31. However, selenium concentrations of up to 0.69 mg/kg were detected in surface soil samples during the background soil investigation (CH2M HILL, 2011). This suggests that the selenium concentrations detected in site surface soils (maximum of 0.67 mg/kg) are within the range of background. For these reasons, selenium was not identified as a refined (Step 3A) COPC.
- No refined (Step 3A) COPCs were identified. Therefore, there are no unacceptable ecological risks associated with this medium.

## Subsurface Soil

Two metals (aluminum and selenium) equaled or exceeded soil screening values based on maximum detected concentrations. However, only aluminum also exceeded the base background 95% UTL concentration (**Attachment C, Tables 4 and 5**). Therefore, aluminum was identified as an initial (Step 2) COPC in subsurface soil.

The initial COPCs were then evaluated to select refined COPCs, as follows:

- Aluminum exceeded its pH-based ecological soil screening value in 1 of 6 samples and also exceeded the base background 95% UTL concentration in this same sample (at a ratio of 1.24). The mean pH at the site, however, was within the pH range defining no adverse effects, the exceedances of the base background 95% UTL concentration were infrequent and of low magnitude, and there were no exceedances for aluminum in surface soil samples. For these reasons, aluminum was not identified as a refined (Step 3A) COPC in subsurface soils.
- No refined (Step 3A) COPCs were identified. Therefore, there are no unacceptable ecological risks associated with this medium.

## Ecological Risk Summary

No refined (Step 3A) COPCs were identified for either surface or subsurface soil. Therefore, there are no unacceptable ecological risks associated with this site.

## Conclusions

Based on the size of the waste slag pile, an adequate number of surface and subsurface soil samples were collected in order to determine if metals attributed to the waste slag pile have leached to soil. One surface and subsurface soil sample was collected from underneath the waste slag material; therefore, the results of the sampling will also be used as pre-waste slag removal characterization samples.

While a comparison of data to conservative screening criterion indicated that four metals (aluminum, chromium, selenium, and thallium) exceeded base background 95% UTL concentrations and at least one screening criterion in surface soil and two metals (aluminum and thallium) exceeded base background 95% UTL concentrations and at least one screening criterion in subsurface soil, there are no unacceptable human health or ecological risks associated with these media:

- While chromium was retained as a COPC for surface soil, chromium is generally found in soil in the trivalent form, unless activities at the site have resulted in the release or formation of hexavalent chromium. Since there is no known likely source of hexavalent chromium at the site, the assumption that all of the chromium is hexavalent chromium likely over-estimates the risk associated with chromium in the soil. Assuming a 1:6 ratio of Cr(VI) to Cr(III) applies to surface soil at the site, the concentration of hexavalent chromium (the maximum detected chromium concentration multiplied by 1/6) would not result in an unacceptable risk (the corresponding cancer risk would be below the  $5 \times 10^{-5}$  risk-ratio screening benchmark).
- While chromium (surface soil), selenium (surface soil), and thallium (surface and subsurface soil) may be leaching to groundwater at concentrations of potential concern to human health based on a conservative assumption of a DAF of 1 if the groundwater is used as a potable water supply, assuming a more realistic DAF of 20, the maximum detected concentrations of selenium and thallium do not exceed the SSL, and therefore are not likely to leach into groundwater at concentrations that may pose risk to human health. In addition, the chromium screening was conducted by conservatively assuming all of the detected chromium was hexavalent chromium. While the total chromium concentration exceeds the SSL for hexavalent chromium, it is much lower than the SSL for trivalent chromium, the more likely actual form of chromium in the soil.
- No refined (Step 3A) COPCs were identified during the ecological risk screening.

In addition, with the exception of chromium, none of the metals identified to be of potential concern during the 1999 SI (antimony, arsenic, chromium, lead, and manganese) were detected in soil at concentrations exceeding the base background 95% UTL concentrations.

Although not discussed in this Tech Memo, the CAX Partnering team has agreed that the waste slag pile will be removed from the site, the details of which will be presented under a separate cover.

### No Action Consensus

The Navy, in partnership with the USEPA and VDEQ, has agreed to remove the waste slag pile at AOC 6, has determined that the soil and groundwater at the Waste Slag Material subarea of AOC 6 poses no potential unacceptable risk to human health and the environment, and that no action following the removal of the waste slag pile is required.

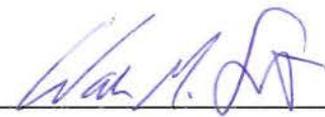
Mr. Scott Park;  
NAVFAC Mid-Atlantic

 Date 9-18-13

Mr. Gerald Hoover;  
USEPA Region 3

 Date 9-18-13

Mr. Wade Smith;  
VDEQ

 Date 09/18/2013

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**Tables**

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Table 2  
Waste Slag Surface Soil Exceedance Results  
AOC 6 Waste Slag Material Subarea; No Further Action Technical Memorandum  
Cheatham Annex  
Williamsburg, Virginia

Station ID Sample ID Sample Date	CLEAN CAX 95% UTL BKG SS	CLEAN RSLs Residential Soil Adjusted	CLEAN RSLs Risk- Based SSLs	Ecological Soil Screening Value (ESV)	CAA06-SO20	CAA06-SO21		CAA06-SO22	CAA06-SO23	CAA06-SO24	CAA06-SO25
					CAA06-SS20-1112	CAA06-SS21-1112	CAA06-SS21P-1112	CAA06-SS22-1112	CAA06-SS23-1112	CAA06-SS24-1112	CAA06-SS25-1112
					11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12
<b>Chemical Name</b>											
<b>Total Metals (MG/KG)</b>											
Aluminum	12,200	7,700	23,000	pH < 5.5	<b>7,550</b>	<b>7,420</b>	<b>6,340</b>	<b>8,990</b>	<b>8,640</b>	<b>7,200</b>	<b>14,900</b>
Arsenic	6.36	0.39	0.0013	18	<b>3.2</b>	<b>4</b>	<b>3.5</b>	<b>2.7</b>	<b>3</b>	<b>4.5</b>	<b>4</b>
Barium	52.9	1,500	120	330	<b>39.6</b>	<b>51.3</b>	<b>45.3</b>	<b>48.1</b>	<b>33.1</b>	<b>64.8</b>	<b>62.2</b>
Beryllium	0.587	16	13	40	<b>0.48</b>	<b>0.57</b>	<b>0.49</b>	<b>0.61</b>	<b>0.35 J</b>	<b>0.57 J</b>	<b>0.51 J</b>
Cadmium <sup>1</sup>	1.5	7	0.52	32	0.05 B	<b>0.35 J</b>	<b>0.26 J</b>	0.05 B	0.03 B	<b>0.14 J</b>	0.33 U
Calcium	2,290	--	--	--	<b>874</b>	<b>1,650</b>	<b>1,740</b>	<b>1,400</b>	<b>1,460</b>	<b>4,670</b>	<b>1,220</b>
Chromium	18.2	0.29	5.90E-04	64	<b>10</b>	<b>7.8</b>	<b>6.8</b>	<b>9.5</b>	<b>11.6</b>	<b>8</b>	<b>20.6</b>
Cobalt	9.93	2.3	0.21	13	<b>3</b>	<b>3.1</b>	<b>2.7</b>	<b>3.2</b>	<b>1.8</b>	<b>2.9</b>	<b>3.4</b>
Copper	4.25	310	22	70	<b>18.3</b>	<b>18.5</b>	<b>18</b>	<b>7.1</b>	<b>4.2</b>	<b>9.6</b>	<b>10.8</b>
Iron	19,900	5,500	270	pH<5 or >8	<b>10,000</b>	<b>7,250</b>	<b>5,580</b>	<b>6,960</b>	<b>9,510</b>	<b>5,450</b>	<b>14,000</b>
Lead	17.4	400	--	120	<b>69.5</b>	<b>77</b>	<b>62.4</b>	<b>44.3</b>	<b>52.8</b>	<b>47.3</b>	<b>13</b>
Magnesium	1,070	--	--	--	<b>588</b>	<b>705</b>	<b>577</b>	<b>719</b>	<b>766 K</b>	<b>744</b>	<b>1,020</b>
Manganese	324	180	21	220	<b>93.6</b>	<b>142</b>	<b>124</b>	<b>158</b>	<b>55.2</b>	<b>298</b>	<b>69.9</b>
Mercury	0.111	2.3	0.033	0.1	<b>0.04</b>	<b>0.04</b>	<b>0.04</b>	<b>0.03 J</b>	<b>0.06</b>	<b>0.1</b>	<b>0.03 J</b>
Nickel	9.52	150	20	38	<b>5</b>	<b>5.2</b>	<b>4.6</b>	<b>5.1</b>	<b>3.8</b>	<b>6</b>	<b>6.1</b>
Potassium	708	--	--	--	<b>498</b>	<b>542</b>	<b>446</b>	<b>739</b>	<b>792 K</b>	<b>609</b>	<b>1,060</b>
Selenium	0.51	39	0.4	0.52	<b>0.49</b>	<b>0.67</b>	<b>0.55</b>	<b>0.57</b>	<b>0.51 L</b>	<b>0.62 J</b>	0.49 B
Sodium	521	--	--	--	22.6 B	24.8 B	22.6 B	31.9 B	23.2 B	<b>33.7 J</b>	<b>48 J</b>
Thallium	--	0.078	0.011	1	<b>0.1</b>	<b>0.17</b>	<b>0.15</b>	<b>0.11</b>	<b>0.22</b>	<b>0.12 J</b>	<b>0.16</b>
Vanadium	27.9	39	78	130	<b>13</b>	<b>12.5</b>	<b>11</b>	<b>14.2</b>	<b>16.7</b>	<b>13.9</b>	<b>29.4</b>
Zinc	26.5	2,300	290	120	<b>34.6</b>	<b>105</b>	<b>73.5</b>	<b>23.2</b>	<b>20.2</b>	<b>36.2</b>	<b>21.1</b>
<b>Wet Chemistry</b>											
pH (ph)	--	--	--	--	<b>6.3</b>	<b>6.2</b>	NA	<b>6.5</b>	<b>5.9</b>	<b>6.6</b>	<b>5.9</b>

Exceeds Background
Exceeds BKG & ECO
Exceeds BKG & Res RSL
Exceeds BKG, ECO & Res RSL
Exceeds BKG, RSL, & SSL

**Bold indicates detections**

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

K - Analyte present, value may be biased high, actual value may be lower

L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

UL - Analyte not detected, quantitation limit is probably higher

MG/KG - Milligrams per kilogram

PH - pH units

Table 3  
Waste Slag Subsurface Soil Exceedance Results  
AOC 6 Waste Slag Material Subarea; No Further Action Technical Memorandum  
Cheatham Annex  
Williamsburg, Virginia

Station ID Sample ID Sample Date	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted	CLEAN RSLs Risk- Based SSLs	Ecological Soil Screening Value (ESV)	CAA06-SO20	CAA06-SO21		CAA06-SO22	CAA06-SO23	CAA06-SO24	CAA06-SO25
					CAA06-SB20-1112	CAA06-SB21-1112	CAA06-SB21P-1112	CAA06-SB22-1112	CAA06-SB23-1112	CAA06-SB24-1112	CAA06-SB25-1112
					11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12
<b>Chemical Name</b>											
<b>Total Metals (MG/KG)</b>											
Aluminum	13,000	7,700	23,000	pH < 5.5	<b>6,840</b>	<b>6,880</b>	<b>12,400</b>	<b>7,250</b>	<b>16,100</b>	<b>8,890</b>	<b>7,470</b>
Arsenic	5.54	0.39	0.0013	18	<b>2.3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>4.3</b>	<b>2.4</b>	<b>2.3</b>
Barium	84.5	1,500	120	330	<b>32.6</b>	<b>39.4</b>	<b>48.6</b>	<b>38.7</b>	<b>44.3</b>	<b>37.1</b>	<b>42.7</b>
Beryllium <sup>1</sup>	0.52	16	13	40	<b>0.5</b>	<b>0.46</b>	<b>0.38 J</b>	<b>0.5</b>	<b>0.5 J</b>	<b>0.5 J</b>	<b>0.5</b>
Cadmium	--	7	0.52	32	0.01 B	<b>0.07 J</b>	0.28 U	0.02 B	0.31 U	0.02 B	0.02 B
Calcium	2,380	--	--	--	<b>206</b>	<b>441</b>	<b>502</b>	<b>482</b>	<b>839 L</b>	<b>602</b>	<b>602</b>
Chromium	33.7	0.29	5.90E-04	64	<b>7.2</b>	<b>7.3</b>	<b>14.4</b>	<b>6.9</b>	<b>24.4 K</b>	<b>9</b>	<b>7.9</b>
Cobalt	5.18	2.3	0.21	13	<b>2.8</b>	<b>2.8</b>	<b>2.2</b>	<b>3.1</b>	<b>2.5</b>	<b>3.2</b>	<b>3.2</b>
Copper	3.17	310	22	70	<b>2.5</b>	<b>3.1</b>	<b>2.3</b>	<b>1.9</b>	<b>1.7 J</b>	<b>2.4 J</b>	<b>2.7</b>
Iron	32,000	5,500	270	pH<5 or >8	<b>5,490</b>	<b>5,090</b>	<b>10,500</b>	<b>4,500</b>	<b>17,600</b>	<b>5,980</b>	<b>5,740</b>
Lead	8.79	400	--	120	<b>9</b>	<b>14.4</b>	<b>7.5</b>	<b>7.1</b>	<b>8.9</b>	<b>9.4</b>	<b>9.2</b>
Magnesium	1,120	--	--	--	<b>533</b>	<b>617</b>	<b>912</b>	<b>570</b>	<b>1,080 K</b>	<b>744</b>	<b>609</b>
Manganese	176	180	21	220	<b>87.1</b>	<b>77.2</b>	<b>51.7</b>	<b>94</b>	<b>33.2 K</b>	<b>82.8</b>	<b>83.3</b>
Mercury <sup>1</sup>	0.14	2.3	0.033	0.1	<b>0.02 J</b>	<b>0.02 J</b>	<b>0.02 J</b>	<b>0.02 J</b>	<b>0.03</b>	<b>0.02 J</b>	<b>0.02 J</b>
Nickel	17.6	150	20	38	<b>3.8</b>	<b>4.1</b>	<b>4.9</b>	<b>4.3</b>	<b>4.6</b>	<b>4.6</b>	<b>4</b>
Potassium	901	--	--	--	<b>408</b>	<b>456</b>	<b>710</b>	<b>466</b>	<b>1,110 K</b>	<b>587</b>	<b>416</b>
Selenium <sup>1</sup>	0.64	39	0.4	0.52	<b>0.53</b>	<b>0.44</b>	<b>0.29 J</b>	<b>0.54</b>	<b>0.32 J</b>	<b>0.59</b>	<b>0.55</b>
Sodium	811	--	--	--	15.1 B	17.1 B	24.1 B	18 B	32.3 J	30.4 B	22.2 B
Thallium	--	0.078	0.011	1	<b>0.1</b>	<b>0.12</b>	<b>0.15</b>	<b>0.1</b>	<b>0.18</b>	<b>0.12</b>	<b>0.1</b>
Vanadium	48.3	39	78	130	<b>10.2</b>	<b>10.7</b>	<b>23.4</b>	<b>10.5</b>	<b>31.5</b>	<b>13.6</b>	<b>11.8</b>
Zinc	28	2,300	290	120	<b>13.1</b>	<b>37.7</b>	<b>18.3</b>	<b>14</b>	<b>17.6</b>	<b>15.8</b>	<b>13.4</b>
<b>Wet Chemistry</b>											
pH (ph)	--	--	--	--	<b>5.1</b>	<b>6</b>	NA	<b>6.8</b>	<b>5</b>	<b>5.9</b>	<b>6.1</b>

**Notes:**

<sup>1</sup>CLEAN CAX 95% UTL BKG SS, some of the values are not included in the 95% UTL criteria. The maximum background values are shown because a 95% UTL was not calculated for this analyte.

Exceeds Background
Exceeds BKG & ECO
Exceeds BKG & Res RSL
Exceeds BKG, ECO & Res RSL
Exceeds BKG, RSL, & SSL

**Bold indicates detections**

- NA - Not analyzed
- B - Analyte not detected above the level reported in blanks
- J - Analyte present, value may or may not be accurate or precise
- K - Analyte present, value may be biased high, actual value may be lower
- L - Analyte present, value may be biased low, actual value may be higher
- U - The material was analyzed for, but not detected
- UL - Analyte not detected, quantitation limit is probably higher
- MG/KG - Milligrams per kilogram
- PH - pH units

**Figures**

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- Legend**
- Activity Boundaries
  - City/County Boundaries

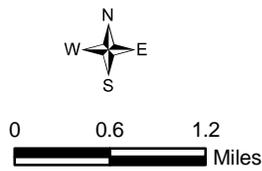


Figure 1  
Location of CAX  
AOC 6 Waste Slag Material Subarea  
No Further Action Technical Memorandum  
Cheatham Annex  
Williamsburg, Virginia



- Legend**
- Approximate Slag Pile Boundary
  - CAX Boundary

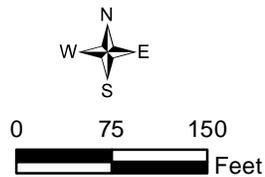


Figure 2  
Site Map  
AOC 6 Waste Slag Material Subarea  
No Further Action Technical Memorandum  
Cheatham Annex  
Williamsburg, Virginia



**Legend**

- Soil Sample Location
- Approximate Slag Pile Boundary
- CAX Boundary

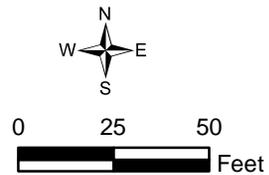
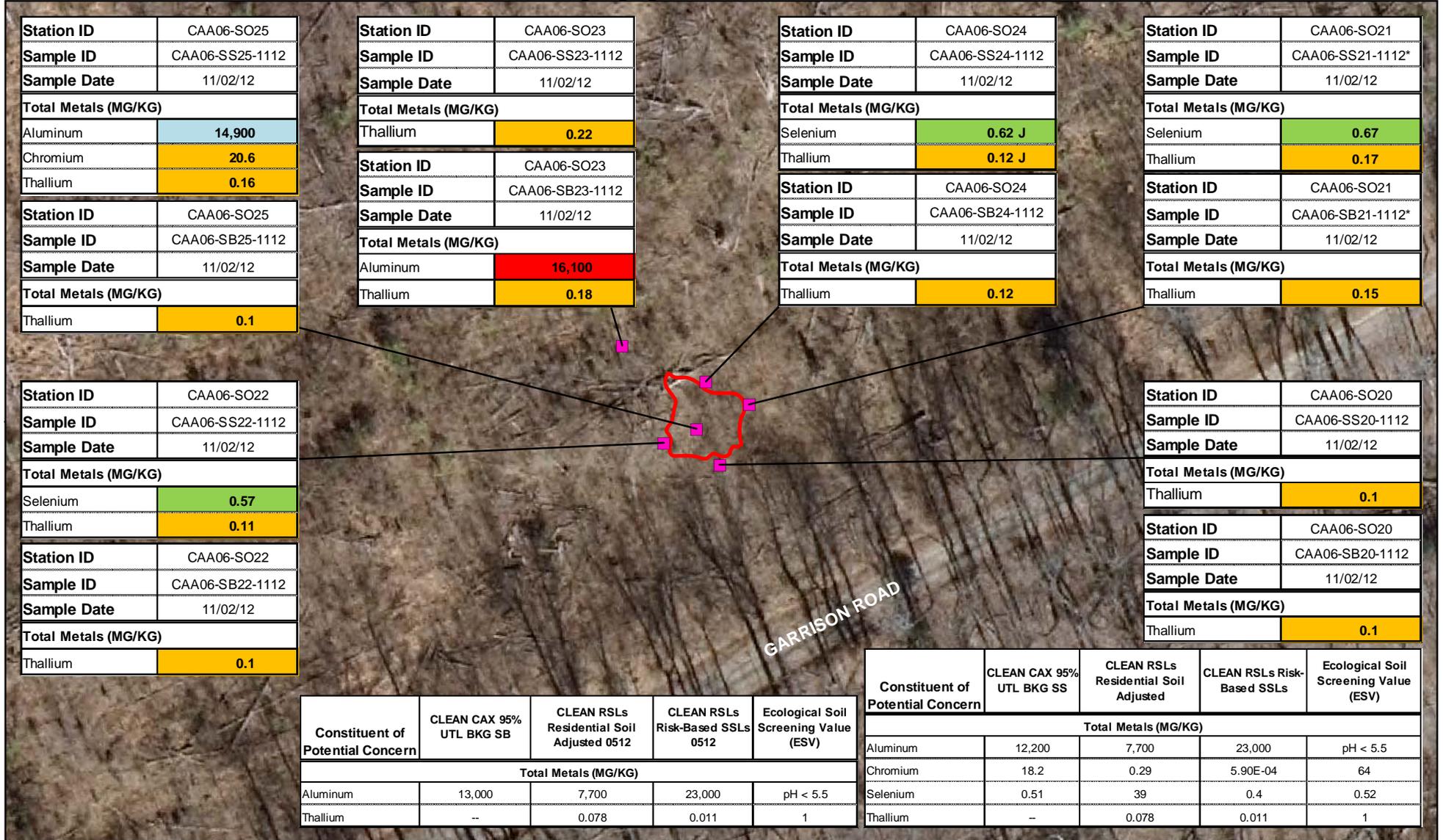


Figure 3  
Soil Sampling Locations  
AOC 6 Waste Slag Material Subarea  
No Further Action Technical Memorandum  
Cheatham Annex  
Williamsburg, Virginia



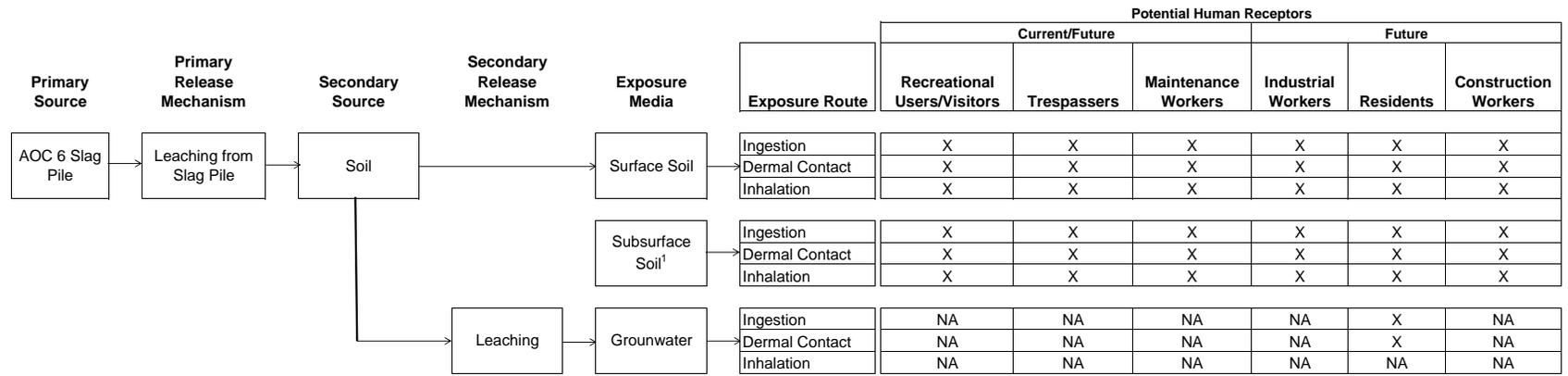
**Legend**

- Soil Sample Location
- Approximate Slag Pile Boundary
- CAX Boundary

- Exceeds BKG & ECO
- Exceeds BKG & Res RSL
- Exceeds BKG, RSL, & SSL
- Exceeds BKG, ECO & Res RSL



Figure 4  
Surface and Subsurface Soil Exceedance Results  
AOC 6 Waste Slag Material Subarea  
No Further Action Technical Memorandum  
Cheatham Annex  
Williamsburg, Virginia



**FIGURE 5**  
 Conceptual Site Model for HHRA  
 AOC 6 Slag Pile Area  
 Cheatham Annex, Williamsburg, Virginia

<sup>1</sup>. Future scenario only  
 NA - Not Applicable or pathway is incomplete  
 X - Potentially complete exposure pathways

**Attachment A**  
**Laboratory Results**

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Attachment A  
Cheatham Annex  
AOC 6 - Waste Slag Subarea  
Surface Soil Analytical Data

Station ID	CAA06-SO20	CAA06-SO21		CAA06-SO22	CAA06-SO23	CAA06-SO24	CAA06-SO25
Sample ID	CAA06-SS20-1112	CAA06-SS21-1112	CAA06-SS21P-1112	CAA06-SS22-1112	CAA06-SS23-1112	CAA06-SS24-1112	CAA06-SS25-1112
Sample Date	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12
Chemical Name							
Total Metals (MG/KG)							
Aluminum	7,550	7,420	6,340	8,990	8,640	7,200	14,900
Antimony	0.13 B	0.54 U	0.33 U	0.56 U	0.43 UL	0.68 U	0.55 U
Arsenic	3.2	4	3.5	2.7	3	4.5	4
Barium	39.6	51.3	45.3	48.1	33.1	64.8	62.2
Beryllium	0.48	0.57	0.49	0.61	0.35 J	0.57 J	0.51 J
Cadmium	0.05 B	0.35 J	0.26 J	0.05 B	0.03 B	0.14 J	0.33 U
Calcium	874	1,650	1,740	1,400	1,460	4,670	1,220
Chromium	10	7.8	6.8	9.5	11.6	8	20.6
Cobalt	3	3.1	2.7	3.2	1.8	2.9	3.4
Copper	18.3	18.5	18	7.1	4.2	9.6	10.8
Iron	10,000	7,250	5,580	6,960	9,510	5,450	14,000
Lead	69.5	77	62.4	44.3	52.8	47.3	13
Magnesium	588	705	577	719	766 K	744	1,020
Manganese	93.6	142	124	158	55.2	298	69.9
Mercury	0.04	0.04	0.04	0.03 J	0.06	0.1	0.03 J
Nickel	5	5.2	4.6	5.1	3.8	6	6.1
Potassium	498	542	446	739	792 K	609	1,060
Selenium	0.49	0.67	0.55	0.57	0.51 L	0.62 J	0.49 B
Silver	0.04 B	0.06 B	0.04 B	0.11 B	0.12 B	0.54 U	0.05 B
Sodium	22.6 B	24.8 B	22.6 B	31.9 B	23.2 B	33.7 J	48 J
Thallium	0.1	0.17	0.15	0.11	0.22	0.12 J	0.16
Vanadium	13	12.5	11	14.2	16.7	13.9	29.4
Zinc	34.6	105	73.5	23.2	20.2	36.2	21.1
Wet Chemistry							
pH (ph)	6.3	6.2	NA	6.5	5.9	6.6	5.9

**Notes:**

Shading indicates detections

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

K - Analyte present, value may be biased high, actual value may be lower

L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

UL - Analyte not detected, quantitation limit is probably higher

MG/KG - Milligrams per kilogram

PH - pH units

Attachment A  
Cheatham Annex  
AOC 6 - Waste Slag Subarea Subsurface Soil Analytical Data

Station ID	CAA06-SO20	CAA06-SO21		CAA06-SO22	CAA06-SO23	CAA06-SO24	CAA06-SO25
Sample ID	CAA06-SB20-1112	CAA06-SB21-1112	CAA06-SB21P-1112	CAA06-SB22-1112	CAA06-SB23-1112	CAA06-SB24-1112	CAA06-SB25-1112
Sample Date	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12
Chemical Name							
<b>Total Metals (MG/KG)</b>							
Aluminum	6,840	6,880	12,400	7,250	16,100	8,890	7,470
Antimony	0.38 U	0.28 U	0.47 U	0.32 U	0.52 UL	0.51 U	0.44 U
Arsenic	2.3	2	3	2	4.3	2.4	2.3
Barium	32.6	39.4	48.6	38.7	44.3	37.1	42.7
Beryllium	0.5	0.46	0.38 J	0.5	0.5 J	0.5 J	0.5
Cadmium	0.01 B	0.07 J	0.28 U	0.02 B	0.31 U	0.02 B	0.02 B
Calcium	206	441	502	482	839 L	602	602
Chromium	7.2	7.3	14.4	6.9	24.4 K	9	7.9
Cobalt	2.8	2.8	2.2	3.1	2.5	3.2	3.2
Copper	2.5	3.1	2.3	1.9	1.7 J	2.4 J	2.7
Iron	5,490	5,090	10,500	4,500	17,600	5,980	5,740
Lead	9	14.4	7.5	7.1	8.9	9.4	9.2
Magnesium	533	617	912	570	1,080 K	744	609
Manganese	87.1	77.2	51.7	94	33.2 K	82.8	83.3
Mercury	0.02 J	0.02 J	0.02 J	0.02 J	0.03	0.02 J	0.02 J
Nickel	3.8	4.1	4.9	4.3	4.6	4.6	4
Potassium	408	456	710	466	1,110 K	587	416
Selenium	0.53	0.44	0.29 J	0.54	0.32 J	0.59	0.55
Silver	0.31 U	0.23 U	0.38 U	0.26 U	0.42 U	0.41 U	0.36 U
Sodium	15.1 B	17.1 B	24.1 B	18 B	32.3 J	30.4 B	22.2 B
Thallium	0.1	0.12	0.15	0.1	0.18	0.12	0.1
Vanadium	10.2	10.7	23.4	10.5	31.5	13.6	11.8
Zinc	13.1	37.7	18.3	14	17.6	15.8	13.4
<b>Wet Chemistry</b>							
pH (ph)	5.1	6	NA	6.8	5	5.9	6.1

**Notes:**

Shading indicates detections

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

K - Analyte present, value may be biased high, actual value may be lower

L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

UL - Analyte not detected, quantitation limit is probably higher

MG/KG - Milligrams per kilogram

PH - pH units

**Attachment B**  
**Human Health Risk Screening Tables**

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Table 2.1  
 OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
 Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current/Future  
 Medium: Surface Soil  
 Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Screening [3] Background [4] Value	COPC Flag	Regional Screening [5] Level	COPC Flag	Soil Screening Level [3] [6]	COPC Flag	Rationale for Contaminant Deletion or Selection [7]	
Surface Soil	<b>7429-90-5</b>	<b>Aluminum</b>	<b>7.2E+03</b>	<b>1.5E+04</b>	<b>MG/KG</b>	<b>CAA06-SS25-1112</b>	<b>6/6</b>	<b>20 - 41</b>	<b>1.5E+04</b>	<b>1.2E+04</b>	<b>YES</b>	<b>7.7E+03 N</b>	<b>YES</b>	2.3E+04	NO	<b>YES</b>	<b>ABK and ARSL</b>
AOC 6	7440-38-2	Arsenic	2.7E+00	4.5E+00	MG/KG	CAA06-SS24-1112	6/6	0.53 - 1.1	4.5E+00	6.4E+00	NO	3.9E-01 C*	YES	1.3E-03	YES	NO	BBK
Slag Pile	7440-39-3	Barium	3.3E+01	6.5E+01	MG/KG	CAA06-SS24-1112	6/6	0.33 - 0.68	6.5E+01	5.3E+01	YES	1.5E+03 N	NO	1.2E+02	NO	NO	BRSL, BSSL
	7440-41-7	Beryllium	3.5E-01 J	6.1E-01	MG/KG	CAA06-SS22-1112	6/6	0.33 - 0.68	6.1E-01	5.9E-01	YES	1.6E+01 N	NO	1.3E+01	NO	NO	BRSL, BSSL
	7440-43-9	Cadmium	1.4E-01 J	3.5E-01 J	MG/KG	CAA06-SS21-1112	2/6	0.33 - 0.68	3.5E-01	1.5E+00	NO	7.0E+00 N	NO	5.2E-01	NO	NO	BBK
	7440-70-2	Calcium	8.7E+02	4.7E+03	MG/KG	CAA06-SS24-1112	6/6	6.6 - 14	4.7E+03	2.3E+03	YES	N/A	NUT	N/A	NUT	NUT	NUT
	<b>7440-47-3</b>	<b>Chromium</b>	<b>7.8E+00</b>	<b>2.1E+01</b>	<b>MG/KG</b>	<b>CAA06-SS25-1112</b>	<b>6/6</b>	<b>0.66 - 1.4</b>	<b>2.1E+01</b>	<b>1.8E+01</b>	<b>YES</b>	<b>2.9E-01 C</b>	<b>YES</b>	<b>5.9E-04</b>	<b>YES</b>	<b>YES</b>	<b>ABK, ARSL, ASSL</b>
	7440-48-4	Cobalt	1.8E+00	3.4E+00	MG/KG	CAA06-SS25-1112	6/6	0.66 - 1.4	3.4E+00	9.9E+00	NO	2.3E+00 N	YES	2.1E-01	YES	NO	BBK
	7440-50-8	Copper	4.2E+00	1.9E+01	MG/KG	CAA06-SS21-1112	6/6	1.7 - 3.4	1.9E+01	4.3E+00	YES	3.1E+02 N	NO	2.2E+01	NO	NO	BRSL, BSSL
	7439-89-6	Iron	5.5E+03	1.4E+04	MG/KG	CAA06-SS25-1112	6/6	6.6 - 14	1.4E+04	2.0E+04	NO	5.5E+03 N	YES	2.7E+02	YES	NO	BBK
	7439-92-1	Lead	1.3E+01	7.7E+01	MG/KG	CAA06-SS21-1112	6/6	0.33 - 0.68	7.7E+01	1.7E+01	YES	4.0E+02 NL	NO	N/A	NO	NO	BRSL
	7439-95-4	Magnesium	5.9E+02	1.0E+03	MG/KG	CAA06-SS25-1112	6/6	6.6 - 14	1.0E+03	1.1E+03	NO	N/A	NUT	N/A	NUT	NO	BBK
	7439-96-5	Manganese	5.5E+01	3.0E+02	MG/KG	CAA06-SS24-1112	6/6	0.33 - 0.68	3.0E+02	3.2E+02	NO	1.8E+02 N	YES	2.1E+01	YES	NO	BBK
	7439-97-6	Mercury	3.0E-02 J	1.0E-01	MG/KG	CAA06-SS24-1112	6/6	0.034 - 0.048	1.0E-01	1.1E-01	NO	2.3E+00 N	NO	3.3E-02	YES	NO	BBK
	7440-02-0	Nickel	3.8E+00	6.1E+00	MG/KG	CAA06-SS25-1112	6/6	0.66 - 1.4	6.1E+00	9.5E+00	NO	1.5E+02 N	NO	2.0E+01	NO	NO	BBK
	7440-09-7	Potassium	5.0E+02	1.1E+03	MG/KG	CAA06-SS25-1112	6/6	66 - 140	1.1E+03	7.1E+02	YES	N/A	NUT	N/A	NUT	NUT	NUT
<b>7782-49-2</b>	<b>Selenium</b>	<b>4.9E-01</b>	<b>6.7E-01</b>	<b>MG/KG</b>	<b>CAA06-SS21-1112</b>	<b>5/6</b>	<b>0.33 - 0.68</b>	<b>6.7E-01</b>	<b>5.1E-01</b>	<b>YES</b>	<b>3.9E+01 N</b>	<b>NO</b>	<b>4.0E-01</b>	<b>YES</b>	<b>YES</b>	<b>ABK and ASSL</b>	
7440-23-5	Sodium	3.4E+01 J	4.8E+01 J	MG/KG	CAA06-SS25-1112	2/6	66 - 140	4.8E+01	5.2E+02	NO	N/A	NUT	N/A	NUT	NO	BBK	
<b>7440-28-0</b>	<b>Thallium</b>	<b>1.0E-01</b>	<b>2.2E-01</b>	<b>MG/KG</b>	<b>CAA06-SS23-1112</b>	<b>6/6</b>	<b>0.066 - 0.14</b>	<b>2.2E-01</b>	<b>ND</b>	<b>YES</b>	<b>7.8E-02 N</b>	<b>YES</b>	<b>1.1E-02</b>	<b>YES</b>	<b>YES</b>	<b>ABK, ARSL, ASSL</b>	
7440-62-2	Vanadium	1.3E+01	2.9E+01	MG/KG	CAA06-SS25-1112	6/6	0.66 - 1.4	2.9E+01	2.8E+01	YES	3.9E+01 N	NO	7.8E+01	NO	NO	BRSL, BSSL	
7440-66-6	Zinc	2.0E+01	1.1E+02	MG/KG	CAA06-SS21-1112	6/6	1.3 - 2.7	1.1E+02	2.7E+01	YES	2.3E+03 N	NO	2.9E+02	NO	NO	BRSL, BSSL	

Table 2.1  
 OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
 Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current/Future Medium: Surface Soil Exposure Medium: Surface Soil
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Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Screening [3] Background [4] Value	COPC Flag	Regional [3] Screening [5] Level	COPC Flag	Soil [3] Screening [6] Level	COPC Flag	Rationale for Contaminant Deletion or Selection [7]
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- |   |  |
|---|--|
| <p>[1] Minimum/Maximum detected concentrations.</p> <p>[2] Maximum concentration is used for screening.</p> <p>[3] Screening Steps: The maximum concentrations were compared to background concentrations. If exceedances, the maximum concentrations were then compared to adjusted residential soil RSL and SSL for protection of groundwater.</p> <p>[4] Background values from Cheatham Annex/Yorktown background surface soil samples; values represent the 95% UTL.</p> <p>[5] Oak Ridge National Laboratory (ORNL). November, 2012. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Residential Soil RSL (based on 10<sup>-6</sup> for carcinogens and adjusted to HQ of 0.1 for noncarcinogens). Available Online: <a href="http://epa-prgs.ornl.gov/chemicals/index.shtml">http://epa-prgs.ornl.gov/chemicals/index.shtml</a></p> <p>[6] Oak Ridge National Laboratory (ORNL). November, 2012. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Risk-based SSLs (based on 10<sup>-6</sup> for carcinogens and HQ of 1 for noncarcinogens). Available Online: <a href="http://epa-prgs.ornl.gov/chemicals/index.shtml">http://epa-prgs.ornl.gov/chemicals/index.shtml</a><br/>         RSL value for chromium(VI) used for chromium.<br/>         The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.<br/>         RSL value for mercuric chloride (and other mercury salts) used for mercury.</p> <p>[7] Rationale Codes</p> <p style="margin-left: 40px;">Selection Reason:</p> <ul style="list-style-type: none"> <li>Above Residential Soil Screening Level (ARSL)</li> <li>Above Soil Screening Level for Protection of Groundwater (ASSL)</li> <li>Above Background (ABK)</li> </ul> <p style="margin-left: 40px;">Deletion Reason:</p> <ul style="list-style-type: none"> <li>Below Background (BBK)</li> <li>Below Residential Soil Screening Level (BRSL)</li> <li>Below Soil Screening Level for Protection of Groundwater (BSSL)</li> <li>Essential Nutrient (NUT)</li> </ul> | <p>COPC = Chemical of Potential Concern<br/>         J = Estimated Value<br/>         C = Carcinogenic<br/>         C* = where: N RSL &lt; 100X C SL, Carcinogenic RSL used<br/>         N = Noncarcinogenic<br/>         NL = Noncarcinogenic, however, RSL not adjusted to HQ of 0.1 for lead<br/>         N/A = Not available or Not applicable<br/>         ND = Not detected<br/>         RSL = Regional Screening Level<br/>         SSL = Soil Screening Level<br/>         MG/KG = milligrams per kilogram</p> |
|---|--|

Table 2.1a  
 Step 2 Surface Soil Screening - Risk Ratio, Maximum Detected Concentration  
 Cheatham Annex, Williamsburg, Virginia

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier) (mg/kg)	Sample Location of Maximum Detected Concentration	Residential Soil RSL (mg/kg)	Acceptable Risk Level	Corresponding Hazard Index <sup>a</sup>	Corresponding Cancer Risk <sup>b</sup>	Target Organ
Aluminum	6 / 6	1.5E+04	CAA06-SS25-1112	7.7E+04	1	0.2	NA	Developmental, Neurological
<b>Chromium<sup>c</sup></b>	<b>6 / 6</b>	<b>2.1E+01</b>	<b>CAA06-SS25-1112</b>	<b>2.9E-01</b>	<b>1E-06</b>	<b>NA</b>	<b>7E-05</b>	<b>NA</b>
Thallium	6 / 6	2.2E-01	CAA06-SS23-1112	7.8E-01	1	0.3	NA	Hair
<b>Cumulative Corresponding Hazard Index<sup>d</sup></b>						<b>0.5</b>		
<b>Cumulative Corresponding Cancer Risk<sup>d</sup></b>							<b>7E-05</b>	
							Total Developmental HI =	0.2
							Total Neurological HI =	0.2
							Total Hair HI =	0.3

**Notes:**

<sup>a</sup> Corresponding Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

<sup>b</sup> Corresponding Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

<sup>c</sup> Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

<sup>d</sup> Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

<sup>e</sup> RSL value for chromium(VI) used for chromium.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern

HI = Hazard Index

mg/kg = milligrams per kilogram

NA = Not available/not applicable

Table 2.1b  
 Step 3 Surface Soil Screening - Risk Ratio, 95% UCL  
 Cheatham Annex, Williamsburg, Virginia

Analyte	Detection Frequency	95% UCL (mg/kg)		95% UCL Rationale	Residential Soil RSL (mg/kg)	Acceptable Risk Level	Corresponding Hazard Index <sup>a</sup>	Corresponding Cancer Risk <sup>b</sup>	Target Organ
Chromium <sup>e</sup>	6 / 6	1.6E+01	AppG	1, 3, 4	2.9E-01	1E-06	NA	6E-05	NA
<b>Cumulative Corresponding Hazard Index<sup>c</sup></b>							<b>0.0</b>		
<b>Cumulative Corresponding Cancer Risk<sup>d</sup></b>								<b>6E-05</b>	

<sup>a</sup> Corresponding Hazard Index equals 95% UCL divided by the RSL divided by the acceptable risk level.

<sup>b</sup> Corresponding Cancer Risk equals 95% UCL divided by the RSL divided by the acceptable risk level.

<sup>c</sup> Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

<sup>d</sup> Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

<sup>e</sup> RSL value for chromium(VI) used for chromium.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05,

Constituents selected as COPCs are indicated by shading.

mg/kg = milligrams per kilogram

ProUCL, Version 4.1.01 used to determine distribution of data and calculate 95% UCL, following recommendations in users guide (USEPA, May 2010, ProUCL, Version 4.1. Prepared by Lockheed Martin Environmental Services).

Options: 95% Approximate Gamma UCL (AppG).

UCL Rationale:

- (1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
- (2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
- (3) Anderson-Darling Test indicates data are gamma distributed.
- (4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
- (5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
- (6) Max value used because 95% UCL greater than max.

Table 2.2  
 OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
 Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
 Medium: Subsurface Soil  
 Exposure Medium: Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Screening [3] Background [4] Value	COPC Flag	Regional Screening [5] Level	COPC Flag	Soil Screening Level [3] [6]	COPC Flag	Rationale for Contaminant Deletion or Selection [7]		
Subsurface Soil, AOC 6 Slag Pile	<b>7429-90-5</b>	<b>Aluminum</b>	<b>6.8E+03</b>	<b>1.6E+04</b>	<b>MG/KG</b>	<b>CAA06-SB23-1112</b>	<b>6/6</b>	<b>17 - 31</b>	<b>1.6E+04</b>	<b>1.3E+04</b>	<b>YES</b>	<b>7.7E+03</b>	<b>N</b>	<b>YES</b>	2.3E+04	NO	<b>YES</b>	<b>ABK and ARSL</b>
	7440-38-2	Arsenic	2.0E+00	4.3E+00	MG/KG	CAA06-SB23-1112	6/6	0.45 - 0.83	4.3E+00	5.5E+00	NO	3.9E-01	C*	YES	1.3E-03	YES	NO	BBK
	7440-39-3	Barium	3.3E+01	4.9E+01	MG/KG	CAA06-SB21P-1112	6/6	0.28 - 0.52	4.9E+01	8.5E+01	NO	1.5E+03	N	NO	1.2E+02	NO	NO	BBK
	7440-41-7	Beryllium	4.6E-01	5.0E-01	MG/KG	CAA06-SB20-1112, CAA06-SB22-1112, CAA06-SB23-1112, CAA06-SB24-1112, CAA06-SB25-1112	6/6	0.28 - 0.52	5.0E-01	5.2E-01	NO	1.6E+01	N	NO	1.3E+01	NO	NO	BBK
	7440-43-9	Cadmium	7.0E-02 J	7.0E-02 J	MG/KG	CAA06-SB21-1112	1/6	0.28 - 0.52	7.0E-02	ND	YES	7.0E+00	N	NO	5.2E-01	NO	NO	BRSL, BSSL
	7440-70-2	Calcium	2.1E+02	8.4E+02 L	MG/KG	CAA06-SB23-1112	6/6	5.7 - 10	8.4E+02	2.4E+03	NO	N/A	NUT	N/A	NUT	NO	NO	BBK
	7440-47-3	Chromium	6.9E+00	2.4E+01 K	MG/KG	CAA06-SB23-1112	6/6	0.57 - 1	2.4E+01	3.4E+01	NO	2.9E-01	C	YES	5.9E-04	YES	NO	BBK
	7440-48-4	Cobalt	2.5E+00	3.2E+00	MG/KG	CAA06-SB24-1112, CAA06-SB25-1112	6/6	0.57 - 1	3.2E+00	5.2E+00	NO	2.3E+00	N	YES	2.1E-01	YES	NO	BBK
	7440-50-8	Copper	1.7E+00 J	3.1E+00	MG/KG	CAA06-SB21-1112	6/6	1.4 - 2.6	3.1E+00	3.2E+00	NO	3.1E+02	N	NO	2.2E+01	NO	NO	BBK
	7439-89-6	Iron	4.5E+03	1.8E+04	MG/KG	CAA06-SB23-1112	6/6	5.7 - 10	1.8E+04	3.2E+04	NO	5.5E+03	N	YES	2.7E+02	YES	NO	BBK
	7439-92-1	Lead	7.1E+00	1.4E+01	MG/KG	CAA06-SB21-1112	6/6	0.28 - 0.52	1.4E+01	8.8E+00	YES	4.0E+02	NL	NO	N/A	NO	NO	BRSL
	7439-95-4	Magnesium	5.3E+02	1.1E+03 K	MG/KG	CAA06-SB23-1112	6/6	5.7 - 10	1.1E+03	1.1E+03	NO	N/A	NUT	N/A	NUT	NO	NO	BBK
	7439-96-5	Manganese	3.3E+01 K	9.4E+01	MG/KG	CAA06-SB22-1112	6/6	0.28 - 0.52	9.4E+01	1.8E+02	NO	1.8E+02	N	NO	2.1E+01	YES	NO	BBK
	7439-97-6	Mercury	2.0E-02 J	3.0E-02	MG/KG	CAA06-SB23-1112	6/6	0.028 - 0.035	3.0E-02	1.4E-01	NO	2.3E+00	N	NO	3.3E-02	NO	NO	BBK
	7440-02-0	Nickel	3.8E+00	4.9E+00	MG/KG	CAA06-SB21P-1112	6/6	0.57 - 1	4.9E+00	1.8E+01	NO	1.5E+02	N	NO	2.0E+01	NO	NO	BBK
	7440-09-7	Potassium	4.1E+02	1.1E+03 K	MG/KG	CAA06-SB23-1112	6/6	57 - 100	1.1E+03	9.0E+02	YES	N/A	NUT	N/A	NUT	NUT	NUT	NUT
	7782-49-2	Selenium	3.2E-01 J	5.9E-01	MG/KG	CAA06-SB24-1112	6/6	0.28 - 0.52	5.9E-01	6.4E-01	NO	3.9E+01	N	NO	4.0E-01	YES	NO	BBK
	7440-23-5	Sodium	3.2E+01 J	3.2E+01 J	MG/KG	CAA06-SB23-1112	1/6	57 - 100	3.2E+01	8.1E+02	NO	N/A	NUT	N/A	NUT	NO	NO	BBK
	<b>7440-28-0</b>	<b>Thallium</b>	<b>1.0E-01</b>	<b>1.8E-01</b>	<b>MG/KG</b>	<b>CAA06-SB23-1112</b>	<b>6/6</b>	<b>0.057 - 0.1</b>	<b>1.8E-01</b>	<b>ND</b>	<b>YES</b>	<b>7.8E-02</b>	<b>N</b>	<b>YES</b>	<b>1.1E-02</b>	<b>YES</b>	<b>YES</b>	<b>ABK, ARSL, ASSL</b>
7440-62-2	Vanadium	1.0E+01	3.2E+01	MG/KG	CAA06-SB23-1112	6/6	0.57 - 1	3.2E+01	4.8E+01	NO	3.9E+01	N	NO	7.8E+01	NO	NO	BBK	
7440-66-6	Zinc	1.3E+01	3.8E+01	MG/KG	CAA06-SB21-1112	6/6	1.1 - 2.1	3.8E+01	2.8E+01	YES	2.3E+03	N	NO	2.9E+02	NO	NO	BRSL, BSSL	

Table 2.2  
 OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
 Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future Medium: Subsurface Soil Exposure Medium: Subsurface Soil
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Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Screening [3] Background [4] Value	COPC Flag	Regional [3] Screening [5] Level	COPC Flag	Soil [3] Screening [6] Level	COPC Flag	Rationale for [7] Contaminant Deletion or Selection
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- |  |   |
|--|---|
| <p>[1] Minimum/Maximum detected concentrations.</p> <p>[2] Maximum concentration is used for screening.</p> <p>[3] Screening Steps: The maximum concentrations were compared to background concentrations. If exceedances, the maximum concentrations were then compared to adjusted residential soil RSL and SSL for protection of groundwater.</p> <p>[4] Background values from Cheatham Annex/Yorktown background subsurface soil samples; values represent the 95% UTL.</p> <p>[5] Oak Ridge National Laboratory (ORNL). November, 2012. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Residential Soil RSL (based on 10<sup>-6</sup> for carcinogens and adjusted to HQ of 0.1 for noncarcinogens). Available Online: <a href="http://epa-prgs.ornl.gov/chemicals/index.shtml">http://epa-prgs.ornl.gov/chemicals/index.shtml</a></p> <p>[6] Oak Ridge National Laboratory (ORNL). November, 2012. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Risk-based SSLs (based on 10<sup>-6</sup> for carcinogens and HQ of 1 for noncarcinogens). Available Online: <a href="http://epa-prgs.ornl.gov/chemicals/index.shtml">http://epa-prgs.ornl.gov/chemicals/index.shtml</a><br/>         RSL value for chromium(VI) used for chromium.<br/>         The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.<br/>         RSL value for mercuric chloride (and other mercury salts) used for mercury.</p> <p>[7] Rationale Codes</p> <p style="margin-left: 40px;">Selection Reason:</p> <ul style="list-style-type: none"> <li>Above Residential Soil Screening Level (ARSL)</li> <li>Above Soil Screening Level for Protection of Groundwater (ASSL)</li> <li>Above Background (ABK)</li> </ul> <p style="margin-left: 40px;">Deletion Reason:</p> <ul style="list-style-type: none"> <li>Below Background (BBK)</li> <li>Below Residential Soil Screening Level (BRSL)</li> <li>Below Soil Screening Level for Protection of Groundwater (BSSL)</li> <li>Essential Nutrient (NUT)</li> </ul> | <p>COPC = Chemical of Potential Concern<br/>         J = Estimated Value<br/>         K = Biased High<br/>         L = Biased Low<br/>         C = Carcinogenic<br/>         C* = where: N RSL &lt; 100X C SL, Carcinogenic RSL used<br/>         N = Noncarcinogenic<br/>         NL = Noncarcinogenic, however, RSL not adjusted to HQ of 0.1 for lead<br/>         N/A = Not available or Not applicable<br/>         ND = Not detected<br/>         RSL = Regional Screening Level<br/>         SSL = Soil Screening Level<br/>         MG/KG = milligrams per kilogram</p> |
|--|---|

Table 2.2a  
 Step 2 Subsurface Soil Screening - Risk Ratio, Maximum Detected Concentration  
 Cheatham Annex, Williamsburg, Virginia

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier) (mg/kg)	Sample Location of Maximum Detected Concentration	Residential Soil RSL (mg/kg)	Acceptable Risk Level	Corresponding Hazard Index <sup>a</sup>	Corresponding Cancer Risk <sup>b</sup>	Target Organ
Aluminum	6 / 6	1.6E+04	CAA06-SB23-1112	7.7E+04	1	0.2	NA	Developmental, Neurological
Thallium	6 / 6	1.8E-01	CAA06-SB23-1112	7.8E-01	1	0.2	NA	Hair
<b>Cumulative Corresponding Hazard Index<sup>c</sup></b>						<b>0.4</b>		
<b>Cumulative Corresponding Cancer Risk<sup>d</sup></b>							<b>0E+00</b>	
							Total Developmental HI =	0.2
							Total Neurological HI =	0.2
							Total Hair HI =	0.2

**Notes:**

<sup>a</sup> Corresponding Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

<sup>b</sup> Corresponding Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

<sup>c</sup> Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

<sup>d</sup> Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern

HI = Hazard Index

mg/kg = milligrams per kilogram

NA = Not available/not applicable

CTO-056  
Cheatham Annex  
Validated AOC Waste Slag Surface Soil Exceeds Analytical Data  
November 2012

Station ID Sample ID Sample Date	CLEAN CAX 95% UTL BKG SS	CLEAN RSLs Residential Soil Adjusted 0512	CLEAN RSLs Risk- Based SSLs 0512	Ecological Soil Screening Value (ESV)	CAA06-SO20	CAA06-SO21		CAA06-SO22	CAA06-SO23	CAA06-SO24	CAA06-SO25
					CAA06-SS20-1112	CAA06-SS21-1112	CAA06-SS21P-1112	CAA06-SS22-1112	CAA06-SS23-1112	CAA06-SS24-1112	CAA06-SS25-1112
					11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12
<b>Chemical Name</b>											
<b>Total Metals (MG/KG)</b>											
Aluminum	12,200	7,700	23,000	pH < 5.5	<b>7,550</b>	<b>7,420</b>	<b>6,340</b>	<b>8,990</b>	<b>8,640</b>	<b>7,200</b>	<b>14,900</b>
Arsenic	6.36	0.39	0.0013	18	<b>3.2</b>	<b>4</b>	<b>3.5</b>	<b>2.7</b>	<b>3</b>	<b>4.5</b>	<b>4</b>
Barium	52.9	1,500	120	330	<b>39.6</b>	<b>51.3</b>	<b>45.3</b>	<b>48.1</b>	<b>33.1</b>	<b>64.8</b>	<b>62.2</b>
Beryllium	0.587	16	13	40	<b>0.48</b>	<b>0.57</b>	<b>0.49</b>	<b>0.61</b>	<b>0.35 J</b>	<b>0.57 J</b>	<b>0.51 J</b>
Cadmium <sup>1</sup>	1.5	7	0.52	32	0.05 B	<b>0.35 J</b>	<b>0.26 J</b>	0.05 B	0.03 B	<b>0.14 J</b>	0.33 U
Calcium	2,290	--	--	--	<b>874</b>	<b>1,650</b>	<b>1,740</b>	<b>1,400</b>	<b>1,460</b>	<b>4,670</b>	<b>1,220</b>
Chromium	18.2	0.29	5.90E-04	64	<b>10</b>	<b>7.8</b>	<b>6.8</b>	<b>9.5</b>	<b>11.6</b>	<b>8</b>	<b>20.6</b>
Cobalt	9.93	2.3	0.21	13	<b>3</b>	<b>3.1</b>	<b>2.7</b>	<b>3.2</b>	<b>1.8</b>	<b>2.9</b>	<b>3.4</b>
Copper	4.25	310	22	70	<b>18.3</b>	<b>18.5</b>	<b>18</b>	<b>7.1</b>	<b>4.2</b>	<b>9.6</b>	<b>10.8</b>
Iron	19,900	5,500	270	pH<5 or >8	<b>10,000</b>	<b>7,250</b>	<b>5,580</b>	<b>6,960</b>	<b>9,510</b>	<b>5,450</b>	<b>14,000</b>
Lead	17.4	400	--	120	<b>69.5</b>	<b>77</b>	<b>62.4</b>	<b>44.3</b>	<b>52.8</b>	<b>47.3</b>	<b>13</b>
Magnesium	1,070	--	--	--	<b>588</b>	<b>705</b>	<b>577</b>	<b>719</b>	<b>766 K</b>	<b>744</b>	<b>1,020</b>
Manganese	324	180	21	220	<b>93.6</b>	<b>142</b>	<b>124</b>	<b>158</b>	<b>55.2</b>	<b>298</b>	<b>69.9</b>
Mercury	0.111	2.3	0.033	0.1	<b>0.04</b>	<b>0.04</b>	<b>0.04</b>	<b>0.03 J</b>	<b>0.06</b>	<b>0.1</b>	<b>0.03 J</b>
Nickel	9.52	150	20	38	<b>5</b>	<b>5.2</b>	<b>4.6</b>	<b>5.1</b>	<b>3.8</b>	<b>6</b>	<b>6.1</b>
Potassium	708	--	--	--	<b>498</b>	<b>542</b>	<b>446</b>	<b>739</b>	<b>792 K</b>	<b>609</b>	<b>1,060</b>
Selenium	0.51	39	0.4	0.52	<b>0.49</b>	<b>0.67</b>	<b>0.55</b>	<b>0.57</b>	<b>0.51 L</b>	<b>0.62 J</b>	0.49 B
Sodium	521	--	--	--	22.6 B	24.8 B	22.6 B	31.9 B	23.2 B	<b>33.7 J</b>	<b>48 J</b>
Thallium	--	0.078	0.011	1	<b>0.1</b>	<b>0.17</b>	<b>0.15</b>	<b>0.11</b>	<b>0.22</b>	<b>0.12 J</b>	<b>0.16</b>
Vanadium	27.9	39	78	130	<b>13</b>	<b>12.5</b>	<b>11</b>	<b>14.2</b>	<b>16.7</b>	<b>13.9</b>	<b>29.4</b>
Zinc	26.5	2,300	290	120	<b>34.6</b>	<b>105</b>	<b>73.5</b>	<b>23.2</b>	<b>20.2</b>	<b>36.2</b>	<b>21.1</b>
<b>Wet Chemistry</b>											
pH (ph)	--	--	--	--	<b>6.3</b>	<b>6.2</b>	NA	<b>6.5</b>	<b>5.9</b>	<b>6.6</b>	<b>5.9</b>

C:\Users\invester\Desktop\Waste Slag TM\Attachments\Attachment B - AOC 6 slag pile Table 2s.xlsx, scamus, 12/13/2012

**Notes:**

<sup>1</sup>CLEAN CAX 95% UTL BKG SS some of the values are not included in the 95% UTL criteria. The maximum background values are shown because a 95% UTL was not calculated for this analyte.

Exceeds Background
Exceeds BKG & ECO
Exceeds BKG & Res RSL
Exceeds BKG, ECO & Res RSL
Exceeds BKG, RSL, & SSL

**Bold indicates detections**

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

K - Analyte present, value may be biased high, actual value may be lower

L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

UL - Analyte not detected, quantitation limit is probably higher

MG/KG - Milligrams per kilogram

PH - pH units

CTO-056  
 Cheatham Annex  
 Validated AOC 6 Waste Slag Subsurface Soil Exceeds Analytical Data  
 November 2012

Station ID Sample ID Sample Date	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted 0512	CLEAN RSLs Risk- Based SSLs 0512	Ecological Soil Screening Value (ESV)	CAA06-SO20	CAA06-SO21		CAA06-SO22	CAA06-SO23	CAA06-SO24	CAA06-SO25
					CAA06-SB20-1112	CAA06-SB21-1112	CAA06-SB21P-1112	CAA06-SB22-1112	CAA06-SB23-1112	CAA06-SB24-1112	CAA06-SB25-1112
					11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12
<b>Chemical Name</b>											
<b>Total Metals (MG/KG)</b>											
Aluminum	13,000	7,700	23,000	pH < 5.5	<b>6,840</b>	<b>6,880</b>	<b>12,400</b>	<b>7,250</b>	<b>16,100</b>	<b>8,890</b>	<b>7,470</b>
Arsenic	5.54	0.39	0.0013	18	<b>2.3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>4.3</b>	<b>2.4</b>	<b>2.3</b>
Barium	84.5	1,500	120	330	<b>32.6</b>	<b>39.4</b>	<b>48.6</b>	<b>38.7</b>	<b>44.3</b>	<b>37.1</b>	<b>42.7</b>
Beryllium <sup>1</sup>	0.52	16	13	40	<b>0.5</b>	<b>0.46</b>	<b>0.38 J</b>	<b>0.5</b>	<b>0.5 J</b>	<b>0.5 J</b>	<b>0.5</b>
Cadmium	--	7	0.52	32	0.01 B	<b>0.07 J</b>	0.28 U	0.02 B	0.31 U	0.02 B	0.02 B
Calcium	2,380	--	--	--	<b>206</b>	<b>441</b>	<b>502</b>	<b>482</b>	<b>839 L</b>	<b>602</b>	<b>602</b>
Chromium	33.7	0.29	5.90E-04	64	<b>7.2</b>	<b>7.3</b>	<b>14.4</b>	<b>6.9</b>	<b>24.4 K</b>	<b>9</b>	<b>7.9</b>
Cobalt	5.18	2.3	0.21	13	<b>2.8</b>	<b>2.8</b>	<b>2.2</b>	<b>3.1</b>	<b>2.5</b>	<b>3.2</b>	<b>3.2</b>
Copper	3.17	310	22	70	<b>2.5</b>	<b>3.1</b>	<b>2.3</b>	<b>1.9</b>	<b>1.7 J</b>	<b>2.4 J</b>	<b>2.7</b>
Iron	32,000	5,500	270	pH<5 or >8	<b>5,490</b>	<b>5,090</b>	<b>10,500</b>	<b>4,500</b>	<b>17,600</b>	<b>5,980</b>	<b>5,740</b>
Lead	8.79	400	--	120	<b>9</b>	<b>14.4</b>	<b>7.5</b>	<b>7.1</b>	<b>8.9</b>	<b>9.4</b>	<b>9.2</b>
Magnesium	1,120	--	--	--	<b>533</b>	<b>617</b>	<b>912</b>	<b>570</b>	<b>1,080 K</b>	<b>744</b>	<b>609</b>
Manganese	176	180	21	220	<b>87.1</b>	<b>77.2</b>	<b>51.7</b>	<b>94</b>	<b>33.2 K</b>	<b>82.8</b>	<b>83.3</b>
Mercury <sup>1</sup>	0.14	2.3	0.033	0.1	<b>0.02 J</b>	<b>0.02 J</b>	<b>0.02 J</b>	<b>0.02 J</b>	<b>0.03</b>	<b>0.02 J</b>	<b>0.02 J</b>
Nickel	17.6	150	20	38	<b>3.8</b>	<b>4.1</b>	<b>4.9</b>	<b>4.3</b>	<b>4.6</b>	<b>4.6</b>	<b>4</b>
Potassium	901	--	--	--	<b>408</b>	<b>456</b>	<b>710</b>	<b>466</b>	<b>1,110 K</b>	<b>587</b>	<b>416</b>
Selenium <sup>1</sup>	0.64	39	0.4	0.52	<b>0.53</b>	<b>0.44</b>	<b>0.29 J</b>	<b>0.54</b>	<b>0.32 J</b>	<b>0.59</b>	<b>0.55</b>
Sodium	811	--	--	--	15.1 B	17.1 B	24.1 B	18 B	32.3 J	30.4 B	22.2 B
Thallium	--	0.078	0.011	1	<b>0.1</b>	<b>0.12</b>	<b>0.15</b>	<b>0.1</b>	<b>0.18</b>	<b>0.12</b>	<b>0.1</b>
Vanadium	48.3	39	78	130	<b>10.2</b>	<b>10.7</b>	<b>23.4</b>	<b>10.5</b>	<b>31.5</b>	<b>13.6</b>	<b>11.8</b>
Zinc	28	2,300	290	120	<b>13.1</b>	<b>37.7</b>	<b>18.3</b>	<b>14</b>	<b>17.6</b>	<b>15.8</b>	<b>13.4</b>
<b>Wet Chemistry</b>											
pH (ph)	--	--	--	--	<b>5.1</b>	<b>6</b>	NA	<b>6.8</b>	<b>5</b>	<b>5.9</b>	<b>6.1</b>

#REF!

**Notes:**

<sup>1</sup>CLEAN CAX 95% UTL BKG SS, some of the values are not included in the 95% UTL criteria. The maximum background values are shown because a 95% UTL was not calculated for this analyte.

Exceeds Background
Exceeds BKG & ECO
Exceeds BKG & Res RSL
Exceeds BKG, ECO & Res RSL
Exceeds BKG, RSL, & SSL

**Bold indicates detections**

- NA - Not analyzed
- B - Analyte not detected above the level reported in blanks
- J - Analyte present, value may or may not be accurate or precise
- K - Analyte present, value may be biased high, actual value may be lower
- L - Analyte present, value may be biased low, actual value may be higher
- U - The material was analyzed for, but not detected
- UL - Analyte not detected, quantitation limit is probably higher
- MG/KG - Milligrams per kilogram
- PH - pH units

**Attachment C**  
**Ecological Risk Screening Tables**

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Table C-1  
 Ecological Screening Values - Soil  
 AOC 6 Waste Slag Material Subarea  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Screening Value	Units	Reference	Comments
<b>Metals</b>				
Aluminum	pH < 5.5	--	USEPA 2003a	Eco-SSL
Antimony	78.0	mg/kg	USEPA 2005a	Eco-SSL - Invertebrate
Arsenic	18.0	mg/kg	USEPA 2005b	Eco-SSL - Plant
Barium	330	mg/kg	USEPA 2005c	Eco-SSL - Invertebrate
Beryllium	40.0	mg/kg	USEPA 2005d	Eco-SSL - Invertebrate
Cadmium	32.0	mg/kg	USEPA 2005e	Eco-SSL - Plant
Chromium	64.0	mg/kg	CCME 2007	Soil Quality Guideline
Cobalt	13.0	mg/kg	USEPA 2005f	Eco-SSL - Plant
Copper	70.0	mg/kg	USEPA 2007a	Eco-SSL - Plant
Iron	5 < pH > 8	--	USEPA 2003b	Eco-SSL
Lead	120	mg/kg	USEPA 2005g	Eco-SSL - Plant
Manganese	220	mg/kg	USEPA 2007b	Eco-SSL - Plant
Mercury	0.10	mg/kg	Efroymson et al. 1997b	Invertebrate
Nickel	38.0	mg/kg	USEPA 2007c	Eco-SSL - Plant
Selenium	0.52	mg/kg	USEPA 2007d	Eco-SSL - Plant
Silver	560	mg/kg	USEPA 2006	Eco-SSL - Plant
Thallium	1.00	mg/kg	Efroymson et al. 1997a	Plant
Vanadium	130	mg/kg	CCME 2007	Soil Quality Guideline
Zinc	120	mg/kg	USEPA 2007e	Eco-SSL - Invertebrate

**Table C-2**  
**Ecological Screening Statistics - Surface Soil**  
**AOC 6 Waste Slag Material Subarea**  
**Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia**

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL (Norm)	Geometric Mean	Screening Value	Frequency of Exceedance <sup>1</sup>	Maximum Hazard Quotient <sup>2</sup>	95% Background UTL	Frequency of UTL Exceedance	Maximum Ratio to UTL	Initial (Step 2) COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined (Step 3A) COPC?
<b>Inorganics (MG/KG)</b>																			
Aluminum	-- --	6 / 6	7,200	14,900	CAA06-SS25-1112	9,117	2,922	11,521	8,808	pH < 5.5	0 / 6	--	--	-- / --	--	NO	--	--	NO
Antimony	0.13 - 0.68	0 / 6	--	--	--	0.24	0.095	0.32	0.22	78.0	-- / --	0.01	--	-- / --	--	NO	--	--	NO
Arsenic	-- --	6 / 6	2.70	4.50	CAA06-SS24-1112	3.57	0.70	4.14	3.51	18.0	0 / 6	0.25	--	-- / --	--	NO	--	--	NO
Barium	-- --	6 / 6	33.1	64.8	CAA06-SS24-1112	49.9	12.4	60.0	48.5	330	0 / 6	0.20	--	-- / --	--	NO	--	--	NO
Beryllium	-- --	6 / 6	0.35	0.61	CAA06-SS22-1112	0.52	0.093	0.59	0.51	40.0	0 / 6	0.02	--	-- / --	--	NO	--	--	NO
Cadmium	0.03 - 0.33	2 / 6	0.14	0.35	CAA06-SS21-1112	0.12	0.13	0.23	0.065	32.0	0 / 6	0.01	--	-- / --	--	NO	--	--	NO
Calcium <sup>3</sup>	-- --	6 / 6	874	4,670	CAA06-SS24-1112	1,894	1,390	3,037	1,614	NSV	-- / --	NSV	--	-- / --	--	NO	--	--	NO
Chromium	-- --	6 / 6	7.80	20.6	CAA06-SS25-1112	11.3	4.79	15.2	10.6	64.0	0 / 6	0.32	--	-- / --	--	NO	--	--	NO
Cobalt	-- --	6 / 6	1.80	3.40	CAA06-SS25-1112	2.90	0.57	3.37	2.84	13.0	0 / 6	0.26	--	-- / --	--	NO	--	--	NO
Copper	-- --	6 / 6	4.20	18.5	CAA06-SS21-1112	11.4	5.86	16.2	10.1	70.0	0 / 6	0.26	--	-- / --	--	NO	--	--	NO
Iron	-- --	6 / 6	5,450	14,000	CAA06-SS25-1112	8,862	3,032	11,356	8,458	5 < pH > 8	0 / 6	--	--	-- / --	--	NO	--	--	NO
Lead	-- --	6 / 6	13.0	77.0	CAA06-SS21-1112	50.7	22.5	69.1	44.4	120	0 / 6	0.64	--	-- / --	--	NO	--	--	NO
Magnesium <sup>3</sup>	-- --	6 / 6	588	1,020	CAA06-SS25-1112	757	143	875	747	NSV	-- / --	NSV	--	-- / --	--	NO	--	--	NO
Manganese	-- --	6 / 6	55.2	298	CAA06-SS24-1112	136	88.8	209	116	220	1 / 6	1.35	324	0 / 6	0.92	NO	--	--	NO
Mercury	-- --	6 / 6	0.030	0.10	CAA06-SS24-1112	0.050	0.027	0.072	0.045	0.10	1 / 6	1.00	0.111	0 / 6	0.90	NO	--	--	NO
Nickel	-- --	6 / 6	3.80	6.10	CAA06-SS25-1112	5.20	0.83	5.88	5.14	38.0	0 / 6	0.16	--	-- / --	--	NO	--	--	NO
Potassium <sup>3</sup>	-- --	6 / 6	498	1,060	CAA06-SS25-1112	707	207	877	684	NSV	-- / --	NSV	--	-- / --	--	NO	--	--	NO
Selenium	0.49 - 0.49	5 / 6	0.49	0.67	CAA06-SS21-1112	0.52	0.15	0.64	0.49	0.52	3 / 6	1.29	0.51	4 / 6	1.31	YES	1.23	0.995	NO
Silver	0.04 - 0.54	0 / 6	--	--	--	0.077	0.096	0.16	0.049	560	-- / --	0.001	--	-- / --	--	NO	--	--	NO
Sodium <sup>3</sup>	22.6 - 31.9	2 / 6	33.7	48.0	CAA06-SS25-1112	22.2	15.3	34.7	18.6	NSV	-- / --	NSV	--	-- / --	--	NO	--	--	NO
Thallium	-- --	6 / 6	0.10	0.22	CAA06-SS23-1112	0.15	0.045	0.18	0.14	1.00	0 / 6	0.22	--	-- / --	--	NO	--	--	NO
Vanadium	-- --	6 / 6	12.5	29.4	CAA06-SS25-1112	16.6	6.43	21.9	15.8	130	0 / 6	0.23	--	-- / --	--	NO	--	--	NO
Zinc	-- --	6 / 6	20.2	105	CAA06-SS21-1112	40.1	32.6	66.8	33.0	120	0 / 6	0.88	--	-- / --	--	NO	--	--	NO
<b>Other Parameters</b>																			
pH	-- --	6 / 6	5.90	6.60	CAA06-SS24-1112	6.23	0.29	6.48	6.23	--	-- / --	--	--	-- / --	--	--	--	--	--

NSV - No Screening Value  
1 - Count of detected samples exceeding or equaling Screening Value  
2 - Shaded cells indicate hazard quotient based on reporting limits  
3 - Macronutrient - Not considered to be a COPC

Table C-3 Ecological Surface Soil Screening - Exceedances AOC 6 Waste Slag Material Subarea Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia									
Chemical	Ecological Soil Screening Value	Background UTL	CAA06-SO20	CAA06-SO21		CAA06-SO22	CAA06-SO23	CAA06-SO24	CAA06-SO25
			CAA06-SS20-1112	CAA06-SS21-1112	CAA06-SS21P-1112	CAA06-SS22-1112	CAA06-SS23-1112	CAA06-SS24-1112	CAA06-SS25-1112
			11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12
<b>Inorganics (MG/KG)</b>									
Aluminum	pH < 5.5	12,200	7,550	7,420	6,340	8,990	8,640	7,200	14,900
Arsenic	18.0	6.36	3.20	4.00	3.50	2.70	3.00	4.50	4.00
Barium	330	52.9	39.6	51.3	45.3	48.1	33.1	64.8	62.2
Beryllium	40.0	0.587	0.48	0.57	0.49	0.61	0.35 J	0.57 J	0.51 J
Cadmium	32.0	1.50	0.05 B	0.35 J	0.26 J	0.05 B	0.03 B	0.14 J	0.33 U
Chromium	64.0	18.2	10.0	7.80	6.80	9.50	11.6	8.00	20.6
Cobalt	13.0	9.93	3.00	3.10	2.70	3.20	1.80	2.90	3.40
Copper	70.0	4.25	18.3	18.5	18.0	7.10	4.20	9.60	10.8
Iron	5 < pH > 8	19,900	10,000	7,250	5,580	6,960	9,510	5,450	14,000
Lead	120	17.4	69.5	77.0	62.4	44.3	52.8	47.3	13.0
Manganese	220	324	93.6	142	124	158	55.2	298	69.9
Mercury	0.10	0.111	0.04	0.04	0.04	0.03 J	0.06	0.10	0.03 J
Nickel	38.0	9.52	5.00	5.20	4.60	5.10	3.80	6.00	6.10
Selenium	0.52	0.51	0.49	0.67	0.55	0.57	0.51 L	0.62 J	0.49 B
Thallium	1.00	--	0.10	0.17	0.15	0.11	0.22	0.12 J	0.16
Vanadium	130	27.9	13.0	12.5	11.0	14.2	16.7	13.9	29.4
Zinc	120	26.5	34.6	105	73.5	23.2	20.2	36.2	21.1
<b>Other Parameters</b>									
pH	--	--	6.30	6.20	NA	6.50	5.90	6.60	5.90
<b>Notes:</b>									
Grey highlighting indicates value greater than screening value									
Yellow highlighting indicates value equal to screening value									
Equals or exceeds Background UTL									
Bold indicates detections									
NA - Not analyzed									

Table C-4  
 Ecological Screening Statistics - Subsurface Soil  
 AOC 6 Waste Slag Material Subarea  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL (Norm)	Geometric Mean	Screening Value	Frequency of Exceedance <sup>1</sup>	Maximum Hazard Quotient <sup>2</sup>	95% Background UTL	Frequency of UTL Exceedance	Maximum Ratio to UTL	Initial (Step 2) COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined (Step 3A) COPC?
<b>Inorganics (MG/KG)</b>																			
Aluminum	-- --	6 / 6	6,840	16,100	CAA06-SB23-1112	9,825	3,687	12,858	9,325	pH < 5.5	2 / 6	--	13,000	1 / 6	1.24	YES	mean pH in range		NO
Antimony	0.32 - 0.52	0 / 6	--	--	--	0.22	0.039	0.25	0.22	78.0	-- / --	0.01	--	-- / --	--	NO	--	--	NO
Arsenic	-- --	6 / 6	2.00	4.30	CAA06-SB23-1112	2.72	0.84	3.41	2.63	18.0	0 / 6	0.24	--	-- / --	--	NO	--	--	NO
Barium	-- --	6 / 6	32.6	48.6	CAA06-SB21-1112	40.7	5.69	45.3	40.3	330	0 / 6	0.15	--	-- / --	--	NO	--	--	NO
Beryllium	-- --	6 / 6	0.46	0.50	CAA06-SB20-1112	0.49	0.016	0.51	0.49	40.0	0 / 6	0.01	--	-- / --	--	NO	--	--	NO
Cadmium	0.01 - 0.31	1 / 6	0.070	0.070	CAA06-SB21-1112	0.043	0.060	0.093	0.019	32.0	0 / 6	0.002	--	-- / --	--	NO	--	--	NO
Calcium <sup>3</sup>	-- --	6 / 6	206	839	CAA06-SB23-1112	539	207	709	497	NSV	-- / --	NSV	--	-- / --	--	NO	--	--	NO
Chromium	-- --	6 / 6	6.90	24.4	CAA06-SB23-1112	11.6	6.83	17.3	10.4	64.0	0 / 6	0.38	--	-- / --	--	NO	--	--	NO
Cobalt	-- --	6 / 6	2.50	3.20	CAA06-SB24-1112	2.93	0.28	3.16	2.92	13.0	0 / 6	0.25	--	-- / --	--	NO	--	--	NO
Copper	-- --	6 / 6	1.70	3.10	CAA06-SB21-1112	2.38	0.52	2.81	2.34	70.0	0 / 6	0.04	--	-- / --	--	NO	--	--	NO
Iron	-- --	6 / 6	4,500	17,600	CAA06-SB23-1112	8,302	5,012	12,425	7,343	5 < pH > 8	0 / 6	--	--	-- / --	--	NO	--	--	NO
Lead	-- --	6 / 6	7.10	14.4	CAA06-SB21-1112	9.67	2.46	11.7	9.44	120	0 / 6	0.12	--	-- / --	--	NO	--	--	NO
Magnesium <sup>3</sup>	-- --	6 / 6	533	1,080	CAA06-SB23-1112	741	216	919	717	NSV	-- / --	NSV	--	-- / --	--	NO	--	--	NO
Manganese	-- --	6 / 6	33.2	94.0	CAA06-SB22-1112	76.3	21.8	94.2	72.5	220	0 / 6	0.43	--	-- / --	--	NO	--	--	NO
Mercury	-- --	6 / 6	0.020	0.030	CAA06-SB23-1112	0.022	0.0041	0.025	0.021	0.10	0 / 6	0.30	--	-- / --	--	NO	--	--	NO
Nickel	-- --	6 / 6	3.80	4.90	CAA06-SB21-1112	4.37	0.41	4.71	4.35	38.0	0 / 6	0.13	--	-- / --	--	NO	--	--	NO
Potassium <sup>3</sup>	-- --	6 / 6	408	1,110	CAA06-SB23-1112	616	268	837	576	NSV	-- / --	NSV	--	-- / --	--	NO	--	--	NO
Selenium	-- --	6 / 6	0.32	0.59	CAA06-SB24-1112	0.50	0.099	0.58	0.49	0.52	4 / 6	1.13	0.64	0 / 6	0.92	NO	--	--	NO
Silver	0.26 - 0.42	0 / 6	--	--	--	0.18	0.031	0.20	0.18	560	-- / --	0.001	--	-- / --	--	NO	--	--	NO
Sodium <sup>3</sup>	15.1 - 30.4	1 / 6	32.3	32.3	CAA06-SB23-1112	14.5	9.09	22.0	12.8	NSV	-- / --	NSV	--	-- / --	--	NO	--	--	NO
Thallium	-- --	6 / 6	0.10	0.18	CAA06-SB23-1112	0.13	0.033	0.15	0.12	1.00	0 / 6	0.18	--	-- / --	--	NO	--	--	NO
Vanadium	-- --	6 / 6	10.2	31.5	CAA06-SB23-1112	16.8	8.70	24.0	15.3	130	0 / 6	0.24	--	-- / --	--	NO	--	--	NO
Zinc	-- --	6 / 6	13.1	37.7	CAA06-SB21-1112	18.6	9.51	26.4	17.2	120	0 / 6	0.31	--	-- / --	--	NO	--	--	NO
<b>Other Parameters</b>																			
pH	-- --	6 / 6	5.00	6.80	CAA06-SB22-1112	5.82	0.67	6.37	5.78	--	-- / --	--	--	-- / --	--	--	--	--	--

NSV - No Screening Value  
 1 - Count of detected samples exceeding or equaling Screening Value  
 2 - Shaded cells indicate hazard quotient based on reporting limits  
 3 - Macronutrient - Not considered to be a COPC

Table C-5  
 Ecological Subsurface Soil Screening - Exceedances  
 AOC 6 Waste Slag Material Subarea  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Ecological Soil Screening Value	Background UTL	CAA06-SO20	CAA06-SO21		CAA06-SO22	CAA06-SO23	CAA06-SO24	CAA06-SO25
			CAA06-SB20-1112	CAA06-SB21-1112	CAA06-SB21P-1112	CAA06-SB22-1112	CAA06-SB23-1112	CAA06-SB24-1112	CAA06-SB25-1112
			11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12	11/02/12
<b>Inorganics (MG/KG)</b>									
Aluminum	pH < 5.5	13,000	6,840	6,880	12,400	7,250	16,100	8,890	7,470
Arsenic	18.0	5.54	2.30	2.00	3.00	2.00	4.30	2.40	2.30
Barium	330	84.5	32.6	39.4	48.6	38.7	44.3	37.1	42.7
Beryllium	40.0	0.52	0.50	0.46	0.38 J	0.50	0.50 J	0.50 J	0.50
Cadmium	32.0	--	0.01 B	0.07 J	0.28 U	0.02 B	0.31 U	0.02 B	0.02 B
Chromium	64.0	33.7	7.20	7.30	14.4	6.90	24.4 K	9.00	7.90
Cobalt	13.0	5.18	2.80	2.80	2.20	3.10	2.50	3.20	3.20
Copper	70.0	3.17	2.50	3.10	2.30	1.90	1.70 J	2.40 J	2.70
Iron	5 < pH > 8	32,000	5,490	5,090	10,500	4,500	17,600	5,980	5,740
Lead	120	8.79	9.00	14.4	7.50	7.10	8.90	9.40	9.20
Manganese	220	176	87.1	77.2	51.7	94.0	33.2 K	82.8	83.3
Mercury	0.10	0.14	0.02 J	0.02 J	0.02 J	0.02 J	0.03	0.02 J	0.02 J
Nickel	38.0	17.6	3.80	4.10	4.90	4.30	4.60	4.60	4.00
Selenium	0.52	0.64	0.53	0.44	0.29 J	0.54	0.32 J	0.59	0.55
Thallium	1.00	--	0.10	0.12	0.15	0.10	0.18	0.12	0.10
Vanadium	130	48.3	10.2	10.7	23.4	10.5	31.5	13.6	11.8
Zinc	120	28.0	13.1	37.7	18.3	14.0	17.6	15.8	13.4
<b>Other Parameters</b>									
pH	--	--	5.10	6.00	NA	6.80	5.00	5.90	6.10

Notes:  
 Grey highlighting indicates value greater than screening value  
 Yellow highlighting indicates value equal to screening value  
 Equals or exceeds Background UTL  
 Bold indicates detections  
 NA - Not analyzed

## Responses to Comments

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**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION III  
1650 Arch Street  
Philadelphia, Pennsylvania 19103-2029**

April 16, 2013

Mr. Scott Park  
NAVFAC MIDLANT, Building N-26, Room 3208  
Attention: Code OPHE3, Mr. Scott Park  
9742 Maryland Avenue  
Norfolk, VA 23511-3095

Subject: Draft No Action Technical Memorandum for Soil and Groundwater at the Waste Slag Subarea of AOC 6; Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia, February 2013

Mr. Park:

Thank you for the opportunity to review the subject document. EPA would like to provide the following comments at this time.

1. On page 1, the Technical Memorandum (TM) states that soil and groundwater were the only media evaluated in this TM. There are no groundwater data contained in this document. According to the text on page 4, groundwater flow is locally controlled by topography, with discharge to nearby surface water bodies and a primary flow direction toward the York River. Based on this text, it is not clear why groundwater from this waste slag pile does not go toward King Creek (375 feet to the south) or to Penniman Lake which is between the waste slag pile and the York River. If these connections exist, then surface water and sediment would be associated with this site for all three water bodies.
2. Table 1 on page 2 of the TM shows contaminant concentrations that exceed USEPA Region 3 RBCs for residential soil from the 1999 SI. This table also needs to show contaminant concentrations exceeding USEPA Region 3 BTAG screening values. Based on the data in Table 1, concentrations of arsenic, lead, and manganese exceed the ecological soil screening values listed in Table 2. This information needs to be adequately discussed in the report.
3. On page 4, the TM states that five surface and five subsurface soil samples were collected from the perimeter of the waste slag pile. In addition, one surface and subsurface soil sample was collected from underneath the waste slag material. The section further states

that based on the size of the waste slag pile (25 feet by 20 feet by 1.5 feet), six surface and six subsurface soil samples are adequate to determine if metals attributed to the waste slag pile have leached to soil. Because contamination is more likely to occur underneath the slag pile, it is unclear that one sample underneath the pile is sufficient to determine if metals have leached into the soils. BTAG had commented on the Sampling and Analysis Plan that the collection of one sample within the pile was insufficient since the distribution of contaminants was unknown, and if concentrations are heterogeneous, there was a high potential for a false negative (low metal concentrations detected even though concentrations are high within the pile). BTAG had recommended a minimum of three soil samples be collected from underneath the pile.

4. On page 9, the TM provides an ecological risk screening to evaluate potential ecological risk to soils. It is unclear why the historical sample location collected as part of the 1999 SI was not evaluated as part of this evaluation. While the exact location is unknown, based on the SI, the sample was a soil sample. Unless sufficient justification can be provided on why this sample from the SI is invalid, this soil sample should be evaluated as part of the ecological risk screening. Of particular concern is the lead concentration (2,600 milligrams per kilogram [mg/kg]), which is above the ecological soil screening levels for both plants (120 mg/kg) and soil invertebrates (1,700 mg/kg), and the manganese concentration (2,070 mg/kg), which is above the ecological soil screening levels for both plants (220 mg/kg) and soil invertebrates (450 mg/kg).
5. On page 10, the TM presents the ecological risk screening results. The text indicates that mean HQs were used to evaluate risk to plants and soil invertebrates. Because these ecological receptor groups have no or minimal movement, evaluating maximum HQ values are appropriate. Please provide the maximum HQ values.
6. On page 10, the TM states that selenium exceeded the ecological screening value for soil organisms (0.52 mg/kg) in 3 of 6 samples at a maximum hazard quotient of 1.29. The mean hazard quotient for selenium was slightly less than one. The soil organism screening value, however, is based on potential impacts to plants. The section further states that the site is heavily vegetated with no sign of stress to plants. The lack of stressed vegetation is not relevant information as this conclusion does not consider differential sensitivity of plant species and potential impacts to the plant community. The statement on the lack of stressed vegetation should be removed from this section as the discussion on selenium at background levels is sufficient justification to eliminate selenium as a contaminant of potential concern.
7. On page 11, Under Subsurface Soil, for aluminum, the text states "...the mean pH at the site...was within the pH range defining no adverse effects...." As previously indicated, maximum exposure scenarios must be evaluated. The ecological risk from aluminum at sample Station ID SO23 with a pH of 5 does not support eliminating aluminum as a refined COPC since the pH is below 5.5. According to Figure 3, SO23 is outside the approximate slag pile boundary. This raises questions about the slag pile boundary location, especially as the text indicated that surface water flow was away from Garrison

Road which would mean towards SO23. This suggests additional samples around the boundary as shown on Figure 3 may be needed.

8. On page 11, the TM states that one surface and subsurface soil sample was collected from underneath the waste slag material; therefore, the results of the sampling will also be used as pre-waste slag removal characterization samples. On page 12, the TM further states that since there is no unacceptable human health or ecological risks associated with the soil at the site, no additional soil removal or soil sampling will be required following removal of the waste slag pile. One sample is insufficient to characterize contamination underneath the waste slag material. In addition, the sample from the 1999 SI suggests there is potential ecological risk at the site. Additional samples should be collected underneath the pile once the waste slag pile is removed to ensure the area underneath the pile does not pose unacceptable ecological risk.

If you have any questions, please contact me at 215-814-3394.

Sincerely,



Susanne Haug, P.E.  
NPL/BRAC Federal Facilities Branch

cc: Wade Smith, VDEQ

# Response to Comments

## No Action Technical Memorandum for Soil and Groundwater at the Waste Slag Subarea of AOC 6

Naval Weapons Station Yorktown Cheatham Annex

Williamsburg, VA

May 16, 2013

Comments received by email on April 16, 2013 from Susanne Haug, Environmental Protection Agency, Region 3.

*EPA Comment 1: On page 1, the Technical Memorandum (TM) states that soil and groundwater were the only media evaluated in this TM. There are no groundwater data contained in this document. According to the text on page 4, groundwater flow is locally controlled by topography, with discharge to nearby surface water bodies and a primary flow direction toward the York River. Based on this text, it is not clear why groundwater from this waste slag pile does not go toward King Creek (375 feet to the south) or to Penniman Lake which is between the waste slag pile and the York River. If these connections exist, then surface water and sediment would be associated with this site for all three water bodies.*

Navy Response: While no groundwater samples were collected as part of this investigation, an evaluation of the potential for the detected metals concentrations to leach into groundwater at concentrations that may pose potential risk was conducted in the Technical Memorandum (TM). The results of this evaluation did not identify any potential risks to groundwater; therefore, further evaluation (e.g., groundwater sampling) is not warranted.

The text the EPA is referring to on Page 4 of the TM is a description of the characteristics of the Yorktown-Eastover aquifer in general. The final sentence of this paragraph discusses the site-specific Waste Slag subarea groundwater characteristics. However, a description of the site-specific anticipated groundwater flow direction (anticipated to be towards King Creek) was omitted. The TM was revised to include this information.

*EPA Comment 2: Table 1 on page 2 of the TM shows contaminant concentrations that exceed USEPA Region 3 RBCs for residential soil from the 1999 SI. This table also needs to show contaminant concentrations exceeding USEPA Region 3 BTAG screening values. Based on the data in Table 1, concentrations of arsenic, lead, and manganese exceed the ecological soil screening values listed in Table 2. This information needs to be adequately discussed in the report.*

Navy Response: Table 1 presents a summary of what occurred during the 1999 SI. The SI did not compare the data from sample (PEN1-SO-07) to USEPA Region 3 BTAG screening values, thus Table 1 only shows those constituents that exceeded the Region 3 RBCs. It is believed that the 1999 SI sample PEN1-SO-07 was collected from the slag material itself; therefore, since the waste slag pile will be removed, it is not appropriate to evaluate the results from this 1999 SI sample in the TM as an impacted medium. While the text of the 1999 SI specified that all waste source samples were “soil,” the only mention of the possibility that this sample is actually soil is in the introduction (Section 1.0) of the report. It is likely that the 1999 SI used the term “soil” to indicate that the slag sample was a solid matrix for laboratory analysis. Other sections of the report that specifically mention the 1999 SI sample PEN1-SO-07 lead the reader to believe this sample is of the waste slag material itself, as outlined below:

- Summary (Section 7.0) of the 1999 SI Report – This summary states that the slag material is contaminated with antimony, arsenic, chromium, lead, and manganese. The concentrations at

which some of these contaminants were detected may pose a significant threat to persons exposed to this slag material, and may contribute to the migration of contaminants off-site, since this slag material is wide-spread and uncontained. It should be noted that the majority of this slag material consists of intact, relatively hard rock-like material. The potential for this material to migrate as particulates is relatively low; however, it may be possible that contaminants are leaching from this slag material and impacting large areas of the site. It was recommended that this material be investigated further, to include a TCLP sample for metals, as well as a soil sample [infers that no soil sample was previously collected] from the overland flow path of surface water runoff from a portion of this slag material. This type of sampling would be useful in order to fully evaluate the potential threat posed by this material.

- Attachment 1 (Sample Summary Log) – This attachment includes the location and objective of all samples collected during the 1999 SI. The Waste Slag Source Material sample is identified as “a solid waste sample collected from the slag material located near sample PEN1-SO-06 to characterize the types and concentrations of hazardous substances present on site.”

Based on the specific references to the waste slag material outlined above, it is believed that the introduction of the 1999 SI report was written to provide a general reference to the sampling activities conducted as part of the 1999 SI, and the mention of all soil samples being analyzed for the various constituent groups is only applicable to the PEN1-SO-07 sample in the context that it was a solid analytical matrix. The reference to the SI text stating that all waste source samples were soil (Page 2) was removed from the TM.

*EPA Comment 3: On page 4, the TM states that five surface and five subsurface soil samples were collected from the perimeter of the waste slag pile. In addition, one surface and subsurface soil sample was collected from underneath the waste slag material. The section further states that based on the size of the waste slag pile (25 feet by 20 feet by 1.5 feet), six surface and six subsurface soil samples are adequate to determine if metals attributed to the waste slag pile have leached to soil. Because contamination is more likely to occur underneath the slag pile, it is unclear that one sample underneath the pile is sufficient to determine if metals have leached into the soils. BTAG had commented on the Sampling and Analysis Plan that the collection of one sample within the pile was insufficient since the distribution of contaminants was unknown, and if concentrations are heterogeneous, there was a high potential for a false negative (low metal concentrations detected even though concentrations are high within the pile). BTAG had recommended a minimum of three soil samples be collected from underneath the pile.*

Navy Response: The CAX Partnering Team discussed BTAG’s recommendation to collect a minimum of three soil samples from underneath the pile. The Team came to an agreement to collect soil samples from five evenly distributed locations around the pile and one location underneath the pile. Since contamination from the waste slag pile is more likely to occur beneath the pile itself, all instances where it states that no additional soil removal or soil sampling will be required following removal of the waste slag pile were removed from the TM. The details of any proposed further soil removal or soil sampling (post-removal samples) will be presented under a separate cover (along with the waste slag pile removal activities).

*EPA Comment 4: On page 9, the TM provides an ecological risk screening to evaluate potential ecological risk to soils. It is unclear why the historical sample location collected as part of the 1999 SI was not evaluated as part of this evaluation. While the exact location is unknown, based on the SI, the sample was a soil sample. Unless sufficient justification can be provided on why this sample from the SI is invalid, this soil sample should be evaluated as part of the ecological risk screening. Of particular concern is the*

*lead concentration (2,600 milligrams per kilogram [mg/kg]), which is above the ecological soil screening levels for both plants (120 mg/kg) and soil invertebrates (1,700 mg/kg), and the manganese concentration (2,070 mg/kg), which is above the ecological soil screening levels for both plants (220 mg/kg) and soil invertebrates (450 mg/kg).*

Navy Response: For the reasons outlined in the response to EPA Comment 2 (above), it is believed that the 1999 SI sample was actually slag material and not soil. Therefore, since the waste slag material at AOC 6 will be removed from the site (the details to be presented under a separate cover), it is not appropriate to include the 1999 SI results in the ecological risk screening. No additional changes (other than outlined in the response to EPA Comment 2) were made to the TM.

*EPA Comment 5: On page 10, the TM presents the ecological risk screening results. The text indicates that mean HQs were used to evaluate risk to plants and soil invertebrates. Because these ecological receptor groups have no or minimal movement, evaluating maximum HQ values are appropriate. Please provide the maximum HQ values.*

Navy Response: Maximum HQ values are shown in Tables C-2 (surface soil) and C-4 (subsurface soil) and were used when selecting the initial COPCs, as discussed in the text (Attachment C of the TM).

*EPA Comment 6: On page 10, the TM states that selenium exceeded the ecological screening value for soil organisms (0.52 mg/kg) in 3 of 6 samples at a maximum hazard quotient of 1.29. The mean hazard quotient for selenium was slightly less than one. The soil organism screening value, however, is based on potential impacts to plants. The section further states that the site is heavily vegetated with no sign of stress to plants. The lack of stressed vegetation is not relevant information as this conclusion does not consider differential sensitivity of plant species and potential impacts to the plant community. The statement on the lack of stressed vegetation should be removed from this section as the discussion on selenium at background levels is sufficient justification to eliminate selenium as a contaminant of potential concern.*

Navy Response: The third, fourth, and fifth sentences from this bulleted paragraph were removed from the document.

*EPA Comment 7: On page 11, Under Subsurface Soil, for aluminum, the text states "...the mean pH at the site...was within the pH range defining no adverse effects..." As previously indicated, maximum exposure scenarios must be evaluated. The ecological risk from aluminum at sample Station ID SO23 with a pH of 5 does not support eliminating aluminum as a refined COPC since the pH is below 5.5. According to Figure 3, SO23 is outside the approximate slag pile boundary. This raises questions about the slag pile boundary location, especially as the text indicated that surface water flow was away from Garrison Road which would mean towards SO23. This suggests additional samples around the boundary as shown on Figure 3 may be needed.*

Navy Response: While the pH in this subsurface soil sample (5.0) was below the ESV threshold (5.5), the concentration was only slightly above the background UTL (ratio of 1.2). Because the one subsurface soil sample below the waste slag pile, and the four subsurface soil samples surrounding the slag pile, were all less than the background UTL, this suggests that the slag pile is not the source of this slightly elevated aluminum concentration, especially considering that the surface soil concentration for aluminum at SO23 did not exceed the ESV or the background UTL. Further, the aluminum concentration in the 1999 sample of the waste slag material itself was 3,080 mg/kg, which is significantly less than the observed soil concentration in sample SO23. This also suggests that the slag pile is not the source of this slightly elevated aluminum concentration, which, even though it is slightly above the background UTL, is likely representative of background concentrations.

*EPA Comment 8: On page 11, the TM states that one surface and subsurface soil sample was collected from underneath the waste slag material; therefore, the results of the sampling will also be used as pre-waste slag removal characterization samples. On page 12, the TM further states that since there is no unacceptable human health or ecological risks associated with the soil at the site, no additional soil removal or soil sampling will be required following removal of the waste slag pile. One sample is insufficient to characterize contamination underneath the waste slag material. In addition, the sample from the 1999 SI suggests there is potential ecological risk at the site. Additional samples should be collected underneath the pile once the waste slag pile is removed to ensure the area underneath the pile does not pose unacceptable ecological risk.*

Navy Response: Please see the response to EPA Comment 3.

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**From:** Smith, Wade (DEQ) <Wade.Smith@deq.virginia.gov>  
**Sent:** Wednesday, April 03, 2013 8:56 AM  
**To:** scott.park@navy.mil  
**Cc:** Ivester, Marlene/VBO; Sawyer, Stephanie/VBO; haug.susanne@epamail.epa.gov  
**Subject:** CAX: AOC 6 No Action Tech Memo (Waste Slag Subarea) - DEQ Comments

Thank you for giving the DEQ the opportunity to comment on the February 2013 *Draft No Action Tech Memo* for AOC 6 at CAX.

The Draft Tech Memo was received by the DEQ on March 4, 2013.

The DEQ has no comments and concurs with the conclusion that the soil and groundwater at the Waste Slag Subarea of AOC 6 poses no potential unacceptable risk to human health and the environment, and that no action following the removal of the waste slag pile is required.

Please let me know if you have any questions.

Sincerely,

Wade M. Smith  
Remediation Project Manager  
Virginia Department of Environmental Quality  
Office of Remediation Programs  
Phone: (804) 698-4125  
[wade.smith@deq.virginia.gov](mailto:wade.smith@deq.virginia.gov)



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION III  
1650 Arch Street  
Philadelphia, Pennsylvania 19103-2029**

July 12, 2013

Mr. Scott Park  
NAVFAC MIDLANT, Building N-26, Room 3208  
Attention: Code OPHE3, Mr. Scott Park  
9742 Maryland Avenue  
Norfolk, VA 23511-3095

Subject: Response to Comments, No Action Technical Memorandum for Soil and Groundwater at the Waste Slag Subarea of AOC 6; Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia, May 16, 2013

Mr. Park:

Thank you for the opportunity to review the subject document. The remaining unresolved comments are related to two topics: potential groundwater impacts and delineating the extents of contamination.

The response to Comment 1 states that an evaluation of the potential for the detected metals concentrations to leach into groundwater at concentrations that may pose potential risk was conducted and goes on to state that the results of that evaluation did not identify any potential risks to groundwater. We still have concerns regarding the uncertainty of potential groundwater impacts and would like to see that evaluation and results.

Our other concern has to do with delineating the extents of contamination. The samples collected to date do not delineate the horizontal and vertical extents of the contamination. We would like post-removal discrete samples to be collected and compared to Ecological Soil Screening Values to verify that no ecological risk remains post-removal.

If you have any questions, please contact me at 215-814-3394.

Sincerely,

A handwritten signature in blue ink, which appears to read "Susanne Haug".

Susanne Haug, P.E.  
NPL/BRAC Federal Facilities Branch

cc: Wade Smith, VDEQ

**Response to Second Round Comments**  
**No Action Technical Memorandum for Soil and Groundwater at the**  
**Waste Slag Subarea of AOC 6**  
**Naval Weapons Station Yorktown Cheatham Annex**  
**Williamsburg, VA**  
**August 6, 2013**

Comments were received via U.S. Environmental Protection Agency (EPA), Region 3 letter dated July 12, 2013. Per the EPA Remedial Project Manager, the resolution of the two comments below will also resolve any outstanding comments on the subject document from the EPA's letter dated April 16, 2013.

*EPA Comment 1: The response to Comment 1 states that an evaluation of the potential for the detected metals concentrations to leach into groundwater at concentrations that may pose potential risk was conducted and goes on to state that the results of that evaluation did not identify any potential risks to groundwater. We still have concerns regarding the uncertainty of potential groundwater impacts and would like to see that evaluation and results.*

Navy Response: An evaluation of the potential for the detected metals concentrations to leach into groundwater at concentrations that may pose potential risk to human health was included under the Human Health Risk Screening Results section of the Technical Memorandum (TM) (Page 8, last two paragraphs). Since ecological receptors do not typically have direct exposure to groundwater, an evaluation of the potential for the detected metals concentrations to leach into groundwater at concentrations that may pose potential risk to ecological receptors was not conducted.

However, as shown on Table C-5 of the TM, only one constituent (aluminum) was detected in one out of the six subsurface soil samples at a concentration (16,100 mg/kg; pH = 5.00) exceeding the ecological screening value (pH<5.5) and the base background 95 percent UTL (13,000 mg/kg). This detected aluminum concentration only slightly exceeds the base background 95 percent UTL; therefore, it is not likely that the aluminum concentrations detected in the subsurface soil are leaching into the groundwater at concentrations that would exceed the groundwater base background 95 percent UTL.

*EPA Comment 2: Our other concern has to do with delineating the extents of contamination. The samples collected to date do not delineate the horizontal and vertical extents of the contamination. We would like post-removal discrete samples to be collected and compared to Ecological Soil Screening Values to verify that no ecological risk remains post-removal.*

Navy Response: The Navy agrees to collect confirmation soil samples following the removal of the waste slag pile. Since the details of these soil sampling activities (location, number, analysis, screening criteria comparison, etc.) will be presented under a separate cover (likely an EE/CA and a subsequent SAP), the CAX Partnering Team will have the opportunity to review and comment on the post removal soil sampling activities well before the waste slag pile is removed.

**Regulatory Acceptance**

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION III  
1650 Arch Street  
Philadelphia, Pennsylvania 19103-2029

August 8, 2013

Mr. Scott Park  
NAVFAC MIDLANT, Building N-26, Room 3208  
Attention: Code OPHE3, Mr. Scott Park  
9742 Maryland Avenue  
Norfolk, VA 23511-3095

Subject: Draft No Action Technical Memorandum for Soil and Groundwater at the Waste Slag Subarea of AOC 6, Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Mr. Park:

EPA has reviewed your Response to Second Round Comments on the subject document dated August 6, 2013. EPA finds these responses acceptable. EPA has no further comments on this document. Please submit a final copy of the subject document for our records.

If you have any questions, please contact me at 215-814-2077.

Sincerely,

A handwritten signature in blue ink that reads "Gerald F. Hoover".

Gerald F. Hoover, RPM  
NPL/BRAC Federal Facilities Branch

cc: Wade Smith, VDEQ



# COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY  
Street address: 629 East Main Street, Richmond, Virginia 23219  
Mailing address: P.O. Box 1105, Richmond, Virginia 23218  
TDD (804) 698-4021  
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Douglas W. Domenech  
Secretary of Natural Resources

David K. Paylor  
Director

(804) 698-4000  
1-800-592-5482

August 9, 2012

Mr. Scott Park  
NAVFAC MIDLANT, Building N-26  
Hampton Roads Restoration Product Line, Code OPHREV4  
9742 Maryland Avenue  
Norfolk, VA 23511-3095

**RE: Final Red-Line Sampling and Analysis Plan Addendum  
AOC 6 – Penniman AOC, Waste Slag Material Subarea  
Naval Weapons Station Yorktown  
Cheatham Annex  
Williamsburg, Virginia**

Dear Mr. Park:

The Virginia Department of Environmental Quality (DEQ) has received the *Final Red-Line Sampling and Analysis Plan Addendum* (SAP Addendum) for AOC 6 – Penniman AOC, Waste Slag Material Subarea at Naval Weapons Station Yorktown, Cheatham Annex (CAX), Williamsburg, Virginia. The August 2012 SAP Addendum, prepared by CH2M HILL, was received by the DEQ (electronically) on July 23, 2012.

Thank you for providing the DEQ's Office of Remediation Programs the opportunity to review the above-referenced SAP Addendum. Subsequent to DEQ's internal review and per CAX Partnering Team discussion, this office concurs with the proposed text revisions and recommends submittal of the *Final Sampling and Analysis Plan Addendum*.

Please contact me at (804) 698-4125 or [wade.smith@deq.virginia.gov](mailto:wade.smith@deq.virginia.gov) with any additional questions.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Wade M. Smith'.

Wade M. Smith  
Remediation Project Manager  
Office of Remediation Programs

cc: Susanne Haug, EPA