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Final

Engineering Evaluation/Cost Analysis for Site 5 Waste/Burnt Soil Area and Impacted Surface Soil and Sediment Areas

St. Juliens Creek Annex
Chesapeake, Virginia

NAVFAC
Naval Facilities Engineering Command
NAVFAC MID-ATLANTIC

Prepared for

Department of the Navy

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Mid-Atlantic

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Prepared by

CH2MHILL

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Virginia Beach, Virginia

Executive Summary

This report presents an Engineering Evaluation/Cost Analysis (EE/CA) for a non-time-critical removal action (NTCRA) at Site 5, St. Juliens Creek Annex (SJCA), Chesapeake, Virginia. Site 5 is the former Burning Grounds, consisting of approximately 21 acres located in the northeastern portion of SJCA. Previous site investigations identified potential unacceptable risk to human health and the environment posed by exposure to waste, burnt soil, and impacted surface soil and sediment. In addition, groundwater samples indicated isolated detections of metals at concentrations above maximum contaminant levels (MCLs).

The goals of the EE/CA are to identify the objectives of the removal action and to scope and analyze the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives. The removal action objectives for Site 5 are to:

- Implement measures that mitigate potential unacceptable risk to human health and the environment posed by exposure to waste, burnt soil, and impacted surface soil and sediment.
- Remove the potential source of contamination to the shallow groundwater.
- Perform a removal action in preparation for site closeout under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) with no further action (NFA).

The following four removal action alternatives were evaluated:

1. No action
2. Cover installation
3. Excavation and backfill
4. Excavation and restoration/wetland creation

Alternative 1, no action, does not meet the objectives of the NTCRA to mitigate risk to human health and the environment. As such, implementation of this alternative is not recommended.

Alternative 2, cover installation, is effective in meeting the first removal action objective, which is to eliminate exposure to human health and the environment. However, since the waste and impacted surface soil and sediment will remain in place, this alternative does not meet the second and third objectives, which are to remove the potential source of contamination to shallow groundwater and to prepare the site for closeout with NFA. Alternative 2 requires land use controls (LUCs) and long-term operation and maintenance (O&M) to control future land use and to provide for future cover maintenance, inspections, and groundwater monitoring. In addition, the implementation of Alternative 2 will result in a permanent loss of approximately 1.7 acres of existing wetland and will require construction of a wetland for compensatory mitigation, for which a site has not been identified. Because Alternative 2 does not achieve all of the removal action objectives, the alternative is not recommended.

Alternative 3, excavation to visible limits and backfill with imported material, is highly effective because it eliminates the onsite risks to human health and the environment. It is also straightforward to implement, utilizing standard construction methods and resources. Because this alternative results in the complete removal of waste and impacted surface soil and sediment, it meets the removal action objectives of the EE/CA to mitigate risk to human health and the environment, remove the source of potential contamination to the shallow groundwater, and to prepare for site closeout with NFA. However, Alternative 3 is not recommended because its cost is higher than Alternative 4, which has similar effectiveness and implementability.

Alternative 4, excavation and restoration/wetlands creation, is highly effective because it eliminates the onsite risks to human health and the environment. It is also straightforward to implement, utilizing standard construction methods and resources. Because this alternative results in the complete removal of waste and impacted surface soil and sediment, it meets the removal action objectives of the EE/CA to mitigate risk to human health and the environment, remove the source of potential contamination to the shallow groundwater, and prepare for site closeout with NFA. The cost of this alternative is moderate and slightly less than Alternative 3. This alternative also provides an environmental benefit by creating additional wetland area and enhancing the quality of the existing wetland. Therefore, Alternative 4 is the recommended alternative.

The recommended alternative includes excavation of the waste/burnt soil area to the visible limits and excavation of the impacted surface soil and sediment areas to a depth of 1 foot (ft). The surface soil and sediment areas will be backfilled and restored to their pre-existing elevation and condition. The waste/burnt soil area will be backfilled with 6 inches of topsoil only, resulting in a lower elevation than was present prior to the removal action. The lower elevation will allow for the enhancement of a portion of the wetland, as well as potential establishment of emergent/shrub/treed wetland transition zones. The transition zones will be seeded/planted with a variety of plant species, allowing for the dominance of the most appropriate species based on the new site conditions. The additional vegetative zones enhance the habitat diversity of the site.

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Acronyms and Abbreviations

amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BTAG	Biological Technical Assistance Group
BTEX	benzene, toluene, ethylbenzene, and xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	chemical of concern
COPC	chemical of potential concern
CTO	Contract Task Order
cy	cubic yard
DRMO	Defense Reutilization and Marketing Office
EE/CA	engineering evaluation/cost analysis
EPC	exposure point concentrations
ERI	expanded remedial investigation
ft	foot, feet
IR	installation restoration
LUC	land use control
MARMC	Mid-Atlantic Regional Maintenance Center
MEC	munitions and explosives of concern
mg/kg	milligram per kilogram
NAPEC	Naval Ammunition Production Engineering Center
NAVFAC	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NEESA	Navy Engineering and Environmental Support Activity
NFA	no further action
NTCRA	non-time-critical removal action
O&M	operations and maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PPE	personal protective equipment
ppm	parts per million

RBC	risk-based concentration
RDA	recommended daily allowance
RDX	hexahydro-trinitro-triazine
RI	remedial investigation
RME	reasonable maximum exposure
SARA	Superfund Amendments and Reauthorization Act
SJCA	St. Juliens Creek Annex
SPAWAR	Space and Naval Warfare Systems Command
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TBC	to-be-considered
TCLP	toxicity characteristic leaching procedure
TCR	target cancer risk
TNT	tetryl, trinitrotoluene
TPH	Total Petroleum Hydrocarbons
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
UTL	upper threshold limit
VDEQ	Virginia Department of Environmental Quality
VDOT	Virginia Department of Transportation
VOC	volatile organic compound

SECTION 1

Introduction

This report presents an Engineering Evaluation/Cost Analysis (EE/CA) for a non-time-critical removal action (NTCRA) for the waste/burnt soil area and impacted surface soil and sediment areas of Installation Restoration (IR) Site 5, Burning Grounds, at St. Juliens Creek Annex (SJCA), Chesapeake, Virginia. The EE/CA is prepared under the Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic Comprehensive Long-Term Environmental Action Navy (CLEAN), Contract Number N62470-02-D-3052, Contract Task Order (CTO) 0054.

The Draft EE/CA (CH2M HILL, March 2006) was prepared to address only the waste/burnt soil area at Site 5. The SJCA Tier I Partnering Team; consisting of representatives from the Navy, United States Environmental Protection Agency (USEPA) Region III, and Virginia Department of Environmental Quality (VDEQ); agreed to revise the draft to incorporate the impacted surface soil and sediment areas posing human health and ecological risks. Incorporation of these additional areas into the EE/CA develops a consistent site-wide approach for the soil and sediment media.

1.1 Regulatory Background

This document is issued by the United States Department of the Navy, lead agency responsible for remediation of SJCA, Site 5, in partnership with the USEPA Region III and the VDEQ, under Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) of 1986.

Section 104 of CERCLA and SARA allows an authorized agency to take any appropriate removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release relating to hazardous substances, pollutants, or contaminants at any time, or to take any other response measures consistent with the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) as deemed necessary to protect public health or welfare and the environment.

The NCP, 40 Code of Federal Regulations (CFR) 300, provides regulations for implementing CERCLA and SARA, and regulations specific to removal actions. The NCP defines a removal action as the "cleanup or removal of released hazardous substances from the environment, such actions as may be necessary to monitor, assess, and evaluate the threat of release of hazardous substances; the disposal of removed material; or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release." Removal actions for Site 5 are not time-critical. NTCRAs are defined in 40 CFR Section 300.415(b)(4) as actions pertaining to an imminent threat to human health and the environment and that have planning periods of 6 months or more.

The 40 CFR Section 300.415 requires the lead agency to conduct an EE/CA when a NTCRA is planned for a site. The goals of an EE/CA are to identify the objectives of the removal action and to analyze the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives. An EE/CA documents the removal action alternatives and selection process. Where the extent of the contamination is well defined and limited in extent, NTCRAs also allow for the expedited cleanup of sites in comparison to the remedial action process under CERCLA.

Community involvement requirements for NTCRAs include preparing an EE/CA and making it available for public review and comment for a period of 30 days. An announcement of the 30-day public comment period on the EE/CA is required in a local newspaper. Written responses to significant comments will be summarized in an Action Memorandum and included in the Administrative Record.

1.2 Purpose and Objectives

Submittal of this document fulfills the requirements for NTCRAs defined by CERCLA, SARA, and the NCP. This EE/CA has been prepared in accordance with USEPA's guidance document *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*, PB93-963402, August 1993.

The EE/CA compares removal alternatives based on their technical feasibility, ability to protect human health and the environment, ability to prevent the potential release of hazardous constituents, and cost. Individual goals of this EE/CA are to: (1) satisfy environmental review and public information requirements for removal actions, (2) satisfy Administrative Record requirements for documenting the removal action selection, and (3) provide a framework for evaluating and selecting alternative technologies.

The objective of this EE/CA is to evaluate the removal alternatives to address the potential risks posed by waste, burnt soil, and impacted surface soil and sediment in preparation for site closeout under CERCLA with no further action (NFA).

The following information is presented within this EE/CA:

- Section 2: Site Characterization
- Section 3: Identification of Removal Action Objectives
- Section 4: Identification and Analysis of Removal Action Alternatives
- Section 5: Comparative Analysis of Removal Action Alternatives
- Section 6: Recommended Removal Action Alternative

SECTION 2

Site Characterization

This section provides a summary of background information and previous investigation activities, establishes removal areas, and develops risk-based cleanup goals.

2.1 SJCA Description and Background

SJCA is a 490-acre facility situated at the confluence of St. Juliens Creek and the Southern Branch of the Elizabeth River in the City of Chesapeake, in southeastern Virginia (Figure 2-1). The facility is bordered to the north by the Norfolk and Western Railroad, the City of Portsmouth, and residential areas; to the west by residential areas; to the south by St. Juliens Creek; and to the east by the Southern Branch of the Elizabeth River. Most surrounding areas are developed and include residences, schools, recreational areas, and shipping facilities for several large industries.

SJCA began operations as a naval facility in 1849. The annex was one of the largest ammunition depots in the United States involving wartime transfer of ammunitions to various other naval facilities. Specific ordnance operations and processes conducted at SJCA included stockpiling Explosive D (ammonium picrate or picrate acid) for use in projectiles, manufacturing MARK VI mines, assembling small caliber guns and ammunition, storing torpedoes, filling shells, and testing ordnance. In 1975, all ordnance operations were transferred to the Yorktown Naval Weapons Station. As a result, decontamination was performed in, around, and under ordnance-handling facilities at SJCA in 1977.

SJCA has also been involved in non-ordnance operations, including degreasing, paint shops, machine shops, vehicle and locomotive maintenance shops, pest control shops, battery shops, print shops, electrical shops, boiler plant operations, wash rack operations, potable water storage, saltwater fire-protection systems, fire-fighter training operations, and oil and chemical storage.

Activity at SJCA has decreased in recent years and many of the aging structures are being demolished. The current primary mission of SJCA is to provide a radar-testing range and warehousing facilities for nearby Norfolk Naval Shipyard and other local naval activities. SJCA also provides administrative offices, light industrial shops, and storage facilities for several tenant commands; including Defense Reutilization and Marketing Office (DRMO) storage, Space and Naval Warfare Systems Command (SPAWAR), Mid-Atlantic Regional Maintenance Center (MARMC), and a cryogenics school.

2.2 Site 5 Description and Background

Site 5 is the former Burning Grounds, consisting of approximately 21 acres located in the northeastern portion of SJCA (Figure 2-2). In earlier documents, Site 5 was also referred to as Solid Waste Management Unit (SWMU) 8 and was reported to consist of approximately 3 acres. Recent investigation activities and review of historical accounts resulted in the site boundary

revision. Review of historical aerial photographs indicate that prior to use as a disposal area, the site and much of the adjacent area had been used for placement of dredge spoil material that reportedly originated from Blows Creek and the Southern Branch of the Elizabeth River.

Operations began at the Burning Grounds in the 1930s when waste ordnance materials, including black powder (mixture of charcoal, nitrate, and sulfur), smokeless powder (nitrocellulose), Explosive D (ammonium picrate), and Composition A-3 (contains hexahydro-trinitro-triazine [RDX] and wax), were disposed of by open burning on three main pads. Tetryl, trinitrotoluene (TNT), fuzes, solvents, paint sludge, pesticides, and various types of refuse were also disposed. Reports stated that the Burning Grounds spontaneously caught fire several times in the 1970s. The amount of ordnance disposed varied from year to year and there is insufficient information to calculate the waste volume. Interviews conducted with former employees in December 2001 indicated that asbestos piping was buried 10 feet (ft) below ground surface (bgs), although there are no other records of disposal to such great depth, and that other material disposed included tables and metal from buildings. In 1974, 427 tons of ordnance items were reportedly disposed at the site; however, the type and location of the ordnance disposal were not identified in the historic records.

In mid-1977, the Burning Grounds surface was used for facility-wide ordnance equipment and material decontamination. The decontamination process included filling equipment from buildings with oil and straw and igniting them. Afterwards, the ground surface was reportedly covered with oil and straw and burned. The top 6 inches of soil was then diced, and the ground surface was covered with oil and straw and burned again. After the decontamination was completed, the Naval Ammunition Production Engineering Center (NAPEC) collected samples for chemical analyses and certified decontamination; however, the level of decontamination was not specified.

The site currently consists of an open field with a wetland in the central portion and a forested area in the southern portion (Figure 2-3). A wetland delineation, conducted in October 2005 and January 2006, identified four wetland areas within Site 5 (Appendix A). The wetland is predominantly supported by surface water runoff and it therefore does not typically maintain standing water, except during and after storm events. A significant portion of the site's southwestern area is covered with a layer of gravel. The Site 5 topography is generally level and slopes gently toward Blows Creek, ranging in elevation from 7 ft above mean sea level (amsl) in the northern portion to 0 ft amsl in the southern portion. The topographic survey of the site is included as Appendix B. Groundwater flow follows the topography and flows toward Blows Creek. The waste/burnt soil area is located in the west-central portion of the site. One to 3 ft deep vegetated upland drainage ditches are located along the perimeters of the site and discharge surface water runoff to Blows Creek, reducing runoff onto the site from adjacent areas. Site 6, located within the east-central portion of Site 5, is a former IR site that was closed under a no action Record of Decision in September of 2003 after a removal action conducted in September of 2002 (Figure 2-3).

2.3 Site 5 Investigation Activities and Results

A detailed description of the Remedial Investigation (RI) activities, results, and conclusions can be found in the following documents:

- *Final Remedial Investigation/Human Health Risk Assessment/Ecological Risk Assessment Report for Sites 3, 4, 5, and 6* (CH2M HILL, March 2003)
- *Final Expanded Remedial Investigation/Human Health Risk Assessment/Ecological Risk Assessment for Site 5* (CH2M HILL, June 2006)

The RI field investigation activities were completed from 1997 to 2001 and included geophysical investigations; monitoring well installation; water-level monitoring; waste delineation; and the collection and analysis of surface and subsurface soil, groundwater, drainage sediment, and drainage surface water samples to characterize the nature, extent, fate, and transport of contaminants and to evaluate potential human health and ecological risks. An Expanded RI (ERI) was completed in December 2003 and included the collection and analysis of surface soil samples to fill spatial data gaps. The ERI field investigation activities included surface soil and shallow groundwater sampling.

2.3.1 Nature and Extent of Contamination

The extent of waste and burnt soil was determined visually during test pitting activities. Waste consisted of construction-related debris including wires, ceramics, brass, glass, and wood. Two spent ordnance, a spent percussion primer and a Mark 7 cartridge case, were found. Debris was generally located within the first 16 inches bgs and burnt/stained soil was identified to a depth of no more than 26 inches bgs.

The nature and extent of contamination was defined by constituent concentrations detected in site media exceeding the 95% background upper threshold limit (UTL) for dredge fill soil and groundwater (CH2M HILL, October 2001 and August 2004). Although samples collected in the upland drainage ditches at Site 5 were identified as sediment samples, the ditches actually contain little or no sediment and are covered with grass that is partly mowed; they were therefore considered to reflect dredge fill conditions and were compared to the site-specific 95% background UTL for dredge fill soil. Because no background data exists for surface water, the nature and extent of contamination in surface water was defined by constituent concentrations detected.

During the RI and ERI, metals, polycyclic aromatic hydrocarbons (PAHs), and pesticides were sporadically detected in soil and sediment throughout the site at concentrations exceeding the 95% background UTL for dredge fill. Volatile organic compounds (VOCs), explosives, and dioxins and furans, for which no background data exists, were also detected in soil. Metals were detected in groundwater exceeding the 95% background UTL for groundwater and Maximum Contaminant Levels (MCLs). In surface water collected from the upland drainage ditches, metals, VOCs, semivolatile organic compounds (SVOCs), and pesticides were detected.

Although the RI and ERI also identified contaminants in groundwater, this EE/CA only addresses waste, soil, and sediment. Therefore, the other media will not be further discussed or evaluated in this EE/CA; the remaining site media will be later addressed in a Feasibility Study.

2.3.2 Risk Summary

The human health and ecological risk assessments concluded that there is potential risk to human and ecological receptors from exposure to chemicals in soil and upland drainage ditch sediment (primarily metals, pesticides, and PAHs). In addition, the waste has not been fully characterized due to the difficulty of collecting samples in waste material, and is therefore assumed to pose a potential risk to human health and the environment.

There are no human health risks above USEPA target risk levels under current land use (trespassers or site workers) or future industrial use (trespassers or other workers). There are no human health risks associated with exposure to subsurface soil (evaluated for future site use). Future residential land use may result in non-cancer risk above USEPA target risk levels associated with ingestion of arsenic, copper, and iron in surface soil and associated with dermal contact of arsenic and iron in sediment. Additionally, the average lead concentration in surface soil at Site 5 is greater than 400 milligrams per kilogram (mg/kg), which is the level considered adequately protective of human health under residential land-use conditions.

Human health risk management considerations are as follows:

- Although arsenic was identified as a contributor to human health risk above USEPA target levels in sediment, the concentrations were below the 95% background UTL for dredge fill soil and the risks are therefore associated with background conditions, and not site-related.
- Iron can be eliminated as a contributor to human health risk on the basis that it is an essential nutrient. The estimated reasonable maximum exposure (RME) intake of iron via incidental ingestion of site soil (0.33 mg/kg-day based on the exposure point concentration [EPC] of 25,667 mg/kg) is within the Recommended Daily Allowance (RDA) range (10 mg/day, or 0.36 to 1.1 mg/kg-day) for children ages 6 months to 10 years (USEPA, January 1999). As a comparison, children's vitamins typically contain 18 mg of iron. Also the tolerance upper limit intake level (the maximum level of daily intake that is likely to pose no risk of adverse effect) for iron is 40 mg/day (equivalent to an intake of 2.7 mg/kg-day; United States Department of Agriculture [USDA], 2006 and Institute of Medicine, 2005). Therefore, the concentration of iron in soil is not considered to pose an unacceptable risk for ingestion by future child residents under conservative exposure scenario assumptions.

  For sediment, a potential non-cancer hazard (hazard index [HI] = 4.4, USEPA's target HI is 1) was identified based primarily on the RME intake of iron via dermal contact (0.23 mg/kg-day); however, this assumes that the sediment is wet and a higher adherence factor (6.7 mg/cm^2 for sediment versus 0.11 mg/cm^2 for soil) was used, resulting in a potential risk to future residents. If the sediment was evaluated as soil, using the lower adherence factor that is used for soil (0.11 mg/cm^2) to estimate dermal exposure, no risk would be identified (HI=0.07 for exposure to all chemicals of potential concern [COPCs] in sediment).

The ecological risk assessment identified the potential for adverse effects to lower trophic-level receptors (plants and soil invertebrates) from the presence of metals, pesticides, and PAHs in surface soil. The ecological risk assessment also identified the potential for adverse effects to one or more avian and/or mammalian wildlife receptor from the presence of metals in surface soil. Metals, pesticides, and PAHs are present in sediment at concentrations that could potentially adversely affect aquatic life if they were to reach Blows Creek.

Although PAHs were initially identified as COPCs in surface soil and sediment, they can be eliminated as ecological risk drivers based on the statistical background comparison indicating that it is unlikely they are a result of site-related activities (CH2M HILL, June 2006).

Table 2-1 provides a summary of the ecological COPCs in surface soil and sediment. The surface soil and sediment sample locations with COPCs exceeding 95% background UTLs and posing potential risk to human and/or ecological receptors are shown in Figure 2-4.

2.4 Determination of Removal Areas

Based on the risk evaluations, removal areas have been identified to reduce human health and ecological risk associated with waste, soil, and sediment to acceptable levels. The removal areas have been defined as follows:

Waste/Burnt Soil Area Removal Area

The waste has not been fully characterized and is therefore assumed to pose a potential risk to human health and the environment. The horizontal limits of the removal area were defined by test pitting during the RI (Figure 2-5). The waste/burnt soil area covers approximately 4.2 acres. The depth of waste/burnt soil ranges from surficial to 26 inches bgs based on test pit results.

Human Health Risk-Based Removal Areas

The sample locations identified in Table 2-2 pose potential human health risk from exposure to surface soil at Site 5 based on 95% upper confidence limit (UCL) calculations. Removal of the soil at these sample locations would reduce risk to an acceptable level for residential exposure (i.e., the 95% UCL of all the remaining sample locations would result in an acceptable level of risk). The removal areas for the identified sample locations were delineated horizontally by existing sample locations not posing unacceptable risk, as shown on Figure 2-5. The exception is the removal boundary defined by sample locations SJS05-SS36 and SJS05-SS37, which are confirmation samples for the removal action conducted at Site 6 in 2002. The Site 6 excavation was backfilled with approved offsite borrow material; therefore, the Site 5 removal area will extend to the Site 6 removal area boundary, including the confirmation sample locations, but not beyond. The vertical extent of the human health risk-based removal areas is 1 ft based on subsurface soil data collected during the RI. Because surface soil samples SJS05-SS19 and SJS05-SS66 are isolated, a 50-ft radius removal area around the samples has been assumed. The actual limits of the excavations of these hot spots will be determined based on field conditions and confirmed by the collection of confirmation samples for comparison to risk-based cleanup goals. Risk-based cleanup goals for the human health COCs (arsenic, copper, and lead) are considered necessary to ensure that the soil remaining following the removal action is protective of human health (see Section 2.5). The human health risk-based removal areas cover approximately 1.8 acres.

Ecological Risk-Based Removal Areas

An ecological risk evaluation was performed to determine if the removal of the waste/burnt soil area and human health risk-based surface soil removal areas would result in an acceptable level of ecological risk for the soil and upland drainage ditch sediment remaining in place. The sample locations planned for removal as part of the waste/burnt soil area and human health risk-based surface soil areas are presented in Table 2-3.

An acceptable level of ecological risk was defined by the ratio of site-wide average concentrations in soil/sediment to the ecological comparison value [highest value of the 95% background UTL for dredge fill soil, the Biological Technical Assistance Group (BTAG) screening value, or alternate screening values from available scientific literature (CH2M HILL, March 2003 and June 2006)] that is at or below 1.0 (Table 2-4). The use of average site-wide concentrations is appropriate because receptor populations as a whole will be exposed to a range of chemical concentrations, and the average concentration is a more realistic indicator of the overall potential for population-level effects, particularly for mobile receptors and uniform habitat conditions.

For site-wide average concentration calculations, it was assumed that excavated areas would be backfilled by a minimum of 6 inches of offsite borrow. Because soil naturally contains low levels of several of the site COPCs, using concentrations of 0 mg/kg for COPCs in the backfilled areas would unrealistically bias the site-wide average low. As a more conservative approach, the concentrations for each COPC from the analytical data of several recent local offsite borrow sources were averaged (Table 2-5) for use as concentrations remaining in place after the removal action.

Averages of the COPCs remaining in place following removal of the waste/burnt soil and human health risk-based removal areas were calculated (Table 2-6). Based on this initial evaluation, it was determined that removal of the waste/burnt soil area and human health risk-based removal areas would not be sufficient to reduce the ecological risk to an acceptable level. Therefore, an iterative approach was used to identify additional areas that require removal in order to achieve an acceptable level of ecological risk. Samples with high COPC concentrations were progressively removed from the data set and replaced with the derived borrow soil concentrations to determine the effect on site-wide average concentrations. This process continued until the ratio of the site-wide average concentration of each COPC (with the exceptions of cyanide and thallium) to the ecological comparison value was at or below 1.0, resulting in an acceptable level of ecological risk (Table 2-7).

The site-wide average concentrations of cyanide and thallium were above the acceptable levels of ecological risk, based on conservative literature-derived effects values. However, because the site-wide average concentrations of cyanide (0.3 mg/kg) and thallium (0.6 mg/kg) (Table 2-7) approximate the derived concentrations for borrow soil (0.25 and 0.5 mg/kg, respectively), additional removal for these COPCs would result in a negligible reduction to site-wide risks. Therefore, no additional removal is recommended for cyanide and thallium.

Based on the ecological risk evaluation, four additional sample locations (SJS05-SS43, SJS05-SS49, SJS05-SS50, and SJS05-SD01) were identified for removal in order to reduce ecological risk to an acceptable level for silver and zinc. The removal areas for the identified sample locations have been delineated horizontally by existing sample locations not contributing to an unacceptable risk (Figure 2-5).

Additionally, two sample locations (SJS05-SS32 and SJS05-SS35) were identified for removal in order to reduce ecological risk to an acceptable level for DDE and DDT. The removal area for SJS05-SS32 has been defined horizontally by existing sample locations not posing unacceptable risk (Figure 2-5). Because there are not surrounding samples to define the horizontal extent of the hot spot at SJS05-SS35, a 50-ft radius removal area around the sample has been assumed. The approach for delineation of the horizontal extent will be presented in a separate work plan

for review by the SJCA Tier I Partnering Team. The vertical extent of the ecological risk-based removal areas is 1 ft based on subsurface soil data collected during the RI.

With the exceptions of cyanide and thallium, which are discussed above, the average concentrations of all of the ecological COPCs in the site-wide subsurface soil samples do not contribute to a ratio at or above 1.0, and therefore do not pose potential ecological risk. Because concentrations of ecological COPCs remaining in place following implementation of a removal action reduce potential ecological risks at the site to an acceptable level, the development of ecological risk-based cleanup goals are not considered necessary. The ecological risk-based removal areas cover approximately 3.5 acres.

A final list of samples identified for removal at Site 5 to address both human health and ecological risk is provided in Table 2-8 and the proposed areas for removal to address both human health and ecological risk is presented in Figure 2-5.

2.5 Cleanup Goal Development

Risk-based cleanup goals for arsenic, copper, and lead are considered necessary to ensure that the soil remaining following the removal action is protective of human health. Since there are currently no planned land use restrictions for the site, a residential land use scenario was used for the development of risk-based cleanup goals. Site-specific risk-based cleanup goals were calculated for adult and child residents exposed to soil via incidental ingestion and dermal absorption as described in the following subsections.

2.5.1 Calculation of Risk-Based Cleanup Goals

Arsenic and Copper

Risk-based cleanup goals were calculated for arsenic and copper using equations presented in USEPA's Risk Assessment Guidance for Superfund Volume 1, Part B (December 1991) that were revised to incorporate the ingestion and dermal absorption pathways for future residents. The same exposure assumptions used in the baseline human health risk assessment to estimate intake via ingestion and inhalation were used for the cleanup goal calculations (CH2M HILL, June 2006). Since updated guidance from USEPA is now available to calculate intake via the dermal absorbed dose, these updated factors were used to calculate risk-based cleanup goals (USEPA, July 2004).

Risk-based cleanup goals are calculated to ensure that the total HI to a target organ does not exceed 1. The risk-based cleanup goals for arsenic and copper were each developed to meet a non-cancer target HI of 1 because each constituent affects a different target organ; target organs for arsenic are skin and vascular whereas the target organ for copper is gastrointestinal. Risk-based cleanup goals were also calculated for arsenic to meet a target cancer risk (TCR) of 10^{-4}; however, because the arsenic concentration for the non-cancer target HI of 1 was lower, that more conservative value was identified as the risk-based cleanup goal. The calculated risk-based cleanup goals are summarized on Table 2-9. Details of the calculation methods for each exposure scenario are provided in Tables 2-10 through 2-12.

Lead

USEPA has not established traditional toxicity factors such as reference doses or cancer slope factors for lead. Exposure to lead is regulated by USEPA based on the concentration of lead in blood. The blood-lead concentration is estimated using a physiologically-based pharmacokinetic model (Integrated Exposure Uptake Biokinetic [IEUBK] model). Average lead concentrations of less than 400 mg/kg in soil at a site are considered adequately protective of human health under residential land use scenarios (USEPA, July 1994).

2.5.2 Selection of Risk-Based Cleanup Goals

The risk-based cleanup goals for arsenic and copper were based on the more conservative non-cancer hazards. The risk-based cleanup goals were compared to the 95% background UTLs for dredge fill soil (CH2M HILL, October 2001). The risk-based cleanup goals were higher than the 95% background UTL for dredge fill soil and were therefore selected as the cleanup goal. The selected risk-based cleanup goals are shaded gray in Table 2-13.

Table 2-1
Ecological COPCs
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

COPCs	Surface Soil	Sediment
Metals		
Aluminum	√	
Antimony	√	
Arsenic	√	√
Barium	√	√
Beryllium	√	√
Chromium	√	√
Cobalt	√	
Copper	√	√
Cyanide	√	√
Iron	√	√
Lead	√	√
Mercury	√	√
Nickel	√	
Selenium	√	
Silver	√	
Thallium	√	√
Vanadium	√	
Zinc	√	√
Pesticides		
4,4'-DDD		√
4,4'-DDE	√	√
4,4'-DDT	√	√
Dieldrin		√
Endrin aldehyde		√

Table 2-2
Sample Locations Posing Unacceptable Levels of Human Health Risk
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

Sample Location	COC	Concentration
SJS05-SS01	Copper	6,470 mg/kg
	Lead	7,210 mg/kg
SJS05-SS09	Arsenic	111 K mg/kg
SJS05-SS11	Arsenic	152 mg/kg
SJS05-SS19	Lead	4,740 mg/kg
SJS05-SS44	Copper	209,000 J mg/kg
SJS05-SS46	Arsenic	136 mg/kg
SJS05-SS66	Copper	99,700 J mg/kg

Table 2-3
Samples Within the Waste/Burnt Soil Area and Human Health Risk-Based Removal Areas
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

Station ID	Sample ID	Sample Date	Planned Removal
SJS05-SS01	SJS05-SS01-000	06/24/97	√
SJS05-SS02	SJS05-SS02-000	06/26/97	
SJS05-SS03	SJS05-SS03-000	06/26/97	
SJS05-SS04	SJS05-SS04-000	06/26/97	
SJS05-SS05	SJS05-SS05-000	06/26/97	√
SJS05-SS06	SJS05-SS06-000	06/26/97	√
SJS05-SS07	SJS05-SS07-000	06/26/97	√
SJS05-SS07	SJS05-SS07-000P	duplicate	√
SJS05-SS08	SJS05-SS08-000	06/26/97	√
SJS05-SS09	SJS05-SS09-000	06/26/97	√
SJS05-SS10	SJS05-SS10-000	04/21/99	√
SJS05-SS11	SJS05-SS11-000	04/21/99	√
SJS05-SS12	SJS05-SS12-000	04/22/99	
SJS05-SS13	SJS05-SS13-000	04/21/99	
SJS05-SS14	SJS05-SS14-000	04/22/99	
SJS05-SS15	SJS05-SS15-000	04/21/99	
SJS05-SS16	SJS05-SS16-000	04/22/99	
SJS05-SS17	SJS05-SS17-000	04/22/99	
SJS05-SS18	SJS05-SS18-000	04/22/99	
SJS05-SS19	SJS05-SS19-000	04/22/99	√
SJS05-SS20	SJS05-SS20-000	04/22/99	
SJS05-SS21	SJS05-SS21-000	04/22/99	
SJS05-SS22	SJS05-SS22-000	04/22/99	
SJS05-SS23	SJS05-SS23-000	04/22/99	
SJS05-SS24	SJS05-SS24-000	04/22/99	
SJS05-SS25	SJS05-SS25-000	04/22/99	
SJS05-SS26	SJS05-SS26-000	04/22/99	
SJS05-SS27	SJS05-SS27-000	04/22/99	
SJS05-SS27	SJS05-SS27-000P	04/22/99	
SJS05-SS28	SJS05-SS28-000	04/22/99	
SJS05-SS30	SJS05-SS30-000	04/19/99	
SJS05-SS31	SJS05-SS31-000	04/19/99	
SJS05-SS32	SJS05-SS32-000	04/19/99	
SJS05-SS33	SJS05-SS33-000	04/22/99	
SJS05-SS34	SJS05-SS34-000	04/22/99	
SJS05-SS35	SJS05-SS35-000	04/22/99	
SJS05-SS36	SJS05-SS36-000	11/04/02	√
SJS05-SS37	SJS05-SS37-000	11/04/02	√
SJS05-SS37	SJS05-SS37P-000	duplicate	√
SJS05-SS38	SJS05-SS38-000	11/04/02	
SJS05-SS39	SJS05-SS39-000	11/04/02	
SJS05-SO40	SJS05-SS40-00-03D	12/11/03	
SJS05-SO41	SJS05-SS41-00-03D	12/11/03	
SJS05-SO42	SJS05-SS42-00-03D	12/11/03	
SJS05-SO42	SJS05-SS42-00-03D-P	duplicate	
SJS05-SO43	SJS05-SS43-00-03D	12/10/03	

Table 2-3
Samples Within the Waste/Burnt Soil Area and Human Health Risk-Based Removal Areas
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

Station ID	Sample ID	Sample Date	Planned Removal
SJS05-SO44	SJS05-SS44-00-03D	12/10/03	√
SJS05-SO45	SJS05-SS45-00-03D	12/10/03	
SJS05-SO46	SJS05-SS46-00-03D	12/10/03	√
SJS05-SO47	SJS05-SS47-00-03D	12/10/03	
SJS05-SO48	SJS05-SS48-00-03D	12/10/03	
SJS05-SO48	SJS05-SS48-00-03D-P	duplicate	
SJS05-SO49	SJS05-SS49-00-03D	12/10/03	
SJS05-SO50	SJS05-SS50-00-03D	12/10/03	
SJS05-SO50	SJS05-SS50-00-03D-P	duplicate	
SJS05-SO51	SJS05-SS51-00-03D	12/10/03	
SJS05-SO52	SJS05-SS52-00-03D	12/10/03	
SJS05-SO53	SJS05-SS53-00-03D	12/10/03	
SJS05-SO54	SJS05-SS54-00-03D	12/10/03	
SJS05-SO55	SJS05-SS55-00-03D	12/10/03	
SJS05-SO56	SJS05-SS56-00-03D	12/11/03	
SJS05-SO57	SJS05-SS57-00-03D	12/11/03	
SJS05-SO58	SJS05-SS58-00-03D	12/11/03	
SJS05-SO59	SJS05-SS59-00-03D	12/11/03	
SJS05-SO60	SJS05-SS60-00-03D	12/11/03	
SJS05-SO61	SJS05-SS61-00-03D	12/11/03	
SJS05-SO62	SJS05-SS62-00-03D	12/10/03	
SJS05-SO63	SJS05-SS63-00-03D	12/10/03	
SJS05-SO64	SJS05-SS64-00-03D	12/10/03	
SJS05-SO65	SJS05-SS65-00-03D	12/10/03	√
SJS05-SO66	SJS05-SS66-00-03D	12/10/03	√
SJS05-SO67	SJS05-SS67-00-03D	12/10/03	
SJS05-SD01	SJS05-SD01-000	07/14/97	
SJS05-SD02	SJS05-SD02-000	07/14/97	
SJS05-SD03	SJS05-SD03-000	06/26/97	
SJS05-SD04	SJS05-SD04-001	04/15/99	
SJS05-SD05	SJS05-SD05-001	04/22/99	
SJS05-SD06	SJS05-SD06-001	04/22/99	
SJS05-SD06	SJS05-SD06-001P	duplicate	
SJS05-SD07	SJS05-SD07-001	10/28/99	
SJS05-SD07	SJS05-SD07-001P	duplicate	

Table 2-4
Selection of Ecological Comparison Values
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

COPCs	Ecological Screening Value[1]	95% Background UTL for Dredge Fill Soil	Ecological Comparison Value[2]
Metals (MG/KG)			
Aluminum	1	22,786	22,786
Antimony	0.48	1.47	1.47
Arsenic	328	24.0	328
Barium	440	98.0	440
Beryllium	0.02	1.0	1.0
Chromium	0.01	45.0	45.0
Cobalt	100	13.0	100
Copper	15	58.0	58.0
Cyanide	0.06	--	0.06
Iron	12	45,805	45,805
Lead	0.01	147	147
Mercury	0.06	1.3	1.3
Nickel	2.00	19.0	19.0
Selenium	1.80	2.2	2.2
Silver	0.00001	0.7	0.7
Thallium	0.001	--	0.001
Vanadium	0.5	70	70
Zinc	10	137	137
Pesticides (UG/KG)			
4,4'-DDD	100	5.3	100
4,4'-DDE	100	9.0	100
4,4'-DDT	100	21.0	100
Dieldrin	100	5.3	100
Endrin aldehyde	100	5.4	100

Notes:
[1] - Screening values used in the ERAs presented in the RI (CH2M HILL, 2003) and ERI (CH2M HILL, 2006)
[2] - The greater of the ecological screening value and the 95% background UTL for dredge fill soil
"--" not detected in background

Table 2-5
Average Ecological COPC Concentrations in Borrow Soil
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

COPCs	LS08-BF1 10/31/2005 Camden Yards	LS08-BF2 2/3/2006 Camden Yards	SJCA-S04-GF13 3/23/2005 Suffolk Materials	SJCA-S04-TS14 4/5/2006 Suffolk Materials	SJS19-BM01 2/27/2006 Suffolk Materials	SJS19-BM02 2/27/2006 Suffolk Materials	Average Borrow Soil Concentration[1]
Metals (MG/KG)							
Aluminum	NA	7900	2,820	7,320	1,670	5,450	5,032
Antimony	NA	0.47 R	0.55 U	0.60 U	0.31 U	0.32 U	0.27
Arsenic	1.9	1.9 J	1.6 B	1.2 B	1.1 B	1.5 B	1.1
Barium	NA	28.5 J	8 B	46.4 B	3.3 B	19 B	0.1
Beryllium	NA	0.15 J	0.097 B	0.13 B	0.031 B	0.091 B	0.06
Chromium	NA	9.4	5.7	5.9	1.7	4.7	5.5
Cobalt	NA	0.73 J	0.28 B	0.53 B	0.31 B	0.37 B	0.30
Copper	NA	7.8 B	1.6 B	5 B	4.3	4.9	3.3
Cyanide	NA	0.22 B	1	0.050 U	0.091 U	0.1 U	0.25
Iron	NA	2140	3,840	4,900	1,860	2,560	3,060
Lead	NA	9.4 K	5.4 N	15	2.1	6.6	7.7
Mercury	NA	0.06 U	0.055 U	0.099 B	0.046 U	0.050 U	0.03
Nickel	NA	3.9 J	0.7 B	2.4 B	1.1 B	2.1 B	1.4
Selenium	NA	0.94 U	0.86 UN	0.94 U	0.62 U	0.64 U	0.4
Silver	NA	0.12 U	0.15 UN	0.17 U	0.41 B	0.24 B	0.11
Thallium	NA	1.1 B	1.4 U	1.5 U	0.56 B	0.48 U	0.50
Vanadium	NA	8.1 J	15.8	10.8 B	5.8 B	7.8 B	7.2
Zinc	NA	12.1 J	3 B	26	5.0	10.0	10.9
Pesticides (UG/KG)							
4,4'-DDD	NA	4.1 U	3.6 U	1.1 J	3.7 U	3.8 U	1.7
4,4'-DDE	NA	4.1 U	3.6 U	9.7	3.7 U	3.8 U	3.5
4,4'-DDT	NA	4.1 U	3.6 U	25	3.7 U	3.8 U	6.5
Dieldrin		11	3.6 U	4.2 U	3.7 U	3.8 U	3.7
Endrin aldehyde	NA	4.1 U	3.6 U	4.2 U	3.7 U	U	1.9

Notes:
[1] - Half of the detection limit values were used for non-detects.

Table 2-6
Site-Wide Summary Statistics Based on Initial Planned Removal
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

COPCs	Acceptable Level of Ecological Risk[1]	Maximum	Maximum Sample ID	Mean[2]	Ratio of Mean to Concentration Posing Acceptable Level of Ecological Risk
Metals (MG/KG)					
Aluminum	22,786	22,200	SJS05-SS49	8,584.1	0.4
Antimony	1.47	28	SJS05-SS38	0.9	0.6
Arsenic	328	81.6	SJS05-SS32	8.8	0.03
Barium	440	3,350	SJS05-SS52	175.5	0.4
Beryllium	1.0	3.5	SJS05-SD01	0.4	0.4
Chromium	45.0	44.7	SJS05-SS35	16.9	0.4
Cobalt	100	46.8	SJS05-SD01	3.5	0.03
Copper	58.0	256	SJS05-SD01	41.2	0.7
Cyanide	0.06	5.2	SJS05-SS51	0.4	6.3
Iron	45,805	161,000	SJS05-SD02	18,065.0	0.4
Lead	147	832	SJS05-SS40	143.9	1.0
Mercury	1.3	1.1	SJS05-SS33	0.2	0.1
Nickel	19.0	71.1	SJS05-SS52	8.1	0.4
Selenium	2.2	2.1	SJS05-SS38	0.5	0.2
Silver	0.7	6.1	SJS05-SS49	0.9	1.3
Thallium	0.001	5.7	SJS05-SD02	0.6	624.7
Vanadium	70	69.1	SJS05-SS35	26.5	0.4
Zinc	137	2,100	SJS05-SS43	172.2	1.3
Pesticides (UG/KG)					
4,4'-DDD	100	160	SJS05-SD01	12.4	0.1
4,4'-DDE	100	4,700	SJS05-SS35	197.6	2.0
4,4'-DDT	100	3,100	SJS05-SS35	157.3	1.6
Dieldrin	100	21	SJS05-SD03	3.7	0.04
Endrin aldehyde	100	8.9	SJS05-SD02	3.1	0.03

Notes:

[1] - The greater of the ecological screening value and the 95% background UTL for dredge fill soil

[2] - Site-wide mean of concentrations remaining after removal of samples driving potential human health risks and backfilling with borrow soil (includes removal of SS01, SS05 through SS11, SS19, SS36, SS37, SS44, SS46, SS65 and SS66). Half of the detection limit values were used for non-detects.

Shaded cells indicate mean ratios-to-acceptable level of ecological risk greater than 1.0

Table 2-7
Site-Wide Summary Statistics Based on Additional Removal to Address Potential Ecological Risk
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

COPCs	Comparison Value[1]	Maximum	Maximum Sample ID	Mean[2]	Ratio of Mean to Comparison Value
Metals (MG/KG)					
Aluminum	22,786	21,300	SJS05-SS56	7,932.9	0.3
Antimony	1.47	28	SJS05-SS38	0.9	0.6
Arsenic	328	37.7	SJS05-SS38	6.5	0.02
Barium	440	3,350	SJS05-SS52	134	0.3
Beryllium	1.0	2.4	SJS05-SD03	0.3	0.3
Chromium	45.0	39.5	SJS05-SS56	14.9	0.3
Cobalt	100	11.1	SJS05-SS18	2.6	0.03
Copper	58.0	235	SJS05-SS67	33.3	0.6
Cyanide	0.06	5.2	SJS05-SS51	0.3	5.3
Iron	45,805	161,000	SJS05-SD02	15,570	0.3
Lead	147	832	SJS05-SS40	124.8	0.8
Mercury	1.3	1.1	SJS05-SS33	0.2	0.1
Nickel	19.0	71.1	SJS05-SS52	6.9	0.4
Selenium	2.2	2.1	SJS05-SS38	0.5	0.2
Silver	0.7	4.7	SJS05-SS56	0.7	1.0
Thallium	0.001	5.7	SJS05-SD02	0.6	636.0
Vanadium	70	62.1	SJS05-SS23	23.1	0.3
Zinc	137	1,870	SJS05-SS52	124.6	0.9
Pesticides (UG/KG)					
4,4'-DDD	100	130	SJS05-SD04	9.6	0.1
4,4'-DDE	100	4,700	SJS05-SS13	101.2	1.0
4,4'-DDT	100	3,100	SJS05-SS56	63.2	0.6
Dieldrin	100	21	SJS05-SD03	3.8	0.04
Endrin aldehyde	100	8.9	SJS05-SD02	3.0	0.03

Notes:

[1] - The greater of 95% background UTL for dredge fill soil, BTAG screening value, or alternate screening value from available scientific literature

[2] - Site-wide mean of concentrations remaining after removal of samples driving potential human health and ecological risks, and backfilling with borrow soil (includes removal of SS01, SS05 through SS11, SS19, SS36, SS37, SS43, SS44, SS46, SS49, SS50, SS65 SS66, and SD01). Half of the detection limit values were used for non-detects.

Shaded cells indicate ratio of mean to comparison value of greater than 1.0

Table 2-8
Summary of Samples Identified for Removal
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

Station ID	Sample ID	Sample Date	Identified for Removal	
			Human Health	Ecological
SJS05-SS01	SJS05-SS01-000	06/24/97	√	
SJS05-SS05	SJS05-SS05-000	06/26/97	√	
SJS05-SS06	SJS05-SS06-000	06/26/97	√	
SJS05-SS07	SJS05-SS07-000	06/26/97	√	
SJS05-SS07	SJS05-SS07-000P	duplicate	√	
SJS05-SS08	SJS05-SS08-000	06/26/97	√	
SJS05-SS09	SJS05-SS09-000	06/26/97	√	
SJS05-SS10	SJS05-SS10-000	04/21/99	√	
SJS05-SS11	SJS05-SS11-000	04/21/99	√	
SJS05-SS19	SJS05-SS19-000	04/22/99	√	
SJS05-SS32	SJS05-SS32-000	04/19/99		√
SJS05-SS35	SJS05-SS35-000	04/22/99		√
SJS05-SS36	SJS05-SS36-000	11/04/02	√	
SJS05-SS37	SJS05-SS37-000	11/04/02	√	
SJS05-SS37	SJS05-SS37P-000	duplicate	√	
SJS05-SO43	SJS05-SS43-00-03D	12/10/03		√
SJS05-SO44	SJS05-SS44-00-03D	12/10/03	√	
SJS05-SO46	SJS05-SS46-00-03D	12/10/03	√	
SJS05-SO49	SJS05-SS49-00-03D	12/10/03		√
SJS05-SO50	SJS05-SS50-00-03D	12/10/03		√
SJS05-SO50	SJS05-SS50-00-03D-P	duplicate		√
SJS05-SO65	SJS05-SS65-00-03D	12/10/03	√	
SJS05-SO66	SJS05-SS66-00-03D	12/10/03	√	
SJS05-SD01	SJS05-SD01-000	07/14/97		√

Table 2-9
Human Health Risk-Based Cleanup Goals
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

COC	Adult Resident	Child Resident
Non-Cancer Hazards	**HI = 1**	**HI = 1**
Arsenic (mg/kg)	196	22
Copper (mg/kg)	28,080	3,043
Cancer Risks*	**TCR = 10^{-4}**	**TCR = 10^{-4}**
Arsenic (mg/kg)	39	39

* Based on Lifetime Resident

Table 2-10
Calculation of Site-Specific Human Health Risk-Based Cleanup Goals for Soil
Lifetime Residential Scenario
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

Chemical	Cancer Slope Factor Oral (CSFo) $(mg/kg\text{-}day)^{-1}$	Cancer Slope Factor Dermal (CSFd) $(mg/kg\text{-}day)^{-1}$	Dermal Absorption from Soil (ABS) (unitless)	Ingestion Adjustment Factor (mg-yr/kg-day)	Dermal Adjustment Factor (mg-yr/kg-day)	Carcinogenic Risk-Based Cleanup Goal $TCR = 10^{-4}$ (mg/kg)
Arsenic	1.50E+00	1.50E+00	3.00E-02	1.14E+02	3.6E+02	3.9E+01
Copper	NA	NA	1.00E-02	NA	NA	NA

Noncarcinogenic calculations:

$$\text{Soil Screening Level (mg/kg)} = \frac{TCR \times AT_c}{10^{-6}\frac{kg}{mg} \times ED \times \left[\left(CSF_{oral} \times Ing\ AF\right) + \left(CSF_{dermal} \times ABS \times Ing\ AF\right)\right]}$$

$$\text{Ingestion Adjustment Factor} = \left(\frac{IR_{child} \times ED_{child}}{BW_{child}}\right) + \left(\frac{IR_{adult} \times ED_{adult}}{BW_{adult}}\right)$$

$$\text{Dermal Adjustment Factor} = \left(\frac{SA_{child} \times AF_{child} \times ED_{child}}{BW_{child}}\right) + \left(\frac{SA_{adult} \times AF_{adult} \times ED_{adult}}{BW_{adult}}\right)$$

EXPOSURE ASSUMPTIONS	Child	Adult
BW - Body weight (kilograms)	15	70
ATc - Averaging time for carcinogens (days)	25,550	25,550
EF - Exposure frequency (days/year)	350	350
ED - Exposure duration (year)	6	24
IRS - Ingestion rate (mg/day)	200	100
SA - Skin surface area (cm^2)	2,800	5,700
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	0.20	0.07
Dermal absorption fraction from soil (unitless)	chemical specific	

[1] Target HQ calculated so that total HQ for a target organ does not exceed 1.

Table 2-11
Calculation of Site-Specific Human Health Risk-Based Cleanup Goals for Soil
Adult Residential Scenario
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Target Organ	Dermal Absorption from Soil (ABS) (unitless)	An	Bn	Noncarcinogenic Hazard Based Cleanup Goal HQ = 1 (mg/kg)
Arsenic	3.0E-04	3.0E-04	Skin/Vascular	3.00E-02	3.3E-01	4.0E-02	2.0E+02
Copper	4.00E-02	4.00E-02	Gastrointestinal	1.00E-02	2.5E-03	1.0E-04	2.8E+04

Noncarcinogenic calculations:

$$\text{Soil Screening Level (mg/kg)} = \frac{\text{Target HQ} \times \text{BW} \times \text{AT}_n}{\text{EF} \times \text{ED} \times (\text{An} + \text{Bn})}$$

$$\text{An} = 1/\text{RfDo} \times \text{IRS}/10^6 \text{ mg/kg}$$

$$\text{Bn} = 1/\text{RfDd} \times \text{SA} \times \text{AF} \times \text{ABS} \times 1/10^6 \text{ mg/kg}$$

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	70
ATnc - Averaging time for noncarcinogens (days)	8,760
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	24
IRS - Ingestion rate (mg/day)	100
SA - Skin surface area (cm^2)	5,700
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	0.07
ABS - Absorption Factor (unitless)	chemical specific

Table 2-12
Calculation of Site-Specific Human Health Risk-Based Cleanup Goals for Soil
Child Residential Scenario
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Target Organ	Dermal Absorption from Soil (ABS) (unitless)	An	Bn	Noncarcinogenic Hazard-Based Cleanup Goal HQ = 1 (mg/kg)
Arsenic	3.0E-04	3.0E-04	Skin/Vascular	3.00E-02	6.7E-01	5.6E-02	2.2E+01
Copper	4.00E-02	4.00E-02	Gastrointestinal	1.00E-02	5.0E-03	1.4E-04	3.0E+03

Noncarcinogenic calculations:

$$\text{Soil Screening Level (mg/kg)} = \frac{\text{Target HQ} \times \text{BW} \times \text{AT}_n}{\text{EF} \times \text{ED} \times (\text{An} + \text{Bn})}$$

$$\text{An} = 1/\text{RfDo} \times \text{IRS}/10^6 \text{ mg/kg}$$

$$\text{Bn} = 1/\text{RfDd} \times \text{SA} \times \text{AF} \times \text{ABS} \times 1/10^6 \text{ mg/kg}$$

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	15
ATnc - Averaging time for noncarcinogens (days)	2,190
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	6
IRS - Ingestion rate (mg/day)	200
SA - Skin surface area (cm^2)	2,800
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	0.20
ABS - Absorption Factor (unitless)	chemical specific

Table 2-13
Summary of Background UTLs and Human Health Risk-Based Cleanup Goals
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

COC	95% Background UTL for Dredge Fill Soil	Human Health Risk-Based Cleanup Goals
Arsenic (mg/kg)	14	22
Copper (mg/kg)	40	3,043
Lead (mg/kg)	86	400*

Recommended cleanup goals are shaded gray

*Average site-wide concentration

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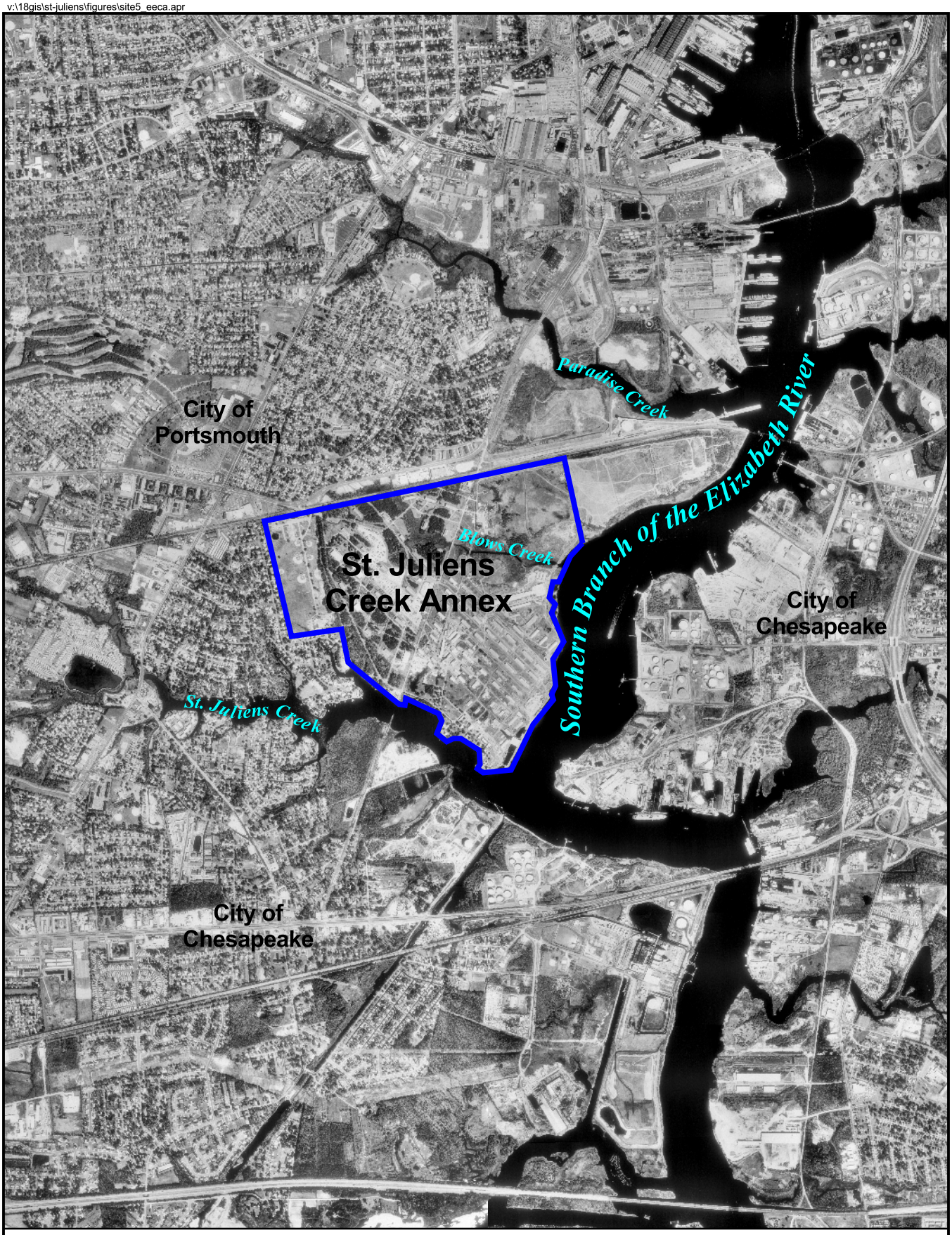

LEGEND

St. Juliens Creek Annex

N

0 1250 2500 Feet

Figure 2-1
Location of St. Juliens Creek Annex
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

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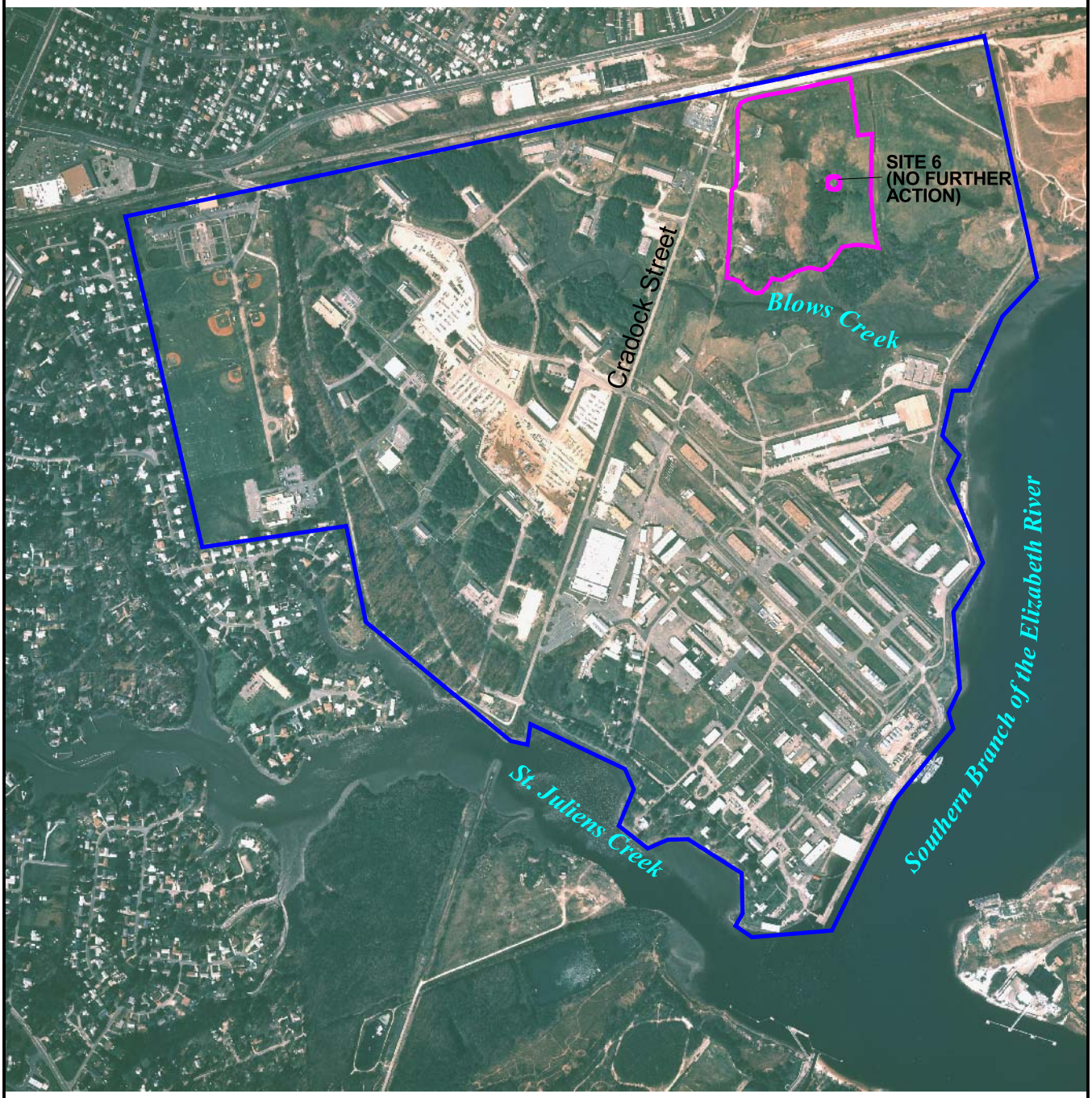

LEGEND

- Site 5 Boundary
- St. Juliens Creek Annex

N

0 500 1000 Feet

Figure 2-2
Location of Site 5
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

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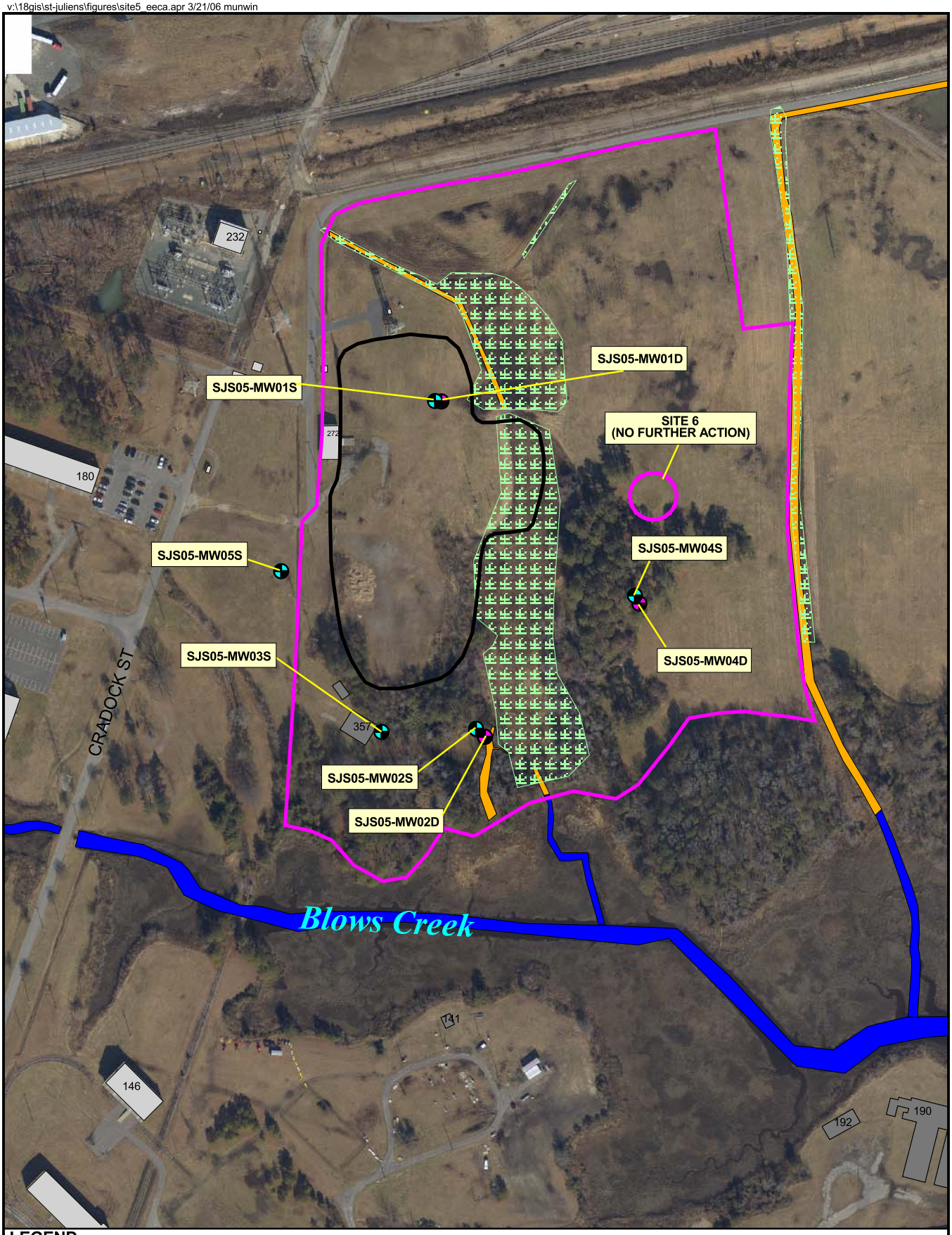

LEGEND

- Shallow Monitoring Well Location
- Deep Monitoring Well Location
- Site 5 Waste/Burnt Soil Area
- Site 5 Boundary
- Lower Drainage
- Upland Drainage
- Existing Wetland Area
- Existing Building
- Former Building

N

0 125 250 Feet

Figure 2-3
Site 5 Layout
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

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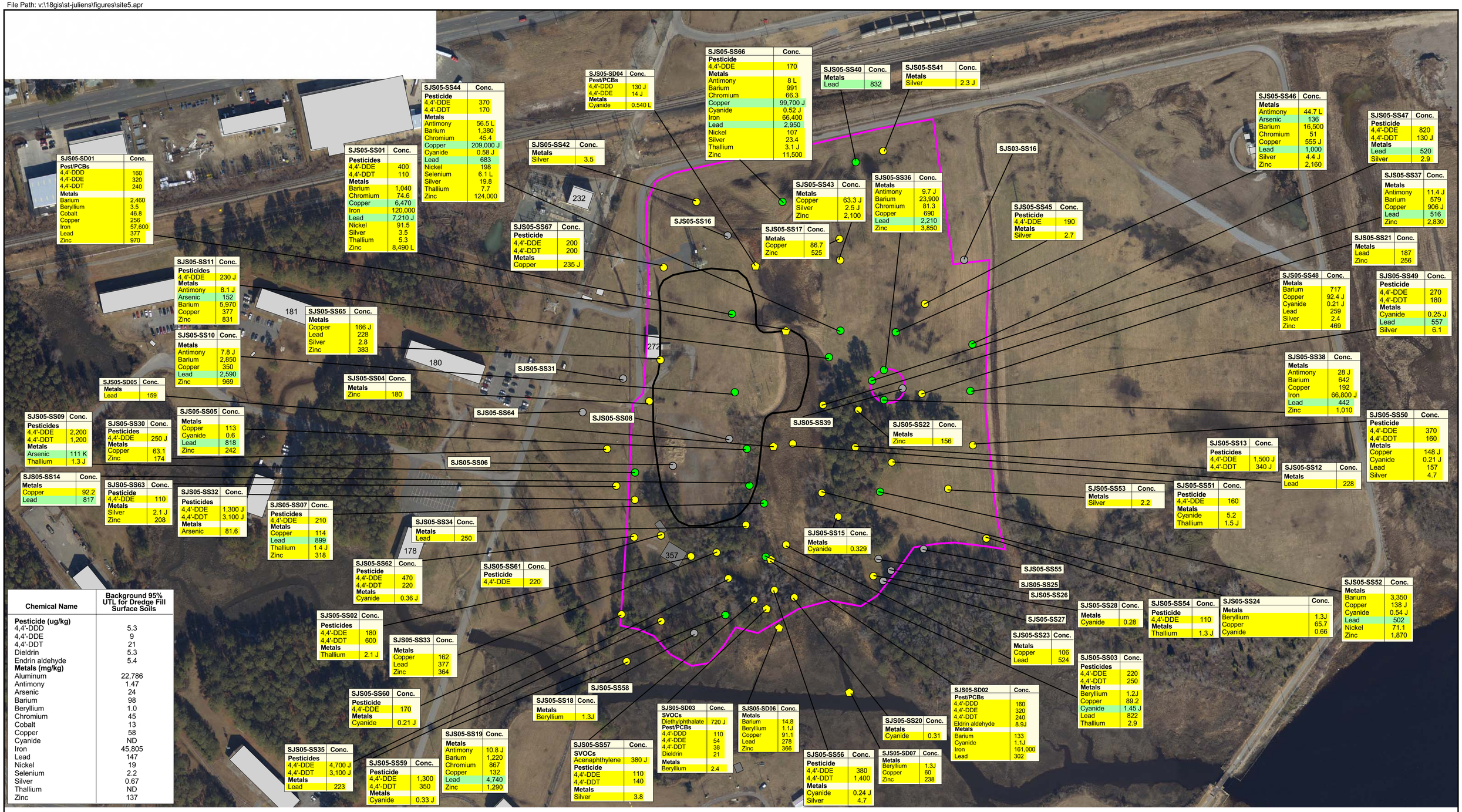

Chemical Name	Background 95% UTL for Dredge Fill Surface Soils
Pesticide (ug/kg)	
4,4'-DDD	5.3
4,4'-DDE	9
4,4'-DDT	21
Dieldrin	5.3
Endrin aldehyde	5.4
Metals (mg/kg)	
Aluminum	22,786
Antimony	1.47
Arsenic	24
Barium	98
Beryllium	1.0
Chromium	45
Cobalt	13
Copper	58
Cyanide	ND
Iron	45,805
Lead	147
Nickel	19
Selenium	2.2
Silver	0.67
Thallium	ND
Zinc	137

LEGEND

- Surface Soil Sample Locations Posing No Potential Risks
- Surface Soil/Sediment Sample Locations with Ecological COPCs Exceeding Background UTLs
- Surface Soil/Sediment Sample Locations with Human Health and Ecological COPCs Exceeding Background UTLs
- Site 5 Waste/Burnt Soil Area
- Ecological COPC
- Ecological and Human Health COPC
- Site 5 Boundary
- Existing Building
- Former Building

Notes:
J - Reported value may not be accurate or precise.
K - Reported value may be biased high.
L - Reported value may be biased low.
ND - Not detected
COPC - Chemical of Potential Concern
UTL - Upper Tolerance Level
Pesticide concentrations are in ug/kg.
Metals concentrations are in mg/kg.

N

0 175 350 Feet

Figure 2-4
Surface Soil and Sediment COPCs Exceeding Background UTLs
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

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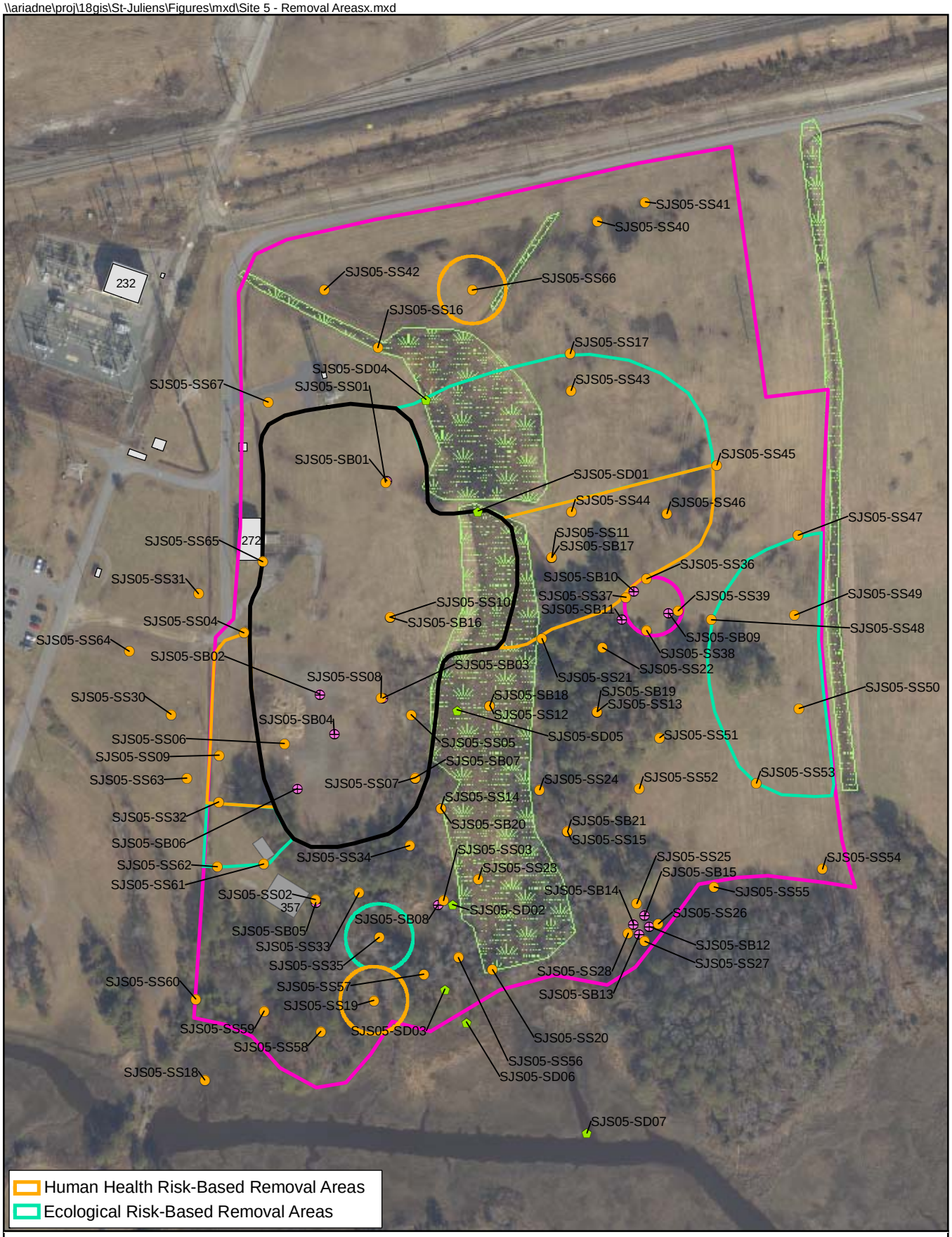

LEGEND

- Site 5 Boundary
- Site 5 Waste/Burnt Soil Area
- Sediment Sample Locations
- Surface Soil Sample Locations
- Subsurface Soil Sample Locations
- Existing Wetland Area
- Existing Buildings
- Former Buildings

N

0 100 200 Feet

Figure 2-5
Removal Areas
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

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SECTION 3

Identification of Removal Action Objectives

3.1 Statutory Limits on Removal Actions

The NCP 40 CFR Part 300.415 dictates statutory limits of $2 million and 12 months of CERCLA fund-financed removal actions, with statutory exemptions for emergencies and actions consistent with the removal action to be taken. This removal action will not be CERCLA fund-financed; it will be financed by the Navy. The Navy/Marine Corps IR Manual does not limit the cost or duration of the removal action; however, cost-effectiveness is a recommended criterion for the evaluation of removal action alternatives.

3.2 Removal Action Scope

The scope of this removal action is to address potential risk to human health and ecological receptors associated with waste, burnt soil, and impacted surface soil and sediment. In this EE/CA, several removal action alternatives have been developed to meet the following removal action objectives for Site 5:

- Implement measures that mitigate potential unacceptable risk to human health and the environment posed by exposure to waste, burnt soil, and impacted surface soil and sediment.
- Remove the potential source of contamination to the shallow groundwater.
- Perform a removal action in preparation for site closeout under CERCLA with NFA.

The scope of the engineering measures for each removal alternative developed is discussed in Section 4.

3.3 Determination of Removal Schedule

The EE/CA was drafted was placed in the information repository for a 30-day public comment period. Notice of its availability, along with a brief summary, was published in the local newspaper on January 19, 2007. No public comments were received during the 30 day period. A public information session was not held during or following the public comment period because no comments were received and the meeting was not requested.

Since this removal action has been designated non-time critical, the start date will be determined by factors other than the urgency of the threat. Possible factors include weather conditions, the availability of resources, and site constraints.

The total project period is predicted to last approximately 14 months from the end of the of the public comment period through completion of CERCLA documentation. Critical milestone periods related to the EE/CA are summarized below:

- EE/CA Public Comment Period—1 month
- Work Plan, Subcontracting and Mobilization—3 months
- Removal Action—6 months
- CERCLA Documentation—4 months

The estimated timeframe includes the time required for mobilization and setup of equipment and performing the selected removal actions.

3.4 Applicable or Relevant and Appropriate Requirements

As required by Section 121 of CERCLA, remedial actions carried out under Section 104 or secured under Section 106 must attain the levels of standards of control for hazardous substances, pollutants, or contaminants specified by the applicable or relevant and appropriate requirements (ARARs) of federal and state environmental laws and state facility-siting laws, unless waivers are obtained. The requirements of CERCLA generally apply as a matter of law only to remedial actions. However, as required by USEPA's policy 40 CFR Section 300.415(j), ARARs will be identified and attained for removal actions to the extent practicable. Three factors will be applied to determine whether the identification and attainment of ARARs is practicable in a particular removal situation: (1) the exigencies of the situation; (2) the scope of the removal action to be taken; and (3) the effect of ARAR attainment on the statutory limits for removal action duration and cost.

ARARs are identified by the USEPA as either being applicable to a situation or relevant and appropriate to it. These distinctions are critical to understanding the constraints imposed on response alternatives by environmental regulations other than CERCLA. The definitions of ARARs below are from the USEPA guidance (USEPA, October 1988).

"Applicable requirements" are standards and other environmental protection requirements of federal or state law dealing with a hazardous substance, pollutant, contaminant, action being taken, location, or other circumstance at a CERCLA site.

"Relevant and appropriate requirements" are standards and environmental protection criteria of federal or state law that, although not "applicable" to a hazardous substance, pollutant, contaminant, action being taken, location, or other circumstance, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. The procedure to determine if a requirement is relevant and appropriate is a two-step process. A requirement is "relevant" if it addresses problems or situations sufficiently similar to the circumstances of the proposed response action. A requirement is "appropriate" if it would also be well suited to the conditions of the site.

A requirement may be "relevant" to a particular situation but not "appropriate," given site-specific circumstances; such a requirement would not be an ARAR for the site. A requirement that is relevant and appropriate must be met as if it were applicable. Relevant and appropriate requirements that are more stringent than applicable requirements take

precedence. However, more discretion is allowed in determining relevant and appropriate requirements than in determining applicable requirements.

"To-be-considered" (TBC) are non-promulgated advisories or guidance issued by federal or state government that are not legally binding, and do not have the status of potential ARARs. TBCs are evaluated along with ARARs and may be implemented by USEPA when ARARs are not fully protective of human health and the environment.

Another factor in determining which response requirement must be met is whether the requirement is substantive or administrative. Onsite CERCLA response actions must meet substantive requirements but not administrative requirements. Substantive requirements are those dealing directly with actions or with conditions in the environment. Administrative requirements implement the substantive requirements by prescribing procedures such as fees, permitting, and inspection that make substantive requirements effective. This distinction applies to onsite actions only; offsite response actions are subject to all applicable standards and regulations, including administrative requirements such as permits.

Three classifications of requirements are defined by USEPA in the ARAR determination process: chemical-specific, location-specific, and action-specific.

Chemical-specific ARARs are health or risk management-based numbers or methodologies that result in the establishment of numerical values for a given medium that would meet the NCP "threshold criterion" of overall protection of human health and the environment. These requirements generally set protective cleanup concentrations for the chemicals of concern (COCs) in the designated media, or set safe concentrations of discharge for response activity. Chemical-specific requirements are generally set for a single chemical or closely related group of chemicals and do not typically consider mixtures of chemicals. When chemical-specific requirements do not adequately protect human health or the environment, cleanup goals may be set below the TBC value. Federal and Commonwealth of Virginia chemical-specific regulations that have been reviewed are summarized in Appendix C.

Location-specific ARARs restrict response activities and media concentrations based on the characteristics of the surrounding environments. Location-specific ARARs may include restrictions on response actions within wetlands or floodplains, near locations of known endangered species, or on protected waterways. Federal and Commonwealth of Virginia location-specific regulations that have been reviewed are summarized in Appendix C.

Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances. Federal and Commonwealth of Virginia action-specific ARARs that may affect the development and conceptual arrangement of response alternatives are summarized in Appendix C.

SECTION 4

Identification and Analysis of Removal Action Alternatives

A removal action is planned for Site 5 based on the removal areas identified in Section 2.4. The alternatives for this NTCRA were considered using professional judgment and information from previous investigations. Alternatives were evaluated based on effectiveness, implementability, and cost. The no action alternative was evaluated for comparative purposes.

4.1 Description of Removal Action Alternatives Common Components

There are several activities that are components of multiple alternatives. A description of those activities follows to reduce the redundancy in the individual alternative descriptions:

Monitoring Well Abandonment/Installation: Two monitoring wells (SJS05-MW01S and SJS05-MW01D) require abandonment for Alternatives 2, 3, and 4. The remainder of the monitoring wells (SJS05-MW02S, SJS05-MW02D, SJS05-MW03S, SJS05-MW04S, SJS05-MW04D, and SJS05-MW05S) remains in place. For alternatives where the wells are abandoned, a new shallow groundwater monitoring well will be installed as near to the original location as practical. The deep groundwater well will not be replaced because no risks were identified in deep groundwater and no additional monitoring is planned.

Munitions and Explosives of Concern (MEC) Support: A two to four person team of MEC support personnel will provide construction support for all intrusive activities at Site 5, including clearing, sampling, excavation, well installation, and fence installation. The MEC support personnel will directly control all intrusive activities in order to achieve maximum operational safety and efficiency. The MEC support team will be responsible for identifying any potential MEC-related items through the use of magnetometers and visual observation during all intrusive activities. No intrusive activities may take place without the presence of the MEC support team. MEC support personnel will also be responsible for overseeing the mechanical screening of all excavated material prior to offsite disposal.

Erosion and Sediment Controls: Erosion and sediment controls will be installed for Alternatives 2, 3, and 4. Specific controls will be developed in the removal action work plan. The controls will be installed and maintained in accordance with the *Virginia Erosion and Sediment Control Handbook*. Erosion and sediment controls will consist of perimeter controls and diversion berms.

Site Clearing: Site clearing will be required for Alternatives 2, 3, and 4 and consists of approximately 1.1 acres of brush clearing and 0.5 acres of small tree clearing.

Waste Characterization Sampling: Waste characterization samples will be collected as part of alternatives that require offsite disposal of material. Waste characterization analysis consists of full Toxicity Characteristic Leaching Procedure (TCLP), corrosivity, reactivity, ignitability, and total petroleum hydrocarbon (TPH), along with any additional testing required by the disposal facility. Waste characterization samples will be collected at the rate required by the disposal facility.

Excavation: Alternatives consisting of excavation include the excavation of the removal areas defined in Section 2.4. As indicated in Section 2.4, the waste/burnt soil area was delineated during the RI. The waste/burnt soil area covers approximately 4.2 acres and extends to a depth ranging from surficial to 26 inches bgs. The actual horizontal and vertical limits will be determined visually during the removal action. The RI test pit locations are indicated in Figure 4-1 and the field logs are provided in Appendix D. Although a SJCA employee interview noted asbestos pipe buried to 10 ft (indicated in Section 2.2), because there are no other records of disposal to such great depth, the removal action depth is based on the RI waste delineation. In the removal areas outside of the waste/burnt soil area, surface soil will be removed to a depth of 1 ft, based on subsurface soil data collected during the RI. Confirmation samples will be collected to confirm the vertical extent of the waste/burnt soil and human health risk-based excavations is sufficient, as described below. All excavated materials will be mechanically screened to identify any MEC-related items prior to being loaded for offsite disposal. MEC support personnel will oversee both the excavation and screening process to ensure that MEC-related items are identified. Materials excavated from below the current water table at the time of the excavation may require dewatering prior to being screened. A dewatering pad will be constructed on the site to allow water to drain from the soil sufficiently to allow mechanical screening; it is anticipated that no dewatering additives will be necessary to sufficiently solidify the material prior to offsite disposal. Water from the dewatering pad will be allowed to re-infiltrate back into the ground at the site.

Confirmation Sampling: Confirmation samples will be collected and analyzed for arsenic, copper, and lead. Within the waste/burnt soil area, confirmation samples will be collected below the visible limits of the waste. In the human risk-based removal areas, confirmation samples will be collected at a depth of 1 ft. To delineate the horizontal extent of the waste/burnt soil area, 10 soil samples will be collected around the perimeter of the excavation. The horizontal extent of the human health risk-based areas is defined by existing samples where concentrations do not pose a potential human health risk (Figure 2-5). To verify that the vertical extent of the removal action results in concentrations protective of human health, the EE/CA assumes that confirmation soil samples will be collected based on 75 × 75 ft grids. For the two isolated human health risk-based removal areas (SJS05-SS19 and SJS05-SS66), confirmation sampling will consist of one floor sample and 4 wall samples.

The confirmation sample results will be screened against the risk-based cleanup goals (Table 2-13). If all of the concentrations from the confirmation samples do not meet the cleanup goals, the 95% upper confidence limit (UCL) of the mean will be calculated for the confirmation samples, and if the 95% UCL of the mean is below the cleanup goal, no additional removal will be required. If the 95% UCL exceeds the cleanup goal, additional removal will be conducted until the 95% UCL of all confirmation samples is below the cleanup goal.

Offsite Transportation and Disposal: All excavated materials will be loaded into haul trucks and transported to an offsite disposal facility for disposal. Disposal facility selection will be based on the results of the waste-characterization samples and will be approved by the Navy prior to transport of any material.

Offsite Borrow: Because there is no known onsite borrow source, all fill material will be brought from offsite. Offsite borrow materials, including general fill, vegetative support material, and topsoil**,** will be certified clean through analytical testing of VOCs, SVOCs, pesticides/polychlorinated biphenyls (PCBs) and metals and comparison to USEPA Region III Residential Risk-Based Concentrations (RBCs) and the 95% UTL for dredge fill. Additionally, cover material will contain less than 50 mg/kg TPH and less than 10 mg/kg benzene, toluene, ethylbenzene, and xylene (BTEX). BTAG ecological screening values will also be considered in evaluation of the fill source. General fill and vegetative support material will consist of clean fill with a maximum particle size of 3 inches. Vegetative support material will be used to provide a suitable base for topsoil. Acceptable topsoil is defined as native or amended soil with an organic salt concentration less than 500 parts per million (ppm), organic content at a minimum of 1.5 percent, and a pH of 6 to 7.5. Topsoil shall be classified as a loam, sandy loam, silt loam, sandy clay loam, or clay loam and have a maximum particle size of ¾ inch.

Vegetative Stabilization through Native Grasses and Wildflowers: Vegetative stabilization through native grasses and wildflowers will consist of hydroseeding all or portions of the site to establish a vegetative stand of temperature- and drought-resistant native grasses and wildflowers. The vegetation will require minimal maintenance, will survive in a low-nutrient soil, and will have sufficient density to control the rate of erosion (less than 2 tons per acre per year).

Compensatory Wetland Mitigation: Implementation of Alternatives 2, 3, and 4 will each result in temporary or permanent impact to the existing wetland. In the case of each alternative, a compensatory wetland mitigation plan will be developed to document the methods that will be employed to off-set the wetland impacts. For the alternatives resulting in temporary impacts (Alternatives 3 and 4), the impacted areas will need to be restored as wetlands. For the alternative resulting in a permanent loss of wetlands (Alternative 2), a wetland will need to be created at an undetermined location to off-set the loss of the wetland. Details of the compensatory mitigation plan for the selected alternative will be developed by the SJCA Tier I Partnering Team.

4.2 Description of Removal Action Alternatives

4.2.1 Alternative 1—No Action

The no action alternative implies that no removal work will be done. The area will be left as it currently exists, leaving the waste, burnt soil, and impacted surface soil and sediment in place. Under this alternative, no controls or removal technologies will be implemented. CERCLA (Section 121(c)), as amended by SARA (1986), requires that the site be reviewed every 5 years since the waste, burnt soil, and impacted surface soil and sediment remain on site. It is assumed that the current level of maintenance will be sustained.

4.2.2 Alternative 2—Cover Installation

Alternative 2 provides for the construction of a cover over the waste/burnt soil area and impacted surface soil and sediment in the human health and ecological risk-based removal areas. The cover consists of a soil cover over most of the site and an asphalt cover over a portion of the site. Figure 4-2 shows the conceptual layout for placing the cover and Figure 4-3 presents schematics of typical soil and asphalt covers. This alternative will include monitoring well abandonment and installation. The site will be cleared with MEC support oversight prior to the cover installation.

The soil cover will be installed with minimum 2 percent slopes to promote surface water drainage and maximum 3H:1V slopes for stability. The soil cover will be 2-ft thick, consisting of an 18-inch vegetative support layer overlain by a 6-inch topsoil layer, and will be stabilized with native grasses and wildflowers.

The asphalt cover will be in accordance with Virginia Department of Transportation (VDOT) standards. Curbs will be installed for storm water control. The regulatory and supplemental layers of the asphalt cover (from bottom to top) will include a compacted leveling layer of offsite general fill, an aggregate base layer of VDOT 21A stone, and an asphaltic concrete pavement layer meeting the mix design criteria of VDOT SM-2A.

Implementation of this alternative will result in the permanent loss of approximately 1.17 acres of wetland. As a result, it is assumed that additional wetland will need to be created at a 2:1 ratio as compensatory wetland mitigation. Determination of the type and location of the compensatory mitigation wetland is not part of this EE/CA; however, a relative cost has been incorporated in the estimate for this alternative in order to more accurately reflect the actual anticipated cost associated with this alternative. Exclusion of the wetland from the cost would bias the cost lower than what it would actually cost.

The cover alternative incorporates actions for erosion protection, maintenance and performance monitoring (groundwater assessment, soil cover inspection, and wetland monitoring), and land use controls (LUCs) (future land use management).

4.2.3 Alternative 3—Excavation and Backfill

Alternative 3 includes the abandonment of monitoring wells, site clearing, excavation of the waste and burnt soil to visible limits, excavation of the surrounding surface soil and sediment in the human health and ecological risk-based removal areas to a minimum of 1 ft bgs, mechanical screening of the excavated material, confirmation sampling, backfill of the excavations to original grade with imported clean fill, restoration to the original condition, and monitoring well installation. The driveway leading to Building 272 will be excavated then restored to operation during the restoration process. MEC support will be required for the intrusive activities of this alternative. Confirmation samples will be collected to verify that the risk-based cleanup goals have been met. Backfill material will consist of general fill and topsoil. General fill will be used to fill the excavation to within 6 in of the surrounding grade. General fill will be placed and compacted in the excavation in 6- to 8-inch lifts. Topsoil will be used for the remaining 6 inches, returning the site to its original grade. Site restoration will include re-vegetation of the upland and wetland areas to their pre-existing condition with the appropriate native seed for each area.

Implementation of Alternative 3 will require 2 years of monitoring and maintenance of the site. Monitoring will verify that the appropriate vegetation has been established to return the wetland to its pre-existing condition. Maintenance will include implementation of measures to prevent the invasion of non-native plant species, including *phragmites*, as well as nuisance wildlife control, including waterfowl and rodents (prevent tree/shrub girding by mice burrowing muskrats and nutria).

For estimating purposes, an excavation depth of 2.5 ft over the waste/burnt soil area and 1-ft over the human health and ecological risk-based removal areas was assumed. It was also assumed that 25% of the confirmation samples will exceed the risk-based cleanup goals and those areas will require an additional 0.5 ft excavation. The total volume of excavated waste, burnt soil, and impacted surface soil and sediment is estimated at 26,420 in-place cubic yards (cy). Figure 4-4 illustrates the limits of the excavation and restoration area, and Figure 4-5 illustrates a typical section of the excavation area.

4.2.4 Alternative 4—Excavation and Restoration/Wetland Creation

Alternative 4 provides for the excavation of the waste/burnt soil area to the visible limits and excavation of the surrounding surface soil and sediment in the human health and ecological risk-based removal areas to a minimum of 1 ft, followed by restoration of a portion of the area as an upland area, a portion as a transitional area, and a portion as a wetland. Several field activities and analyses were conducted to assess the feasibility of this alternative, and are documented in a technical memorandum (Appendix E).

Specific components of the excavation portion of the alternative include monitoring well abandonment, clearing, excavation, confirmation sampling, material screening, offsite disposal, and monitoring well installation. Figure 4-6 illustrates the excavation area for this alternative. MEC support will be required for all intrusive activities of this alternative. During the excavation, the driveway leading to Building 272 will be excavated and restored to operation during the restoration process. Other restoration components include backfill of the surrounding surface soil and sediment in the human health and ecological risk-based removal areas with general fill and topsoil; the placement of 6 inches of imported topsoil to provide a suitable planting base; installation of a monitoring well; vegetative stabilization of the upland portion of the site with native grasses, shrubs, trees, and wildflowers; establishment of an emergent wetland in the eastern portion of the site by seeding the area with emergent wetland plants; and establishment of transitional wetland areas between the upland and emergent wetland by planting fast-growing wetland shrubs and trees as well as seeding the area with emergent vegetation.

During the restoration, minor sloping will be performed to tie the excavated area to the surrounding grade. A planting plan, including quick-growing wetland shrubs and trees, will be developed within the removal action work plan to provide the best possible chance of precluding further spreading of the *phragmites* from the adjacent areas; however, because the hydrology and hydrogeology of the area may not be capable of supporting a high quality emergent wetland, in the event that *phragmites* spreads into the restored area, no active *phragmites* removal will be conducted after the removal action (e.g. during the follow-up maintenance and monitoring).

It is anticipated that restoration will include various planting zones. Portions of the site will be seeded with emergent wetland species, such as soft rush, sedges, and cattail. Around this emergent wetland area, a transitional area will be created by seeding with emergent wetland species and planting quick-growing wetland shrubs and trees, such as hazel adler and silky dogwood. Adjacent, another transitional area will be created by planting of wetland shrubs and trees, such as red maple, and seeding with an upland grass/wildflower mixture. The remaining portion of the site will be seeded with native grasses and wildflowers for restoration as an upland area. Figure 4-7 illustrates the various anticipated planting zones and conceptual restoration plan. Based on the hydraulic conditions of the site, the appropriate vegetation will naturally dominate the areas over time. Because the existing and adjacent wetlands at the site are dominated by *phragmites*, it is possible that the restoration area will eventually be dominated by *phragmites*.

Physical deterrents will be installed concurrently with the restoration of the site, including both fencing and overhead wiring with bird scare tape attached, to prevent large birds, including geese, from walking or flying into the area while the plants become established.

The existing wetland is supported largely by surface water from north and east of the site that flows through a culvert from the south end of Wetland 1 to the north extreme of Wetland 3 (Figure 2-3). Because the area where the culvert is located will be excavated during this alternative, the culvert will be removed and replaced further east of its current location. A diversion berm will be installed just west of the culvert to maintain the water level and hydroperiod of the existing wetland by preventing water discharging from the culvert from flowing into the lower elevation of the excavated area.

Implementation of Alternative 4 will require 2 years of monitoring and maintenance of the site. Monitoring will verify sufficient vegetation has been established (i.e., 85% coverage). Maintenance will include implementation of nuisance wildlife control, including waterfowl and rodents (prevent tree/shrub girding by mice burrowing muskrats and nutria).

For estimating purposes, an excavation depth of 2.5 ft over the waste/burnt soil area and 1 ft over the human health and ecological risk-based removal areas was assumed. It was also assumed that 25% of the confirmation samples will exceed the risk-based cleanup goals and those areas will require an additional 0.5 ft excavation. The total volume of excavated waste, burnt soil, and impacted surface soil and sediment is estimated at 26,420 in-place cy. Topsoil placement of 0.5 ft will follow to provide planting medium if the underlying exposed soil is determined to be unsuitable for plant growth.

4.3 Evaluation Criteria

The evaluation criteria are based on the USEPA guidance document *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* (USEPA/540-R-93-057).

4.3.1 Effectiveness

The *effectiveness* criterion addresses the expected results of the removal alternatives. It includes two major subcategories: protectiveness and ability to achieve the removal objectives.

Protectiveness

To be protective, the removal alternative must be:

- Protective of public health and community;
- Protective of workers during implementation;
- Protective of the environment; and
- Compliant with ARARs.

Ability to Achieve Removal Objectives

To successfully achieve the removal objectives, the removal alternative must:

- Meet the expected level of treatment or containment;
- Have no residual effect concerns; and
- Maintain long-term control.

4.3.2 Implementability

The *implementability* criterion encompasses the technical and administrative feasibility of the removal action. It includes three subcategories: technical feasibility, availability of resources, and administrative feasibility.

Technical Feasibility

Technical feasibility includes:

- Construction and operational consideration;
- Demonstrated performance and useful life;
- Adaptability to environmental conditions;
- Contribution to performance of long-term removal actions; and
- Implementation within the allotted time.

Availability of Resources

Availability of resources includes:

- Availability of equipment;
- Availability of personnel and services;
- Laboratory testing capacity;
- Offsite treatment and disposal capacity; and
- Post-removal site control.

Administrative Feasibility

Administrative feasibility includes:

- Required permits and/or easement or rights-of-way;
- Impacts on adjoining property;
- Ability to impose institutional controls; and
- Likelihood of obtaining exemptions from statutory limits (if needed).

4.3.3 Cost

The *cost* criterion encompasses the life-cycle costs of a project, including the projected implementation costs and the long-term operational and maintenance costs of the remedial action. For the detailed cost analysis, the expenditures required to complete each alternative were estimated in terms of capital costs, including direct and indirect costs, to complete initial construction activities. Direct costs include the cost of construction, equipment, land and site development, treatment, transportation, and disposal. Indirect costs include engineering expenses and contingency allowances.

Annual Operations and Maintenance (O&M) costs, which are post-construction costs required to ensure the continued effectiveness of the removal action, are applicable to Alternative 2 and 5, and are incorporated into the cost estimate. Expenditures that occur over a time period are analyzed using present worth, which discounts all future costs to a common base year. Present worth analyses allows the cost of the removal action to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, will be sufficient to cover all costs associated with the life of the removal action. Assumptions associated with present worth calculations include a discount rated of 3.0 percent (OMB Circular No. A-94, Appendix C, Revised January 2003), cost estimates in the planning years in constant dollars, and a period of performance that will vary on the activity, but will not exceed 30 years.

The costs estimates are provided to an accuracy of +50 percent and -30 percent. The alternative cost estimates were developed in 2005 dollars and based on information published by R.S. Means *Site Work and Landscape Cost Data* (2005), and have therefore been adjusted by 3% per year to reflect inflation. Where R.S. Means data were not available or not applicable, phone quotes, similar projects, or engineering estimates were used for unit pricing. Appendix E provides cost estimate details pertaining to each alternative discussed in the following sections.

4.4 Evaluation of Alternatives

Table 4-1 presents a comparison of these alternatives with respect to effectiveness, ease of implementation, and present worth cost over 30 years.

Table 4-1
Evaluation of Removal Alternatives
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

Alternative	Description	Effectiveness	Ease of Implementation	Present Worth Cost
Alternative 1 **No Action**	No removal work performed. Site will be left "as is".	**Not Effective** *Protectiveness* The impacted waste, soil, and sediment is left onsite, and constituents may migrate into surrounding environmental media over time. This alternative is not protective of human health and the environment. *Compliance with ARARs* This alternative does not comply with chemical-specific ARARs. Location- and action-specific ARARs do not apply. *Ability to Achieve Removal Action Objectives* This alternative does not meet the removal action objectives.	**Straightforward** *Technical Feasibility* No action to implement *Availability of Resources* No resources required *Administrative Feasibility* This alternative has the potential for contaminant migration.	**No Cost** **$0**
Alternative 2 **Cover Installation**	Construct cover (partial soil, partial asphalt). Post-construction activities, including O&M of cover, groundwater monitoring, and LUCs will be required.	**Moderately Effective** *Protectiveness* This alternative minimizes surface water run-on and erosion to prevent exposure to the waste and impacted soil and sediment and reduces the infiltration of precipitation and the subsequent leaching of contaminants to groundwater. However, because the waste and impacted soil and sediment is left onsite, constituents may migrate into surrounding environmental media over time. This alternative potentially exposes workers to contaminated materials during construction; workers would be required to receive training and use personal protective equipment. This alternative is protective of human health and the environment because it prevents direct exposure to waste and impacted soil and sediment. *Compliance with ARARs* Because waste and impacted soil and sediment will remain in place, groundwater monitoring will be required to verify the effectiveness of the remedy. Since a portion of the wetland present on site will be permanently lost, this alternative does not achieve compliance with location- and action-specific ARARs. *Ability to Achieve Removal Action Objectives* This alternative does not achieve the removal action objectives since the waste and impacted soil and sediment would remain in place.	**Moderately Straightforward** *Technical Feasibility* Methods for implementation of this alternative are well-established and can be completed with conventional equipment in a relatively short time frame. However, because of the flat topography of the site, it will be difficult to achieve proper drainage on the site with the construction of the soil cover. *Availability of Resources* Equipment, personnel, and services required for implementation of this alternative are readily available in the area. Because implementation of this alternative would result in the permanent loss of wetland, compensatory wetland mitigation will be likely be required and a location will need to be identified where the wetland can be created. *Administrative Feasibility* Because impacted soil and sediment remains on site, regular maintenance and groundwater monitoring, deed restrictions, LUCs, and five-year reviews will be required. There is also a slight potential for contaminant migration. A compensatory mitigation plan needs to be prepared and USACE approval needs to be obtained prior to excavation of the wetland area*. Because a portion of the wetland will be permanently lost, approval may be difficult. Construction of a compensatory wetland will most likely be required. Identification of an appropriate location and implementation may be difficult.	**Moderate** **$2,622,000**
Alternative 3 **Excavation and Backfill**	Excavate waste and burnt soil to visible and impacted site-wide surface soil and upper drainage sediment to a minimum of 1-ft, collect confirmation samples, backfill with imported material, and restore the site (grading and seeding) to pre-existing conditions.	**Highly Effective** *Protectiveness* Because excavated waste and impacted soil and sediment are being transported off site, this alternative has a slight risk of exposing the surrounding communities to the contaminants during transport. To prevent exposure to the community, trucks will not be overloaded and will be covered prior to leaving the site. This alternative potentially exposes workers to contaminated materials during construction; workers would be required to receive training and use personal protective equipment. Since waste and impacted soil and sediment is removed from the site, potential risks to human health and the environment is eliminated. Thus, this alternative is protective. *Compliance with ARARs* This alternative complies with chemical-specific ARARs. Although existing wetlands are impacted, they are restored to their current condition; therefore, this alternative achieves compliance with location- and action-specific ARARs. *Ability to Achieve Removal Action Objectives* This alternative meets the removal action objectives.	**Moderately Straightforward** *Technical Feasibility* Methods for excavation and backfill are well-established and can be completed with conventional equipment in a relatively short time frame. Precautionary measures for MEC identification and segregation and management of nuisance water encountered during the excavation are required and increase the difficulty of implementation. *Availability of Resources* Equipment, personnel, and services required for implementation of this alternative are readily available in the area. MEC support personnel are not standard but are available. Off-site disposal capacity for the excavated material is locally available. *Administrative Feasibility* A compensatory mitigation plan and coordination with USACE are required prior to excavation within the wetland area; however, because the wetland impacts are temporary and the wetland will be restored, approval should be obtainable*.	**Moderate** **$3,878,000**

Table 4-1
Evaluation of Removal Alternatives
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

Alternative	Description	Effectiveness	Ease of Implementation	Present Worth Cost
Alternative 4 Excavation and Restoration/ Wetland Creation	Excavate waste and burnt soil to visible limits and impacted site-wide surface soil and upper drainage sediment a minimum of 1-ft, collect confirmation samples, backfill waste/burnt soil area with 6" of imported material, backfill impacted site-wide surface soil areas to pre-existing grade, and restore the site in various zones (upland, transitional, wetland).	**Highly Effective** *Protectiveness* Because excavated waste and impacted soil and sediment are being transported off site, this alternative has a slight risk of exposing the surrounding communities to the contaminants during transport. To prevent exposure to the community, trucks will not be overloaded and will be covered prior to leaving the site. This alternative potentially exposes workers to contaminated materials during construction; workers would be required to receive training and use personal protective equipment. Since waste and impacted soil and sediment is removed from the site, potential risks to human health and the environment are eliminated. Thus, this alternative is protective. In addition, there is an opportunity for environmental enhancement through the enlargement and enhancement of wetlands. *Compliance with ARARs* This alternative complies with chemical-specific ARARs. Although existing wetlands are impacted, they are restored and improved; therefore, this alternative achieves compliance with location- and action-specific ARARs. *Ability to Achieve Removal Action Objectives* This alternative meets the removal action objectives.	**Moderately Straightforward** *Technical Feasibility* Methods for excavation and restoration are well-established and can be completed with conventional equipment in a relatively short time. Precautionary measures for MEC identification and segregation and management of nuisance water encountered during the excavation are required and increase the difficulty of implementation. *Availability of Resources* Equipment, personnel, and services required for implementation of this alternative are readily available in the area. MEC support personnel are not standard but are available. Off-site disposal capacity for the excavated material is locally available. A contractor with experience in wetlands construction is required for the site restoration, and is locally available. *Administrative Feasibility* A compensatory mitigation plan and coordination with USACE are required prior to excavation within the wetland area; however, because the wetland impacts will be temporary and the wetland will be restored and enlarged, approval should be obtainable*.	**Moderate** **$3,593,000**

*Under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act the United States Army Corps of Engineers (USACE) Nationwide Permit (NWP) 38 allows for activities in wetlands to contain, stabilize, or remove hazardous or toxic materials and requires preconstruction notification (PCN). CERCLA Section 121(e) and 40 CFR Part 300.400(e) states that no federal, state, or local permits are required for CERCLA on-site response actions. Therefore, the Navy is not required to obtain permits under Section 404 of the Clean Waters Act or Section 10 of the Rivers and Harbors Act. However, the Navy is required to meet the regulatory requirements. The NWP General Condition 19 outlines the factors for consideration for appropriate and practicable mitigation necessary to offset adverse effects on the aquatic environment that are more than minimal. General Condition 19(c) states that compensatory mitigation at a minimum one-for-one ratio is required for all wetlands impacts requiring a PCN, unless a project-specific waiver is granted.

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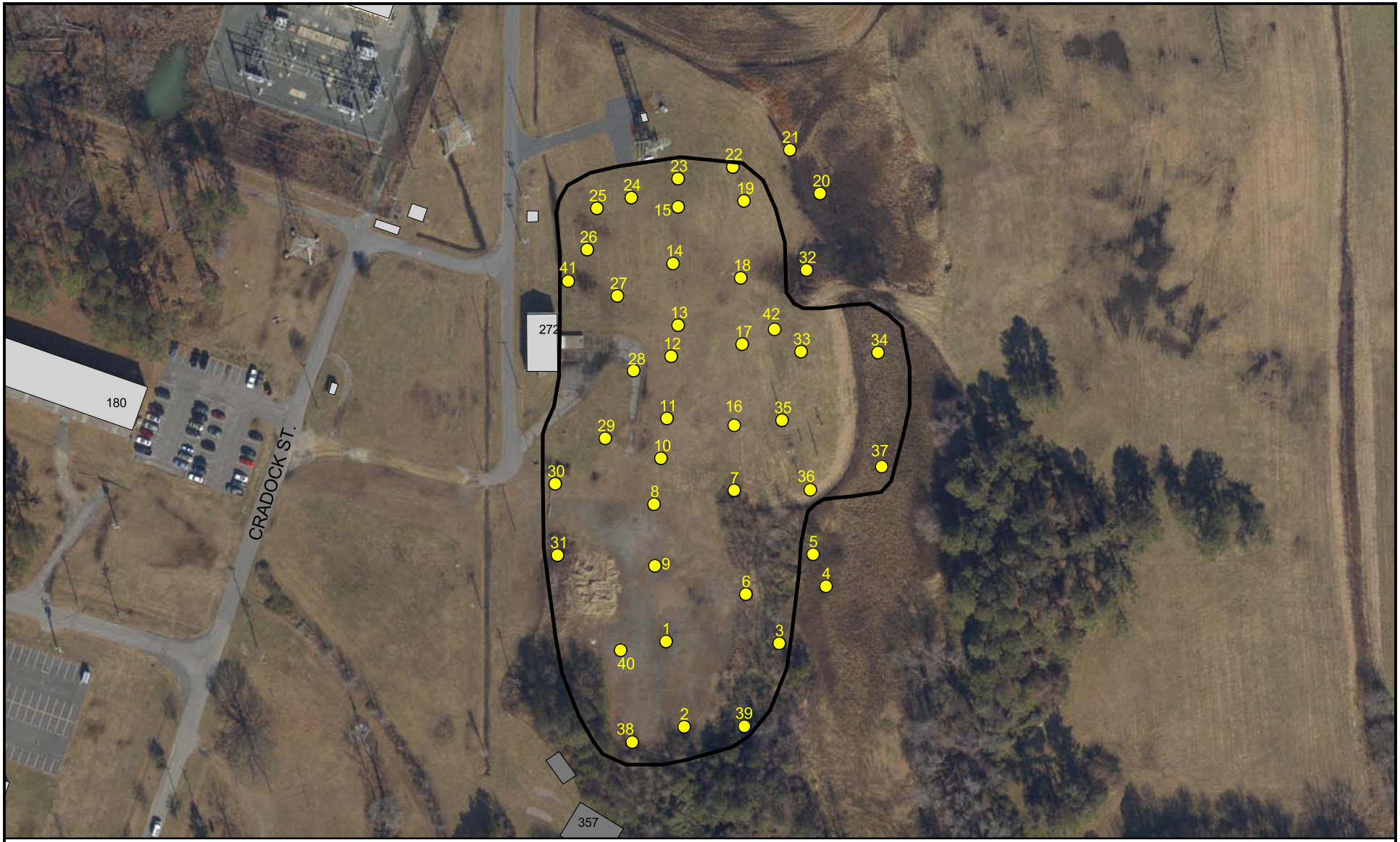

LEGEND

- Test Pit
- Site 5 Waste/Burnt Soil Area
- Existing Building
- Former Building

N

0 75 150 Feet

Figure 4-1
Remedial Investigation Test Pit Locations
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

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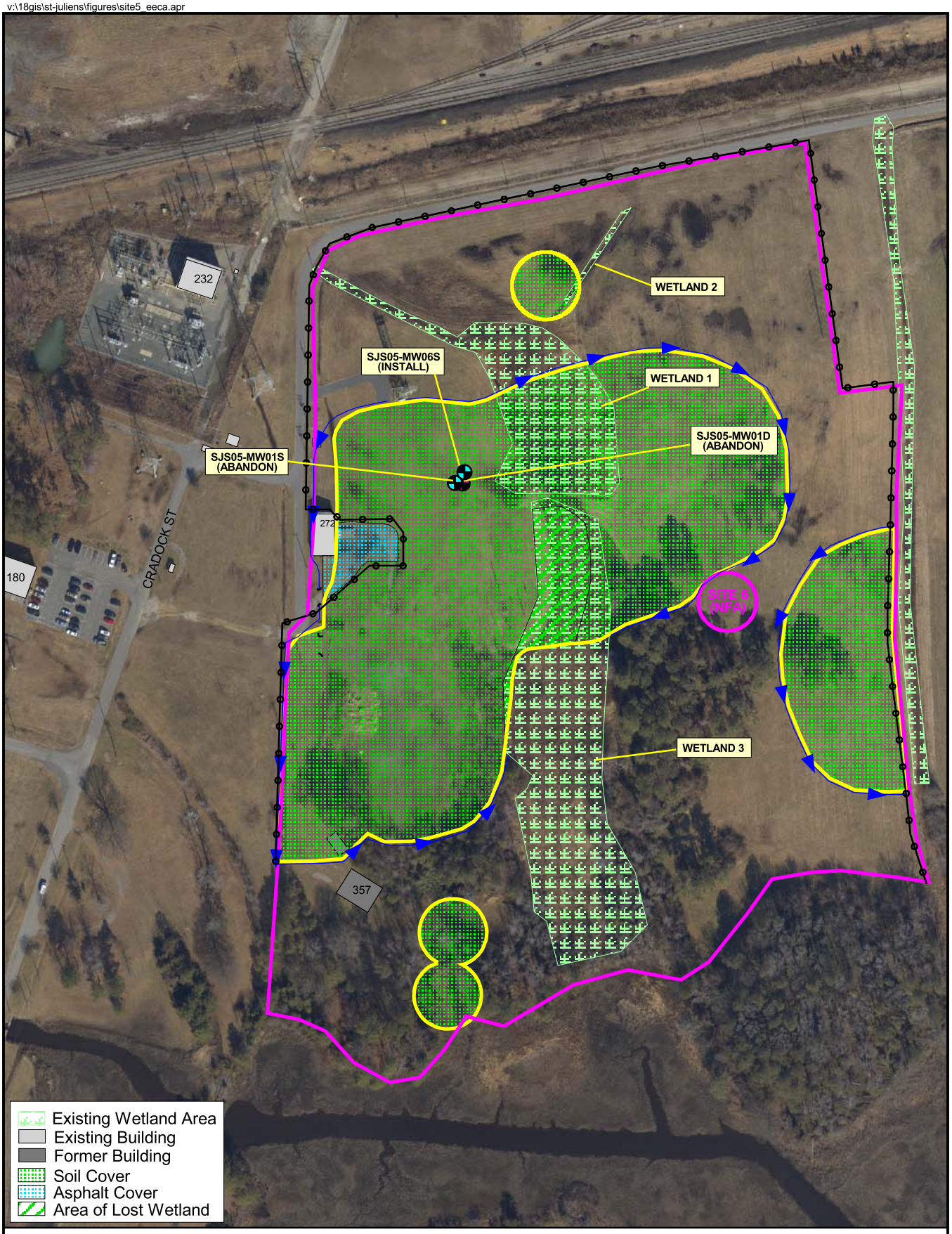


LEGEND

- Site 5 Boundary
- Removal Area
- Shallow Monitoring Well Location
- Deep Monitoring Well Location
- Chain Link Fence
- Drainage Ditch
- Culvert

N

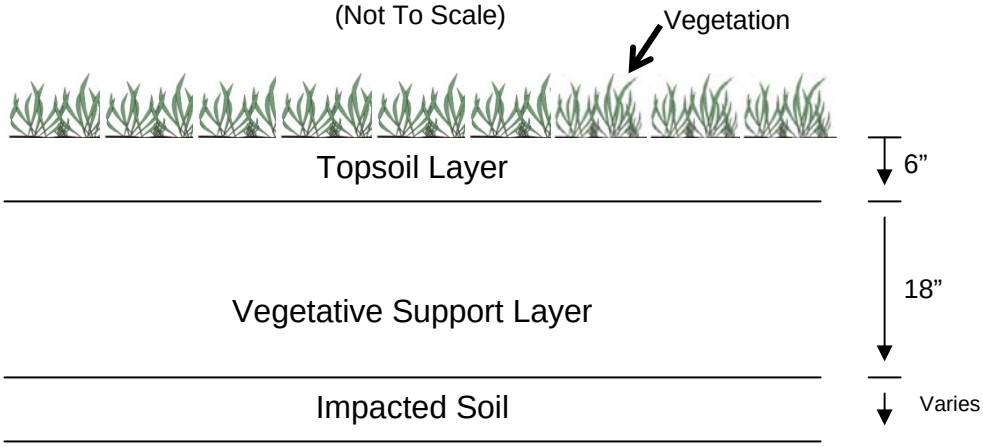
0 100 200 Feet

Figure 4-2
Alternative 2 - Cover Layout
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL

Soil Cover Section

(Not To Scale)



Asphalt Cover Section

(Not To Scale)

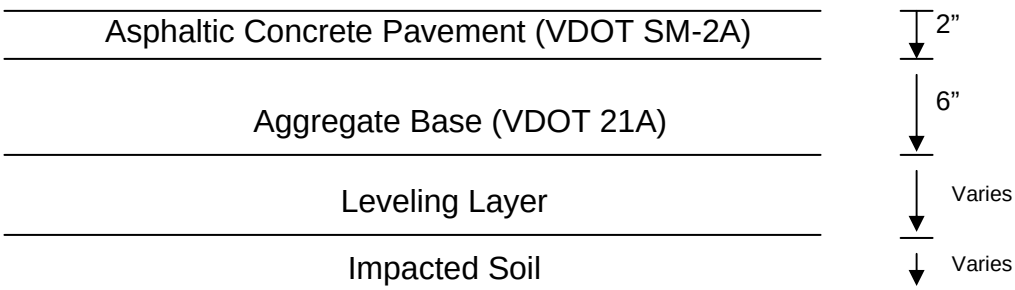


Figure 4-3
Alternative 2 – Cover Sections
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

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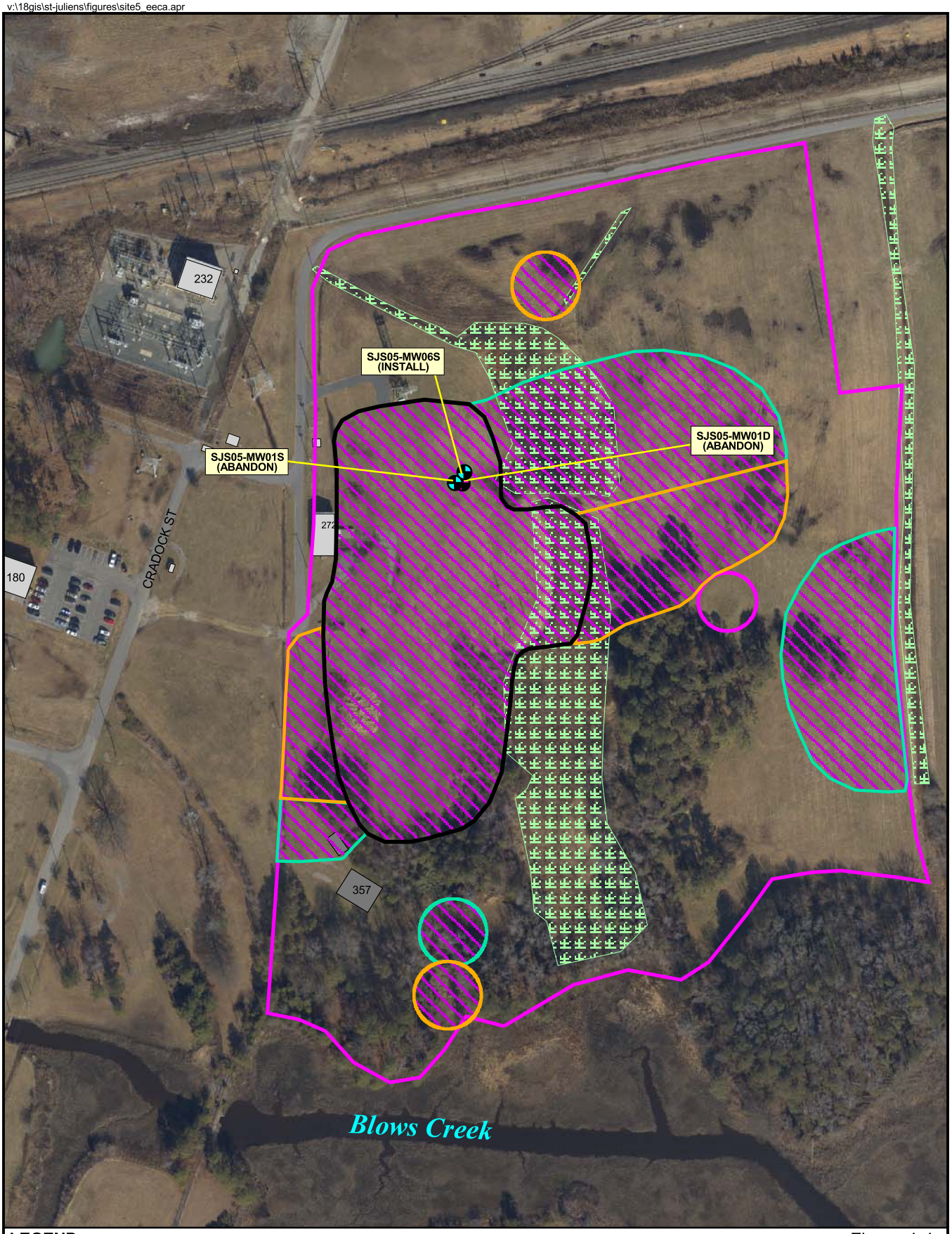


LEGEND

- Site 5 Boundary
- Waste/Burnt Soil Area
- Shallow Monitoring Well Location
- Deep Monitoring Well Location
- Human Health Risk-Based Removal Areas
- Ecological Risk-Based Removal Areas
- Excavation/Restoration Area
- Wetland Area
- Existing Building
- Former Building

N

0 100 200 Feet

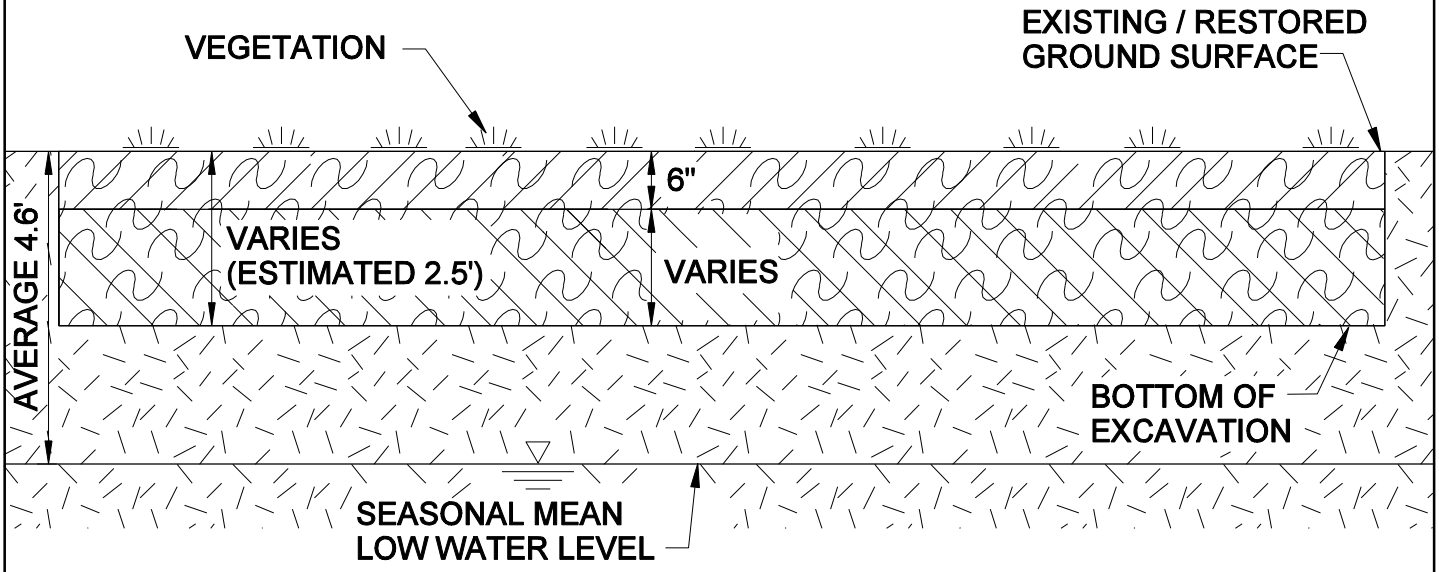
Figure 4-4
Alternative 3
Excavation and Restoration Areas
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL

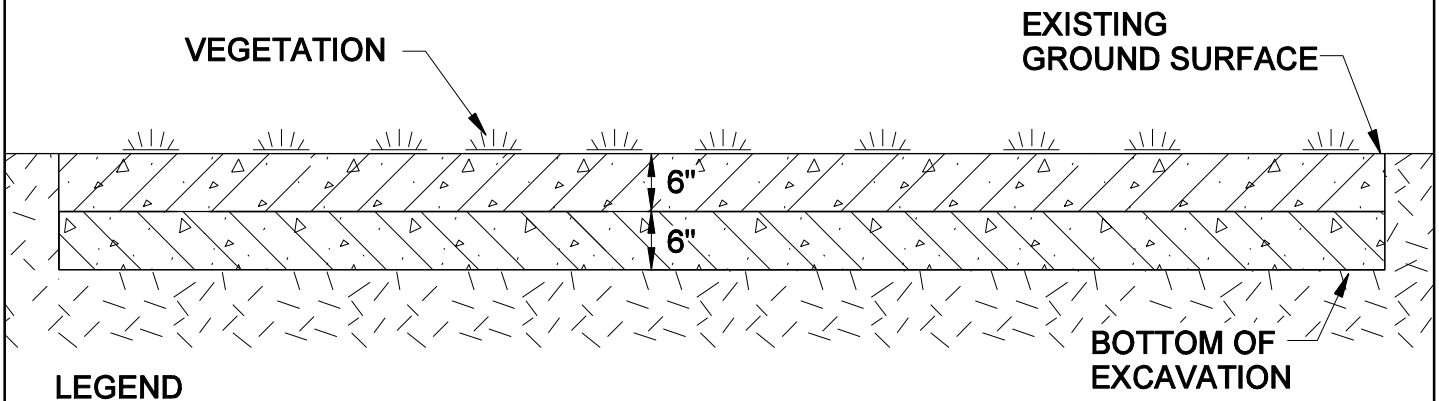
ALTERNATIVE 3 TYPICAL SECTIONS

(NOT TO SCALE)

WASTE/BURNT SOIL AREA



IMPACTED SURFACE SOIL AND SEDIMENT AREAS



LEGEND

- WASTE / BURNT SOIL
- CLEAN SOIL
- GENERAL FILL
- TOPSOIL
- IMPACTED SURFACE SOIL AND SEDIMENT

FIGURE 4-5
ALTERNATE 3 - TYPICAL SECTION
EE/CA FOR SITE 5

ST. JULIENS CREEK ANNEX
CHESAPEAKE, VA

CH2MHILL

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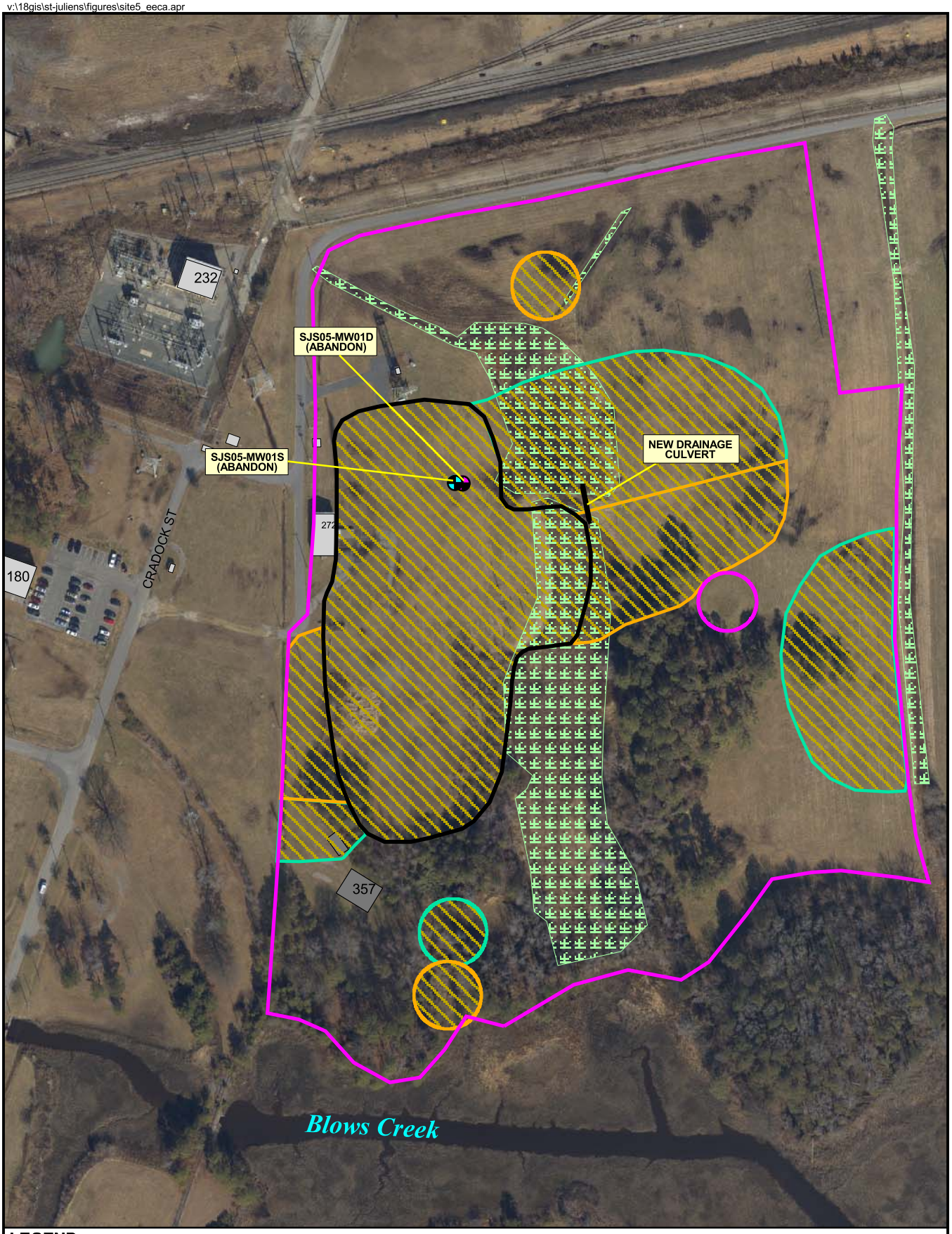

LEGEND

- Site 5 Boundary
- Waste/Burnt Soil Area
- Shallow Monitoring Well Location
- Deep Monitoring Well Location
- Human Health Risk-Based Removal Areas
- Ecological Risk-Based Removal Areas
- Excavation Area
- Existing Wetland Area
- Existing Building
- Former Building

N

0 100 200 Feet

Figure 4-6
Alternative 4 - Excavation Plan
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

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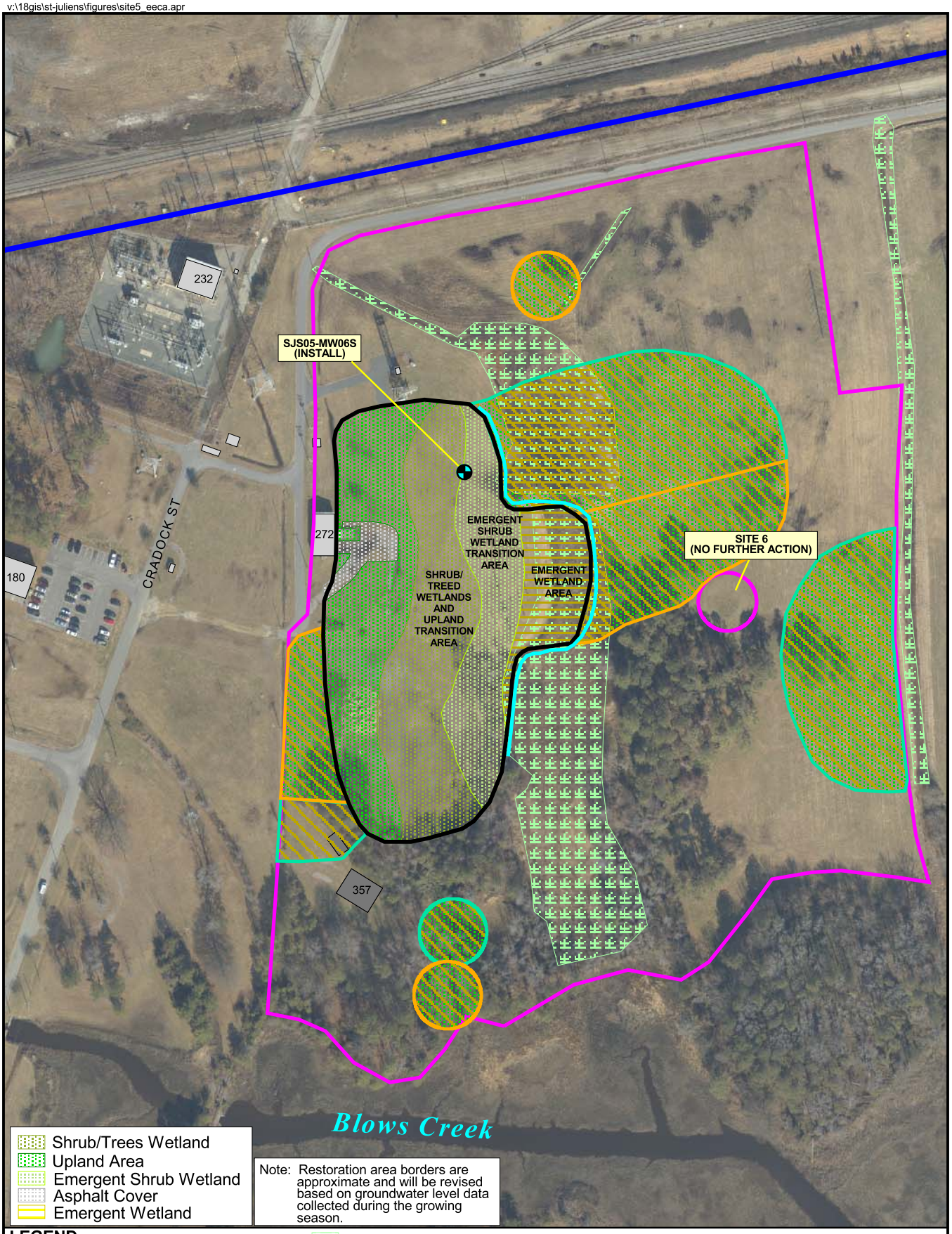

Figure 4-7
Alternative 4 - Conceptual Restoration Plan
EE/CA for Site 5
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL

SECTION 5

Comparative Analysis of Removal Action Alternatives

5.1 Comparative Criteria

Section 4 provided an evaluation of the alternatives based on their effectiveness, ease of implementation, and cost. In this section, the alternatives are directly compared to one another for each of these three criteria.

This analysis clarifies which alternative is preferable in each category and consequently, which will be recommended for implementation at Site 5. The removal actions are summarized for comparison in Table 4-1.

5.1.1 Effectiveness

Alternative 1 is not effective. It is not protective of human health and the environment, does not achieve compliance with ARARs, and does not achieve the removal action objectives of this EE/CA.

Alternative 2 is moderately effective because it prevents direct exposure to waste, burnt soil, and impacted surface soil and sediment on site and to the surrounding community. However, since waste, burnt soil, and impacted surface soil and sediment are left on site, there is the potential for contaminants to migrate via groundwater or by excavation of soil/sediment by burrowing animals to the surrounding media over time. The contaminant levels (elevated metals concentrations) detected in the groundwater collected from dowgradient monitoring wells are an indication that migration is likely. Alternative 2 does not comply with ARARs since the waste, burnt soil, and impacted surface soil and sediment will be left in place and a soil cover will be constructed over a portion of the existing wetlands. Additionally, since Alternative 2 results in waste, burnt soil, and impacted surface soil and sediment remaining in place, it does not achieve the removal action objectives.

Although the excavation portion of Alternatives 3 and 4 results in a potential risk to surrounding communities during the transport of waste, burnt soil, and impacted surface soil and sediment offsite, they are considered highly effective because the complete removal of the waste and impacted surface soil and sediment eliminates the onsite risks to human health and the environment for the long-term. Alternative 4 is slightly less effective because it results in a lower ground surface elevation, where groundwater with elevated metals concentrations may occasionally be exposed to the surface, which may create an exposure pathway to these metals in groundwater. However, the elevated metals have been detected largely in the groundwater collected from downgradient monitoring wells and the groundwater collected from upgradient monitoring wells contain lower levels of metals, suggesting that the areas where groundwater may become surface water are likely to contain low to moderate concentrations of metals (ecological risk evaluation presented in

Appendix E). Additionally, the concentrations of metals in groundwater will be reduced over time due to the source removal and flushing. Alternative 3 is the most protective of human health and the environment because the excavation is backfilled, providing an additional buffer between the groundwater and the surface. However, Alternative 4 is beneficial to the environment since the existing wetland area is enlarged and the wetland is enhanced to increase the quality of the habitat.

Given the appropriate training and personal protective equipment (PPE), Alternatives 3 and 4 are protective of workers during construction. Precautions are required to protect workers against contact with waste and impacted surface soil and sediment and any nuisance water that is encountered. Additionally, workers will need to follow MEC construction support procedures. Although these are standard procedures, there is additional risk to workers during construction due to the nature of MEC. MEC support personnel will be onsite to oversee all intrusive activities to maintain a safe work environment.

Waste and impacted surface soil and sediment are removed during the implementation of Alternatives 3 and 4; thus, chemical-specific ARARs are achieved. Wetlands are located within the boundary of this removal action and are impacted by the excavation. However, once excavation is complete, the wetlands are restored to their current condition for Alternative 3 and enlarged and enhanced for Alternative 4. Therefore these alternatives comply with location- and action-specific ARARs. However, because the wetlands are temporarily impacted to remove the waste and impacted surface, a compensatory mitigation plan and United States Army Corps of Engineers (USACE) notification are required.

Waste and impacted surface soil and sediment are removed during the implementation of Alternatives 3 and 4 and therefore these alternatives achieve all of the removal action objectives.

5.1.2 Implementability

Alternative 1 involves no action and therefore is easy to implement.

The overall implementation of Alternative 2 is moderately straightforward and can be accomplished in a relatively short time frame utilizing standard construction methods and available resources. Implementation of the cover is straightforward; however, completion of the compensatory mitigation that will be required for the alternative will make it slightly more difficult. A location will need to be identified where the wetland can be created and approval will be required. Because of the flat topography of the site, it will be difficult to achieve proper drainage on the site with the construction of the cover. Because waste and impacted surface soil and sediment remain in place, maintenance, monitoring, inspections, deed restrictions, LUCs, and 5-year reviews are required. Compensatory wetland mitigation will be likely be required if this alternative is implemented due to the permanent loss of wetland area; monitoring of the compensatory wetland may be required to verify its success.

Alternatives 3 and 4 can also be accomplished utilizing standard construction methods and available resources. These alternatives are slightly more difficult to implement than Alternative 2 because they require MEC construction support, which also increases the duration of the removal action. However, experienced MEC construction support personnel are available in the area. Alternatives 3 and 4 may require monitoring, inspections, and

invasive species control to verify the success of the restored portion of the wetland impacted by the excavation.

5.1.3 Cost

The cost estimates for the alternatives are provided in Appendix E and summarized in Table 4-1. Alternative 1 has no cost and is thereby the least expensive. Alternative 2 is estimated at $2,622,000 and is therefore the least expensive of the remaining alternatives. Alternative 4 is estimated at $3,593,000 and is the second most expensive. Alternative 3, estimated at $3,878,000, is the most expensive alternative.

SECTION 6

Recommended Removal Action Alternative

Based on the comparative analysis of the removal alternatives provided in this EE/CA, the recommended removal action is Alternative 4 – Excavation and Restoration/Wetland Creation. Alternative 4 consists of the excavation of the waste/burnt soil area to the visible limits and excavation of the impacted surface soil and sediment areas to a depth of 1 ft. The surface soil and sediment areas will be backfilled and restored to their pre-existing elevation and condition. The waste/burnt soil area will be backfilled with 6 inches of topsoil only, resulting in a lower elevation than was present prior to the removal action. The lower elevation will allow for the enhancement of a portion of the wetland, as well as establishment of emergent/shrub/treed wetland transition zones. The transition zones will be seeded/planted with a variety of plant species, allowing for the dominance of the most appropriate species based on the new site conditions. The additional vegetative zones enhance the habitat diversity of the site.

Alternative 4 achieves the removal action objectives, complies with ARARs, eliminates the onsite risks to human health and the environment through the removal of the waste, burnt soil, and impacted surface soil and sediment, and is straightforward to implement utilizing standard construction methods and resources. Navy, USEPA, and VDEQ representatives were involved with the development of this alternative through the Tier I Partnering Team process and will have opportunity to comment on the recommendation during the regulatory review period. Following the regulatory review period, a 30-day public comment period will be held to determine public acceptance of the recommended alternative. If public comments are received, a Responsive Summary addressing significant comments will be prepared as part of the Action Memorandum and included in the Administrative Record, along with the Final EE/CA. Although the cost of this alternative is more expensive than Alternative 2—Cover Installation, Alternative 2 does not achieve the removal action objectives of this EE/CA since the waste, burnt soil, and impacted surface soil and sediment would remain in place. Alternative 4 has the lowest cost of the two alternatives that achieve the removal action objectives (Alternatives 3 and 4) and has additional environmental benefits through the enhancement and creation of wetlands.

After finalization of the EE/CA, the path forward for Site 5 is completion of the removal action and preparation of the construction closeout report. Following the removal action, the remainder of the site (groundwater) will be addressed during a Feasibility Study.

SECTION 7

References

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Appendix A
Wetland Delineation Report

Wetland Delineation Report

Site 2 - Waste Disposal Area B and Site 5 – Burning Grounds

St. Juliens Creek Annex

Chesapeake, Virginia

Prepared for

Department of the Navy

Naval Facilities Engineering Command

Mid-Atlantic Division

March 2006

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Philadelphia, PA 19380

Introduction

CH2M HILL was contracted by the Navy to conduct a wetland delineation at Site 2 – Waste Disposal Area B and at Site 5 – Burning Grounds at St. Juliens Creek Annex (SJCA), Chesapeake, Virginia (Figure 1). This delineation was conducted to support an Engineering Evaluation/Cost Analysis (EE/CA) for Site 5 and a Feasibility Study (FS) for Site 2. The extent of subsurface waste and impacted soil for Sites 2 was determined by the Remedial Investigation (RI) (CH2M HILL, 2004) and the Expanded RI (ERI) (CH2M HILL, 2005). The extent of waste and impacted soil for Site 5 was determined during the RI (CH2M HILL, 2003). Some of the waste and subsurface contamination is located within or adjacent to wetland areas. Planned removal actions at both sites have the potential to adversely impact wetland areas through excavation, filling, the construction of access roads and the use of heavy equipment. The objective of the wetland delineation is to define the spatial extent of the on-site wetlands (by wetland type) relative to the areas of waste and impacted soils and qualitatively determine wetland quality. These data will be considered during the removal actions to minimize wetland impacts as well as to guide design and construction of remedial activities for site closure.

This report presents a summary description of the site, a description of the wetlands delineated at the site on September 30, 2005 and January 4, 2006, the methodology used in the jurisdictional wetland delineation, and a qualitative evaluation of the value of the wetlands.

Site Description

SJCA is located in Chesapeake, VA, along the northern shore of St. Juliens Creek at its confluence with the Elizabeth River.

Site 2 was observed to be a partially mixed scrub-forested area with saltmarsh habitats and a non-tidal and tidal channel that bisects the saltmarsh and scrub-forest area. Adjacent upland areas were observed to be coniferous forest edges with routinely maintained lawn areas.

Site 5 was observed to be a routinely maintained field with mixed hardwood and coniferous forests along its southeastern and southwestern boundaries. Adjacent to the southern end of the field, an emergent wetland lies between the forest areas and extends to a saltmarsh habitat adjacent to Blows Creek. In the eastern portion of the Site 5 field, a swale was observed draining east towards Site 4 and Blows Creek.

Wetland Delineation

The jurisdictional wetland delineation was performed by CH2M HILL environmental scientists on September 30, 2005 within the limits of Site 2 near St. Juliens Creek and Site 5 near Blows Creek (Figure 2). Additional wetland delineations were performed at Site 5 on January 4, 2006. The three-parameter approach outlined in the 1987 *U.S. Army Corps of Engineers Wetlands Delineation Manual* (Manual; ACOE 1987) was used to determine jurisdictional wetland boundaries. Vegetation was identified and characterized by stratum (herb, shrub, and tree layers) and regional indicator status (Reed 1995), the soil was

described, and evidence of hydrology was noted. Wetland flagging was placed in the field to mark the wetland/upland boundaries. The flag locations were later surveyed separately by a licensed surveyor. The flag locations were then downloaded to a base map to define the wetland boundaries in order to assess potential wetland impacts (Figures 3 and 4). A second site visit to Site 5 was conducted on January 5, 2006 to continue the delineation of Wetland 3. During this effort the locations of the flags were logged by CH2M HILL with a Global Positioning System (GPS) Pathfinder® Pro XRS backpack unit. Data forms were completed to document the types of wetland plants, the presence or absence of hydrologic indicators, and the presence or absence of hydric soil conditions within each delineated wetland. Within Site 2 one jurisdictional wetland was delineated (Figure 3), while Site 5 was determined to contain four separate wetlands areas (Figure 4). The data forms for each of the delineated wetlands are presented in Appendix A of this report.

Site 2

Site 2 consists of a 0.934-acre wetland. The dominant wetland type observed within Site 2 was a palustrine scrub shrub deciduous and estuarine intertidal emergent (PSS1/E2EM) wetland system. The Site 2 wetland was observed to be dominated by scrub forest vegetation in its upper gradients that include red maple (*Acer rubrum*), pin oak (*Quercus palustris*) and green briar (*Smilax rotundifolia*). The lower gradients consisted of saltmarsh habitat with dominant areas of *Spartina alterniflora* and cattails (*Typha latifolia*) (Figure 3).

Primary wetland hydrology indicators included saturated soil in the upper 12 inches, water marks, drift lines, and drainage patterns in the wetlands. Secondary indicators included oxidized root channels in the upper 12 inches, water-stained leaves, and evidence of hydrology and tidal fluctuation. Hydric soil indicators included sulfidic odor and low-chroma colors.

The Site 2 wetland was observed to be a moderate quality habitat due to the area's diversity of scrub shrub, emergent and saltmarsh wetland habitats. The saltmarsh habitat within Site 2 was observed to be lower quality due to the eroded condition of the marsh area in fringes along the adjacent scrub shrub and forested areas of the site.

Site 5

The dominant wetland types located within Site 5 are characterized as: Wetland 1 – 0.989-acre freshwater Palustrine Emergent (PEM) swale and low area; Wetland 2 is a – 0.028-acre PEM swale; Wetland 3 – 2.00 acre PEM low area; and Wetland 4 – 0.429-acre swale (Figure 4). In each wetland, soils were observed, but not handled due to known contaminants.

Wetland 1 was observed to be dominated by smart weed (*Polygonum hydropiper* and *Polygonum arifolium)*, soft rush (*Juncus effusus*) and barnyard grass (*Echinocloa muricata*). Common reed (*Phragmites australis*) was also observed in portions of the wetland area. Wetland 2 was observed to be a low area or former drainage dominated by smart weed, soft rush and barnyard grass. Common reed was also observed in portions of the wetland area. Wetland 3 was observed to be a lower area or former drainage dominated by smart weed, soft rush, black willow (*Salix nigra*) and barnyard grass. Dense areas of common reed (greater then 50% of dominant vegetation) were also observed in the lower portions of the wetland area that extended into saltmarsh areas adjacent to Blow's Creek. A small drainage

ditch, located near monitoring well SJS05-MW02S, flows south from Wetland 3 before draining into the above mentioned saltmarsh area adjacent to Blow's Creek (Figure 4). This drainage ditch (SJ-D01) is fed by two small tributaries. To the north, SJ-D01 begins as an underground seep from Wetland 3 that flows into a well defined 4 to 4.5 foot channel. The eastern arm of the drainage ditch is a small 0.5 foot shallow undefined channel which flows directly from Wetland 3 before exiting into the drainage ditch. This drainage ditch flows between a steep man-made berm before flowing directly into the saltmarsh area adjacent to Blow's Creek (Figure 4). Wetland 4 was observed to be a defined swale dominated by smart weed, soft rush, cattails (*Typha latifolia*) and barnyard grass.

For Wetlands 1, 2, 3, and 4 at Site 5, the primary wetland hydrology indicators were saturation in the upper 12 inches and drainage patterns in the wetlands. The secondary wetland hydrology indicators for all four wetlands included oxidized root channels in the upper 12 inches and water-stained leaves. Hydric indicators for all four wetlands include a sulfidic odor and low-chroma soils with iron concretions.

Conclusion

This investigation identified one 0.934-acre area within Site 2 and four areas totaling 3.446 acres within Site 5 which met the vegetation, soil, and hydrology criteria indicative of a jurisdictional wetland as established in the 1987 *U.S. Army Corps of Engineers Wetlands Delineation Manual* (Manual; ACOE 1987).

Pursuant to meeting the intent of the Clean Water Act, restoration and mitigation for temporary and/or permanent impact to regulated wetlands resulting from remedial practices implemented on the Project Site should be implemented to the extent practicable.

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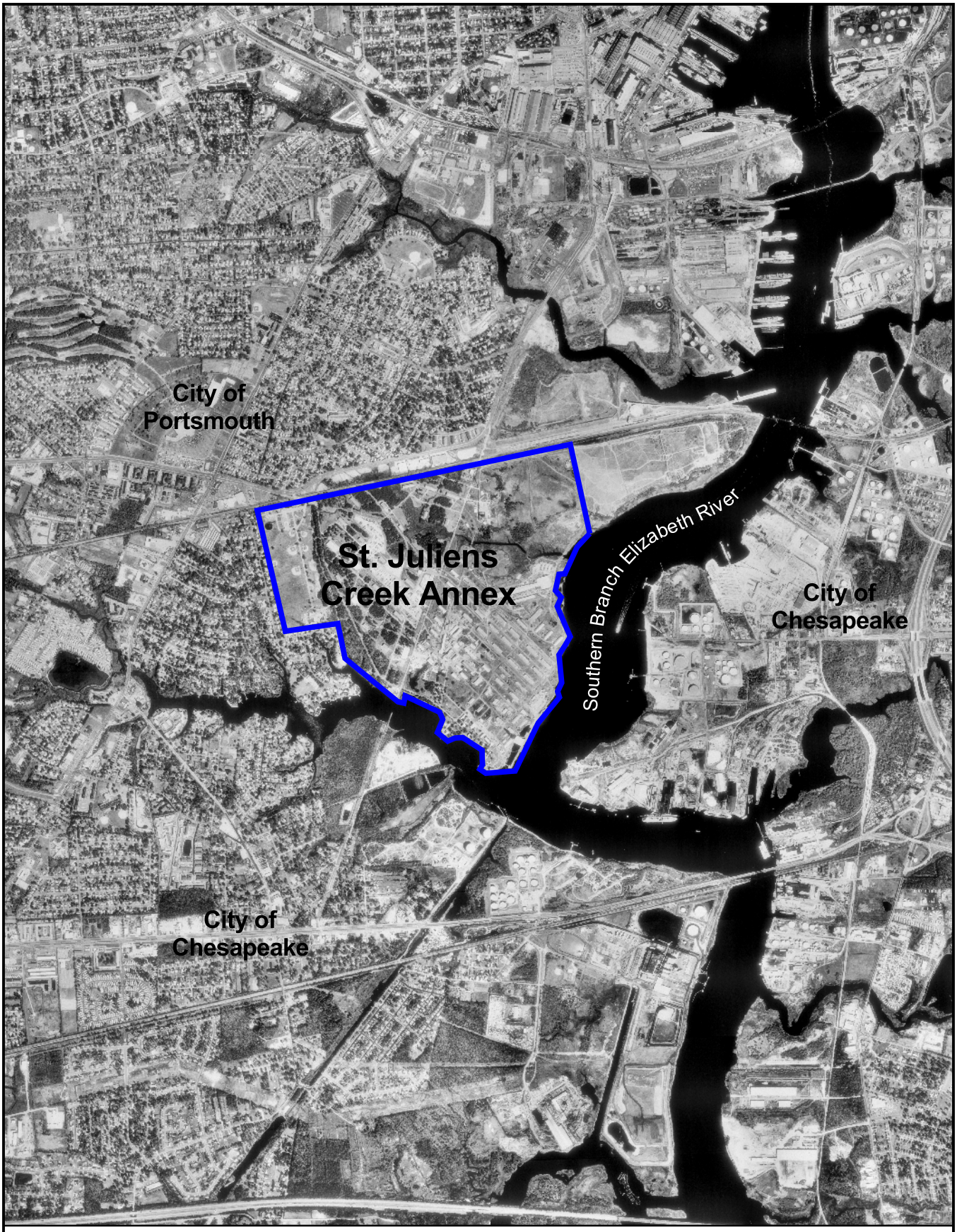

LEGEND

St. Juliens Creek Annex

N

0 2000 4000 Feet

Figure 1
Location of St. Juliens Creek Annex
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL

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Legend

- Sites 2 and 5 Boundaries
- Site 5 Waste/Burnt Soil Area
- Activity Boundary

N

0 500 1000 Feet

Figure 2
Locations of Sites 2 and 5
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL

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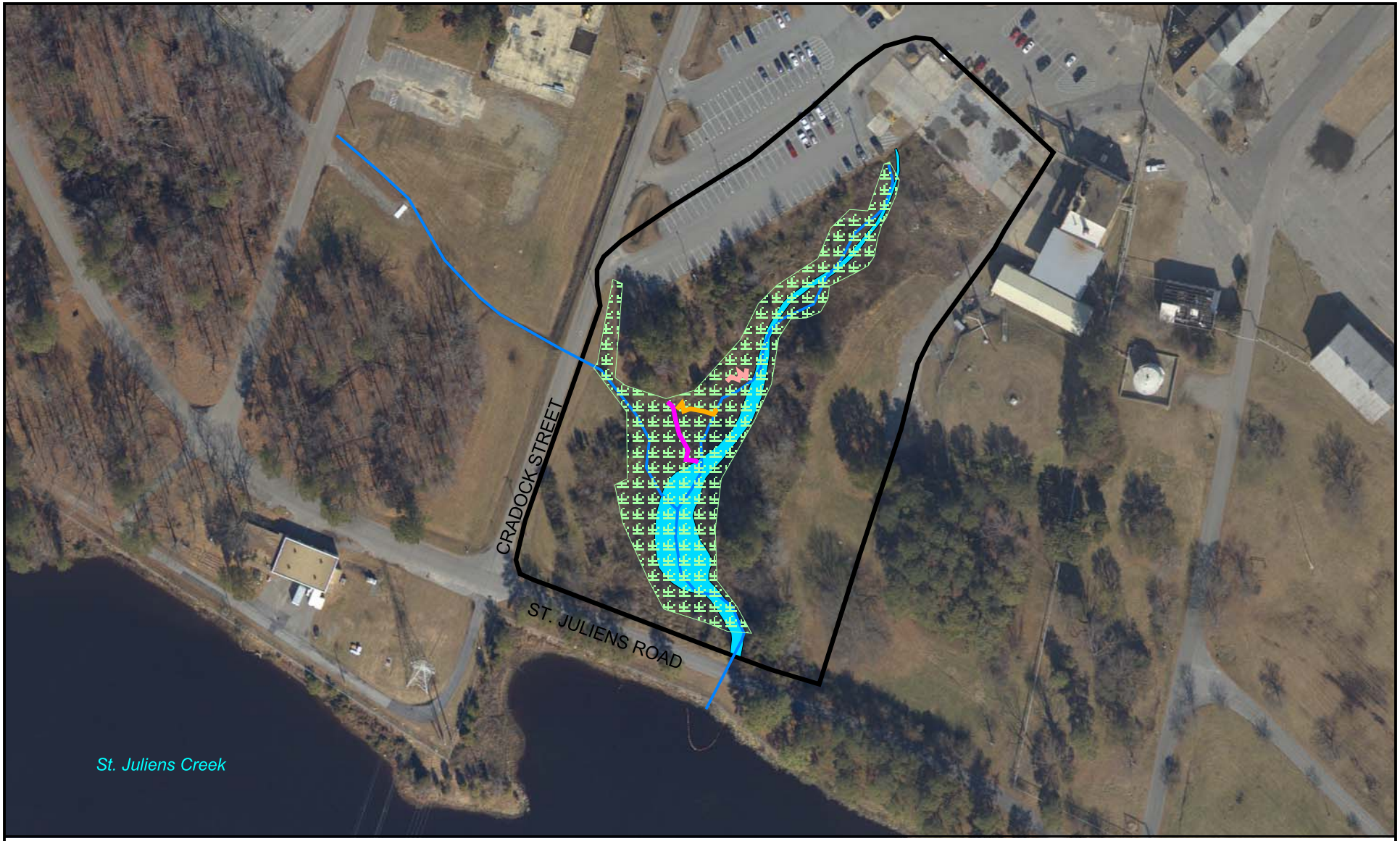

LEGEND

- Site 2 Boundary
- Drainage
- Wetland Area
- Site 2 Inlet
- Transect 1
- Transect 2
- Transect 3

N

0 150 300 Feet

Figure 3
Wetland Delineation
Site 2 - Waste Disposal Area B
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL

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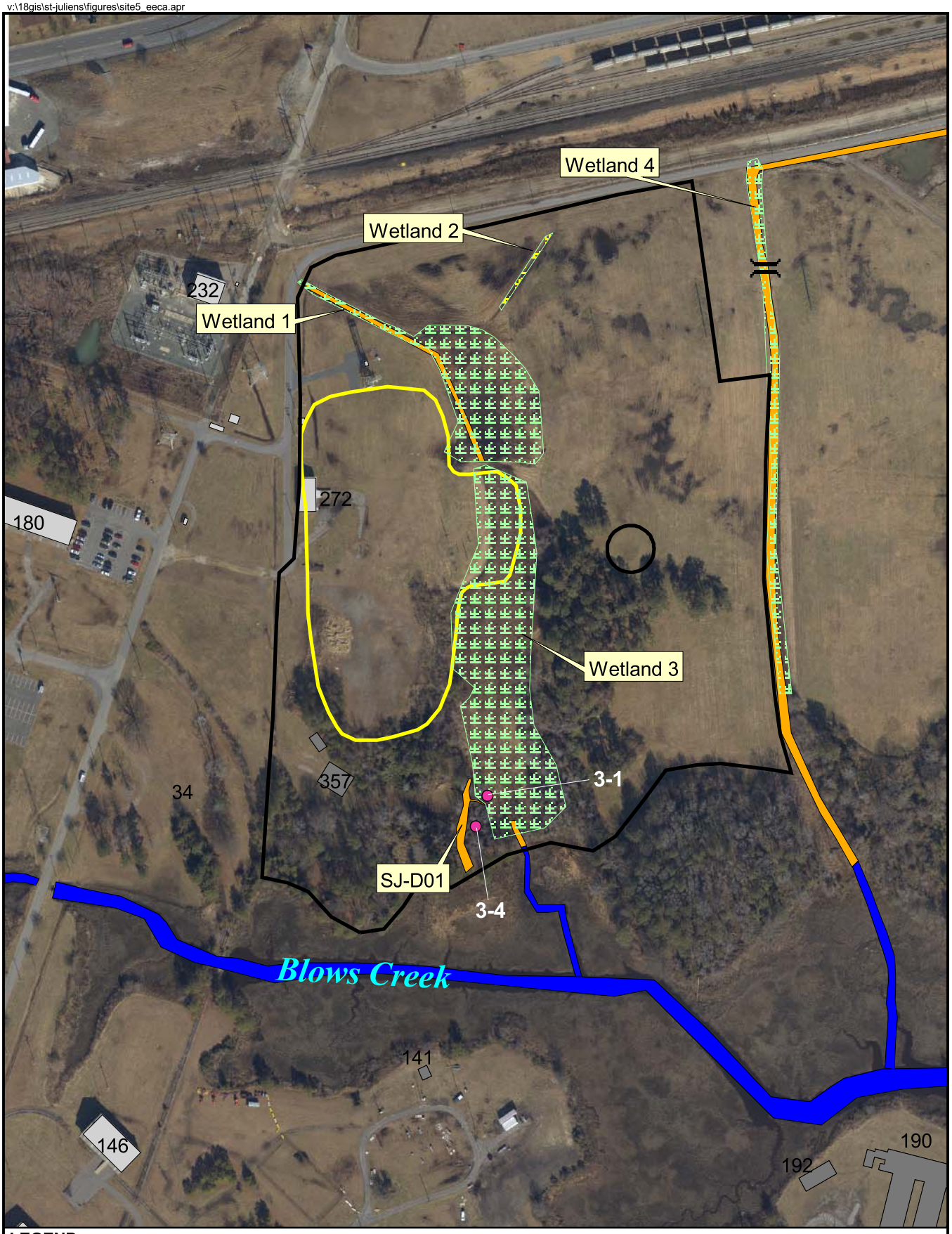


LEGEND

- Site 5 Waste/Burnt Soil Area
- Site 5 Boundary
- Lower Drainage
- Upland Drainage
- Existing Buildings
- Former Buildings
- Wetland Area
- Culvert

N

0 125 250 Feet

Figure 4
Wetland Delineation
Site 5 Burning Grounds
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL

Appendix A
Routine Wetland Determination Data Forms

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	St. Juliens Creek Annex – Site 5	Date:	9/30/05
Applicant/Owner:	Navy	County:	Chesapeake
Investigator:	DD/AC	State:	VA

Do Normal Circumstances exist on the site?	**Yes**	No	Community ID:	Wetland 1
Is the site significantly disturbed (Atypical Situation)?	Yes	**No**	Transect ID:	1-1
Is the area a potential Problem Area? (If needed, explain on reverse)	Yes	**No**	Plot ID:	Wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Phragmites australis*	HB	FACW	9.		
2. *Juncus effusus*	HB	FACW	10.		
3. *Polygonum arifolium*	HB	OBL	11.		
4. *Echinocloa muricata*	HB	FACW	12.		
5. *Polygonum hydropiper*	HB	OBL	13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Greater than 50% of the predominant vegetation was observed to be hydrophytic.

HYDROLOGY

Recorded Data (Describe in Remarks):
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs
- ____ Other

____ No Recorded Data Available

Field Observations:

Depth of Surface Water: 0 (in.)

Depth to Free Water in Pit: 12 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- x Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- x Oxidized Root Channels in Upper 12 Inches
- x Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- x Other (Explain in Remarks)

Remarks: Evidence of hydrology observed. Iron concretions observed.

SOILS

Map Unit Name (Series and Phase): Disturbed Land

Drainage Class:

Taxonomy (Subgroup):

Field Observations Confirm Mapped Type? Yes No

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-18		10YR 4/1	NI	20 – 10YR 5/2	Sandy

Hydric Soil Indicators:

	Histosol		Concretions
	Histic Epipedon		High Organic Content in Surface Layer in Sandy Soils
x	Sulfidic Odor		Organic Streaking in Sandy Soils
	Aquic Moisture Regime		Listed on Local Hydric Soils List
	Reducing Conditions		Listed on National Hydric Soils List
x	Gleyed or Low-Chroma Colors		Other (Explain in Remarks)

Remarks: Evidence of hydric soils observed. Observations only, due to contamination, no handling of soils occurred.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	**Yes**	No	
Wetland Hydrology Present?	**Yes**	No	
Hydric Soils Present?	**Yes**	No	Is this Sampling Point Within a Wetland? **Yes** No

Remarks: All parameters have been met.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	St. Juliens Annex – Site 5	Date:	9/30/05
Applicant/Owner:	Navy	County:	Chesapeake
Investigator:	DD/AC	State:	VA

Do Normal Circumstances exist on the site?	**Yes**	No	Community ID:	Wetland 2
Is the site significantly disturbed (Atypical Situation)?	Yes	**No**	Transect ID:	2-2
Is the area a potential Problem Area? (If needed, explain on reverse)	Yes	**No**	Plot ID:	Wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Phragmites australis*	HB	FACW	9.		
2. *Juncus effusus*	HB	FACW	10.		
3. *Polygonum arifolium*	HB	OBL	11.		
4. *Polygonum hydropiper*	HB	OBL	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Greater than 50% of the predominant vegetation was observed to be hydrophytic.

HYDROLOGY

_____ Recorded Data (Describe in Remarks):
- _____ Stream, Lake or Tide Gauge
- _____ Aerial Photographs
- _____ Other

_____ No Recorded Data Available

Field Observations:

Depth of Surface Water: 0 (in.)

Depth to Free Water in Pit: 6 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- _____ Inundated
- x Saturated in Upper 12 Inches
- _____ Water Marks
- _____ Drift Lines
- _____ Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- x Oxidized Root Channels in Upper 12 Inches
- x Water-Stained Leaves
- _____ Local Soil Survey Data
- _____ FAC-Neutral Test
- x Other (Explain in Remarks)

Remarks: Evidence of hydrology observed. Iron concretions observed.

SOILS

Map Unit Name (Series and Phase): Disturbed Land

Drainage Class:

Taxonomy (Subgroup):

Field Observations Confirm Mapped Type? Yes No

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-18		10YR 5/1	NI	20 – 10YR 4/2	Sandy

Hydric Soil Indicators:

	Histosol		Concretions
	Histic Epipedon		High Organic Content in Surface Layer in Sandy Soils
x	Sulfidic Odor		Organic Streaking in Sandy Soils
	Aquic Moisture Regime		Listed on Local Hydric Soils List
	Reducing Conditions		Listed on National Hydric Soils List
x	Gleyed or Low-Chroma Colors		Other (Explain in Remarks)

Remarks: Evidence of hydric soils observed. Observations only, due to contamination, no handling of soils occurred.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	**Yes**	No	
Wetland Hydrology Present?	**Yes**	No	
Hydric Soils Present?	**Yes**	No	Is this Sampling Point Within a Wetland? **Yes** No

Remarks: All parameters have been met.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	St. Juliens Creek Annex – Site 5	Date:	1/4/06
Applicant/Owner:	Navy	County:	Chesapeake
Investigator:	LC/JR	State:	VA

Do Normal Circumstances exist on the site?	**Yes**	No	Community ID:	Wetland 3
Is the site significantly disturbed (Atypical Situation)?	Yes	**No**	Transect ID:	3-1
Is the area a potential Problem Area? (If needed, explain on reverse)	Yes	**No**	Plot ID:	Wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Phragmites australis*	HB	FACW	9.		
2. *Lonicera japonica*	HB	FAC-	10.		
3. *Liquidambar styraciflua*	TR	FAC+	11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Greater than 50% of the predominant vegetation was observed to be hydrophytic.

HYDROLOGY

____ Recorded Data (Describe in Remarks):
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs
- ____ Other

____ No Recorded Data Available

Field Observations:

Depth of Surface Water: 0 (in.)

Depth to Free Water in Pit: 12 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- x Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- x Oxidized Root Channels in Upper 12 Inches
- x Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- x Other (Explain in Remarks)

Remarks: Evidence of hydrology observed.

SOILS

Map Unit Name (Series and Phase): Disturbed Land

Drainage Class:

Taxonomy (Subgroup):

Field Observations Confirm Mapped Type? Yes No

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-2	O	NA	NA	NA	NA
2-12	A	Gley 1 5/10Y	7.5 YR 5/6	35%	Sandy

Hydric Soil Indicators:

	Histosol		Concretions
	Histic Epipedon		High Organic Content in Surface Layer in Sandy Soils
x	Sulfidic Odor		Organic Streaking in Sandy Soils
	Aquic Moisture Regime		Listed on Local Hydric Soils List
	Reducing Conditions		Listed on National Hydric Soils List
x	Gleyed or Low-Chroma Colors		Other (Explain in Remarks)

Remarks: Evidence of hydric soils observed.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	**Yes**	No	
Wetland Hydrology Present?	**Yes**	No	
Hydric Soils Present?	**Yes**	No	Is this Sampling Point Within a Wetland? **Yes** No

Remarks: All parameters have been met.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	St. Juliens Creek Annex – Site 5	Date:	1/4/06
Applicant/Owner:	Navy	County:	Chesapeake
Investigator:	LC/JR	State:	VA

Do Normal Circumstances exist on the site?	**Yes**	No	Community ID:	Wetland 3
Is the site significantly disturbed (Atypical Situation)?	Yes	**No**	Transect ID:	3-4
Is the area a potential Problem Area? (If needed, explain on reverse)	Yes	**No**	Plot ID:	Upland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Quercus alba*	TR	FACU-	9.		
2. *Juniperus virginiana*	TR	FACU	10.		
3. *Lonicera japonica*	HB	FAC-	11.		
4. *Rubus occidentalis*	HB	FACU	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 0%

Remarks: All plants observed within the plot are found within upland areas.

HYDROLOGY

_____ Recorded Data (Describe in Remarks):
- _____ Stream, Lake or Tide Gauge
- _____ Aerial Photographs
- _____ Other

_____ No Recorded Data Available

Field Observations:

Depth of Surface Water: 0 (in.)

Depth to Free Water in Pit: 0 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- _____ Inundated
- _____ Saturated in Upper 12 Inches
- _____ Water Marks
- _____ Drift Lines
- _____ Sediment Deposits
- _____ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- _____ Oxidized Root Channels in Upper 12 Inches
- _____ Water-Stained Leaves
- _____ Local Soil Survey Data
- _____ FAC-Neutral Test
- _____ Other (Explain in Remarks)

Remarks: No evidence of hydrology observed.

SOILS

Map Unit Name (Series and Phase): Disturbed Land

Drainage Class:

Taxonomy (Subgroup):

Field Observations Confirm Mapped Type? Yes No

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-2	O	NA	NA	NA	NA
2-12	A	7.5 YR 4/4	7.5 YR 4/5	20%	Sandy

Hydric Soil Indicators:

_____ Histosol	_____ Concretions
_____ Histic Epipedon	_____ High Organic Content in Surface Layer in Sandy Soils
_____ Sulfidic Odor	_____ Organic Streaking in Sandy Soils
_____ Aquic Moisture Regime	_____ Listed on Local Hydric Soils List
_____ Reducing Conditions	_____ Listed on National Hydric Soils List
_____ Gleyed or Low-Chroma Colors	_____ Other (Explain in Remarks)

Remarks: No evidence of hydric soils observed.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes	**No**	
Wetland Hydrology Present?	Yes	**No**	
Hydric Soils Present?	Yes	**No**	Is this Sampling Point Within a Wetland? Yes **No**

Remarks: Plot is not within a wetland.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	St. Juliens Creek Annex – Site 5	Date:	9/30/05
Applicant/Owner:	Navy	County:	Chesapeake
Investigator:	DD/AC	State:	VA

Do Normal Circumstances exist on the site?	**Yes**	No	Community ID:	Wetland 3
Is the site significantly disturbed (Atypical Situation)?	Yes	**No**	Transect ID:	3-5
Is the area a potential Problem Area? (If needed, explain on reverse)	Yes	**No**	Plot ID:	Wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Phragmites australis*	HB	FACW	9.		
2. *Juncus effusus*	HB	FACW	10.		
3. *Polygonum arifolium*	HB	OBL	11.		
4. *Polygonum hydropiper*	HB	OBL	12.		
5. *Salix nigra*	SH	FACW+	13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Greater than 50% of the predominant vegetation was observed to be hydrophytic.

HYDROLOGY

Recorded Data (Describe in Remarks):
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs
- ____ Other

____ No Recorded Data Available

Field Observations:

Depth of Surface Water: 0 (in.)

Depth to Free Water in Pit: 6 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- x Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- x Oxidized Root Channels in Upper 12 Inches
- x Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- x Other (Explain in Remarks)

Remarks: Evidence of hydrology observed. Iron concretions observed.

SOILS

Map Unit Name (Series and Phase): Disturbed Land

Drainage Class:

Taxonomy (Subgroup):

Field Observations Confirm Mapped Type? Yes No

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-18		10YR 5/1	NI	20 – 10YR 4/2	Sandy

Hydric Soil Indicators:

	Histosol		Concretions
	Histic Epipedon		High Organic Content in Surface Layer in Sandy Soils
x	Sulfidic Odor		Organic Streaking in Sandy Soils
	Aquic Moisture Regime		Listed on Local Hydric Soils List
	Reducing Conditions		Listed on National Hydric Soils List
x	Gleyed or Low-Chroma Colors		Other (Explain in Remarks)

Remarks: Evidence of hydric soils observed. Observations only, due to contamination, no handling of soils occurred.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	**Yes**	No	
Wetland Hydrology Present?	**Yes**	No	
Hydric Soils Present?	**Yes**	No	Is this Sampling Point Within a Wetland? **Yes** No

Remarks: All parameters have been met.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	St. Juliens Creek Annex – Site 5	Date:	9/30/05
Applicant/Owner:	Navy	County:	Chesapeake
Investigator:	DD/AC	State:	VA

Do Normal Circumstances exist on the site?	**Yes**	No	Community ID:	Wetland 4
Is the site significantly disturbed (Atypical Situation)?	Yes	**No**	Transect ID:	4-4
Is the area a potential Problem Area? (If needed, explain on reverse)	Yes	**No**	Plot ID:	Wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Phragmites australis*	HB	FACW	9.		
2. *Juncus effusus*	HB	FACW	10.		
3. *Polygonum arifolium*	HB	OBL	11.		
4. *Polygonum hydropiper*	HB	OBL	12.		
5. *Typha latifolia*	HB	OBL	13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Greater than 50% of the predominant vegetation was observed to be hydrophytic.

HYDROLOGY

Recorded Data (Describe in Remarks):
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs
- ____ Other

____ No Recorded Data Available

Field Observations:

Depth of Surface Water: 0 (in.)

Depth to Free Water in Pit: 6 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- x Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- x Oxidized Root Channels in Upper 12 Inches
- x Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- x Other (Explain in Remarks)

Remarks: Evidence of hydrology observed. Iron concretions observed.

SOILS

Map Unit Name (Series and Phase): Disturbed Land

Drainage Class:

Taxonomy (Subgroup):

Field Observations Confirm Mapped Type? Yes No

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-18		10YR 3/1	NI	20 – 10YR 4/2	Sandy

Hydric Soil Indicators:

	Histosol		Concretions
	Histic Epipedon		High Organic Content in Surface Layer in Sandy Soils
x	Sulfidic Odor		Organic Streaking in Sandy Soils
	Aquic Moisture Regime		Listed on Local Hydric Soils List
	Reducing Conditions		Listed on National Hydric Soils List
x	Gleyed or Low-Chroma Colors		Other (Explain in Remarks)

Remarks: Evidence of hydric soils observed. Observations only, due to contamination, no handling of soils occurred.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	**Yes**	No	
Wetland Hydrology Present?	**Yes**	No	
Hydric Soils Present?	**Yes**	No	Is this Sampling Point Within a Wetland? **Yes** No

Remarks: All parameters have been met.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	St. Juliens Creek Annex – Site 2	Date:	9/30/05
Applicant/Owner:	Navy	County:	Chesapeake
Investigator:	DD/AC	State:	VA

Do Normal Circumstances exist on the site?	**Yes**	No	Community ID:	Site 2
Is the site significantly disturbed (Atypical Situation)?	Yes	**No**	Transect ID:	5-3
Is the area a potential Problem Area? (If needed, explain on reverse)	Yes	**No**	Plot ID:	Wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Phragmites australis*	HB	FACW	9.		
2. *Juncus effusus*	HB	FACW	10.		
3. *Typha latifolia*	HB	OBL	11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Greater than 50% of the predominant vegetation was observed to be hydrophytic.

HYDROLOGY

____ Recorded Data (Describe in Remarks):
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs
- ____ Other

____ No Recorded Data Available

Field Observations:

Depth of Surface Water: 0 (in.)

Depth to Free Water in Pit: 6 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- x Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- x Oxidized Root Channels in Upper 12 Inches
- x Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- x Other (Explain in Remarks)

Remarks: Evidence of hydrology observed. Iron concretions observed.

SOILS

Map Unit Name (Series and Phase): Disturbed Land

Drainage Class:

Taxonomy (Subgroup):

Field Observations Confirm Mapped Type? Yes No

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-6		10YR 3/2	NI	20 – 10YR 4/1	Silty - organic
6-18					liquified

Hydric Soil Indicators:

	Histosol		Concretions
	Histic Epipedon		High Organic Content in Surface Layer in Sandy Soils
x	Sulfidic Odor		Organic Streaking in Sandy Soils
	Aquic Moisture Regime		Listed on Local Hydric Soils List
	Reducing Conditions		Listed on National Hydric Soils List
x	Gleyed or Low-Chroma Colors		Other (Explain in Remarks)

Remarks: Evidence of hydric soils observed. Observations only, due to contamination, no handling of soils occurred.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	**Yes**	No	
Wetland Hydrology Present?	**Yes**	No	
Hydric Soils Present?	**Yes**	No	Is this Sampling Point Within a Wetland? **Yes** No

Remarks: All parameters have been met.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	St. Juliens Creek Annex – Site 2	Date:	9/30/05
Applicant/Owner:	Navy	County:	Chesapeake
Investigator:	DD/AC	State:	VA

Do Normal Circumstances exist on the site?	**Yes**	No	Community ID:	Site 2
Is the site significantly disturbed (Atypical Situation)?	Yes	**No**	Transect ID:	5-19
Is the area a potential Problem Area? (If needed, explain on reverse)	Yes	**No**	Plot ID:	Wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Spartina alterniflora*	HB	OBL	9.		
2. *Juncus effusus*	HB	FACW	10.		
3. *Typha latifolia*	HB	OBL	11.		
4. *Salix nigra*	SH	FACW	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Greater than 50% of the predominant vegetation was observed to be hydrophytic.

HYDROLOGY

Recorded Data (Describe in Remarks):
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs
- ____ Other

____ No Recorded Data Available

Field Observations:

Depth of Surface Water: 0 (in.)

Depth to Free Water in Pit: 0 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- x Saturated in Upper 12 Inches
- x Water Marks
- x Drift Lines
- ____ Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- x Oxidized Root Channels in Upper 12 Inches
- x Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- x Other (Explain in Remarks)

Remarks: Evidence of hydrology observed. Tidal area.

SOILS

Map Unit Name (Series and Phase): Disturbed Land

Drainage Class:

Taxonomy (Subgroup):

Field Observations Confirm Mapped Type? Yes No

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-6		10YR 3/2	NI	20 – 10YR 4/1	Silty - organic
6-18					liquified

Hydric Soil Indicators:

	Histosol		Concretions
	Histic Epipedon		High Organic Content in Surface Layer in Sandy Soils
x	Sulfidic Odor		Organic Streaking in Sandy Soils
	Aquic Moisture Regime		Listed on Local Hydric Soils List
	Reducing Conditions		Listed on National Hydric Soils List
x	Gleyed or Low-Chroma Colors		Other (Explain in Remarks)

Remarks: Evidence of hydric soils observed. Observations only, due to contamination, no handling of soils occurred.

WETLAND DETERMINATION

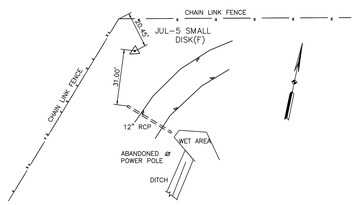
Hydrophytic Vegetation Present?	**Yes**	No	
Wetland Hydrology Present?	**Yes**	No	
Hydric Soils Present?	**Yes**	No	Is this Sampling Point Within a Wetland? **Yes** No

Remarks: All parameters have been met.

Appendix B
Site 5 Topographical Map

MONITORING WELLS		
NUMBER	NORTHING	EASTING
SJS05-MW01S	3456044.058	12123946.110
SJS05-MW01D	3456043.493	12123957.060

NOTE:
1. HORIZONTAL DATUM-NAD 83(96) VIRGINIA STATE PLANE COORDINATE SYSTEM SOUTH ZONE U.S. SURVEY FOOT.
2. VERTICAL DATUM-NAVD 88 U.S. SURVEY FOOT, GPS DERIVED
3. JUL-5 (SMALL DISK (F))AS SHOWN ON SHEET 1 OF 3 IS SITE BM ELEVATION=6.69



CONTROL REFERENCE SKETCH
JUL-5
N.T.S

LEGEND

- MONITORING WELL
- NAIL FOUND
- NAIL SET
- EDGE OF PAVEMENT
- DIRT
- GRAVEL
- CONCRETE
- STORM DRAIN MANHOLE
- SANITARY SEWER MANHOLE
- YARD INLET GRATE
- DROP INLET
- UTILITY MANHOLE
- STORM SEWER PIPE
- FIRE HYDRANT
- GUY WIRE
- POWER POLE
- OHE — OVERHEAD ELECTRIC LINE
- PROPERTY LINE
- EDGE OF WATER
- POST
- TREELINE
- BOLLARD
- SIGN
- TRAVERSE POINT
- ELECTRICAL TOWER
- PINE TREE
- TREES
- WATER VALVE
- FLAG POLE
- TELEPHONE PEDESTAL

CONTOUR LEGEND

- MINOR CONTOUR
- MAJOR CONTOUR

30' 15' 0 30' 60' 90'
SCALE 1"= 30'

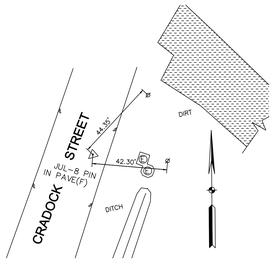
COMMONWEALTH OF VIRGINIA
PAUL deC. HOLT, JR.
No. 001497-B
LAND SURVEYOR

DRAWN: ODG
CHECKED: KBW
DATE: 3/1/06
SCALE: 1"=30'
SHEET 1 OF 3
FILE NO: 14257-1-0

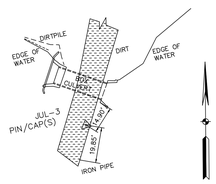
TOPOGRAPHIC SURVEY
OF
ST. JULIENS CREEK ANNEX
CTO-057, SITE 5
CHESAPEAKE, VIRGINIA

PHR+A
Patton Harris Rust & Associates
Engineers. Surveyors. Planners. Landscape Architects.
195 S. ROSEMONT ROAD, SUITE 101 VIRGINIA BEACH, VIRGINIA 23452
T 757.497.7472 **F** 757.497.0250

FILE NAME: P:\PROJECT\14257\1-0\SURVEY\WORK AREA\SITE 5 ST. JULIENS CREEK.DWG



CONTROL REFERENCE SKETCH
JUL-8
N.T.S



CONTROL REFERENCE SKETCH
JUL-3
N.T.S

MONITORING WELLS		
NUMBER	NORTHING	EASTING
SJS05-MW01S	3456044.058	12123946.110
SJS05-MW01D	3456043.493	12123957.060

NOTE:
1. HORIZONTAL DATUM-NAD 83(96) VIRGINIA STATE PLANE COORDINATE SYSTEM SOUTH ZONE U.S. SURVEY FEET.
2. VERTICAL DATUM-NAVD 88 U.S. SURVEY FEET, GPS DERIVED
3. JUL-5 (SMALL DISK (F))AS SHOWN ON SHEET 1 OF 3 IS SITE BM ELEVATION=6.69

LEGEND

- MONITORING WELL
- NAIL FOUND
- NAIL SET
- EDGE OF PAVEMENT
- DIRT
- GRAVEL
- CONCRETE
- STORM DRAIN MANHOLE
- SANITARY SEWER MANHOLE
- YARD INLET GRATE
- DROP INLET
- UTILITY MANHOLE
- STORM SEWER PIPE
- FIRE HYDRANT
- GUY WIRE
- POWER POLE
- OHE — OVERHEAD ELECTRIC LINE
- PROPERTY LINE
- EDGE OF WATER
- POST
- TREELINE
- BOLLARD
- SIGN
- TRAVERSE POINT
- ELECTRICAL TOWER
- PINE TREE
- TREES
- WATER VALVE
- FLAG POLE
- TELEPHONE PEDESTAL

CONTOUR LEGEND

- MINOR CONTOUR
- MAJOR CONTOUR

30' 15' 0 30' 60' 90'
SCALE 1"= 30'

COMMONWEALTH OF VIRGINIA
PAUL deC. HOLT, JR.
No. 001497-B
LAND SURVEYOR

DRAWN: ODG
CHECKED: KBW
DATE: 3/1/06
SCALE: 1"=30'
SHEET 2 OF 3
FILE NO: 14257-1-0

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TOPOGRAPHIC SURVEY
OF
ST. JULIENS CREEK ANNEX
CTO-057, SITE 5
CHESAPEAKE, VIRGINIA

FILE NAME: P:\PROJECT\14257\1-0\SURVEY\WORK AREA\SITE 5 ST. JULIENS CREEK.DWG

MONITORING WELLS		
NUMBER	NORTHING	EASTING
SJS05-MW04S	3455684.348	12124315.575
SJS05-MW04D	3455668.664	12124324.328

NOTE:
1. HORIZONTAL DATUM-NAD 83(96) VIRGINIA STATE PLANE COORDINATE SYSTEM SOUTH ZONE U.S. SURVEY FEET.
2. VERTICAL DATUM-NAVD 88 U.S. SURVEY FEET, GPS DERIVED
3. JUL-5 (SMALL DISK (F))AS SHOWN ON SHEET 1 OF 3 IS SITE BM ELEVATION=6.69

LEGEND

- MONITORING WELL
- NAIL FOUND
- NAIL SET
- EDGE OF PAVEMENT
- DIRT
- GRAVEL
- CONCRETE
- STORM DRAIN MANHOLE
- SANITARY SEWER MANHOLE
- YARD INLET GRATE
- DROP INLET
- UTILITY MANHOLE
- STORM SEWER PIPE
- FIRE HYDRANT
- GUY WIRE
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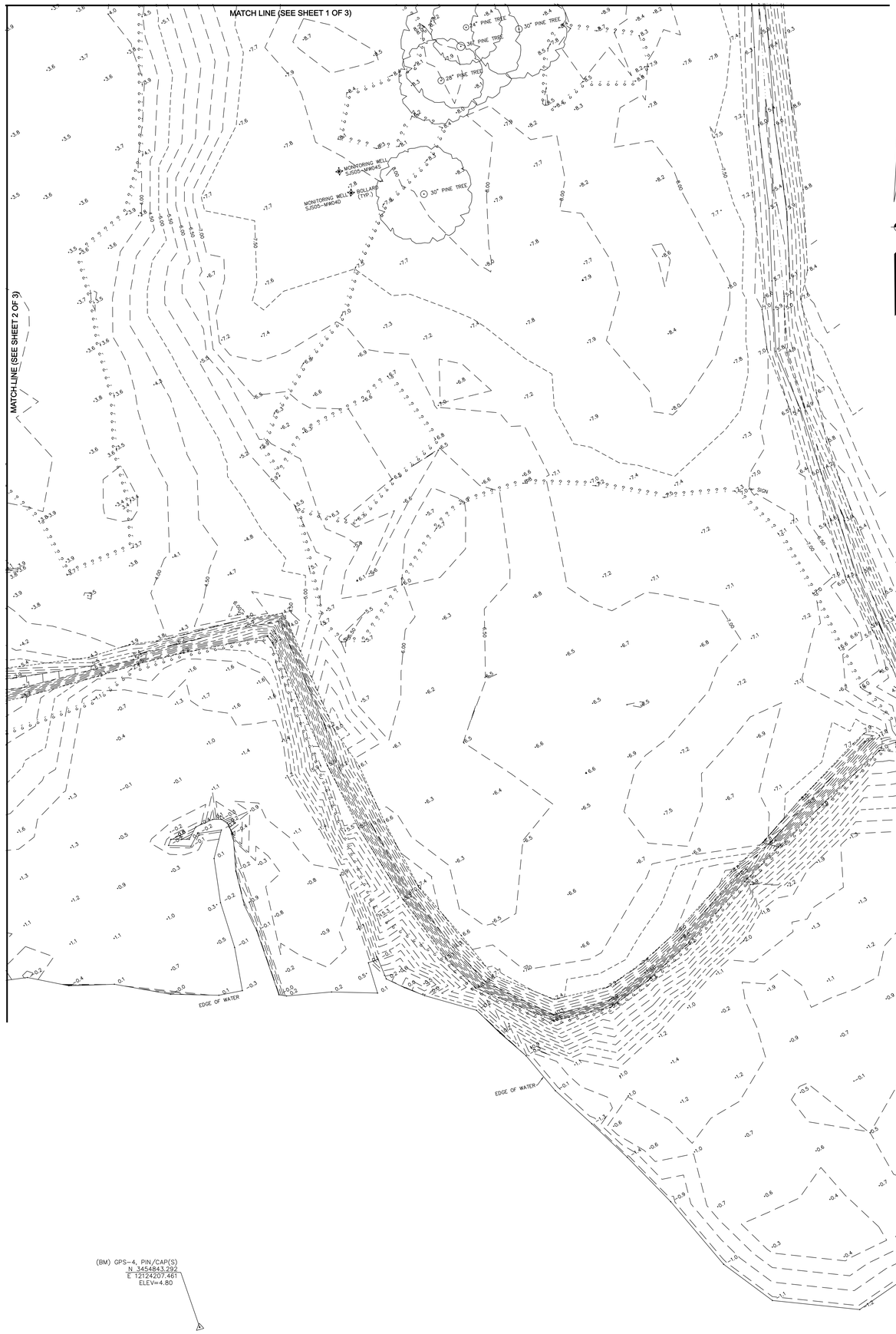
- ELECTRICAL TOWER
- PINE TREE
- TREES
- WATER VALVE
- FLAG POLE
- TELEPHONE PEDESTAL

CONTOUR LEGEND

- MINOR CONTOUR
- MAJOR CONTOUR



30' 15' 0 30' 60' 90'

SCALE 1"= 30'

COMMONWEALTH OF VIRGINIA
PAUL deC. HOLT, JR
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TOPOGRAPHIC SURVEY
OF
ST. JULIENS CREEK ANNEX
CTO-057, SITE 5
CHESAPEAKE, VIRGINIA

DRAWN: ODG
CHECKED: KBW
DATE: 3/1/06
SCALE: 1"=30'
SHEET 3 OF 3
FILE NO: 14257-1-0

FILE NAME: P:\PROJECT\14257\1-0\SURVEY\WORK AREA\SITE 5 ST. JULIENS CREEK.DWG

Appendix C
ARARs Tables

Acronyms and Abbreviations

ARAR	Applicable or relevant and appropriate requirement
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
DCR	Virginia Department of Conservation and Recreation
DNH	Division of Natural Heritage
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NAAQS	National Ambient Air Quality Standards
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NSDWRs	National Secondary Drinking Water Regulations
NSPS	New Source Performance Standards
PCB	Polychlorinated biphenyls
PMCL	Primary Maximum Contaminant Level
POTW	Publicly Owned Treatment Works
ppm	Parts per Million
RBC	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contaminant Level
TBC	To Be considered
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substance Control Act
USACE	US Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
VA	Virginia
VAC	Virginia Administrative Code
VMRC	Virginia Marine Resource Commission
VPA	Virginia Pollutant Abatement
VPDES	Virginia Pollutant Discharge Elimination System

References

Commonwealth of Virginia, 2004. Preliminary Identification, Applicable or Relevant and Appropriate Requirements.

USEPA, 1998. *CERCLA Compliance with Other Laws Manual: Interim Final* . Office of Emergency and Remedial Response. EPA/540/G-89/006.

USEPA, 1998. *CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes.* Office of Emergency and Remedial Response. EPA/540/G-89/009.

USEPA, 1998. RCRA, Superfund & EPCRA Hotline Training Manual. Introduction to Applicable or Relevant and Appropriate Requirements. EPA540-R-98-020.

Table C-1
Federal Chemical-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Clean Air Act						
Air	NAAQS specify the maximum concentration of each criteria pollutant (carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, sulfur dioxide) which is to be permitted in the ambient air, as averaged over a period of time. Requirements differ for new sources of air pollutant emissions and existing sources. Requirements also differ based on the air quality designation of the site's location (i.e., attainment, non-attainment, unclassified, or transport) (*see Federal Location-Specific ARARs*).	Emissions of criteria pollutants during the response action, or during the operation and maintenance of the response action. NAAQSs are not enforceable in and of themselves. Any substantive standards contained within the State Implementation Plan are, however, federally enforceable.	40 CFR 50.4 to 50.12	2 - 5	TBC	Federal NAAQS are non-enforceable standards. No discharges to air are anticipated other than fugitive dust during the removal action activities.
Air	NSPS are emission standards to ensure that new sources are designed, built, and operated in a manner that reflects the best demonstrated technology and retain economic feasibility in a uniform manner across the country. Four designated pollutants (fluorides, sulfuric acid mist, total reduced sulfur, and municipal waste combustor emissions) have been designated. To-date NSPSs have been promulgated for over 50 source categories.	Emissions of designated pollutants from a major new stationary source or major modifications to an existing source.	40 CFR 60.1 to 60.2875	2 - 5	Not Applicable	Construction activities do not employ a new stationary source or existing source that will discharge pollutants to air.
Air	NESHAPS are point-source standards for hazardous air pollutants. These standards address both new and existing sources at the point of emission. Eight hazardous air pollutants (asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride) were initially designated. The 1990 amendments greatly expanded the list of hazardous air pollutants, including 189 new pollutants and designating 174 source categories. Maximum Achievable Control Technology standards were developed for all source categories that emit hazardous air pollutants.	Emissions of hazardous air pollutants from a point source.	40 CFR 61.01 to 61.359	2 - 5	Not Applicable	Construction activities do not employ one of the specific source categories regulated.

Table C-1
Federal Chemical-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Clean Water Act						
Surface water	Both on-site and off-site direct discharges of pollutants (126 pollutants are listed) to surface waters are required to meet the substantive requirements of the NPDES program. These substantive requirements include discharge limitations (both technology and water quality based), certain monitoring requirements, and best management practices. Ambient water quality standards include Federal water quality criteria and State water quality standards.	Direct discharges to surface waters.	*Clean Water Act* , §303, 304, and 402	2 - 5	Not Applicable	Construction activities do not involve point source discharge of pollutants to surface waters.
Safe Drinking Water Act						
Groundwater	SDWA standards serve to protect public water systems. Primary drinking water standards consist of federally enforceable MCLs. MCLs are the highest level of a contaminant that is allowed in drinking water.	Impact to public water systems that have at least 15 service connections or serve at least 25 year-round residents. May also be cleanup standards for on-site ground or surface waters that are current or potential sources of drinking water.	40 CFR 141.11 to 141.16 and 141.61 to 141.66	2	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action. However, since waste will remain on site, groundwater will be monitored to verify the effectiveness of the cover.
				3 - 5	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action.
Groundwater	SDWA standards serve to protect public water systems. The MCLG is the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.	Impact to public water systems that have at least 15 service connections or serve at least 25 year-round residents. May also be cleanup standards for on-site ground or surface waters that are current or potential sources of drinking water.	40 CFR 141.50 to 141.55	2	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action. However, since waste will remain on site, groundwater will be monitored to verify the effectiveness of the cover.
				3 - 5	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action.

Table C-1
Federal Chemical-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Groundwater	National Secondary Drinking Water Regulations (NSDWRs or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water.	Impact to public water systems that have at least 15 service connections or serve at least 25 year-round residents. May also be cleanup standards for on-site ground or surface waters that are current or potential sources of drinking water.	40 CFR 143	2	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action. However, since waste will remain on site, groundwater will be monitored to verify the effectiveness of the cover.
				3 - 5	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action.
Resource Conservation and Recovery Act Subtitle C						
Waste	Wastes to be managed must be sampled for TCLP analyses to determine the appropriate waste characterization.	Treatment, storage, and/or disposal of wastes (i.e., soil, water, solid waste).	40 CFR 261	2	Not Applicable	Construction of the cover will not result in waste disposal.
				3 - 5	Applicable	Excavated soil will require waste characterization prior to disposal.
USEPA Region III RBC Tables						
Water, air, fish tissue, soil	Chemical concentrations corresponding to fixed levels of human health risk (i.e., a hazard quotient of 1, or lifetime cancer risk of 10^{-6}, whichever occurs at a lower concentration).	Assessment of potential human health risks.	USEPA Region III RBC Tables	2 - 5	TBC	RBCs for soil were used to screen against site concentrations as a preliminary indicator of risk. Site-specific clean-up goals will be used for implementation of this removal action.
USEPA Region III BTAG Screening Values						
Soil, sediment, surface water	Chemical concentrations corresponding to fixed levels of risks to ecological receptors (flora and/or fauna).	Assessment of potential ecological risks.	USEPA Region III BTAG Screening Values	2	Not Applicable	Clean off-site borrow will be used for construction of the cover, thereby eleiminating the exposure pathway.
				3 - 4	Not Applicable	Excavation of soil will result in the removal of the ecological risk posed by contaminants in soil. Additionally, the excavations will be backfilled to their preexisting grade with clean off-site borrow material, thereby eliminating the exposure pathway.
				5	Not Applicable	Excavation of soil will result in the removal of the ecological risk posed by contaminants in soil. Additionally, a six-inch layer of clean off-site borrow will be placed over the excavation grade to provide a suitable planting medium, thereby eliminating the exposure pathway.

Table C-2
Virginia Chemical-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
State Water Control Law **[VA Code Ann. §§ 62.1-44.2 to 62.1-44.34:28 (2003)]**						
Groundwater, decontamination water, or other materials to be discharged to surface waters	Must meet effluent discharge limits established. Site-specific limits may be established following receipt of estimated discharge rates and initial design documents.	VPDES Permit.	*Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation* , 9 VAC 25-31-10 to 940	2	Not Applicable	The construction of the cover will not involve or require discharges to surface water and a VPDES permit is not required.
				3 - 5	Relevant and Appropriate	Groundwater encountered during excavation will be managed within the excavation to prevent discharge to surface waters.
Surface water	Mandates the protection of existing high-quality state waters and provides for the restoration of all other state waters so they will permit reasonable public uses and will support the growth of aquatic life. Water quality standards consist of statements that describe water quality requirements. They also contain numeric limits for specific physical, chemical, biological or radiological characteristics of water. These statements and numeric limits describe water quality necessary to meet and maintain uses such as swimming and other water-based recreation, public water supply, and the propagation and growth of aquatic life.	State surface waters designated for aquatic life or human uses.	*Water Quality Standards* , 9 VAC 25-260-5 to 550	2 - 5	Not Applicable	This removal action is being performed to address waste and impacted soil. Impacts to surface water are not anticipated.
Groundwater	Establishes groundwater quality standards to protect the public health or welfare and enhance the quality of water.	Standards are used when no MCL is available.	*Groundwater Quality Standards* , 9 VAC 25-280	2	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action. However, since waste will remain on site, groundwater will be monitored to verify the effectiveness of the cover.
				3 - 5	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action.

Table C-2
Virginia Chemical-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Environmental Health Services **[VA Code Ann. §§ 32.1-163 to 248.2]**						
Groundwater	Ensures that all water supplies destined for public consumption be pure water. Cleanup levels for potential drinking water sources must be based on PMCLs. In the absence of PMCLs, other health-based standards or criteria, or best professional judgment based on risk assessment, may be employed. Where groundwater that is a potential drinking water source discharges to surface water, the cleanup level at the discharge point would be the more stringent of either the PMCL or a discharge limit based on the *Water Quality Standards* .	Potential drinking water source.	*Waterworks Regulations* , 12 VAC 5-590-10 to 1280	2	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action. However, since waste will remain on site, groundwater will be monitored to verify the effectiveness of the cover.
				3 - 5	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action.
Groundwater	SMCLs are guidelines pertaining to aesthetic qualities of drinking water (i.e., color, odor, and taste).	Potential drinking water source.	*Waterworks Regulations* , 12 VAC 5-590-10 to 1280	2	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action. However, since waste will remain on site, groundwater will be monitored to verify the effectiveness of the cover.
				3 - 5	Not Applicable	This removal action is being completed to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action.
Virginia Waste Management Act [VA Code Ann. §§ 10.1-1400 to 1457 (2004)]						
Waste	Wastes to be managed must be sampled to determine the appropriate waste characterization.	Management of wastes.	H*azardous Waste Regulations* , 9 VAC 20-60-12 to 1505 *Solid Waste Management Regulations,* 9 VAC 20-80-10 to 790	2	Not Applicable	Construction of the cover will not result in wastes to be managed.
				3 - 5	Applicable	Excavated soil will be characterized prior to disposal.

Table C-2
Virginia Chemical-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Air Pollution Control Board **[VA Code Ann. §§ 10.1-1300 to 1326 (1998)]**						
Air	Assures that ambient concentrations of air pollutants are consistent with established criteria and serves as the basis for effective and reasonable management of the air resources of the Commonwealth. Primary ambient air quality standards define levels of air quality which, allowing an adequate margin of safety, are necessary to protect the public health. Secondary ambient air quality standards define more stringent levels of air quality which are necessary to protect the public welfare from any known or anticipated adverse effects associated with the presence of air pollutants in the ambient air.	Air emission from disturbance of soil, treatment of soil or water, or other pollutant management activities.	*Ambient Air Quality Standards* , 9 VAC 5-30-10 to 80	2 - 5	Applicable	No discharges to air are anticipated other than fugitive dust during excavation and fill placement.

Table C-3
Federal Location-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Clean Air Act						
Attainment area	New major stationary sources shall apply best available control technology for each pollutant, subject to regulation under the Clean Air Act, that the source would have potential to emit in significant amounts. Owner or operator of proposed source or modification shall demonstrate that allowable emissions increases or reductions (including secondary emissions) will not cause or contribute to a violation of the NAAQS or applicable maximum allowable increase over baseline concentrations.	Major stationary sources that emits, or has the potential to emit, 100 tons per year or more of any regulated pollutant; any other stationary source that emits, or has the potential to emit, 250 tons per year or more of any regulated pollutant.	40 CFR 52.21(j)	2 - 5	Not Applicable	Construction activities do not employ a new stationary source or existing source that will discharge pollutants to air.
Non-attainment area	Source must obtain emissions offsets in Air Quality Control Region of greater than one-to-one. Source subject to "lowest achievable emission rate". All major stationary sources owned or operated by the person in the State are in compliance, or on a schedule for compliance, with all applicable emission standards.	Any stationary facility or source of air pollutants that directly emits, or has the potential to emit, 100 tons per year or more of any air pollutant (including any major emitting facility or source of fugitive emissions of any such pollutants).	*Clean Air Act* , Part D §173(1) to (3); 40 CFR 51.18(j)	2 - 5	Not Applicable	Construction activities do not employ a new stationary source or existing source that will discharge pollutants to air.
Clean Water Act						
Wetlands	Avoid adverse effects, minimize potential harm, and preserve and enhance wetlands, to the extent possible.	Action involving construction of facilities or management of property in wetlands. Wetland as defined by Executive Order 11990 Section 7 (protection of Wetlands).	*Clean Water Act,* §404; Executive Order 11990; 40 CFR 6, Appendix A	2	Applicable	Construction of a cover will require fill material to be placed over existing wetland areas. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. A Compensatory Mitigation Plan will be prepared and compensatory mitigation will be performed if required.
				3 - 4	Applicable	Wetlands are located within the boundary of the proposed excavation and backfill. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. The site, including wetland areas, will be restored to the preconstruction condition. However, because of the temporary impact to the wetlands, a Compensatory Mitigation Plan will be necessary.

Table C-3
Federal Location-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
				5	Applicable	Wetlands are located within the boundary of the proposed excavation area. The wetland will be temporarily impacted for the excavation, but this alternative includes the construction of additional wetland in the excavated area. This will enhance the quality of the wetlands present onsite. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. A Compensatory Mitigation Plan will be required due to the temporary wetland impact for the excavation.
Safe Drinking Water Act						
Sole source aquifer	SDWA prevents federal funding from being committed to any project that may contaminate a "sole source aquifer," meaning any USEPA-designated aquifer that is the only principal drinking water supply for a given area which, if contaminated, would present a significant human health hazard.	Generally, CERCLA activities do not in and of themselves increase pre-existing contamination of sole source aquifers. Although it is unlikely that CERCLA activities would be subject to funding restrictions, a review of potential problems associated with sole source aquifers should be conducted.	40 CFR 149	2	Not Applicable	Although the underlying Columbia and Yorktown Aquifers are sole source aquifers, this removal action is being implemented to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action. However, since waste will remain on site, groundwater will be monitored to verify the effectiveness of the cover.
				3 - 5	Not Applicable	Although the underlying Columbia and Yorktown Aquifers are sole source aquifers, this removal action is being implemented to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action.
National Historic Preservation Act						
Historic district, site, building, structure, or object	Avoid impacts on cultural resources; recover and preserve artifacts and historic properties. Where impacts are unavoidable, mitigate through design and data recovery. Plan action to minimize harm to National Historic Landmarks.	Properties listed in the National Register of Historic Places, or eligible for such listing. Alteration of terrain that threatens significant scientific, prehistorical, historical or archaeological data.	*National Historic Preservation Act* , 16 USC 469 to 470; 36 CFR 65; 36 CFR 800	2 - 5	Not Applicable	Site 5 is not located in a known historic district or in the vicinity of historical structures or artifacts.

Table C-3
Federal Location-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Endangered Species Act						
Critical habitat of/or presence of an endangered or threatened species	Identify activities that may affect listed species. Actions must not threaten the continued existence of a listed species. Actions must not destroy critical habitat.	Presence of species or habitat listed as endangered or threatened.	*Endangered Species Act* , 16 USC 1531 et. seq.; 50 CFR 200; 50 CFR 402; *Fish and Wildlife Coordination Act* (16 USC 661 et seq.); 33 CFR 320 to 330	2 - 5	Not Applicable	Except for the potential of occasional transient individuals, no rare, threatened, or endangered wildlife species are known to occur at Site 5.
Wild and Scenic Rivers Act						
Wild, scenic, or recreational river	Determine if project will affect the free-flowing characteristics, scenic, or natural values of a designated river; not authorize any water project or any other project that would directly or indirectly impact any designated river without notifying the Department of Energy or Forest Service.	Any river, and the bordering adjacent land, designated as "wild and scenic or recreational."	*Wild and Scenic Rivers Act* , 16 USC 1271 et. seq.; 36 CFR 297.4; 40 CFR 6.302(e)	2 - 5	Not Applicable	Site 5 does not border a wild and scenic or recreational river.
Coastal Zone Management Act						
Coastal zone or area that will affect the coastal zone	Federal activities must be consistent with, to the area that will affect maximum extent practicable, State coastal zone management programs. Federal agencies must supply the State with a consistency determination.	Wetland, flood plain, estuary, beach, dune, barrier island, coral reef, and fish and wildlife and their habitat, within the coastal zone.	*Coastal Zone Management Act* , 16 USC 1451 et. seq.; 15 CFR 930.30; 15 CFR 930.34	2 - 5	Relevant and Appropriate	Site 5 and its surrounding vicinity is located within the coastal zone. Activities will be conducted in accordance with approved management program.
Wilderness Act						
Wilderness area	Areas must be administered in such manner as will leave it unimpaired as wilderness and to preserve its wilderness. The following are not allowed in a wilderness area: commercial enterprises, permanent roads (except as necessary to administer the area), motor vehicles, motorized equipment, motorboats, aircraft, mechanized transport, and structure or buildings.	Any unit of the National Wildlife Refuge System.	*Wilderness Act,* 16 USC 1131 et. seq.; 50 CFR 35.1 et. seq.	2 - 5	Not Applicable	Site 5 is not designated as a National Wildlife Refuge System.
Resource Conservation and Recovery Act						
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout. For existing surface impoundments, waste piles, land treatment units, landfills, and miscellaneous units, no adverse effects on human health or the environment will result if washout occurs.	RCRA hazardous waste; treatment, storage, or disposal.	40 CFR 264.18(b)	2 - 5	Not Applicable	Site 5 is located within the 100-year floodplain; however, the removal action does not involve the construction of a treatment, storage, or disposal facility.
Within salt dome formation, underground mine, or cave	Placement of non-containerized or bulk liquid hazardous waste prohibited.	RCRA hazardous waste; placement.	40 CFR 264.18(c)	2 - 5	Not Applicable	A salt dome formation, underground mine, or cave are not present at Site 5.

Table C-3
Federal Location-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Fish and Wildlife Coordination Act						
Floodplain	Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood prone areas.	*Fish and Wildlife Coordination Act* , 16 USC 661 et. seq.; Executive Order 11988; 40 CFR 6, Appendix A; 40 CFR 6.302	2 - 5	Applicable	As Site 5 is located in a relatively flat area adjoining surface waters, construction activities may require compliance with this order. Erosion control measures will be implemented.
Area affecting stream or river	Requires that activities avoid, minimize, or compensate for impacts to fish and wildlife and their habitats.	Diversion, channeling or other activity that modifies a stream or river and affects fish or wildlife and their habitat.	*Fish and Wildlife Coordination Act,* 16 USC 661 et. seq.; 40 CFR 6.302	2 - 5	Applicable	As Site 5 is located adjacent to Blows Creek, construction activities may require compliance with this order. Erosion control measures will be implemented.
National Wildlife Refuge System						
Wildlife refuge	Only actions allowed under the citation may be undertaken in areas that are part of the National Wildlife Refuge System.	Area designated as part of National Wildlife Refuge System.	16 USC 668dd et. seq.; 50 CFR 27	2 - 5	Not Applicable	Site 5 is not designated as a wildlife refuge.
Coastal Barrier Resources Act						
Designated coastal barrier	Prohibits any new Federal expenditure within the Coastal Barrier Resource System.	Activity within the Coastal Barrier Resource System.	*Coastal Barrier Resources Act* , 16 USC 3501 et. seq.	2 - 5	Not Applicable	Site 5 is not designated as a coastal barrier system.
Rivers and Harbors Appropriation Act						
Navigable waterways of the United States	Meet regulatory requirements to conduct activity in navigable waterways of the United States.	Prohibits the construction of any structures, excavation, fill, or altering of any port, roadstead, haven, harbor, canal, navigable river, or other water of the United States, outside established harbor lines, or where no harbor lines have been established, without meeting established guidelines.	*Rivers and Harbors Appropriation Act* , 33 USC 401-403	2 - 5	Not Applicable	Construction activities will not occur in navigable waters of the United States.
Marine Research and Sanctuaries Act						
Ocean waters	Prohibits dumping into ocean waters of any material that would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities. Must meet regulatory requirements to conduct dumping into ocean waters.	Applies to actions that result in discharge to ocean waters.	*Marine Research and Sanctuaries Act* , 16 USC 32	2 - 5	Not Applicable	Construction activities will not involve direct discharge to the ocean.

Table C-3
Federal Location-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Migratory Bird Treaty Act						
Migratory bird area	Protects almost all species of native birds in the United States from unregulated taking which can include poisoning at hazardous waste sites.	Presence of migratory birds.	*Migratory Bird Treaty Act* , 16 USC 703	2 - 4	Applicable	Migratory birds are present at Site 5. The removal action will prevent migratory birds from future contact with contaminated soil.
				5	Applicable	Migratory birds are present at Site 5. Excavation will prevent migratory birds from future contact with contaminated soil. Construction of a wetland will enhance the quality of the habitat.

Table C-4
Virginia Location-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
General Provisions Relating to Marine Resources Commission **[VA Code Ann. §§ 28.2-1300 to 1320 (1998)]**						
Wetlands	Mitigate or minimize the loss of wetlands and the adverse ecological effects of all permitted activities. To preserve the wetlands as much as possible in their natural state and to consider appropriate requirements for compensation only after it has been proven that the loss of the natural resource is unavoidable and that the project will have the highest public and private benefit. The determination as to whether compensation is warranted and permissible is conducted on a case-by-case basis. Commitments to preserve other existing wetlands shall not ordinarily be an acceptable form of compensation.	If a wetlands zoning ordinance has been adopted by local government, in accordance with the *General Provisions Relating to Marine Resources Commission* , and the response action is not exempt from its provisions, the project must comply with the requirements of the ordinance. In the case of absence of an ordinance, or of an exemption to it, VMRC can exercise jurisdiction over tidal wetlands.	*Wetlands Mitigation Compensation Policy* , 4 VAC 20-390-10 to 50	2	Applicable	Construction of a cover will require fill material to be placed over existing wetland areas. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. A Compensatory Mitigation Plan will be prepared and compensatory mitigation will be performed if required.
				3 - 4	Applicable	Wetlands are located within the boundary of the proposed excavation and backfill. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. The site, including wetland areas, will be restored to the preconstruction condition. However, because of the temporary impact to the existing wetland, a Compensatory Mitigation Plan will be prepared.
				5	Applicable	This alternative includes the construction of a wetland in the excavated area. This will enhance the quality of the wetlands present onsite. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. A Compensatory Mitigation Plan will be prepared for the temporary impact to the existing wetland.
Chesapeake Bay Preservation Act **[VA Code Ann. §§ 10.1-2100 to 2116]**						
Chesapeake Bay and its tributaries	Criteria that provide for the protection of water quality of the Chesapeake Bay and its tributaries, that will also accommodate economic development in Tidewater Virginia. Under these requirements, certain locally designated tidal and nontidal wetlands, as well as other sensitive land areas, may be subject to limitations regarding land-disturbing activities, removal of vegetation, use of impervious cover, erosion and sediment control, stormwater management, and other aspects of land use that may have effects on water quality.	Location is within a Chesapeake Bay Preservation Area.	*Chesapeake Bay Preservation Area Designation and Management Regulations* , 9 VAC 10-20-10 to 260	2 - 5	Applicable	Site 5 is located within the Chesapeake Bay watershed. Activities conducted at Site 5 will comply with Chesapeake Bay Restoration Act.

Table C-4
Virginia Location-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Endangered Species **[VA Code Ann. §§ 29.1-563 to 570 (1998)]**						
Presence of any threatened or endangered species of fish or wildlife	Prohibits taking, transporting, processing, selling, or offering for sale within the Commonwealth any threatened or endangered species of fish or wildlife except as authorized by law.	Habitat of endangered species of fish or wildlife.	*Definitions and Miscellaneous in General* , 4 VAC 15-20-130 to 140	2 - 5	Not Applicable	Except for the potential of occasional transient individuals, no rare, threatened, or endangered wildlife species are known to occur at Site 5.
Endangered Plant and Insect Species Act **[VA Code Ann. §§ 3.1-1020 to 1030 (1998)]**						
Presence of any threatened or endangered species of plant or insect	Prohibits taking, transporting, processing, selling, or offering for sale within the Commonwealth any threatened or endangered species of plant or insect except as authorized by law.	Habitat of endangered species of plant or insect.	*Rules and Regulations for the Enforcement of the Endangered Plant and Insect Species Act* , 2 VAC 5-320-10	2 - 5	Not Applicable	Except for the potential of occasional transient individuals, no rare, threatened, or endangered wildlife species are known to occur at Site 5.
Virginia Natural Area Preserve Act **[VA Code Ann. §§ 10.1-209 to 217 (1998)]**						
Natural preserve area	Protects and conserves natural heritage resources (habitats of rare plants and animals; exemplary natural communities; other rare natural features) throughout the state. Offers strong levels of protection by placing privately and publicly held natural areas into a legally established statewide preserve system with statutory protection against most forms of condemnation and conversion to other land uses. This system of protected lands is administered by the Virginia Department of Conservation and Recreation (DCR) and managed by the Division of Natural Heritage (DNH).	Location is a dedicated natural area preserve.	*Virginia Natural Areas Preserve Act* , VA Code Ann. §§ 10.1-209 to 217 (1998)	2 - 5	Not Applicable	Site 5 is not designated as a natural preserve area.
Groundwater Management Act of 1992 **[VA Code Ann. §§ 62.1-254 to 62.1-279]**						
Groundwater management area	Regulates groundwater withdrawals in Ground Water Management Areas. Any person or entity wishing to withdraw 300,000 gallons per month or more in a declared management area must obtain a permit.	Location is in a Groundwater Management Area. Currently (June 2005), there are two Ground Water Management Areas in the state. The Eastern Virginia Ground Water Management Area comprises an area east of Interstate 95 and south of the Mattaponi and York Rivers. The Eastern Shore Ground Water Management Area includes Accomack and Northampton counties.	*Groundwater Management Act of 1992,* VA Code Ann. §§ 62.1-254 to 62.1-270	2 - 5	Not Applicable	Site 5 is not located in a groundwater management area.

Table C-4
Virginia Location-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Land Use Authority **[VA Code Ann. § 15.2-2223 and § 15.2-2283)]**						
Sole source aquifer	Requires each State to adopt an approved wellhead protection program that specifies public water supply systems, delineates wellhead protection areas, identifies sources of contamination within protection areas, develops management approaches, develops contingency plans for alternate water sources in the event of contamination, considers protection options when siting new wells, and ensures public participation in plan development. Prevents federal funding from being committed to any project that may contaminate a sole source aquifer, meaning any USEPA-designated aquifer that is the only principal drinking water supply for a given area which, if contaminated, would present a significant human health hazard.	Generally, CERCLA activities do not in and of themselves increase pre-existing contamination of sole source aquifers. Although it is unlikely that CERCLA activities would be subject to funding restrictions, a review of potential problems associated with sole source aquifers should be conducted.	*Land Use Authority,* VA Code Ann. § 15.2-2223 and § 15.2-2283	2	Not Applicable	Although the underlying Columbia and Yorktown Aquifers are sole source aquifers, this removal action is being implemented to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action. However, since waste will remain on site, groundwater will be monitored to verify the effectiveness of the cover.
				3 - 5	Not Applicable	Although the underlying Columbia and Yorktown Aquifers are sole source aquifers, this removal action is being implemented to address the waste and impacted soil within the Waste/Burnt Soil Area only. Existing groundwater contamination will be addressed as a separate component of the Site 5 response action.

Table C-5
Federal Action-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Clean Water Act						
Direct discharges	Controls the direct discharge of pollutants to surface waters through the NPDES program. NPDES standards include technology-based pollutant controls, or effluent standards, governing surface water discharges.	Direct discharges to surface waters.	*Clean Water Act* , §402	2	Not Applicable	The construction of the cover will not result in direct discharge to surface waters.
				3 - 5	Relevant and Appropriate	Groundwater encountered during excavation will be managed to prevent discharge to surface waters.
Indirect discharges	Discharge must comply with local POTW pretreatment program, including POTW-specific pollutants, spill prevention program requirements, and reporting and monitoring requirements.	Indirect discharges of wastewater to a POTW through performance and technology-based pretreatment standards.	*Clean Water Act,* §307(b)	2 - 5	Not Applicable	Construction activities will not result in discharge to a POTW.
Discharge of dredge-and-fill	No discharge of dredged or fill material will be allowed unless appropriate and practicable steps are taken that minimize potential adverse impacts of the discharge on the aquatic ecosystem.	Discharges of dredged or fill material to surface waters, including wetlands.	*Clean Water Act,* §404; 40 CFR 230; 33 CFR 320 to 330	2	Applicable	Construction of a cover will require fill material to be placed over existing wetland areas. Steps will be taken to minimize the impacts to the ecosystem.
				3 - 4	Applicable	A wetland is present within proposed boundary of the excavation and backfill. The wetland will be temporarily impacted for the removal of the waste and impacted soil, then restored as a wetland. Steps will be taken to minimize the impacts to the ecosystem.
				5	Applicable	A wetland is present within the proposed boundary of the excavation. The wetland will be temporarily impacted for the excavation. This alternative includes the restoration of that area as a wetland and establishment of additional wetland area. This will enhance the quality of the wetlands present onsite.
Clean Air Act						
Air emissions	Ensure compliance with the Clean Air Act which regulates the various types of air emissions: mobile sources, hazardous air pollutants, acid deposition and electrical utility emissions, stationary sources, and stratospheric ozone. Requirements are based on the air quality designation of the site's location (i.e., attainment, non-attainment, unclassified, or transport) (see Federal Location-Specific ARARs) for each NAAQS, the classification of each area, the required control measures, and baseline emission estimates. Must meet specific NSPS standards for incineration, use of statutory gas turbines, and storage of petroleum liquids.	Air pollutant emissions during the response action, or during the operation and maintenance of the response action.	40 CFR 50.4 to 50.12 40 CFR 60.112 to 60.52	2 - 5	Applicable	No discharges to air are anticipated other than fugitive dust.

Table C-5
Federal Action-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Safe Drinking Water Act						
Underground injection	Regulates the subsurface emplacement of liquids through the Underground Injection Control program, which governs the design and operation of five classes of injection wells in order to prevent contamination of underground sources of drinking water. The Underground Injection Control program regulates well construction, well operation, and monitoring.	Underground injection of wastes and treated groundwater.	40 CFR 144 to 148 40 CFR 268.2	2 - 5	Not Applicable	Underground injection does not pertain to this removal action.
Toxic Substances Control Act						
Use/presence of chemicals	Chemical control measures including information gathering, chemical testing, labeling, inspection, use, storage, and disposal requirements.	Use/presence of asbestos, CFCs used as aerosol propellants, hexavalent chromium, and PCBs.	*Toxic Substances Control Act* , §6; 40 CFR 700 to 766	2	Relevant and Appropriate	Although historical data suggests asbestos piping is present in the subsurface, it is anticipated that these pipes will be undisturbed during the construction of the cover. No soil will be removed during the construction of the cover.
				3 - 5	Applicable	Historical data suggests asbestos piping is present in the subsurface. Asbestos piping encountered during excavation will be properly disposed. Excavated soil will be characterized for proper disposal.
PCB management	Governs many aspects of PCB management, including cleanup of spills, storage, and disposal. USEPA has also proposed PCB spill response regulations which utilize self-implementing, performance-based, and risk-based cleanup standards to address various types of PCB releases.	Presence of PCBs. PCB contamination below 50 ppm is not regulated by TSCA, except under special circumstances.	*Toxic Substances Control Act, §6;* 40 CFR 761	2	Not Applicable	PCBs were sampled for but were not detected during site investigation activities. No soil will be removed during the construction of the cover.
				3 - 5	Not Applicable	PCBs were sampled for but were not detected during site investigation activities. Soil will be characterized prior to disposal.
Federal Insecticide, Fungicide, and Rodenticide Act						
Disposal of pesticides, pesticide containers, and pesticide residue	Must follow proper disposal methods.	Pesticides requiring disposal.	40 CFR 165.7 to 165.9	2	Not Applicable	Construction of the cover does not involve the disposal of pesticides.
				3 - 5	Not Applicable	Excavation and backfill of soil at Site 5 does not involve the disposal of pesticides or pesticide containers. Soil will be characterized prior to disposal.
Labeling pesticides	Labeled per specifications to show ingredients, warnings and precautionary statements, toxicity, and directions for use (including storage and disposal methods).	Labeling requirements may apply when pesticides are considered products, and not RCRA hazardous wastes.	40 CFR 162.10	2	Not Applicable	Construction of the cover does not involve the disposal of pesticides.
				3 - 5	Not Applicable	Pesticides detected in site soil are not considered products. Excavated soil will be characterized for proper disposal.
Handling pesticides	Individuals handling certain pesticides must be State or Federally approved applicators.		40 CFR 171.4	2 - 5	Not Applicable	Construction activities do not involve the application of pesticides.

Table C-5
Federal Action-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Resource Conservation and Recovery Act Subtitle C						
Treatment, storage, and/or disposal of hazardous waste	Design and operating specifications for hazardous waste treatment, storage, and disposal units.	Potential CERCLA remedial alternatives include but are not limited to: capping, closure with no post-closure care, closure with waste-in-place, closure of land treatment units, consolidation between units, container storage, construction of new landfill, construction of new surface impoundment, dike stabilization, incineration, land treatment, surface water control, tank storage, treatment, waste pile.	40 CFR 264	2	Not Applicable	Construction of the cover does not involve the handling, storage, treatment, disposal, or transportation of hazardous waste.
				3 - 5	Relevant and Appropriate	Based on the analytical results from the site investigation, it is not anticipated that excavated soil will require disposal as hazardous wastes. Soil will be characterized prior to disposal.
Generation of hazardous waste	Land disposal restrictions and standards for hazardous wastes placed on land. Treatment standards vary depending on the type of hazardous waste being treated and are concentration- and technology-based designed to reduce the mobility and toxicity of hazardous constituents present in hazardous wastes.	Placement of restricted hazardous wastes moved or treated outside the area of contamination.	40 CFR 268	2	Not Applicable	Construction of the cover does not involve the handling, storage, treatment, disposal, or transportation of hazardous waste.
				3 - 5	Relevant and Appropriate	Based on the analytical results from the site investigation, it is not anticipated that excavated soil will require disposal as hazardous wastes. soil will be characterized prior to disposal.
Closure and post-closure of hazardous waste management unit	There are two types of potentially applicable RCRA closure schemes: clean closure and landfill closure. Clean closure involves removing or decontaminating all waste residues, contaminated equipment, and contaminated soil so that no additional care or monitoring is required, either at RCRA or CERCLA sites. Landfill closure involves leaving hazardous wastes and contaminated equipment in place, and there are requirements for the use of a final cap or cover for the unit and continued groundwater monitoring in the post-closure period.	Removal or decontamination of all waste residues, contaminated equipment, and contaminated soil so that no additional care or monitoring is required or leaving hazardous wastes and contaminated equipment in place.	40 CFR 264 Subpart G	2 - 5	Not Applicable	Based on previous investigations and historic records, Site 5 does not require closure as a hazardous waste management unit.
Groundwater monitoring of hazardous waste land disposal units	RCRA groundwater monitoring standards, which involve the use of monitoring wells to detect the presence of contaminants in underlying aquifers, are applicable when a Superfund response involves the creation of a new land disposal unit or the remediation of an existing land disposal unit.	Groundwater monitoring of hazardous waste land disposal units.	40 CFR 264 Subpart F	2 - 5	Not Applicable	Based on previous investigations and historic records, Site 5 is not a land disposal unit.

Table C-5
Federal Action-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Off-site disposal of hazardous wastes	Administrative standards for hazardous wastes sent off-site for further management. Administrative RCRA standards include the obligation to obtain permits and keep various records at all hazardous waste treatment, storage, and disposal facilities; and the requirement to include a hazardous waste manifest when sending hazardous wastes off-site.	Off-site disposal of hazardous wastes.	40 CFR 240 to 282	2	Not Applicable	Construction of the cover does not involve the handling, storage, treatment, disposal, or transportation of hazardous waste.
				3 - 5	Relevant and Appropriate	Based on the analytical results from the site investigation, it is not anticipated that excavated soil will require disposal as hazardous wastes. Soil will be characterized prior to disposal.

Table C-6
Virginia Action-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
State Water Control Law **[VA Code Ann. §§ 62.1-44.2 to 62.1-44.34:28 (2003)]**						
Dredging, filling, and/or discharging pollutants into, or adjacent to, surface waters (including wetlands)	Permitting requirements in addition to complying with USACE requirements (Nationwide Permits) and *Virginia Wetlands Mitigation Policy* . Administered by local wetlands boards and/or VMRC.	Activities requiring a permit include dredging, filling, or discharging any pollutant into or adjacent to surface waters, or otherwise altering the physical, chemical or biological properties of surface waters, excavating in wetlands, or conducting the following activities in a wetland: 1. New activities to cause draining that significantly alters or degrades existing wetland acreage or functions. 2. Filling or dumping. 3. Permanent flooding or impounding. 4. New activities that cause significant alteration or degradation of existing wetland acreage or functions. This would include any project that requires a *Clean Water Act* Section 404 permit or a R*ivers and Harbors Act* Section 10 permit, or a water withdrawal that also requires a Section 404 permit or a Federal Energy Regulatory Commission license or license re-issuance, as well as the same projects that do not require a Federal permit.	*Virginia Water Protection Permit Program Regulation* , 9 VAC 25-210-10 to 260	2	Applicable	Construction of a cover will require fill material to be placed over existing wetland areas. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. A Compensatory Mitigation Plan will be prepared and compensatory mitigation will be performed if required.
				3 - 4	Applicable	Wetlands are located within the boundary of the proposed excavation and backfill. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. The site, including wetland areas, will be restored to the preconstruction condition. However, because of the temporary impact to the existing wetland, a Compensatory Mitigation Plan will be prepared.
				5	Applicable	This alternative includes the construction of a wetland in the excavated area. This will enhance the quality of the wetlands present onsite. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. A Compensatory Mitigation Plan will be prepared for the temporary impact to the existing wetland.
Discharge of stormwater from construction activities to a surface water or through a municipal or non-municipal separate storm sewer system to surface waters	This general permit regulation governs stormwater discharges from construction activities.	Discharges are defined as storm water discharges associated with industrial activity, and storm water discharges associated with small construction activity. Storm water discharges associated with other types of industrial activity shall not have coverage under this general permit. This general permit covers only discharges through a point source to a surface water or through a municipal or non-municipal separate storm sewer system to surface waters. Storm water discharges associated with industrial activity that originate from the site after construction activities have been completed and the site has undergone final stabilization are not authorized by this permit.	*VPDES General Permit Regulation for Discharges of Storm Water from Construction Activities* , 9 VAC 25-180-10 to 70	2 - 5	Applicable	As a result of the potential for stormwater runoff during construction, erosion control measures will be implemented.

Table C-6
Virginia Action-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Operation, construction, or modification of sewage or sewage treatment works	Governs the design, construction and operation of sewerage systems and treatment works serving more than one residence or a non-residential sewage source.	Control of sewage or sewage treatment works.	*Sewage Collection and Treatment Regulation* , 9 VAC 25-790-10 to 1000	2 - 5	Not Applicable	Construction activities do not pertain to sewage or sewage treatment works.
Discharge of groundwater, decontamination water, or other materials to surface waters	Establishes consistent procedures and requirements for the issuance of permits for discharges of pollutants through point sources to surface waters of the Commonwealth in order to effectuate the proper and comprehensive protection of such waters.	Discharge of groundwater, decontamination water, or other materials to surface waters.	*Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation* , 9 VAC 25-31-10 to 940	2	Not Applicable	Construction of a cover does not involve discharge of groundwater, decontamination water, or other materials to surface waters.
				3 - 5	Relevant and Appropriate	Groundwater encountered during excavation will be managed within the excavation to prevent discharge to surface waters.
Discharge of wastes and/or wastewater to state waters	Regulates the treatment, storage, and land application of industrial waste (sludge and wastewater), sewage sludge, municipal wastewater, and animal waste. A permit may be issued for pollutant management activities. Specific limitations on proposed response activities can be established following receipt of a detailed description of the activities.	Handling of waste and wastewater in a manner that does not involve discharging to a sewage treatment work, or to state waters pursuant to a valid VPDES permit.	*Virginia Pollution Abatement (VPA) Permit Regulation* , 9 VAC 25-32-10 to 300;	2 - 5	Not Applicable	Construction activities do not involve discharge of waste to state waters.
Construction and maintenance development activities	Establishes general permit number WP4 to govern impacts related to the construction and maintenance of development activities, and activities directly associated with mining.	Activities requiring a permit include dredging, filling, or discharging any pollutant into or adjacent to surface waters, or otherwise altering the physical, chemical or biological properties of surface waters, excavating in wetlands, or conducting the following activities in a wetland: 1. New activities to cause draining that significantly alters or degrades existing wetland acreage or functions. 2. Filling or dumping. 3. Permanent flooding or impounding. 4. New activities that cause significant alteration or degradation of existing wetland acreage or functions. This would include any project that requires a *Clean Water Act* Section 404 permit or a *Rivers and Harbors Act* Section 10 permit, or a water withdrawal that also requires a Section 404 permit or a Federal Energy Regulatory Commission license or license re-issuance, as well as the same projects that do not require a Federal permit.	*Virginia Water Protection General Permit for Impacts from Development Activities Regulation* , 9 VAC 25-690-10 to 100	2	Applicable	Construction of a cover will require fill material to be placed over existing wetland areas. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. A Compensatory Mitigation Plan will be prepared and compensatory mitigation will be performed if required.

Table C-6
Virginia Action-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
				3 - 4	Applicable	Wetlands are located within the boundary of the proposed excavation and backfill. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. The site, including wetland areas, will be restored to the preconstruction condition. However, because of the temporary impact to the existing wetland, a Compensatory Mitigation Plan will be prepared.
				5	Applicable	This alternative includes the construction of a wetland in the excavated area. This will enhance the quality of the wetlands present onsite. Since this is an onsite CERCLA response action, the substantive requirements will be met, but a permit will not be required. A Compensatory Mitigation Plan will be prepared for the temporary impact to the existing wetland.
Surface Water Management Areas [VA Code Ann. §§ 62.1-242 to 62.1-253]						
Establishment of surface water management area and /or surface water withdrawal during periods of low stream flow	Procedures and requirements to be followed in connection with establishment of surface water management areas, the issuance of surface water withdrawal permits and the issuance of surface water withdrawal certificates for the protection of beneficial uses during periods of low stream flow.	Establishment of surface water management areas and /or surface water withdrawal during periods of low stream flow.	*Surface Water Management Area Regulation* , 9 VAC 25-220-10 to 330	2 - 5	Not Applicable	No surface water management area will be established and no surface water withdraw will be conducted as part of the removal action.
***Erosion and Sediment Control Law* [VA Code Ann. §§ 10.1-560 to 571 (2003)]**						
Erosion and deposits of soil/sediment caused by land disturbing activities	Regulations for the effective control of soil erosion, sediment deposition and nonagricultural runoff which must be met in any control program to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources.	If a local soil and erosion control program has been adopted in accordance with the *Erosion and Sediment Control Law* , and the *Erosion and Sediment Control Regulations* , and the response action is not exempt under the local program, the project must comply with the program. In the case of absence of a local program, or of an exemption to it, the standards and regulations should be followed.	*Erosion and Sediment Control Regulations* , 4 VAC 50-30-10 to 110	2 - 5	Applicable	Erosion and sediment control measures will be implemented for the construction activities.

Table C-6
Virginia Action-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Air Pollution Control Board **[VA Code Ann. §§ 10.1-1300 to 1326 (1998)]**						
Air emissions from disturbance of soil, treatment of soil or water, or other pollutant management activities	Standards for visible emissions, fugitive dust/emissions, hazardous air pollutants, and toxic pollutants from new and modified sources.	Source of visible emissions, fugitive dust/emissions, and/or a stationary source that emits or may emit any toxic pollutant.	*Standards of Performance for Visible Emissions and Fugitive Dust/Emissions [Rule 5-1]* , 9 VAC 5-50-60 to 120; US*EPA National Emission Standards for Hazardous Air Pollutants [Rule 6-1]* , 9 VAC 5-60-60 to 80; *Emission Standards for Toxic Pollutants from New and Modified Sources [Rule 6-5]* , 9 VAC 5-50-60-300 to 370	2 - 5	Applicable	No discharges to air are anticipated other than fugitive dust during construction.
Stormwater Management Act **[VA Code Ann. §§ 10.1-603.1 to 603.15 (2001)]**						
Stormwater runoff caused by development of land that contributes to water pollution, erosion, and localized flooding	Procedures and requirements to be followed in connection with establishment of surface water management areas, the issuance of surface water withdrawal permits and the issuance of surface water withdrawal certificates to provide for the protection of beneficial uses during periods of low stream flow.	Every locality that establishes a local stormwater management program; and every state project. If a local stormwater management program has been adopted in accordance with the *Stormwater Management Act* , and the *Stormwater Management Regulations* , and the response action is not exempt under the local program, the project must comply with the program. In the case of absence of a local program, or of an exemption to it, the standards and regulations should be followed.	*Stormwater Management Regulations* , 4 VAC 3-20-10 to 251	2 - 5	Relevant and Appropriate	As a result of the potential for stormwater runoff during construction, a stormwater management program may be required.
Virginia Waste Management Act **[VA Code Ann. §§ 10.1-1400 to 1457 (2004)]**						
Handling, storage, treatment, disposal, and/or transportation of hazardous waste	Provides for the control of all hazardous wastes that are generated within, or transported to, the Commonwealth for the purposes of storage, treatment, or disposal or for the purposes of resource conservation or recovery. Any disposal facility must be properly permitted and in compliance with all operational and monitoring requirements of the permit and regulations.	Management of wastes that meet the definition of hazardous waste.	*Hazardous Waste Regulations* , 9 VAC 20-60-12 to 1505; *Regulations Governing the Transportation of Hazardous Materials* , 9 VAC 20-110-10 to 130	2	Not Applicable	This cover installation does not involve the handling, storage, treatment, disposal, or transportation of hazardous waste.
				3 - 5	Relevant and Appropriate	Based on the analytical results from the site investigation, it is not anticipated that excavated soil will require disposal as hazardous waste. soil will be characterized prior to disposal.

Table C-6
Virginia Action-Specific ARARs
Site 5 Engineering Evaluation/Cost Estimate
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Handling, storage, treatment, disposal, and/or transportation of solid waste	Establishes standards and procedures pertaining to the management of solid wastes, and siting, design, construction, operation, maintenance, closure, and post-closure care of solid waste management facilities in this Commonwealth in order to protect the public health, public safety, the environment, and natural resources. Provides the means for identification of open dumping of solid waste and provides the means for prevention or elimination of open dumping of solid waste to protect the public health and safety and enhance the environment. Sets forth the requirements for undertaking corrective actions at solid waste management facilities. Any disposal facility must be properly permitted and in compliance with all operational and monitoring requirements of the permit and regulations.	Management of wastes that meet the definition of solid waste.	*Solid Waste Management Regulations* , 9 VAC 20-80-10 to 790	2	Not Applicable	This cover installation does not involve the handling, storage, treatment, disposal, or transportation of solid waste.
				3 - 5	Applicable	Based on the analytical results from the site investigation, it is anticipated that excavated soil will be disposed as solid wastes. soil will be characterized prior to disposal. Based on previous investigations and historic records, Site 5 does not require closure as a waste management facility.

Appendix D
Remedial Investigation Test Pit Logs

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 1	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/25/01 15:10 END : 6/25/01 15:30 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2			Stained soils present.
4			
6	0-12"	GRAVEL and SAND, brown to gray, dry, loose.	
8			
10			
12			
14	12-15"	Sandy SILT, orange to black stained horizon, slightly cohesive.	No odor. Collected sample SJS05-SB22-001.
16			
18			
20	15-28"	Silty CLAY, dark brown to brown, dry, sticky, cohesive, plastic.	
22			
24			
26			
28			
30			
32	28-36"	Black organic horizon with tree branches, roots, and leaves.	
34			
36			
38			
40	36-48"	CLAY, brown, wet, sticky, cohesive, non plastic.	Photo 21
42			
44			
46			
48			
50			Total Depth 4'
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 2	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/25/01 15:56 END : 6/25/01 16:30 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-7"	GRAVEL and SAND, brown, dry.	While digging trench 2 the backhoe pulls up a fabric which appears to be some type of barrier between the overlying gravel and the clay. Photo 20
20	7-43"	Clayey SILT, brown becoming gray at bottom, sticky, soft.	No indication of burning. Photo 19 & 18 Collected sample SJS05-SB23-001.
44			Total Depth 3'7"

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 3	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/25/01 16:30 END : 6/25/01 16:45 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-7"	GRAVEL and SAND, brown, dry.	Thin synthetic liner.
4			
6			
8			
10			
12			
14			
16			
18			
20	7-43"	Clayey SILT, brown becoming gray at bottom, sticky, soft.	No indication of burning.
22			Collected sample SJS05-SB23-001.
24			
26			
28			
30			
32			
34			
36			
38			
40			
42			
44			Total Depth 3'7"
46			Location should coincide with an old burn pit.
48			A synthetic liner over clay. May have stained soil right under synthetic layer.
50			Photo 17
52			Trench identical to Trench 2.
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 4	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 08:10 END : 6/26/01 08:50 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-6"	Top soil, organic SILT, black, moist, cohesive.	
6	6-46"	Silty CLAY to clayey SILT, gray to brown at top becoming dark gray at bottom, sticky, cohesive. Plant roots and small tree roots present.	Water rapidly moved into hole. Water table at 3' bgs. Photo 36 & 35
46			Total depth 3'10" No indication of burnt soil or fill.

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 5	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 08:50 END : 6/26/01 09:00 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2			
4	0-6"	Top soil, organic SILT, black, moist, cohesive.	
6			
8			
10			
12			
14			
16			
18			
20			
22	6-48"	Silty CLAY to clayey SILT, gray to brown at top becoming dark gray at bottom, sticky, cohesive. Plant roots and small tree roots present.	Silt layers from 6-16".
24			
26			
28			
30			
32			
34			
36			Water rapidly moved into hole. Water table at 3' bgs.
38			
40			
42			
44			
46			
48			
50			Total depth 4' No indication of burning. Photo 34-32
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 6	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 09:25 END : 6/26/01 10:06 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-12"	GRAVEL, light brown to gray over plastic mesh material.	This location has a fabric underneath it similar to location 2 & 3. Photo 30
12	12-18"	Top soil, brown, sandy SILT, roots, cohesive, non plastic grading to (see below)	
18	18-42"	Silty CLAY to clayey SILT, gray, sticky, cohesive.	
42			Total Depth 3'6" No indication of contamination or burnt soils.

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 7	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 10:10 END : 6/26/01 10:20 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-3"	Top soil, black, SILT to clayey silt, cohesive, abundant roots.	
4	3-9"	Sandy GRAVEL, light brown, dry, loose.	
6			
8			
10	9-15"	Fine to medium grained sandy SILT with some rocks, may indicate burnt soils, loose to cohesive.	
12			
14			
16	15-39"	SILT to silty CLAY with fine layers of silt similar to Site 3, tan to orange with roots, cohesive.	Collected sample SJS05-SB24-001.
18			
20			
22			
24			
26			
28			
30			
32			
34			
36			
38			
40			Total Depth 3'3" Photo 29
42			
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 8	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 10:42 END : 6/26/01 11:18 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-3"	GRAVEL and SAND, light gray to tan, dry, loose.	Fabric beneath sand and gravel.
4			
6	3-14"	GRAVEL and SAND, brown to tan.	
8			
10			
12			
14			
16	14-20"	Clayey SILT, black to dark brown, sticky, cohesive.	Pieces of brick in upper portion (14-17"). May indicate contaminated or burnt soils.
18			
20			
22	20-45"	Mottled CLAY to clayey SILT, gray to brown, cohesive, slightly plastic, roots present.	
24			
26			
28			
30			
32			
34			
36			
38			
40			
42			
44			
46			Total Depth 3'9" Photos 27 & 26
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 9	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 11:18 END : 6/26/01 12:25 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-7"	GRAVEL and SAND, light brown to tan, dry, loose.	Fabric at 7" bgs.
7	7-18"	Sandy GRAVEL, brown to tan.	
18	18-23"	Clayey SILT with roots, black.	Appears to have burned soils. Slight odor, possible contaminated soils.
23	23-45"	Clayey SILT, black to gray-green, dry, sticky, cohesive, non plastic.	
45			Total Depth 3'9" Photos 25 & 24

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 10	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 12:25 END : 6/26/01 13:00 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-8"	Top soil & GRAVEL, light brown to gray, dry, loose.	
8	8-15"	Fine sandy SILT with some coarser sand and some pieces of gravel.	Pieces of wood present. Iron stained at top.
15	15-42"	Silty CLAY to clayey SILT, silt is in very fine layers, tan to brown to yellow, clay is dark gray to gray green, dry, cohesive, plastic.	
42			Total Depth 3'6" Photos 23 & 22 Appears to be stained soils.

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 11	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 13:00 END : 6/26/01 13:25 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2			
4			
6	0-12"	Top soil and FILL with gravel and sandy silt.	
8			
10			
12			
14			
16			
18			
20			
22	12-40"	CLAY, dark gray, cohesive, blocky, plastic.	
24			
26			
28			
30			
32			
34			
36			
38			
40			
42			Total Depth 3'4" Photos 21 & 20-19 Burnt material, burnt wood, and some pieces of metal.
44			
46			
48			
50			
52			
56			
58			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 12	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 13:25 END : 6/26/01 13:55 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-7"	Top soil, silty SAND with some gravel, brown.	
7	7-16"	Sandy SILT matrix with debris present, black.	Debris present, corrogated shingles, scrap metal, strapping, glass, and wood. Appears have been burned at one time.
16	16-45"	Silty clay to CLAY, gray to gray green silt, sticky, cohesive, non plastic.	Water coming in bottom.
45			Total Depth 3'9"

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 13	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 13:55 END : 6/26/01 14:18 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-8"	Top soil and GRAVEL, sandy SILT, dry, slightly cohesive.	
8	8-20"	Blank sandy horizon with burnt material.	
20	20-24"	CLAY to SILT, gray, dry, cohesive, non plastic to plastic.	
24			Total Depth 2' Photo 17 & 16 Evidence of burning or of material being pushed. Pieces of metal, ceramics, glass, pieces of metal, wires, nails, brass.

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 14	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 14:18 END : 6/26/01 14:40 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-5"	Top soil, silty SAND, black to brown, roots, cohesive.	
5	5-15"	Silty SAND with debris, black to dark brown.	Some iron staining.
15	15-22"	SILT, gray to tan, cohesive, non plastic, finely layered with some roots.	
22			Total Depth 1'10" Photos 15 & 14 Debris found, brick, glass, wood, wire, piece of ceramic pipe. Some of the wood appears to be burned.

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 15	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 14:40 END : 6/26/01 15:15 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-8"	Top soil and SILT with fine sand, brown to dark brown, abundant roots.	
8	8-12"	Silty SAND, black, pieces of glass and small debris.	No odor.
12	12-24"	CLAY to silty clay, gray to greenish gray, cohesive, plastic.	May be moving away from burn material.
24			Total Depth 2" Photo 13 No strong indication of burning, few pieces of metal, brass, and glass.

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 16	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 15:15 END : 6/26/01 15:36 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-5"	Silty top soil, brown, roots.	
5	5-16"	Silty SAND, brown with iron staining at top becoming black layer with debris.	Debris, pieces of trees, wood, brick, glass, and scattered pieces of metal.
16	16-26"	CLAY and clayey SILT, gray, dry, sticky, non plastic.	
26			Total Depth 2'2" Photos 12, 11, 10 Indication of burning. Burnt wood and glass.

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 17	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 15:36 END : 6/26/01 16:00 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-6"	Top soil and sandy SILT, dry, loose, roots.	
4			
6			
8	6-14"	Silty SAND with concrete, brown, dry, loose.	
10			
12			
14			
16	14-20"	CLAY, gray to black with some iron staining at top.	May have some burnt/contaminated soils, no odor.
18			
20			
22	20-26"	CLAY and SILT layers, gray to tan and rust colored, cohesive, blocky, non plastic, roots.	
24			
26			
28			Total Depth 2'2" Trench had abundant concrete but no wood or metal.
30			
32			
34			
36			
38			
40			
42			
44			
46			
48			
50			
52			
56			
58			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 18	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 16:00 END : 6/26/01 16:24 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-3"	Top soil and SILT with sand, dark brown to black, roots.	
4	3-9"	Sandy debris.	Oxidized or burnt.
6			
8			
10			
12	9-19"	SILT and CLAY with layered fine silt, gray to brown, cohesive, non plastic, roots.	Photo 6
14			
16			
18			
20			Total Depth 1'7"
22			Photo 7
24			Some of the soil appears orange, almost rusted soils, really doesn't look burned, oxidized metal, and piece of pipe.
26			
28			
30			
32			
34			
36			
38			
40			
42			
44			
46			
48			
50			
52			
56			
58			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 19	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/26/01 16:24 END : 6/26/01 16:40 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2			
4	0-8"	Top soil, silty, brown to black, roots.	
6			
8			
10	8-15"	Silty SAND, iron stained to black.	Glass, debris, possible burned soil. No odor.
12			
14			
16			
18	15-24"	CLAY and SILT, almost peat like, gray to brown, cohesive, non plastic, roots.	
20			
22			
24			
26			Total Depth 2'
28			Photo 6
30			An OE (percussion primer Mark 14) item found, copper wire, glass, soils appear to be stained.
32			
34			
36			
38			
40			
42			
44			
46			
48			
50			
52			
56			
58			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 20	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 08:05 END : 6/27/01 08:25 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-6"	Top soil, SILT, and some sand, dark brown, moist, cohesive, organic, roots.	
4			
6			
8	6-15"	Finely layered SILT, gray to tan to yellow, cohesive, non plastic, roots.	
10			
12			
14			
16	15-42"	CLAY to silty clay, dark gray, sticky, non plastic.	
18			
20			
22			
24			
26			
28			
30			
32			
34			
36			
38			
40			
42			
44			Total Depth 3'6" Photo 35 No indication of filling. Followed metal detector until there was no more signal.
46			
48			
50			
52			
56			
58			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 21	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 08:25 END : 6/27/01 08:46 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-3"	Top soil and SILT, brown, roots.	
4			
6	3-14"	Fine silty layers, tan to brown and gray, cohesive, non plastic.	
8			
10			
12			
14			
16			
18			
20	14-34"	CLAY to clayey SILT, sticky, cohesive, non plastic.	Oxidized zones with roots. Some water at bottom.
22			
24			
26			
28			
30			
32			
34			
36			Total Depth 2'10" Photos 34 & 33 No indication of burned soils. No debris found.
38			
40			
42			
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 22	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 08:46 END : 6/27/01 09:15 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2			
4	0-10"	Top soil and SILT, dark brown, dry, loose, high root content.	
6			
8			
10			
12	10-18"	SILT, fine layers, tan, brown, and gray, dry to moist, cohesive, non plastic, roots	
14			
16			
18			
20	18-42"	Clayey SILT to silt, dark gray, sticky, non plastic.	
22			
24			
26			
28			
30			
32			
34			
36			
38			
40			
42			
44			Total Depth 3'6" A few pieces of scrap metal near the surface but no indication of burnt or contaminated soils.
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 23	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 09:15 END : 6/27/01 09:50 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2–4–6–8	0-9"	Top soil with silty organic layer, dark brown, high root content.	Some debris, glass, piece of metal just below the top soil. May indicate some signs of debris of stained soils but a small 6" layer.
10–12–14	9-15"	SILT with some debris.	Debris, glass, wire, and small pieces of metal.
16–18–20–22–24–26–28–30–32	15-32"	Clayey SILT to silt, finely layered, brown to tan, cohesive, non plastic.	
34–36–38–40–42	32-42"	SILT to clayey silt, dark gray, moist, sticky, non plastic.	Water seeping in at bottom of hole. Photo 31
44–46–48–50–52–54–56			Total Depth 3'6"

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 24	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 09:50 END : 6/27/01 10:15 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2–14	0-14"	Top soil layer with debris, blackened under soil.	Debris, glass, metal. May indicate area where material was pushed around. Orange staining from oxidation.
16–24	14-25"	Finely layered SILT, tan to gray with oxidized horizons, cohesive, friable, non plastic, roots.	
26–44	25-44"	Clayey SILT to silt, gray, sticky, non plastic.	Hole filling with water.
46–56			Total Depth 3'8" Photo 30

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 25	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 10:15 END : 6/27/01 10:42 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2			
4	0-9"	Silty, organic top soil, dark brown to black, roots.	
6			
8			
10			
12	9-19"	SILT, tan to gray with oxidized layers, cohesive, friable, non plastic, roots.	
14			
16			
18			
20			
22			
24			
26	19-38"	SILT to clayey silt, dark gray, sticky, non plastic.	Bottom of hole filling with water.
28			
30			
32			
34			
36			
38			
40			Total Depth 3'2" Photo 29 There was just a few pieces of metal, maybe some china just below top soil, but no other signs of filling, contaminated, or burnt soils.
42			
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 26	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 10:42 END : 6/27/01 11:06 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-4"	Silty top soil, dark brown, high root content.	Minor layer of burnt material just below top soil. Horizon may just be 1-2" thick.
4			
6	4-6"	Black horizon of SILT, cohesive, loose.	Pieces of burnt wood.
8	6-11"	Finely layered SILT, gray to tan, friable.	
10			
12			
14			
16			
18			
20	11-36"	SILT to clayey silt, dark gray, sticky, non plastic.	Water coming into bottom of hole.
22			
24			
26			
28			
30			
32			
34			
36			
38			Total Depth 3' Photos 28 & 27
40			
42			
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 27	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 11:06 END : 6/27/01 11:34 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-6"	Top soil and SILT, dark brown, roots.	Small debris, some pieces of wood.
4			
6			
8	6-9"	SILT, brown, iron stained, roots.	
10	9-10"	Silty SAND, black, stained layer.	Small pieces of wood and rock.
12			
14	10-20"	SILT, tan to gray with oxidized layers and roots, friable, cohesive.	
16			
18			
20			
22			
24			
26			
28	20-41"	Dark gray, sticky, non plastic.	Water in bottom 6" of hole.
30			
32			
34			
36			
38			
40			
42			Total Depth 3'6" Photo 26 Surface debris beneath top soil, wire, shingle, thin lense of black stained soil, no odor, but pieces of rock and wood.
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 28	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 11:34 END : 6/27/01 12:00 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-8"	Silty top soil, brown, roots.	Pieces of wood, very little metal beneath top soil.
4			
6			
8			
10	8-15"	SILTY, black horizon, debris.	Debris includes some brick, wood. Soils do appear to be stained.
12			
14			
16	15-38"	Silty CLAY to SILT, brown at top becoming gray at bottom, cohesive, slightly plastic.	3" Mark 7 Mod Cartridge Case, Expended. Photo 24
18			
20			
22			
24			
26			
28			
30			
32			
34			
36			
38			
40			Total Depth 3'2" Photo 25 of found
42			
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 29	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 12:25 END : 6/27/01 12:52 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-6"	Top soil and SILT, brown, abundant roots.	
6	6-10"	Silty SAND, brown to tan, friable, slightly cohesive.	
10	10-12"	SILTY black horizon.	No odor, burnt wood pieces. Evidence of burnt soils.
12	12-24"	CLAY to silty clay becoming silty, gray to brown, cohesive, blocky, plastic, roots.	
24	24-38"	SILT to clayey silt, dark gray, sticky.	Photo 23
38			Total Depth 3'2"

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 30	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 12:52 END : 6/27/01 13:38 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2			
4	0-10"	GRAVEL, road bed.	
6			
8			
10			
12			
14	10-22"	SILT to clayey silt, dark gray, sticky, cohesive, non plastic.	
16			
18			
20			
22			
24	22-26"	Medium grained SAND, black.	Pieces of burnt wood and rocks.
26			
28			
30	26-36"	Sandy SILT to silty SAND to sandy silt, brown.	Water coming into bottom of hole.
32			
34			
36			
38			Total Depth 4' Photo 22 & 21
40			
42			
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 31	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 13:38 END : 6/27/01 14:06 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-2"	Top soil.	
4	2-7"	SAND and GRAVEL, gray.	
6			
8			
10	7-15"	Silty CLAY, brown with orange-brown mottles, cohesive, plastic.	Darker layer at about 12-17". May be older road bed. The black material is sandy silt, no debris, no odor. I don't believe that the layer is burnt soil.
12			
14			
16	15-20"	Black horizon.	
18			
20			
22	20-36"	Silty SAND medium to fine grained, brown to tan, cohesive.	Wet at bottom. Photo 20
24			
26			
28			
30			
32			
34			
36			
38			Total Depth 3' Similar to Trench 30. No debris.
40			
42			
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 32	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 14:06 END : 6/27/01 14:25 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-4"	Top soil and organic SILT, dark brown, high root content.	
4			
6			
8	4-14"	SILT, brown with orange mottling, oxidized layers, friable, cohesive.	
10			
12			
14			
16			
18			
20			
22	14-38"	SILT to clayey SILT, gray to dark gray, dry to wet, sticky, non plastic.	
24			
26			
28			
30			
32		Last 6" is organic layer, peaty, high root content.	Water at bottom.
34			
36			
38			
40			Total Depth 3'2" Photo 19 No indication of burnt or contaminated soils.
42			
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 33	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 14:25 END : 6/27/01 14:55 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-6"	Silty top soil, dark brown to black, high root content.	
4			
6			
8			
10	6-18"	Medium to fine-grained SAND with silt and pieces of concrete, brown, dry, loose.	Iron stained horizon at bottom. No metals found.
12			
14			
16			
18			
20	18-20"	Sandy SILT, black horizon.	Soils have a slight odor.
22			
24			
26			
28	20-36"	SILT, gray to dark gray, dry at top, friable, sticky when wet, non plastic.	
30			
32			
34			
36			
38			
40	36-42"	SILT with fine to medium grained sand, dark gray, wet.	Photo 18 Water seeping in among sand.
42			
44			Total Depth 3'6"
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 34	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 14:55 END : 6/27/01 15:50 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
0	0-6"	Top soil and SILT, black to dark brown, high root content.	
6	6-18"	SILT to silty CLAY, brown to gray, oxidized layers, roots.	
18	18-42"	Clayey SILT, wet, sticky, non plastic.	
42			Total Depth 3'6" Water filled pit to 32" bgs. No indication of stained soils, just surface debris. Photo 13

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 35	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/27/01 15:50 END : 6/27/01 16:10 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-4"	Silty top soil, black, high organic content.	Pieces of metal present.
4			
6	4-12"	Fine to medium grained SAND with SILT, tan to light brown, loose, friable.	Concrete.
8			
10			
12			
14	12-14"	Sandy SILT, black horizon.	No apparent odor. Indication of stained soils.
16	14-20"	Silty CLAY to clayey SILT with fine layers of silt, tan to brown to slightly rust orange, cohesive, non plastic.	
18			
20			
22	20-36"	Silty CLAY to SILT, dark gray, moist, sticky.	
24			
26			
28			
30			
32			
34			
36			
38			Total Depth 3' Photo 13
40			
42			
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 36	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/28/01 08:40 END : 6/28/01 09:10 LOGGER : P. Landin

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-5"	Top soil, dark brown, organic, abundant roots.	Pieces of metal but no burnt or contaminated soil horizon.
4			
6	5-11"	Finely layered SILT, tan to brown, dry, cohesive, friable, non plastic.	
8			
10			
12			
14			
16			
18			
20	11-39"	SILT, dark gray, dry at top, becoming moist, sticky when moist, cohesive, friable, non plastic.	Debris in top soil, but no indication of contaminated soils.
22			
24			
26			
28			
30			
32			
34			
36			
38			
40			Total Depth 3'3" Photo 35 of trench Photo 34-33 of excavator
42			
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 37	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/28/01 09:10 END : 6/28/01 10:05 LOGGER : P. Landin

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-6"	Top soil, high root structure.	Bolts and nails, no other sign of filling.
4			
6			
8			
10	6-18"	Finely layered SILT, tan to gray to yellow, friable, cohesive, non plastic.	
12			
14			
16			
18			
20	18-43"	SILT, dark gray, wet, sticky, non plastic.	
22			
24			
26			
28			
30			
32			
34			
36			
38			
40			
42			
44			Total Depth 3'7" Photo 32 Water in hole, depth to water 2'6".
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 38	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/28/01 09:40 END : 6/28/01 10:05 LOGGER : P. Landin

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-2"	Top soil, sandy GRAVEL, dark brown, roots.	Scrap metal.
4	2-6"	GRAVEL and SAND, brown, dry, loose.	Filter fabric
6			
8			
10			
12	6-24"	Finely layered, tan to gray, friable, roots.	
14			
16			
18			
20			
22			
24			
26			
28			
30			
32	24-48"	SILT and fine SAND, moist, cohesive, friable.	No indication of burnt or stained soil.
34			
36			
38			
40			
42			
44			
46			
48			
50			Total Depth 4' Photo 31
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 39	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/28/01 10:05 END : 6/28/01 10:30 LOGGER : P. Landin

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-2"	Top soil.	
4	2-6"	Coarse GRAVEL with sand fill.	Underlain by filter fabric.
6			
8			
10	6-18"	Clayey SILT, gray with brown mottles, stiff.	
12			
14			
16			
18			
20	18-36"	Same as above, no sand at bottom, clayey silt is not mottled near bottom, gray.	Photo 30 No signs of debris or stained soils.
22			
24			
26			
28			
30			
32			
34			
36			
38			Total Depth 3'6" No visible groundwater in bottom of hole.
40			
42			
44			
46			
48			
50			
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 40	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 6/28/01 10:30 END : 6/28/01 10:45 LOGGER : P. Landin

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-2"	Top soil, heavy roots.	
4	2-8"	Coarse GRAVEL with SAND.	No fabric at this location.
8			
10			
12			
14	8-24"	Clayey SILT, gray with brown and orange mottles, stiff.	
16			
18			
20			
22			
24			
26	24-27"	Organic layer, dark brown to black, moist, roots.	
28			
30			
32			
34			
36	27-48"	Fine to medium grained SAND with trace clay, light brown to tan, wet to moist.	Groundwater filling in very bottom of hole.
38			
40			
42			
44			
46			
48			
50			Total Depth 4' No signs of waste or stained soil. Photo 29
52			
54			
56			

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 41	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 7/3/01 10:00 END : 7/3/01 10:20 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2			
4	0-12"	Top soil and sandy SILT, brown with iron staining.	Some debris, glass and nails.
6			
8			
10			
12			
14			
16			
18			
20			
22			
24	12-41"	SILT, yellow to brown, oxidized horizon, finely layered.	
26			
28			
30			
32			
34			
36			
38			
40			
42			
44	41-65"	Fine to medium grained silty SAND, tan, wet, roots.	Water filling hole.
46			
48			
50			
52			
54			
56			Total Depth 5'5" Photo 31 No indication of burning or contaminated soils.

PROJECT NUMBER	TEST PIT NUMBER	
138804.FI.TR	SJS05-TRENCH 42	SHEET 1 OF 1

TEST PIT LOG

PROJECT : St. Juliens Creek Annex - Site 5 LOCATION : Chesapeake, Virginia

ELEVATION : N/A TRENCHING CONTRACTOR : IMS Environmental

DRILLING METHOD AND EQUIPMENT USED : N/A

WATER LEVELS : N/A START : 7/3/01 10:20 END : 7/3/01 11:35 LOGGER : B. Friedmann

Depth (inches)	Interval (inches)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
2	0-4"	Top soil and SILT, brown to dark brown, dry, roots.	
4			
6			
8			
10	4-18"	SAND, tan to brown.	Concrete and wood.
12			
14			
16			
18			Iron stained at 18" bgs.
20	18-20"	Silty CLAY, gray to black, cohesive, slightly plastic.	Black stained horizon - may be indication of burnt soils. The layer is discontinuous.
22			
24			
26			
28			
30	20-50"	SILT, gray, non plastic.	
32			
34			
36			
38			
40			
42			
44			
46			
48			
50			
52			Total Depth 4'2" Photo 30 Collect sample SJS05-SB26-001 for dioxins
54			
56			

Appendix E
Technical Memorandum: Site 5 Waste/Burnt Soil Area Wetland Feasibility Analysis

Site 5 Waste/Burnt Soil Area Wetland Feasibility Analysis

PREPARED FOR: SJCA Tier I Partnering Team

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In conjunction with the preparation of the Engineering Evaluation/Cost Analysis (EE/CA) for the Site 5 Waste/Burnt Soil Area, several field activities and analyses were performed to determine whether or not restoration of the excavated area as a created wetland is feasible. Field activities associated with the EE/CA preparation included wetland delineation, a topographic survey, weekly groundwater level monitoring, and a site visit to assess the hydrologic characteristics of the area. Analyses that were performed included a water budget analysis, a groundwater flux analysis, and an evaluation of the shallow groundwater data based on potential ecological risk. This technical memorandum summarizes the results of the field activities and analyses and assesses the feasibility of creating a wetland during the post-removal action site restoration.

Field Activities

Wetland Delineation

CH2M HILL performed wetland delineation activities at Site 5 on September 30, 2005 and January 4, 2006. A wetland delineation report was prepared and is included as (Appendix A of the EE/CA). Based on the wetland delineation, there are 3.45 acres of wetland located within the Site 5 boundary (Figure 4 of the wetland delineation report). Of those, approximately 0.39 acres are within the Waste/Burnt Soil Area. The existing wetland within the Waste/Burnt Soil Area (Wetland 3) is defined as a Palustrine Emergent (PEM) low area, dominated by smart weed (*Polygonum hydropiper* and *Polygonum arifolium)*, soft rush (*Juncus effusus*), black willow (*Salix nigra*) and barnyard grass (*Echinocloa muricata*). Dense areas of common reed (*Phragmites australis*) (greater then 50% of dominant vegetation) were also observed in the lower portions of the wetland, south east of the Waste/Burnt Soil Area. The other Site 5 wetland areas are located outside of the Waste/Burnt Soil Area and are described in the wetland delineation report.

Topographic Survey

A topographic survey of Site 5 was performed in February of 2006. The survey is included as Attachment A of this memorandum. Elevations of the Waste/Burnt Soil Area range from approximately 7 feet (ft) above mean sea level (amsl) in the northern portion of the area to

approximately 5 ft amsl in the southern portion of the area. The Waste/Burnt Soil Area gently slopes toward Blows Creek.

Weekly Groundwater Level Monitoring

Beginning October 6, 2005, weekly rounds of groundwater levels are collected from the shallow monitoring wells at Site 5. The groundwater level monitoring serves two purposes: to determine the seasonal low groundwater level and to aid in the determination of the impact of groundwater on the excavation. The results of pre-existing data and the weekly groundwater level readings are included as Attachment B of this memorandum. Based on the data collected to date, the seasonal low groundwater level ranges from approximately 0 ft amsl at the southern portion of the excavation area to approximately 3 ft amsl at the northern portion of the excavation area. The weekly groundwater level data was evaluated in relation to the existing ground surface and the anticipated post-excavation ground surface to assess the potential for groundwater to support the wetland. Based on the assumption that the site is excavated to a depth of 2.5 ft below the existing ground surface and backfilled with 6 inches of topsoil, it was estimated that the groundwater would be less than 1 ft below the new ground surface or higher for a significant portion of the year. A water table within 1 ft of the ground surface generally creates hydric conditions appropriate for supporting a wetland. Areas with standing water could potentially support an emergent wetland, assuming the standing water would remain during the growing season; areas without standing water but having saturated soil conditions could support a shrub or treed wetland. The comparison of the weekly water table data and the projected ground surface indicates that groundwater should be able to support a wetland over a portion of the site. However, there is limited water level data available during the growing season, which is the most critical time period. Weekly water level readings were begun in October of 2005 and will continue to be collected throughout the EE/CA review process. Should readings result in any changes to the conclusions of the EE/CA, the recommendation will be revised.

Hydrology Site Visit

Because topographical data was not available for the area surrounding the site, a site visit was conducted on February 9, 2006 to observe the hydrologic characteristics of the area surrounding the site in support of the water budget analysis. The notes and field sketch from the site visit are included as Attachment C. The site visit concluded that a drainage area of approximately 9 acres would drain to the Waste/Burnt Soil Area.

Analyses

Water Budget

A hydrologic analysis of the site was conducted to determine whether surface runoff alone would be sufficient to support a wetland within the Waste/Burnt Soil Area excavation. At the time of the analyses, detailed topographic information of the site and surrounding area was not available, and a drainage area of 10 acres (including the site itself) was assumed based on orthographic photography of the area. The water budget analysis was conducted prior to the hydrology site visit; although the observed drainage area was 9 acres, slightly less than the area used for this analysis, the calculation was not revised because the conclusion would not be impacted. The water budget analysis assumes that stormwater runoff from a total of 10 acres (including the site itself) will be directed to the site.

A spreadsheet tool was used to perform the water budget analysis calculations. The budget analysis used inflows due to direct precipitation and runoff from the watershed. Outflows accounted for in the budget analysis were evapotranspiration, infiltration, and overflow from the wetland area. It was assumed that the maximum depth of the wetland was 2.0 ft. Any volume of water that caused the wetland depth to exceed 2.0 ft was considered overflow and counted as an outflow. Table 1 below summarizes the data used in the spreadsheet calculations.

TABLE 1
Summary of Water Budget Analysis Data

Site	Wetland Area (acres)	Drainage Area – Estimated (acres)	Average Overland Inflow (in/year)	Normal Precip-itation (in/year)	Infiltration without clay layer (in/day)	Infiltration with clay layer (in/day)	Evapo-transpir-ation (in/ year)
Site 5	4.3	10	13.2	45.1	0.6*	0.03	33.0
Source of data	Available wetland area	Watershed delineation	Calculated based on curve number	NOAA data Norfolk, VA	Wass 1997	Das 1998	http://climate.virginia.edu/va_pet_prec_diff.htm

* 0.6 in/day is a conservative infiltration rate; the infiltration rate would be significantly reduced by a high water table, which would limit the infiltration capacity of the underlying soil and result in infiltration through the excavation sides only

The water budget analysis calculated the change in storage by adding the inflows and subtracting the outflows each month. The basic equation used in the water budget analysis is given below:

> Change in storage = Overland inflow + Precipitation – (Infiltration + Evapotranspiration + Overflow)

The water budget analysis was also conducted considering the hydrology with a half-foot thick clay liner installed to decrease the infiltration rate underneath the wetland area, allowing it to retain water for a longer period of time. This analysis assumed that an infiltration rate typical for clay soil conditions could be achieved either with the installation of a clay liner or equivalent.

Assuming an initial wetland depth of 2.0 ft, the results indicate that a wetland within the entire excavation area of the Waste/Burnt Soil Area (4.3 acres) could not be supported by surface water alone; as it would drain completely dry during the course of two months and remain dry, assuming that the water table elevation is well below the wetland bottom. Also, the slope of the property suggests that water ponding would only occur within the east one third of the excavation area. However, if the water table is higher than the wetland bottom, the infiltration rate will be significantly lower than the rate used in this analysis, resulting in infiltration through the sides of the wetland only and potentially allowing for ponded water. The results of the water budget analysis for the clay-lined conditions also show that a 4.3 acre-wetland would drain completely and remain dry for months at a time, assuming that the water table elevation is well below the wetland bottom. These results indicate that the site with a clay-liner may not have enough surface water runoff to support a wetland area of 4.3 acres if the water is lost to infiltration, evapotranspiration, and overflow.

However, the hydrology of the area can support a smaller wetland area (approximately 0.25 acres without a clay liner and 1.4 acres with a clay liner) and high groundwater levels could result in a larger wetland area.

A memorandum providing more detail of the hydrologic evaluation and associated assumptions is provided in Attachment D.

Groundwater Flux

A hydrogeologic evaluation was conducted to estimate the groundwater flux that would flow into the Waste/Burnt Soil Area excavation. Both Darcy's Law groundwater flow equations and WinSitu™ (a two-dimensional groundwater modeling program) were used to estimate groundwater flux into the proposed Site 5 excavation. The analysis was performed based on a 2.5 ft excavation below the ground surface. The results of the Darcy's Law calculation are provided in Table 2 and the results of the two-dimensional groundwater monitoring are provided in Table 3. Two cases were analyzed (standing water in the excavation and no standing water), with two different hydraulic conductivity rates considered for each. The hydraulic conductivity of 3.4 ft/day was based on the results of slug tests conducted in 2003 during the Site 5 Remedial Investigation. However, the data is inconsistent with the soil description (silty sand, clay, silt), and a value of 0.28 ft per day was also considered, which is typical for the soil lithology.

TABLE 2

Summary of Groundwater Flux Results: Darcy's Law Flux into the Excavation in Gallons per Day

Variable 1	k = 0.28 ft/d		k = 3.4 ft/d	
Variable 2	Standing Water*	No Standing water	Standing Water*	No Standing water
High Groundwater	54	108	654	1309
Average Groundwater	8	17	133	267

* Standing water fills half of the excavation between low water and average/high water elevations (e.g. – excavation half full)

TABLE 3
Summary of Groundwater Flux Results: 2-Dimensional Groundwater Modeling Flux into the Excavation in Gallons per Day

Variable 1	k = 0.28 ft/d		k = 3.4 ft/d	
Variable 2	Standing Water*	No Standing water	Standing Water*	No Standing water
High Groundwater	47	106	695	1390
Average Groundwater	25	84	209	1040

* Standing water fills half of the excavation between low water and average/high water elevations (e.g. – excavation half full)

Groundwater discharge into an excavation can be expected to vary considerably through the year, and the flux rate into an excavation will depend on variable groundwater levels. If average groundwater conditions, the site hydraulic conductivity of 3.4 ft/day, and discharge into existing standing water are assumed then the flux rate to the excavation will be on the order of 100 to 200 gallons per day.

Potential Ecological Risk

An ecological risk screening evaluation was performed on the most recent round of groundwater data for each of the shallow monitoring wells at Site 5 (Figure 1) to evaluate whether groundwater would pose a potential risk to aquatic life at Site 5 if a wetland is created.

Chemical analytical data collected from the shallow monitoring wells at Site 5 were screened for their potential to pose risk to aquatic life. Because shallow groundwater would discharge directly to the wetland, the data were evaluated as surface water. Detected concentrations of groundwater constituents were compared to the Ambient Water Quality Criteria (AWQC) for the protection of aquatic life (USEPA, 2002) or the Biological Technical Assistance Group (BTAG) Region III surface water screening values for fresh water (USEPA, 2005). The groundwater was assumed to be freshwater, based on salinity measurements collected from samples in December 2003 (0.1% at MW02S and 0.01% at MW03S). This screening evaluation is conservative because it does not assume that any dilution of the groundwater is occurring nor does it consider other factors that could reduce the presence/bioavailability of chemicals in surface water (e.g., sorption of constituents to sediment).

The screening was used to derive risk estimates using the hazard quotient (HQ) method. HQs that are greater than 1 indicate the potential for unacceptable risk because the chemical concentration (exposure) exceeds the screening value (effect). HQs less than or equal to 1 indicate that unacceptable risks are unlikely. Both the maximum and (arithmetic) mean concentrations were compared to the screening values to evaluate a worst-case scenario (maximum) and a more realistic (mean) exposure scenario. Because the groundwater would be discharging to a common area (the wetland), the mean concentration provides a more realistic (but still conservative) estimate of potential future exposures. A constituent with both maximum and mean HQs of greater than 1 will be considered a Constituent of Potential Concern (COPC). Additionally, consideration was given to the concentrations of COPCs relative to the background upper tolerance limits (UTLs) for shallow groundwater at

SJCA (CH2M HILL, 2004). Individual sample results for the COPCs were qualitatively compared to the background UTLs to determine whether they appear to be site-related.

Based on the screening, the maximum and mean-based HQs for eight total and dissolved inorganics (aluminum, barium, beryllium, cadmium, cobalt, iron, manganese, and silver) and one pesticide (4,4'-DDD) were greater than 1. All nine of these constituents were identified as COPCs (Table 4). Five of the COPCs (aluminum, barium, beryllium, cadmium, and cobalt) concentrations exceed the background UTLs at one or more wells, indicating they are potentially site-related. The site-related COPCs aluminum, beryllium, cadmium, and cobalt were present at MW02S and MW03S, barium was present at MW01S, and aluminum was present at MW04S. However, based on the groundwater flow direction (south) and location of MW02S, MW03S, and MW04S in relation to the Waste/Burnt Soil Area, leaching of the groundwater from the area of these wells into the wetland area is unlikely. Additionally, because waste materials and burnt soils would be removed, only residual contamination would remain in groundwater. It is anticipated this residual groundwater contamination would decrease in concentration with discharge to the wetland area and recharge with un-impacted groundwater and surface water (precipitation), decreasing the potential for ecological risk.

TABLE 4
Concentrations of COPCs in Shallow Groundwater Compared to Background UTLs

Station ID	Background UTL	SJS05-MW01S	SJS05-MW02S	SJS05-MW03S	SJS05-MW04S	SJS05-MW05S
Sample ID		SJS05-GW1S-003	SJS05-MW02S-03D[1]	SJS05-MW03S-03D	SJS05-GW4S-001	SJS05-GW5S-001
Sample Date		05/19/99	12/15/03	12/15/03	05/19/99	05/23/99
Chemical Name						
Inorganics (UG/L)						
Aluminum	1,710	89.7 J	21,800	11,400	613	362
Barium	77.1	249	22.8 J	19.8 J	55.2 J	47.7 J
Beryllium	1.4	0.10 U	5.50	7.60	0.10 U	0.10 U
Cadmium	0.74	0.69 J	2.20 J	4.80 J	0.30 U	0.30 U
Cobalt	15.8	0.50 U	62.9	72.5	3.20 J	5.40 J
Iron	107,000	74,300	18,400	24,800	30,200	20,300
Silver	1.9	0.900 U	0.81 J	1.4 J	0.900 U	0.900 U
Manganese	13,700	3,080	2,060	3,870	1,360	3,320
Dissolved Metals (UG/L)						
Aluminum	399	167 J	22,400	11,400	744	71.1 B
Barium	93.3	243	27.3 J	22.1 J	54.6 J	50.1 J
Beryllium	0.31	0.10 U	5.80	7.50	0.10 U	0.10 U
Cadmium	0.78	0.56 J	2.40 J	5.00 J	0.30 U	0.30 U
Cobalt	15	0.50 U	64.4	71.6	3.20 J	9.10 J
Iron	94,000	74,900	19,000 J	22,900 J	44,100	16,900
Silver	2.4	0.900 U	0.8 J	1.6 J	0.900 U	1.4 J
Manganese	11,800	3,080	2,120 J	3,790 J	1,620	3,130
Pesticides/PCBs (UG/L)						
4,4'-DDD	ND	0.11 U	NA	NA	0.011 J	0.012 J

NA – Not analyzed

ND – Not detected

1 – A duplicate was collected for this; results provided are the maximum concentration between the sample and the duplicate

Shaded cells indicate COPC concentrations in excess of the background UTL (CH2M HILL, 2004)

Conclusions

Based on the field data collected and the analyses that have been performed, it appears that neither surface water nor groundwater alone can support a wetland over the entire 4.3-acre excavation area, assuming that the water table elevation is well below the wetland bottom during the growing season. However, anecdotal on-site evidence, as well as observations of lands adjacent to the site, suggests that portions of the excavation may be able to support a wetland. This could occur if the water table is higher than the wetland bottom, since only limited infiltration is likely to occur through the sides of the wetland in that situation. Because groundwater data through the growing season is not available, the size and type of the potential created wetland cannot be accurately determined at this point. However, based on the average groundwater levels from the available data, it is anticipated that an area of approximately 1 acre can be restored as either an emergent (assuming high water table) or a shrub/treed (assuming lower water table) created wetland. The wetland area would be surrounded by a transitional area seeded with both wetland and upland species. The

remaining portion of the excavation area would be restored as an upland area if there is a low groundwater table for much of the growing season or a shrub/treed wetland if the groundwater level remains high (within 1 foot of the ground surface) through most of the growing season. It is important to note that once constructed, the size of the area in which wetland plants could be supported and the size of the transitional zone would vary from year to year depending on actual local rainfall and groundwater conditions. Due to concern about surface water quality and in order to prevent taking surface water directly from the existing site wetlands, stormwater runoff from upstream tributary areas will be diverted away from the created wetland site by a berm. Only stormwater runoff from within the excavated 4.3-acre site (including the upland area and the created wetland itself) will reach the created wetland. Groundwater level data will continue to be collected throughout the EE/CA review process in order to more accurately determine the size and type of wetland. Additional analyses will be performed after sufficient additional data is available in order to develop an updated estimate of the amount of area that may be restored as a created wetland.

Based on the source removal, dilution from un-impacted groundwater and precipitation, and the low groundwater flux into the excavation area, the groundwater would pose minimal ecological risks to aquatic receptors and these risks would rapidly decrease over time.

v:\18gis\st-juliens\figures\site5_eeca.apr 3/10/06 munwin

LEGEND

- Shallow Monitoring Well Location
- Deep Monitoring Well Location
- Site 5 Waste/Burnt Soil Area
- Lower Drainage
- Upland Drainage
- Wetland Area
- Existing Building
- Former Building
- Groundwater Flow Direction

N

0 125 250 Feet

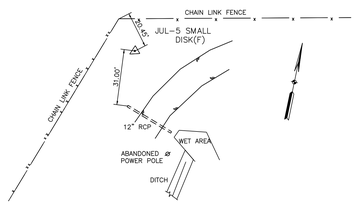
Figure 1
Site 5 Waste/Burnt Soil Area
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL

Attachment A

MONITORING WELLS		
NUMBER	NORTHING	EASTING
SJS05-MW01S	3456044.058	12123946.110
SJS05-MW01D	3456043.493	12123957.060

NOTE:
1. HORIZONTAL DATUM-NAD 83(96) VIRGINIA STATE PLANE COORDINATE SYSTEM SOUTH ZONE U.S. SURVEY FOOT.
2. VERTICAL DATUM-NAVD 88 U.S. SURVEY FOOT, GPS DERIVED
3. JUL-5 (SMALL DISK (F))AS SHOWN ON SHEET 1 OF 3 IS SITE BM ELEVATION=6.69



CONTROL REFERENCE SKETCH
JUL-5
N.T.S

LEGEND

- MONITORING WELL
- NAIL FOUND
- NAIL SET
- EDGE OF PAVEMENT
- DIRT
- GRAVEL
- CONCRETE
- STORM DRAIN MANHOLE
- SANITARY SEWER MANHOLE
- YARD INLET GRATE
- DROP INLET
- UTILITY MANHOLE
- STORM SEWER PIPE
- FIRE HYDRANT
- GUY WIRE
- POWER POLE
- OHE — OVERHEAD ELECTRIC LINE
- PROPERTY LINE
- EDGE OF WATER
- POST
- TREELINE
- BOLLARD
- SIGN
- TRAVERSE POINT
- ELECTRICAL TOWER
- PINE TREE
- TREES
- WATER VALVE
- FLAG POLE
- TELEPHONE PEDESTAL

CONTOUR LEGEND

- MINOR CONTOUR
- MAJOR CONTOUR

30' 15' 0 30' 60' 90'
SCALE 1"= 30'

COMMONWEALTH OF VIRGINIA
PAUL deC. HOLT, JR.
No. 001497-B
LAND SURVEYOR

DRAWN: ODG
CHECKED: KBW
DATE: 3/1/06
SCALE: 1"=30'
SHEET 1 OF 3
FILE NO: 14257-1-0

TOPOGRAPHIC SURVEY
OF
ST. JULIENS CREEK ANNEX
CTO-057, SITE 5
CHESAPEAKE, VIRGINIA

PHR+A
Patton Harris Rust & Associates
Engineers. Surveyors. Planners. Landscape Architects.
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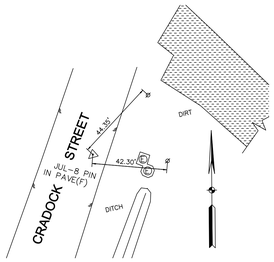
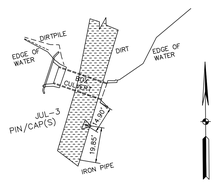
T 757.497.7472 **F** 757.497.0250

FILE NAME: P:\PROJECT\14257\1-0\SURVEY\WORK AREA\SITE 5 ST. JULIENS CREEK.DWG



CONTROL REFERENCE SKETCH
JUL-8
N.T.S



CONTROL REFERENCE SKETCH
JUL-3
N.T.S

MONITORING WELLS		
NUMBER	NORTHING	EASTING
SJS05-MW01S	3456044.058	12123946.110
SJS05-MW01D	3456043.493	12123957.060

NOTE:
1. HORIZONTAL DATUM-NAD 83(96) VIRGINIA STATE PLANE COORDINATE SYSTEM SOUTH ZONE U.S. SURVEY FEET.
2. VERTICAL DATUM-NAVD 88 U.S. SURVEY FEET, GPS DERIVED
3. JUL-5 (SMALL DISK (F))AS SHOWN ON SHEET 1 OF 3 IS SITE BM ELEVATION=6.69

LEGEND

- MONITORING WELL
- NAIL FOUND
- NAIL SET
- EDGE OF PAVEMENT
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CONTOUR LEGEND

- MINOR CONTOUR
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30' 15' 0 30' 60' 90'
SCALE 1"= 30'

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DRAWN: ODG
CHECKED: KBW
DATE: 3/1/06
SCALE: 1"=30'
SHEET 2 OF 3
FILE NO: 14257-1-0

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ST. JULIENS CREEK ANNEX
CTO-057, SITE 5
CHESAPEAKE, VIRGINIA

FILE NAME: P:\PROJECT\14257\1-0\SURVEY\WORK AREA\SITE 5 ST. JULIENS CREEK.DWG

MONITORING WELLS		
NUMBER	NORTHING	EASTING
SJS05-MW04S	3455684.348	12124315.575
SJS05-MW04D	3455668.664	12124324.328

NOTE:
1. HORIZONTAL DATUM-NAD 83(96) VIRGINIA STATE PLANE COORDINATE SYSTEM SOUTH ZONE U.S. SURVEY FEET.
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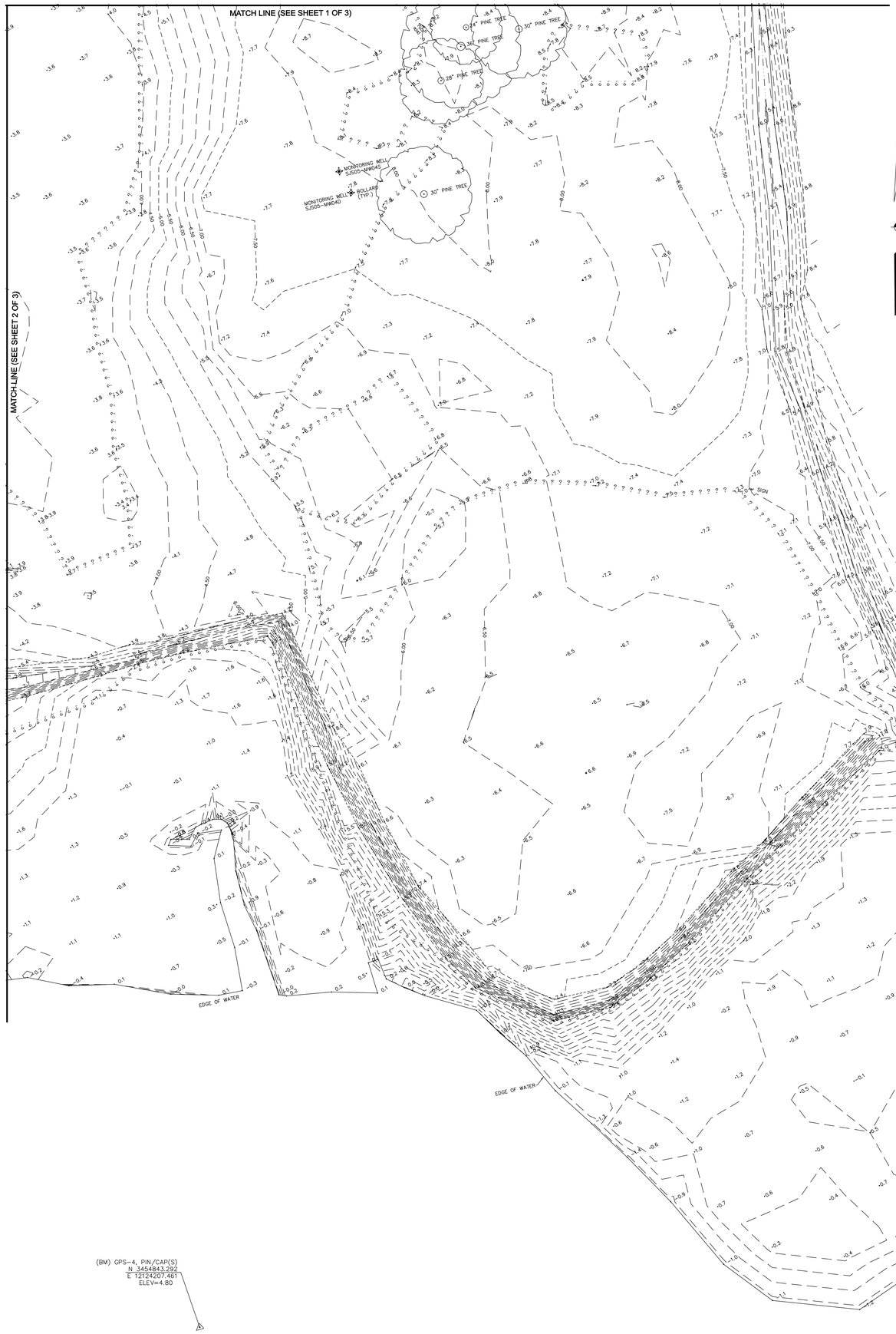

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CHESAPEAKE, VIRGINIA

DRAWN: ODG
CHECKED: KBW
DATE: 3/1/06
SCALE: 1"=30'
SHEET 3 OF 3
FILE NO: 14257-1-0

FILE NAME: P:\PROJECT\14257\1-0\SURVEY\WORK AREA\SITE 5 ST. JULIENS CREEK.DWG

Attachment B

ATTACHMENT B
WEEKLY WATER LEVEL MONITORING
SITE 5 SHALLOW GROUNDWATER WELLS

Well ID	Ground Surface Elevation (NAVD88)	TOC Elevation (NAVD88)	Minimum Groundwater Elevation (NAVD88)	Excavation Depth to Min GW (ft)	Date of Measurement	DTW (ft BTOC)	Water Level Elevation (ft above msl)	pH	Rain Gauge (in/week)	Tide Predictions* (m above MLLW)	DTW (bgs existing ground)	DTW (bgs 2.5' ex + 6" topsoil filled)
SJS05-MW01S	6.268	9.108	2.83	3.44								
					4/19/2005	4.65	4.46				1.81	-0.19
					5/17/1999	3.96	5.15				1.12	-0.88
					8/16/2001	6.22	2.89				3.38	1.38
					10/2/2003	3.87	5.24				1.03	-0.97
					10/6/2005	6.28	2.83				3.44	1.44
					10/13/2005	3.36	5.75		6.25"		0.52	-1.48
					10/20/2005	4.20	4.91		0"		1.36	-0.64
					10/27/2005	3.51	5.60		1.2"	0.246	0.67	-1.33
					11/2/1997	3.44	5.67				0.60	-1.40
					11/3/2005	4.20	4.91		0"	0.376	1.36	-0.64
					11/10/2005	4.63	4.48		0.5"	0.148	1.79	-0.21
					11/17/2005	4.94	4.17		0.6"	1.018	2.10	0.10
					11/23/2005	3.1	6.01		3.25"	0.754	0.26	-1.74
					12/1/2005	3.15	5.96	7	0.3"	0.893	0.31	-1.69
					12/8/2005	3.10	6.01	6	2.3"	0.01	0.26	-1.74
					12/15/2003	3.16	5.95				0.32	-1.68
					12/15/2005	2.96	6.15	6	0.4"	0.148	0.12	-1.88
					12/22/2005	3.16	5.95	6	0.4"	0.108	0.32	-1.68
					12/29/2005	2.95	6.16	6	0.2"	0.864	0.11	-1.89
					1/5/2006	2.95	6.16	6.5	0.3"	0.493	0.11	-1.89
					1/12/2006	3.19	5.92	7	0.2"	0.607	0.35	-1.65
					1/19/2006	3.10	6.01	6	0.7"	0.594	0.26	-1.74
					1/26/2006	3.25	5.86	6.5	0.1"	0.547	0.41	-1.59
					2/2/2006	3.27	5.84	6	0.3"	0.473	0.43	-1.57
					2/9/2006	3.51	5.60	Litmus = 6.5 YSI Meter = 6.06	0.1"	0.468	0.67	-1.33
					2/16/2006	3.75	5.36	7	0.15"		0.91	-1.09
					2/23/2006	3.73	5.38	4	0.1"	0.856	0.89	-1.11
					3/2/2006	4.15	4.96	6	0.0"	-0.144	1.31	-0.69
					3/9/2006	4.55	4.56	6	0.1"	0.792	1.71	-0.29
					3/16/2006	4.89	4.22	6	0.0"	0.211	2.05	0.05
					3/23/2006	5.08	4.03	6	0.2"	0.659	2.24	0.24
SJS05-MW02S	4.248	7.208	0.18	4.07								
					4/19/2005	4.03	3.18				1.07	-0.93
					5/17/1999	4.55	2.66				1.59	-0.41
					8/16/2001	7.02	0.19				4.06	2.06
					10/2/2003	4.57	2.64				1.61	-0.39
					10/6/2005	7.03	**0.18**				4.07	2.07
					10/13/2005	4.14	3.07		6.25"		1.18	-0.82
					10/20/2005	4.64	2.57		0"		1.68	-0.32
					10/27/2005	4.26	2.95		1.2"	0.246	1.30	-0.70
					11/2/1997	3.89	3.32				0.93	-1.07
					11/3/2005	4.73	2.48		0"	0.376	1.77	-0.23
					11/10/2005	4.59	2.27		0.5"	0.148	1.98	-0.02
					11/17/2005	4.6	2.26		0.6"	1.018	1.99	-0.01
		6.858			11/23/2005	3.44	3.42		3.25"	0.754	0.83	-1.17
					12/1/2005	3.72	3.14	5	0.3"	0.893	1.11	-0.89
					12/8/2005	3.46	3.40	5	2.3"	0.01	0.85	-1.15
					12/15/2003	3.68	3.53				0.72	-1.28
					12/15/2005	3.61	3.25	5	0.4"	0.148	1.00	-1.00
					12/22/2005	3.64	3.22	4	0.4"	0.108	1.03	-0.97
					12/29/2005	3.41	3.45	5	0.2"	0.864	0.80	-1.20
					1/5/2006	3.36	3.50	5	0.3"	0.493	0.75	-1.25
					1/12/2006	3.61	3.25	4	0.2"	0.607	1.00	-1.00
					1/19/2006	3.41	3.45	4	0.7"	0.594	0.80	-1.20
					1/26/2006	3.62	3.24	4	0.1"	0.547	1.01	-0.99
					2/2/2006	3.61	3.25	4.5	0.3"	0.473	1.00	-1.00
					2/9/2006	3.69	3.17	Litmus = 4 YSI Meter = 3.50	0.1"	0.468	1.08	-0.92
					2/16/2006	3.78	3.08	5	0.15"	0.06	1.17	-0.83
					2/23/2006	3.81	3.05	5	1"	0.846	1.20	-0.80
					3/2/2006	3.89	2.97	4	0.0"	-0.09	1.28	-0.72
					3/9/2006	3.99	2.87	4	0.1"	0.749	1.38	-0.62
					3/16/2006	4.16	2.70	4	0.0"	0.09	1.55	-0.45
					3/23/2006	4.13	2.73	5	0.2"	0.73	1.52	-0.48
SJS05-MW03S	5.708	8.598	-0.12	5.8								
					4/19/2005	4.84	3.76				1.95	-0.05
					5/17/1999	5.54	3.06				2.65	0.65
					8/16/2001	8.69	-0.09				5.80	3.80
					10/2/2003		NA					-2.00
					10/6/2005	8.72	**-0.12**				5.83	3.83
					10/13/2005	4.98	3.62		6.25"		2.09	0.09
					10/20/2005	5.97	2.63		0"		3.08	1.08
					10/27/2005	5.40	3.20		1.2"	0.246	2.51	0.51
					11/2/1997	5.07	3.53				2.18	0.18
					11/3/2005	6.14	2.46		0"	0.376	3.25	1.25
					11/10/2005	6.65	1.95		0.5"	0.148	3.76	1.76
					11/17/2005	6.81	1.79		0.6"	1.018	3.92	1.92
					11/23/2005	4.13	4.47		3.25"	0.754	1.24	-0.76
					12/1/2005	4.85	3.75	5	0.3"	0.893	1.96	-0.04
					12/8/2005	4.27	4.33	5	2.3"	0.01	1.38	-0.62
					12/15/2003	3.51	5.09				0.62	-1.38
					12/15/2005	4.76	3.84	5	0.4"	0.148	1.87	-0.13
					12/22/2005	4.82	3.78	5	0.4"	0.108	1.93	-0.07
					12/29/2005	4.31	4.29	4	0.2"	0.864	1.42	-0.58
					1/5/2006	4.20	4.40	4.5	0.3"	0.493	1.31	-0.69
					1/12/2006	5.76	2.84	4.5	0.2"	0.607	2.87	0.87
					1/19/2006	4.42	4.18	4	0.7"	0.594	1.53	-0.47
					1/26/2006	4.87	3.73	5	0.1"	0.547	1.98	-0.02
					2/2/2006	4.94	3.66	4	0.3"	0.473	2.05	0.05
					2/9/2006	5.09	3.51	Litmus = 4 YSI Meter = 3.31	0.1"	0.468	2.20	0.20
					2/16/2006	5.33	3.27	5	0.15"	0.06	2.44	0.44
					2/23/2006	5.47	3.13	4	0.1"	0.846	2.58	0.58
					3/2/2006	5.58	3.02	4	0.0"	-0.09	2.69	0.69
					3/9/2006	5.75	2.85	4	0.1"	0.792	2.86	0.86
					3/16/2006	5.95	2.65	4	0.0"	0.211	3.06	1.06
					3/23/2006	6.02	2.58	5	0.2"	0.73	3.13	1.13
SJS05-MW04S	7.778	10.228	2.65	5.13								
					4/19/2005	4.65	5.58				2.20	0.20
					5/17/1999	5.54	4.69				3.09	1.09
					8/16/2001	7.58	**2.65**				5.13	3.13
					10/2/2003	4.53	5.70				2.08	0.08
					10/6/2005	7.43	2.80				4.98	2.98
					10/13/2005	4.96	5.27		6.25"		2.51	0.51
					10/20/2005	5.24	4.99		0"		2.79	0.79
					10/27/2005	5.19	5.04		1.2"	0.246	2.74	0.74
					11/2/1997	NA	NA					
					11/3/2005	5.44	4.79		0"	0.376	2.99	0.99
					11/10/2005	5.63	4.60		0.5"	0.148	3.18	1.18
					11/17/2005	5.77	4.46		0.6"	1.018	3.32	1.32
					11/23/2005	4.18	6.05		3.25"	0.754	1.73	-0.27
					12/1/2005	4.29	5.94	7	0.3"	0.893	1.84	-0.16
					12/8/2005	3.57	6.66	6	2.3"	0.01	1.12	-0.88
					12/15/2003	2.90	7.33				0.45	-1.55
					12/15/2005	3.90	6.33	7	0.4"	0.148	1.45	-0.55
					12/22/2005	3.97	6.26	7	0.4"	0.108	1.52	-0.48
					12/29/2005	3.40	6.83	7	0.2"	0.864	0.95	-1.05
					1/5/2006	3.33	6.90	6	0.3"	0.493	0.88	-1.12
					1/12/2006	3.98	6.25	6	0.2"	0.607	1.53	-0.47
					1/19/2006	3.84	6.39	6.5	0.7"	0.594	1.39	-0.61
					1/26/2006	4.24	5.99	5	0.1"	0.547	1.79	-0.21
					2/2/2006	4.34	5.89	6.5	0.3"	0.473	1.89	-0.11
					2/9/2006	4.5	5.73	Litmus = 7 YSI Meter = 6.96	0.1"	0.468	2.05	0.05
					2/16/2006	4.64	5.59	7	0.15"	0.012	2.19	0.19
					2/23/2006	4.79	5.44	6	0.1"	0.858	2.34	0.34
					3/2/2006	4.92	5.31	7	0.0"	-0.144	2.47	0.47
					3/9/2006	5.19	5.04	6	0.1"	0.792	2.74	0.74
					3/16/2006	5.47	4.76	7	0.0"	0.211	3.02	1.02
					3/23/2006	5.6	4.63	7	0.2"	0.659	3.15	1.15

* Money Point (LST)
DTW within 1' of existing ground surface
Water level > ground surface (standing water)
DTW within 1' of excavated ground surface

* Tide predictions using Money Point, VA. For weekly measurements, value from the closest hour prediction used in table.

Well ID	Time	DTW (ft below TOC)	Water Level Elevation (ft above msl)	Tide Predictions* (m above MLLW)
SJS05-MW01S	8:47	3.00	6.11	0.034
	9:13	3.01	6.10	0.099
	10:14	3.01	6.10	0.305
	11:13	2.95	6.16	0.54
	12:18	2.95	6.16	0.756
	13:17	2.96	6.15	0.843
	14:14	2.96	6.15	0.806
	15:18	2.96	6.15	0.643
	16:18	2.98	6.13	0.434
SJS05-MW02S	8:30	3.36	3.50	-0.006
	9:09	3.37	3.49	0.082
	10:08	3.37	3.49	0.283
	11:06	3.36	3.50	0.517
	12:12	3.37	3.49	0.741
	13:09	3.37	3.49	0.836
	14:08	3.37	3.49	0.815
	15:10	3.38	3.48	0.662
	16:09	3.39	3.47	0.478
SJS05-MW03S	8:37	4.19	4.41	0.007
	9:11	4.20	4.40	0.099
	10:11	4.21	4.39	0.305
	11:09	4.20	4.40	0.517
	12:15	4.21	4.39	0.741
	13:13	4.15	4.45	0.84
	14:10	4.22	4.38	0.806
	15:14	4.16	4.44	0.662
	16:13	4.17	4.43	0.456
SJS05-MW04S	8:57	3.34	6.89	0.049
	9:20	3.34	6.89	0.117
	10:19	3.33	6.90	0.328
	11:19	3.33	6.90	0.562
	12:23	3.30	6.93	0.771
	13:24	3.30	6.93	0.844
	14:20	3.32	6.91	0.796
	15:20	3.33	6.90	0.643
	16:23	3.35	6.88	0.411
SJS05-MW05S	8:25	3.50	5.69	-0.017
	9:00	3.50	5.69	0.065
	10:00	3.50	5.69	0.26
	11:00	3.50	5.69	0.493
	12:05	3.50	5.69	0.724
	13:05	3.50	5.69	0.836
	14:03	3.52	5.67	0.823
	15:03	3.53	5.66	0.697
	16:05	3.56	5.63	0.478

* Tide predictions using Money Point, VA. For hourly measurements, value from the closest minute prediction used in table.

Well ID	Time	DTW (ft below TOC)	Water Level Elevation (ft above msl)	Tide Predictions* (m above MLLW)
SJS05-MW01S	9:17	3.32	5.79	0.487
	10:13	3.25	5.86	0.302
	11:12	3.26	5.85	0.118
	12:08	3.26	5.85	0.018
	13:07	3.26	5.85	0.01
	14:13	3.28	5.83	0.114
	15:08	3.28	5.83	0.251
	16:08	3.29	5.82	0.425
SJS05-MW02S	9:08	3.61	3.25	0.527
	10:06	3.62	3.24	0.322
	11:06	3.62	3.24	0.134
	12:03	3.62	3.24	0.025
	13:03	3.62	3.24	0.006
	14:07	3.62	3.24	0.101
	15:03	3.62	3.24	0.235
	16:03	3.62	3.24	0.408
SJS05-MW03S	9:13	4.87	3.73	0.507
	10:09	4.87	3.73	0.322
	11:08	4.80	3.80	0.134
	12:08	3.26	5.34	0.018
	13:07	3.26	5.34	0.01
	14:13	3.28	5.32	0.114
	15:05	4.82	3.78	0.251
	16:05	4.82	3.78	0.425
SJS05-MW04S	9:26	4.24	5.99	0.467
	10:18	4.24	5.99	0.282
	11:19	4.24	5.99	0.103
	12:12	4.23	6.00	0.012
	13:13	4.23	6.00	0.016
	14:16	4.24	5.99	0.127
	15:13	4.24	5.99	0.268
	16:12	4.20	6.03	0.443
SJS05-MW05S	8:58	4.16	5.03	0.547
	10:00	4.17	5.02	0.343
	11:00	4.17	5.02	0.151
	12:00	4.17	5.02	0.025
	13:00	4.17	5.02	0.006
	14:00	4.18	5.01	0.088
	15:00	4.19	5.00	0.235
	16:00	4.21	4.98	0.408

* Tide predictions using Money Point, VA. For hourly measurements, value from the closest minute prediction used in table.

Attachment C

Site 5 Watershed Delineation
St Juliens Creek Annex, Chesapeake, Virginia

Estimated Watershed – 9 acres (measured by planimeter)

Culverts

1. Metal, 12 inch diameter circular culvert with sediment covering 50% of opening. There is standing water in the surrounding areas with heavy vegetation. Vegetation appears to be wetland in nature, thick and tall.

2. Metal 12" diameter circular culvert (connected to #1) with sediment covering 75% of the opening. The surrounding area is dry and there is significantly less vegetation than #1. There are no signs of continuous flow.

3. Stone circular culvert with 100% blockage by sediment. Appears to be between 12 and 18 inches in diameter. Sediment is moist but no standing water.

4. This culvert is buried, I could not locate it, but it is connected with #3. Sediments are moist.

5. Along the fence line connecting SJCA to the power sub station, there is a ditch with a rigged catch basin using steel piping. The area is 7.5 feet long and the steel piping is tethered to the fence. The ditch on SJCA is dry. On the other side of the fence (sub station area) there is broken vegetation and debris lining the fence line. Sediment appears moist and there are sediment deposits along the road leading to the catch basin. The catch area is partially blocked by organic debris.

6. Concrete culvert with exposed steel re-bar. Appears to be approximately 18 inches in diameter but most of it is buried. There is standing water in the ditch and fresh sediment buildup in the opening. It is 75% blocked and there is small vegetation surrounding the ditch and culvert.

7. Connected with #6. Circular concrete culvert approximately 18 inches in diameter. It is 30% blocked by sediment and has larger vegetation than #6. Thick grasses line the ditch and the sediment is saturated. There is no standing water.

8. Appears that part of the underground culvert is exposed. The culvert is concrete and 18 inches in diameter. It is 100% blocked by sediment and there is very thick vegetation surrounding it.

9. This culvert is connected with #8. It is 18 inches in diameter and has standing water in the ditch and the opening of the culvert. It is 50% blocked and is surrounded by very thick vegetation.

10. There is a hole in the ground covered by vegetation. It is adjacent to the corner of the fence near the substation. It is 3 ft wide and 18 inches deep. I couldn't find any structures.

11. Concrete culvert 18 inches in diameter. It was freshly dug out by the surveyors but is still 50% full of sediment. The ditch is saturated and lined with small vegetation.

12. This culvert is connected to #11. It is 18 inches in diameter and concrete. There is standing water in the opening and the ditch is saturated and lined with grassy vegetation.

13. Concrete culvert, 12 inches in diameter. There is no standing water and the opening is 25% blocked. There is small vegetation in the area.

14. This one is connected to #13. Concrete culvert, 12 inches in diameter. No standing water and 25% blocked. Small vegetation surrounds the area.

15. This culvert is 16 inches in diameter and metal. It is 10% blocked and the sediment in the ditch is moist. The area is mostly free of vegetation.

16. This culvert is constructed of metal and is 16 inches in diameter. There is heavy vegetation and debris in the surrounding area. The sediment is dry to damp.

17. This culvert is connected with # 16. Metal 16 inches in diameter. Heavy vegetation and debris in the area and the sediment is dry to damp.

18. This culvert is steel and has a diameter of 24 inches. There is evidence of old sediment deposits and the area is dry. There is some vegetation and debris. The opening is 25% covered.

19. This culvert is metal and completely exposed and clear. There is no vegetation and the structure is 1 to 2 feet above the bottom of the ditch.

No other culverts along this ditch were observed. The ditch is eventually consumed by rocks, sand, and other organic debris.

North of Site along Railroad Tracks

On the north side of the gravel road, there is a ditch approximately 3 ft across and varying in depth from a few inches to 1.5 ft at its greatest depth. This area is near a steel culvert that connects to across the street just north of the power sub station. This culvert was 80% full of water and flow was observed on both sides of the street. The flow appears to be away from SJCA and deposits into a wetland area on the northwest side of the substation. Phragmites and Cattails were observed in the marshy area.

Craddock St

Everything to the west of Craddock St appears to flow west.

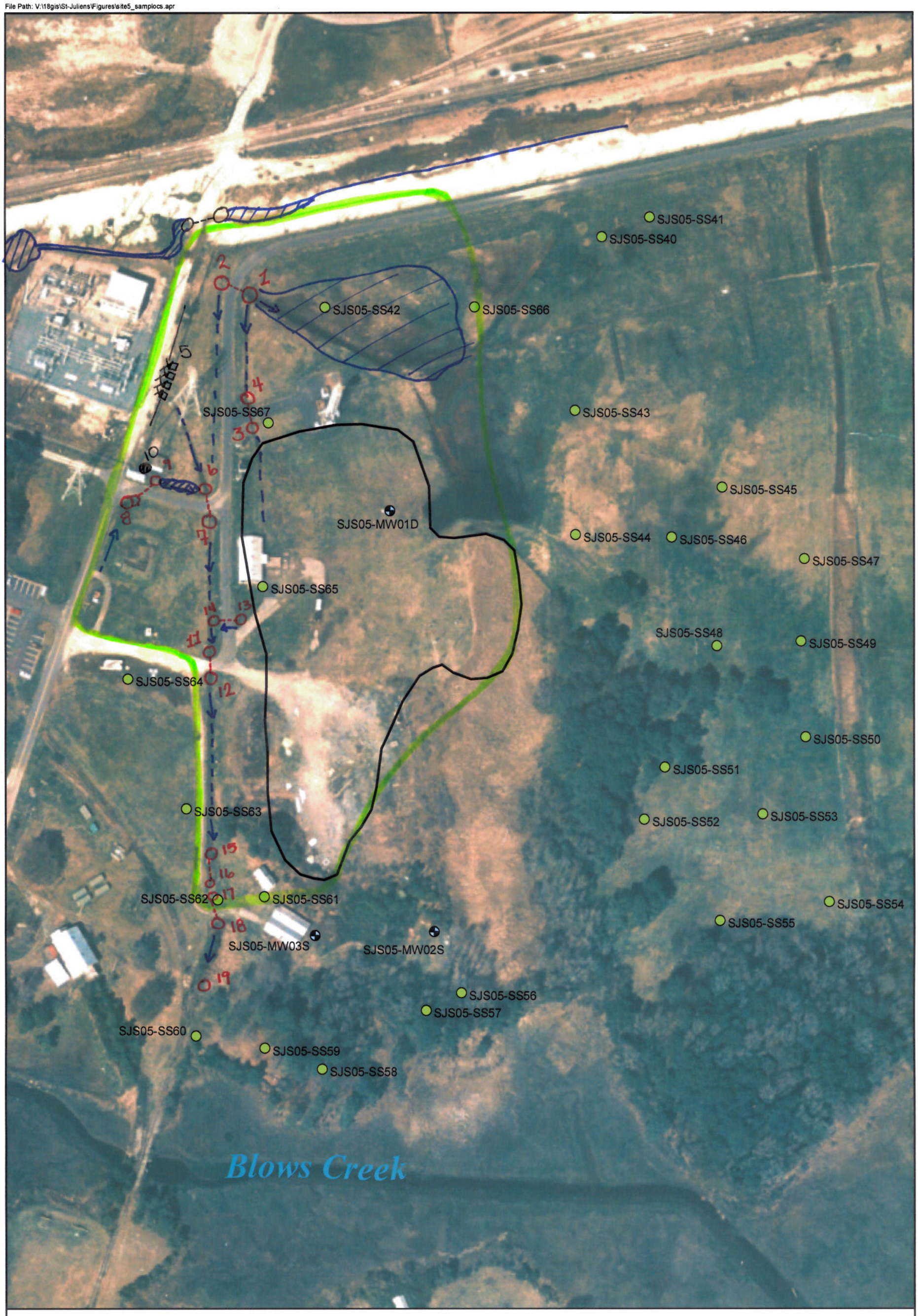
Looking SW from substation street to Site 5

Looking SW from substation street to Site 5

Looking SW from substation street to Site 5

North of SJCA and gravel road looking West

File Path: V:\18gis\St-Juliens\Figures\site5_samplocs.apr



Groundwater Sampling Locations
Surface Soil Sampling Locations
Site Boundary
OSJCA culverts
--- Connected
→ Water flow
Standing Water
O other culverts or items of interest
Estimated Watershed

N

0 100 200 Feet

Figure 2-3
Site 5 Expanded Remedial Investigation Sampling Locations
Site 5 Expanded Remedial Investigation
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL

Attachment D

St. Julien Wetland Analysis

PREPARED FOR: FILE

PREPARED BY: CH2M HILL

DATE: March 7, 2006

PROJECT NUMBER: 314790.EC.DR

Introduction

The following summarizes an analysis performed to determine whether the proper hydrologic conditions exist to support a freshwater wetlands mitigation sites at the Site 5 waste location east of Cradock Street and south of Center Street. Separate analyses were prepared by Erik Spande/CHI to determine whether groundwater could be used as a potential source of water for the proposed wetlands. This memorandum summarizes analysis performed by Phil Blonn/CIN to consider whether there is sufficient surface water runoff to support the wetlands.

Location Description

This potential site is located immediately to the south of Center Street and to the east of Cradock Street. An area of approximately 4.3 acres is available at this site to be developed into freshwater mitigation wetlands. Detailed topographic information was not available. The drainage area was estimated from available orthographic photos. More detailed topographic information, such as 2-foot contours will be required to move beyond the preliminary conclusions of this analysis. The drainage area of the site was estimated to include only area east of Cradock Street and south of Alcoa Drive, including a total of roughly 10 acres, comprised mainly of land to the north and west of the site. It is unknown if additional areas west of Cradock Street or north of Alcoa Drive also drain towards the site. Based on the review of the orthographic photos, it was estimated that the drainage area could potentially be as large as 16 acres. For the purpose of this analysis, calculations were performed with a drainage area of 10 acres and also with a drainage area of 16 acres, so that those cases serve as bounding conditions.

Water Budget Analysis

A spreadsheet tool was used to perform the water budget analysis calculations. The budget analysis used inflows due to direct precipitation and runoff from the watershed. Actual monthly precipitation data from the period 1950 through 2002 was used in the calculations with assumptions regarding the distribution of storm events during each month. Outflows accounted for in the budget analysis were evapotranspiration, infiltration, and, overflow from the wetland area. Norfolk International Airport data were used for the evapotranspiration rates, while the infiltration rate was a typical rate measured at several existing constructed wetlands. The local soil report does not list infiltration rates of the existing soils in the area, as the existing soil is comprised of fill material (USDA, 1983). This

analysis uses 0.60 in/day as a typical infiltration rate for constructed wetlands (Wass, 1997). In addition, a clay liner option was analyzed, which allows an infiltration rate of 0.03 in/day (Das, 1998). It was assumed that the maximum depth of the wetland was 2.5 feet. Any volume of water that caused the wetland depth to exceed 2.5 feet was considered overflow and counted as an outflow. Exhibit 1 below summarizes the data used in the spreadsheet calculations. Some of the data summarized annually in Exhibit 1 varied by month in the detailed spreadsheet calculations.

EXHIBIT 1
Summary of Water Budget Analysis Data

Site	Wetland Area (acres)	Drainage Area – Estimated – Bounding Conditions (acres)	Average Overland Inflow (in/year)	Normal Precip-itation (in/year)	Infiltration without clay layer (in/day)	Infiltration with clay layer (in/day)	Evapo-transpir-ation (in/ year)
Site 5	4.3	10 - 16	13.2	45.1	0.6	0.03	33.0
Source of data	Available wetland area	Watershed delineation	Calculated based on curve number	NOAA data Norfolk, VA	Wass 1997	Das 1998	http://climate.virginia.edu/va_pet_prec_diff.htm

The water budget analysis calculated the change in storage each month by adding the inflows and subtracting the outflows each month. The basic equation used in the water budget analysis is given below:

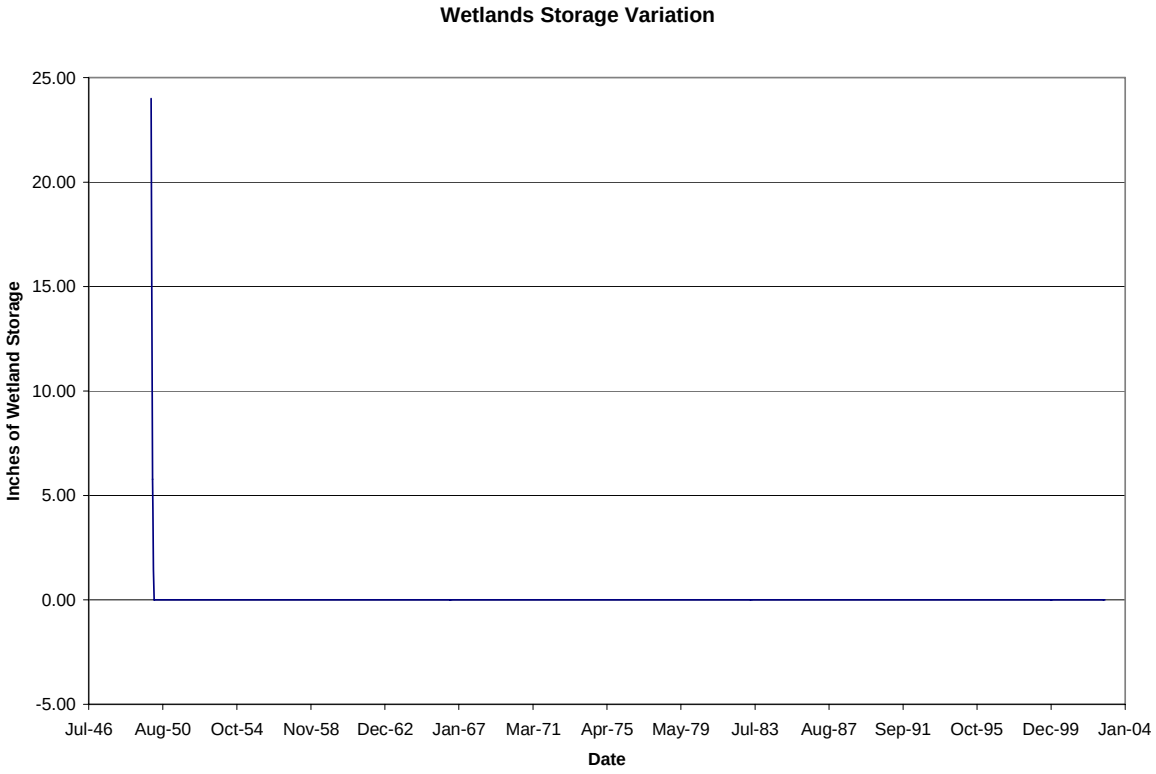
Change in storage = Overland inflow + Precipitation – (Infiltration + Evapotranspiration + Overflow)

The water budget analysis was also conducted considering the hydrology with a half-foot thick clay liner installed to decrease the infiltration rate underneath the wetland area, allowing it to retain water for a longer period of time. This analysis assumes that an infiltration rate typical for clay soil conditions can be achieved either with the installation of a clay liner, geotextile fabric, or combination of the two.

Water Budget Analysis Results

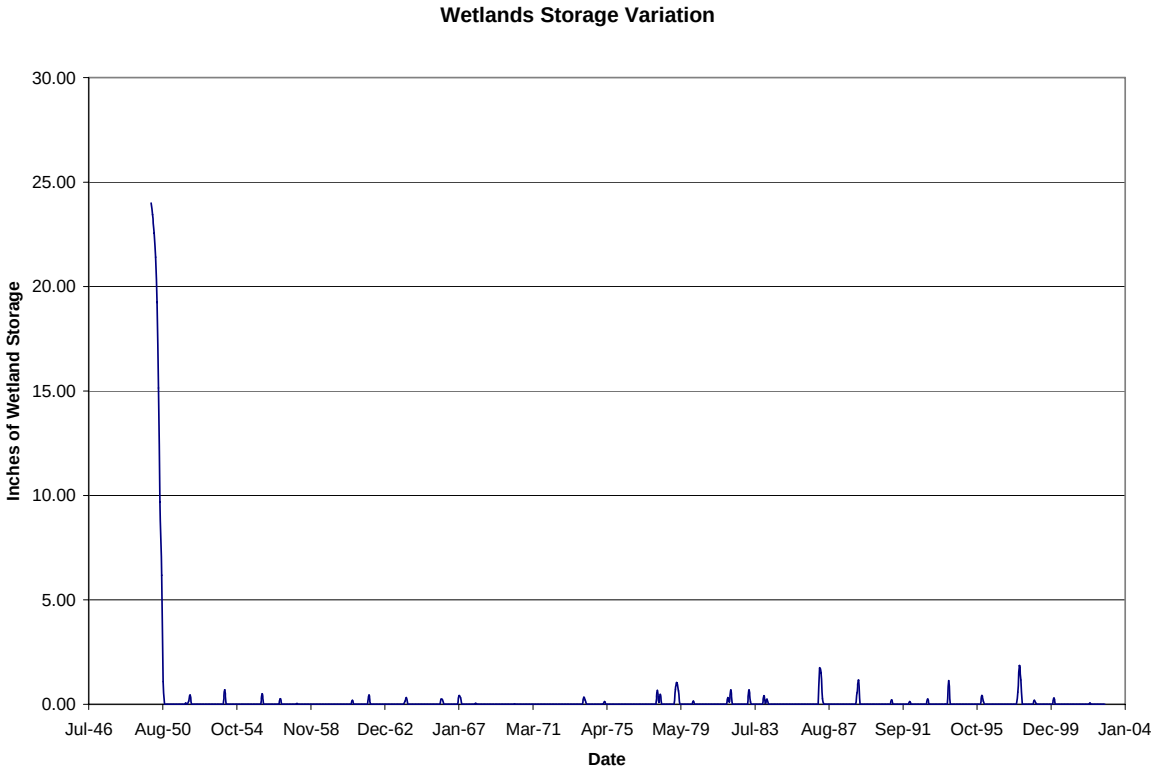
Initial wetland depths are planned to vary from 12 inches to 30 inches. Calculations were performed for an average wetland depth of 12 inches, 24 inches, and 30 inches. For an initial wetland depth of 2.5 feet, and a drainage area of 10 acres, the results found indicate that a wetland area at Site 5 would drain completely dry during the course of two months and remain dry as shown below in the graph in Exhibit 2. These results mean that under this scenario, the site does not have enough surface water runoff to support a wetland area.

EXHIBIT 2
Wetlands Storage Variation (without Clay-liner)



The results of the water balance analysis for the clay-lined conditions for a 10-acre drainage area and a 2.5-foot average depth wetland are shown in Exhibit 3. The simulation shows that the wetlands would drain completely and remain dry for months at a time. These results mean that the site with a clay-liner still does not have enough surface water runoff to support a wetland area.

EXHIBIT 3
Wetland Storage Variation (with Clay-liner)



Summary of Results for all Conditions Analyzed

Exhibit 4 below summarizes results for all conditions analyzed.

EXHIBIT 4
Results of all conditions analyzed

Drainage Area (acres)	Average Depth of Wetland (inches)	Clay-liner	Could support 4.3-acre wetland?	Maximum area of wetland conditions could support (acres)
10	12	No	No	0.2
10	24	No	No	0.25
10	30	No	No	0.3
10	12	Yes	No	1.2
10	24	Yes	No	1.4
10	30	Yes	No	1.6
16	12	No	No	0.35
16	24	No	No	0.4
16	30	No	No	0.45
16	12	Yes	No	2.3

EXHIBIT 4
Results of all conditions analyzed

Drainage Area (acres)	Average Depth of Wetland (inches)	Clay-liner	Could support 4.3-acre wetland?	Maximum area of wetland conditions could support (acres)
16	24	Yes	No	2.4
16	30	Yes	No	2.5

References

Das, Braja M. *Principles of Geotechnical Engineering*. 1998. PWS Publishing Co., Boston, MA.

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Appendix F
Cost Estimates

Alternative 2: Cover Installation

Site: Site 5 - Burning Grounds
Location: St. Juliens Creek Annex, Chesapeake, Virginia
Phase: EE/CA
Date: 9-Oct-06

Description: Construction of a cover over the Site 5 Waste/Burnt Soil Area and impacted surface soil and sediment areas, including a soil cover and an asphalt cover.

CALCULATIONS		
Cover Area (sq ft)		413820
Soil cover area (sq ft):		405979
Asphalt cover area (sq ft):		7841
Soil Cover, Volume for Sloping (cu yd)		
For simplicity, assume site is a flat circle		
Area of a circle = pi*r*r, so radius is: (ft)		359
2% slope over radius = vertical delta (ft)		7.2
Volume of a cone = pi*r*r*h/3 (cu ft)		972948
Volume for sloping (cu yd)		36035
Because the site is slightly sloped, assume only 50% is needed		18018
Volume of General Fill to achieve 2% slope:		**18018**
Soil Cover, Volume for 2-ft cover		
Thickness of general fill (ft)		1.5
Thickness of topsoil (ft)		0.5
Volume of general fill (cu yd)		22554
Volume of topsoil (cu yd)		7518
Asphalt Cover Materials (cu yd)		
Volume of leveling layer general fill (cu yd)		145
Area of asphalt (6" stone base, 2" binder course, 1" topping)		7841
Soil Cover, Additional Volume for Compaction (25%)		
Volume of general fill (cu yd)		10179
Volume of topsoil (cu yd)		1880
Total Volumes		
Volume of general fill (cu yd)		**50896**
Volume of topsoil (cu yd)		**9398**
		60294
Production Rate		
Fill placement per day (cu yd)		1000
Labor (local) & Equipment Cost		
Schedule (in days)		60
Schedule (in weeks)		13
Equipment Operator Rate	$	22
Laborer Rate	$	12
Dozer mobe & demobe	$	414
Dozer weekly rate	$	1,770
Total Labor Cost	$	32,800
Total Equipment Cost	$	46,848
Labor and Equipment Cost per cu yd	**$**	**1.32**

ASSUMPTIONS

1) Clearing
- * Shrubs and trees will be removed
- * Vegetation will be mowed

2) MEC Support
- * 2 MEC technicians will be present during intrusive activities
- * Intrusive activities include clearing, well installation, and fence installation
- * Work will take place in September through March
- lodging, meals, and incidental = $118 per day per person

3) Erosion and Sediment Controls
- * Perimeter controls @ $1 per foot around the 3,100 foot perimeter are assumed.

4) Fill Material (soil cover and asphalt cover)
- * Fill material will come from an offsite borrow source
- * The minimum final slope will be 2%.
- * Final slopes of the cover will not exceed 3 horizontal:1 vertical
- * Material will arrive and placed at a rate of 1,000 cu yd per day
- * General fill will be used below the top 6 inches
- * Top soil will be used for the top 6 inches
- * 25% extra fill volume for compaction

5) Installation and abandonment of Monitoring Wells
- * 1 monitoring well will be installed
  (the top 3 ft will be double cased to prevent downward migration of contaminants)
- * 2 monitoring wells will be abandoned
- * Well installation and abandonment will be concurrent to minimize cost
- * Well installation and abandonment will be completed in 2 days

6) Groundwater Sampling
- * 2 field technicians at $55/hour
- * 2 hours per well, 4 hours mobilization/demobilization
- * Cost for TAL metals in groundwater is $115/sample
- * 12 groundwater samples (per area) including QA/QC samples
- * QA/AC samples include 1 duplicate, 1 equipment blank, 1 field blank, and 1 matrix spike/matrix spike duplicate
- * Annual Report

7) Cover Maintenance
- * Cover maintenance will include mowing to the perimeter fence and edge trimming along the perimeter fence
- * Cover vegetation will be maintained on a monthly basis from May through September (5 months). No mowing October through April.
- * Annual cost for potential monitoring well repairs
- * Annual cost for potential cover repairs
- * Annual cost for site inspections

8) Perimeter Fence
- * 3100 LF of fence
- * 1 gate
- * 1 large sign and 6 small signs

9) Wetland Compensatory Mitigation
- * A cost is included for a constructed wetland for compensatory mitigation; however, because a location hasn't been identified for the wetland, actual cost can vary significantly
- * Constructed wetland will be 2 times the size of the lost wetland

10) Labor & Equipment
- * Equipment operators & laborers will be local (no per diem included)
- * Work crew will include 2 equipment operators & 2 laborers
- * 2 dozers will be used

Alternative 2: Cover Installation

Site: Site 5 - Burning Grounds
Location: St. Juliens Creek Annex, Chesapeake, Virginia
Phase: EE/CA
Date: 9-Oct-06

Description: Construction of a cover over the Site 5 Waste/Burnt Soil Area and impacted surface soil and sediment areas, including a soil cover and an asphalt cover.

CAPITAL COSTS

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Work Plan & Closeout Report					
Draft and Final Submissions of Work Plan	1	LUMP	$12,000.00	$12,000	Engineer's Estimate
Draft and Final Submissions of Compensatory Mitigation Plan	1	LUMP	$5,000.00	$5,000	Engineer's Estimate
Draft and Final Submissions of Closeout Report	1	LUMP	$8,000.00	$8,000	Engineer's Estimate
Draft and Final Submissions of Operation and Maintenance Plan	1	LUMP	$5,000.00	$5,000	Engineer's Estimate
				$30,000	
Erosion and Sediment Controls					
Installation of Erosion and Sedient Controls	3,100.0	LF	$1.00	$3,100	Engineer's Estimate
SUBTOTAL				$3,100	
Clearing and Grubbing					
Brush mowing	1.1	ACRE	$536.82	$590	RS Means 02200-200-1080
Cut and chip trees	0.5	ACRE	$3,607.06	$1,804	RS Means 02200-100-0199
SUBTOTAL				$2,394	
Intrusive Activities Support					
MEC Technician II/III for MEC scanning (2 MEC technicians)	2	DAYS	$1,800.00	$3,600	Engineer's Estimate
MEC Mobilization (2 MEC technicians)	2	DAYS	$3,500.00	$7,000	Engineer's Estimate
MEC Demobilization (2 MEC technicians)	2	DAYS	$3,500.00	$7,000	Engineer's Estimate
Per Diem (24 MEC technicians)	3.5	DAYS	$236.00	$826	DOD Travel Per Diem Allowance, FY2007
SUBTOTAL				$18,426	
Soil Cover (Haul, Dump, Spread, Compact)					
General Fill	50,715	CU YD	$9.50	$481,792	Engineer's Estimate
Topsoil	9,398	CU YD	$18.50	$173,857	Engineer's Estimate
Equipment (mobe/demobe), labor, and materials	60,294	CU YD	$1.32	$79,648	Engineer's Estimate
SUBTOTAL				$735,297	
Asphalt Cover (Haul, dump, spread, and compact leveling layer; install asphalt)					
General Fill	182	CU YD	$9.50	$1,724	Engineer's Estimate
Equipment (mobe/demobe), labor, and materials for general fill	182	CU YD	$1.32	$240	Engineer's Estimate
Asphalt installation	7,841	SF	$1.85	$14,474	RS Means 02740-315-0020
SUBTOTAL				$16,438	
Monitoring Wells					
Installation	1	EACH	$1,300.00	$1,300	Engineer's Estimate
Abandonment	2	EACH	$1,400.00	$2,800	Engineer's Estimate
Mobe/Demobe & standby	1	EACH	$4,500.00	$4,500	Engineer's Estimate
Decon (including decon pad)	1	EACH	$1,100.00	$1,100	Engineer's Estimate
IDW drums and handling	1	EACH	$500.00	$500	Engineer's Estimate
Per Diem (2 people)	1.5	EACH	$236.00	$354	DOD Travel Per Diem Allowance, FY2007
SUBTOTAL				$10,554	
Site Restoration					
Seeding	447	MSF	$48.27	$21,557	RS Means 02920-320-4600
Culvert Installation	445	LF	$14.04	$6,246	RS Means 02600-520-1060
SUBTOTAL				$27,803	
Institutional Controls					
Fence	3,100	LF	$54.21	$168,057	RS Means 02820-150-6600
Gate	1	OPENENING	$1,835.36	$1,835	RS Means 02820-130-5080
Sign (large)	1	EACH	$318.80	$319	RS Means 10400-200-2200
Sign (small)	16	EACH	$66.31	$1,028	RS Means 10400-200-1200
Deed Restrictions	1	EACH	$3,500.00	$3,500	Engineer's Estimate
SUBTOTAL				$174,739	
Constructed Wetland for Compensatory Wetland Mitigation					
Note: Constructed wetland costs vary greatly. Because a location for the constructed wetland has not been identified this cost is a rough estimate.					
Constructed Wetland	2.35	ACRE	$160,000	$375,392	Recent local wetland construction
SUBTOTAL				$1,394,142	
Contingency	15%			$209,121	Engineer's estimate
SUBTOTAL				$1,603,264	
Project Management	6%			$96,196	Source: A Guide to Developing and Documenting Cost
Removal Action Design	12%			$192,392	Estimates During the Feasibility Study - USEPA/USACE,
Construction Management	8%			$128,261	July 2000
TOTAL CAPITAL COST				**$2,020,112**	

Alternative 2: Cover Installation

Site: Site 5 - Burning Grounds
Location: St. Juliens Creek Annex, Chesapeake, Virginia
Phase: EE/CA
Date: 9-Oct-06

Description: Construction of a cover over the Site 5 Waste/Burnt Soil Area and impacted surface soil and sediment areas, including a soil cover and an asphalt cover.

OPERATION AND MAINTENANCE COSTS - COVER (1 to 30 years)

Long Term Groundwater Monitoring					
Groundwater sampling (labor, equipment, materials)	4	EVENT	$1,990.00	$7,960	Engineer's Estimate, 5 monitoring wells, quarterly
Laboratory analysis, including QA/QC	4	EVENT	$1,380.00	$5,520	Engineer's Estimate
Annual report	1	UNIT	$2,500.00	$2,500	Engineer's Estimate
SUBTOTAL				$15,980	
Cover Monitoring					
Mowing cover vegetation	2233	MSF	$1.55	$3,459	RS Means 02935-300-4160
Edge trimming	15500	LF	$0.04	$658	RS Means 02935-300-5000
Repair to cover and monitoring wells	1	UNIT	$2,000.00	$2,000	Engineer's Estimate
Annual cover inspection and report	1	UNIT	$2,000.00	$2,000	Engineer's Estimate
SUBTOTAL				$8,116	
5-year Reviews					
5-year Review and report	0.2	EVENT	$7,500.00	$1,500	Engineer's Estimate
SUBTOTAL				$1,500	
SUBTOTAL				$25,596	
Contingency	15%			$5,119	Engineer's estimate
SUBTOTAL				$30,716	

OPERATION AND MAINTENANCE COSTS - WETLAND (2 years)

Wetland Monitoring					
Quarterly Inspections	4	EVENT	$650.00	$2,600	Engineer's Estimate
Water Level Monitoring (weekly)	52	EVENT	$100.00	$5,200	Engineer's Estimate
Quarterly Inspection Reports	4	EVENT	$500.00	$2,000	Engineer's Estimate
SUBTOTAL				$9,800	
Contingency	15%			$1,470	
SUBTOTAL				$11,270	

PRESENT VALUE ANALYSIS

i = 0.03
cover t = 30
wetland t = 2

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (3.0%)	Present Value
Capital	0	$2,020,112	$2,020,112	1.000	$2,020,112
O&M	1-30	$921,467	$30,716	19.60	$602,039
O&M (wet)	1-2	$22,540	$11,270	1.91	$21,565
					$2,622,151
TOTAL PRESENT VALUE OF ALTERNATIVE					**$2,622,000**

*Discount factor established per "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis", OSWER Directive No. 9355.3-20, June 25, 1993.

The costs estimates are provided to an accuracy of +50 percent and -30 percent.

cu yd = cubic yard
ft = foot, feet
IDW = investigation derived waste
LF = linear foot
mobe/demobe = mobilization/demobilization
MSF = thousand square feet
sq ft = square feet
MEC = munitions and explosives of concern

Alternative 3: Excavation and Backfill

Site: Site 5 - Burning Grounds
Location: St. Juliens Creek Annex, Chesapeake, Virginia
Phase: EE/CA
Date: 9-Oct-06

Description: Excavation to visible limits of the Site 5 Waste/Burnt Soil Area, excavation of impacted surface soil and sediment areas to a minimum of 1 ft, and backfill with imported soil

CALCULATIONS

Excavated Material		
Impacted Area (2.5 ft excavation)		
Area (sq ft)		187308
Depth (ft)		2.5
Assumed soil weight (tons/cu yd)		1.6
In-Place Volume of soil to be excavated (cu yd)		17343
Volume of soil to be excavated (tons)		27749
Human Health Risk-Based Removal Areas (1 ft excavation)		
Area (sq ft)		135036
Depth (ft)		1
Assumed soil weight (tons/cu yd)		1.6
In-Place Volume of soil to be excavated (cu yd)		5001
Soil to be excavated (tons)		8002
Ecological Risk-Based Removal Areas (1 ft excavation)		
Area (sq ft)		69696
Depth (ft)		1
Assumed soil weight (tons/cu yd)		1.6
In-Place Volume of soil to be excavated (cu yd)		2581
Soil to be excavated (tons)		4130
Additional excavation based on failed confirmation samples		
Area requiring additional excavation (sq ft)		80586
Thickness of additional excavation (ft)		0.5
Assumed soil weight (tons/cu yd)		1.6
In-Place Volume of soil to be excavated (cu yd)		1492
Soil to be excavated (tons)		2388
Total for disposal (tons)		**42269**

Excavation Cost		
Equipment (all from Means, except mobe/demobe for screen - eng. est.)		
Dozer - weekly rate	$	1,770
Excavator - weekly rate	$	1,030
Front End Loader - weekly rate	$	835
Excavator - weekly rate	$	1,030
Screen Plant - weekly rate	$	1,390
Off-road Dump - weekly rate	$	2,495
Mobe & Demobe (dozer, excavators, loader)	$	1,656
Mobe & Demobe (dump)	$	610
Mobe & Demobe (screen)	$	1,000
Labor (engineer's estimate)		
Equipment Operators - hourly rate	$	22
Equipment Operators - number		5
Laborers - hourly rate	$	12
Laborers - number		2
Schedule		
Production Rate (cu yd screened per day)		400
Duration of excavation activity (weeks)		17
Duration of excavation activity (days)		83
Cost		
Equipment	$	144,439
Labor	$	110,627
	$	255,066
Cost per ton	$	6.03

Fill Cost		
Material		
General Fill (cu yd)		23948
Topsoil (cu yd)		9075
Total Fill Material (cu yd)		**33023**
Equipment (all from Means, except mobe/demobe for screen - eng. est.)		
Dozer - weekly rate		1770
Mobe & Demobe (dozers, excavator, loader)		414
Labor (engineer's estimate)		
Equipment Operators - hourly rate	$	22
Laborers - hourly rate	$	12
Equipment Operators - number		1
Laborers - number		1
Schedule		
Production Rate (cu yd fill per day)		1000
Duration of fill activity (weeks)		7
Duration of fill activity (days)		33
Cost		
Equipment	$	12,104
Labor	$	8,982
	$	21,086
Cost per yard	$	0.64

ASSUMPTIONS

1) Clearing
   * Shrubs and trees will be removed
   * Vegetation will be mowed
2) MEC Support
   * 2 MEC technicians will be present during intrusive activities and screening of material
   * Work will take place in September through March
     lodging, meals, and incidental = $118 per day per person
3) Erosion and Sediment Controls
   * Perimeter controls @ $1 per foot around the 3,100 foot perimeter are assumed.
4) Excavation
   * Depth of waste and burnt soil is 2.5 ft
   * Depth of impacted soil and sediment areas is 1 ft
   * Excavated materials disposed at offsite landfill as non-hazardous waste
     Landfill located within 50 miles of site
5) Excavation Dewatering
   * Material excavated from within the wetland area will require dewatering
   * Wetland area is 17,100 SF
   * A dewatering pad will be constructed
   * No dewatering agents will be required
   * Water from dewatering process can be released on site
6) Mechanical screening of excavated material
   * All excavated material will require mechanical screening prior to disposal
   * Excavation rate will be limited by screening; screening will be at a rate of 400 cu yd per day
   * Amount screened is 25% more than in-place excavation volume
7) Removal of Excavated Soil
   * 20 trucks/day at 20 tons of soil /truck x 2 trips/day x 53 days = 42400 tons
8) Confirmation Sampling
   * Collected on 75 ft by 75 ft grids in Waste/Burnt Soil Area & human health risk-based removal areas plus 10 perimeter samples
   * Samples analyzed for arsenic (ICP/MS), copper, and lead (ICP)
   * 25% of samples will fail and require an additional 6 inches of excavation & resampling
9) Fill Material
   * Backfill material will come from an offsite borrow source
   * Complete backfill of material removed, restoring original grade
   * General fill will be used below the top 6 inches
   * Top soil will be used for the top 6 inches
   * Additional 25% of excavated material to allow for compaction
   * Material will be delivered at a rate of 1,000 cu yd per day
10) Disposal Characterization
   * 1 sample per 2,000 cu yd
   * Actual frequency of disposal characterization samples will be based on facility
   * $700/sample for TCLP
11) Installation and abandonment of Monitoring Wells
   * 1 monitoring well will be installed
     (the top 3 ft will be double cased to prevent downward migration of contaminants)
   * 2 monitoring wells will be abandoned
   * Well installation and abandonment will be concurrent to minimize cost
   * Well installation and abandonment will be completed in 2 days
12) Equipment and Labor
   * Equipment will consist of a dozer, 2 excavators, a front end loader, an off-road dump, and a screen plant
   * Labor will consist of 5 equipment operators and 2 laborers
   * Schedule is based on 10-hr work days
   * Equipment operators & laborers will be local (no per diem included)
13) Wetland Compensatory Mitigation
   * Because the impact to the wetland for excavation will be temporary, compensatory mitigation will consist of restoring the wetland to its pre-existing state.
   * Seed will be applied to the impacted wetland area at a rate of 15 pounds per acre
     15 * 1.17 = 18 pounds

CAPITAL COSTS

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Work Plan & Closeout Report					
Draft and Final Submissions of Work Plan	1	LUMP	$12,000.00	$12,000	Engineer's Estimate
Draft and Final Submissions of Compensatory Mitigation Plan	1	LUMP	$5,000.00	$5,000	Engineer's Estimate
Draft and Final Submissions of Closeout Report	1	LUMP	$8,000.00	$8,000	Engineer's Estimate
Draft and Final Submissions of O&M Plan	1	LUMP	$5,000.00	$5,000	Engineer's Estimate
SUBTOTAL				$30,000	
Erosion and Sediment Controls					
Installation of Erosion and Sedient Controls	3,100	LF	$1.00	$3,100	Engineer's Estimate
SUBTOTAL				$3,100	
Clearing and Grubbing					
Brush mowing	1.1	ACRE	$536.82	$590	RS Means 02200-200-1080
Cut and chip trees	0.5	ACRE	$3,607.06	$1,804	RS Means 02200-100-0199
SUBTOTAL				$2,394	
Remove Contaminated Soil					
Excavate and load material	42,269	TON	$6.03	$255,066	Engineer's Estimate
Dewatering	1	LUMP	$5,000.00	$5,000	Engineer's Estimate
SUBTOTAL				$260,066	
Excavation Support					
MEC Technician II/III for MEC scanning (4 MEC technicians)	83	DAYS	$3,600.00	$297,206	Engineer's Estimate
MEC Mobilization (4 MEC technicians)	1	DAYS	$7,000.00	$7,000	Engineer's Estimate
MEC Demobilization (4 MEC technicians)	1	DAYS	$7,000.00	$7,000	Engineer's Estimate
Per Diem (4 MEC technicians)	83	DAYS	$472.00	$38,967	DOD Travel Per Diem Allowance, FY2007
SUBTOTAL				$350,173	
Confirmation Sampling					
Laboratory Analysis (Metals - Arsenic)	82	UNIT	$85.00	$6,939	Engineer's Estimate
Laboratory Analysis (Metals - copper, lead, and iron)	82	UNIT	$60.00	$4,898	Engineer's Estimate
SUBTOTAL				$11,837	
Disposal Characterization					
TCLP Analysis	17	UNIT	$700.00	$11,558	Engineer's Estimate
SUBTOTAL				$11,558	
Transportation and Disposal (Nonhazardous Waste)					
Transportation and disposal (local)	42,269	TON	$45.00	$1,902,120	Engineer's Estimate
SUBTOTAL				$1,902,120	
Clean Fill (Haul, Dump, Spread, Compact)					
General Fill	23,948	CU YD	$9.50	$227,505	
Topsoil	9,075	CU YD	$18.50	$167,888	
Placement (Equipment (mobe/demobe) and labor)	33,023	CU YD	$0.64	$21,086	Engineer's Estimate
SUBTOTAL				$416,479	
Monitoring Wells					
Installation	1	EACH	$1,300.00	$1,300	Engineer's Estimate
Abandonment	2	EACH	$1,400.00	$2,800	Engineer's Estimate
mobe/demobe & standby	1	EACH	$4,500.00	$4,500	Engineer's Estimate
Decon (including decon pad)	1	EACH	$1,100.00	$1,100	Engineer's Estimate
IDW drums and handling	1	EACH	$500.00	$500	Engineer's Estimate
Per Diem (2 people)	1.5	EACH	$236.00	$354	DOD Travel Per Diem Allowance, FY2007
SUBTOTAL				$10,554	
Site Restoration					
Wetland seed	18	LB	$39.24	$706	Engineer's Estimate
Wetland seed application	51	MSF	$48.27	$2,460	RS Means 02920-320-4600
Seeding (upland)	412	MSF	$48.27	$19,870	RS Means 02920-320-4600
SUBTOTAL				$23,037	
SUBTOTAL				$3,021,318	
Contingency	15%			$453,198	Engineer's estimate
SUBTOTAL				$3,474,515	
Project Management	5%			$173,726	Source: A Guide to Developing and Documenting Cost Estimates During the Feasibility Study - USEPA/USACE, July 2000
Construction Management	6%			$208,471	
TOTAL CAPITAL COST				**$3,856,712**	

OPERATION AND MAINTENANCE COSTS (2 years)

Wetland Monitoring					
Quarterly Inspections	4	EVENT	$650.00	$2,600	Engineer's Estimate
Water Level Monitoring (weekly)	52	EVENT	$100.00	$5,200	Engineer's Estimate
Quarterly Inspection Reports	4	EVENT	$500.00	$2,000	Engineer's Estimate
SUBTOTAL				$9,800	
Contingency	15%			$1,470	
SUBTOTAL				$11,270	

PRESENT VALUE ANALYSIS

					i =	0.030
					t =	2
Cost Type	**Year**	**Total Cost**	**Total Cost Per Year**	**Discount Factor (3.0%)**	**Present Value**	
Capital	0	$3,856,712	$3,856,712	1.000	$3,856,712	
O&M	1-2	$22,540	$11,270	1.91	$21,565	
					$3,878,277	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$3,878,000**	

*Discount factor established per "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis", OSWER Directive No. 9355.3-20, June 25, 1993.

The costs estimates are provided to an accuracy of +50 percent and -30 percent.

cu yd = cubic yard
cu ft = cubic feet
ft = foot,feet
LF = linear foot
mobe/demobe = mobilization/demobilization
PAH = polycyclic aromatic hydrocarbon
sq ft = square feet
MEC = munitions and explosives of concern

Alternative 4: Excavation and Restoration/Wetlands Creation

Site: Site 5 - Burning Grounds
Location: St. Juliens Creek Annex, Chesapeake, Virginia
Phase: EE/CA
Date: 9-Oct-06

Description: Excavation to visible limits of the Site 5 Waste/Burnt Soil Area and excavation of impacted surface soil and sediment areas to a minimum of 1 ft; restoration as a combination wetland and upland area

CALCULATIONS

Excavated Material	
Impacted Area (2.5 ft excavation)	
Impacted (sq ft)	187308
Thickness of impacted soil (ft)	2.5
Assumed soil weight (tons/cu yd)	1.6
Volume of soil to be excavated (cu yd)	17343
Soil to be excavated (tons)	27749
Human Health Risk-Based Removal Areas (1 ft excavation)	
Area (sq ft)	135036
Depth (ft)	1
Assumed soil weight (tons/cu yd)	1.6
In-Place Volume of soil to be excavated (cu yd)	5001
Soil to be excavated (tons)	8002
Ecological Risk-Based Removal Areas (1 ft excavation)	
Area (sq ft)	69696
Depth (ft)	1
Assumed soil weight (tons/cu yd)	1.6
In-Place Volume of soil to be excavated (cu yd)	2581
Soil to be excavated (tons)	4130
Additional excavation based on failed confirmation samples	
Area requiring additional excavation (sq ft)	80586
Thickness of additional excavation (ft)	0.5
Assumed soil weight (tons/cu yd)	1.6
Volume of soil to be excavated (cu yd)	1492
Soil to be excavated (tons)	2388
Total for disposal (tons)	**42269**

Excavation Cost		
Equipment (all from Means, except mobe/demobe for screen - eng. est.)		
Dozer - weekly rate	$	1,770
Excavator - weekly rate	$	1,030
Front End Loader - weekly rate	$	835
Excavator - weekly rate	$	1,030
Screen Plant - weekly rate	$	1,390
Off-road Dump - weekly rate	$	2,495
Mobe & Demobe (dozers, excavator, loader)	$	1,656
Mobe & Demobe (dump)	$	610
Mobe & Demobe (screen)	$	1,000
Labor (engineer's estimate)		
Equipment Operators - hourly rate	$	22
Equipment Operators - number	$	12
Laborers - hourly rate		5
Laborers - number		2
Schedule		
Production Rate (cu yd screened per day)		400
Duration of excavation activity (weeks)		17
Duration of excavation activity (days)		83
Cost		
Equipment	$	144,439
Labor	$	110,627
	$	255,066
Cost per ton	$	6.03

Fill Cost		
Material		
Topsoil (cu yd)		9075
Equipment (all from Means, except mobe/demobe for screen - eng. est.)		
Dozer - weekly rate		1770
Mobe & Demobe (dozers, excavator, loader)		414
Labor (engineer's estimate)		
Equipment Operators - hourly rate	$	22.00
Laborers - hourly rate	$	12.00
Equipment Operators - Number		1
Laborers - number		1
Schedule		
Production Rate (cu yd fill per day)		800
Duration of fill activity (weeks)		2
Duration of fill activity (days)		11
Cost		
Equipment	$	4,430
Labor	$	3,086
	$	7,515
Cost per yard	$	0.83

Restoration Cost	
Rate of application (pounds per acre)	15
Emergent Wetland Area (acre)	1.26
Transitional Area 1 - Emergent and Shrub wetland (acre)	0.90
Transitional Area 2 - Shrub/Treed Wetland & Upland (acre)	1.36
Upland Area (acre)	5.80
Asphalt Replacement	0.13

ASSUMPTIONS

1) Clearing
   * Shrubs and trees will be removed
   * Vegetation will be mowed
2) MEC Support
   * 2 MEC technicians will be present during intrusive activities and screening of material
   * Work will take place in September through March
   lodging, meals, and incidental = $118 per day per person
3) Erosion and Sediment Controls
   * Perimeter controls @ $1 per foot around the 3,100 foot perimeter are assumed.
4) Excavation
   * Depth of waste and burnt soil is 2.5 feet
   * Depth of impacted soil and sediment areas is 1 ft
   * Excavated materials disposed at offsite landfill as non-hazardous waste
   * Landfill located within 50 miles of site
5) Excavation Dewatering
   * Material excavated from within the wetland area will require dewatering
   * Wetland area is 17,100 SF
   * A dewatering pad will be constructed
   * No dewatering agents will be required
   * Water from dewatering will be released on site
6) Mechanical screening of excavated material
   * All excavated material will require mechanical screening prior to disposal
   * Excavation rate will be limited by screening; screening will be at a rate of 400 cu yd per day
   * Amount screened is 25% more than in-place excavation volume
7) Removal of Excavated Soil
   * 20 trucks/day at 20 tons of soil /truck x 2 trips/day x 53 days = 42,400 tons
8) Confirmation Sampling
   * Collected on 75 foot by 75 foot grids in Waste/Burnt Soil Area & human health risk-based removal areas plus 10 perimeter samples
   * Samples analyzed for arsenic (ICP/MS), copper, and lead (ICP)
   * 25% of samples will fail and require an additional 6 inches of excavation & resampling
9) Fill Material
   * Backfill material will come from an offsite borrow source
   * Complete backfill of material removed, restoring original grade
   * General fill will be used below the top 6 inches
   * Top soil will be used for the top 6 inches
   * Additional 25% of excavated material to allow for compaction
   * Material will be delivered at a rate of 1,000 cu yd per day
10) Disposal Characterization
   * 1 sample per 2,000 cu yd
   * Actual frequency of disposal characterization samples will be based on facility
   * $700/sample for TCLP
11) Wetland Creation
   * Seed cost is based on a floodplain wildlife mix
   * 15 pounds of seed per acre
   * Seed will be applied by broadcast
   * Shrubs and trees cost the same: $10 each
   * Transitional Area 2 will be 50% trees and 50% shrubs
   * Invasive species control will be required for 25% of the emergent area and emergent/shrub transitional area
12) Installation and abandonment of Monitoring Wells
   * 1 monitoring well will be installed
   (the top 3 ft will be double cased to prevent downward migration of contaminants)
   * 2 monitoring wells will be abandoned
   * Well installation and abandonment will be concurrent to minimize cost
   * Well installation and abandonment will be completed in 2 days
13) Equipment and labor
   * Equipment will consist of a dozer, 2 excavators, a front end loader, an off-road dump, and a screen plant for the excavation and a dozer for the topsoil placement
   * Labor will consist of 5 equipment operators and 2 laborers for the excavation and 1 equipment operator and 1 laborer for the topsoil placement
   * Schedule is based on 10-hr work days
   * Equipment operators & laborers will be local (no per diem included)

CAPITAL COSTS

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Work Plan & Closeout Report					
Draft and Final Submissions of Work Plan	1	LUMP	$12,000.00	$12,000	Engineer's Estimate
Draft and Final Submissions of Compensatory Mitigation Plan	1	LUMP	$5,000.00	$5,000	Engineer's Estimate
Draft and Final Submissions of Closeout Report	1	LUMP	$8,000.00	$8,000	Engineer's Estimate
Draft and Final Submissions of O&M Plan	1	LUMP	$5,000.00	$5,000	Engineer's Estimate
				$30,000	
Erosion and Sediment Controls					
Installation of Erosion and Sedient Controls	3,100	LF	$1.00	$3,100	Engineer's Estimate
SUBTOTAL				$3,100	
Clearing and Grubbing					
Brush mowing	1.1	ACRE	$536.82	$590	RS Means 02200-200-1080
Cut and chip trees	0.5	ACRE	$1,803.53	$902	RS Means 02200-100-0199
SUBTOTAL				$1,492	
Remove Contaminated Soil					
Excavate and load material	42,269	TON	$6.03	$255,066	Engineer's Estimate
Dewatering	1	LUMP	$5,000.00	$5,000	Engineer's Estimate
SUBTOTAL				$260,066	
Excavation Support					
MEC Technician II/III for MEC scanning (4 MEC technicians)	83	DAYS	$3,600.00	$297,206	Engineer's Estimate
MEC Mobilization (4 MEC technicians)	1	DAYS	$7,000.00	$7,000	Engineer's Estimate
MEC Demobilization (4 MEC technicians)	1	DAYS	$7,000.00	$7,000	Engineer's Estimate
Per Diem (4 MEC technicians)	83	DAYS	$472.00	$38,967	DOD Travel Per Diem Allowance, FY2007
SUBTOTAL				$350,173	
Confirmation Sampling					
Laboratory Analysis (Metals - Arsenic)	82	UNIT	$85.00	$6,939	Engineer's Estimate
Laboratory Analysis (Metals - copper and lead)	82	UNIT	$60.00	$4,898	Engineer's Estimate
SUBTOTAL				$11,837	
Disposal Characterization					
TCLP Analysis	17	UNIT	$700.00	$11,558	Engineer's Estimate
SUBTOTAL				$11,558	
Transportation and Disposal (Nonhazardous Waste)					
Transportation and disposal (local)	42,269	TON	$45.00	$1,902,120	Engineer's Estimate
SUBTOTAL				$1,902,120	
Clean Fill (Haul, Dump, Spread, Compact)					
Topsoil	9,075	CU YD	$18.50	$167,888	
Equipment (mobe/demobe) and labor	9,075	CU YD	$0.83	$7,515	Engineer's Estimate
SUBTOTAL				$175,403	
Monitoring Wells					
Installation	1	EACH	$1,300.00	$1,300	Engineer's Estimate
Abandonment	2	EACH	$1,400.00	$2,800	Engineer's Estimate
mobe/demobe & standby	1	EACH	$4,500.00	$4,500	Engineer's Estimate
Decon (including decon pad)	1	EACH	$1,100.00	$1,100	Engineer's Estimate
IDW drums and handling	1	EACH	$500.00	$500	Engineer's Estimate
Per Diem (2 people)	1	EACH	$430.00	$430	DOD Travel Per Diem Allowance, FY2007
SUBTOTAL				$10,630	
Site Restoration					
Upland Hydroseeding (including seed - native grass and wildflower)	312	MSF	$48.27	$15,049	RS Means 02920-320-4600
Wetland Seed (wetland area and transitional area)	32	LB	$39.24	$1,271	Engineer's Estimate
Wetland Seed Application (wetland area and transitional area)	94	MSF	$48.27	$4,542	RS Means 02920-320-4600
Shrubs (material and installation)	688	UNIT	$10.00	$6,882	Engineer's Estimate
Trees (material and installation)	296	UNIT	$10.00	$2,962	Engineer's Estimate
Asphalt	5,663	SF	$1.85	$10,453	RS Means 02740-315-0020
Culvert Installation	40	LF	$14.04	$561	RS Means 02600-520-1060
SUBTOTAL				$41,721	
SUBTOTAL				$2,798,100	
Contingency	15%			$419,715	Engineer's estimate
SUBTOTAL				$3,217,815	
Project Management	5%			$160,891	Source: A Guide to Developing and Documenting Cost Estimates During the Feasibility Study - USEPA/USACE, July 2000
Construction Management	6%			$193,069	
TOTAL CAPITAL COST				**$3,571,775**	

OPERATION AND MAINTENANCE COSTS (2 years)

Wetland Monitoring					
Quarterly Inspections	4	EVENT	$650.00	$2,600	Engineer's Estimate
Water Level Monitoring (weekly)	52	EVENT	$100.00	$5,200	Engineer's Estimate
Quarterly Inspection Reports	4	EVENT	$500.00	$2,000	Engineer's Estimate
SUBTOTAL				$9,800	
Contingency	15%			$1,470	
SUBTOTAL				$11,270	

PRESENT VALUE ANALYSIS

i = 0.030
t = 2

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (3.0%)	Present Value
Capital	0	$3,571,775	$3,571,775	1.000	$3,571,775
O&M	1-2	$22,540	$11,270	1.91	$21,565
					$3,593,339
TOTAL PRESENT VALUE OF ALTERNATIVE					**$3,593,000**

*Discount factor established per "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis", OSWER Directive No. 9355.3-20, June 25, 1993.

The costs estimates are provided to an accuracy of +50 percent and -30 percent.

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