EPA/ROD/R03-98/065
1998

EPA Superfund
Record of Decision:

LANGLEY AIR FORCE BASE/NASA LANGLEY RESEARCH CENTER
EPA ID: VA2800005033
OU 03
HAMPTON, VA
09/30/1998

EPA 541-R98-065
<IMG SRC 980650>

RECORD OF DECISION

NASA LANGLEY RESEARCH CENTER

TABBS CREEK OU

September 1998

RECORD OF DECISION
NASA LANGLEY RESEARCH CENTER

DECLARATION

SITE NAME AND LOCATION

NASA Langley Research Center (NASA LaRC)
Tabbs Creek Operable Unit
Hampton, Virginia

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedial action for the Tabbs Creek Operable Unit (OU) at the NASA Langley Research Center (LaRC) in Hampton, Virginia (the "Site"), chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, 42 U.S.C. º9601 et seq. and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300. This decision is based on the Administrative Record for this Site.

The Virginia Department of Environmental Quality (VDEQ) concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this OU, if not addressed by implementing the response actions selected in this ROD, may present an imminent and substantial endangerment to public health, welfare or the environment.

DESCRIPTION OF SELECTED REMEDY

The Tabbs Creek OU cleanup is part of a comprehensive environmental investigation and cleanup currently being performed at the NASA LaRC under the CERCLA program. NASA LaRC is currently addressing five OUs under its environmental remediation program. The remaining four OUs will be addressed in other RODs.

This action addresses the principle threat at the OU by dredging and disposing contaminated sediment.

The selected remedy is dredging and off-site disposal of contaminated sediments and includes:

- Dredging of the contaminated sediment from the creek and adjacent marsh areas;
- Dewatering of the sediment;
- Treating and discharging dredging water;

Transporting and disposing of the sediment off-site in a Toxic Substances Control Act (TSCA)-approved chemical waste landfill;
Backfilling the dredged sediment/marsh areas;
Restoring the wetland vegetation;
Annual biota monitoring;
Restrictions on biota harvesting for five years;

DECLARATION OF STATUTORY DETERMINATION

The selected remedy is protective of human health and the environment, complies with federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. The remedy utilizes permanent solutions and alternative treatment technologies, to the maximum extent practicable. However, because treatment of the principle threats of the site was not found to be practicable, this remedy does not satisfy the statutory preference for treatment as a principal element. The technologies chosen are proven reliable and cost effective.

Because this remedy will not leave hazardous substances on-site above health-based levels, a long-term monitoring and five year review of the remedial action will not be necessary. However, annual biota monitoring for five years will be conducted to determine the effectiveness of the selected remedy. Should this sampling show that the selected remedy is not protective of human health and the environment, additional action will be undertaken in full consideration with the public.

<IMG SRC 98065A>

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RECORD OF DECISION

NASA LANGLEY RESEARCH CENTER
TABBS CREEK OPERABLE UNIT

DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

NASA LaRC is a 787-acre NASA research center located in southeastern Virginia in the Hampton Roads area. NASA LaRC is bounded by State Route 172 on the West, by Brick Kiln Creek to the North and by Langley Air Force Base to the South and East (Figure 1, Appendix A). NASA LaRC together with Langley Air Force Base was proposed for listing on the National Priorities List (NPL) in 1993; NPL listing was finalized in 1994.

Tabbs Creek is a meandering creek flowing east-northeast into the northwest branch of the Back River and has marsh 400-2,000 yards wide; thick brush and trees along its perimeter. Four storm sewers discharge to the upstream portion of the creek from NASA's West Facility. The Tabbs, Creek drainage area includes part of NASA and Langley Air Force Base, and approximately 20 tributaries drain into the creek. The creek has a 2-3 foot tidal variation under normal conditions and the surface of the creek is approximately 5 feet above mean sea level. The water quality in the creek varies, but is generally brackish.

Sediments in the creek consist of fine-grained silts and clays mixed with organic mater. Complex erosion and deposition patterns exist due to the combination of stream flow, ebbing and rising tides, surface runoff and discharges, and groundwater movement.

The majority of the marsh is relatively undisturbed and provides exceptional habitat for a variety of wildlife. This includes forage and/or roosting habits for numerous species of waterfowl. The banks of Tabbs Creek are not fenced; however, because of its location and extent of accumulated marshland, access by land is difficult. The lower half of the creek is accessible by boat. Access to the upper half of the creek is obstructed due to a water pipe crossing the creek. Figure 1B (Appendix A) depicts the major features of the creek and its surrounding areas.

The site is located within the Atlantic Coastal Plain physiographic province. The geology of the area, primarily flat lying marine sediments, consists of the Norfolk Formation and the Yorktown Formation. The uppermost soil unit at the site consists of varying sequences of silt, clay, and silty to clayey sands belonging to the Norfolk Formation. In the boring drilled for the Site Inspection, this unit occurs from 0 to 9 feet in depth and consists of brown, mottled orange and gray soils. They are typically dry to moist and slightly to moderately plastic. The underlying Yorktown Formation consists of gray silty clay and clayey silt with abundant shells and shell fragments. It is typically wet to saturated, moderately to highly plastic and occasionally mottled. Local sand tenses are common, as are partially hardened shelly layers (coquina). The Yorktown Formation extends to approximately 400 feet below grade at the site.

II. SITE HISTORY

This section describes the history of waste disposal, and CERCLA, investigations response actions at the Site.

A. HISTORY OF WASTE DISPOSAL

The primary function of NASA LaRC is research and development of advanced technologies for aircraft and spacecraft. Specific studies center on instrumentation, materials fatigue, acoustics, aerodynamics, and guidance control. In conducting its research and development mission, NASA LaRC requires many support facilities including Underground Storage Tanks (USTs) for fuel and other raw products, power plants, wind tunnels, laboratories and administrative buildings. All of these facilities have the potential to impact the environment through disposal activities, material(s) transportation and inadvertent releases such as spills or mechanical malfunctions.

There are currently 5 Operable Units being investigated under CERCLA at NASA LaRC. They include: the Construction Debris Landflll, the Chemical Waste Pit, Area E Warehouse, Stratton Substation and Tabbs Creek. A brief summary of these areas is provided on Table 1. Figure 1C (Appendix A) provides the location of these areas. The 4 other Operable Units will be addressed in separate Records of Decision.

Table 1. Summary of Operable Units Under CERCLA Investigations

OU Name	Findings	Current Status
Construction Debris Landfill	Organic and inorganic contaminants found in groundwater, surface water, sediment, and soil.	Draft Remedial Investigation/Feasibility Study (RI/FS) under regulatory review
Chemical Waste Pit	Chemical wastes reportedly buried at the site.	Chemical Waste Pit was found to be located within the boundaries of the Construction Debris Landfill (CDL) OU and is addressed in the CDL RI/FS.
Area E warehouse	Low levels of Polychlorinated Biphenyls (PCBs) and metals contaminated soils.	Record of Decision to be signed by the end of FY98. Remedy is the implementation of institutional controls (land use restrictions).
Stratton Substation	PCB contaminated soil.	Draft Final Focused RI/FS currently under regulatory review.

PCBs and Polychlorinated Terphenyls (PCTs) were inadvertently discharged into several NASA LaRC storm sewers and eventually deposited in Tabbs Creek. The contamination in the storm sewers and contamination source have been cleaned up pursuant to Federal Facilities Compliance Agreement (FFCA) Docket No. III-FF-CWA-003.

B. CERCLA INVESTIGATIONS

NASA completed CERCLA, Preliminary Assessment (PA) and Site Inspection (SI) Reports in 1988 and 1989, respectively. In 1993, NASA LaRC, together with Langley Air Force Base (LAFB), was proposed for inclusion on the National Priorities List (NPL) and included on the NPL in 1994. A Federal Facilities Agreement (FFA) was signed by EPA, NASA and the Virginia Department of Environmental Quality (VDEQ) in 1994. The FFA establishes a procedural framework and schedule for implementing site cleanups at NASA LaRC (the Site).

In 1982, Water and Air Research, under contract to the U.S. Air Force Occupational and Environmental Health Lab, collected groundwater, surface water, and sediment samples to study the effects of several local landfills adjacent to Tabbs Creek (U.S. Air Force, 1982). Results indicated that the landfills had discharged pollutants to the creek. However, at that time no significant contamination of the creek existed and periodic water sampling was recommended.

Oyster samples were collected and analyzed for PCBs and PCTs in 1988 as part of a study conducted by Robert C. Hale, College of William and Mary/Virginia Institute of Marine Sciences (VIMS) (Hale, 1990a). Samples collected at the bridge crossing Tabbs Creek contained elevated levels of PCBs and PCTs relative to other samples obtained from the Back River vicinity. By studying the distribution of PCT in sediment and its bioavailability to aquatic organisms, Hale indicated that the sediment contained elevated levels of PCTs throughout the creek (Hale, 1990b).

In 1989, Bionetics Analytical Laboratory, under contract with NASA, reported that sediment samples were contaminated with PCBs and PCTs in Tabbs Creek (NASA, 1990). The results indicated a general decrease in concentrations progressing downstream; however, levels were still elevated compared to the background sample at the Back River.

In 1991, the Preliminary Site Characterization was completed by Foster Wheeler Environmental, formerly Ebasco, as the initial phase of Remedial Investigation (RI) (Ebasco, 1991). Contaminants of concern (COCs) identified included pesticides, PCBs, PCTs, volatiles, semivolatiles, and several Target Analyte List (TAL) metals. PCB and PCT levels appeared to be below levels found in previous investigations.

An engineering assessment of the Storm Sewers at NASA LaRC was completed by Foster Wheeler Environmental in 1992 (Ebasco, 1993). Data indicated that manholes and catch basins were contaminated with PCBs and PCTs. The portion of storm sewer that drains through Outfall 009 into Tabbs Creek was determined to be the source of PCB/PCT contamination of Tabbs Creek. The West Area storm sewer has since been cleaned up to eliminate the source of contamination.

Kathryn Gallagher of the College of William and Mary/VIMS conducted an investigation to determine the levels of PCTs in aquatic organisms in Tabbs Creek (Gallagher, 1992). Results indicated the species contained PCTs and their concentrations generally decreased with distance downstream.

A Remedial Investigation (RI) was performed by Foster Wheeler Environmental in 1991 and 1992 (Foster Wheeler Environmental, 1998). The investigation consisted of sampling and analysis of surface water, sediment, and biota samples for both organic and inorganic contamination. The results were used to conduct human health and ecological risk assessments. The results indicated that concentrations up to 760 parts per million (ppm) of PCBs and PCTs were found in sediment samples from the creek, with PCTs dominating in concentrations and sampling locations. The contamination was primarily confined to the area of the creek bed and the highest levels were found in the upper estuary near Stotm Sewer Outfall 009.

Based on the results of the remedial investigation and risk assessments, a Feasibility Study (FS) was conducted by Foster Wheeler Environmental for Tabbs Creek site from 1992 to 1996 (Foster Wheeler Environmental, 1998).

III. HIGHLIGHTS OF COMMUMITY PARTICIPATION

In accordance with Sections 113 and 117 of CERCLA, 42 U.S.C. Sections 9613 and 9617, NASA, in conjunction with EPA, issued a Proposed. Plan on August 31, 1998, presenting the preferred remedial alternative for the Tabbs Creek OU. The Proposed Plan and the supporting documentation became available for review at that time and are among the documents which comprise the CERCLA Administrative Record for NASA LaRC.

The Administrative Record is and has been available for review by the public at the following information repositories:

Poquoson Public Library 800 City Hall Avenue Poquoson, Virginia	Floyd L. Thompson Library NASA LaRC Hampton, Virginia

An announcement for an availability session, the comment period, and the availability of the Administrative Record for the remedy for the Tabbs Creek OU was published in the Daily Press on August 28 and 30, 1998, the Poquoson Post on September 2 and 9, 1998, and the Yorktown Crier on September 2 and 9, 1998. The public comment period for the Proposed Plan was from August 28, 1998 to September 26, 1998. A public availability session was held at the Virginia Air and Space museum in Hampton, Virginia on September 14, 1998, to inform the public of all the remedial alternatives and to seek public comments. At this meeting, representatives from NASA, USEPA, VDEQ, Foster Wheeler (an environmental consultant) were available to answer questions about conditions at the site and the remedial alternatives under consideration. Responses to the comments received during this period are included in the Responsiveness Summary section of this ROD.

All documents considered or relied upon in reaching the remedy selection decision contained in this ROD are included in the Administrative Record for the Site and can be reviewed at the information repositories.

IV. SCOPE AND ROLE OF THIS REMEDIAL ACTION

Discrete portions of an NPL site are often managed more effectively as Operable Units (OU). NASA has organized work to date into five operable units. This ROD for the Tabbs Creek OU addresses PCB and PCT contaminated sediment. The other Operable Units are:

- Construction Debris Landfill
- Chemical Waste Pit
- Area E Warehouse
- Stratton Substation

These four other Operable Units are undergoing independent CERCLA investigations and will be addressed in separate Records of Decision.

V. SUMMARY OF SITE CHARACTERISTICS AND EXTENT OF CONTAMINATION

Summarized below am the relevant findings of the work to date with regard to contaminated soil located within the boundaries of the NASA LaRC including the Tabbs Creek OU.

A. SITE CHARACTERISTICS

1. Ecology

Open land, woodland, wetland and aquatic habitats are all found within or near NASA LaRC. These include mowed fields and lawns, nonforested overgrown land, wooded areas, forested wetlands, scrub/shrub wetlands, creeks, tributaries and streams.

2. Soils

Soil at the Tabbs Creek OU has generally been graded and/or filled to support buildings and road surfaces. Coarse sand and gravel is found within the upper two feet of the ground surface. Grass covered areas were graded with topsoil and some subsurface soil samples encountered the Norfolk Formation.

3. Groundwater Use

Groundwater in the area can be found at a depth of 5 to 50 feet below the land surface. This aquifer, known as the Columbia aquifer, is brackish and its use is limited to lawn and garden watering. It is currently not used or usable as a source of potable water. Both the Yorktown and the Yorktown-Eastover aquifers underlie the Columbia aquifer. The Yorktown-Eastover aquifer is confined and is used at other locations as a source of domestic potable water, Groundwater is not being addressed as part of this remedial action.

B. NATURE AND EXTENT OF CONTAMINATION

The following is a summary of the sampling results of the Remedial Investigation.

Surface Water

PCBs and PCTs were not detected in the surface water samples. Only low levels of several organic contaminants were detected in a few surface water samples. These include methylene chloride (7 ppb), acetone (1100 ppb), chloroform (9.3 ppb), trichloroethane (71 ppb), 1,1-dichloroethane (10 ppb), 1,1-dichloroethene (4.7 ppb), bromodichloromethanbe (3 ppb).

Inorganic contaminants were found in all surface water samples. The maximum concentrations of arsenic (194 ppb), copper (643 ppb), lead (16.1 ppb), silver (8-6 ppb), zinc (316 ppb), and cyanide (10.9 ppb) in the unfiltered samples exceeded either EPA's Ambient Water Quality Criteria (AWQC) or Virginia standards for surface waters. Results of filtered samples indicated that only arsenic (162 ppb) exceeded the Virginia standards in more than one sample. Copper (20.5 ppb) and nickel (9.7 ppb) had one exceedance at Outfall 009. Note that arsenic concentrations were randomly distributed throughout the creek and the background stations, indicating that LaRC may not be a source of arsenic in surface water.

Sediment

Up to 760 ppm of PCBs and PCTs were detected with the highest concentrations in the upper estuary near the Storm Sewer Outfall 009. PCT concentration levels were generally greater than PCB levels and found more frequently at sampling locations. Figures 2A and 2B (Appendix A) show the investigation results.

Pesticides, including DDD, DDE, DDT, dieldrin, endosulfan II, endosulfur sulfate and methoxychlor, were detected at low concentrations in 8 of 70 samples. Maximum levels of these include DDD at 96 ppb, DDE at 160 ppb, DDT at 60 ppb, dieldrin at 45 ppb, endosulfan II at 13 ppb, endosulfan sulfate at 900 ppb and methoxychlor at 32 ppb. No spatial pattern was evident, indicating that the contamination was not related to any direct or point source discharge.

Polynuclear aromatic hydrocarbons (PAHs) were detected in seven of 68 sediment samples with concentrations of total PAHs greater than 10 ppm. Four samples showed total PAHs between 5 and 10 ppm. Contaminant levels were higher in the upper estuary and at the Storm Sewer outfalls.

The arsenic concentrations at the outfalls and in the creek were generally higher than the background samples. However, all levels were within the natural background ranges of U.S. clays and soils (Dragun, 1988). Chromium copper, lead, mercury, silver, and zinc occurred in concentrations exceeding the natural background ranges of U.S. clays and soils, usually in the upper portion of the estuary. Source(s) of these metals can not be positively identified. It is suspected that the landfills along Tabbs Creek may have contributed to the metal contamination.

Several dioxin or furan isomers were detected at Outfall 008 at concentrations higher than the background levels. The concentrations of octachlorodibenzodioxin (OCDD) (115 ppb) and total heptachlorodibenzo p-dioxin (HpCDD) (28 ppb) were significantly greater than that of the maximum local background levels of 1.6 ppb (estimated) and 0.3 ppb, respectively. The sample from Outfall 008 also contained tetrachlorodibenzodioxin (2,3,7,8-TCDD) at an extremely low concentration (0.02 ppb). PCBs and PCTs were not detected in samples taken from Outfall 008.

Sediment Toxicity Characteristic Leaching Procedure (TCLP) results revealed no leachate samples with contaminant concentrations albove the maximum toxicity characteristic levels.

Biota

Biota samples, including saltmarsh cordgrass, shrimp, mussel, blue crabs, fish, fish fillet, and snapping turtle, were collected and analyzed. PCBs and/or PCTs were detected in saltmarsh cordgrass, mussel, blue crabs, fish, and fish fillet, with concentrations decreasing from Outfall 009 toward the background station. Pesticides, including chlordane, dieldrin, 4,4'-DDD, and 4,4'-DDE, and metals were detected in some of the biota samples; however, there were no obvious pattern distributions observed. Figures 3A, 3B, 3C, and 3D (Appendix A) depict the sampling results.

VI. SUMMARY OF SITE RISKS

A risk assessment was conducted as part of the RI in accordance with the latest EPA policy on Risk Assessments (USEPA, 1989). The results are summarized below.

Human Health Risk Assessment

Health risks are based on a conservative estimate of the potential carcinogenic risk or potential to cause other health effects not related to cancer. Carcinogenic risks and noncarcinogenic risks were evaluated as part of the risk assessment; three factors were considered:

1. nature and extent of contaminants at the OU,
2. the pathways through which human health and ecological receptors are or may be exposed to those contaminants at the OU, and
3. potential toxic effects of those contaminants.

Cancer risks are expressed as a number reflecting the increased chance that a person will develop cancer, if he/she is directly exposed to the contaminants found in the groundwater, surface water, soil and sediment at the OU for 30 years. For example, EPA's acceptable risk range for cancer is 1 x 10 -4 to 1 x 10 -6, meaning there is one additional chance in ten thousand (1 x 10 -4) to one additional chance in one million (1 x 10 -6) that a person will develop cancer if exposed to a hazardous waste site. The risk associated with developing other health effects is expressed as a hazard index. A hazard index of one or less means that a person exposed to a hazardous waste site is unlikely to experience adverse health effects. A hazard index is also used to evaluate ecological risks.

The Risk Assessment in the Tabbs Creek Site RI Report (Foster Wheeler, 1998) identified a number of potential exposure pathways for facility workers and local residents as follows:

1. Dermal contact with and inadvertent ingestion of sediment in Tabbs Creek and the marsh;

2. Dermal contact with surface water;

3. Inhalation of particulates and contaminants volatilized from sediment and surface water, and

4. Consumption of oysters, crabs, and fish from Tabbs Creek and the adjacent marsh areas.

The receptors considered as part of the Reasonable Maximum Exposure (RME) Risk Assessment are as follows: future youth trespassers; sewer maintenance workers; crab and oyster harvesters; hunters; adult crab, fish, and oyster consumers and youth crab, fish, and oyster consumers. Exposure parameters used for the Tabbs Creek RME Risk Assessment were largely based on EPA Region III guidance, EPA Standard Default Exposure Factors Guidance, EPA's Risk Assessment Guidance for Superfund, which is often referred to as RAGS, and EPA's Dermal Exposure Assessment manual.

Table 2 (Appendix B) summarizes the results of RME risk calculations for various exposure scenario cases. Based on the results of the risk calculations, cancer risks from exposure to contaminated sediment and consumption of contaminated biota exceeded EPA's target range. The contaminants of concern (COCs) which were responsible for most of the risk include PCTs (for all pathways), PCBs (fish consumption) and dieldrin (crab consumption). For noncarcinogenic risk, only oyster and crab consumption pathways slightly exceeded the hazard index of 1. The principal agents driving the noncancer risks for oyster consumers was zinc; for crab consumers were dieldrin, silver, copper and bis(2-ethylhexyl)phthalate.

For all the pathways, biota ingestion dominated the total multipathway risks and hazard indices for all of the populations. The COCs which were responsible for most of the risk are the PCT Aroclor 5432 and the PCB Aroclor 1248.

The lifetime cancer risks and hazard indices for the non-carcinogenic effects associated with human contact with contaminated sediment and biota, is presented in Table 2 (Appendix B).

Ecological Risk Assessment

A risk characterization was conducted to address the following Ecological Risk Assessment endpoints of concern for the Tabbs Creek system: (1) reductions in species diversity and/or abundance; (2) acute (lethal) and/or chronic (sub-lethal) toxicities of site-related contaminants to biota; and (3) bioaccurnuiation of site-related contaminants and consequent trophic transfers which may occur. PCBs and PCTs were selected ecological COCs for the ecological risk assessment because of their concentrations in the sediment.

Based on the results of the benthic invertebrate surveys, there do not appear to be any statistically significant differences in species diversity (richness) or abundance between the sample and background stations. In addition, laboratory sediment bioassays conducted on Tabbs Creek sediments using Ampelisca abdita (a common estuarine amphipod) and Nereis virens (a polychaete worm) demonstrated no statistically significant differences in survival between the sample and background stations. This indicates that concentrations of PCTs (and other ecological COCs) in Tabbs Creek sediments are not acutely toxic (lethal) to the benthic community.

Although a limited number of metals, PAHs, and pesticides were detected in sediment and biota samples, and may be causing chronic stresses to aquatic/wetlands organisms, the most significant ecological COCs are PCBs (Aroclor 1260) and PCTs (Aroclor 5432) because their concentrations in sediment are well over an order-of-magnitude higher than those for other COCs. Therefore the Ecological Risk Assessment focused primarily on potential impacts of PCBs and PCTs mid sediment cleanup goals were derived based on these compounds. The results of the bioaccumulation analyses and probabilistic food chain model indicated that direct uptake of PCBs, and potentially PCTs, from sediments and subsequent trophic transfers are occurring in Tabbs Creek.

C. CONCLUSIONS

The remedial action objectivcs are to protect human health and the environment. Based on available information, and standards such as applicable or relevant and appropriate requirements of federal and state law (ARARs), and risk-based levels established in the risk assessments, the remedial action objectives for the Tabbs Creek Site are presented for surface water and sediment. As indicated in the human health and ecological risk assessments, PCBs and PCTs in sediment are the primary site contaminants that posed the most risk to human health and the environment.

Surface Water

PCBs and PCTs were not detected in surface water. Although several metals, arsenic, copper, and nickel were detected at concentrations exceeding the AWQC or Virginia Water Quality Standards in surface water samples, including samples from the background locations, both the Human Health and Ecological Risk Assessments concluded that the contaminants in surface water did not pose significant risks to human health and the environment. Therefore, no remedial action for surface water is required.

Sediment

The Human Health Risk Assessment concluded that direct exposure to contaminated sediment would pose a cancer risk slightly exceeding the EPA's acceptable risk range of 10^{-6} to 10^{-4}. However, the consumption of PCB- and PCT-contaminated biota would pose risks higher than 10^{-4} and, in the case of crab ingestion, higher than 10^{-3}. The ecological assessment indicated that PCTs may have caused chronic stress to aquatic organisms. In view of the results from the human health and ecological assessment, the remedial action objective for the sediment would be to remediate PCBs and PCTs in sediment to a level that is protective of human health and the environment. A cleanup level of 5 ppm of total concentration of PCBs and PCTs is recommended for the Tabbs Creek site based on the protection of the ecological receptors, including human beings. The reasons for selecting the 5 ppm cleanup level include:

(1) Based on the food chain model, the 5 ppm cleanup level provides the most conservative approach to protect human health and the environment;

(2) The 5 ppm cleanup level would remove almost all hot spots of contamination yet disturb only a relatively small area (1.4 acres) of the total creek which is comprised of approximately 60

acres; and

(3) When compared to a less conservative cleanup level (e.g., 10 ppm), the dredging area is increased only to 1.4 acre from 0.7 acre for the cleanup level of 10 ppm. This dredging area is small as compared to approximately 60 acres of creek.

The recommended cleanup level is based on the assumption that PCBs and PCTs would have similar toxic effects because of their similarity in molecular structure. This approach is considered conservative because there is no toxicity data for PCTs and PCTs are currently not regulated. Once the cleanup level in sediment is achieved, chronic stress to biota would be reduced. Because the other potential contaminants including DDT. PAHs and organics were generally found within the recommended cleanup area, it is assumed that when the PCB and PCT contaminated sediment is removed, these other contaminants will also be removed.

Contaminated Sediment Areas and Volumes

Using the 5 ppm cleanup level established, the total contaminated sediment area was estimated to be 1.4 acres. The total contaminated sediment volume was estimated at approximately 4,300 cubic yards. Figure 4 (Appendix A) depicts the areas with total PCB and PCT concentrations exceeding the cleanup level. Table 2 (Appendix B) summarizes the calculations and the assumptions used for the calculations. Note that the assumptions used are believed to be conservative and the final cleanup volume and area may be different from the estimate. Areas and volume of sediment to be dredged will be further refined during the design and remediation phase of the project.

Most of the contamination is located near Outfall 009 (see Figures 2A and 2B, Appendix A) and its downgradient area. In the areas of Outfall 009, point bars (sampling areas) 5, 6, 7, 9, 10, 11, 12, and 13, and sample points T5MC, T6MC, and P14MCP13, PCB and PCT contamination is from the surface to deeper levels (approximately 4 feet), and exceeds the cleanup level. These areas contain the majority of the contamination (hot spots) and pose the greatest risk to biota because the contamination is at the surface.

At sample locations P14MC, P16MCP15, SSP18-10, P19L3, and P22L4/SSP22-5 contamination is isolated and slightly exceeds the cleanup level. Remediation of these five areas, i.e., dredge the top 6" to 4' of sediment, would be considered during the remedial design/action phase based on field conditions, such as, ease of access and potential harm to the environment from the construction activities.

VII. DESCRIPTION OF ALTERNATIVES

The sediment remediation technologies were identified and screened using effectiveness and implementability as the criteria. The screening process is described in Table 3 (Appendix B). Table 4 (Appendix 3) summarizes the process options that were retained to form alternatives, with two process options (dewatering and process water treatment) retained as support technologies. Using these retained process options, three alternatives: 1) no-action, 2) dredging/off-site incineration; and 3) dredging/off-site disposal in a TSCA landflll were developed for detailed analysis as follows:

Alternative 1 - No Action

The NCP requires that a no action alternative be considered to provide a baseline for comparison with action alternatives. Under this alternative, no remedial action would be undertaken at this time to address contaminated sediment at the Tabbs Creek OU.

A long-term (30 years) monitoring program would be conducted. The program would include annual monitoring of biota, sediment, and surface water, and reviews of the sample results every 5 years. A recommendation for further courses of action would be provided at five-year reviews.

Capital Cost: $10,000
Operations and maintenance (0 & M) cost: $31,000
Net Present Worth: $420,000

Alternative 2: Dredging/Off-Site Incineration

Alternative 2 is a source removal alternative in which approximately 4,300 cy of the contaminated sediment from the creek and the adjacent marsh areas would be dredged (Note: Dredging is selected as representative process option for alternative development. Other methods, including excavation, will be evaluated during remedial design), dewatered, and shipped off-site for treatment by an incinerator. Dredging water will be treated and tested to ensure that water quality standards are being met. If EPA and the Army Corps of Engineers determined it is beneficial to the environment, the dredged sediment areas would be restored to the original grades with clean fill and replacement of vegetation. Figure 4, Appendix A, shows the approximate areas of contaminated sediment to be dredged.

To achieve the remedial action objective, the top 6" to 4' of sediment, where most biological exposures occur, from the above identified areas would be dredged. Dredging would start from Outfall 009 continuously to P14MCP13, and then to the individual hot spots. Once the dredged areas are backfilled with uncontaminated sediment, biota would only be exposed, to clean sediment. For the remaining areas of the creek, only minor contamination, with most samples in the non-detect to 5 ppm range, was detected. The average residual contamination is estimated at approximately 2.1 ppm, which is significantly below the cleanup level of 5 ppm. All ARARs would be met (see Tables 6, 7 and 8, Appendix B).

Long-term monitoring would not be required since the contaminated sediment, with concentrations of PCBs/PCTs greater than 5 ppm, would have been removed from the site. However, annual biota monitoring, consisting of live box studies, would be conducted for 5 years to determine the effectiveness of this remedy.

Fishing, crabbing, and shellfish harvesting would be banned in Tabbs Creek during these 5 years. Signs would be posted along the perimeter of the creek to serve the purposes.

Capital Cost: $12,800,000
Operations and maintenance: (0 & M) cost: $25,000
Net Present Worth: $13,000,000

It is anticipated that the time required to achieve remedial action objectives for this alternative is approximately 12 months: 4 months for the preparation and approval of the design; 4 months for site preparation, 3 months for dredging and dewatering operations and one month for demobilization.

Alternative 3: Dredging/Off-Site Disposal

Similar to Alternative 2, this is also a source-removal alternative, except that the contaminated sediment would be disposed of off-site at a TSCA permitted chemical waste landfill instead of treated at an incineration facility. The dredging, dewatering, dredge-water treatment, backfilling and restoration, and monitoring would be the same as discussed in Alternative 2. All ARARs would be met (see Tables 6, 7 and 8, Appendix B).

Capital Cost: $4,700,000

Operations and maintenance (0 & M) cost: $25,000
Net Present Worth: $4,800,000

As with Alternative 2, it is anticipated that the time required to achieve remedial action objectives is approximately 12 months.

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

During the detailed evaluation of remedial alternatives, each alternative is assessed against the following nine evaluation criteria: overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); long-term effectiveness and permanence, reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; cost; regulatory acceptance; and community acceptance.

A comparative analysis for the three alternatives based on these evaluation criteria is presented in the following sections. In addition, Table 5 (Appendix B) provides a summary of contaminated sediment remedial alternatives evaluation.

A. OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 1 provides no remedial action and the creek would continue to be contaminated. The existing ban on shellfish fishing would provide some limited protection to human health but not the environment. Alternatives 2 and 3 would provide protection to human health and the environment from exposure to the contaminated sediment since the surface sediment with contamination above the cleanup levels for PCBs and PCTs would be removed from the site. Contaminated biota will die off gradually and disperse into the sediment. Over time, the new generations of biota will have less and less contamination from the site. With off-site disposal of contaminated sediment, Alternative 3 would contain contaminants in a controlled environment (i.e., a landflll meeting TSCA-PCB disposal requirements). With off-site incineration, Alternative 2 would destroy the contaminants. Alternative 2 would be most effective because the destruction process is not reversible. However, Alternative 3 also meets this criteria because it provides protection of human health and the environment and is more cost effective than Alternative 2.

Remedial activities in Alternatives 2 and 3 would cause short-term impacts to the wetland. These activities are essentially unavoidable to provide access to the wetland to remove the contaminated sediment and allow for final grading and restoration of the wetland. In all cases, it is the intent of the alternatives to restore the wetland to its original beneficial use, although time would be required for biota to become reestablished in the disturbed areas. Alternative 1 with no remedial activities would not incur disturbance of the wetland.

B. COMPLIANCE WITH ARARS

TSCA requirements for disposal of PCB contaminated sediments is applicable and therefore an action-specific ARARs for contaminated sediment. The cleanup level was derived to protect biota and consumers of biota at the site. Alternatives 2 and 3 would meet the cleanup level by removing the sediment with contamination exceeding the level and treating/disposing the sediment at an offsite facility. These alternatives would meet the remedial action objectives. For Alternative 1, the cleanup level would not be attained.

Alternatives 2 and 3 would likely attain the AWQC for surface water once the source has been removed. Alternative 1 might not comply with the AWQC as the source would not be remediated. Alternatives 2 and 3 would comply with State Pollutant Discharge Elimination System (SPDES)-discharge requirements for surface water pumped and created from the marsh. Alternative

1 would not involve discharging any water.

Remedial activities at the marsh would comply with location-specific ARARs. Alternatives 2 and 3 would involve work in the wetland and floodplain. The activities would be of short duration and the wetland would be restored under these alternatives. Engineering measures would be implemented to prevent impact from a potential 100-year flood during remediation. Alternative 1 would not incur any disturbance of the wetland or floodplain and would, therefore, these location-specific ARARs do not apply. Endangered species are not known to be present at the site.

All alternatives would be executed in a manner that is in compliance with action-specific ARARs such as OSHA, RCRA facility standards, transportation and manifest documentation, and air emissions. Tables 6, 7, and 8 (Appendix B) stipulate the chemical-specific, location-specific and action-specific ARARs, respectively, and their design considerations.

C. LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternatives 2 and 3 would be effective in addressing the site contaminants since the sediment with contamination above the cleanup level would be completely removed from the site. Alternative 2 would be most effective in the long term since incineration of contaminated sediment is not reversible and does not require long-term maintenance. Alternative 3 would provide off-site containment of PCBs and PCTs, which would be less effective than the treatment processes. A landfill will require long-term proper maintenance.

Alternative 1 would not provide any type of remedy for the contaminated sediment; therefore, future remedial actions would probably be required.

D. REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative 2 would reduce the toxicity, mobility, and volume of contaminated sediment at the Tabbs Creek site through treatment. Alternative 3 does not involve treatment. Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminants. The treatment process under Alternative 2 is irreversible. Although Alternative 3 does not reduce toxicity mobility or volume through treatment, it is protective of human health and the environment and more cost-effective than Alternative 2. In addition, principal threats for which treatment is most likely to be appropriate include liquids, areas contaminated with high concentrations of toxic compounds, and highly mobile materials. Conditions at the Tabbs Creek OU do not meet these criteria to warrant treatment, but do warrant removal of contaminated sediment.

E. SHORT-TERM EFFECTIVENESS

Alternative 1 would not involve any construction activities; therefore, it would provide the least short-term risks to the community, workers, and the environment.

Alternatives 2 and 3 would require dredging, dewatering, and handling of contaminated sediment, posing some risk of contact to workers and residents. Engineering measures would be implemented to protect the workers and the community. They may also cause a traffic inconvenience to neighboring communities.

Once on-site work begins, Alternatives 2 and 3 would require approximately 8 months to Complete and achieve remedial action objectives in 12 months. Alternative 1 does not involve any on-site work and does not meet remedial action objectives.

F. IMPLEMENTABILITY

Alternative 1 would be the easiest alternative to implement since no construction activities would be performed at the Tabbs Creek Site. However, if additional remedial action is required in the future, Alternative 1 would be more difficult to implement as time goes by since the contamination would spread to a larger area.

Alternatives 2 and 3 would involve removal of the contaminated sediment from the creek area. There would be some difficulty in maneuvering the dredging equipment and support equipment because of the shallow and narrow nature of the creek and the low-bearing capacity of the surrounding area. However, dredging, dewatering, and waste transporting would use common equipment and procedures. Incineration and landfilling in Alternatives 2 and 3 are also common and proven technologies utilized in PCB remediation. After removal of contaminated sediment, clean material would be used to backfill the dredged area. Restoration of wetlands would also be conducted if required. However, the restoration process is not a proven technology.

G. COST

Alternative 1 has long-term monitoring costs associated with implementation. Alternative 2 would eliminate long term maintenance costs and reduce toxicity, mobility, and volume at a significant increase in cost over the other alternatives. Alternative 3 would provide protection similar to Alternative 2, but at approximately one third the cost of Alternative 2. Alternative 3 is the more cost-effective alternative. It will meet all remediation goals (in contrast to Altemative 1) with significantly less cost than Alternative 2.

H. STATE ACCEPTANCE

The Virginia Department of Environmental Quality concurs with the selection of Alternative 3, Dredging and Off-Site Disposal as the selected remedy for this OU.

I. COMMUNITY ACCEPTANCE

An availability session on the Proposed Plan was held on September 14, 1998 in Hampton, Virginia. Comments received orally and/or in writing at the availability session are referenced in the Responsiveness Summary (Section
XII of this ROD).

IX. SELECTED REMEDY

Following review and consideration of the information in the Administrative Record file, requirements of CERCLA, and the NCP, and the public comments reviewed on the Proposed Remedial Action Plan, NASA and EPA, in consultation with VDEQ, have selected Alternative 3: Dredging/Off-Site Disposal as the remedy for the Tabbs Creek Operable Unit. This remedy would prevent unacceptable exposure to contaminated sediment.

Based on available information, NASA and EPA believe that the selected remedy would be protective of human health and the environment, would be cost effective, and would provide the best balance of trade-offs among the alternatives with respect to the evaluation criteria.

The selected remedy for the Tabbs Creek OU includes the following major components:

ò Dredging of the contaminated sediment from the creek and adjacent marsh areas;
ò Dewatering of the sediment;
ò Treating and discharging dredging water
ò Transporting and disposing the sediment off-site in a TSCA-approved chemical waste landfill;

ò	Backfilling the dredged sediment/marsh areas
ò	Restoring wetlands
ò	Annual biota monitoring; and
ò	Restrictions on biota harvesting for five years

The present worth of this remedy is $4,800,000.

PERFORMANCE STANDARDS

Dredging/Off-Site disposal shall remove all sediments with concentrations greater than 5 ppm. This includes dredging to a depth of 4 feet in certain areas. All dredging water shall be treated and tested to ensure compliance with water quality standards prior to discharge into Tabbs Creek. To mitigate the loss of productive wetlands and habitats and to reduce the erosion after dredging, the site shall be restored by replanting vegetation and sediment replacement.

X. STATUTORY DETERMINATION

A. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy, Alternative 3, would protect human health and the environment by preventing exposure through the removal (dredging) of the contaminated sediments and containment in a landfill designed to store PCBs and PCTs.

B. COMPLIANCE WITH ARARS

The selected remedy will comply with all ARARs including TSCA (see Tables 6, 7, and 8, Appendix B). The remedial action objectives will be met by the selected alternative since the contaminated sediment in excess of the cleanup level will be removed. Since the source (the sediment) will be removed, concentrations of contaminants in the surface water should remain below AWQC.

With regard to location-specific ARARs, the selected alternative will comply with the wetland protection Executive Order (E.O.) No. 11990 because wetlands will be reestablished. Flood control capacity would not be affected since the creek system will be backfilled to the original grades when necessary. The dredged sediment and wastewater treatment facilities will be located within the 100-year floodplain. Engineering measures such as berms or locating equipment above the flood level can easily be provided. Therefore, this alternative is considered to be in compliance with Federal Floodplain Management E.O. No. 11988. Since the wetland would be disturbed, compliance with Section 404 and Section 10 requirements will be necessary.

The selected alternative will comply with action-specific ARARs which include OSHA, Section 404 permit requirements, state discharge criteria (SPDES), air emissions standards, and transportation and disposal regulations (see Table 8, Appendix B).

C. COST EFFECTIVENESS

The selected remedy is cost-effective. The present worth cost is $4,800,000.

D. UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATE TREATMENT TECHNOLOGIES
OR RESOURCE RECOVERY TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

The removal of contaminated sediment in the selected alternative would permanently reduce the volume of contaminants in the marsh and creek. After the remedial action is completed, residual risks around the site would be within an acceptable level. The possibility of contaminated sediment contaminating surface water to levels exceeding AWQC would also be eliminated. The wetland would be restored under this alternative. Off-site disposal of contaminated sediment in a landfill would control the mobility of the contaminants.

The selected remedy does not utilize permanent treatment technologies for this site due to cost and other considerations. Although this action does not fully address the statutory mandate for treatment, this action provides for a permanent remedy and thus partially satisfies this mandate.

E. PREFERENCE FOR TREATMENT AS A PRINCIPLE ELEMENT

The selected alternative does not treat the contaminants. However, dredging and off-site disposal are proven and reliable technologies, and would achieve the remedial action objectives as effectively as the treatment alternative at the site.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES

The proposed plan for the Tabbs Creek OU was released for public comment on August 28, 1998. The Proposed Plan identified Alternative 3, Dredging/Off-Site Disposal, as the preferred alternative. NASA, EPA and VDEQ reviewed and considered all comments received during the public meeting and during the public comment period. Upon review of these comments, it was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, are necessary.

XII. RESPONSIVENESS SUMMARY

A. OVERVIEW

In a Proposed Plan released for public comment on August 28, 1998, NASA, with the support of EPA, identified Alternative 3 as the preferred remedial alternative for the Tabbs Creek OU at the Site. Alternative 3 in the Proposed Plan was described in Section VIII.

B. COMMUNITY INVOLVEMENT TO DATE

NASA and EPA established a public comment period from August 28, 1998 to September 26, 1998 for interested parties to comment on the Proposed Plan the Remedial Investigation and the Feasibility Study and other documents pertaining to the Tibbs Creek OU. These and all other documents considered or relied upon during the remedial selection process for the Tabbs Creek OU are included in the Administrative Record, which has been in two information repositories accessible to the public since the beginning of the public comment period for the Tabbs Creek OU. An availability session was held at the Virginia Air and Space Center on September 14, 1998 to present the Proposed Plan, answer questions, and accept both oral and written comments on the Tabbs Creek OU remedial alternatives. Three people attended this session.

C. SUMMARY OF RESPONSES RECEIVED DURING THE PUBLIC COMMENT PERIOD AND COMMENT RESPONSES

The following was the only comment submitted in writing during the public availability held on September 14, 1998 at the Virginia Air and Space Center located in Hampton, Virginia:

Comment 1: The commenter suggested that NASA look into the possibilities of bioremediation and provided the name of a company who specializes in bioremediation. Also, the commenter noted that she is interested in the most environmentally correct method of handling the problem at Tabbs Creek and added her concern that by depositing the contaminated sediments into a landfill NASA was postponing the problem to a later date.

Response 1: The company recommended by the commenter was contacted. This company has no previous experience in bioremediating sediments contaminated with PCBs. In fact, staff members of NASA, VDEQ and EPA were consulted on this topic and to the best of their knowledge, remediation of contaminated sediments through bioremediation has not been successfully proven as effective. NASA, EPA and VDEQ are also interested in handling the contaminated sediment at Tabbs Creek in the most environmentally correct manner and feel that disposal in a TSCA approved landfill achieves this. TSCA approved landfills, which meet the requirements of 40 C.F.R. 761.75, are carefully designed to contain PCB waste(s). Among other things, they have multiple impermeable liners to prevent leaks and groundwater monitoring systems to detect leaks immediately in the unlikely event that they occur. Although the dewatered PCB contaminated sediment will not be treated, NASA, EPA and VDEQ feel that disposal in a TSCA-approved landfill this will be protective of human health and the environment.

XIII. REFERENCES

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APPENDIX A

FIGURES

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APPENDIX C

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

APPENDIX B

TABLES

Table 2
Results of RME Risk Estimates

Receptor	Cancer Risk Total Risk	Noncancer Risk Hazard Index
Future Use Scenarios		
Future Youth Trespassers	9.3x10 -5	0.053
Sewer Maintenance Worker	2.2x10 -6	0.0026
Harvesters & Hunters		
Crab Harvesters	7.7x10 -4	0.081
Oyster Harvesters	4.9x10 -4	0.053
Hunters	4.1x10 -4	0.044
Biota Consumers		
Adult Crab Consumer	5.8x10 -3	2.8
Youth Crab Consumer	1.9x10 -4	0.47
Adult Fish Consumer	6.6x10 -4	0.39
Youth Fish Consumer	1.8x10 -5	0.054
Adult Oyster Consumer	6.3x10 -4	1.9
Youth Oyster Consumer	5.1x10 -5	0.77

Table 3
Volume of Contaminated Sediment Calculations

Section	Length (ft)	Total Width Including Buffer (ft)	Area(ft 2)	Proposed Excavation Depth (ft)	Volume (ft 3)
A	150	20	3,000	4	12,000
B	180	40	7,200	4	28,000
C	480	30	14,400	2	28,000
D	100	30	3,000	2	6,000
E	100	10	1,000	4	4,000
F	500	40	20,000	0.5	10,000
G	60	40	2,400	2	4,800
H	60	20	1,200	0.5	600
I	100	15	1,500	0.5	750
J	100	40	4,000	4	16,000
K	100	10	1,000	4	4,000

Total Area = 58,700 ft 2
or = 1.4 Acres

Total Volume = 115,750 ft 3
or = 4,300 yd 3

Table 4
Evaluation of Process Options

Remedial Technology	Process Option	Effectiveness	Implementability	Cost
No Action	No Action	Does not achieve remedial action objectives	May not be acceptable to local government/public.	No capital, low O&M.
Institutional Controls	Use and Access Restrictions	Effectiveness depends on continued future implementation. Does not reduce contamination.	Requires legal authority to enforce restrictions.	Low capital and O&M.
Public Awareness	Warning Signs/Public Meetings	Effective in informing workers and public of risks on site. No contaminant reduction.	Easily implemented.	Low capital and O&M.
Monitoring	Monitoring	Useful for documenting conditions. Does not reduce risk by itself.	Easily implemented.	Low capital, medium O&M.
Capping	Non-RCRA Cap	Effective in preventing direct contact and sediment migration. Susceptible to erosion. No reduction in TMV (through treatment).	Easily implemented. Would destroy wetlands Reliability a problem because of flooding.	Low capital, low O&M.
	RCRA Cap	Effective in minimizing infiltration and preventing direct contact. No reduction in TMV (through treatment).	Would destroy wetlands if installed in a marsh area. Requires stable sub-base after sediment dewatering. Reliability a problem because of flooding.	High capital and O&M.
Removal	Excavation	Effective in removing contaminated soil and sediment. Waste requires further processing to achieve remedial objectives.	Use commercially available equipment. Accessibility is a problem. Requires Section 404 permit.	Medium capital, no O&M.
	Dredging	Effective in removing sediments. Waste requires further processing to achieve remedial objectives Resuspension of sediment is a concern.	Commercial facilities are available. Requires Section 404 permit.	High capital, no O&M.
Solidification/ Stabilization	Cement/Pozzolanic	Effective in stabilizing PCB-contaminated soil and sediment. Treatability study required to determine proper formula. Process could be reversed under adverse conditions such as low pH.	Technology widely available. Considered by some not to be a treatment technology.	Low capital and O&M.
Soil Washing	Solvent Extraction	Effectiveness varies with system and process. Treatability study is required to determine effectiveness	Limited experience. No commercial system exists	Medium capital, low O&M

Table 4 continued
Evaluation of Process Options

Remedial Technology	Process Option	Effectiveness	Implementability	Cost
Chemical Treatment	Dechlorination (KPEG)	Effectiveness in destruction of PCBs. Limited experience in treating PCB-contaminated solids.	Limited experience in treating solids. Availability could be problematic because of limited number of vendors.	Medium capital low O&M.
	Base Catalyzed Dechlorination Process (BCD)	Completely dehalogenates PCBs.	Limited experience, especially in treating solids. Can be used with Anaerobic Thermal Processor (ATP) system.	Unknown
Thermal	Off-site and On-site Incineration	Best Demonstrated Available Technology (BDAT) for treating PCBs. Contamination is destroyed.	Commercial facilities are available. Requires excavation and either transportation of contaminated sediment or mobilization of incineration unit.	Off-site: High capital, no O&M. On-site: Medium capital, no O&M.
	Low-temperature Thermal Desorption	Has been demonstrated at other hazardous waste sites to extract and destroy PCBs.	Only a few commercial units are available. Small waste volume is not cost-effective to be treated on-site.	Medium capital, no O&M.
	Vitrification	Effective in destruction of PCBs.	Limited experience. No commercial system exists.	Medium capital, low O&M.
	Desorption and Vapor Extraction	Effective in removal of PCBs from sediment.	Limited experience. One mobile unit has been manufactured.	Medium capital.
	Thermal Gas Phase Reduction	A demonstration scale unit was effective in removal of PCBs and their destruction.	Only a pilot-scale unit is available. A full scale unit is scheduled for 1994.	Medium capital.
In-Situ Treatment	In-Situ Stabilization	Effectiveness is a concern when performing underwater. Treatability study required to determine proper formula. Process could be reversed under adverse conditions such as low pH.	Accessibility a problem. No institutional constraints. Considered by some not be a treatment technology.	Low capital and O&M.
Disposal	Off-site TSCA-approved Landfill	Effective in isolating waste to reduce risk.	Commercial facilities are available. Long distance for transportation.	Medium capital, no O&M.
	On-site Backfill	Effective in disposing treated sediment.	Easily implemented.	Low capital, low O&M.

Table 5

Summary of Contaminated Sediment Remedial Alternative Evaluation
Tabbs Creek Site

Alternative 1 No Action	Alternative 2 Dredging/Off-Site Incineration	Alternative 3 Dredging/Off-Site Disposal
Description:		
No remedial action. Long-term monitoring and five-year site review.	Dredge, dewater, and transport contaminated sediment off-site for incineration in a TSCA-approved facility. Backfill excavated area and restore to a wetland. Ban fishing and crabbing in Tabbs Creek for five years.	Dredge and dewater contaminated sediment and dispose off-site in a TSCA landfill. Backfill excavated area and restore to a wetland. Ban fishing and crabbing in Tabbs Creek for five years.
Overall Protection:		
Little risk to human health from direct contact. High risks from ingestion of contaminated biota. Chronic stress to biota. No disturbance of wetlands.	Protects human health and the environment. Site contaminants removed removed and treated. Clean sediment cover eliminates future contact of any remaining contaminants with biota. Restoration of destroyed wetland requires a long time.	Protects human health and the environment. Site contaminants removed and backfilled. Clean sediment cover eliminates future contact of any remaining contaminants with biota. Restoration of destroyed wetland requires a long time.
Compliance with ARARs:		
There are no ARARs for PCBs in sediment.	Would comply with TSCA and clean-up goals, AWQC, location of the treatment facility would be located in 100-year floodplain.	Would comply with TSCA and clean-up goals, AWQC, location-and-treatment facility would be located in 100-year floodplain.
Long-Term Effectiveness:		
Not effective in reducing impact to environment and risk from ingestion of biota. Long-term monitoring required.	Effective in eliminating risk by removing source of contamination to biota and surface water. Wetland would be reestablished and restored over time. Ban on fishing and crabbing would reduce exposure to contaminated biota. Incineration is irreversible and is reliable.	Effective in eliminating risk by removing source of contamination to biota and surface water. Wetland would be reestablished and restored over time. Ban on fishing and crabbing would reduce exposure to contaminated biota. Landfilling is reliable if managed properly.

Table 5(Continued)

Summary of Contaminated Sediment Remedial Alternative Evaluation
Tabbs Creek Site

Alternative 1 No Action	Alternative 2 Dredging/Off-Site Incineration	Alternative 3 Dredging/Off-Site Disposal
Reduction of Toxicity, Mobility, or Volume through Treatment:		
No reduction of toxicity, mobility or volume.	Removal and treatment of sediment would reduce toxicity, mobility, and volume of contaminants. Treatment process is not reversible.	No reduction in toxicity, mobility or volume through treatment. Removal and containment of sediment would reduce mobility of contaminants. Toxicity and volume would be unchanged.
Short-Term Effectiveness:		
No remedial action implemented. No disturbance of the wetland. Monitoring program would not pose risk to workers or community.	Achieves remedial objectives in 12 months. Risks to public or workers during remediation from dust and transport off site. Workers would be required to wear protective equipment. Measures required to protect public and workers from dust during dredging and material handling. The wetland and floodplain would be impacted during dredging prior ot backfilling.	Achieves remedial action objectives in 12 months. Risks to public or workers during remediation from dust and transport off site. Workers would be required to wear protective equipment. Measures required to protect public and workers from dust during dredging and material handling. The wetland and floodplain would be impacted during dredging prior to backfilling.
Implementability:		
Long-term monitoring can be implemented with no difficulty.	Fishing and crabbing ban can be implemented by NASA, state, and local officials. Dredging and off-site incineration is common construction and commercially available. Wetland restoration has not been demonstrated and may pose difficulties. Approximately eight months would be required to dredge, dewater, and transport sediment to off-site incineration facility.	Fishing and crabbing ban can be implemented by NASA, state, and local officials. Dredging and off-site incineration is common construction and commercially available. Wetland restoration has not been demonstrated and may pose difficulties. Approximately eight months would be required to dredge, dewater, and transport sediment to off-site landfill.
Cost ($):		
Capital: 10,000	Capital: 12.9 million	Capital: 4.7 million
Annual O&M: 31,500	Annual O&M: 25,300	Annual O&M: 25,300
Five-Year Review Cost: 9,600	3-Year Evaluation Cost: 9,600	3-Year Evaluation Cost: 9,600
Present Worth: 420,000	Present Worth: 13 million	Present Worth: 4.8 million

Table 6

Chemical-specific ARARs, Criteria, and Guidance

Regulatory Level	ARAR Identification	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
Federal	CWA National Ambient Water Quality Criteria (NAWQC) for Protection of Human Health and Aquatic Life	Relevant and Appropriate	Containment levels regulated by NAWQC are provided to protect human health from exposure from ingestion of unsafe drinking water, and/or from consuming aquatic organisms (primarily fish); and to protect aquatic organisms.	Activities that could impact surface water will comply with the promulgated values.
Federal	Toxic Substances Control Act (TSCA), 40 CFR, Part 761, Subpart G; PCB Spill Cleanup Policy	To Be Considered	Provides soil cleanup levels for low/high concentrations spills and restricted/non-restricted areas.	The cleanup levels will be considered for the site.
State	Virginia Water Quality Standards for Surface Water (9 VAC 25-260-5 to 550)	Applicable	Quality criteria are provided to maintain surface water of satisfactory quality, be consistent with public health and recreational purposes, enhance the propagation and protection of fish and aquatic life, and advocate other beneficial uses of the water. All state waters shall be maintained at such quality as will permit all reasonable and beneficial uses and will support the propagation and growth of all aquatic life, including game fish, which might reasonably be expected to inhabit them. Reasonable beneficial uses include, but are not limited to, recreational uses (e.g., swimming and boating) and production of edible and marketable natural resources (e.g., fish and shellfish).	The promulgated values will be considered in determining the discharge limit from the remedial treatment facility.

Table 7

Location-specific ARARs, Criteria, and Guidance

Regulatory Level	ARAR Identification	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
Federal (Non-Regulatory	Floodplains Executive Order (EO 11988)	Applicable	Federal agencies are required to reduce the risk of flood loss, to minimize impact of floods, and to restore and preserve the natural and beneficial values of floodplains.	The potential effects of the remedy will be evaluated and addressed to ensure that the planning and decision-making reflect consideration of flood hazards and floodplains management, including restoration and preservation of natural, undeveloped floodplains.
Federal (Non-Regulatory)	Wetlands Executive Order (EO 11990)	Applicable	Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance natural and beneficial values of wetlands.	The portion of the remedy that involves constructiont will include all practicable means of minimizing harm to wetlands Wetlands protection considerations will be incorporated into the remedial design.
Federal	Fish and Wildlife Coordination Act (16 USC 661)	Applicable	This regulation requires that any Federal agency that purposes to modify a body of water must consult with the U.S. Fish and Wildlife Services (USFWS). This requirement is addressed under CWA Section 404 requirements.	During the remedial design, the effects on streams and wetlands will be evaluated and addressed. If an alternative modifies a body of water or potentially affects fish or wildlife, EPA must consult the USFWS.
Federal	Fish and Wildlife Conservation act of 1980 (16 USC 2901)	Applicable	The Fish and Wildlife Conservation Act (or non-Game Act) addresses the conservation of non-game wildlife species through the establishment of State conservation plans. The Non-Game act is administered by the USFWS, which encourages States to consult with the National Marine Fisheries Service (NMFS) and the Department of Commerce regarding marine species. After the State's conservation program has been approved by the FWS, it is eligible for 75% reimbursement on non-game projects. Essentially, the Act provides Federal funding for wildlife conservation activities conducted by the States. This Act applies to proposed impoundments, diversions, dredging, controling or modifying surface waters, requiring EPA to notify various Federal agencies of the proposed actions.	State must consult with the NMFS and the Department of Commerce regarding marine species. The Fish and Wildlife Coordination Act requires that the project must be coordinated with the USFWS (freshwater), NMFS (marine), and the State agency responsible for administering the fish and wildlife resources of the State. Prior to undertaking the remedial action the project will be coordinated with the USFWS, NMFS, and the Virginia Department of Game and Inland Fisheries (DGIF) regarding any activities to be undertaken in water bodies at the project site. This coordination could be undertaken as part of the application process for a U.S. Army Corps of Engineers (ACOE) Section 404 permit for any dredging or filling of water bodies or wetlands required for the project. Then, the ACOE would incorporate the recommendations of the fish and wildlife agencies into the condition of any Section 404 permit issued for the project.

Table 7 (Continued)

Location-specific ARARs, Criteria, and Guidance

Regulatory Level	ARAR Identification	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
Federal	The EPA 404(b)(C1) Guidelines for Specifications of Disposal Site for Dredged or Fill Material(40CFR 230)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative that has less effect is available. If there is no other practicable alternative, impacts must be mitigated.	During the remedial design the effects on wetlands will be evaluated and addressed. Permits may be required for some alternatives.
Federal	Endangered Species Act of 1973 (16 USC 1531 [40CFR 502])	Applicable	Certain species of fish and wildlife are identified as being threatened with extinction and are entitled to special preservation and protection under these statutes.	The potential effects of the remedy will be evaluated and addressed to ensure that any endangered or threatened species would not be affected.
Federal	Resource Conservation and Recovery Act (RCRA) Location Standards (40 CFR 264.18)	Applicable	This regulation outlines the requirements for constructing a RCRA facility on a 100-year floodplain.	The remedy will be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood, unless waste may be removed safely before floodwater can reach the facility or no adverse effects on human health or the environment would result if washout occurred.

Regulatory Level	ARAR Identification	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
State	Chesapeake Bay Preservation Act, Code of Virginia Sections 10.1-2100 et. seq.; Chesapeake Bay Preservation Act Designation and Management Regulations (CBPA Regulations)(9 VAC 10-20-10 to 280)	Applicable	Requires that certain locally designated tidal and nontidal wetlands, as well as other sensitive land areas, 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.	During the remedial design-, the effects on wetlands and water quality will be evaluated and addressed.
State	Virginia Board of Game and Inland Fisheries, Code of Virginia Sections 29.1-100 et. seq.; Virginia Endangered Species Act, Code of Virginia Sections 29.1-563 et. seq.; Virginia Endangered Species Regulations (VA 325-01-1/4VAC 15-20-130 et. seq.; Virginia Natural Area Preserves Act (VNAPA) Code of Virginia Sections 10.1-209 et. seq.; Endangered Plant and Species Act, Code of Virginia sections 3.1-1020 et. seq.; Endangered Plant and Insect Species Regulations (VR 115-04-01/2VAC 5-320-10).	Applicable	Assessments should be deducted and submitted to the Virginia Department of Environmental Quality (VDEQ) for review by the Department of Game and Inland Fisheries (VDEQ Department of Conservation and Recreation (DCR), and Department of Agriculture and Consumer Services (DACS).	DGIF, DCP, and DACS will determine whether any ecological significant areas supporting natural heritage Resources, any rare, or endangered animal species, endangered plant or insect species or their habitat(s) are threatened by the contamination and/or remediation of the site. Certain species of plants and/or insects, as well as certain species of fish and wildlife are identified as being rare, threatened or endangered and are entitled to special preservation and protection measures under these statutes.
State	Virginia Water Protection Regulations (VR 680-15-02)	Applicable	These regulations delineate the procedures and requirements to be followed in connection with activities such as dredging, filling or discharging any pollutant into, or adjacent to, surface waters, or any activity which impacts the physical, chemical or biological properties of surface waters (The definition of surface waters includes wetlands). The standards are typically required in addition to the U.S. Army Corps of Engineers Section 404 permit, and are established in coordination with requirements of the Chesapeake Bay Preservation Act Administered by local permitting boards or requirements of the Virginia Marine Resources Commision.	The requirements will be complied with during the developement of the remedial design and implementation of the remedial action.

Table 8
Action-Specific ARARs for Sediment and Surface Water

ARARs	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
		A. COMMON TO ALL ALTERNATIVES	
Occupational Safety and Health Act (OSHA)-General Industry Standards (29 CFR 1910)	Applicable	These regulations specify an 8-hour time-weighted average concentratim for worker exposure to various organic compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 1919.120	Proper respiratory equipment will be worn if it is not possible to maintain the work atmosphere below these concentrations.
OSHA-Safety and Health Standards (29 CFR 1926)	Applicable	This regulation specifics the type of safety equipment and procedures to be followed during site remediation.	All appropriate safety equipment will be on-site and appropriate procedures will be followed during remediation activities.
OSHA-Recordkeeping, Reporting and Related Regulations (29 CFR 1904)	Applicable	This regulation outlines the recordkeeping and reporting requirements for an employer under OSHA.	These regulations apply to the company(ies) contracted to install, operate, and maintain the treatment unit.
RCRA-Standards for Owners/Operators of Permitted Hazardous Waste Facilities (40 CFR 264)	Relevant and Appropriate	The standards apply to owners or operators of the facilities which treat, store, or dispose of hazardous waste. The standards apply to all treatment, storage, or disposal of hazardouse waste at these facilities.	All workers will be properly trained. Safety and communication equipment will be installed at the site. Local authorities will be familiarized with the site. Plans will be developed and implemented during remedial. design. Copies of the plans will be kept on-site.
Virginia Solid Waste Management Regulations (VR 672-20-10, Part V), December 22, 1988	Relevant and Appropriate	This regulation establishes criteria for siting, design/ construction, operation, groundwater monitoring, and closure of sanitary landfill.	Below 1 ppm, PCBs will be disposed of in a sanitary landfill. Above 50 ppm, PCBs will be managed according to Federal law (TSCA). Between 1 ppm and 50 ppm PCBs will be disposed of in facilities with double liners and double leachate collection system.
		B. OFF-SITE DISPOSAL	
Waste Transportation Department of Transportation (DOT) Rules for Transportation of Hazardous Materials (49 CFR Parts 171,172,177,179)	Applicable	This regulation outlines procedures for the packaging, labeling, manifesting, and transporting of hazardous materials.	This regulation will be applicable to any company contracted to transport hazardous material from the site.
TSCA-PCB Waste: Disposal Records and Reports (40 CFR 761.202, 205, 207 to 211, 215 and 218	Applicable	This regulation establishes the responsibility of generators, transporters, and disposers of PCB waste in the handling, transportation, and management of the waste. Requires a manifest and record-keeping.	This regulation will be applicable to any company contracted to transport PCB material from the site.

ARARs	Status	Requirement of Synopsis	Action to be Taken to Attain ARARs
		B. OFF-SITE DISPOSAL (continued)	
Waste Transportation (continued)			
VHWMR-Hazardous Waste Management Regulations (VR 672-10-1), July 1, 1991	Applicable	The Virginia Department of Environmental Quality has adopted certain DOT regulations governing the transport of hazardous materials.	This regulation will be applicable to any company contracted to transport hazardous material from the site.
Virginia Regulations Governing the Transportation of Hazardous Materials (9 VAC 20-110-10 to 130)	Applicable	These regulations designate the manner and method by which hazardous materials shall be loaded, unloaded, packed, identified. marked, placarded, stored, and transported.	This regulation will be applicable to any company contracted transport hazardous material from the site.
Discharge			
Clean Water Act (40CFR Sections 122, 125 and 136)	Relevant and Appropriate	The National Pollulant Discharge Elimination System (NPDES) permit requirements for point soisme discharges must be met, including the NPDES Best Management Practice Program. These regulations include, but are not limited to, requirements for compliance with water quality standards, a discharge monitoring system, and records maintenance.	Project will meet NPDES permit requirements for point source discharges.
Fish and Wildlife Coordination Act of 1980 (16 USC 2901)	Relevant and Approprite	Requires EPA to notify various Federal agencies of proposed impoundments, diversions, dredging, controlling, or modifying surface water.	Project must be coordinated with the USFWS, NMFS, and Virginia Department of Game and Inland Fisheries (DGIF) regarding any activities to be undertaken in water bodies at the project site. This coordination could be undertaken as part of the application process for a U.S. Army Corps of Engineers (ACOE) Section 404 permit for any dredging or filling of water bodies or wetlands required for the project, whereby the ACOE would incorporate the recommendations of the fish and wildlife agencies into the condions of any Section 404 permit issued for the Project.
Virginia Department of Environmental Quality (DEQ)(9 VAC 25-31-10 to 940) Permit Regulation [Virginia Pollutant Discharge Elimination Sytem (VPDES) and Virginia Pollution Abatement (VPA) Permit Program]), Adopted March 28-29, 1982	Applicable	The permit governs the discharge of any pollutant, including sewage, industial wastes, or other wastes, into or adjacent to State waters that may alter the physical, chemical, or biological properties of State waters, except as authorized pursuant to a VPDES or VPA permit.	The remedy shall comply with all EPA toxic effluent standards and prohibitions promulgated under the Act within the time provided by the regulation. All reasonable steps not to adversely affect human health or the environment shall be taken. Proper operation and maintenance includes effective plant performance; and adequate funding & license operator staffing, and laboratory and process control, including appropriate quality assurance procedures.

ARARs	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
B. OFF-SITE DISPOSAL (continued)			
Disposal			
TSCA Chemical Waste Landfill (40 CFR 761.75)	Applicable	Covers the basic design, monitoring, and operations requirements for chemical waste landfill used to dispose of PCB wastes.	Any off-site facility accepting PCB waste from the site must be properly permitted. Implementation of the alternative will include consideration of all requirements.
TSCA Disposal Requirements (40 CFR Part 761.60)	Applicable	Requires liquid PCBs at concentrations greater than 500 ppm to be disposed of in an incinerator or by another technology capable of providing equal treatment. Liquids at concentrations above 50 ppm but less than 500 ppm and soils contaminated above 50 ppm may also be disposed of in a chemical waste landfill.	Alternative development will consider disposal requirements.
TSCA PCB Remediation Work (40 CFR Part 761.61 (b))	Applicable	Requires PCB remediation waste, which term includes the dredged sediments containing certain amounts of PCBs, to be disposed of in one of several ways. One permissable disposal method is disposal in an approved TSCA PCB landfill.	This requirement shall be met by disposing of dredged, PCB-containing sediment in an approved TSCA PCB landfill.
TSCA PCB Remediation Waste (40 CFR Part 761.63)	Applicable	Requires PCBs greater than 50 ppm be disposed of within one year.	Piled, dewatered sediment will meet this requirement.
RCRA Land Disposal Restriction (40 CFR 268, Subpart D)	Applicable	After November 8, 1988, movement of excavated materials to a new location and placement in or on land would trigger land disposal restrictions (for non-CERCLA actions). CERCLA actions became regulated under this requirement on November 8, 1990.	If sediment is RCRA waste, the excavated material will be property disposed or treated as required by the regulations.
Virginia Hazardous Waste Manage Regulations (VR 672-10-1/9 VAC 20-60-10 Hazardous Waste Permit Program,	Applicable	Covers the basic permitting, application, monitoring, and reporting requirements for off-site hazardous waste management facilities. will include consideration of requirements. Part X.	Any off-site facility accepting hazardous waste from the site must be properly permitted. Implementation of the alternative to 1480):
Virginia Solid Waste Management Regulations (VSWMR)(9 VAC 20-80-10 to 790)	Applicable	Virginias program to properly manage solid waste treatments, storage, or disposal of any solid waste by obtaining a permit. This includes solid wastes containing PCB concentrations between 1.0 ppm and 50.0 ppm.	This regulation may be applied to the disposal of debris off-site or on-site. PCB concentrations between 1.0 ppm and 50-0 ppm are restricted to disposal in sanitary landfills or industrial waste landfills with leachate collection, liners, and appropriate groundwater monitoring as required in Part V of the VSWMR.
C. EXCAVATION AND/OR STABILIZATION			
CAA-National Ambient Air Quality Standards (NAAQS) for Total Suspended Particulates (40 CFR 129, 105, 750)	Relevant and Appropriate	This regulation specifies maximum primary and secondary 24-hour Concentrations for particulate matter. Fugitive dust emissions from site excavation activities must be maintained below 260 g/m 3 (primary standard).	Proper dust suppression methods such as water spray would be specified when implementing excavation and/or solidification/stabilization actions.
40 CFR 264, Subpart L	To Be Considered	Provides requirements to design and operate waste piles.	Piled, dewatered sediment will meet this requirement.
RCRA (40 CFR 264)	Relevant and Appropriate	Requires owner/opetator to control wind dispersal of particulate matter.	Fugitive dust emissions will be controlled during implementation to maintain concentrations below these levels.

ARARs	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
		C. EXCAVATION AND/OR STABILIZATION (continued)	
CAA-NAAQS40 CFR 50	Applicable	Provides air quality standards for particulate matter, lead, NO 2, SO 2, CO 2 and volatile organic matter.	Same as above.
CWA, Section 10 Permit and 33 CFR 322	Applicable	Required to obtain ACOE authorization for any work at or below mean high water, including dredging, discharging dredged or fill material at Tabbs Creek and wetland areas.	If required, the equired documentation will be submitted to ACOE to obtain its approval for dredging and filling.
CWA, Section 404 Permit, 33 CFR 323 and 40 CFR 230	Applicable	Required to meet EPA guidelines for the 404 Permit Program to place fill material or dredge and backfill in the tidal wetlands.	If required, will submit the required document to ACOE; takes 60-90 days for approval. ON-site activities will be properly Conducted to minimize any adverse effects.
Virginia Air Pollution Control Law, Code of Virginia Sections 10.1-1300 et. seq.; Virginia Department of Air Pollution Control, Regulations for the Control and Abatement of Air Pollution (9 VAC 5-50-60 to 230)	Applicable	The Virginia Department of Air Pollution Control's emissions standards must be met with regard to the potential release of toxic pollutants subject to the Department's standards that we released due to remedial activities at a site. Also, any disturbance of surface or underlying soil at a site, or treatment of soil or water must met the Air Boards standards for particulate emmisions to the air.	Proper dust suppression methods and monitoring will be required when implementing excavatiom and/or solidification actions to prevent particulate matter from becoming airborne.
Virginia Erosion and Sediment Control Law, code of Virginia Sections 10.1-560 et. seq.; and the Virginia Erosion and Sediment Control Regulations (VR 625-02-00/4 VAC 50-30-10 to 110)	Applicable	Outlines Virginia Erosion and Sediment Control Law and Regulations and practices to minimize erosion.	Recommended practices will be followed during excavation, NO "land disturbing" activity, as governed by the State statute or a local erosion and sediment control ordinance, may take place until an erosion and sediment control plan for the activity has been submitted and approved by the proper authority
Virginia Stormwater Management Regulations (1990)(VR 215-02-00/4 VAC 3-20-1 et. seq.)	Applicable	Requires State agencies and local stormwater management programs to maintain post-development runoff characteristics; controls non-point source pollution, establishes acceptable administrative procedures; requires stormwater management facilities,; provides for interpretation of stormwater management programs with erosion and sediment control, and other land development-related programs; and reviews and evaluates local management programs.	Proper management of stormwater programs.
Wetlands Mitigation Compensation Policy Virginia Water Protection Permit Regulations (9 VAC 25-210-10 to 260)	Applicable	These regulations delineate the procedures and requirements to be followed in connection with activities such as dredging, filling or discharging any pollutant into, or adjacent to, surface waters, or any activity which impacts the physical, chemical, or biological properties of surface waters.	Remedial activities will comply with substantive requirements.(4 VAC 20-390- to 50); No permits will be required.
Virginia Historic Resources Law, Code of Virginia sections 10. 1-2300-206.	Applicable	Requires that reasonable and good faith effort be made to identify and evaluate historic properties, to assess to assess the project's effects when historic properties are found, and to offer the Virginia Department of Historic Resources an opportunity to comment on the affected property when it is either listed or eligible for listing on the National Register of Historic Places.	Activities impacting resources governed by these statutes must comply with state requirements.

APPENDIX C

GLOSSARY

Glossary of Terms

Amphipod: Any of various small crustaceans.

Aquifer: A saturated, permeable geologic formation or structure that is capable of yielding water in usable quantities under ordinary hydraulic gradients.

Benthic Invertebrate: A form of animal life that is found on or near the bottom of a stream, lake, ocean or other water body.

Bioaccumulation: An increase in concentration in living organisms as they take in contaminated air, water, or food because the substances are very slowly metabolized or excreted.

Bioavailability: A general term to describe the accessibility of contaminants to ecological populations. Bioavailabilty consists of: 1) a physical aspect related to phase distribution and mass transfer, and 2) a physiological aspect related to the suitability of the contaminant as a substance.

Biodegradation: 1) The reduction in concentration of a chemical or physical agent through naturally occurring microbial activity. 2) The process of an organic molecule becoming transformed by biological means.

Downgadient: The direction that groundwater flows similar to "downstream" for surface water.

Endpoints of Concern: Conclusions that can be drawn from an investigation.

Fate and Transport: Includes the tendency for a chemical to migrate through the environment and the degree to which a chemical remains unaltered in the environment.

Feasibility Study (FS): Report that summarizes the development and analysis of remedial alternatives considered for the cleanup of CERCLA sites.

Groundwater: The supply of fresh water found beneath the Earth's surface in the interstices between soil grains, in fractures, or in porous formations.

Leachate: Water that collects contaminants as it trickles through wastes, pesticides or fertilizers. Leaching may occur in farming areas, feedlots, and landfills, and may result in hazardous substance entering surface water, groundwater or soil.

Polychaete worm: The most numerous marine form of the Phylum Annelida (segmented worms). They vary widely in body shape, but almost all are clearly segmented externally and have bristles or setae. Many are conventionally "worm like" with dozens or hundreds of segments. There are both mobile (pelagic) and sessile (tube) forms. Feeding mechanisms have evolved to form jaws; filters; mouth parts for licking, sucking, and piercing; and indiscriminant ingestion of mud/sand.

Receptors: Any living organism or environmental medium which is exposed to contamination's from a discharge.

Remedial Action: Implementation of plans and specifications, developed as part of the design, to remediate site.

Remedial Investigation (RI): The RI is prepared to report the type, extent and potential for transport of constituents of potential concern at a hazardous waste site, and directs the types of cleanup options that are developed in the FS.

Semi-volatiltes: Compounds that do not readily volatilize at standard temperature and pressure. Compounds that are amenable to analysis by extraction if the sample with an organic solvent.

Target Analyte List: A standard list of metals to analyze in samples.

Trophic transfers: The amount of material (usually measured in terms of energy or matter [i.e. contamination]) that passes from step to step in the food chain (i.e. herbivore to carnivore to higher carnivore). Each of these steps is called a trophic level.

Volatilization: To evaporate or cause to evaporate.