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EPA REGION 3
AUGUST 1993

RECORD OF DECISION
E.I. DU PONT, NEWPORT SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

081182

RECORD OF DECISION
E.I. DU PONT, NEWPORT SITE

DECLARATION

SITE NAME AND LOCATION

E.I. Du Pont, Newport Site
Newport, New Castle County, Delaware

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the E.I. Du Pont, Newport Site (Site), in Newport, New Castle County, Delaware, which was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, 42 U.S.C. §§ 9601 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 document explains the factual and legal basis for selecting the remedy for this Site. The information supporting this remedial action decision is contained in the Administrative Record file for this Site.

The State of Delaware has elected not to concur on the selected remedy for the reasons outlined in its August 17, 1993 letter (see Attachment A of this Record of Decision). However, during the Record of Decision (ROD) development process, the State expressed support for many of the major components of the selected remedy.

ASSESSMENT OF THE SITE

The Site is highly contaminated and this contamination is mainly the result of decades of industrial waste disposal and plant operations. Pursuant to duly delegated authority, I hereby determine, pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606, that actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

This remedy addresses soils, sediments, surface water, and ground water contamination at the Site. This is a final Record of Decision for the Site. The principal threats at this Site are contaminated soils containing hazardous substances at the north and south landfills and at the CIBA-GEIGY and the Du Pont Holly Run plants, and contaminated sediments containing hazardous substances in the north drainage way. Treatment is a major component of the remedy at the south landfill while containment is the major component at the other locations due to Site-specific conditions. Below is a summary of the selected remedy:

- Ballpark: Excavation of soils above 500 ppm lead with disposal in the north landfill.
  - Purpose: Prevent human exposure to elevated levels of lead.
- North landfill: Capping; wetland remediation, restoration, and monitoring; vertical barrier wall down to base of the Columbia aquifer; and ground-water recovery and treatment.
  - Purpose: Prevent continued releases of contaminants to the ground water which discharges to the river and the north wetlands, clean up areas of unacceptable environmental impact in the north wetlands, prevent exposure of plant and terrestrial life to contaminated soils.
- South landfill: Excavation and consolidation of contaminated soil underneath and to the east of Basin Road or South James Street onto the south landfill; *in-situ* soil stabilization of the combined soil; capping of the south landfill.
  - Purpose: Prevent continued releases of contaminants to the ground water which discharges to the river and the south wetlands, prevent unacceptable human exposure to contaminated soils from the landfill.
- South wetlands: Excavation, restoration, monitoring.
  - Purpose: Prevent unacceptable impacts to environmental receptors.
- Christina River: Dredging, monitoring.
  - Purpose: Prevent unacceptable impacts to environmental receptors.

- <u>CIBA-GEIGY and Du Pont Holly Run plants</u>: Vertical barrier wall along the Christina River at the CIBA-GEIGY plant, pave the rest of the ground within the contaminated plant areas, recover and treat the ground water up-gradient of the barrier wall, institute special health and safety plans for intrusive work.

  - <u>Purpose</u>: Prevent continued releases of contaminants to the ground water which discharges to the river, prevent unacceptable human exposure to contaminated soils.

- <u>Ground water</u>: Monitoring, provide public water supply along Old Airport Road, establish a ground water management zone.

  - <u>Purpose</u>: Prevent human exposure to Site-related contaminated ground water, prevent further contamination of the Columbia and the Potomac aquifers, protect the south wetlands.

The remedy for the ground water also includes invoking the "greater risk to human health and the environment" applicable or relevant and appropriate requirements (ARAR) waiver. This waiver applies to both the Columbia and Potomac aquifers. Attempts to remediate the Potomac aquifer will cause more contamination to migrate into the Potomac aquifer directly underneath the Site from the more highly contaminated Columbia aquifer. Attempts to remediate the Columbia aquifer will adversely affect the wetlands around the south landfill. These adverse effects outweigh the benefits of installing pump and treat systems in these aquifers. There is currently no human exposure to this ground water, nor is any expected to occur in the future. However, a long-term monitoring program will be instituted as part of this Record of Decision to make sure that this waiver continues to be justified. Appropriate remedial measures shall be taken if the monitoring data indicates a necessity to do so.

State of Delaware Surface Water Quality Standards (SWQSs) are being waived in the north wetlands and the river using the "technical impracticability" ARAR waiver because of off-site sources. Federal ambient water quality criteria are hereby being waived in the river for the same reason. SWQSs are also being waived in the south wetlands using the "greater risk to human health and the environment" waiver because compliance would require destruction of far more wetlands than is estimated necessary in order to protect the environment.

The total present worth cost of the selected remedy is approximately $47,700,000.

DECLARATION OF STATUTORY DETERMINATIONS

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 (or a waiver can be justified for any federal and state applicable or relevant and appropriate requirements that will not be met) and is cost-effective. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable, and it satisfies the statutory preference for remedies that employ treatment that reduce toxicity, mobility, or volume as their principal element.

Because this remedy will result in hazardous substances remaining on Site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Such reviews will be conducted every five years thereafter until EPA determines that the cleanup levels set forth in this ROD have been achieved, or that the hazardous substances remaining on the Site do not prevent unlimited use and unrestricted exposure at the Site.

Stanley L. Laskowski
Acting Regional Administrator
Region 3

8/26/93
Date

DECISION SUMMARY

SITE DESCRIPTION AND BACKGROUND

The E.I. Du Pont, Newport Superfund Site (commonly known as the Du Pont-Newport Site and referred to throughout this document as the "Site") is located partially in Newport, New Castle County, Delaware and partially in unincorporated New Castle County, Delaware. It is an approximately 120-acre site located at James and Water Streets in Newport, Delaware near the I-95, I-495, and Delaware State 141 interchange (see Figure 1). The Site includes land currently occupied by a paint pigment production facility (the CIBA-GEIGY plant), a chromium dioxide production facility (the Du Pont Holly Run plant), two industrial landfills separated by the Christina River[1] (the Site includes portions of the river in which Site-related contamination has come to be located), and a baseball diamond (owned by Du Pont and referred to as the ballpark) located just northwest of the CIBA-GEIGY plant across the Amtrak railroad (see Figure 2).

The pigment plant, originally built during the period from 1900 to 1902, was owned and operated by Henrik J. Krebs and manufactured Lithopone, a white, zinc- and barium-based inorganic paint pigment. In 1929, E.I. du Pont de Nemours & Company (Du Pont) purchased the plant and continued to produce Lithopone. Due to a decline in popularity, Lithopone production ceased in 1952. By this time, however, Du Pont had begun to produce different organic and inorganic pigments, as well as other miscellaneous products. Some of these included purified titanium dioxide (the titanium dioxide was produced elsewhere), titanium metal, blue and green copper phthalocyanine pigments (CPC), red quinacridone pigment (QA), high purity silicon, thoriated nickel, and chromium dioxide. In order to expand the production of chromium dioxide, Du Pont constructed the Holly Run plant during the 1970's. In 1984, Du Pont sold the pigment manufacturing operations to CIBA-GEIGY Corporation, but retained the chromium dioxide production operations.

The Holly Run plant and the CIBA-GEIGY plant were built on fill material placed over low-lying farmland. Most of the fill material underneath the CIBA-GEIGY plant and a small portion at the Du Pont plant is contaminated with heavy metals such as

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[1]Known locally also as the Christiana River. Public water supply; industrial water supply; primary contact recreation; fish, aquatic life and wildlife; and agricultural water supply are the designated uses for this area of the river per Delaware's Surface Water Quality Standards, as amended, February, 26, 1993. Boating, water skiing, and fishing have been observed adjacent to CIBA-GEIGY's plant.

cadmium, lead, barium, and zinc. This is a result of disposal operations and poor storage and handling practices of raw materials. As part of the CIBA-GEIGY pigment plant operations (although prior to CIBA-GEIGY's ownership), waste and off-specification products were disposed of in the north and south landfills.

The north landfill was constructed by building a berm along the Christina River on low-lying farmland adjacent to the Lithopone plant. Disposal activities involved backfilling behind the berm. Construction was such that waste and runoff could have flowed around the toe of the berm and into the river. There was no bottom liner in the landfill. It was used for the disposal of Lithopone wastes, other organic pigment wastes, chromium wastes, and other miscellaneous wastes including off-spec thoriated nickel. Wastes were disposed of in the north landfill from 1902 to 1974.

The south landfill was used for the disposal of large quantities of Lithopone wastes which were pumped through a hose on the river bottom and discharged to diked area in a wetland. There was no bottom liner, and some of the waste is currently in the water table. The south landfill operated from approximately 1902 to 1953.[2]

A small portion of the ballpark appears to have become contaminated when contaminated soil from the pigment plant was used to groom the field. It should be noted that this Site is located downstream of Churchman's Marsh which the Water Resources Agency of New Castle County is evaluating as a potential location of a public water supply reservoir. EPA does not expect the remedy outlined in the ROD to impact Churchman's Marsh but can not state so definitively until the remedial design is completed.

In the late 1970's and early 1980's, the Delaware Department of Natural Resources and Environmental Control (DNREC) and Du Pont sampled and analyzed ground water from on-site monitoring wells. The results indicated elevated levels of heavy metals (especially barium, cadmium, and zinc) and volatile organic compounds (mainly tetrachloroethene and trichloroethene) in ground water. During the mid 1980's, EPA and DNREC gathered and

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[2]Based on the information obtained during the remedial investigation and feasibility study, on-Site disposal activities stopped prior to the enactment of the Resource Conservation and Recovery Act (RCRA, 42 U.S.C. §§ 6901 et seq.). When necessary, the determination of whether or not RCRA is an ARAR is discussed for each area of the Site under the "Description of Alternatives and Summary of the Comparative Analysis of Alternatives" section and in the "Compliance With Applicable or Relevant and Appropriate Requirements" section of this Record of Decision.

reviewed information to determine whether or not the Site was eligible for the National Priorities List (NPL). The Site was proposed for inclusion on the NPL in January 1987 and was promulgated in February 1990.

On August 22, 1988 Du Pont entered into an Administrative Order by Consent with EPA whereby Du Pont agreed to perform a Remedial Investigation and Feasibility Study (RI/FS) for the Site. This study has included collection of ground water, soil, sediment, and surface water (both river and wetlands) samples. Although the Site was originally included on the NPL because of ground-water contamination caused by the north landfill, the RI/FS has found that the river and the adjacent wetlands are contaminated as well. Some areas show significant impacts to the ecosystem, although other areas have only minor impacts. The RI/FS also determined that the south landfill and the soil underneath the production plants are sources of ground-water contamination.

HISTORY OF OTHER ENFORCEMENT ACTIVITIES

On June 10, 1993, EPA and Du Pont entered into a removal consent order to address seepage of a heat transfer fluid (similar in composition to Dowtherm) into the Christina River. The seeps, along the north bank of the Christina River, are causing an oil sheen on the Christina River. CIBA-GEIGY has been reporting these releases to the National Response Center beginning in October 1992. Oil sorbing booms are currently in place to control the spread of the fluid. EPA has determined that the levels of Dowtherm are potentially hazardous to aquatic life and that the booms are not an adequate measure of control until such a time as this ROD is implemented which will permanently address this problem. Compliance with the EPA removal order will provide an interim remedy for the seeps.

Several other projects have taken place during the RI/FS in order to address environmental problems. CIBA-GEIGY removed an underground storage tank that at one time was used to store diesel fuel. CIBA-GEIGY also performed repairs to discharge piping to the Christina River. Cracks in the piping were allowing ground water infiltration which was causing discharges of zinc in excess of CIBA-GEIGY's NPDES permit.

HIGHLIGHTS OF COMMUNITY PARTICIPATION

Pursuant to Section 113(k)(2)(B)(i-v) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, the RI/FS reports and the Proposed Remedial Action Plan (Proposed Plan) for this Site were released to the public for comment on November 13, 1992. These documents were made available to the public in the Administrative Record file located at the EPA Docket Room in Region 3's Philadelphia office, The Kirkwood Library in Wilmington, Delaware, and the Town Hall of Newport in Newport, Delaware. The notice of availability of these documents was published in The Wilmington News Journal on November 13, 1992. A public comment period on the documents was originally scheduled from November 13, 1992 to December 14, 1992. However, due to a timely request for an extension, 45 days were added to the comment period, extending it to January 28, 1993. In addition, a public meeting was held on December 2, 1992, at the Town Hall of Newport. At this meeting, representatives from EPA answered questions about conditions at the Site and the remedial alternatives under consideration. A response to the comments received during the public comment period, including those expressed verbally at the public meeting, is included in the Responsiveness Summary, which is part of this Record of Decision (ROD). This ROD presents the selected remedial action for the E.I. Du Pont, Newport Site in New Castle County, Delaware, chosen in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300. The decision for this Site is based on the Administrative Record placed in the above-mentioned locations.

SUMMARY OF SITE CHARACTERISTICS

Data collected during the RI/FS determined that the Site has extensive contamination in soils, sediments, ground water, surface water, and plant tissue. Some slightly elevated levels of contamination were also detected in one fish species. The following sections discuss the contaminants found in soils, sediments, ground water, and surface water. Data collected during the fish tissue studies, plant tissue studies, benthic studies, and sediment toxicity tests will be discussed in the "Summary of Site Risks" section.

SOILS

The RI determined that high concentrations of certain metals exist in soils in the north landfill, in the south landfill, and underneath the CIBA-GEIGY and the Du Pont Holly Run plants. Elevated levels of metals were also found in the ballpark. Background metal concentrations for soils in the vicinity of the Site were difficult to establish due to the generally disturbed nature of the soils in the area. For this reason, metals detected in the soils at the Site were compared to reported background soil concentrations in a northern Delaware site in the U.S. Geological Survey's "Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States" (see Table 1) which EPA has determined are adequate for this RI. Figure 3 shows the location of soil samples col[illegible]ed during the RI and where metals levels exceeded background [illegible], where contamination is present). It also lists contaminant levels at various locations. At many of these sampling locations, a number of samples were collected at different depths.

Barium, zinc, cadmium, arsenic, lead, mercury, silver, antimony, cobalt, copper, selenium, and vanadium were all detected above background levels. Of these metals barium, zinc, cadmium, and lead were the most prevalent. Contaminant levels underneath the CIBA-GEIGY plant are as high as 0.6% arsenic, 13% lead, 9% barium, and 6% zinc. The north landfill has levels as high as 4% barium, 5% zinc, and 5% lead. The south landfill has levels as high as 7% barium, 1.6% lead, and 1% zinc.[3]

As indicated above, the north and south landfills are heavily contaminated. See Table 2 for a list of estimated quantities of materials that were disposed of in the north landfill. One of the largest waste streams at the Site came from the Lithopone process where raw zinc and barium ores were refined to make a paint pigment. This waste stream consisted of insoluble residues from the zinc and barium refining process. This residue also contained all of the heavy metal contaminants present in the raw material ore as well as zinc and barium. Some of this waste appears to have been disposed of in the north landfill although most of it was disposed to the south landfill.

The Lithopone waste stream was pumped as a slurry through a pipeline to the south side of the Christina River and discharged into a wetland. Dikes had been built to control the movement of the sludge (which hardened upon exposure to air, forming the south landfill), however aerial photographs show that at times, the dikes were breached, and the sludge flowed into areas of which some are the present day wetlands.

The south landfill was covered in the early 1970's with soil excavated from the area which is now part of the Delaware Route 141 Christina River bridge approach ramp. This was done by the Delaware Department of Transportation (DelDOT) as part of the bridge construction. In order to construct this bridge, Basin Road (or South James Street) was moved west onto the south landfill. Historical aerial photographs show the south landfill extended to the edge of the original Basin Road. DelDOT soil borings taken in the early 1970's confirmed this when one of the stratigraphic units in several borings located between the new and old Basin Road was characterized as "chemical fill" (see Figures 4 and 5).

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[3]10,000 parts per million (ppm) are equivalent to one percent. Therefore, soil containing 5% lead is equivalent to soil containing 50,000 ppm lead.

At the contaminated plant areas, the highest metals concentrations are predominantly in the former barium and zinc ore storage areas associated with historic Lithopone production and in the Lithopone production areas at the central and eastern end of the CIBA-GEIGY plant. Construction of the original Lithopone plant began near James Street. As the plant was expanded, construction moved westward. Originally, the land was low-lying farmland. The elevation was raised with fill material. Photographs show that early raw material handling practices included open piles of barium and zinc ores. Some of these ores were probably mixed into the fill material. Also, a part of the central to western portion of the CIBA-GEIGY plant was constructed on top of a former industrial pond that most likely contained wastes from the Lithopone process. Undoubtedly, much of the contamination in the soils is a result of waste disposal in this pond.

Organic contaminants as well as metals were found in the soil at the contaminated plant areas. The organic contamination (mainly tetrachloroethene and trichloroethene, but also including polynuclear aromatic hydrocarbons (PAHs) such as benzo(a)anthracene, phthalate esters such as bis(2-ethylhexyl)phthalate, chlorobenzenes, dibenzofuran, and chlorophenols) was not nearly as prevalent as the metal contamination and was generally located in the central and western portion of the CIBA-GEIGY plant area. Past production of copper phthalocyanine (CPC), quinacridone (QA), and titanium metal are probable causes of the organic contamination. Utility operations which involved the burning of coal probably contributed to the PAH contamination. QA continues to be produced at the CIBA-GEIGY plant today.

Elevated levels of metals in the ballpark are primarily in the area adjacent to Ayre Street and the baseball diamond (see Figure 6 for sampling locations and contaminant concentrations). It is believed that the only source of these metals is from fill for the baseball field (as opposed to transport of airborne particulates). A review of aerial photography dating back to 1937 for this area of the Site suggests that the current location of the ballpark coincides with the recreational area that existed during much of the historical Lithopone operation era. Conversion of the ballpark into a parking lot coincided approximately with the termination of Lithopone operations in the early 1950's. By 1968, the area was returned to use as a ballpark. Fill material from the Site was reportedly used to manicure the baseball diamond over the history of its use (from pre-1940's). Pedestrian tracking to the parking lot from the Site and the use of fill material at the baseball diamond are believed to have been sufficient to create the concentrations of metals found there. Lead is the only metal elevated to a level of concern in the ballpark.

SEDIMENTS

Sediments at the Site have become contaminated in a variety of ways including: precipitation of some of the contaminants from ground water as it discharges to the Christina River or the wetlands; direct dumping (as in the case of the breached dikes at the south landfill); erosion/surface water runoff which in all likelihood carried contamination from the north disposal area to the river during the time the landfill was open; and the incoming tide carrying contamination from the north drainage way to the north wetlands. Sediments samples were collected in the north wetlands (including the drainage way), the south wetlands (including the south pond), and the river. Figure 7 shows the sampling locations and some of the actual chemistry analysis results. As can be seen from this figure, the contaminant levels are relatively high. For comparison purposes, see Table 3 for a list of EPA Threshold Value Guidelines (TVGs).[4] TVGs are not promulgated criteria, but are levels at which toxicity is expected to occur.

Since contaminant levels at a particular sampling location are very dependent on the physical characteristics of the sediments, grain size and total organic carbon (TOC) analyses were also performed. This physical data of the sediments allowed the chemistry data to be normalized[5] so differences between sampling stations could be ascertained. By plotting the normalized sediment data of the Christina River, it can be clearly seen that sediments adjacent to the north landfill and the CIBA-GEIGY plant have sharply elevated levels of a number of Site-related contaminants including lead, cadmium, chromium, barium, copper, mercury, and zinc (See Figure 8).

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[4]EPA Threshold Value Guidelines, National Perspective on Sediment Quality (1985).

[5]Due to the extreme variability that can occur in sediment contaminant levels due to naturally occurring physical/chemical conditions such as deposition rates, sediment types, grain size and organic matter content, comparing sediment chemistry from different sampling stations and sampling events to determine where anthropogenic (manmade) loading has occurred becomes difficult. Normalizing the data allows a more direct comparison of sediment chemistry between different stations to take place. In this case it was determined that the grain size of the sediments was the greatest cause of natural variability (see Environmental Evaluation, 8/7/92, page 4-6). By normalizing the data to grain size (dividing the actual contaminant levels by the percentage of sediments from that sample that pass through a 64 micron sieve) the effect of grain size on the sediment chemistry is removed.

GROUND WATER

Data collected during the RI/FS showed that two major aquifers are present beneath the Site: the Columbia (the upper aquifer) and the Potomac (the lower aquifer). The Potomac aquifer is subdivided into two water-bearing zones, the upper Potomac aquifer and the lower Potomac aquifer. All of the filling operations (for construction and waste disposal) have created another localized aquifer referred to as the fill zone (see Figure 9 for a simplified cross section). Low-permeability soils restrict ground water from flowing between the different *water-bearing zones and aquifers, but do not prevent flow.* This provides a pathway for contamination to migrate between the water-bearing zones and/or aquifers. Five rounds of ground-water samples were collected during the three phases of the RI. The chemical analyses performed on these samples are summarized in Tables 4 and 5. Figures 10, 11, 12, and 13 show the well locations in each of the water-bearing zones with examples of ground-water sampling results. Table 6 shows the maximum contaminant levels (MCLs) and the non-zero maximum contaminant level goals (MCLGs) for various contaminants at the Site. Figure 14 shows the extent of ground-water contamination that exceeds MCLs or non-zero MCLGs and is considered unsafe to drink. The chemicals that were found at concentrations which exceed MCLs or non-zero MCLGs include cadmium, PCE, TCE, lead, barium, beryllium, carbon tetrachloride, 1,2-dichlorobenzene, 1,4-dichlorobenzene, chlorobenzene, vinyl chloride, benzene, and antimony. Also, zinc, arsenic, and cobalt have been detected at levels at the Site that are considered unsafe to drink.

Generally, ground water in the Columbia aquifer flows toward the Christina River while ground water in the Potomac aquifer flows south. Ground water from the Potomac leaks upward into the Columbia, although in portions of the Site it is the other way around (see Figures 15 and 16 that show the direction of ground water flow between the different water-bearing units).

Data collected during the RI and during the early 1980's indicated that, although the ground water itself has been migrating, the size of the organic or inorganic contaminant plume has not appreciably changed. The limited migration away from the Site is probably caused by ground-water flow directions in the Columbia aquifer mainly confining the contaminants to the Site. For the Potomac aquifer, the fact that since the plant process water wells have ceased operation, there is only a small potential for contaminants to transfer from the Columbia aquifer to the Potomac aquifer thereby limiting the spread of contaminants. For the inorganic contaminants, this retardation has also likely occurred because at the leading edge of the plume where the contaminant levels are small, naturally-occurring anions in the ground water cause the inorganic contaminants to precipitate out of solution.

To date, EPA has not concluded that the nearby residential wells located southeast of the Site along Old Airport Road are affected by Site-related contamination.

SURFACE WATER

Surface water at the Site includes the Christina River, the north wetland area and drainage way, and the south wetlands. Surface water in these areas of the Site is being contaminated by discharging ground water and/or due to being in contact with contaminated sediments. Surface water in the Christina River also receives contamination from point-source discharges from the CIBA-GEIGY plant. These discharges are monitored through a National Pollution Discharge Elimination System (NPDES) permit. During the RI, a number of unpermitted discharge pipes were discovered that had been installed over the years of plant operation. These have since been plugged. Also, repairs have been made to some of the remaining discharge pipes because of cracks in the piping that were allowing contaminated ground water to enter and flow to the river, at times causing NPDES permit limits for zinc to be exceeded.

Most of the samples collected were analyzed for Target Analyte List (TAL) metals. A small number of samples (mostly leachate samples along the north river bank) were also analyzed for Target Compound List (TCL) volatile organic compounds. Several samples from this subset were also analyzed for TCL semi-volatile organic compounds. Figure 17 shows the surface water sampling locations and selected results. Contamination was found in all of the samples. One of the leachate samples from the north landfill was also analyzed for radioactivity. The results of the sampling were compared to Ambient Water Quality Criteria (AWQC) and the State of Delaware's Surface Water Quality Standards (SWQSs). The following contaminants exceeded AWQC and SWQSs at one or more locations (most were found over a vast portion of the Site): lead, copper, zinc, cadmium, aluminum, iron, chromium, mercury, *dichlorobenzenes*, and *tetrachloroethene*. See Table 7 for a list of the actual SWQS values. Note that while iron and aluminum may be considered Site-related contaminants, they exist in naturally-occurring high levels in soils and, therefore, in the ground water and surface water in this area. Also note that the *italicized* compounds were detected in leachate seeps along the north river bank in a localized area. These seeps are toxic to aquatic life. The ground-water seeps along the north bank of the river would require as high as a 600 to 1 dilution for zinc, as high as a 400 to 1 dilution for lead and as high as a 140 to 1 dilution for cadmium in order to reach their respective AWQC or SWQSs (see Figure 66, RI report, 8/26/92). These seeps are very likely to cause near-field AWQC exceedances[6] and must be controlled in order to protect the environment.

Although there are other known sources of contamination to the Christina River upstream of the Site, several sets of metal loading calculations (see the Data Sufficiency Memorandum, Remedial Investigation-Phase 2, 4/27/89, and the Remedial Investigation Report, 8/26/92, in the Administrative Record) performed during the RI show that the Site potentially contributes greatly to the AWQC exceedances in the river. For example, one model showed the Site causing the zinc levels in the river to increase by 61 ppb. The AWQC for zinc is 110 ppb with exceedances occurring in the river at the Site. Controlling the discharge of the ground water to the river and wetlands would eliminate the toxic effects on aquatic life caused by the contamination in the ground water.

OTHER: RADIONUCLEIDE STUDIES

Because drums of solid waste containing thorium-232, which is a radioactive material, were disposed of in the north landfill from 1961 to 1966, data was collected before and during the RI to evaluate the potential threat of a release to soils or ground water. Most of these drums that were buried in the north landfill contained an off-specification product of nickel containing two to five percent thorium oxide. Plant records indicate that the drums were buried 10 feet below the surface. Since their burial, another two feet of soil has been placed on the north landfill. Du Pont reported in the RI that all thorium buried in the north landfill was in the thorium oxide form. Thorium oxide has a very low solubility, and under most natural environmental conditions, leaching of thorium oxide would not result in any significant ground-water contamination. Du Pont was also licensed to dispose of small quantities of soluble thorium salts which if present in the north landfill pose a greater potential threat of contamination to the ground water.

Thorium-232 is a commonly used metal in high temperature alloys such as those found in jet engines. It is also used in gas lamp mantels. Thorium is a radioactive material that decays spontaneously releasing radiation and producing various decay products, which are also radioactive and which can cause significant radiation exposure. The thorium oxide production and disposal operation was licensed by the U.S. Atomic Energy Commission.

Radiation emitted from the thorium and its decay products in the north landfill was not observed above background radiation

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[6]EPA interview of Rick Green, Water Resources Division, DNREC, 5/27/93

levels at the surface of the landfill. The cover of the landfill and the other wastes present in the landfill attenuate the gamma radiation from the thorium waste. One well, SM-4, had levels of radium-228 at 5.6 picoCuries per liter (piC/l). Radium-228 is a daughter product from the decay of thorium-232. Well SM-4 has also consistently exhibited gross alpha levels slightly above the MCL of 15 piC/l. Since SM-4 is located at the toe (southwest end) of the landfill, there was concern early in the RI that the drums of thoriated nickel were causing a release. Further sampling of ground water, leachate from the landfill, and river sediments provided no further evidence of a release. In fact, the results indicate that the levels detected in SM-4 are more likely caused by background thorium[7] since SM-3, which is between SM-4 and the suspected burial area, did not show any signs of a release.

The principle radiation hazard associated with the thorium waste is from direct gamma radiation emitted from the thorium and its decay products. If someone, who was not wearing proper personnel protective equipment, exposed the thorium waste at the surface by excavating through the cover, that individual could receive significant exposure from gamma radiation emitted by the thorium waste. In addition, inhalation of dust containing the thorium waste, ingestion of contaminated crops and ground water, and inhalation of radioactive radon-220 gas formed as a decay product of thorium-232 would cause radiation exposure which could be significant depending upon the concentration of the thorium in the waste and the conditions of the exposure.

EPA has determined that the most protective remedy for these drums involves leaving them buried in the north landfill as long as the only form of thorium that was disposed of is thorium oxide. Due to the method of disposal and the high insolubility of thorium oxide, it is highly unlikely that there would be any migration of radioactive contaminants at any significant levels away from the north landfill. Ground water monitoring can verify whether or not there is a release in the future. EPA has also determined that institutional controls can be implemented which are adequate to protect the public from direct contact exposure to the thorium. In the future, if potential changes in the land use indicate that the institutional controls may not be adequate, EPA may require further response actions at that time beyond those called for in this ROD.

Furthermore, if in the future, information becomes available that indicates that soluble forms of thorium were or probably were disposed of at the Site in large enough quantities to pose a

[7] The background levels of radium-228 (a daughter product of thorium) in public drinking water supplies averages in the 4 to 6 piC/l range in some states.

significant threat to the public or the environment, EPA may at that time require further response actions beyond those called for in this ROD such as removing the drums to an EPA-approved off-site disposal facility.

SCOPE AND ROLE OF REMEDIAL ACTION

As part of the RI/FS, a risk assessment was performed by Du Pont to evaluate the actual and potential threats that the contamination poses to human health (Human Health Evaluation: 3/18/92)[8] and to the environment (Environmental Evaluation: 8/7/92). For a discussion of the results of the risk assessment, see the next section titled "Summary of Site Risks."

Once EPA determines from the risk assessment that remedial action is necessary at a site, EPA characterizes waste on-site as either a principal threat waste or a low level threat waste. The concept of principal threat waste and low level threat waste as developed by EPA in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) is applied on a site-specific basis when characterizing source material. "Source material" is defined as material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to ground water, to surface water, to air, or that acts as a source for direct exposure. Source materials are considered to be principal threat wastes when they contain high concentrations of toxic compounds (e.g., several orders of magnitude above levels that allow for unrestricted use and unlimited exposure) or are highly mobile and generally cannot be reliably contained.

From the results of the RI/FS, EPA has determined that contaminated soil or sediments in several areas of the Site are principal threats. The principle threats include the contaminated soil beneath the CIBA-GEIGY plant, the contaminated waste in the north and south landfills, and the contaminated sediments in the north drainage way (adjacent to the north landfill). The sediments in the north drainage way have contaminant levels as high as 3% lead and 2% zinc.

Section 300.430(a)(1)(iii) of the NCP states that "EPA expects to use treatment to address the principal threats posed by a site, wherever practicable," that "EPA expects to use engineering controls, such as containment, for waste that poses a relatively low, long-term threat or where treatment is impracticable," and that "EPA expects to use a combination of methods, as appropriate, to achieve protection of human health

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[8]EPA has independently reviewed Du Pont's human health risk assessment and has determined that it is acceptable to EPA.

and the environment." It also states that "EPA expects to use institutional controls...to supplement engineering controls as appropriate...," and that institutional controls may be used "where necessary, as a component of the completed remedy." However, the NCP also states that institutional controls "shall not substitute for active response measures...as the sole remedy unless such active measures are determined not to be practicable..." After giving careful consideration to the NCP, to available technologies, and to the Site characteristics, EPA has determined that treatment is practicable for one but not all of the principal threats at the Site.

EPA has determined that treatment of the contaminated soil in the south landfill is practicable. However, for contaminated soil beneath the CIBA-GEIGY plant, the contaminated soil in the north landfill, and the contaminated sediments in the north drainage way, EPA has determined that, due to Site-specific conditions, it is not feasible to meet the expectation that these principal threats be treated. *In-situ* stabilization[9] is not practicable and *ex-situ* stabilization is not feasible in the north landfill area[10] because of the debris that was buried there. For example, trash (glass, wood, paper, and cardboard), steel drums, concrete rubble, steel work, and artificial marble have been buried in the north landfill. It is also not very feasible to treat the contaminated soils under the CIBA-GEIGY plant since this would require the shut down and removal of the existing facility, and there is little value in tearing down the CIBA-GEIGY plant in order to stabilize the soil underneath the plant since the north landfill and the CIBA-GEIGY plant are one large contiguous area of contamination. In light of these Site-specific conditions, EPA has determined that for both current and potential future conditions, engineering and institutional controls at the north landfill and the CIBA-GEIGY plant will provide the necessary protection of human health and the environment.

The remedial alternatives in this ROD address contaminated soils, sediments, surface water, and ground water at the Site. The remedial action objectives are the following:

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[9]Stabilization (the use of a binding agent to reduce the mobility of contaminants) is the best demonstrated available technology (and the only available technology for a site of this size) for the treatment of metals. It should be noted, however, that even this technology will not destroy the waste (because much of the waste consists of elemental metals) but only greatly limit the ability for the contaminants to migrate.

[10]The remediation of the north drainage way is included with the remediation of the north landfill since the north drainage way cuts through the landfill and then runs along the base of it.

1. Prevent exposure to the contaminated ground water (see detailed discussion under "Ground Water" in the "Alternatives Analyzed" section as to why EPA is not proposing to return the ground water to its beneficial use).

2. Prevent further migration of the contaminated ground water.

3. Prevent exposure to contaminated soils.

4. Prevent exposure to contaminated sediments.

5. Prevent further degradation of the environment caused by the discharge of contaminated ground water to the Christina River and to the wetlands adjacent to the north and south landfills.

As discussed further in the next section, "Summary of Site Risks," preventing exposure to contaminated ground water is required to protect human health, preventing exposure to contaminated soils is required to protect human health and the environment, preventing exposure to contaminated sediments is required to protect the environment, and preventing exposure to highly contaminated surface water is necessary to protect the environment.

This ROD addresses all of the threats currently known that are posed by the contamination at this Site and is, at present, the final response action planned for this Site. This ROD includes the final remedy for the threats posed by the heat transfer fluid seeping into the Christina River that is being addressed on an interim basis by a June 1993 removal action order.

Among the factors considered by EPA in the ROD is the fact that the Du Pont Holly Run plant and the CIBA-GEIGY plant are currently active manufacturing plants. If one or both of the plants were to change materially their present operations, then EPA would assess any proposed change in operation at the Site and consider whether or not to take further response actions at the Site based upon the proposed change. EPA will review the effect that any proposed change in plant operations might have upon the remedy selected in this ROD.

Although this is the final remedy planned for this Site, changes in conditions may lead to further response actions. Other possible response actions include removal of the thorium drums if unacceptable levels of soluble thorium are discovered, further remediation of the wetlands and the river if long-term monitoring shows that the remedy selected in this ROD is no longer protective, further actions at the north landfill and the

CIBA-GEIGY and Du Pont Holly Run plant areas if there are changes in available treatment technologies or changes in the on-going operations of the chemical plants.

SUMMARY OF SITE RISKS

Du Pont prepared a baseline risk assessment to assess the potential human health and environmental impacts that may result from exposure to contaminants associated with the Site in the absence of active remediation. To determine whether there is an actual or a potential impact at the Site, a complete exposure pathway must be established. A complete exposure pathway consists of the following components:

1. A source or mechanism for contaminants to be released to the environment.

2. A medium through which contaminants may be transported such as water, soil, sediment, or air.

3. A point of actual or potential exposure or contact for humans or environmental receptors.

4. A route or mechanism such as ingestion, inhalation, or dermal contact for exposure at the contact point.

Current and potential future exposure scenarios were evaluated for complete exposure pathways which met the above criteria.

The Risk Assessment is a two-volume set of documents comprised of the Human Health Evaluation (HHE) and the Environmental Evaluation (EE). The HHE assesses the risks associated with the Site to people. The EE assesses risks associated with the Site to plants and animals. EPA has determined that actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to human health and the environment.

HUMAN HEALTH EVALUATION

The HHE is divided into two categories of impacts: carcinogenic and non-carcinogenic or systemic. Many contaminants cause both types of impacts. Remedial action is generally warranted when the calculated carcinogenic risk level exceeds $1x10^{-4}$ (meaning that one additional person out of 10,000 is at risk of developing cancer caused by a lifetime of exposure to contaminants at the Site) under current or future conditions for any of the evaluated exposure scenarios. Remedial action is also generally warranted if the calculated non-carcinogenic Hazard

Index[11] exceeds 1.0 under current or future conditions for any of the evaluated exposure scenarios.

The risks were calculated by first determining all the various ways in which humans come in contact with contaminants at the Site currently or potentially in the future. At the ballpark, children can come into contact with contaminated soils during recreational activities. At the north landfill, a maintenance worker can come into contact with surface soils while cutting grass.

At the south landfill, there are several different possible ways for humans to come into contact with contaminants. First, an owner-employed maintenance worker may accompany a New Castle County maintenance worker inspecting the sanitary sewer force main that runs through the south landfill. This same owner-employed maintenance worker may have other, although infrequent activities, at the south landfill. Although there are no currently planned construction activities at the south landfill, it was assumed that in the future some type of construction may take place that would involve earth-moving activities. The south landfill is also accessible to trespassers who are assumed to be adults and adolescents (ages 14-23 years, inclusive). It was assumed that humans would not come into contact with the sediments in the south wetlands.

In the Christina River, exposure to contaminated water (both the river water itself and leachate seeps along the river bank) can and/or does take place during recreational activities including fishing, boating, and swimming. In the Du Pont Holly Run and CIBA-GEIGY plant areas exposure to contaminated soils can and/or does take place during maintenance activities such as cutting grass and construction activities which involve soil excavation.

The ground water poses a potential future risk. No one is currently consuming ground water contaminated by the Site to levels above MCLs or non-zero MCLGs. However, in the future the plume of contamination may migrate to nearby private drinking water wells or a land owner adjacent to the south landfill could

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[11]The potential for health effects resulting from exposure to non-carcinogenic compounds is estimated by comparing an estimated dose to an acceptable level, or reference dose. If this ratio exceeds 1.0, there is a potential health risk associated with exposure to that chemical. The ratios can be added for exposures to multiple contaminants. The sum, known as the Hazard Index, is not a mathematical prediction of the severity of toxic effects, but rather a numerical indicator of the transition from acceptable to unacceptable levels.

drill a new well into the contaminated plume. This could happen in either the Columbia or Potomac aquifers.

Since the Site has been an operating industrial facility since at least 1902; since it is surrounded by two major highways (Interstate 95 and Delaware 141), a salvage yard, another Superfund site (Koppers), and a light industrial area; since it is separated from the nearest residential area by the northeast corridor line of Amtrak; and since potentially responsible parties currently own a vast majority of the contaminated areas; there was no future residential land use assumed. Therefore, there is no exposure scenario involving residents being exposed to soils at the landfills or the chemical plants or ground water directly underneath these areas.

Different routes for contaminants to enter the body (i.e., ingestion, inhalation, or dermal contact) were taken into account in the risk calculations as appropriate for each exposure scenario (see Table 8). Table 9 contains the major assumptions about exposure frequency and duration for each of the exposure scenarios.

The second step in the risk calculations involves determining which contaminants are contributing significantly to the total risk and should be labeled as contaminants of concern. Using procedures outlined in EPA's "Risk Assessment Guidance for Superfund" (EPA/540/1-89/002), a list of contaminants of concern was developed for each media in each area related to an exposure pathway.

Another part of a risk calculation is the cancer potency factors (CPFs)[12] or reference doses (RfDs)[13]. Used both in

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[12]CPFs, also known as slope factors, have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs, which are expressed in units of $(mg/kg/day)^{-1}$, are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

[13]An RfD is a toxicity value used to estimate the potential for adverse non-carcinogenic health effects. The model to determine RfDs from the dose-response assessment assumes that there is a concentration for non-carcinogens below which there is little potential for adverse health effects over a lifetime of exposure. The RfD is designed to represent this threshold level. The RfD is calculated from the highest chronic exposure level that did not cause adverse effects (the no-observed-adverse-

the screening steps and the actual risk calculations, CPFs and RfDs are estimates of the degree of a contaminant's toxicity.

The actual or potential risk is calculated by multiplying the CPFs and the RfDs by an intake factor (calculated from all of the exposure assumptions) and by the concentration of each contaminant of concern for each exposure pathway.[14]

Table 10 identifies both the carcinogenic and non-carcinogenic risks associated with various areas of the Site. Note in Table 10 that the Hazard Index was calculated with and without taking lead into account because, due to the biological complexity of lead exposure and toxicity, EPA does not currently have an approved reference dose for lead. The reference dose is a major component in the calculation of the Hazard Index. Therefore, EPA determined at this Site a clean-up criteria for lead of 500 ppm in residential settings and 1000 ppm in industrial settings.[15] See Figure 18 for surficial lead

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effect level, or NOAEL) in animals. The NOAEL is divided by a factor to account for any uncertainty such as using data on animals to predict effects on humans and an allowance for sensitive individuals. Uncertainty factors range from 1 to 10,000, based on the confidence level associated with the data. The resulting RfD (mg/kg-body weight/day) is used to quantify the risk.

[14]The concentration value used here is the 95% upper confidence limit (UCL) for the arithmetic mean of the levels of each contaminant found in the samples taken from the appropriate media in each area. This particular concentration value is a statistical estimate of the highest average concentration predicted to occur in 95 out of 100 sets of samples. The use of the 95% UCL produces an estimate of risks for the "Reasonable Maximum Exposure" (RME) scenario. The 95% UCL is used to account for the fact that the actual number of samples is relatively small to accurately predict the average. This method of calculating risks is designed to provide a conservative estimate and makes the underestimation of actual risks highly unlikely.

[15]EPA's Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-02 (dated 9/7/89) set forth an interim soil clean-up level for total lead for direct contact in residential settings at 500 ppm to 1000 ppm. Site-specific conditions may warrant the use of soil clean-up levels below the 500 ppm level or somewhat above the 1000 ppm level. EPA Region 3 Superfund Program practice is to use 500 ppm for residential settings unless there is evidence that 500 ppm is not protective in which case an uptake/biokinetic model that takes into account site-specific conditions may be used to determine a lead clean-up level. Since at this Site there are no true residential exposure

contamination levels. For many exposure scenarios, these criteria can be used in place of a reference dose in calculating the contribution of lead to the Hazard Index. For other scenarios, such as the recreational activity scenarios in the Christina River, this method overstates lead's contribution to the Hazard Index. The lead levels in the river are so low that EPA has determined they do not pose any significant health risk for someone undertaking recreational activities in the river and, therefore, were not included in the Hazard Index calculations for the recreational exposure scenarios in the Christina River.

The contaminants which contribute most to the human health risk at the Site are lead, vinyl chloride, arsenic, tetrachloroethene, trichloroethene, cobalt, zinc, cadmium, and manganese.

Receptors for which risks are unacceptable include the future construction worker and the adolescent trespasser at the south landfill area; the maintenance worker for the north landfill area and the Holly Run plant; the maintenance and future construction worker at the CIBA-GEIGY plant; and the resident, in the future, drinking contaminated ground water just off the south landfill property.[16]

The RI/FS also found no evidence that Site-related contaminants result in unacceptable health risks from eating fish in the Christina River because there were no data that showed elevated levels of metals in fish typically consumed by humans caught near the Site relative to those caught upstream and out of the influence of the Site.

ENVIRONMENTAL EVALUATION

The Environmental Evaluation (EE) focused on potential impacts to aquatic life in the wetlands and the river. However, it also examined potential impacts to terrestrial animals and plant life. Sediment chemistry, benthic (macroinvertebrates

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settings (recreational activities at the ball park and trespassing at the south landfill have only minimal exposure times to elevated levels of lead), EPA believes that 500 ppm is protective. EPA Region 3 Superfund Program practice is to use 1000 ppm for an industrial exposure scenario unless there is evidence that 1000 ppm is not protective. EPA has determined that a soil clean-up level of 1000 ppm for lead based on a direct contact industrial exposure scenario is appropriate for this Site.

[16]Although not reflected in the risk calculation, remediation of a lead hotspot is required at the ballpark because of lead levels above 500 ppm.

living in and on the sediments) studies, and sediment toxicity were the main indicators of aquatic impacts. Plant chemistry, literature research, and field observations were used to determine impacts to plant life. Estimates of impacts to terrestrial animals were calculated in a way similar to that used to calculate the non-carcinogenic risks to humans.

Figures 19 and 20 show some of the results of the biological tests and the ratio of the normalized metals concentrations at each station to those at the reference station (the enrichment factor). Figure 19 contains test results for the wetland areas, and Figure 20 contains test results for the river. The figures also include results of the sediment elutriate toxicity tests measuring percent survival of water fleas (*Ceriodaphnia*) and fathead minnows (*Pimephales promelas*); solid phase toxicity tests measuring percent survival of *Chironomus tentans* and *Hyallela azteca*; the density (number of organisms per unit area) and diversity (number of different types of organisms and relative abundance of each type) measurements of benthic organisms at different sampling stations as well as the relative frequency of pollution tolerant benthic organisms to the total population. Some of the other tests that are available in the RI include Target Analyte List (TAL) metals analyses data for the sediments, results of the sediment elutriate toxicity tests reproduction rate of water fleas (*Ceriodaphnia*) and the growth rate of fathead minnows (*Pimephales promelas*), solid phase toxicity tests measuring the growth rate of *Chironomus tentans* and *Hyallela azteca*.

Areas that were examined for potential environmental impacts included tidal wetlands adjacent to the north landfill, wetlands in a drainage way that cuts through the north landfill, non-tidal wetlands adjacent to the south landfill, a pond adjacent to the south landfill, upland areas (much of which is on top of the two landfills), and the Christina River (see Figure 21).

The tidal wetland area adjacent to the west end of the north landfill (excluding the lower part of the north drainage way) is approximately seven acres in size. Contamination was detected at the two sampling stations, with lead and zinc being detected as high as 10 times (on a normalized-to-grain size basis) the Site reference station (station RS15 located four to five miles upstream in the Christina River). The location of these two stations indicates that the contamination is present throughout the north wetland area. Contamination is most likely widespread due to the incoming tide carrying contaminated sediment and water throughout this area. Sediment toxicity tests and benthic studies were done to determine impacts caused by the contamination. Slight impacts could be determined from one of the toxicity tests and from the high abundance of pollution tolerant benthos species. Most of the toxicity test results did not indicate any significant levels of toxicity. EPA has determined that currently no remedial action in the north wetlands is warranted because measured impacts are slight and preserving or enhancing the existing viable wetland habitat is preferable to stripping the wetland sediments and creating a new wetland.[17]

The worst toxicity results at the Site were for samples collected from the drainage way that crosses the north landfill and then wraps around the western base of the landfill and discharges to the Christina River. The mid- and lower sections of the drainage way (where it goes over the edge and potentially cuts into the landfill itself) show signs of extreme impact. Lead levels are extremely high (27,000 ppm maximum). Several of the sediment toxicity tests had no survivors, and the benthic density (number of macroinvertebrates per unit area) was also very depressed (one sampling station in the lower section had a benthic density less than 0.5% of that found in the upper portion of the drainage way). Remediation is required for the mid- and lower sections of the north drainage way in order to protect the environment. The upper end of the drainage way did not exhibit any measurable environmental impacts but did have slightly elevated levels of cadmium, copper, lead, and zinc. EPA has determined that remediation for the mid- and lower sections of the drainage way is necessary because of extreme environmental impact.

The non-tidal wetlands area adjacent to the south landfill is 18 acres in size. This area is not a tidal wetland because a tide gate prevents river water from entering the wetland at high tide. Very high levels of barium (34,700 ppm), lead (5,550 ppm), and zinc (12,800 ppm) have been found in sediments. In one area, the benthic density is depressed, there is a high abundance of pollution tolerant species, and the survival rate of *Hyallela azteca* was low. EPA has determined that remediation is necessary in part of the south wetlands due to unacceptable impacts to environmental receptors. The exact areal extent requiring remediation is unknown at this time.

The pond adjacent to the south landfill has barium levels as high as 60 times the reference station (on a normalized basis) and lead levels as high as 27 times the reference station (also on a normalized basis) showing that the pond has been affected by Site-related activities. The toxicity tests and benthic studies indicated only slight environmental impacts. Field observations

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[17]Although data collected to date do not show a need for remediating the north wetlands, data collected during the remedial design may show areas of the north wetland to be above the clean-up criteria and, therefore, that require remediation. See the discussion below in this section regarding the determination of clean-up criteria.

show this area to be a viable habitat for turtles and muskrats. Vegetation is abundant and representative of a relatively healthy ecosystem. Plant tissue analysis does show chemical uptake and there is concern about the potential impacts this may have to terrestrial receptors. Risk assessment calculations similar to that for determining the Hazard Index for humans show there is a potential impact to animals who consume plants from this area. Because the toxicity tests and the benthic studies did not indicate severe environmental impacts, EPA believes that remediation is not warranted for the south pond. However, monitoring should take place to make sure that the metals do not become bioavailable to aquatic or terrestrial life.

About 30 acres of the Site is considered upland areas (such as the north and south landfills) which provide habitat for animals. Signs of, or actual sightings of deer, beaver, fox, and mice have occurred. Estimates of risks were made due to ingestion of contaminated soils using the deer mouse as a representative species. EPA has determined that remediation of the upland areas is not warranted due to impacts to terrestrial life except for several areas of potential concern. One is a barren area at the southwest corner of the north landfill. High levels of metals (arsenic, barium, cadmium, copper, lead, nickel, and zinc) exist in the surface soil. Levels of zinc are high enough to likely produce toxic effects to the plant life thereby preventing vegetation growth. Although the lack of vegetation may not attract terrestrial life for feeding, bare spots are known to be used for daily habits of many ecological receptors (i.e., birds). EPA has determined that this barren area needs covering to prevent potential exposure to ecological receptors. Also, there are several small (less than one cubic yard) piles of Lithopone waste in the upland area to the west of the north landfill that EPA has determined require removal.

The Christina River flows through the Site and between the north and south landfills. Chemical analyses of the river sediments show high levels of heavy metals associated with the Lithopone process. Elevated levels of metals have been detected from the north drainage way to several miles downstream. All up-gradient sampling appears to have been done far enough up-river from the north landfill to be out of any influence of the Site (the Site is considered to be any place that Site-related contamination has come to be located). However, since the nearest up-river sampling location was over a mile and a half from the north landfill, the potential exists for contamination to have migrated up-river from the Site due to tidal influences and been deposited between the north landfill and the up-river sampling stations. Surficial sediments, which are contaminated by ground water, do have high levels of contamination that tests indicate are toxic in some areas (see data for RS11 and RS12 in Figure 20). EPA has determined that these contaminated sediments need to be remediated. The areal extent of this impact is not known at this time. However, impacts appear to be highest near the north river bank in the area of the landfills and the CIBA-GEIGY plant.

During the RI, the Site reference station for both the wetlands and the river was RS15 which was about 5 miles upstream on the Christina River from the north drainage way. While apparently unaffected by the Site itself, data from station RS15 suggest that RS15 is influenced by some other site and is therefore not representative of pristine background conditions in the river. This fact should be taken into account when comparing data from Site sampling stations to the reference station to evaluate the presence and extent of any degradation. Efforts should be made during the remedial design and the remedial action to find a reference station, preferably near the Site, which is representative of background conditions (preferably a separate station for wetlands and for the river). Also, through examination of aquatic conditions at other areas of northern Delaware, a list of conditions should be developed that would be expected in a pristine environment (i.e., the ideal reference station).

As described above, EPA has determined that review of all available data (especially that of the toxicity tests, the benthic studies, and the chemistry tests) indicates that several areas of the wetlands and the river warrant remediation. Figure 22 generally outlines these areas. However, due to the broad spacing of samples collected during the RI/FS, the exact areal extent of remediation is currently unknown but will be determined during the remedial design (RD) phase. Figure 23 shows the area in which delineation of unacceptable impacts must be performed in order to determine the exact areas requiring remediation.

In order to make the determination of the exact areal extent of excavation practical, EPA has set Site-specific clean-up criteria for the wetlands and the river based on all available data with an emphasis on the toxicity tests and the benthic studies.[18] The clean-up criteria correspond to the concentration of contaminants found in areas which require remediation based on the results of the bioassessment data. During the remedial design, chemistry tests will have to be done to delineate the exact areas which require remediation. Due to the extreme variability that can occur in sediment contaminant levels due to grain size, it is best to normalize the contaminant levels to grain size in order to compare different sampling stations and sampling events. Therefore, the clean-up criteria

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[18]See the "Memo To File" dated 7/9/93 titled "River & Wetland Remediation Goals (Sediment Clean-up Criteria), Third and Final Edition" attached to this ROD (see Attachment B).

are stated as normalized (to grain size) contaminant levels. The clean-up criteria are:

Lead	1200	ppm
Cadmium	60	ppm
Zinc	5600	ppm

Areas where any one of the above normalized contaminant criteria is exceeded will be remediated. However, one area where EPA has determined that these criteria do not apply is the south pond. Although the above criteria would trigger remediation of the pond, the biological tests indicated no severe environmental impacts in the pond. For example, sampling station AS-01 in the pond had the highest recorded benthic density recorded during the RI and one of the most diverse benthic communities. The difference in the environmental conditions between the pond and the marshy wetlands may be causing a difference in the bioavailability of the contaminants. Due to the fact that 1) the above criteria are not applicable to the south pond and 2) the levels are relatively high compared to sediment contaminant levels that generally have been found to be toxic at other locations, a minimal amount of further toxicity testing will be done during the remedial design to make sure that the levels are protective. In each of the north wetlands, south wetlands, south pond, and Christina River, a minimal number of *Hyallela azteca* solid phase toxicity tests shall be performed in areas where the contaminant levels are below the Site-specific clean-up criteria but above the "apparent effects threshold" (AET) levels for cadmium, lead, and zinc (9.6 ppm, 660 ppm, and 1600 ppm respectively on an absolute basis).[19] EPA may decide to reduce the Site-specific clean-up criteria based upon the results of the toxicity tests although not to levels below the AET values described above. Any reduction may be done across the Site as a whole or independently for each area. The test in the south pond would be evaluated to confirm whether or not the whole pond should be remediated. No criteria will be set for the pond. It should be noted that any sediment clean-up criteria developed for this Site are site-specific criteria to be used at this Site only.

EPA has determined from the information collected during the RI that actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

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[19]The cost estimate for the ROD assumed four sampling stations in each of the four areas with four replicates at each sampling station. See the attached 7/9/93 "Memo to File" for a detailed discussion (see Attachment B).

SUMMARY OF AREAS REQUIRING REMEDIATION

In summary, based on the potential impacts to human health and the environment, EPA has determined that the following areas of the Site warrant remediation:

1. Ballpark: The east entrance to the ballpark near the end of Ayre Street has surface soils above EPA's clean-up criteria of 500 ppm that create an unacceptable risk to human health.

2. North landfill including the drainage way: This area continually releases contaminants to the ground water in the fill and/or Columbia aquifers which affects shallow ground water in the direction of migration and ground-water discharge areas. One of the areas affected by the discharge is the Christina River which has AWQC or SWQS exceedances and some sediments which exhibit unacceptable environmental impacts. Another area affected by the discharge is the north drainage way, parts of which exhibit extreme impacts to ecological receptors.

3. South landfill: This area continually releases contaminants to the ground water in the fill zone and/or Columbia aquifers which affects shallow ground water in the direction of migration and ground-water discharge areas. The two discharge points are the river and the south wetlands which have AWQC or SWQS exceedances and some sediments which exhibit unacceptable environmental impacts. Future subsurface maintenance or construction activities would result in unacceptable risks to humans.

4. South wetlands: Part of this area exhibits unacceptable environmental impacts including low benthic density and poor benthic diversity (i.e., a high percentage of pollution tolerant species).

5. Christina River: Some of the sediments in the river exhibit unacceptable environmental impacts. AWQC or SWQS for several Site-related contaminants, including cadmium, lead, and zinc, are exceeded in the vicinity of the Site.

6. CIBA-GEIGY plant and a small portion of the Du Pont Holly Run plant: Exposure to surface and subsurface soils cause unacceptable risks to humans. This area continually releases contaminants to the ground water in the fill zone and/or Columbia aquifers which affects shallow ground water in the direction of migration, ground water in the Potomac aquifer where the hydraulic gradient is downward, and ground-water discharge areas. One of the discharge points that is affected is the river which has AWQC or SWQS exceedances and some sediments which exhibit unacceptable environmental impacts.

7. Ground water: The ground water in the fill zone and both the Columbia and the Potomac aquifers at the Site is not safe to drink. Levels of contaminants such as tetrachloroethene, trichloroethene, cadmium, barium, and lead exceed their MCLs or non-zero MCLGs in the Columbia aquifer. Arsenic, cobalt, manganese, and zinc also contribute to unacceptable human health risks in the Columbia aquifer. Levels of contaminants such as tetrachloroethene, cadmium, lead, and trichloroethene exceed their MCLs or non-zero MCLGs in the Potomac aquifers. Cobalt also contributes to unacceptable risks to humans. No one is currently consuming any ground water that has MCL or non-zero MCLG exceedances caused by the Site.

DESCRIPTION OF ALTERNATIVES AND SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

The following alternatives were evaluated in detail in the feasibility study to determine which would be the most effective in achieving the goals of CERCLA, and in particular, achieving the remedial action objectives for the Site. The detailed analysis of remedial alternatives for the areas of the Site are briefly described below. As required by the NCP, EPA used nine criteria to evaluate alternatives. These criteria are summarized in Table 11. The first two criteria (overall protection of human health and the environment, compliance with applicable or relevant and appropriate requirements (ARARs)) are threshold criteria. The selected remedy must meet these threshold criteria (except when an ARAR waiver is invoked). The next five criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost) are the primary balancing criteria. The remaining two criteria (state and community acceptance) are referred to as modifying criteria.

Alternative #1 in each of the sections below is the "no action" alternative which, although not listed in each section, was evaluated for each area as required under Section 300.430(e)(6) of the NCP. This section of the NCP requires EPA to evaluate the "no action" alternative at every site to establish a baseline for comparison to other alternatives. Under the "no action" alternative, no action would be taken to address current or future exposure to contaminants remaining at the Site. No costs are associated with the "no action" alternative, and no time is required for implementation.

BALLPARK

ALTERNATIVE #2: A small area, where Ayre Street dead ends at the ballpark (see Figures 2 and 24), with lead levels above 500 ppm would be excavated. Samples would be taken to delineate the waste material and to determine if the soil to be excavated would be classified as a RCRA-hazardous waste. Soil would be excavated to a depth and extent such that remaining lead levels are below 500 ppm. Confirmatory samples will be taken before the area is backfilled and reseeded. The estimated amount of soil requiring excavation is one cubic yard. Testing would be performed to show whether or not the excavated soil is a RCRA-hazardous waste (i.e., exceeds the Toxicity Characteristic Leaching Procedure (TCLP) criteria). If the excavated soil is not a RCRA-hazardous waste, then it would be disposed of in the north landfill. If the excavated soil is a RCRA-hazardous waste, it may be disposed of either in the north landfill or off-site at an EPA-approved facility in accordance with RCRA regulations. If the excavated soil is a RCRA-hazardous waste and is disposed of in the north landfill, the soil would be treated by stabilization until it is no longer a RCRA-hazardous waste in order for the disposal to be in compliance with RCRA land disposal regulations. The present worth cost for this alternative is $10,000.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Alternative #1 (no action) does not protect human health due to the unacceptable levels of lead that would be left in the ballpark. Alternative #2 does provide overall protection to human health by preventing exposure to soils containing high levels of lead. If TCLP tests indicate that the soil is a RCRA-hazardous waste, RCRA land disposal requirements would be met through either on-site treatment (to achieve the requirements as ARARs) or off-site treatment (to achieve the requirements as regulations). Alternative #2 provides excellent long-term effectiveness since no soil will remain in the ballpark that could cause unacceptable risks to humans. Reduction of mobility through treatment would be met in Alternative #2 if the excavated soil is a RCRA-hazardous waste. The short-term effectiveness and implementability of Alternative #2 are also excellent since the amount of soil to be excavated is very small.

Alternative #2 has the support of the State. Written comments received from the public, including Du Pont, showed strong support to remove whatever contaminated soil is necessary from the ballpark in an expeditious fashion. Upon evaluation of the alternatives by the nine criteria, EPA has determined that Alternative #2 is the selected remedy.

NORTH LANDFILL

ALTERNATIVE #2: A low-permeability cover system (cap) would be installed to reduce infiltration in order to minimize continued ground water contamination from this area. For example, the cover could be a geosynthetic clay liner. Figure 25 shows the approximate area to be covered and a potential cross section of the cover system. The exact location of the thorium drums would be determined, and a marker indicating their location would be installed on the surface of the landfill once the cap was completed.

A low-permeability cover system would also be placed on the river bank that extends from the crest of the bank down to the river (referred to as the river bank cover system). An example of a potential river bank cover system includes a concrete revetment mattress (a layer of concrete cast in place using connected fabric bags as forms) placed on top of a geosynthetic clay liner which is underlain by another geomembrane and anchoring layers of concrete-filled fabric bags placed on the lower portion of the liner (see Figure 26).

Several small (less than one cubic yard) piles of Lithopone waste in the upland area to the west of the north landfill would be consolidated in the north landfill prior to capping.

Part of the north drainage way would be covered by the cap. The wetlands associated with the lower part of the north drainage way would be remediated by removing the top one foot of sediments. The excavated area would be backfilled with clean fill and revegetated. The exact area requiring remediation would be determined during remedial design by sampling sediments throughout the north wetlands. The excavated sediments would be stabilized and placed underneath the cap.[20] The excavated areas would be restored as a wetland. In order to compensate for the wetlands lost due to capping (a small area on top of the landfill, the upper part of the drainage way, and any portions of the covered river bank that are classified as wetlands), approximately three quarters of an acre of upland area adjacent to the north wetland (unless EPA determines during the remedial design that the type of wetlands requires more than one-to-one replacement) would be graded to establish wetland hydrology. Then other measures would be taken to successfully establish the wetland including planting a variety of grasses and hydrophytic species common to the area.

The lower section of the north drainage way and the north wetlands will undergo long-term monitoring to ensure that the remedy is protective. Also as part of this alternative, long-term monitoring of the north wetlands would take place to make sure the remedy remains protective. The present worth cost of this alternative is $3,500,000.

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[20]RCRA land disposal regulations would be ARARs at this Site only if placement (i.e., disposal) occurs. For placement to occur, the sediments would have to fail the TCLP test and be treated "*ex-situ*." LDRs would not be ARARs for any "in-situ" treatment because no placement would occur since movement of sediments from the north wetlands to the north landfill is considered consolidation within an area of contamination.

ALTERNATIVE #3: This alternative includes everything from Alternative #2 plus the addition of a fill zone hydraulic barrier system (a system of pumping wells that would prevent migration of ground water past a line of recovery wells). The hydraulic barrier system would create a ground water divide that would prevent ground water from the fill zone from discharging to the river. The recovered ground water would be treated with a combination of air stripping to remove volatile organic compounds (VOCs) and precipitation to remove heavy metals. If necessary to comply with DNREC and EPA requirements and regulations, the off-gas from the air stripper would be treated. The treated ground water would be discharged to the Christina River in compliance with the substantive requirements of a National Pollution Discharge Elimination System (NPDES) permit. It is anticipated that the ground-water treatment sludges would be hazardous waste. Since one of the original uses of the tetrachloroethylene in the ground water was as a degreaser of magnesium in the production of titanium metal, any treatment residues containing tetrachloroethylene shall be considered F002 waste. Disposal of any treatment sludges or other wastes would be in accordance with appropriate Federal and State regulations. The present worth cost of this alternative is $12,000,000.

ALTERNATIVE #4: This alternative is the same as Alternative #2 with the addition of a physical barrier wall (an actual wall that limits migration of ground water) that would extend to the base of the Columbia aquifer (see Figure 27 for the approximate wall location). If necessary, this wall would be part of a fully circumscribing wall around the CIBA-GEIGY plant as discussed under the "CIBA-GEIGY and Du Pont Holly Run Plants" section below. Different barrier wall technologies were evaluated in the feasibility study, including deep soil mixing, sheet piles, and a soil/bentonite slurry. Further evaluation will take place in the remedial design. Use of geosynthetic membranes as a physical barrier will also be evaluated in the remedial design. The wall would limit to the maximum extent practicable contaminated ground water from the fill and Columbia zones from entering the Christina River. The wall will cause mounding of the ground water to occur in the landfill. Extraction wells would be installed to control the mounding effect. Ground-water treatment would take place as described under Alternative #3. The present worth cost of this alternative is $12,500,000.

ALTERNATIVE #5: This alternative is the same as Alternative #4 except this alternative leaves the natural vegetation on the river bank instead of installing the river bank cover system. The present worth cost of this alternative is $12,100,000.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Alternative #1 (no action) would not provide overall protection of the environment since it would leave the area of worst environmental impact, the north drainage way, unremediated. Each of the other alternatives does remediate the north drainage way by replacing the top one foot of sediments where biota (small aquatic organisms) live, thereby contributing to the protection of the environment. Alternatives #2, #3, #4, and #5 provide for capping the landfill which will greatly decrease, but not eliminate, this area's contribution to an overall Site ground water problem in which MCLs are exceeded.[21] However, in order to provide overall protection of human health and the environment and long-term effectiveness, the discharge of ground water from the fill zone and the Columbia aquifer must be limited to the maximum extent practicable. Discharge of the ground water will continually contaminate sediments and contribute to AWQC or SWQS exceedances in both adjacent wetlands and the Christina River. This is especially important of the fill zone ground water that discharges on the west side of the landfill into the drainage way where there is only very limited surface water to dilute the leachate. Alternatives #4 and #5, which include a provision for a physical barrier wall which extends to the base of the Columbia aquifer, limits the migration of contaminated ground water from this area to the maximum extent practicable and, therefore, meet the threshold criteria of overall protection of human health and the environment. Alternatives #2 and #3 do not adequately limit the discharge of ground water to the adjacent wetlands and the river (since they do not control the discharge of the Columbia aquifer) and therefore do not meet the overall protection of human health and the environment threshold criteria.

Although the river bank cover system in Alternatives #2, #3, and #4 would decrease the ability of contaminants in the landfill

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[21]RCRA Subtitle C landfill closure regulations are not considered ARARs for the north landfill. Since the north landfill was closed prior to the enactment of RCRA, RCRA landfill closure regulations are not applicable. The closure regulations are relevant since in all likelihood some of the waste in this landfill would fail the TCLP test. However, the closure regulations are not appropriate. The main technical parts of the closure regulations are that the cap must be less permeable than the bottom liner to prevent a bathtub effect and that the ground water must be monitored to determine if any contamination is migrating from the landfill. Since the landfill has no bottom liner, meeting the closure regulations would only require a slightly impermeable cap. EPA has determined that this is not protective enough of the environment. As for the ground-water monitoring, since the north landfill is adjacent to a river, since the Columbia aquifer is already contaminated, and since active ground-water remediation will not take place in this area, the monitoring requirements as described in 40 CFR 264.98 are not appropriate, and therefore, the closure regulations are not appropriate.

berm from leaching into the river, the natural river bank vegetation (as part of Alternative #5) offers better slope stability. The natural vegetation also provides feeding, roosting, breeding, and cover habitat for birds; provides spawning, nursery, feeding, and cover habitat for fish; and provides benefits for the river such as cooling. The benefits to the environment of the natural river bank vegetation are greater than the benefits of the river bank cover system when combined with the physical barrier wall in Alternative #4. Therefore, Alternative #5 offers a greater degree of overall protection of human health and the environment as compared to Alternative #4.

The ground-water treatment system associated with the installation of the physical barrier wall in Alternatives #4 and #5 would meet all air, water, and RCRA ARARs. The estimated withdrawal rate ranges from 25,000 to 200,000 gallons per day (from north landfill and the CIBA-GEIGY plant area combined). Unless the remedial design ascertains that the withdrawal rate will not exceed 50,000 gallons per day, Delaware River Basin Commission (DRBC) Ground Water Protection Area Regulations would be considered ARARs (although they would no longer be applicable if the actual withdrawal rate was below 50,000 gallons per day).

None of the alternatives would bring the north wetlands into compliance with the State of Delaware's Surface Water Quality Standards (SWQSs), which are ARARs for this area, due to upstream sources of zinc (entering the wetland with the tide) and possible background sources of iron and aluminum. Therefore, by issuing this ROD, EPA is invoking the "technical impracticability" waiver as outlined in Section 300.430(f)(1)(ii)(C)(*3*) of the NCP because it is not possible for remedial actions in the north landfill (wetlands area) to meet the SWQSs.

Alternatives #4 and #5 offer the greatest degree of long-term effectiveness since they limit to the maximum extent practicable the discharge of contaminated ground water which could recontaminate the remediated portions of the wetlands and the river. Alternatives #2, #3, #4, and #5 have potential for short-term impacts because they require locating the thorium drums and drilling into the landfill. A health and safety plan would be developed during the remedial design to protect the workers (including from radiological hazards). Alternatives #4 and #5 would have moderate short-term impacts due to temporary destruction of wetlands, potential construction worker exposure to waste in the north landfill, and sediment transport to the river due to erosion. Erosion controls would have to be implemented to reduce sediment transport. Each of the alternatives would require on-going maintenance since the waste is not being removed or treated to levels that allow unrestricted use.

The overall present worth costs of Alternatives #5 are less than those of Alternative #4. The present worth costs for both of these alternatives are significantly higher than the present worth costs for Alternative #2, due largely to the costs associated with treating the contaminated ground water prior to discharge. However, of the alternatives that meet the threshold criteria of overall protection of human health and the environment and achieves ARARs (Alternatives #4 and #5), Alternative #5 is the most cost-effective.

Overall, the State supports the selection of Alternative #5 except that the State does not agree with determination of the Site-specific clean-up criteria for the sediments. The State strongly believes that a substantial amount of sediment toxicity tests must be performed in the north wetlands to determine which areas must be remediated (see Attachment A for details on the State's position).

At the public meeting there was general support of the preferred alternative (which is practically the same as the selected remedy without the river bank cover system). Written comments from the public, including Du Pont, supported capping the north landfill and remediating the north drainage way, but did not support the potential remediation of the north wetlands or the need to control the discharge of the ground water into the river. However, only areas of the north wetlands that exceed the Site-specific sediment clean-up criteria will be remediated. The two sampling stations in the north wetlands in the RI did not show exceedances of the Site-specific sediment clean-up criteria. Also, as discussed above, EPA has determined that controlling the discharge of the ground water into the river is necessary to protect the environment and that the physical barrier wall that is discussed in Alternative #4 is the most effective means of limiting continued migration of the contaminated ground water in the fill zone and the Columbia aquifer to the Christina River and the north drainage way. Therefore, upon evaluation of the alternatives by the nine criteria, EPA has determined that Alternative #5 is the selected remedy.

SOUTH LANDFILL

ALTERNATIVE #2: This alternative would involve institutional controls, access road improvements on the berm in the south wetlands, excavation and backfilling of the portion of the landfill underneath and to the east of Basin Road (i.e., all of the landfill currently on Delaware property) with consolidation in the rest of the landfill, and installation of a low-permeability cover over the portion of the landfill on Du Pont property (see Figure 28). Also, in order to provide better Site security to control trespassing, additional fencing and a barrier of plants (perhaps thorny plants) would be installed around the entire south landfill area including the landfill and the adjacent wetland area. The institutional controls would include a notification in the deed regarding past land use, and restrictions on future land use. Access road improvements would involve regrading the southern berm, installing erosion control matting, adding crushed stone on top of the berm and installing a culvert through the existing breach. The low-permeability cover would be of the same construction as on the north landfill. The present worth cost of this alternative is $7,000,000.

ALTERNATIVE #3: This alternative is the same as Alternative #2 with the addition of a physical barrier wall that extends to the base of the Columbia aquifer (technology to be chosen during remedial design from deep soil mixing, soil/bentonite slurry, sheet piles, or geosynthetic membrane) along the river and ground-water recovery and treatment similar to that described in Alternative #2 for the north landfill. The present worth cost of this alternative is $16,000,000.

ALTERNATIVE #4: This alternative is the same as Alternative #2 except that the waste in the south landfill will be stabilized *in-situ* prior to capping and the berm would be removed in order to mitigate the impacts that the increased volume of the landfill has on the floodplain. By stabilizing the waste, the ability of the metals to be leached by the ground water will be greatly reduced.[22] Currently the water table is in the waste material and even after capping, about two feet of waste will still be in the water table. For the purposes of the feasibility study, Portland Cement Type I was used as the stabilization agent although a design optimization study would have to be done to determine the appropriate agent to be used during the remedial action. Stabilization would continue until the waste passed the TCLP test and passed a TCLP-like test using background Site ground water instead of acetic acid to leach the contaminants. The criteria for passing this second test would be MCLs. The present worth cost of this alternative is $15,300,000.

ALTERNATIVE #5: This alternative is the same as Alternative #4 except instead of a double layer low-permeability cap, a RCRA Subtitle D cap (containing a minimum of 18" of 10^{-5} cm/s permeability soil on top or its equivalent) would be constructed on top of the south landfill. The present worth cost of this alternative is $14,300,000.

COMPARATIVE ANALYSIS OF ALTERNATIVES: The "no action" alternative does not meet the threshold criteria of overall protection of the environment because of continued contaminant release to the ground water which discharges to the adjacent

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[22]Since no placement would occur, RCRA land disposal regulations would not be triggered.

wetlands and contaminates the sediments and the surface water. Alternatives #2, #3, #4, and #5 call for capping the landfill which would significantly reduce the release of contaminants to the ground water thereby protecting the wetlands and the river and contributing to a reduction in ground-water contaminant levels (which exceed MCLs) and to a reduction in surface water contaminant levels (which exceed AWQCs in the south wetlands and the river). Also, by consolidating the landfill, all of the landfill could be capped, and potential worker exposure during any future subsurface work along Basin Road would be eliminated.

Currently, much of the waste in the south landfill is below the water table. Capping the landfill would reduce the ground-water mound, but approximately two feet of waste would still be in the water table even after the mound dissipates. By stabilizing the waste before it is capped (as called for in Alternatives #4 and #5), the amount the of contaminants that could be leached out by natural ground-water flow would be limited to the maximum extent practicable, thereby contributing to the protection of the ground water and the surface water.[23]

Most of the major ARARs for this part of the Site are related to the protection of wetlands with the exception of RCRA Subtitle D closure requirements and Delaware Regulations Governing Solid Waste (see Table 12). Alternatives #2, #3, #4, and #5 all meet their respective ARARs. Care would be taken during the design and construction to prevent any adverse affects in the south wetlands and the Christina River. Any wetlands that would be destroyed during remedial action would be replaced on a one-to-one area ratio.

RCRA Subtitle C landfill regulations (in particular those related to closure) are not ARARs for the south landfill. Although there is currently waste material in the south landfill that could be classified as RCRA-hazardous waste, disposal occurred before 1980 so these regulations are not applicable. These regulations would be relevant for Alternatives #2 and #3

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[23]Although in wastes with a large number of metal contaminants, stabilization has been shown in some studies to cause the leachability of some contaminants to increase while decreasing others, stabilization has been determined by EPA to be the best demonstrated available technology (BDAT) for soils and sludges with heavy metal contamination. A design optimization study would have to be done during remedial design to determine the proper type and amount of stabilization agent. It should also be noted that stabilization decreases mobility by not only decreasing the leachability, but also greatly decreasing the permeability of the waste and therefore reducing the ability of the leaching agent (in this case ground water or infiltrating rain water) from coming into contact with the waste.

since the waste being capped would be a RCRA-hazardous waste. However, for Alternatives #2 and #3, they are not appropriate because they are not well suited for this area. One of the major closure requirements is for a cap to be installed that is less permeable than the liner or natural subsoils underneath the waste (to prevent a bathtub effect). This is an inadequate requirement for this area because it would allow a cap that would not adequately control infiltration. For Alternative #4 and #5, since the waste is being stabilized to the point of no longer being a hazardous waste prior to capping, these regulations would not be relevant.

Alternatives #4 and #5 offer the greatest degree of long-term effectiveness although the difference from Alternative #3 is small. By stabilizing the waste material (as in Alternative #4 and #5), the leachability of the metals would be greatly decreased thereby reducing the ability of the contaminants from the south landfill to migrate to the wetlands and cause an impact to environmental receptors. While in Alternative #3, any ground water that comes into contact with waste material, would be extracted before it enters the river (and by pumping, this ground water could not enter the south wetlands), the extremely high amount of operations and maintenance (that would probably be required forever) greatly decreases (in comparison to Alternative #4) the ability to maintain reliable protection of the environment.

Stabilizing the waste would greatly reduce its mobility but would increase its volume by about 25%. Alternatives #2 and #3 offer no reduction of toxicity, mobility, or volume through treatment. Alternative #2 is the best in terms of short-term effectiveness (with Alternatives #4 and #5 being the worst) because it has the least number of major components. However, in all the alternatives (except the "no action" alternative), traffic along Basin Road, which is the only easy access to a number of salvage yards, would be greatly restricted and possibly halted during part of the construction. Alternatives #2, #3, #4, and #5 are all implementable with Alternative #2 being the easiest and Alternatives #4 and #5 being the most difficult. The net present worth cost of Alternative #2 is significantly less than the other three, with Alternative #5 being less than Alternative #4 which is slightly less than Alternative #3.

EPA has determined that Alternative #5 (consolidation, stabilization, and capping) is the preferred remedy because it provides a high degree of overall protection of human health and the environment (almost that of Alternative #4). Alternative #5 significantly reduces the ability of the contaminants at the south landfill to migrate where they contribute to ground-water MCL exceedances and the surface-water SWQS exceedances. It also meets EPA's preference for treatment and has the second highest degree of permanence and long-term effectiveness among the compared alternatives. However, EPA has determined that the extra protection afforded by Alternative #4 is not necessary because the waste, once stabilized, would no longer fail the TCLP test and has selected the least costly of the two alternatives that offer overall protection to human health and the environment.

The State does not support the selection of Alternative #5. The State's position is that a low-permeability cap (such as that described in Alternative #2) would be sufficient to protect the environment (see Attachment A for details on the State's position). Written comments received from the public, including Du Pont, support capping or possibly stabilizing the waste but not both. Also, strong objections have been expressed to any temporary complete closing of Basin Road or South James Street. To alleviate the concerns, the performance standards state that the excavation must be conducted in such a way as to allow some traffic through this area during daily business hours.

SOUTH WETLANDS

ALTERNATIVE #2: This alternative involves determining the exact areal extent of unacceptable environmental impact (based on the clean-up criteria for cadmium, lead, and zinc (Figure 29 shows the approximate area requiring remediation, the exact areal extent will be determined during the remedial design), stabilization of the excavated sediments and then disposal in the south landfill,[24] backfilling the area of excavation to return the area to original grade, re-vegetating and re-establishing the wetlands, long-term monitoring of the entire south wetland area, and long-term maintenance of the tide gate to prevent the Christina River from entering the wetlands. The present worth cost of this alternative is $4,200,000.

ALTERNATIVE #3: This alternative is the same as Alternative #2 except that instead of using the sediment clean-up criteria to determine what area required remediation, remediation would take place wherever Delaware's SWQS exceedances occur in the wetlands. Work would be done during the remedial design to determine sediment clean-up criteria that would allow the surface water in the wetland to stay below the SWQSs. This is estimated to be a much larger area than if the sediment clean-up criteria in Alternative #2 are used. For the purposes of a cost estimate, it is assumed that the whole south wetland area would require remediation for this alternative. The present worth cost of this alternative is $9,900,000.

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[24] Since placement would not occur, RCRA land disposal regulations would not be triggered.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Alternative #1 (no action) does not meet the threshold criteria of overall protection of the environment in that it leaves portions of the wetlands unremediated that have unacceptable environmental impacts. Alternatives #2 and #3 would comply with ARARs which prohibit the loss of wetland acreage and value.

Alternative #3 would comply with Delaware's Surface Water Quality Standards (SWQSs), especially if the ground water in the Columbia aquifer is remediated. In Alternative #2, Delaware's SWQSs may not be met in the south pond and in the southern portion of the south wetlands. For example at AS05, cadmium, chromium, copper, lead, and zinc exceed Delaware's SWQSs (aluminum and iron also exhibit exceedances although EPA has not concluded at this time that it is Site-related contamination) yet data collected during the RI show that this station is not expected to trigger EPA's Site-specific sediment clean-up criteria. EPA believes that it is mainly the contaminants in the sediments that are causing the exceedances and not discharging ground water (contaminant levels in the ground water at MW-5A are lower than in the surface water at AS05) although the ground water does contribute to the contamination in the surface water.

Although Alternative #3 would comply with water quality ARARs, EPA has determined relying on actual Site biological tests rather than the SWQSs to direct remediation provides a more protective remedy since the surface water contaminant levels are not much above SWQSs[25] and since compliance with SWQSs would

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[25]At AW01 (the same location as AS01 in the south pond, see Figure 7), lead and zinc exhibited SWQS exceedances. However, the total lead concentration was just above the SWQS while the dissolved concentration was below the SWQS. For zinc, during one sampling total and dissolved levels were below the SWQS and during the other sampling event, although the total concentration was above the acute SWQS, the dissolved concentration was below the chronic SWQS. At AW02, (the same location as AS02 in the south pond), the total lead concentration was above the chronic SWQS, but the dissolved lead concentration was below the chronic SWQS. At AS05, the total zinc concentration was above the acute SWQS, but it is expected that the dissolved concentration would be below the chronic SWQS (the dissolved zinc analysis was not done but the levels are generally two to ten times lower than the total concentration). For copper, the total concentration was just above the chronic SWQS. For cadmium, the total concentration was just above the chronic SWQS. For lead, the total concentration was above the chronic SWQS yet way below the acute SWQS, and the dissolved concentration, although not analyzed, is not expected to have been above the chronic SWQS. For chromium, the total concentration exceeded the chronic SWQS, but the dissolved concentration is not expected to.

likely involve stripping more wetlands than is necessary to protect the environment. Therefore, by issuing this ROD, EPA has determined that complying with the SWQSs in the south wetlands would create greater harm to the wetlands than relying mainly on the biological test data collected during the RI to decide where to remediate. EPA has also determined that Alternative #2 provides a greater degree of protection to human health and the environment, and EPA has decided to invoke the "greater risk to human health and the environment" ARAR waiver as outlined in Section 430(f)(ii)(C)(*2*) of the NCP. To make sure that there are not areas of the south wetlands where SWQSs exceedances are so extreme that the waiver is no longer considered protective, this waiver only applies as long as the dissolved concentration of a Site-related contaminant stays below its respective acute SWQS. If the dissolved concentration of any one Site-related contaminant goes above its respective acute SWQS, the sediments shall be removed regardless of whether or not there are exceedances of EPA's Site-specific sediment clean-up criteria.[26]

Alternative #2 provides for overall protection of the environment because it calls for removal of the portion of sediments that are creating unacceptable impacts to aquatic life. Long-term monitoring will provide a measurement of the effectiveness of the remedy and will help determine if the contamination left in the unremediated portions of the wetland becomes more bioavailable creating unacceptable environmental impacts.

The long-term effectiveness of Alternative #2 is expected to be good. Although Alternative #2 will not remove all of the contamination in the south wetlands and the remaining contamination will cause some impact to environmental receptors, EPA expects that the Site-specific sediment clean-up criteria will remain protective (i.e., EPA expects that in the future the impact of removing the rest of the contamination would be greater than the impact of the contamination itself). A reduction of mobility through treatment would occur if the waste material is stabilized. The short-term impacts are severe as the function of the wetlands will be lost during construction and, even after construction, re-establishing the wetland could take a significant period of time. Alternative #2 is implementable.

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[26]Since it is highly unlikely that the dissolved concentration of Site-related contaminants would exceed the acute SWQS, surface water chemistry samples do not need to be taken at every sampling station during the delineation of the areas that require remediation. Only 20% of those stations where the Site-specific clean-up criteria do not require remediation need surface water chemistry samples performed.

EPA has determined that Alternative #2 is the selected remedy for this area of the Site. The State does not support Alternative #2 because of its position that the Site-specific sediment clean-up criteria were developed without an adequate amount of data (see Attachment A for details on the State's position). Written comments received from the public, including Du Pont, supported the need for excavation; however, the public believed that hotspot remediation would be adequate.

CHRISTINA RIVER

ALTERNATIVE #2: This alternative involves determining the exact areal extent of unacceptable environmental impact (based on the clean-up criteria[27] for cadmium, lead, and zinc), hydraulic dredging of the river in this area, covering the area with clean fill, and dewatering and disposal of dredged sediments either on-site or off-site.[28] Silt curtains would be used to minimize transport of sediments away from the dredging area. Long-term monitoring would be conducted to determine if the unremediated areas develop unacceptable impacts and to confirm the long-term effectiveness of the remedy. The present worth cost of this alternative is $4,700,000 (based on disposal in the north landfill).

ALTERNATIVE #3: This alternative involves the determination of the exact areal extent of unacceptable environmental impact and capping this area with a concrete revetment blanket (a concrete revetment blanket is a series of connected fabric pillows that once anchored to the river bottom, is pumped full of concrete). Monitoring would occur to make sure the remedy remains protective of the environment. The present worth cost of this alternative is $2,700,000.

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[27]Whereas delineation of contamination in the wetlands involves only sampling the top six inches of sediments, delineation of sediment contamination in the river for Alternative #2 (dredging) would be done in six-inch increments to a depth of two feet. Any of these samples could trigger remediation. In areas where remediation is required, further vertical delineation of contamination would take place prior to dredging to a depth of two feet. This would insure that any sediments that would reasonably be expected to become mobile during a major regional storm event would be remediated. Dredging would continue until contaminant levels go below the clean-up criteria. The dredged area would be backfilled with clean sediments.

[28]RCRA Land Disposal regulations would be triggered only if disposal occurs off-site and if the dredged sediments fail the TCLP test.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Alternative #1 (no action) is unacceptable because it does not provide for the overall protection of the environment. Alternatives #2 and #3 do protect the environment by preventing exposure of aquatic life to sediment contaminant levels that produce unacceptable impacts. However, Alternative #3 (capping) potentially causes greater harm to the environment because deposition is not expected to occur on the blanket and therefore, the remediated area would not support aquatic life (i.e, capping does prevent exposure to the contaminated sediment but also permanently destroys the habitat). The long-term monitoring in both alternatives would ensure the implemented remedy is protective of the environment.

Major ARARs include Federal AWQC, Delaware's SWQSs, the Delaware Regulations Governing the Use of Subaqueous Lands, and the Coastal Zone Management Act. EPA cannot ensure that Alternative #3 (capping) would be consistent with the State of Delaware's Coastal Zone Management Plan and therefore capping does not comply with the Coastal Zone Management Act.

Neither alternative would attain AWQC or SWQSs, which are ARARs for this area, in the river at the Site due to upstream sources of zinc. Therefore, EPA is invoking the "technical impracticability" waiver as outlined in Section 300.430(f)(1)(ii)(C)(*3*) of the NCP because it is not possible for remedial actions at this Site to attain the SWQSs for any contaminant where upgradient sources are causing the exceedances of SWQSs.

The long-term effectiveness of Alternative #2 is much greater than Alternative #3 because the sediments are removed from the area and, if necessary, treated before being properly disposed of. The ability of either of these alternatives to maintain reliable protectiveness depends on limiting the discharge of ground water from the Site into the river. The Site-specific sediment clean-up criteria are expected to remain protective.

Dredging offers some opportunity for reduction of toxicity, mobility, or volume through treatment in this area. Dredged material would, in all likelihood, be disposed of on-site. At the north landfill stabilization would likely be required to improve structural stability of the sediments. If disposed of in the south landfill, the dredged material would almost definitely require stabilization. This stabilization would also reduce mobility of the metal contaminants. However, dredging would also cause an estimated 1 to 2 percent of the sediments to migrate from the Site with the river current. Alternative #3 offers the best short-term effectiveness. However, by limiting the period of dredging to times of low current velocity and low aquatic life activity, impacts can be kept to a minimum. Relative to dredging, installation of the cap would not take very long. Both

Alternatives #2 and #3 are implementable with Alternative #3 being the easiest.

Capping is more cost effective than dredging, especially if the wastes are not disposed of in the north landfill since costs would go up significantly (an estimated additional $8.5 million for off-site disposal).

EPA has determined that Alternative #2 is the preferred remedy. Although Alternative #3 does protect aquatic life by preventing exposure to contaminated sediments, it also destroys a substantial area of habitat and thereby does not meet the overall protection of human health and the environment threshold criteria. Alternative #2 would allow the habitat to be restored thus providing greater overall protection to the environment. Careful implementation of Alternative #2 should keep any sediment transport to a minimum. The State does not support Alternative #2 because of its position that the Site-specific sediment clean-up criteria were developed without an adequate amount of data (see Attachment A for details on the State's position). Written comments received from the public, including Du Pont, strongly opposed dredging and stated that Alternative #3 should be selected due to the risk of sediment transport during dredging operations.

CIBA-GEIGY AND DU PONT HOLLY RUN PLANTS

The remedies in this section address the areas shown in Figure 30. This area includes the complete CIBA-GEIGY plant and a portion of the Du Pont Holly Run plant that has contaminated soils (called "contaminated plant areas" below). Only about 3% of the Holly Run plant area is included.

ALTERNATIVE #2: This alternative involves institutional controls, paving the remaining portions of the contaminated plant areas, installing ground-water recovery wells in the fill zone near the river, treating recovered ground water, and installing a river bank cover system (see Alternatives #2 and #3 in the "North Landfill" section for the description of the river bank cover system and the ground-water treatment system). Institutional controls would involve deed restrictions, ground-water use restrictions and a special health and safety plan to be used during any subsurface work in the contaminated plant areas. Paving the rest of the contaminated plant areas (the exact portion of the Holly Run plant requiring paving to be determined during the remedial design) would decrease infiltration of rain water and prevent exposure to soil lead levels above 1000 ppm. The combination of the river bank cover system and ground-water recovery system would prevent the flow of fill zone ground water to the river and prevent erosion of contaminated soil into the river. The present worth cost of this alternative is $9,300,000.

ALTERNATIVE #3: This alternative is the same as Alternative #2 except that a physical barrier wall (technology to be chosen during the remedial design from deep soil mixing, soil/bentonite slurry, sheet piles, or geosynthetic membrane) will be installed to the base of the Columbia aquifer along the river (see Figure 37 for the approximate location). Ground water would continue to be recovered on the plant side of the wall to control any ground-water mounding that could affect building foundations and that could force contaminated ground water downward into the Potomac aquifer. The present worth cost of this alternative is $11,500,000.

ALTERNATIVE #4: This alternative is the same as Alternative #3 except that the physical barrier wall would be placed completely around the contaminated plant areas (this wall would join both ends of the wall along the river side of the north landfill, completely surrounding all of the contaminated soil associated with the north landfill and the contaminated plant areas). A ground-water recovery system inside the wall would be needed to control any ground-water mounding as described in Alternative #3 and another would be needed north of the Site in Newport to control mounding that would occur up-gradient of the wall. An interceptor trench or a series of recovery wells would be installed on the Site (if an interceptor trench could be used) or on the north side of the railroad tracks, but very near the Site, to reduce the ground-water mounding. If no steps were taken to reduce the ground-water mounding effect, construction of the barrier wall would likely result in an increase in ground-water elevations over the approximately 50-acre area shown in Figure 31. The present worth cost of this alternative is $16,300,000.

ALTERNATIVE #5: This alternative is the same as Alternative #3 except that it does not include the river bank cover system. The natural vegetation would be left on the river bank. The present worth cost of this alternative is $11,000,000.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Alternative #1 (no action) does not meet the threshold criteria of overall protection of human health and the environment in that nothing is done to prevent worker exposure to soils or to control the contaminated plant areas' contribution to impacts in the river and to MCL exceedances in the ground water.

Alternatives #2, #3, #4, and #5 do provide overall protection of human health by controlling worker exposure to contaminated soils. They also greatly decrease the plant areas' contribution to environmental impacts in the river. However, Alternative #2 does not address the Columbia ground-water discharge to the river which is contributing to AWQC exceedances and thus, does not provide overall protection to the environment and does not meet ARARs. Alternatives #3, #4, and #5 limit, to the maximum extent practicable, contaminated Columbia aquifer ground water from entering the river. Although a circumscribing barrier wall would make it easier to ensure that in all areas of the plant there is an upward migration of the ground water between the Columbia and Potomac aquifers (which would prevent additional contamination from entering the Potomac and thereby provide a greater degree of overall protection to the environment), a barrier wall just along the river (Alternatives #3 and #5) can also greatly limit any downward migration because most of the area where the Columbia aquifer migrates to the Potomac aquifer is along the river where the recovery wells would be placed.

Although the river bank cover system in Alternative #2, #3, and #4 would decrease the ability of contaminants in the landfill berm from leaching into the river, the natural river bank vegetation (as part of Alternative #5) offers better slope stability. The natural vegetation also provides habitat for birds and provides benefits for the river such as cooling. The benefits to the environment of the natural river bank vegetation are greater than the benefits of the river bank cover system (only if the physical barrier wall is installed at least along the river). Therefore, Alternative #5 offers a greater degree of overall protection of human health and the environment as compared to Alternative #3.

Alternative #3, #4, and #5 would comply with ARARs for this area including the Archeological and Historical Preservation Act of 1974. Due to the digging along the river bank, inspection, documentation, and/or collection of artifacts would be done. Alternatives #3, #4, and #5 offer the same degree of long-term effectiveness. Alternative #2 has little long-term effectiveness because by not capturing the Columbia aquifer ground water before it discharges to the river, the area of remediation in the river could become recontaminated over time.

Alternative #2 would be the easiest to implement as well as have the greatest short-term effectiveness in that it would be the fastest alternative to construct and have operational. Installing a barrier wall, either along the river or completely around the contaminated area, will be difficult although judged to be implementable (however, Alternatives #3 and, especially, #5 would be much easier to implement than Alternative #4). For Alternatives #3, #4, and #5, plant utilities (sewer, nitrogen, and power lines) would potentially have to be moved. There is a strong possibility of production being interrupted in the CIBA-GEIGY and the Du Pont Holly Run plants, especially in Alternative #4. Also in Alternative #4, installation of recovery wells and piping would cause temporary impacts to lawn areas and could disrupt traffic in the area immediately adjacent to the north side of the railroad tracks. Of the alternatives that meet the threshold criteria of overall protection of human health and the environment (Alternatives #3, #4, and #5), the net present worth cost of Alternative #5 is the least although it is only slightly less expensive than Alternative #3. Alternative #4 is significantly more expensive than the other alternatives.

EPA has determined that Alternative #5 is the selected remedy for this area of the Site in that it provides for overall protection of human health and the environment. Also, for the alternatives that meet the threshold criteria, Alternative #5 is the easiest to implement and costs the least. The State supports this determination. Comments (both verbal and written) opposed the circumscribing physical barrier wall that was proposed because of the need for a ground water recovery system in the Town of Newport to prevent any basement flooding. EPA has addressed these concerns by selecting a remedy which only specifies the physical barrier wall along the river. One commentor objected to the proposed river bank cover system because it destroyed valuable habitat along the river. The river bank cover system is not part of the selected remedy. Comments were also received which opposed any barrier wall since installation will cause disruptions for CIBA-GEIGY and since, in the opinion of some of the commentors, there is no need for the wall. However, EPA has determined that controlling the discharge of the ground water into the river is necessary to protect the environment and that the physical barrier wall that is discussed in Alternative #5 is the most effective means of limiting continued migration of the contaminated ground water in the fill zone and the Columbia aquifer to the Christina River.

GROUND WATER

In the discussions of the alternatives in several of the previous sections (north landfill, south landfill, and the CIBA-GEIGY and Du Pont Holly Run plants), ground water has been a major factor. Preferred alternatives were proposed in these areas which would prevent continued release of contaminants to the ground water. This section discusses alternatives to remediate the ground water in both the Columbia and Potomac aquifers that is already contaminated.

Generally, ground water in the Columbia aquifer flows toward the Christina River (i.e., on the north side of the river, the Columbia ground water flows south to the river and on the south side of the river, the Columbia ground water flows north to the river). Columbia ground water on the north side of the river discharges into the river and the wetlands on the west side of the north landfill. A small portion may flow underneath the river and discharge into the south wetlands. Columbia ground water on the south side of the river discharges into the river and the south wetlands. Ground water in the Potomac aquifer flows south. On-site ground water from the Potomac leaks upward into the Columbia, although in portions of the Site it is the other way around.

The ground water at the Site is a Class IIA aquifer (i.e., the aquifer system, both the Columbia and the Potomac, is a current source of drinking water). Therefore, the NCP states that EPA's goal would be to return the ground water to its beneficial use by considering MCLs or non-zero MCLGs as ARARs. However, the NCP does provide certain instances where ARARs may be waived. Sections 300.430(f)(1)(ii)(C)(*1-6*) of the NCP outline six different ARAR waivers, including the interim measure waiver, the equivalent standard of performance waiver, the greater risk to human health and the environment waiver, the technical impracticability waiver, the inconsistent application of state standard waiver, and the Fund-balancing waiver. The greater risk to human health and the environment waiver may be invoked when compliance with an ARAR will cause greater risk to human health and the environment than non-compliance.

Section 300.430(f)(5)(iii)(A) of the NCP states that performance (for example, attainment of ARARs) shall be measured at appropriate locations in the ground water, surface water, etc. The preamble to the NCP explains that for ground water, remediation levels should generally be attained throughout the contaminated plume or at and beyond the edge of the waste management area when waste is left in place (55 FR 8753). Figure 32 shows the boundary of the "waste management area" for this Site and also indicates the area where MCLs or non-zero MCLGs are exceeded outside of the waste management area. The area outside of the waste management area is where MCLs or non-zero MCLGs are considered ARARs and is called the "area of attainment." The following alternatives address this area of attainment.

ALTERNATIVE #2: This alternative would involve institutional controls, ground-water monitoring, and placing residences and businesses along Old Airport Road on public water supply. Institutional controls would include deed restrictions and establishing a ground-water management zone in the area of the Site (see Figure 33 for the approximate area) to limit the future installation of drinking water wells. Long-term monitoring, including monitoring at the north landfill for thorium, of the Columbia and the Potomac aquifers would provide data to measure the rate of contaminant attenuation in the Columbia aquifer and the rate of contaminant migration in the

Potomac aquifer to the south.[29] The present worth cost of this alternative is $1,400,000.

ALTERNATIVE #3: This alternative includes everything from Alternative #2 with the addition of a ground-water recovery system installed along the south edge of the south landfill and in the south wetlands to clean up the Columbia aquifer south of the south landfill (see Figure 34 to see the area to be remediated and approximate locations of the recovery wells) and a ground-water recovery system that would create a hydraulic barrier in the Potomac aquifer. The hydraulic barrier would prevent migration of contaminated Potomac ground water from the waste management area and would remediate the ground water in the area of attainment (see Figure 35 for the approximate recovery well locations). The recovered ground water would be treated as discussed in the "North Landfill" section and discharged to the south wetlands to prevent any dewatering of the wetlands that might tend to occur due to the withdrawal of the Columbia ground water. The present worth cost of this alternative is $13,500,000.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Each of the alternatives provides for the overall protection of human health except Alternative #1 (under the "no action" alternative, nothing would preclude someone, in the future, from drilling a drinking water well in the contaminated area). Alternative #2 does not meet ARARs since the ground water is not returned to its beneficial use by reducing contaminant levels to MCLs or non-zero MCLGs (except perhaps by natural attenuation which, even if it does occur, could take a very long time).

Alternative #3 would meet ground-water ARARs in the Potomac aquifer. However, the ground water upgradient of the hydraulic barrier will become more contaminated since the pumping will cause a reversal of the natural upward flow of the ground water into the Columbia aquifer and will pull more highly contaminated ground water down into the Potomac aquifer. Also in the Potomac aquifer, the long-term effectiveness and permanence is greatest with Alternative #2 because the plume should eventually attenuate naturally to levels safe to drink since the sources of

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[29] For the Columbia aquifer, the monitoring would include sampling MW-21A, MW-23A, MW-24A, MW-25A, and MW-26A for metals. For the Potomac aquifer, the monitoring would include sampling MW-6B, MW-18B, MW-21B, and MW-26BS. If the monitoring shows that any of the Site-related contaminants have migrated to any one of these wells at a level sufficient to produce a risk (cumulative risk caused by all Site-related contaminants) of either $1x10^{-6}$ for carcinogenic risks or 1 for non-carcinogenic risks, further remedial action separate from this ROD (such as restoration or containment of the ground water) will be considered at that time.

reduced and perhaps eliminated). However, if the monitoring shows that the plume is becoming unacceptable in area of extent, remedial measures in addition to the public water line selected in this ROD may be called for at that time.

In order to select Alternative #2, EPA must invoke the greater risk to human health and the environment waiver (NCP Section 300.430(f)(ii)(c)(*2*)) in recognition of the fact that to meet MCL or non-zero MCLG ARARs would create more harm than good.[30] Although ARARs would not be met with Alternative #2, the alternative would provide overall protection of human health and the environment. EPA has determined that Alternative #2 has advantages over Alternative #3 in that pumping the Potomac aquifer (as outlined in Alternative #3) would cause an increase in contaminant levels in a portion of the Potomac aquifer and pumping the Columbia aquifer (as outlined in Alternative #3) would potentially harm the south wetlands and cause greater contaminant levels in the Columbia aquifer. Further, implementation of Alternative #2 will be protective of human health since installation of a public water supply line to nearby residents and businesses along Old Airport Road and use of institutional controls to limit new wells from being drilled would prevent human exposure to ground water contaminated by harmful levels of Site-related contaminants.

The State supports the selection of Alternative #2 except that the State wants the ROD to state that if the long-term monitoring wells begin to exhibit levels of contaminants considered unsafe to drink, further remedial action would be taken rather than just considered (see Attachment A for details on the State's position). Written comments received from the public, including Du Pont, were generally supportive of Alternative #2.

SELECTED REMEDY: DESCRIPTION AND PERFORMANCE STANDARDS

Based on the findings of the RI/FS; the nine criteria identified in Section 300.430(e)(9)(iii) of the NCP (see Table 11); and written comments received from the public, including Du Pont; EPA has selected a remedy for this Site. The selected remedy addresses the human health and environmental risks presented by this grossly contaminated Site. Below is a summary and a detailed description with performance standards of

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[30]The "greater harm to human health and the environment" ARAR waiver also applies to the State of Delaware Regulations Governing Public Drinking Water (revised 3/11/91) Sections 22.2, 22.3, 22.4, 22.6, and 22.10 and the Delaware Regulations Governing Hazardous Substance Cleanup (1/93), Section 9 for the Columbia and Potomac aquifers.

contamination are being controlled. Active remediation in the Potomac aquifer would create a slug of contamination underneath the waste management area that would require pumping for a longer period of time than would be required to let the existing contamination in the Potomac aquifer to attenuate naturally to currently acceptable levels.

Alternative #3 also has the potential of meeting ground-water ARARs in the Columbia aquifer by remediating the contaminated portion of the Columbia aquifer in the area of attainment. However, the Columbia aquifer may become more contaminated because pumping the Columbia aquifer may cause the wetland area to become a recharge area for ground water instead of a discharge area for ground water. If the Columbia aquifer ground water is recharged from the surface water in the wetlands, higher levels of contamination may be introduced into the ground water by the washing of contaminants from the sediments. The active remediation of Alternative #3 does offer the greatest degree of long-term effectiveness and permanence for the Columbia aquifer. However, contaminant levels in the Columbia aquifer should decrease in Alternative #2 since the sources of contamination (releases from north and south landfills and the contaminated plant areas) are being controlled.

Alternative #3 offers some reduction in mobility or volume through treatment. However, evidence to date indicates that the plume has not migrated very much in the last 15 years. Alternative #2 rates the best in the area of short-term effectiveness because in Alternative #3 wells will be placed in wetlands. This will cause temporary and possibly permanent loss of these wetlands because access roads will have to built. Each of the alternatives is implementable, although Alternative #2 is the easiest to implement. Alternative #2 costs significantly less (approximately 10 times less) than Alternative #3.

EPA has determined that Alternative #2 (monitoring and installation of a public water supply line) is the preferred remedy for this area of the Site because it would provide the best overall protection of human health and the environment. Once this alternative is implemented, there would be no possibility of human exposure to contaminated ground water. The selected remedies for the other areas of the Site would minimize to the maximum extent practicable the release of contaminated ground water into the environment. EPA does not expect the contaminant plume in the Potomac aquifer to expand. To date, the plume has exhibited limited migration potential due most likely to anions in the natural ground water combining with the heavy metals and precipitating the metals out of solution so they are no longer mobile. Also, the selected remedy for the other areas of the Site will greatly decrease, if not eliminate, contaminant migration from the Columbia aquifer to the Potomac aquifer (i.e., the source of contamination to the Potomac will be greatly the selected remedy. It should be noted that some changes may be made to the implementation of the remedy as a result of the remedial design and construction processes. Such changes, in general, reflect modifications resulting from the engineering design process. Any changes to the remedy will be done in accordance with the NCP.

SUMMARY OF EPA'S SELECTED REMEDY

1. Ballpark

   - Selected Remedy: Excavation of soils above 500 ppm lead with disposal in the north landfill (Alternative #2).

   - Purpose: Prevent human exposure to elevated levels of lead.

   - Cost: $10,000

2. North landfill

   - Selected Remedy: Capping; wetland remediation, restoration and monitoring; vertical barrier wall down to base of the Columbia aquifer; and ground-water recovery and treatment (Alternative #5).

   - Purpose: Prevent continued releases of contaminants to the ground water which discharges to the river and the north wetlands, clean up areas of unacceptable environmental impact in the north wetlands, prevent exposure of plant and terrestrial life to contaminated soils.

   - Cost: $12,100,000

3. South landfill

   - Selected Remedy: Excavation and consolidation of contaminated soil underneath and to the east of Basin Road or South James Street onto the south landfill; *in-situ* soil stabilization of the combined soil; capping (RCRA Subtitle D) of the south landfill (Alternative #5).

   - Purpose: Prevent continued releases of contaminants to the ground water which discharges to the river and the south wetlands, prevent unacceptable human exposure to contaminated soils from the landfill.

   - Cost: $14,300,000

4. South wetlands

- Selected Remedy: Excavation, restoration, monitoring (Alternative #2).

- Purpose: Prevent unacceptable impacts to environmental receptors.

- Cost: $4,200,000

5. Christina River

- Selected Remedy: Dredging, monitoring (Alternative #2).

- Purpose: Prevent unacceptable impacts to environmental receptors.

- Cost: $4,700,000 (based on disposal of the dredged sediments in the north landfill)

6. CIBA-GEIGY and Du Pont Holly Run plants

- Selected Remedy: Vertical barrier wall along the Christina River at the CIBA-GEIGY plant, pave the rest of the ground within the contaminated plant areas, recover the ground water up-gradient of the barrier wall, institute special health and safety plans for intrusive work (Alternative #5).

- Purpose: Prevent continued releases of contaminants to the ground water which discharges to the river, prevent unacceptable human exposure to contaminated soils.

- Cost: $11,000,000

7. Ground water

- Selected Remedy: Monitoring, provide public water supply along Old Airport Road, establish a ground water management zone, invoke the "greater risk to human health and the environment" ARAR waiver (Alternative #2)

- Purpose: Prevent human exposure to Site-related contaminated ground water, prevent further contamination of the Columbia and the Potomac aquifers, protect the south wetlands.

- Cost: $1,400,000

The total present worth cost of the proposed remedy is approximately $47,700,000. See Table 13 for a cost summary of the overall remedy and Tables 14 to 20 for a detailed cost of each portion of the remedy.

DETAILED DESCRIPTION AND PERFORMANCE STANDARDS

1. BALLPARK

1.1 **Soil Removal and Disposal**

DESCRIPTION: A smal area, where Ayre Street dead ends at the ballpark (see Figures ı and 24), with lead levels above 500 ppm shall be excavated. Samples shall be taken to delineate the waste material and to determine if the soil to be excavated should be classified as a RCRA-hazardous waste. Soil shall be excavated to a depth and extent such that remaining lead levels are below 500 ppm. Confirmatory samples shall be taken before the area is backfilled with clean fill from an EPA-approved off-site source and re eeded. The estimated amount of soil requiring excavation is one cubic yard. The excavated material shall be disposed of in the north landfill. Tests shall be performed to determined if the soil to be excavated is a RCRA-hazardous waste (.e., exceeds the Toxicity Characteristic Leaching Procedure (TCLP) criteria). If the soil fails the TCLP test, the excavated soil shall, in compliance with RCRA land disposal regulations, be treated until it is no longer a RCRA-hazardous waste (through stabilization) and then disposed of in the north landfill. If testing reveals that the soil is not a RCRA-hazardous waste, it shall be disposed of in the north landfill without treatment. The present worth cost for this alternative is $10,000. See Table 14 for details of the cost including the capital cost and annual operations and maintenance costs.

PERFORMANCE STANDARDS: Below are the performance standards for the ballpark portion of the selected remedy:

1.1.1. A statistically significant number of surface soil samples (0-6" depth) to determine the areal extent of lead contamination above 500 ppm shall be collected in the ballpark in the vicinity of the end of Ayre Street. These samples shall be analyzed, at a minimum, for lead using standard EPA Contract Laboratory Program (CLP) protocols for metals.

1.1.2. All soils above the 500 ppm lead levels shall be excavated to a depth where the lead levels are below 500 ppm.

1.1.3. Confirmatory soil samples shall be collected from the excavated area (of sufficient number to statistically determine that the lead levels remaining in the excavation pit are below 500 ppm).

1.1.4. TCLP tests for metals (complete list of TCLP metals) shall be performed on soils which have been determined by the above testing (see paragraph 1.1.1) to be above 500 ppm total lead (either before or after excavating).

1.1.5. If the soil samples from the area requiring excavation fail the TCLP test for metals, the excavated soil shall be stabilized. Stabilization shall involve thoroughly mixing the excavated soils with a cementitious or pozzolanic reagent mixture developed specifically to bind the metal constituents within the stabilized matrix. The actual stabilization agent shall be selected during the remedial design and is subject to EPA approval. Due to the expected small volume of excavated soil (approximately one cubic yard) and to the use of the north landfill for disposal (which is not being stabilized), design optimization tests do not have to be performed to determine the stabilization agent. Instead, a literature review shall be performed to determine the nature and quantity of stabilizing agent to be used. The performance standard for the stabilized soil is that it shall pass the TCLP test for metals prior to disposal in the north landfill (RCRA land disposal regulations are ARARs).

1.1.6. The excavated soil shall be disposed of in the north landfill prior to capping.

1.2 Ballpark Cost

DESCRIPTION: The estimated present worth cost of Alternative #2 is $10,000.

2. NORTH LANDFILL

2.1. Landfill Cover

DESCRIPTION: A low-permeability cover system (cap) shall be installed to reduce infiltration in order to minimize continued ground-water contamination from this area. For example, the cover could be a geosynthetic clay liner. Figure 25 shows the approximate area to be covered and a potential cross section of the cover system. The thorium bearing drums shall be located.

PERFORMANCE STANDARDS:

2.1.1. Prior to capping, the exact location of the thorium drums shall be determined.

2.1.2. A landfill cap shall be installed that completely covers the north landfill (see Figure 25 for the approximate area of this cap).

2.1.3. The landfill cap shall sufficiently overlap or tie-in to the pavement at the CIBA-GEIGY and Du Pont Holly Run plants to prevent infiltration of water between the area that is paved and the area that is capped and shall sufficiently overlap or tie-in to the physical ground-water barrier wall to prevent infiltration of water between the area that is capped and the hydraulic barrier wall.

2.1.4. The landfill cap shall have a permeability of $1x10^{-7}$ cm/sec or less.

2.1.5. The landfill cap shall have at least two layers of low-permeability material, one of which shall be a geosynthetic membrane.

2.1.6. The landfill cap shall be designed and constructed: to function with minimum maintenance; to promote drainage and minimize erosion or abrasion of the cover; to accommodate settling so that the cover's integrity is maintained; and to provide adequate freeze protection for the liner.

2.1.7. The landfill cap shall be re-vegetated in such a way as to provide a high quality habitat for wildlife to the maximum extent practicable (without endangering the liner). The types of vegetation shall be identified in the remedial design. The remedial design is subject to EPA approval.

2.1.8. All material disposed of in the north landfill shall be of such structural strength as to adequately support the cap.

2.1.9. All material that is to be disposed of in the north landfill (see paragraphs 1.1.6, 2.2.1, 2.3.1, and 5.3.2) shall be disposed of prior to capping.

2.2. **Stabilization and Disposal of Upland Waste Piles**

DESCRIPTION: Several small (less than one cubic yard) piles of Lithopone waste in the upland area to the west of the north landfill shall be stabilized, if necessary, and then consolidated to the north landfill prior to the capping set forth in section 2.1.

PERFORMANCE STANDARDS:

2.2.1. The several small piles of Lithopone waste in the uplands adjacent to the north wetlands and to the west of the north landfill shall be excavated and disposed of in the north landfill.

2.2.2. Samples from the material excavated per paragraph 2.2.1 shall undergo a TCLP test for metals. Any of the material that fails the TCLP test shall be stabilized prior to disposal in the north landfill.

2.2.3. Stabilization shall involve thoroughly mixing the excavated soils with a cementitious or pozzolanic reagent mixture developed specifically to bind the metal constituents within the stabilized matrix. The actual stabilization agent shall be identified in the remedial design and approved by EPA. Due to the expected small volume of excavated soil (approximately one cubic yard) and to the use of the north landfill for disposal (which is not being stabilized), design optimization tests do not have to be performed to determine the stabilization agent. Instead, a literature review shall be performed to determine the nature and quantity of stabilizing agent to be used. The performance standard for the stabilized soil is that it shall pass the TCLP test for metals prior to disposal in the north landfill.

2.3. North Drainage Way and North Wetlands

DESCRIPTION: The upper and parts of the mid- and lower north drainage way will be covered by the cap called for in section 2.1. The wetlands associated with the lower part of the north drainage way (i.e., those not covered by the cap described in paragraph 2.1 above) and the rest of the north wetlands that contain sediments in excess of the Site-specific sediment clean-up criteria shall be remediated by removing the top one foot of sediments. The exact area requiring remediation shall be determined during remedial design by sampling sediments throughout the north wetlands. The excavated sediments, if necessary, shall be stabilized to make a more structurally sound material and put underneath the cap. The excavated wetland area shall be restored.

PERFORMANCE STANDARDS:

2.3.1. The following shall be the Site-specific clean-up criteria for the sediments in the north wetlands (these are absolute chemistry values normalized to grain size):

Lead	1200	ppm
Cadmium	60	ppm
Zinc	5600	ppm

Areas that exceed any one of the above Site-specific clean-up criteria for the north wetlands, as revised if necessary pursuant to paragraph 2.3.3, shall be excavated to a depth of one foot. The designation of areas which exceed the Site-specific clean-up criteria and require excavation is subject to EPA approval.

2.3.2. A statistically significant number (and a number sufficient to direct remedial activities) of samples shall be collected from the top 6" of the sediments in the north wetlands (see area in Figure 36) to delineate areas containing sediments above the Site-specific sediment clean-up criteria. The samples shall be analyzed for the complete Target Analyte List (TAL) of metals and grain size. The samples shall be collected from areas estimated to have a minimum of 50% fines (percentage of sediments that can pass through a 64 micron sieve).

2.3.3. A minimum of four solid phase sediment toxicity tests (involving four toxicity test replicates and total organic carbon (TOC), grain size, and TAL metals analyses) measuring the survival rate of *Hyallela azteca* shall be performed in the north wetlands in areas where the cadmium, lead, and zinc levels are below the Site-specific clean-up criteria and above their AET values (9.6 ppm, 660 ppm, and 1600 ppm, respectively, on an absolute basis). A 30% reduction in survival compared to the control sample shall be considered a significant impact. If significant impacts are seen in any of the toxicity tests performed for the north wetlands, EPA may modify the Site-specific clean-up criteria as described in Paragraph 2.3.1 (however, not below their respective AET values) for the north wetlands, if appropriate, to protect the environment.

2.3.4. Prior to excavating 32 work-hours shall be spent collecting and moving to an appropriate habitat any wildlife that is residing in areas to be affected by the remediation.

2.3.5. The excavated area shall be backfilled with clean fill from an EPA-approved source and returned to original grade.

2.3.6. The wetlands that will be directly affected by the cap construction and the north drainage way excavation shall be delineated to determine wetland type prior to remedial action using the "Federal Manual for the Delineation of Jurisdictional Wetlands" (Federal Interagency Committee for Wetland Delineation, 1989).

2.3.7. The excavation of the sediments shall be designed and performed in such a way as to minimize environmental damage and to utilize, to the maximum extent practicable, excavation methods such as vacuum dredging or other alternative excavation methods.

2.3.8. A portion of uplands (formerly farmland) adjacent to the north wetlands equal in size (unless EPA determines during the remedial design that the type of wetlands requires more than one-to-one replacement) to any wetlands destroyed by the north landfill cap construction (this includes, for example, a small area on top of the landfill and the upper part of the drainage way) shall be graded to establish wetland hydrology. The exact location and size shall be identified in the remedial design. The remedial design shall be subject to EPA's approval prior to implementation.

2.3.9. The wetlands shall be successfully re-established. A complete restoration program shall be developed during remedial design to address the excavated area and the newly created wetland area. This program shall, at a minimum identify factors which are key to a successful restoration program including, but not limited to, replacing and regrading soils and re-establishment of vegetation. The program shall be implemented. Other appropriate measures, including but not limited to, periodic maintenance (i.e., planting) may also be necessary to ensure long-term restoration.

2.3.10. A variety of grasses and hydrophytic species common to the area shall be used to revegetate the wetland.

2.3.11. The newly constructed wetland shall be located and constructed in such a manner as to prevent the runoff from the north landfill cap from destroying or de-stabilizing the new wetland.

2.3.12. The excavated sediments shall be, if necessary, stabilized (or otherwise processed just for the purpose of removing or binding the water to make a sufficiently structurally sound material to adequately support the cap) and shall be disposed of in the north landfill (RCRA land disposal regulations would be triggered only if the sediments fail the TCLP test and are stabilized "*ex-situ*"). The remedial design shall describe tests and procedures for determining if stabilization or other physical processing is necessary to prior to putting the excavated sediments underneath the cap. These tests and procedures shall also include specifications for the final stabilized or otherwise processed material.

2.4. **North Wetlands Long-term Monitoring**

DESCRIPTION: The lower section of the north drainage way and the north wetlands shall undergo long-term monitoring to ensure that the remedy is protective.

PERFORMANCE STANDARDS:

2.4.1. A long-term monitoring plan shall be developed and implemented to monitor the effectiveness of the remedial action in the north wetlands/drainage way and to make sure that the

Site-specific clean-up criteria remain protective of the environment.

2.4.2. The monitoring plan shall include sediment monitoring stations located in both remediated and unremediated areas (also include a Site background location); TAL metals analysis and acute and chronic toxicity tests shall be performed (preferably using *Hyallela azteca*) at these locations.

2.4.3. The monitoring plan shall include appropriate field observations of plant growth and of the general conditions of the wetlands in sufficient detail to provide sufficient information to determine the successful establishment of the wetlands.

2.4.4. The monitoring plan shall identify the frequency of monitoring and reporting requirements. The reporting requirements shall include a discussion of the results in addition to data presentation.

2.4.5. The monitoring plan for the north wetlands shall include the determination of a reference station to be approved by EPA. The reference station shall be representative of natural background conditions in a tidal wetland and is, preferably, near the Site (EPA does not consider RS15 to be representative of natural background conditions). Also since there is probably no pristine area near the Site, a list of conditions that would be expected in a pristine tidal wetland shall be developed through examination of aquatic conditions at areas in northern Delaware or other appropriate areas.

2.4.6. Performance standards 2.4.1 to 2.4.5 above are the minimum requirements of the monitoring plan. The monitoring plan is subject to EPA approval. The discussion of the monitoring results is also subject to EPA approval. If at some time EPA determines that this monitoring data indicates that the Site-specific clean-up criteria are no longer protective (for example, the metals remaining in the sediments become more bioavailable due to changing conditions and cause a greater impact), additional remedial measures beyond those described in this ROD may be required including further dredging.

2.5. **North Landfill Physical Barrier Wall**

DESCRIPTION: A physical barrier wall (an actual wall that limits migration of ground water to the maximum extent practicable) shall be constructed to extend from the ground surface to the base of the Columbia aquifer keying into the aquitard which separates the Columbia aquifer and the Potomac aquifer (see Figure 27 for the approximate wall location). This wall shall connect to the physical barrier wall to be installed along the river bank at the CIBA-GEIGY plant as discussed under the "CIBA-GEIGY and Du Pont Holly Run Plants" section below (see section 6.4). Because the wall may cause mounding of the ground water to occur in the landfill, ground-water extraction wells shall be installed to control any mounding effect. The recovered ground water shall be treated.

PERFORMANCE STANDARDS:

2.5.1. A physical barrier shall be constructed to extend from the surface to the base of the Columbia aquifer. The design shall be such as to minimize to the maximum extent practicable the flow of Columbia ground water underneath the barrier wall into the Christina River. The approximate barrier location is shown in Figure 27. The exact location of the physical barrier wall shall be identified in the remedial design and subject to EPA approval. The east end shall connect to the barrier wall in the CIBA-GEIGY plant. The west end shall extend far enough around the north landfill to capture all of the Columbia and fill zone ground water that has come into contact with contaminated soil.

2.5.2. The barrier shall have a permeability of $1x10^{-7}$ cm/sec or less.

2.5.3. Different barrier wall technologies including deep soil mixing, sheet piles, geosynthetic membranes, and slurry walls shall be evaluated in the remedial design. Of the technologies that are implementable, the remedial design shall identify the technology considered to have the longest life. More than one technology may be necessary depending on the wall location. EPA will make the final decision as to the type of barrier wall technology to be used.

2.5.4. Any unused piping found to cross the path of the barrier wall shall be plugged or removed to a distance to be identified in the remedial design, subject to EPA approval, that will keep a reservoir of potentially contaminated ground water from being formed adjacent to the barrier wall. Any used piping shall be inspected to make sure it is in proper working condition so that a seal can be formed between the pipe and the barrier wall that is of sufficient quality as to prevent a preferential flow path of ground water from forming.

2.5.5. Ground-water recovery wells shall be installed in sufficient number to control any mounding effect created by the barrier wall. The wells shall draw the water table down to the maximum extent practicable without affecting the water table underneath the chemical plants in such a way as to cause structural problems to buildings or pavement. The wells shall be installed in accordance with appropriate State regulations (see Table 12).

2.5.6. All extracted ground water shall be treated and discharged to the Christina River (or if determined by EPA during the remedial design to be acceptable, the treated ground water may be discharged to a publicly owned treatment works-POTW). This treatment shall include removing all contaminants (including metals, organics, and, if necessary, radionucleides) necessary to meet all discharge requirements (especially compliance with the substantive requirements of a National Pollution Discharge Elimination System [NPDES] permit if discharging to the Christina River). If an air stripper or other vented system is used to treat the ground water, secondary controls will be necessary in order to comply with Federal and State air ARARs (see Table 12) if the emissions exceed the specified amounts in these ARARs. Secondary controls will also be installed if necessary to ensure protectiveness of human health and the environment (for protection of human health, secondary emission controls shall be installed if the emissions from the air stripper cause a greater than $1x10^{-6}$ excess cancer risk). It is anticipated that the treatment sludges will be hazardous waste. Any treatment residues containing tetrachloroethylene shall be considered to be F002 waste. Disposal of any treatment sludges or other wastes shall be in accordance with appropriate Federal and State regulations (see Table 12).

2.6. **North Landfill Institutional Controls**

DESCRIPTION: Institutional controls shall be put in place in order to ensure the protectiveness of the remedy.

PERFORMANCE STANDARDS:

2.6.1. No excavation or construction, except as necessary to maintain the integrity and the level of protectiveness of the north landfill cap, shall be allowed once the cap is installed.

2.6.2. No uses of the north landfill shall be made which may impair the cap's integrity. Any change in land use following completion of the remedial action shall require the prior written approval of EPA, and/or its successors.

2.6.3. As long as the buried thorium is present, the property owner(s), and its successors-in-interest, shall continuously maintain a metal monument placed on the north landfill, said monument to be approved by EPA to warn of the presence of buried radioactive thorium-bearing material and to mark the specific location(s) of the thorium-bearing material in the north landfill.

2.6.4. The property owner(s), and its successors, shall notify EPA, and/or its successors, of its intent to convey any interest in the property described herein. Such conveyance shall not be made without the prior written approval of EPA, and/or its successors. No conveyance of title, easement, or other interest in the property shall be consummated by the property owner(s), and its successors, without adequate and complete provision for continued maintenance and protection of the north landfill cap.

2.6.5. The property owner(s), its successors and assigns, shall not at any time institute legal proceedings, by way of quiet title or otherwise, to remove or amend these institutional controls unless EPA, and/or its successors, has given the property owner(s), and/or its successors, advance written approval.[31]

2.6.6. No drinking water wells shall be installed at the north landfill. No industrial water production wells shall be installed in the Potomac aquifer at the north landfill.

2.6.7. The north landfill shall not be used for residential purposes.

2.6.8. The north landfill shall not be used for recreational purposes as long as thorium remains present in the landfill.

2.6.9. Once remediation at the north landfill is completed and the vegetation is restored, the vegetation shall not be removed except for maintenance activities.

2.6.10. The restrictions on the use of the property shall be included in the deeds to the Site property. The deeds to the affected property shall also be modified to give notice to the public of past land disposal and of the fact that releases and threats of releases of hazardous substances have affected their respective parcels.

2.6.11. Additional measures may be required to implement the institutional controls outlined in paragraphs 2.6.1 to 2.6.10.

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[31]Paragraphs 2.6.2 to 2.6.5 are necessary for EPA to ensure adequate protection of human health and the environment from any potential risks posed by the buried thorium. The U.S. Nuclear Regulatory Commission (NRC) has commented to EPA that the possibility exists for NRC itself to exempt this Site from NRC's decommissioning regulations in 10 CFR Part 40.4. NRC would require a strong set of institutional controls to be in place before it would consider allowing the drums to remain at the Site.

2.7. North Landfill Cost

DESCRIPTION: The estimated present worth cost of Alternative #2 is $12,100,000. See Table 15 for details of this cost estimate including the capital cost and annual operations and maintenance costs.

3. SOUTH LANDFILL

3.1. Excavation of the Basin Road Area

DESCRIPTION: The portion of the landfill underneath and to the east of Basin Road (i.e., all of the landfill currently on Delaware property) shall be excavated and backfilled with clean fill, and the excavated soil shall be consolidated in the rest of the south landfill.

PERFORMANCE STANDARDS:

3.1.1. A statistically significant number of samples (to be analyzed for TAL metals) shall be collected to determine the extent (lateral and vertical) of the contamination at the south landfill on Delaware property underneath and to the east of Basin Road (or South James Street). See Figure 4.

3.1.2. The contaminant levels allowed to remain in soils at the Basin Road excavation area shall 1) not contribute to ground-water contamination, determined as follows: for soil left at the Basin Road area (above or below the water table), a TCLP-like leach test using clean ground water from near the Site, instead of acetic acid, shall meet MCLs; and 2) shall protect human health, determined as follows: the levels set shall produce a carcinogenic risk of no greater than $1x10^{-5}$ and a non-carcinogenic risk below 1 for a utility repair/construction scenario. These soil clean-up criteria are subject to EPA approval.

3.1.3. Soils above the clean-up criteria on Delaware property, and on whatever Du Pont property necessary to allow construction of the cap and to provide unlimited access to the boat ramp at the west side of the James Street bridge, shall be excavated and consolidated to the remaining portion of the south landfill.

3.1.4. The excavation activities (and potentially other remedial action tasks at the south landfill and south wetlands) will require temporary restrictions or re-routing of traffic. Nearby residents and business shall be notified in a timely manner of these activities. The scheduling of work shall be done in such a way as to allow limited road access through this area during normal daily business hours for vehicles which do not have an alternate route.

3.1.5. A statistically significant number of confirmation samples shall be collected to determine whether or not the soil remaining in the excavation is below the clean-up criteria.

3.1.6. Once the excavation passes the confirmatory sampling, it shall be backfilled with clean fill from an EPA-approved source. Backfilling shall be done in such a way as to minimize settlement and provide an adequate base for Basin Road.

3.1.7. After the excavation is backfilled, Basin Road shall be reconstructed in accordance with DelDOT road construction requirements.

3.2. *In-situ* Stabilization

DESCRIPTION: The waste in the south landfill shall be stabilized *in-situ* prior to capping. By stabilizing the waste, the ability of the metals to be leached by the ground water will be reduced to acceptable levels. A design optimization study shall be performed to determine the appropriate stabilization agent to be used.

PERFORMANCE STANDARDS:

3.2.1. Prior to stabilization, corings shall be collected to adequately determine the depth of the waste material (TAL metals analysis may be necessary).

3.2.2. After excavation and consolidation of the soils/waste from the east portion of the south landfill (see section 3.1) and the sediments from the south wetlands (see section 4.1) into the remaining part of the south landfill, all of the soil, waste, and sediment in the south landfill shall be stabilized *in-situ* as necessary to pass the TCLP test. Stabilization shall involve thoroughly mixing a cementitious or pozzolanic reagent mixture without removing the soil from the landfill.

3.2.3. Prior to stabilization, design optimization tests shall be done in order to determine the proper nature and quantity of the stabilization agent. A task of the remedial design shall be to develop a work plan (subject to EPA approval) for the design optimization tests. The choice of stabilization agents is subject to EPA approval.

3.2.4. Stabilization shall continue until the soil, waste, and sediment material passes the TCLP test and passes a TCLP-like test using background Site ground water instead of acetic acid. MCLs shall be used as the criteria for the second test.

3.3. South Landfill Cap

DESCRIPTION: A cap with a minimum of 18" of $1x10^{-5}$cm/s permeability soil (or its equivalent) shall be installed over the portion of the landfill on Du Pont property (see Figure 28).

PERFORMANCE STANDARDS:

3.3.1. Prior to excavating 32 work-hours shall be spent collecting and moving to a new environment any wildlife that is residing in areas to be affected by the remediation.

3.3.2. A landfill cap shall be installed that completely covers the portion of the south landfill that is on Du Pont property.

3.3.3. The landfill cap shall be designed and constructed in such a way as to limit to the maximum extent practicable any encroachment on the south wetlands, the south pond, and the Christina River. The wetlands constructed in place of the berm, as described in paragraphs 3.4.1 and 3.4.2, shall be used to replace the loss of any wetlands caused by the construction of the south landfill cap.

3.3.4. The landfill cap shall have or be equivalent to having a permeability of $1x10^{-5}$ cm/sec or less with a minimum of 18" of soil.

3.3.5. The landfill cap shall have a drainage layer of adequate thickness and appropriate permeability to ensure that any surface water infiltration at the south landfill is effectively distributed.

3.3.6. The landfill cap shall be designed and constructed: to function with minimum maintenance; to promote drainage and minimize erosion or abrasion of the cover; to accommodate settling so that the cover's integrity is maintained; and to provide adequate freeze protection for the cap.

3.3.7. The landfill cap shall be re-vegetated in such a way as to provide a high quality wildlife habitat to the maximum extent practicable (without endangering the liner). The types of vegetation shall be identified in the remedial design and are subject to EPA approval.

3.4. Site Security and Berm Removal

DESCRIPTION: The berm shall be removed to the maximum extent practicable without adversely affecting the south pond. Also, in order to provide better Site security to control trespassing, additional fencing and a barrier of thorny plants shall be installed around the entire south landfill area including the landfill and the adjacent wetland area.

PERFORMANCE STANDARDS:

3.4.1. The berm shall be removed to the maximum extent practicable without adversely affecting the south pond. As much area as possible shall be graded to allow wetland hydrology to develop. The south wetland restoration program, outlined in paragraphs 4.1.10 and 4.1.11 below, shall be performed in this area as well.

3.4.2. Human access to the Site shall be limited to the maximum extent practicable, without severely limiting the migration of terrestrial animals into this area. This shall be accomplished by using a combination of fencing and thorny plants. The locations of the fences and the thorny plants (see Figure 28 for the approximate location of the fences and bushes) and the choice of plants is subject to EPA approval.

3.5. South Landfill Institutional Controls

DESCRIPTION: Institutional controls shall be placed on the Du Pont property south of the Christina River to restrict future land use, to notify the public of past land use, and to ensure the protectiveness of the remedy.

PERFORMANCE STANDARDS:

3.5.1. No excavation or construction, except as necessary to maintain the integrity and the level of protectiveness of the south landfill cap, shall occur once the cap is installed.

3.5.2. The south landfill shall not be used for residential purposes.

3.5.3. Once remediation at the south landfill is completed and the vegetation is restored, the vegetation shall not be removed except for maintenance activities.

3.5.4. No drinking water wells shall be installed at the south landfill. No industrial water production wells shall be installed in the Potomac aquifer at the south landfill.

3.5.5. The restrictions on the use of the property shall be included in the deeds to the Site property. The deeds to the affected property shall also be modified to give notice to the public of past land disposal and of the fact that releases and threats of releases of hazardous substances have affected their respective parcels.

3.5.6. Additional measures may be required to implement the institutional controls outlined in paragraphs 3.5.1 to 3.5.5.

3.5. **South Landfill Cost**

DESCRIPTION: The estimated present worth cost of Alternative #5 is $14,300,000. See Table 16 for details of the cost estimate including the capital cost and annual operations and maintenance costs.

4. SOUTH WETLANDS

4.1. **South Wetlands Sediment Excavation**

DESCRIPTION: The exact areal extent of unacceptable environmental impact (based on the clean-up criteria for cadmium, lead, and zinc) shall be identified in the remedial design (Figure 29 shows the approximate area requiring remediation), subject to EPA approval. Sediments above these criteria shall be excavated to a depth of one foot. The excavated sediments shall be stabilized and then disposed of in the south landfill prior to placement of the south landfill cap as described in paragraphs 3.3.1 to 3.3.7 above. The area of excavation shall be backfilled to return the area to original grade and re-vegetated to restore the wetlands.

PERFORMANCE STANDARDS:

4.1.1. The following shall be the Site-specific clean-up criteria for the sediments in the south wetlands (these are absolute chemistry values normalized to grain size):

Lead	1200	ppm
Cadmium	60	ppm
Zinc	5600	ppm

Areas that exceed any one of the above Site-specific clean-up criteria in the south wetlands shall be excavated to a depth of one foot. Other areas may require excavation to a depth of one foot pursuant to paragraphs 4.1.2 to 4.1.6.

4.1.2. A statistically significant number (and a number sufficient to direct remedial activities) of samples shall be collected from the top 6" of the sediments in the south wetlands (see area in Figure 38) to delineate areas containing sediments above the Site-specific sediment clean-up criteria. The samples shall be analyzed for the complete Target Analyte List (TAL) of metals and grain size. The samples shall be collected from areas estimated to have a minimum of 50% fines (percentage of sediments that can pass through a 64 micron sieve).

4.1.3. A minimum of four solid phase sediment toxicity tests (involving four toxicity test replicates and total organic carbon (TOC), grain size, and TAL metals analyses) measuring the survival rate of *Hyallela azteca* shall be performed in the south wetlands in areas where the cadmium, lead, and zinc levels are below the Site-specific clean-up criteria and above their AET values (9.6 ppm, 660 ppm, and 1600 ppm, respectively, on an absolute basis). A 30% reduction in survival compared to the control sample shall be considered a significant impact. If significant impacts are seen in any of the toxicity tests performed for the south wetlands, EPA may modify the Site-specific clean-up criteria as described in Paragraph 4.1.1 (however, not below their respective AET values) for the south wetlands, if appropriate, to protect the environment.

4.1.4. A minimum of four solid phase sediment toxicity tests (involving four toxicity test replicates and total organic carbon (TOC), grain size, and TAL metals analyses) measuring the survival rate of *Hyallela azteca* shall be performed in the south pond. A 30% reduction in survival compared to the control sample shall be considered a significant impact. If significant impacts are seen in any of the toxicity tests performed for the south pond, the south pond shall be included in the area of the south wetlands to be remediated if EPA determines that it is appropriate to adequately protect the environment.

4.1.5. At 20% of the chemistry sampling locations called for in paragraph 4.1.2 above that are outside of the expected area of remediation (see Figure 29), surface water chemistry samples shall be collected and analyzed for total and dissolved TAL metals. Areas where the dissolved concentration of any one Site-related contaminant, present also in the sediments at that location, exceeds its respective Delaware acute SWQS shall be included in the area of the south wetlands to be remediated. EPA does not consider the "greater risk to human health and environment" ARAR waiver to be protective in these areas (i.e., in areas where the dissolved concentration of a Site-related contaminant exceeds its respective acute SWQS, EPA no longer considers the Site-specific sediment clean-up criteria to be protective).

4.1.6. Areas of the south wetlands that exceed any one of the Site-specific clean-up criteria for the south wetlands, as revised if necessary, or where the dissolved metal concentration of any one Site-related contaminant (present in the sediments in that particular area) exceeds its respective Delaware acute SWQS shall be excavated to a depth of one foot. The excavation of the sediments shall be designed and performed in such a way as to minimize environmental damage and utilize, to the maximum extent practicable, excavation methods such as vacuum dredging or other alternative excavation methods. The determination of which areas exceed the Site-specific clean-up criteria and require excavation is subject to EPA approval.

4.1.7. Prior to excavating 32 work-hours shall be spent collecting and moving to a new environment any wildlife that is residing in areas to be affected by the remediation.

4.1.8. The excavated area shall be backfilled with clean fill from an EPA-approved source and returned to original grade.

4.1.9. The excavated sediments shall be consolidated to the south landfill prior to stabilization and capping in accordance with the performance standards under the "South Landfill" section above.

4.1.10. The wetlands shall be successfully re-established. A complete restoration program shall be developed during remedial design to address the excavated area and the newly created wetland area. This program shall, at a minimum identify factors which are key to a successful restoration program including, but not limited to, replacing and regrading soils and re-establishment of vegetation. The program shall be implemented. Other appropriate measures, including but not limited to, periodic maintenance (i.e., planting) may also be necessary to ensure long-term restoration.

4.1.11. A variety of grasses and hydrophytic species common to the area shall be used to revegetate the wetland.

4.1.12. Only if EPA decides to include the south pond in the area of the south wetlands to be remediated, shall paragraphs 4.1.13 to 4.1.15 be complied with.

4.1.13. The south pond shall be excavated to a depth of one foot. The excavation of the sediments shall be designed and performed in such a way as to minimize environmental damage and utilize, to the maximum extent practicable, excavation methods such as vacuum dredging or other alternative excavation methods.

4.1.14. Paragraphs 4.1.6, 4.1.7, 4.1.8, 4.1.9, and 4.1.10 apply to the south pond also.

4.1.15. Vegetation of similar type and quantity that existed in the south pond prior to remediation shall be successfully re-established.

4.2. South Wetlands Long-term Monitoring

DESCRIPTION: Long-term monitoring of the entire south wetland area shall be conducted to ensure that the remedy remains protective.

PERFORMANCE STANDARDS:

4.2.1. A long-term monitoring plan shall be developed and implemented to monitor the effectiveness of the remedial action in the south wetlands to make sure that the Site-specific clean-up criteria remain protective of the environment and to make sure the restoration is successful.

4.2.2. The monitoring plan shall include sediment monitoring stations located in both remediated and unremediated areas (also include a Site background location). TAL metals analysis, TOC, grain size, acute and chronic toxicity tests (preferably using *Hyallela azteca*), and benthic density and diversity measurements shall be performed at these locations.

4.2.3. The monitoring plan shall include muskrat monitoring at the south pond and a background station every other year during the first five years after the remedy is implemented. The monitoring shall include whole body tissue analyses for TAL metals and organ histeopaths of the liver and kidney or blood and hair analyses for TAL metals.

4.2.4. The monitoring plan shall include appropriate field observations of plant growth and of the general conditions of the wetlands of sufficient detail to provide sufficient information to determine the successful establishment of the wetland.

4.2.5. The monitoring plan shall determine the frequency of monitoring and reporting requirements. The reporting requirements shall include a discussion of the results in addition to data presentation.

4.2.6. The monitoring plan for the south wetlands shall include the determination of a reference station to be approved by EPA. The reference station shall be representative of natural background conditions in a non-tidal wetland and, preferably, near the Site (EPA does not consider RS15 to be representative of natural background conditions). Also since there is probably no pristine area near the Site, a list of conditions that would be expected in a pristine non-tidal wetland shall be developed through examination of aquatic conditions at areas in northern Delaware or other appropriate areas.

4.2.7. Performance standards 4.2.1 to 4.2.6 above are the minimum requirements of the monitoring plan. The monitoring plan is subject to EPA's approval. The discussion of the monitoring results is also subject to EPA's approval. If at some time EPA determines that this monitoring data indicates that the Site-specific clean-up criteria are no longer protective (for example, the metals remaining in the sediments become more bioavailable due to changing conditions and cause a greater impact), additional remedial measures beyond those described in this ROD may be required including further dredging.

4.3. **Tide Gate**

DESCRIPTION: The tide gate shall be maintained as part of the operations and maintenance of this area to prevent the Christina River from entering the wetlands.

PERFORMANCE STANDARDS:

4.3.1. The tide gate shall be maintained in such a way as to allow water to discharge from the south wetlands to the Christina River but not allow water, and therefore aquatic life, from the Christina River to enter the south wetlands.

4.4. **South Wetland Institutional Controls**

DESCRIPTION: Institutional controls shall be put in place in order to ensure the protectiveness of the remedy.

PERFORMANCE STANDARDS:

4.4.1. No drinking water wells shall be installed in the south wetlands area. No industrial water production wells shall be installed in the Potomac aquifer in the south wetlands area.

4.4.2. Paragraph 4.4.1 applies to all of the land between the south landfill and Old Airport Road that is currently owned by Du Pont and not just those areas classified as wetlands. These restrictions shall be included in the deeds to the Site property. Deeds to the affected property shall be modified to give notice to the public of past land disposal and of the fact that releases and threats of releases of hazardous substances have affected the property.

4.4.3. Additional measures may be required to implement the institutional controls outlined in paragraphs 4.4.1 to 4.4.2.

4.5. South Wetlands Cost

DESCRIPTION: The estimated present worth cost of Alternative #2 is $4,200,000. See Table 17 for details of the cost estimate including the capital cost and annual operations and maintenance costs.

5. CHRISTINA RIVER

5.1. Delineation of Area to be Dredged

DESCRIPTION: The exact areal extent of unacceptable environmental impact (based on the clean-up criteria for cadmium, lead, and zinc) shall be determined.

PERFORMANCE STANDARDS:

5.1.1. The following shall be the Site-specific clean-up criteria for the sediments in the Christina River (these are absolute chemistry values normalized to grain size):

Lead	1200	ppm
Cadmium	60	ppm
Zinc	5600	ppm

Areas that exceed any one of the Site-specific clean-up criteria in the Christina River, at sample depths described in paragraph 5.1.4 below, shall be dredged until the river bottom in the dredged area is below each Site-specific clean-up criteria described above (revised as necessary pursuant to paragraph 5.1.3 below).

5.1.2. A statistically significant number (and a number sufficient to direct remedial activities) of samples shall be collected from the Christina River (see area in Figure 39) to delineate areas containing sediments above the Site-specific sediment clean-up criteria. The samples shall be analyzed for the complete Target Analyte List (TAL) of metals and grain size. The samples shall be collected from areas estimated to have a minimum of 50% fines (percentage of sediments that can pass through a 64 micron sieve).

5.1.3. A minimum of four solid phase sediment toxicity tests (involving four toxicity test replicates and total organic carbon (TOC), grain size, and TAL metals analyses) measuring the survival rate of *Hyallela azteca* shall be performed in the Christina River in areas where the cadmium, lead, and zinc levels are below the Site-specific clean-up criteria and above their AET values (9.6 ppm, 660 ppm, and 1600 ppm, respectively, on an absolute basis). A 30% reduction in survival compared to the control sample shall be considered a significant impact. If significant impacts are seen in any of the toxicity tests performed for the Christina River, EPA may modify the Site-specific clean-up criteria as described in paragraph 5.1.1 (however, not below their respective AET values) for the Christina River, if appropriate, to protect the environment.

5.1.4. Each sampling station in Paragraph 5.1.2 shall have four samples collected and analyzed for TAL metals. The samples shall be taken at depths of 0-6", 6-12", 12-18", and 18-24". Exceedance of any one Site-specific clean-up criteria, as revised if necessary, at any depth sampled shall cause the area represented by that sample to be included in the area(s) to be dredged. The area of dredging is subject to EPA approval. Small, localized hotspots located away from the CIBA-GEIGY/Du Pont facility may be excluded from the dredging if EPA determines that dredging the hotspot(s) is not cost effective and leaving them in the river is protective of the environment.

5.2. **Christina River Dredging**

DESCRIPTION: Hydraulic dredging of the river shall take place in this area(s) of unacceptable environmental impact. The dredged area shall then be covered with clean fill.

PERFORMANCE STANDARDS:

5.2.1. The area of unacceptable environmental impact as established pursuant to 5.1.4 above shall be dredged until the river bottom in this area(s) is below the Site-specific clean-up criteria.

5.2.2. Dredging shall only be carried out when the river current velocity is 1.5 feet per second (fps) or below (approximately one hour before and after slack tide).

5.2.3. Dredging shall only take place during the period of November to March (inclusive) to avoid anadromous fish runs and the time of greatest benthic activity.

5.2.4. All available engineering controls shall be used to minimize, to the maximum extent practicable, transport of sediments away from the dredging area. Examples of the types of controls to consider include increasing the percentage water intake at the cutter head, using silt curtains, and/or using hydraulic dredging equipment.

5.2.5. Monitoring shall be performed downgradient from the dredging area to monitor sediment transport. The remedial design shall specify unacceptable levels of sediment transport that require dredging to be temporary halted or be modified. These levels shall be submitted to EPA for approval prior to dredging.

5.2.6. Dredged sediments shall be pumped to a treatment plant at the plant areas.

5.2.7. A statistically significant number of samples shall be taken after dredging to ensure that the sediments remaining on the river bottom are below the Site-specific clean-up criteria.

5.2.8. Clean fill from an EPA-approved source which meets specifications to be determined during the remedial design shall be placed in the dredged areas to return the river bottom to its original grade.

5.3. Dewatering of Dredged Material

DESCRIPTION: The dredged sediments shall be dewatered and properly disposed of either on-site or off-site.

PERFORMANCE STANDARDS:

5.3.1. The remedial design shall identify, subject to EPA approval, the best method for properly handling the dredged sediments and appropriately preparing them for disposal. Dewatering and/or stabilization may be used to provide adequate structural strength for disposal. If stabilization is required and the sediments fail the TCLP test, the sediments shall be stabilized in such a way as to pass the TCLP test.

5.3.2. The dredged sediments shall be properly prepared for disposal. The properly-prepared dredged sediments shall be disposed. The order of preference for the disposal location of the processed sediments shall be on-site in either the north or the south landfills, and then off-site in an EPA-approved disposal facility.

5.3.3. If off-site disposal will take place, TCLP tests shall be performed on the sediments to determine if they are a RCRA-hazardous waste prior to any processing other than physical dewatering. If they fail the TCLP test, RCRA land disposal regulations shall be complied with, and the sediments shall be stabilized so that they pass the TCLP test.

5.3.4. Any stabilization required to meet RCRA land disposal regulations shall involve thoroughly mixing the excavated soils with a cementitious or pozzolanic reagent mixture developed specifically to bind the metal constituents within the stabilized matrix. The actual stabilization agent shall be identified in the remedial design and subject to EPA approval.

The performance standard for the stabilized soil is that it shall pass the TCLP test for metals prior to disposal.

5.3.5. Disposal, whether on-site or off-site, shall occur in a timely manner.

5.3.6. Wastewater generated from the treatment of dredged sediments shall be discharged to the Christina River in compliance with the substantive requirements of a NPDES permit for such activity or discharged to a POTW in compliance with any necessary pre-treatment requirements.

5.4. **Christina River Long-term Monitoring**

DESCRIPTION: Long-term monitoring shall be conducted in the Christina River to determine if the unremediated areas develop unacceptable impacts and to confirm the long-term effectiveness of the remedy.

PERFORMANCE STANDARDS:

5.4.1. A long-term monitoring plan shall be developed and implemented to monitor the effectiveness of the remedial action in the Christina River and to make sure that the Site-specific clean-up criteria remain protective of the environment.

5.4.2. The long-term monitoring plan shall include sediment monitoring stations in the Christina River in both remediated and unremediated areas (and include a Site background station). TAL metals analysis, TOC and grain size tests, acute and chronic toxicity tests (preferably using *Hyallela azteca*), and benthic density and diversity measurements shall be performed at these locations.

5.4.3. The long-term monitoring plan shall determine frequency of monitoring and reporting requirements. The reporting requirements shall include a discussion of the results in addition to data presentation.

5.4.4. The monitoring plan for the Christina River shall include the determination of a reference station to be approved by EPA. The reference station shall be representative of natural background conditions in a tidal river environment and, preferably, shall be near the Site (EPA does not consider RS15 to be representative of natural background conditions). Also since there is probably no pristine area near the Site, a list of conditions that would be expected in a pristine tidal river environment shall be developed through examination of aquatic conditions at areas in northern Delaware or other appropriate areas.

5.4.5. Performance standards 5.4.1 to 5.4.4 above are the minimum requirements of the monitoring plan. The monitoring plan shall be submitted to EPA for approval. The discussion of the monitoring results shall also be submitted to EPA for approval. If at some time EPA determines that this monitoring data indicates that the Site-specific clean-up criteria are no longer protective (for example, the metals remaining in the sediments become more bioavailable due to changing conditions and cause a greater impact), additional remedial measures beyond those described in this ROD may be required including further dredging.

5.5. Christina River Cost

DESCRIPTION: The estimated present worth cost of Alternative #5 is $4,700,000. See Table 18 for details of the cost estimate including the capital cost and annual operations and maintenance costs.

6. CIBA-GEIGY AND DU PONT HOLLY RUN PLANTS

6.1. DESCRIPTION: The remedies in Section 6 address the area shown in Figure 30. This area includes the complete CIBA-GEIGY plant and a portion of the Du Pont Holly Run plant that has contaminated soils (called "contaminated plant areas" below). Only about 3% of the Holly Run plant area is included.

6.2. CIBA-GEIGY and Du Pont Holly Run Plants Institutional Controls

DESCRIPTION: Institutional controls shall be placed on the contaminated plant areas to restrict future land use, to ensure the protectiveness of the remedy, and to notify the public of past land use.

PERFORMANCE STANDARDS:

6.2.1. The contaminated plant areas shall not be used for residential purposes.

6.2.2. No drinking water wells shall be installed at the contaminated plant areas. No water production wells shall be installed in the Potomac aquifer at the CIBA-GEIGY Corporation Newport and Du Pont Holly Run plants.

6.2.3. The pavement and/or building structures located at the Site property shall be maintained in a manner which limits, to the maximum extent practicable, the infiltration of water.

6.2.4. The property owners, and/or their successors, shall notify EPA, and/or its successors, of their intent to convey any interest in the Site property. Such conveyance shall not be made without the prior written approval of EPA, and/or its successors. No conveyance of title, easement, or other interest in the Site property shall be consummated by the property owners, and/or their successors, without adequate and complete provision for continued maintenance of the property.

6.2.5. The property owners, and/or their successors, shall notify EPA, and/or its successors, of any substantial change to their present operations at the Site at least six months prior to the proposed change.

6.2.6. Any change in land use following completion of the remedial action shall require the prior written approval of EPA, and/or its successors.[32]

6.2.7. The respective Site owners shall modify the deeds to the affected Site property to give notice to the public of the past land disposal practices and of the fact that releases and threats of releases of hazardous substances have affected the property.

6.2.8. Additional measures may be required to implement the institutional controls outlined in paragraphs 6.2.1 to 6.2.7.

6.3. **Paving of Contaminated Plant Areas**

DESCRIPTION: The remaining unpaved portions of the contaminated plant areas shall be paved.

PERFORMANCE STANDARDS:

6.3.1. The remaining unpaved portions of the contaminated plant areas shall be paved. Paving shall be done in such a way as to minimize the need for maintenance and to limit to the maximum extent practicable infiltration of water into the ground.

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[32]Paragraphs 6.2.4 to 6.2.6 are necessary for EPA to ensure adequate protection of human health and the environment from any potential risks posed by the buried thorium. The U.S. Nuclear Regulatory Commission (NRC) has commented to EPA that the possibility exists for NRC itself to exempt this Site from NRC's decommissioning regulations in 10 CFR Part 40.4. NRC would require a strong set of institutional controls to be in place before it would consider allowing the drums to remain at the Site.

6.4. **Plant Areas Ground Water Physical Barrier Wall**

DESCRIPTION: A physical barrier wall (an actual wall that limits migration of ground water to the maximum extent practicable) shall be constructed to extend from the ground surface to the base of the Columbia aquifer keying into the aquitard which separates the Columbia aquifer and the Potomac aquifer (see Figure 37 for the approximate wall location). Ground water shall be recovered on the chemical plant side of the wall to control any ground-water mounding that could affect building foundations and that could force contaminated ground water downward into the Potomac aquifer. Recovered ground water shall be treated prior to discharge.

PERFORMANCE STANDARDS:

6.4.1. A physical barrier wall (an actual wall that limits migration of ground water to the maximum extent practicable) shall be constructed to extend from the ground surface to the base of the Columbia aquifer keying into the aquitard which separates the Columbia aquifer and the Potomac aquifer (see Figure 37 for the approximate wall location). The design shall be such as to minimize the flow of Columbia ground water underneath the barrier wall. The approximate barrier location is shown in Figure 37. The exact location of the physical barrier wall shall be identified in the remedial design and subject to EPA approval. The west end shall connect to the barrier wall in the north landfill. The east end shall extend far enough around the CIBA-GEIGY plant to capture all of the Columbia and fill zone ground water that has come into contact with contaminated soil.

6.4.2. The barrier shall have a permeability of $1x10^{-7}$ cm/sec or less.

6.4.3. Different barrier wall technologies including deep soil mixing, sheet piles, geosynthetic membranes, and slurry walls shall be evaluated in the remedial design. Of the technologies that are implementable, the remedial design shall identify the technology considered to have the longest life. More than one technology may be necessary depending on the wall location. EPA will make the final decision about what barrier wall technology will be used.

6.4.4. Any unused piping found to cross the path of the barrier wall shall be plugged or removed to a distance to be identified in the remedial design, subject to EPA approval, that will keep a reservoir of potentially contaminated ground water from being formed adjacent to the barrier wall. Any used piping shall be inspected to make sure it is in proper working condition so that a seal can be formed between the pipe and the barrier wall that is of sufficient quality as to prevent a preferential flow path for the ground water from forming.

6.4.5. Ground-water recovery wells shall be installed in sufficient number to control any mounding effect created by the barrier wall. The wells shall draw the water table down to the maximum extent practicable without affecting the water table underneath the chemical plants in such a way as to cause structural problems to buildings or pavement. The wells shall be installed in accordance with appropriate State regulations.

6.4.6. All extracted ground water shall be treated and discharged to the Christina River (or if determined by EPA during the remedial design to be acceptable, the treated ground water may be discharged to a publicly owned treatment works-POTW). This treatment shall include removing all contaminants (including metals, organics, and, if necessary, radionucleides) necessary to meet all discharge requirements (especially compliance with the substantive requirements of a National Pollution Discharge Elimination System [NPDES] permit if discharging to the Christina River). If an air stripper or other vented system is used to treat the ground water, secondary controls may be necessary in order to comply with Federal and State air ARARs (see Table 12) and to ensure protectiveness of human health and the environment (for protection of human health, secondary emission controls shall be installed if the emissions from the air stripper cause a greater than $1x10^{-6}$ excess cancer risk). It is anticipated that the treatment sludges will be hazardous waste. Any treatment residues containing tetrachloroethylene shall be considered F002 waste. Disposal of any treatment sludges or other wastes shall be in accordance with appropriate Federal and State regulations (see Table 12).

6.5. **Health and Safety Plan for Subsurface Work**

DESCRIPTION: A special health and safety plan shall be used during any future subsurface work in the contaminated plant areas.

PERFORMANCE STANDARDS:

6.5.1. A health and safety plan to protect workers against exposure to contaminated soils shall be developed and complied with for all future subsurface work.

6.5.2. The health and safety plan shall include a waste management section. This section shall discuss procedures for testing any soil excavated post-remedial action to determine of it is a RCRA-hazardous waste. If so determined, the soil shall be handled and disposed of as such.

6.6. Contaminated Plant Areas Cost

DESCRIPTION: The estimated present worth cost of Alternative #5 is $11,000,000. See Table 19 for details of the cost including the capital cost and annual operations and maintenance costs.

7. GROUND WATER

7.1. Public Water Supply Line

DESCRIPTION: To mitigate potential future risks from ground water, the residences and businesses near the Site along Old Airport Road shall be placed on public water supply.

PERFORMANCE STANDARDS:

7.1.1. A public water supply line shall be installed along Old Airport Road as far as, and including, private well #16 of the RI, located at Cress Collision Service, Inc. (see Figure 40).

7.1.2. Residences and businesses between the Site and private well #16, including well #16 (approximately 7 wells) that desire to have public water shall be connected to a public water supply line.

7.1.3. Costs of public water usage shall be the responsibility of the appropriate residence or business.

7.1.4. Coordination shall take place with a local water supply company that services this area (that is in compliance with the Safe Drinking Water Act and its implementing regulations) to ensure that the public water supply line is properly installed.

7.1.5. The existing private wells at businesses or residences that are connected to the public water supply line shall be abandoned in accordance with State regulations.

7.2 Ground-water Management Zone

DESCRIPTION: Institutional controls including deed restrictions and a ground-water management zone in the area of the Site (see Figure 33 for the approximate area) shall be established to limit the future installation of drinking water wells.

PERFORMANCE STANDARDS:

7.2.1. The State shall establish and maintain a ground-water management zone in the area of the Site for as long as levels of contaminants remain that make the ground water unsafe to drink. No drinking water wells shall be permitted to be drilled in areas where the contaminant levels make the ground water unsafe to drink or where the pumping of the well threatens to spread the contamination.

7.3. **Long-term Monitoring of the Ground Water**

DESCRIPTION: Long-term monitoring of the Columbia and the Potomac aquifers shall take place to monitor the rate of contaminant migration and attenuation in the Columbia aquifer and the rate of contaminant migration and attenuation in the Potomac aquifer to the south.

PERFORMANCE STANDARDS:

7.3.1. A long-term monitoring plan for the Columbia and the Potomac aquifers shall be developed, submitted to EPA for approval, and implemented to monitor the rate of contaminant migration and attenuation in the Columbia aquifer (for the area outside of the waste management area as shown in Figure 32) and to monitor the rate of migration and attenuation of contaminants to the south in the Potomac aquifer.

7.3.2. This plan shall outline which wells are to be sampled (new wells may be necessary if the current ones are not in the right locations), type and frequency of analyses, and frequency of reporting. The reports shall include a discussion of the monitoring results. At a minimum, for the Columbia aquifer, the monitoring shall include sampling MW-21A, MW-23A, MW-24A, MW-25A, and MW-26A for metals twice per year. For the Potomac aquifer, the monitoring shall include sampling MW-6B, MW-18B, MW-21B, and MW-26BS for metals twice per year. If any of the Site-related contaminants migrates to any one of these wells at a level sufficient to produce a risk of either $1x10^{-6}$ for carcinogenic risks or 1 for non-carcinogenic risks, EPA, in consultation with DNREC, may require active remedial measures (such as restoration or containment of the ground water) beyond those described in this ROD at that time. The monitoring reports, including all of the appropriate information, shall be submitted to EPA for approval.

7.3.3. The monitoring plan shall also provide for wells in each aquifer in the waste management area to help monitor the effectiveness of the remedy in these areas.

7.3.4. Monitoring for thorium shall take place every six months by sampling monitoring wells MW-33, SM-1, SM-3, and SM-4 for thorium-232 and its daughter products and gross alpha and beta radiation. The detection limits shall be low enough to provide adequate data to determine if a release is occurring. Monitoring for thorium will stop if all of the thorium is ever removed from the north landfill.

7.4. **Ground-water Cost**

DESCRIPTION: The estimated present worth cost of Alternative #2 is $1,400,000. See Table 20 for details of the cost estimate including the capital cost and annual operations and maintenance costs.

8. OTHER MISCELLANEOUS PERFORMANCE STANDARDS

8.1. DESCRIPTION: Below are other performance standards that apply to several areas of the Site or the Site as a whole.

8.2. **Operations and Maintenance Plan**

DESCRIPTION: An operations and maintenance plan shall be developed and implemented for each portion of the remedy.

PERFORMANCE STANDARDS:

8.2.1. The plan shall include a list of all vendor-required maintenance activities.

8.2.2. The plan shall include a list of potential operations and maintenance problems and their proposed solution.

8.2.3. The plan shall include a list of all required inspections and general guidelines for the inspections.

8.2.4. The plan shall include operating instructions for the ground-water recovery and treatment system.

8.2.5. The plan shall include reporting requirements and forms.

8.2.6. The plan shall include health and safety requirements.

8.2.7. The plan shall include tasks to inspect, document, and repair any erosion problems along either the north or the south river bank.

8.2.8. The plan shall include tasks to inspect, document, and repair any pavement or other problems that contribute to the infiltration of water in the contaminated plant areas.

8.2.9. Performance standards 8.2.1 to 8.2.8 are the minimum requirements of the operation and maintenance plan. The plan, including all of the appropriate information shall be submitted to EPA for approval.

8.2.10. All requirements of the approved plan shall be carried out.

8.3. **Erosion Control Plan**

DESCRIPTION: An erosion control plan shall be developed and implemented.

PERFORMANCE STANDARDS:

8.3.1. An erosion control plan shall be developed and implemented which outlines procedures to be used to control transport of soil and sediment due to erosion, to the maximum extent practicable and in accordance with the ARARs in Table 12, for all activities which present the potential for transporting soils or sediments. This plan shall also include procedures to be used to properly discharge stormwater from the construction areas.

8.3.2. This plan shall be developed in accordance with any State and local regulations and shall be submitted to EPA for approval.

8.4. **Particulate Air Emissions**

DESCRIPTION: All remedial work shall be done in such a manner as to minimize transport of airborne particulate emissions.

PERFORMANCE STANDARDS:

8.4.1. As part of the remedial action health and safety plan, levels of particulate considered to pose an unacceptable health risk shall be developed along with monitoring requirements to measure particulate counts.

8.4.2. Air monitoring shall be done at appropriate times to ensure protectiveness of human health.

8.4.3. If the air monitoring results indicate that particulate counts are high enough that EPA concludes that unacceptable health risks are posed to people on-site or off-site, appropriate measures shall be taken to reduce the particulate count to safe levels off-site, and either to reduce the particulate count to safe levels on-site or to protect the workers through personal protective equipment.

8.5. **Waste Management Plan**

DESCRIPTION: A waste management plan shall be developed to handle any other wastes generated during remedial design or remedial action for which waste management performance standards have not previously been set.

PERFORMANCE STANDARDS:

8.5.1. A waste management plan shall be developed, submitted to EPA for approval, and implemented to handle any other wastes generated during remedial design or remedial action that have not previously had waste management performance standards set. The plan shall outline how all Federal, State, and local regulations will be complied with.

8.6. **ARARs**

DESCRIPTION: The selected remedy shall meet all chemical, location, and action specific ARARs that apply to the remedy unless waived formally by EPA.

PFRFORMANCE STANDARDS:

8.6.1. The selected remedy shall attain, at a minimum, all chemical, location, and action specific ARARs listed in Table 12 unless waived formally by EPA.

8.7. **Habitat Value Balance Sheet**

DESCRIPTION: A balance sheet shall be developed during remedial design to keep track of and compare current and future land use values.

PERFORMANCE STANDARDS:

8.7.1. A balance sheet shall be developed during remedial design which accounts for all current habitat land use values at the Site and accounts for all habitat land use values post-remedial action. This balance sheet may be used by EPA to help review the remedial design. The balance sheet shall also describe any temporary habitat losses caused by construction.

STATUTORY DETERMINATIONS

EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA, 42 U.S.C. § 9621, establishes several other statutory requirements and preferences. These requirements specify that when complete, the selected remedial action for each site must comply with applicable or relevant and appropriate (ARARs) environmental standards established under federal and state environmental laws unless a statutory waiver is invoked. The selected remedy also must be cost effective and utilize treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that permanently and significantly reduce the volume, toxicity, or mobility of hazardous substances. The following sections discuss how the selected remedy for this site meets these statutory requirements.

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy provides overall protection of human health and the environment. It protects human health by:

1. Removing all soil from the ballpark containing greater than 500 ppm lead will eliminate the possibility of children being exposed to unacceptable levels of lead during recreational activities.

2. Capping the north landfill to prevent exposure to maintenance workers cutting grass from contaminated soils. Capping will eliminate risks posed by this pathway.

3. Instituting health and safety plans for all subsurface work in areas of contaminated soil at the Du Pont Holly Run/CIBA-GEIGY plants and at the south landfill. This will prevent unacceptable levels of exposure for work activities to contaminated soils in these areas.

4. Capping the south landfill and providing improved Site-security by modifications to the fencing and installation of thorny plants around the south landfill and south wetlands will prevent exposure to adolescent trespassers from contaminated soils. Capping and improving Site security will address risks posed by this pathway.

5. Paving the remaining areas of the CIBA-GEIGY plant and contaminated area of the Du Pont Holly Run plant to prevent exposure of maintenance workers cutting grass to contaminated soils. Paving will eliminate risks posed by this pathway.

6. Installing a public water supply line to residents and businesses along Old Airport Road to prevent any potential future exposure to contaminated ground water caused by plume migration to existing wells. Installing a water supply line will eliminate any potential risks posed by this pathway.

7. Establishing a ground water management zone to prevent any new wells from being drilled into the plume. Preventing installation of new drinking water wells will eliminate risks to potential future users posed by this pathway.

8. Excavating contaminated soils underneath and to the east of Basin Road or South James Street to prevent future exposure by construction workers to contaminated soils. Following excavation and backfilling with clean fill, this pathway will no longer pose unacceptable risks to off-site workers.

9. Capping the north landfill, paving the contaminated plant areas, installing a physical barrier wall along the river in the area of the CIBA-GEIGY plant and the north landfill, controlling the hydraulic head of the Columbia aquifer upgradient of the barrier wall, capping and *in-situ* stabilization of the south landfill, excavating the soil underneath and to the east of Basin Road will limit to the maximum extent practicable any continued release of contamination to the Columbia and Potomac aquifers and therefore minimize, to the extent practicable and possibly prevent, the spread of contaminants in these two aquifers. These parts of the selected remedy will help prevent the potential for exposure of humans to contaminated ground water.

The selected remedy will protect the environment by:

1. Removing sediments in the north wetlands (including the north drainage way), the south wetlands, and the Christina River that are above the Site-specific clean-up criteria and then backfilling the wetland areas with clean sediments to prevent exposure of aquatic life to levels of contamination that EPA has determined at this Site produce unacceptable risks to environmental receptors. There will be some residual risk to environmental receptors in the remediated areas because, for example, it will be impossible to prevent some contamination from the unremediated portions of the wetlands and river to migrate to the remediated areas. However, the risks will be greatly reduced.

2. Capping the north landfill, paving the contaminated plant areas, installing a physical barrier wall along the river in the area of the plants and the north landfill, controlling the hydraulic head of the Columbia aquifer upgradient of the barrier wall (through ground-water pumping and treating), capping and *in-situ* stabilization the south landfill, and excavating the soil

underneath and to the east of Basin Road. This will greatly decrease the loading of contaminants (mainly heavy metals) to the river and the wetlands thus limiting to the maximum extent practicable any continued build-up of contaminant levels in sediments in the river and wetlands, and should significantly improve (especially in the river) the surface water quality which currently exceeds AWQC or SWQSs.

3. Removing the berm in the south wetlands will help mitigate adverse impacts to the floodplain caused by the volume increase at the south landfill due to stabilization. This will also eliminate any erosion of surface soils to the south wetlands that are creating or could create an adverse impact to the wetlands. Using this area to create wetlands in compensation for wetlands lost due to other construction activities at the south landfill will greatly increase the habitat value of this section of the Site.

4. Installing thorny plants around the south landfill/south wetland area to decrease Site access by humans and yet allow migration of terrestrial animals which are known to inhabit to Site.

5. Invoking the "greater harm to human health and the environment" ARAR waiver for the ground water. In the Columbia aquifer, this will prevent potential adverse affects on the south wetlands caused by pumping the aquifer and removing the natural source of recharge to the south wetlands and potentially introducing contamination from the wetland sediments into the Columbia aquifer. In the Potomac aquifer, invoking the ARAR waiver will prevent more contamination from being introduced to the portion of the Potomac aquifer underneath the waste management area. It is believed that most of the contamination in the Potomac aquifer is due to the use of process water wells at the pigment plant drawing contamination down from the Columbia aquifer to the Potomac aquifer. Recovery wells screened in the Potomac aquifer to remediate the portion of the plume outside the waste management area would have the same impact as the process water wells on the portion of the plume in the Potomac aquifer underneath the waste management area.

6. Instituting long-term monitoring of both remediated and unremediated portions of the wetlands and the river and long-term monitoring of the muskrat population at the south pond. The monitoring of the wetlands and the river will ensure the selected remedy remains protective. The muskrat monitoring will help ensure that the decision not to remediate the south pond continues to be protective of the environment.

COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The selected remedy shall attain all action, location, and chemical specific applicable or relevant and appropriate requirements for the Site which are listed in Table 12. Also included in the table are criteria, advisories or guidance to be considered (TBCs) for implementation of this remedy.

Several of the ARARs in Table 12 merit further discussion. First, RCRA Subtitle C landfill closure regulations are not considered ARARs for the north or the south landfill. Since the south landfill was closed prior to the enactment of RCRA, RCRA landfill closure regulations are not applicable. Also, once the stabilization process is complete at the south landfill, the landfill will no longer contain material similar to a RCRA-hazardous waste and RCRA Subtitle C closure regulations would not be considered relevant. Similarly, the north landfill was closed prior to the enactment of RCRA, so RCRA landfill closure regulations are not applicable. The closure regulations are relevant since some of the waste in this landfill may fail the TCLP test. However, the closure regulations are not appropriate. The main technical parts of the closure regulations are that the cap must be less permeable than the bottom liner to prevent a bathtub effect and that the ground water must be monitored to determine if any contamination is migrating from the landfill. Since the north landfill has no bottom liner, meeting the closure regulations would only require a slightly impermeable cap. EPA has determined that only a slightly impermeable cap would not be protective, and that the requirements of this ROD (a low permeability cap) are required to be protective of human health and the environment. As for the ground-water monitoring, since the north landfill is adjacent to a river, since the Columbia aquifer is already contaminated, and since active ground-water remediation will not take place in this area, the monitoring requirements as described in 40 CFR 264.98 are not appropriate,[33] and therefore, the closure regulations are not appropriate.

Second, EPA has determined that for the overall protection of human health and the environment at this Site, compliance with the MCL and non-zero MCLG ground water ARARs must be waived.[34]

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[33]Ground water monitoring at the north landfill will take place to monitor for releases of thorium. Metals analyses will also be performed to monitor the levels of contamination but this will not be in accordance with 40 CFR 264.98.

[34]The "greater harm to human health and the environment" ARAR waiver also applies to the State of Delaware Regulations Governing Public Drinking Water (revised 3/11/91) Sections 22.2,

The ground water at the Site is a Class IIA aquifer (i.e., the aquifer system, both the Columbia and the Potomac, is a current source of drinking water). Therefore, the NCP states that EPA's objective would be to return the ground water to its beneficial use by considering MCLs or non-zero MCLGs as ARARs. However, the NCP does provide certain instances where ARARs may be waived. Sections 300.430(f)(1)(ii)(C)(1-6) of the NCP outline six different ARAR waivers, including the interim measure waiver, the equivalent standard of performance waiver, the greater risk to human health and the environment waiver, the technical impracticability waiver, the inconsistent application of state standards waiver, and the Fund-balancing waiver. The greater risk to human health and the environment waiver may be invoked when compliance with an ARAR will cause greater risk to human health and the environment than non-compliance.

EPA has concluded that the "greater risk to human health and the environment" waiver should be invoked in this case. Active remediation in the Potomac aquifer will cause the ground water upgradient of the hydraulic barrier (underneath the waste management area) to become more contaminated since the pumping will cause a reversal of the natural upward flow of the ground water into the Columbia aquifer and will pull more highly contaminated ground water down into the Potomac aquifer (which is how the Potomac aquifer originally became contaminated). EPA does not expect the contaminant plume in the Potomac aquifer to expand. To date, the plume has exhibited limited migration potential due most likely to anions in the natural ground water combining with the heavy metals and precipitating them out of solution. Also, the selected remedy for the other areas of the Site will greatly decrease, if not eliminate, contaminant migration from the Columbia aquifer to the Potomac aquifer (i.e., the source of contamination to the Potomac will be greatly reduced, if not actually eliminated).

Active remediation in the Columbia aquifer may cause the Columbia aquifer to become more contaminated because pumping may cause the wetland area to become a recharge area for ground water instead of a discharge area for ground water. If the Columbia ground water is recharged from the surface water in the wetlands, higher levels of contamination may be introduced into the ground water by the washing of contaminants from the sediments.[35] As

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22.3, 22.4, 22.6, and 22.10 and the Delaware Regulations Governing Hazardous Substance Cleanup (1/93), Section 9 for the Columbia and Potomac aquifers.

[35]The clean-up criteria for the sediments were set to protect aquatic life only since there was not expected to be any human exposure by direct contact to the sediments. However, sediment contaminant levels that are protective of aquatic life

with the Potomac aquifer, EPA does not expect the plume in the Columbia aquifer to spread since the sources will be controlled. Also, in the Columbia aquifer, ground water generally flows toward the Christina River, thus keeping the plume from expanding.

As a result, EPA has determined that compliance with MCL and non-zero MCLG ground water ARARs will cause a greater harm to human health and the environment than non-compliance and invokes the "greater harm to human health or the environment" ARAR waiver. If, however, EPA determines through monitoring that the migration rate in either the Columbia aquifer or the Potomac aquifer is larger or different than expected and that, if left uncontrolled, the plume would pose a greater threat to human health or the environment, appropriate remedial measures beyond those called for in this ROD may be called for at that time.

Third, State SWQSs have been waived in the north wetlands, the south wetlands, and the Christina River. In the river, Federal AWQC were also waived. For both the north wetlands and river, background sources of contaminants prevent Site remedial measures from attaining these ARARs requiring that EPA invoke the "technical impracticability" ARAR waiver. For the south wetlands, substantially more sediments would have to be dredged than appears necessary to protect the wetlands. Stripping the complete south wetland just to attain SWQSs would cause more harm than good, thus EPA is invoking the "greater risk to human health and the environment" ARAR waiver.

COST-EFFECTIVENESS

Of the alternatives that offer adequate protection of human health and the environment, the selected remedy is the least costly. It also meets all other requirements of CERCLA and affords overall effectiveness proportionate to the cost. Also, the net present worth of $47.7 million is much less expensive than the estimated cost of $750 million for complete removal of the contamination. For several areas of the Site, cost had little to do with the selection of the remedy for that area of the Site because only one alternative passed the threshold criteria of overall protection of human health and the environment and compliance of ARARs. However, there are several issues relating to the cost-effectiveness of the selected alternative which do merit further discussion.

In the north landfill area, two alternatives met the threshold criteria. The alternative that provided the greatest degree of overall protection to human health and the environment

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may, as potentially in this circumstance, not be protective of human health through ingestion of ground water.

also happened to be the less costly of the two alternatives by $400,000.

In the south landfill area, the stabilization and cap alternative is $7 million more expensive than the cap only alternative. However, since the waste material is in the water table (and will continue to be even after the localized groundwater mounding dissipates after capping), EPA determined the cost was worth the extra degree of protection of the environment because stabilization will limit to the maximum extent practicable the migration of heavy metals to the river and the south wetlands. Also, stabilization and capping meet the statutory preference for treatment as a principal element. EPA has selected the stabilization alternative that does not include the most costly cap.

In the Du Pont Holly Run and CIBA-GEIGY plant areas, the alternative involving the physical barrier wall along the river was selected over the circumscribing physical barrier wall because it will provide the same degree of protection of the environment and yet will cost $5 million less. In the Christina River, dredging was selected over capping. EPA has determined that since capping of the river sediments would permanently destroy an area of habitat (even though it would protect aquatic life from the contaminated sediments), the dredging alternative would still be the preferred alternative even if the additional costs to dredging associated with off-site disposal of the sediments (estimated at $8.5 million) is considered.

UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

Of those alternatives that are protective of human health and the environment, EPA has determined that the selected remedy provides the best tradeoff in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, and cost, also considering the statutory preference for treatment as a principal element and considering State and community acceptance.

For the ballpark, the north landfill, the south wetlands, the Christina River, and the ground water, the threshold criteria of overall protection of human health and the environment dictated the choice of the selected remedy. For the south landfill, a greater degree of overall protection of the environment and reduction of mobility through treatment played a major role in the selection of stabilization and capping. For the Du Pont Holly Run and CIBA-GEIGY plant areas, short-term effectiveness, implementability, and cost dictated the decision to select the alternative with the physical barrier wall along the river instead of around the complete area of contamination.

Also, the local community had expressed concern about an alternative that would raise the water table in the town of Newport as would the alternative involving a circumscribing barrier wall.

As discussed in detail in the "Scope and Role of Remedial Action" section, the only permanent solution to the principal threats at the Site is complete removal of the north landfill, the south landfill, and the CIBA-GEIGY plant (including its destruction). This is not practical for several reasons. The major reason is the cost. An estimated $750 million (includes the cost of plant reconstruction) would be needed to perform a complete removal of the principal threats. The need to incur costs of this magnitude is not warranted based on the risks to human health and the environment since for both current and potential future conditions, engineering and institutional controls can provide the necessary protection of human health and the environment. Also, although the contamination could be removed it can not be destroyed.

The only portion of the Site where a permanent solution was employed that allows unlimited and unrestricted access is the ballpark. EPA has determined that this is the only portion of the Site for which a permanent solution is practical. EPA has also determined that there are not alternative treatment technologies or resource recovery options suitable for implementation at this Site. Therefore, the selected remedy utilizes permanent solutions and treatment technologies to the maximum extent practicable.

PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

From the results of the RI/FS, EPA has determined that several areas of the Site are principal threats. These include the soil beneath the CIBA-GEIGY plant, the north and south landfills, and the sediments in the north drainage way (adjacent to the north landfill). The major contaminants of concern in these areas are metals. Stabilization is the best demonstrated available technology (and the only available technology for a site of this size) for the treatment of metals. *In-situ* and *ex-situ* stabilization are not practicable in the north landfill area[36] because of the debris that was buried there. For example, trash (glass, wood, paper, and cardboard), steel drums, concrete rubble, steel work, and artificial marble have been buried in the north landfill. There is little value in tearing down the CIBA-GEIGY plant in order to stabilize the soil

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[36]The remediation of the north drainage way is included with the remediation of the north landfill since the north drainage way cuts through the landfill and then runs along the base of it.

underneath the plant since the north landfill and the CIBA-GEIGY plant are one large contiguous area of contamination.

After giving careful consideration to available technologies and Site characteristics, EPA has determined that treatment of the south landfill is practicable. However, for the CIBA-GEIGY plant, the north landfill, and the north drainage way sediments, EPA has determined that treatment is not practicable. Therefore, the statutory preference for treatment as a principal element has been satisfied with the selection of stabilization as part of the remedy at the south landfill.

DOCUMENTATION OF SIGNIFICANT CHANGES

The selected remedy described in this ROD contains a number of significant changes from EPA's preferred alternative in the Proposed Plan. The changes were made in response to comments on the Proposed Plan and consultations with the State of Delaware and other federal agencies including the Nuclear Regulatory Commission (NRC), US Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration (NOAA). The changes are described below.

1. The cost of the dredging alternative for the Christina River was reduced by approximately $8,000,000. The cost estimate in the Proposed Plan was based on off-site disposal of the dredged material. The cost estimate in the ROD more accurately reflects the cost of the preferred alternative in the Proposed Plan and the selected remedy for the Christina River which calls for the preference of on-site disposal.

2. In response to a resident's concern that contaminants are transported during heavy rainfall from the south wetlands to the south side of Old Airport Road, an area south of Old Airport Road has been added to the area of the south wetlands from which sediment sampling will take place. This sampling may delineate areas requiring remediation (see Figure 38). EPA verified the resident's concern by observing evidence that surface water had flowed from the South wetlands over Old Airport Road after a period of heavy rainfall.

3. The public water supply along Old Airport Road will be installed only to Cress Collision Service, Inc. and not to the end of the road as originally intended. This change was the result a Du Pont comment that due to the extent of the source control at the south landfill, it is not necessary at this time to install the water line to the end of the road. (See comment G.2 in the Responsiveness Summary.)

4. The selected remedy does not include the river bank cover along the north river bank at the north landfill and the

CIBA-GEIGY plant. This is in response to a Department of the Interior comment which raised concerns about stripping the vegetation along the river bank. (See comment H.11 in the Responsiveness Summary.)

5. In order to allow continued use of a boat ramp on the south bank of the Christina River between South James Street and the current South landfill fence, the boat ramp area shall be excavated and backfilled with clean fill along with the rest of the south landfill that is located on the State of Delaware's property.

6. In response to comments by Du Pont and the Town of Newport regarding the circumscribing physical barrier wall, EPA's selected remedy now specifies that the physical barrier wall be installed along the Christina River only. (See comment F.1 in the Responsiveness Summary.)

7. The sediment clean-up criteria in the ROD reflect slight revisions from those presented in the Proposed Plan, mainly because DNREC raised concerns that the criteria in the Proposed Plan were not based on a large enough data base. EPA, NOAA, DNREC, and the FWS have had numerous discussions in an attempt to develop mutually agreeable sediment clean-up criteria.

The ROD contains clean-up criteria developed by EPA after thoroughly considering the concerns of DNREC, NOAA, FWS, and the comments of Du Pont. These criteria include sediment chemistry values (on a normalized to grain size basis) which are slightly below the values presented in the Proposed Plan. Sediments containing normalized contaminant levels above the criteria will be dredged. The criteria also include performing a small number of *Hyallela azteca* solid phase toxicity tests in each of the north wetlands, the south wetlands, the Christina River, and the south pond to make that sure the sediment chemistry values are protective. The values may be lowered, if necessary to protect the environment, based on the results of the added toxicity tests. The sediment clean-up criteria in the ROD have the support of EPA, FWS, and NOAA. The complete details of the development of the sediment clean-up criteria are contained in the Administrative Record for the Site. The "Third and Final Edition" of the "Memo To File: River & Wetland Remediation Goals (Sediment Clean-up Criteria), Du Pont-Newport Site, Third and Final Edition" (dated 7/9/93) is attached to this ROD.

8. The ROD contains specific language describing where the long-term ground-water monitoring is to take place and how the results are to be used in evaluating whether the ground-water ARAR waiver remains protective of human health and the environment.

9. Several ARAR waivers are included in the ROD that were not discussed in the Proposed Plan. These include waiving Delaware's SWQSs for the north and south wetlands and the Christina River for either "technical impracticability" (as in the case of the north wetlands and the river) or for "greater risk to human health and the environment" (as in the case of the south wetlands). Federal AWQC are also being waived for the Christina River by invoking the "technical impracticability" ARAR waiver. The waivers do not affect the remedy itself. The selected remedy for the north and south wetlands and the Christina River is essentially the same as EPA's preferred alternative in the Proposed Plan.

10. After discussions with the U.S. Nuclear Regulatory Commission and review of its regulations, the selected remedy now includes a task to locate and mark the location of the thorium drums buried in the north landfill.

11. After further review of the sediment clean-up criteria outlined in the Proposed Plan, mercury and copper have been removed from the Site-specific clean-up criteria for the sediments that is part of the ROD. EPA determined that the use of lead, cadmium, and zinc was enough to adequately delineate the areas of sediments in the wetlands and the river that require remediation.

12. In response to comments received from Du Pont and concerns of the State of Delaware, the cap on the south landfill in the ROD only has to meet RCRA Subtitle D requirements instead of being a low-permeability cap identical to that called for at the north landfill.

13. EPA's preferred alternative in the Proposed Plan for the south landfill called for access road improvements and erosion controls to be installed at the south berm. The selected remedy calls for the berm to be removed to mitigate impacts to the floodplain caused by the volume increase of the south landfill due to the consolidation, stabilization, and capping. Restoring this area to a wetland will help compensate for lost wetlands due to the capping of the south landfill.

TABLE 1

TYPICAL BACKGROUND
METAL CONCENTRATIONS
(RANGES IN MG/KG (PPM))

Metal	Dragun, 1988 (Typical)	Shacklette & Boergner, 1984 (Eastern, US Range)	Shacklette & Boergner, 1984 (North Delaware)
Antimony	0.6 - 10	< 1 - 8.8	< 1
Arsenic	0.1 - 40	< 0.1 - 73	0.1 - 2.6
Barium	100 - 3,500	10 - 1,500	500
Beryllium	0.1 - 40	< 1 - 7	< 1
Cadmium	0.1 - 7.0	--	--
Chromium	5.0 - 3,000	1 - 1,000	50
Cobalt	1.0 - 40	< 3.0 - 70	< 3 - 5
Copper	2.0 - 100	< 10 - 700	< 1 - 10
Lead	2.0 - 200	< 10 - 300	20
Manganese	100 - 4,000	< 2 - 7,000	< 2 - 150
Mercury	0.01 - 0.8	0.01 - 3.4	0.051
Nickel	5.0 - 1,000	< 5 - 700	7 - 10
Selenium	0.1 - 2.0	< 1.0 - 3.9	0.5
Silver	0.1 - 5.0	--	--
Thallium	--	--	--
Vanadium	20 - 500	< 7 - 300	30 - 500
Zinc	10 - 300	< 5 - 2,900	28

TABLE 2

NORTH DISPOSAL SITE
WASTE DISPOSAL INVENTORY
DU PONT-NEWPORT SITE

MATERIAL	ESTIMATED QUANTITY
• Garbage	Several tons
• Trash (glass, wood, paper, cardboard)	100 tons
• Steel Drums	Several hundred tons
• Lever Packs	Several hundred tons
• Sand and dirt	Several thousand tons
• Concrete	
• Steel work	
• Asbestos	5 tons
• Light ballasts - PCB's/PBB's	2 tons
• Rubber - gasket material, tires from garage	A few tons
• Nylon shutters	2 tons
• Artificial marble - "Corian"	4 tons
• Acrylates and latex emulsions	Several hundred lbs.
• Quinacridone tars	1,000 tons
• Off-grade quality copper phthalocyanine pigment	100 tons
• Off-grade quality quinacridone pigment	
• Off-grade quality "Afflair" pigment	Estimate 10,000-15,000 lbs.
• Off-grade quality Chromium Dioxide "Mylar" recording tape	6 tons
• "Afflair" fines (30% mica) plus (70% TiO_2)	Estimated 100,000 lbs.
• Off-grade quality Chromium Dioxide floor sweeping and bags	2 tons
• Thoriated nickel	20 tons of combined waste
• Dirt contaminated with zinc ore	Several hundred tons
• Raw materials left in bag liners and drums and leaks from drums	Several hundred tons
- Quinacridone	A few tons
- Copper phthalocyanine	A few tons
- "Afflair"	A few tons
- Magnetic products	A few tons

TABLE 3

EPA THRESHOLD VALUE GUIDELINES (TVGs)*
FOR SEDIMENT

ARSENIC	33 ppm
CADMIUM	31 ppm
CHROMIUM	25 ppm
COPPER	136 ppm
LEAD	132 ppm
MERCURY	0.8 ppm
NICKEL	20 ppm
ZINC	760 ppm

OTHERS: BARIUM <20 (GREAT LAKES HARBOR SEDIMENT GUIDELINE)

ppm = parts per million

*EPA Threshold Value Guidelines, National Perspective on Sediment Quality (1985)

TABLE 4
GROUNDWATER SAMPLING SUMMARY
PHASE I REMEDIAL INVESTIGATION
DUPONT-NEWPORT SITE

Well Number	August, 1987	December, 1987
SM-1	X	
SM-2	X	X
SM-3	X	X
SM-4	X	X
SM-5	X	X
DM-4	X	
DM-6	X	X
DMU-7	X	X
DML-7	X	X
DM-8	X	X
WW-11		X
WW-13		
MW-1A	X	X
MW-1B	X	X
MW-1C	X	X
MW-2A	X	X
MW-2B	X	X
MW-2C	X	X
MW-3A	X	X
MW-3B	X	X
MW-3C	X	X
MW-4A	X	X
MW-4B	X	X
MW-4C	X	X
MW-5A	X	X
MW-5B	X	X
MW-5C	X	X
MW-6A	X	X
MW-6B	X	X
MW-6C	X	X
MW-7A	X	X
MW-7B	X	X
MW-7C	X	X
MW-8	X	X
MW-9	X	X
MW-11	X	X
MW-13	X	X
MW-14	X	X
MW-15	X	X
Nocastro A*		X
Nocastro B*		X

*Residential well located on Old Airport Road proximal to Du Pont property.

Note: The August 1987 groundwater samples were analyzed for the complete Hazardous Substance List (HSL) parameters. The December 1987 groundwater samples were analyzed for HSL volatile organics; HSL base/neutral semi-volatile organics; barium, cadmium, chromium, copper, lead, nickel, zinc, arsenic, sodium, beryllium, silver and sulfate.

TABLE 5
GROUNDWATER SAMPLING SUMMARY: DUPONT-NEWPORT SITE
REMEDIAL INVESTIGATION: PHASE II & III

Well No.	PHASE II ANALYSES
ROUND 1 - NOVEMBER 1988	
MW-5A	Total Zn, Dissolved Zn
MW-5B	Total Zn, Dissolved Zn
MW-5C	Total Zn, Dissolved Zn
MW-11	Total Zn, Dissolved Zn
MW-13	Total Zn, Dissolved Zn
Upgradient Well	TCL Organics, TAL Metals, Dissolved Metal, Cyanide
MW-16A	TCL Volatiles, Total Metals, Dissolved Metals
MW-17A	TCL Volatiles, Total Metals, Dissolved Metals
MW-17B	TCL Volatiles, Total Metals, Dissolved Metals
MW-18A	TCL Volatiles, Total Metals, Dissolved Metals
MW-19A	TCL Volatiles, Total Metals, Dissolved Metals
MW-19B	TCL Volatiles, Total Metals, Dissolved Metals
ROUND 2 - DECEMBER 1988	
DM-6	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
DM-8	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
DML-7	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
DMU-7	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-1A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-1B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-1C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-2A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-2B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-2C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-3A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-3B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-3C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-4A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-4B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-4C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-5A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-5B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-5C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-6A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-6B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-6C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-7A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-7B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-7C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-8	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-9	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-11	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-13	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-14	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-15	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-16A	TCL Volatiles, TAL Total Dissolved Metals
MW-17A	TCL Volatiles, TAL Total Dissolved Metals
MW-17B	TCL Volatiles, TAL Total Dissolved Metals
MW-18A	TCL Volatiles, TAL Total Dissolved Metals
MW-18B	TCL Volatiles, TAL Total Dissolved Metals
MW-19A	TCL Volatiles, TAL Total Dissolved Metals
MW-19B	TCL Volatiles, TAL Total Dissolved Metals
Necastro A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
SM-4	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
SM-5	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
WW-13	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba

TABLE 5 (Continued)
PHASE III Analyses

Drilled prior to Phase III	Drilled as part of Phase III
MW-18B	MW-6A (A)
MW-18A	MW-29B
MW-14	MW-28B
MW-7C	MW-28A
MW-7B	MW-21B
MW-7A	MW-23A
MW-13	MW-24A
MW-7C	MW-25A
MW-6A(F)	MW-26BS
MW-6B	MW-26BD
MW-11	MW-21A
MW-5C	MW-2A(A)
MW-5B	MW-1A(A)
MW-5A	MW-36A
MW-19B	MW-29A(A)
MW-4C	MW-29A(F)
MW-3C	MW-37A
MW-3B	DM-8
DM-6	SM-5
MW-8	MW-32B
MW-9	MW-32A
DM-U7	MW-32F
DM-L7	MW-33C
MW-4B	MW-33A
MW-4A	MW-31A
MW-15	MW-31F
MW-16A	MW-39F
MW-19A	MW-39F
MW-17B	MW-30B
MW-17A	MW-30A
MW-2C	MW-30F
MW-2B	MW-28C
MW-2A(F)	MW-27A
SM-3	MW-26A
MW-1C	MW-20A
MW-1B	MW-20B
MW-1A(F)	MW-33B
MW-3A	MW-31B
SM-4	MW-34B
SM-2	MW-35C
	MW-35B
	MW-35A

Note: Pre-Phase III (drilled prior to Phase III) wells analyzed for TCL VOA; TAL Metals (Total/Dissolved) as part of Phase III; Phase III (drilled as part of Phase III) wells analyzed for TCL VOA, SVOA Pest/PCBs; TAL Metals (Total/Dissolved)

TABLE 6

MAXIMUM CONTAMINANT LEVELS (MCLs) &
MAXIMUM CONTAMINANT LEVELS GOALS (MCLGs)
FOR SITE-RELATED GROUND WATER CONTAMINANTS

INORGANICS	MCLG (ppb)	MCL (ppb)
ANTIMONY	6	6
ARSENIC	N/A	50
BARIUM	2000	2000
BERYLLIUM	4	4
CADMIUM	5	5
CHROMIUM (total)	100	100
LEAD (at tap)	0	N/A*
MERCURY (inorganic)	2	2
NICKEL	100	100
ORGANICS		
BENZENE	0	5
CARBON TETRACHLORIDE	0	5
CHLOROBENZENE	100	100
1,2-DICHLOROBENZENE	600	600
1,4-DICHLOROBENZENE	75	75
TETRACHLOROETHENE	0	5
TRICHLOROETHENE	0	5
VINYL CHLORIDE	0	2
RADIONUCLEIDES		
GROSS ALPHA ACTIVITY	0	15 piCu/l
RADIUM-228	0	5 piCu/l

*EPA currently uses 15 ppb as an "action level" that provides adequate protection to human health.

TABLE 7

DNREC SURFACE WATER QAULITY STANDARDS
FOR SITE-RELATED CONTAMINANTS

	CHRONIC (ppb)	ACUTE (ppb)
CADMIUM*	1.1	3.9
CHROMIUM (VI)**	11	16
COPPER*	12	18
LEAD*	3.2	82
MERCURY	0.012	2.4
NICKEL*	160	1400
ZINC*	110	120
ALUMINUM	87	750
IRON	1000	N/A

BARIUM: No water quality criteria are available according to the Hazardous Substance Data Base, 1992, the average background concentration is 43 ppb with a range of 2 to 340ppb

*Values are hardness dependent; value listed is based on 100 ppm as $CaCO_3$; measured values in wetlands near the north and south landfills range from 104 to 183 ppm $CaCO_3$

**US EPA

TABLE 8
CHEMICALS POTENTIALLY CONTRIBUTING TO RISK BY MEDIA OF CONCERN
DU PONT-NEWPORT SITE

Parameter	SDS	CG	HRP	NDS	CRSW	BP	CR Seeps	*CFGW	*PFGW
Antimony		X		X		X	X		X
Barium	X	X	X	X	X	X	X	X	X
Benzo(a)anthracene				X					
Beryllium	X		X	X		X	X		X
bis(2-ethylhexyl)phthalate									X
Cadmium	X	X		X	X	X	X	X	X
Carbon Tetrachloride							X		X
4-Chloroaniline							X		
Chlorobenzene							X		
Chromium	X	X	X	X	X	X	X		X
Cobalt	X	X	X	X		X	X	X	X
Copper	X			X		X			
1,1-Dichloroethene							X		
Manganese	X	X	X	X	X	X	X	X	X
Mercury				X					
Nickel	X		X	X				X	X
Trichloroethene					X		X	X	X
Thalium		X							
Trichloroethene								X	X
Vanadium			X	X	X	X			
Vinyl Chloride							X		
Zinc	X	X		X	X	X	X	X	X

Notes: SDS - South Disposal Area Soils NDS - North Disposal Area Soils CR Seeps - Christina River Seepage
CG - CIBA-GEIGY Plant Soils CRSW - Christina River Surface Water CFGW - Columbia Formation Groundwater
HRP - Holly Run Plant Soils BP - Ballpark Soils PFGW - Potomac Formation Groundwater

* Only four Columbia Formation wells were screened by the concentration-toxicity screen. No other screening was done for the Columbia Formation wells. All the Potomac Formation welils were screened by the concentration-toxicity screen.

TABLE 9

AREA (YEARS)	RECEPTOR	EXPOSURE TIME (HOURS/DAY)	EXPOSURE FREQUENCY(DAY/YEAR)	EXPOSURE DURATION
Ballpark	Children (Ages 6-14)	4 Hrs/Days	39	9Years
North Landfill	Maintenance Worker	8		45
South Landfill	Maintenance Worker	8	2	45
	Construction Worker	8	80	2
	Trespasser (Adult)	4	48	30
	Trespasser (Adolescent) (Ages 14-23)	4	48	9
Christina River	Swimmer (Adult)	3	39	30
	Swimmer (Children)	3	39	9
	Non-swimmer (Adult)	3	39	30
	Non-swimmer (Children)	3	39	9
CIBA-GEIGY Plant	Maintenance Worker	8	6	45
	Construction Worker	8	80	2
Holly Run Plant	Maintenance Worker	8	56	45
Ground Water	Resident (Adult)	2 liters/Day	365	30

TABLE 10

AREA OF INTEREST	POTENTIAL RECEPTOR*	CARCINO-GENIC RISK	HAZARD INDEX WITHOUT LEAD	HAZARD INDEX WITH LEAD
Ballpark	Recreational (Child)**	$7.2X10^{-7}$	0.16	0.38
North Landfill & Holly Run	Maintenance Worker	$4.1X10^{-6}$	0.075	4.0
South Landfill	Maintenance Worker	$9.0x10^{-6}$	0.0027	0.93
	Construction Worker***	$2.8x10^{-7}$	0.70	3.0
	Trespasser (Adult)	$7.0x10^{-7}$	0.032	0.96
	Trespasser (Adolescent)	$4.9x10^{-7}$	0.074	1.9
Christina River	Recreational (Child)**	$9.1x10^{-6}$	0.039	
	Recreational (Adult)	$6.6x10^{-6}$	0.016	
CIBA-GEIGY Plant	Maintenance Worker	$1.4x10^{-5}$	0.068	20
	Construction Worker	$1.1x10^{-5}$	6.0	26
Ground water	Residential (Adult)***			
	Columbia Aquifer	$3.0X10^{-4}$	170	190
	Potomac Aquifer	$4.6X10^{-6}$	3.6	5.9

* Exposure routes for these receptors included inhalation, ingestion, and dermal contact as appropriate for each scenario.

** The total risk associated with the Site to a Child partaking in recreational activities is the sum of the risks associated with the ballpark and the river. For non-carcinogenic risks, the total Hazard Index is 0.42.

*** Potential future use only.

TABLE 11

EVALUATION CRITERIA

Overall Protection of Human Health and the Environment: Addresses whether the remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls.

Compliance with ARARs: Refers to whether a remedy will meet all Applicable or Relevant and Appropriate Requirements (ARARs) of Federal and State environmental statutes and/or provides grounds for invoking a waiver. It also addresses whether or not the remedy complies with advisories, criteria, and guidance that EPA and DNREC have agreed to follow.

Long-Term Effectiveness and Permanence: Refers to the magnitude of residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time once clean-up standards have been met.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Relates to the anticipated performance of the treatment technologies with respect to these criteria.

Short-Term Effectiveness: Refers to the period of time needed to achieve protection, and any adverse impacts on human health and the environment that may be posed during the construction and implementation, until clean-up standards are achieved.

Implementability: The technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

Cost: The following costs are evaluated: estimated capital, operation and maintenance, and present worth.

State Acceptance: Indicates whether, based on its review of the feasibility study and the Proposed Plan, the support agency concurs with or opposes the selected remedy.

Community Acceptance: Relates to the comments received from the public, including the Potentially Responsible Parties, during the public comment period for the Proposed Plan.

TABLE 12

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND TO BE CONSIDERED MATERIAL (TBCs)
DU PONT-NEWPORT SITE

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
I. CHEMICAL SPECIFIC					
A. Water					
1. Safe Drinking Water Act	42 U.S.C. § 300f et seq.				
a. Maximum Contaminant Level Goals (MCLGs)	40 C.F.R § 141.50-51	Relevant and Appropriate	Non-enforceable health goals for public water supplies. The NCP requires that non-zero MCLGs shall be attained by remedial actions for ground water that is a current or potential source of drinking water, where the MCLGs are relevant and appropriate under the circumstances of the release.	The "greater harm to human health and the environment" ARAR waiver has been invoked for both the Potomac and Columbia aquifers.	GW
b. Maximum Contaminant Levels (MCLs)	40 C.F.R § 141.11-12	Relevant and Appropriate	Enforceable standards for public drinking water supply systems (with at least fifteen service connections or used by at least 25 persons). The NCP requires that MCLs, for those contaminants whose MCLG is zero, shall be attained by remedial actions for ground water that is a current or potential source of drinking water, where the MCLs are relevant and appropriate under the circumstances of the release.	The "greater harm to human health and the environment" ARAR waiver has been invoked for both the Potomac and Columbia aquifers.	GW
c. Maximum Contaminant Levels (MCLs)	40 C.F.R § 141.11-12	Applicable	Enforceable standards for public drinking water supply systems (with at least fifteen service connections or used by at least 25 persons). MCLs apply to public water systems that provide piped water for human consumption.	Installation of public water supply line shall be done in such a way as to provide drinking water in compliance with these standards.	GW
2. Health Effects Assessment		To be Considered	Non-enforceable toxicity data for specific chemicals for use in public health assessments. Also "to be considered" are Carcinogenic Potency Factors and Reference Doses provided in the Superfund Public Health Evaluation Manual.	To be considered where remedial action addresses risk-based criteria or when setting clean-up standards for the protection of human health.	NL,SL, CG/HR, GW

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
3. Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites	EPA OSWER Directive #9355.4-02, dated 12/8/89	To Be Considered	To be considered when remedial action addresses soils that cause a threat to human health through direct contact, ingestion, or inhalation of lead.	To be considered when lead is present and remedial action addresses soils that cause a threat to human health through direct contact, ingestion, or inhalation.	BP,NL, SL, CG/HR
4. State of Delaware Regulations Governing Public Drinking Water Revised March 11, 1991	Sections 22.2, 22.3, 22.4, 22.6, 22.10	Relevant and Appropriate	Sets criteria for public drinking water supplies. These requirements are not directly applicable since ground water at the Site is used as a private dirnking water supply. However, under the circumstances of this Site, these requirements are relevant and appropritate.	The "greater harm to human health and the environment" ARAR waiver has been invoked for both the Potomac and Columbia aquifers.	GW
6. State of Delaware Regulations Governing Public Drinking Water Revised March 11, 1991	Sections 22.2, 22.3, 22.4, 22.6, 22.10	Applicable	Sets criteria for public drinking water supplies.	Installation of public water supply line shall be done in such a way as to provide drinking water in compliance with these standards.	GW
7. Delaware Comprehensive Water Resources Management Committee Reports, December 13, 1983		To Be Considered	The reports were adopted as policy by the DNREC Secretary. Among these reports is the Groundwater Quality Management Report, July 1983, which provided Delaware with a number of tools for dealing with ground-water contamination.	To be considered for ground-water monitoring.	GW
8. Clean Water Act	Clean Water Act, Section 303	Relevant and Appropriate	Water quality criteria set at levels to protect human health for water and fish ingestion and protection of aquatic life in streams, lakes, and rivers.	These standards have been waived for the surface water in the Christina River by invoking the "technical impracticability" ARAR waiver due to non-Site related upstream sources of contamination.	CR
9. Delaware Surface Water Quality Standards as amended, Feb. 26, 1993	Sections 3, 4, 5, 6, 8, 9, 10, 11.1, 11.2, 11.3, 11.4, 11.6, 12	Applicable	Criteria are provided to maintain surface water for streams, lakes, rivers, and standing water in wetlands of satisfactory quality consistent with public health and recreational purposes, the propagation and protection of fish and aquatic life, and other beneficial uses of water.	1. Any surface water discharge must meet these levels if more stringent than federal regulations. 2. These standards have been waived for the surface water in the north wetlands and the Christina River by invoking the "technical impracticability" ARAR waiver due to non-Site related upstream sources of contamination. These standards have been waived for the surface water in the south wetlands by invoking the "greater harm to human heatlh and the environment" ARAR waiver.	NL,SW, CR, CG/HR

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
B. Air					
1. Clean Air Act	42 U.S.C § 7401				
a. National Emissions Standards for Hazardous Air Pollutants	40 C.F.R Part 61	Relevant and Appropriate	Standards promulgated for air emissions from specific source categories. Not applicable but may be relevant and appropriate for emissions from air strippers at Superfund sites.	Relevant and appropriate for potential releases of vinyl chloride and radionucleides resulting from ground-water treatment.	NL, CG/HR
2. Delaware Ambient Air Quality Standards	Title 7, Delaware Code, Ch 60, Regulation 3, Section 6003	Applicable	Establishes ambient air quality standards.	Applicable for potential releases from air stripping of ground water, excavation work, or other remedial actions.	ALL
C. Miscellaneous					
1. Standards for Protection Against Radiation	10 C.F.R. Part 20	Relevant and Appropriate	These standards are designed to limit radiation hazards caused by Nuclear Regulatory Commission-licensed activities. The general requirement is that every reasonable effort to maintain radiation exposures "as low as is reasonably achievable" be made. This regulation also describes specific radiation dose limits for the protection of workers and memebers of the public, radioactivity concentration limits for effluents, precautionary procedures, and waste diposal requirements.	Remediation must take place in such a way as to prevent over-exposure of radiation to workers or public. Discharges to air or water must meet specific concentration limits for radionucleides. Waste disposal must also meet any pertinent requirements.	NL, CG/HR
2. Delaware Radiation Control Regulations	Title 16, Delaware Code, 7405	Applicable	Establishes regulations for registration of facilities, licensing of materials, standards of protection, safety requirements, and notification requirements.	May be applicable for work at the north landfill and the ground water pump and treat system at this area.	NL, CG/HR
II. LOCATION SPECIFIC					
1. Coastal Zone Management Act of 1972; Coastal Zone Act Reauthorization Amendments of 1990	16 U.S.C. 1451 <u>et seq</u>. 15 C.F.R. Part 930	Applicable	Requires that Federal agencies conducting or supporting activities directly affecting the coastal zone, conduct or support those activities in a manner that is consistent with the approved appropriate State coastal zone management program. (See Delaware's Comprehensive Update and Routine Program Implementation, March 1993)	On-site remedial actions are required to be consistent, to the maximum extent practicable, with Delaware's coastal zone management program. EPA must notify Delaware of its determination that the actions are consistent to the maximum extent practicable.	NL,SL, SW,CR, CG/HR

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
2. The Archaeological and Historical Preservation Act of 1974	16 U.S.C § 469	Applicable	Requirements relating to potential loss or destruction of significant scientific, historical, or archaeological data	Archeological and historical resources have not been identified to date. However, the installation of the physical barrier wall along the Christina River has the potential for disturbing archeological resources. Further action will be taken to identify resources and, if identified, action will be taken to mitigate any adverse effects on those resources that would result from construction. If resources happen to be identified in other areas (although no specific actions will be taken to find), action will be taken to mitigate any adverse effects on those resources that would result from implementation of the remedial action.	NL, CO/HR
3. Protection of Floodplains	40 C.F.R. Part 6, Appendix A	Applicable	Sets forth EPA policy for carrying out provisions of Executive Order 11988 (Floodplain Management) which requires actions to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values.	Applicable since much of the remedial action will take place within the 500-year floodplain. Due to the volume increase of the south landfill, the berm in the south wetlands will be removed to mitigate the loss of volume inside a floodplain.	ALL
4. Protection of Wetlands	40 C.F.R. Part 6, Appendix A	Applicable	Sets forth EPA policy for carrying out provisions of Executive Order 11990 (Protection of Wetlands) which requires actions to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values.	Applicable since the construction of the north and south landfill caps will affect wetlands.	NL,SL, SW
5. Delaware Coastal Zone Act, 7 Delaware Code Chapter 70; Coastal Zone Act Regulations, 6/9/93	7 Delaware Code Sections 7003, 7004	To Be Considered	Controls the location, extent, and type of industrial development in Delaware's coastal areas.	Will be considered for consistency since the remedial action involves substantial aquatic habitat and is located in Delaware's coastal area although not in the defined coastal zone of this statute.	ALL
6. Delaware Wetlands Regulations Revised June 29, 1984	Sections 1, 2, 7	Applicable	Requires activities that may adversely affect wetlands in Delaware to be permitted. Permits must be approved by the county or municipality having jurisdiction.	Any substative requirements shall be met since wetlands will be destroyed and replaced in the north drainage way; and dredged (or excavated) and restored in the north and south wetlands. Since all of the wetland or remediation is considered "on-site", no permit will be obtained.	NL,SL, SW

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
7. Delaware Regulations Governing the Use of Subaqueous Lands, amended September 2, 1992	Sections 1, 3, 4	Applicable	Requires activities that affect public or private subaqueous lands in the State be permitted.	Any substantive requirements shall be met since the remediation involves dredging of the Christina River. However, no permit shall be obtained.	NL, SL,SW, CR
8. Delaware Executive Order 56 on Freshwater Wetlands (1988)		To Be Considered	General policy to minimize the adverse effects to freshwater wetlands.	To be considered for wetland remediation and restoration.	NL,SL, SW
9. Governor's Roundtable Report on Freshwater Wetlands (1989)		To Be Considered	General policy to minimize the adverse effects to freshwater wetlands.	To be considered for wetland remediation and restoration.	NL,SL, SW
10. Ground Water Protection Strategy of 1984	EPA 440/6-84-002	To be Considered	Identifies ground water quality to be achieved during remedial actions based on aquifer characteristics and use.	The EPA aquifer classification will be taken into consideration during design and implementation of the treatment remedy.	GW
III. ACTION SPECIFIC					
A. Miscellaneous					
1. Council on Environmental Quality	40 C.F.R. 1500.2(f)	Relevant and Appropriate	Requires use of all practicable means, consistent with the requirements of NEPA to restore and enhance the quality of the human environment and avoid or minimize any possible adverse effects upon the quality of the human environment.	Institutional controls shall be added to the north and south landfill properties to make sure they remain wildlife habitat.	NL,SL
2. Delaware Regulations Governing Hazardous Substance Cleanup, 1/93	Section 9	Relevant and Appropriate	Establishes clean-up criteria for hazardous waste sites. Only criteria considered relevant and appropriate are for ground water and soil ($1x10^{-5}$; Hazard Index of 1; or natural background if higher).	1. Waived for ground water using the "greater harm to human health and the environment" waiver. 2. Applies to the determination of soil clean-up criteria at the Basin Road portion of the south landfill.	SL,GW
B. Water					
1. Clean Water Act (CWA); National Pollutant Discharge Elimination System Requirements	40 C.F.R. Part 122-125	Applicable	Enforceable standards for all discharges to waters of the United States.	Discharge limits shall be met for all on-site discharges to surface water including treated ground water and wastewater from dewatering dredge material. Only substantive requirements shall be met and no permit shall be obtained.	NL, CG/HR, CR

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
2. General Pretreatment Regulations	40 C.F.R Part 403	Applicable	Standards for discharge to POTW.	Applicable should the extracted ground water, treated ground water, or wastewater from dredge material be discharged to a POTW.	NL, CG/HR, CR
3. Section 10 of the River and Harbors Act	33 U.S.C. Section 403 33 C.F.R. Part 320-330	Applicable	Permitting requirements for dredging.	The river dredging will comply to any substantive requirements, but no permit will be obtained.	CR
4. State of Delaware Regulations Governing the Construction of Water Wells, January 20, 1987	Sections 3, 4, 5, 6, 7, 8, 9, 10	Applicable	Contain requirements governing the location, design, installation, use, disinfection, modification, repair, and abandonment of all wells and associated pumping equipment.	Installation of any monitoring and recovery wells and the abandonment of wells shall meet all substantive requirements.	NL,SL, SW, CG/HR, GW
5. Delaware Water Quality Standards, as amended, February 26, 1993	Sections 3-6, 8-10, 11.1, 11.2, 11.3, 11.4, 11.6, 12	Applicable	Standards are established in order to regulate the discharge into state waters in order to maintain the integrity of the water.	Applicable should the ground-water treatment system involve discharge to surface water.	NL, CG/HR
6. Delaware River Basin Commission (DRBC) Water Quality	DRBC Ground Water Protected Area Regulation, No. 4, 6(f), 9, 10; Water Code of the Basin, Sections 2.20.4, 2.50.2	Applicable	Regulate restoration, enhancement, and preservation of waters in the Delaware River basin.	Applicable if remedial action involves discharge of >50,000 gallons/day average over any month or a withdrawal of ground water of 100,000 gallons/day or more average over any month.	NL, CG/HR
7. Delaware Regulations Governing the Allocation of Water March 1, 1987	Sections 1, 3, 5.05	Applicable	Contain information pertaining to water allocation permits and criteria for their approval.	May be applicable for the ground-water recovery system or the public water supply line. No permit required.	NL, CG/HR, GW
8. State of Delaware Groundwater Management Plan November 1, 1987		To Be Considered	Policy for ground-water management.	To be considered in setting the ground water management zone.	GW
9. Delaware Regulations Governing Control of Water Pollution, amended 6/23/83	Section 7, 8, 9, 10, 11, 12, 13	Applicable	Contain water quality regulations for the discharging into surface and ground water.	Applicable for potential discharge of treated ground water into surface water. Also applicable for stormwater runoff into the Christina River.	NL, SL, CG/HR

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
10. State of Delaware Regulations Governing Public Drinking Water March 31, 1991	Sections 22.2, 22.3, 22.4, 22.6, 22.10	Applicable	Establishes requirements for public drinking water supplies.	Applicable for the establishment of public drinking water service to residents along Old Airport Road.	GW
C. Air					
1. Control of Air Emissions from Air Strippers at Superfund Ground Water Sites, June 15, 1989	EPA OSWER Directive 9355.0-28	To be Considered	Policy to guide the selection of controls for air strippers at groundwater sites according to the air quality status of the site's location (i.e., ozone attainment or non-attainment area).	To be considered in determining if air emissions controls are necessary for an air stripper because New Castle is in an ozone non-attainment area. Sources most in need of controls are those with emissions rates in excess of 3 lbs./hour or 15 lbs./day or a potential rate of 10 tons/year of total VOCs.	NL, CG/HR
2. Delaware Regulations Governing the Control of Air Pollution	Regulations Number 2, 19, 24	Applicable	Sets forth the requirement that a permit is necessary to operate an air stripper if emissions will exceed 2.5 lbs./day. Section 2 describes general conditions. Section 19 deals with odor. Section 24 deals with volatile organic compounds.	If emissions exceed 2.5 lbs./day then the substantive requirements of the regulation must be met. In addition, the emissions from the air stripper must meet the Ambient Air Quality Standards set forth in Regulation 3 of 7 Delaware Code, Chapter 60, Section 6003.	NL, CG/HR
E. Sediments/Solids					
1. Delaware Sediment and Stormwater Regulations January 23, 1991	Section 3, 6, 9, 10, 11, 15	Applicable	Establishes a statewide sediment and stormwater management program.	A stormwater and sediment management plan consistent with Delaware requirements must be approved by EPA only before construction disturbing over 5,000 square feet of land can begin.	NL,SL, SW,CR CG/HR
F. Waste Handling and Disposal					
1. RCRA Subtitle D Landfill Regulations	40 C.F.R. 258.60(a)	Relevant and Appropriate	Closure requirements for RCRA subtitle D landfills.	Provides some technical requirements for the cap at the south landfill.	SL
2. Delaware Requlations Governing Solid Waste	Sections 2, 5, 6	Relevant and Appropriate	Establishes regulations to implement an improved solid waste management program.	Relevant and appropriate for the south landfill.	SL

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
3. Delaware Regulations Governing Hazardous Waste	SEE BELOW F.5, F.7, F.9, F.11, F.13, F.15, F.17	SEE BELOW	Delaware Regulations Governing Hazardous Waste Part 261 define "hazardous waste". The regulations listed below apply to the handling of such hazardous waste.	SEE BELOW	SEE BELOW
4. Resource Conservation and Recovery Act of 1976; Hazardous and Solid Waste Amendments of 1984	SEE BELOW F.6, F.8, F.10, F.12, F.14, F.16, F.18 Federal regulations would not apply for those regulations which Delaware has the authority from EPA to administer.	SEE BELOW	Regulates the management of hazardous waste, to ensure the safe disposal of wastes, and to provide for resource recovery from the environment by controlling hazardous wastes "from cradle to grave."	SEE BELOW	SEE BELOW
5. Standards Applicable to Generators of Hazardous Waste	Delaware Regulations Governing Hazardous Waste, Part 262.10-58	Applicable	Establishes standards for generators of hazardous wastes including waste determination manifests and pre-transport requirements.	Applicable to operator(s) of the wastewater treatment plant if the wastes generated by the groundwater treatment system is a RCRA-hazardous waste.	NL, CG/HR
6. Standards Applicable to Generators of Hazardous Waste	EPA Regulations, 40 C.F.R Part 262.10-58	Applicable	Establishes standards for generators of hazardous wastes including waste determination manifests and pre-transport requirements.	Applicable to operator(s) of the wastewater treatment plant if the wastes generated by the groundwater treatment system is a RCRA-hazardous waste.	NL, CG/HR
7. Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	Delaware Regulations Governing Hazardous Waste, Part 264 (40 C.F.R Part 264)	Applicable	Regulations for owners and operators of TSDFs which define acceptable management of hazardous wastes.	Applies to onsite recovery and treatment systems which handle hazardous waste	NL, CG/HR
8. Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	EPA Regulations, 40 C.F.R Part 264	Applicable	Regulations for owners and operators of TSDFs which define acceptable management of hazardous wastes.	Applies to onsite recovery and treatment systems which handle hazardous waste	NL, CG/HR

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
9. RCRA Requirements for Use and Management of Containers	Delaware Regulations Governing Hazardous Waste, Part 264.170-178	Applicable	Requirements for storage of hazardous waste in storage containers.	Applicable for temporary storage containers and on-site treatment systems.	NL,SL, SW, CG/HR, CR
10. RCRA Requirements for Use and Management of Containers	EPA Regulations, 40 C.F.R Part 264.170-178	Applicable	Requirements for storage of hazardous waste in storage containers.	Applicable for temporary storage containers and on-site treatment systems.	NL,SL, SW, CG/HR, CR
11. RCRA Requirements for Tanks Systems	Delaware Regulations Governing Hazardous Waste, Part 264.190-199	Applicable	Requirements for storage or treatment of hazardous waste in tank systems.	Only applicable for onsite treatment systems and temporary storage tanks containing hazardous wastes.	NL,SL, SW, CG/HR, CR
12. RCRA Requirements for Tanks Systems	EPA Regulations. 40 C.F.R Part 264.190-199	Applicable	Requirements for storage or treatment of hazardous waste in tank systems.	Only applicable for onsite treatment systems and temporary storage tanks containing hazardous wastes.	NL,SL, SW, CG/HR, CR
13. The Hazardous Waste Permit Program	Delaware Regulations Governing Hazardous Waste, Part 122	Applicable	Requires a permit for the treatment, storage, or disposal of any hazardous waste as identified or listed in Part 261.	Any substative requirements will be met. But no permit will be obtained	NL,SL, SW, CG/HR, CR
14. The Hazardous Waste Permit Program	EPA Regulations, 40 C.F.R. Part 122	Applicable	Requires a permit for the treatment, storage, or disposal of any hazardous waste as identified or listed in Part 261.	Any substative requirements will be met. But no permit will be obtained	NL,SL, SW, CG/HR, CR
15. Identification and Listing of Hazardous Wastes	Delaware Regulations Governing Hazardous Wastes, Part 261	Applicable	Identifies solid wastes which are regulated as hazardous wastes.	Use to determine which materials to be disposed of are hazardous wastes.	ALL
16. Identification and Listing of Hazardous Wastes	EPA Regulations, 40 C.F.R. Part 261	Applicable	Identifies solid wastes which are regulated as hazardous wastes.	Use to determine which materials to be disposed of are hazardous wastes.	ALL

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
17. RCRA Land Disposal Restrictions	Delaware Regulation Governing Hazardous Waste, Part 268	Applicable	Restrictions on land disposal of hazardous wastes.	Applies to remedial actions in the south landfill, the south wetlands, and the Christina River only if any stabilization is done ex-situ and waste is hazardous. Applies to dirt from the ballpark if it is hazardous.	BP,NL, SL,SW, CR
18. RCRA Land Disposal Restrictions	EPA Regulations, 40 C.F.R. Part 268	Applicable	Restrictions on land disposal of hazardous wastes.	Applies to remedial actions in the south landfill, the south wetlands, and the Christina River only if any stabilization is done ex-situ and waste is hazardous. Applies to dirt from the ballpark if it is hazardous.	BP,NL, SL,SW, CR

TABLE 13

COST SUMMARY FOR
SELECTED REMEDY
E.I. DU PONT, NEWPORT SUPERFUND SITE
(BASED ON 1992 DOLLARS)

	CAPITAL COSTS	O&M COSTS[1]	TOTAL
Ballpark	10,000	-0-	10,000
North Landfill	3,947,000	8,153,000	12,100,000
South Landfill	14,007,000	266,000	14,300,000
South Wetlands	3,111,000	1,046,000	4,200,000
Christina River	4,012,000	677,000	4,700,000
CIBA-GEIGY & Du Pont Holly Run Plant	3,555,000	7,445,000	11,000,000
Ground Water	378,000	1,020,000	1,400,000

Operation & Maintenance Costs, net present worth at 5% discount rate for 30 years.

TABLE 14

REMEDIAL COSTS FOR THE BALLPARK
(Based on 1992 dollars)

TOTAL DIRECT COSTS (including sampling, excavation, site restoration)		5,200
Mobilization & Demobilization Health and Safety Engineering Costs		
	60% of DC	3,100
		8,300
Contingency (20%)		1,700
O&M		0
TOTAL PRESENT WORTH COSTS		$10,000

TABLE 15

REMEDIAL COSTS FOR THE NORTH LANDFILL
(based on 1992 dollars)

DIRECT COSTS:		
Landfill cover		913,000
Barrier wall		622,000
Ground-water pump and treat system		444,000
Wetlands remediation & restoration		354,000
Other		134,000
	TOTAL DIRECT COSTS	$2,467,000
Mobilization & Demobilization Health & Safety Engineering Costs Wetlands Mitigation Plan		
	30% of DC	740,000
		$3,207,000
Wetlands Contaminant Delineation		71,000
		$3,278,000
Contingency (20%)		656,000
O&M (5% Discount Rate, 30 Years):		
Wells/Pumps, Cover, Misc., Treatment System		7,580,000
Long-Term Monitoring 93,000/Event, 12 Events		573,000
TOTAL PRESENT WORTH COSTS		$12,100,000

TABLE 16

REMEDIAL COSTS FOR THE SOUTH LANDFILL
(based on 1992 dollars)

DIRECT COSTS:	
Cover	800,000
Berm removal/site security	92,000
Excavation, backfill, pavement	1,342,000
Stabilization	6,748,000
TOTAL DIRECT COSTS	$8,982,000
Mobilization & demobilization	
Health & safety	
Engineering costs	
30% OF DC	2,695,000
	11,677,000
CONTENGINECY (20%)	2,335,000
	14,012,000
O&M (5% DISCOUNT RATE, 30 YEARS):	
COVER, ACCESS ROAD, FENCING 18,000/YEAR	266,000
TOTAL PRESENT WORTH COSTS	$14,300,000

TABLE 17

REMEDIAL COSTS FOR THE SOUTH WETLANDS
(based on 1992 dollars)

DIRECT COSTS:	
Site clearing & sediment removal	128,000
Stabilization & consolidation	947,000
Confirmatory testing	88,000
Restoration	464,000
Other	51,000
TOTAL DIRECT COSTS	$1,678,000
Mobilization & demobilization Health & safety Engineering costs Wetlands mitigation plan	
40% OF DC	672,000
	2,349,000
Wetland contaminant delineation	244,000
	2,593,000
Contingency (20%)	518,000
	3,111,000
O&M (5% DISCOUNT RATE, 30 YEARS):	
Maintenance	298,000
50,000 for five years 17,000 for next five years 3,000 for last twenty years	
Long-term monitoring	748,000
$103,000/event, 12 events 46,000/event, 3 events	
TOTAL PRESENT WORTH COSTS	$4,200,000

TABLE 18

REMEDIAL COSTS FOR THE CHRISTINA RIVER
(based on 1992 dollars)

DIRECT COSTS:	
Dredging	192,000
Sediment dewatering	892,000
Disposal at north landfill	375,000
Water treatment	10,000
TOTAL DIRECT COSTS:	$1,469,000
Mobilization & demobilization Health & safety Engineering costs	
40% OF DC	588,000
	2,057,000
River contaminant delineation	1,287,000
	3,344,000
CONTINGENCY (20%)	699,00
	4,012,000
O&M (5% DISCOUNT RATE, 30 YEARS):	
Long-term monitoring $110,000/event, 12 events	677,000
TOTAL PRESENT WORTH COSTS	$4,700,000

TABLE 19

REMEDIAL COSTS FOR THE CIBA-GEIGY AND
DU PONT HOLLY RUN PLANT AREA
(based on 1992 dollars)

DIRECT COSTS:	
Paving	26,000
Barrier wall	347,000
Ground water pump and treat	443,000
TOTAL DIRECT COSTS:	$816,000
Mobilization & demobilization Health & safety Engineering costs	
40% OF DC	326,000
	1,142,000
CONTINGENCY (20%)	229,000
CIBA-GEIGY plant modifications	2,200,000
	3,571,000
O&M (5% DISCOUNT RATE, 30 YEARS):	
Paving $1300/year	20,000
Riverbank cover $9,140/year	141,000
Well maintenance $22,000/year	336,000
Water treatment $452,000/year	6,948,000
TOTAL PRESENT WORTH COSTS	$11,000,000

TABLE 20

REMEDIAL COSTS FOR THE GROUND WATER
(based of 1992 dollars)

DIRECT COSTS:	
Potable water supplies	225,000
TOTAL DIRECT COSTS	$225,000
Mobilization & demobilization Health & safety Engineering costs	
40% OF DC	90,000
	315,000
CONTINGENCY (20%)	63,000
	378,000
O&M (5% DISCOUNT RATE, 30 YEARS)	
Long-term monitoring	1,020,000
TOTAL PRESENT WORTH COSTS:	$1,400,000

FIGURE 1
Site Location Map
E.I. Du Pont, Newport Superfund Site

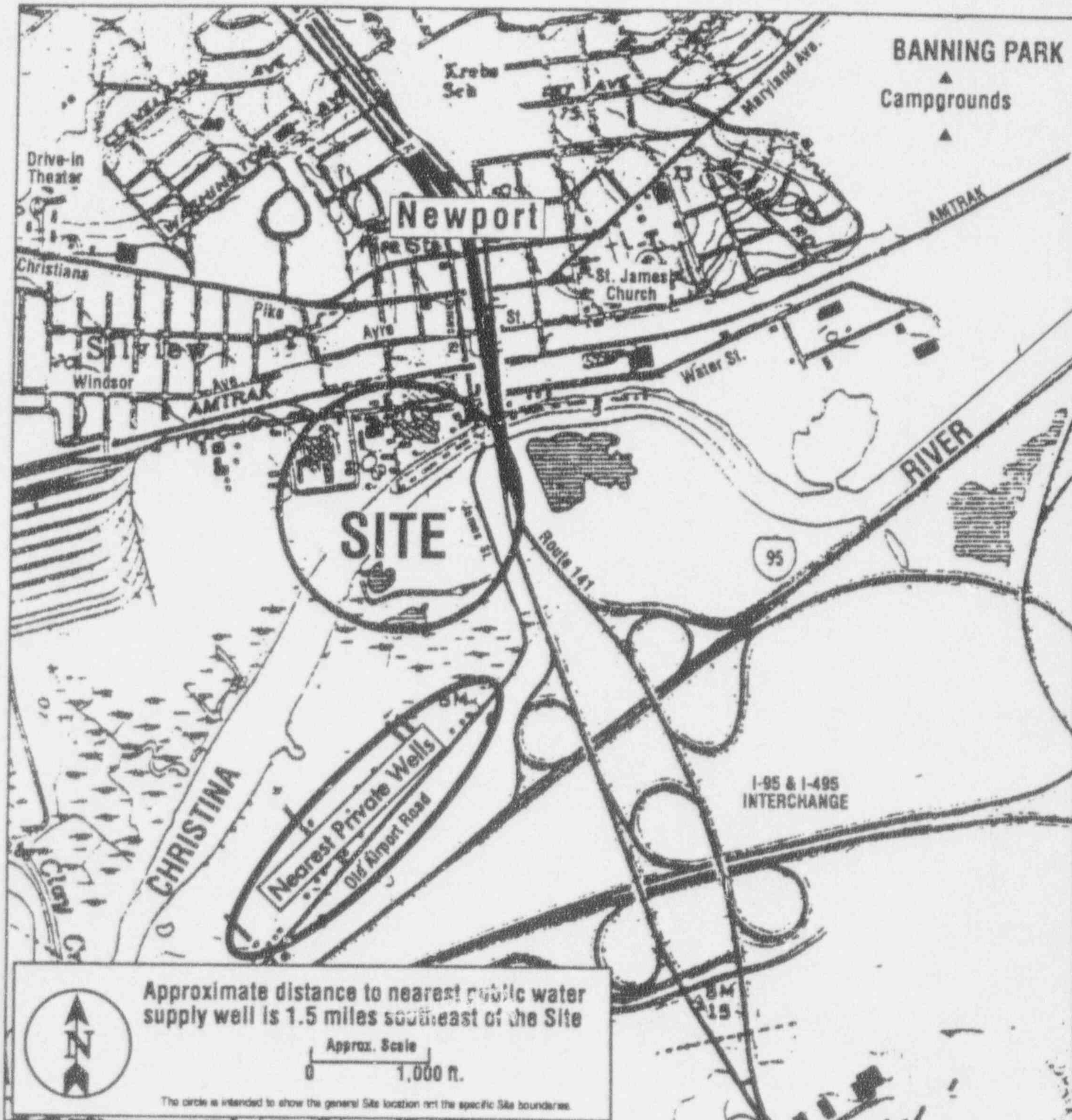


FIGURE 2
Site Layout Map

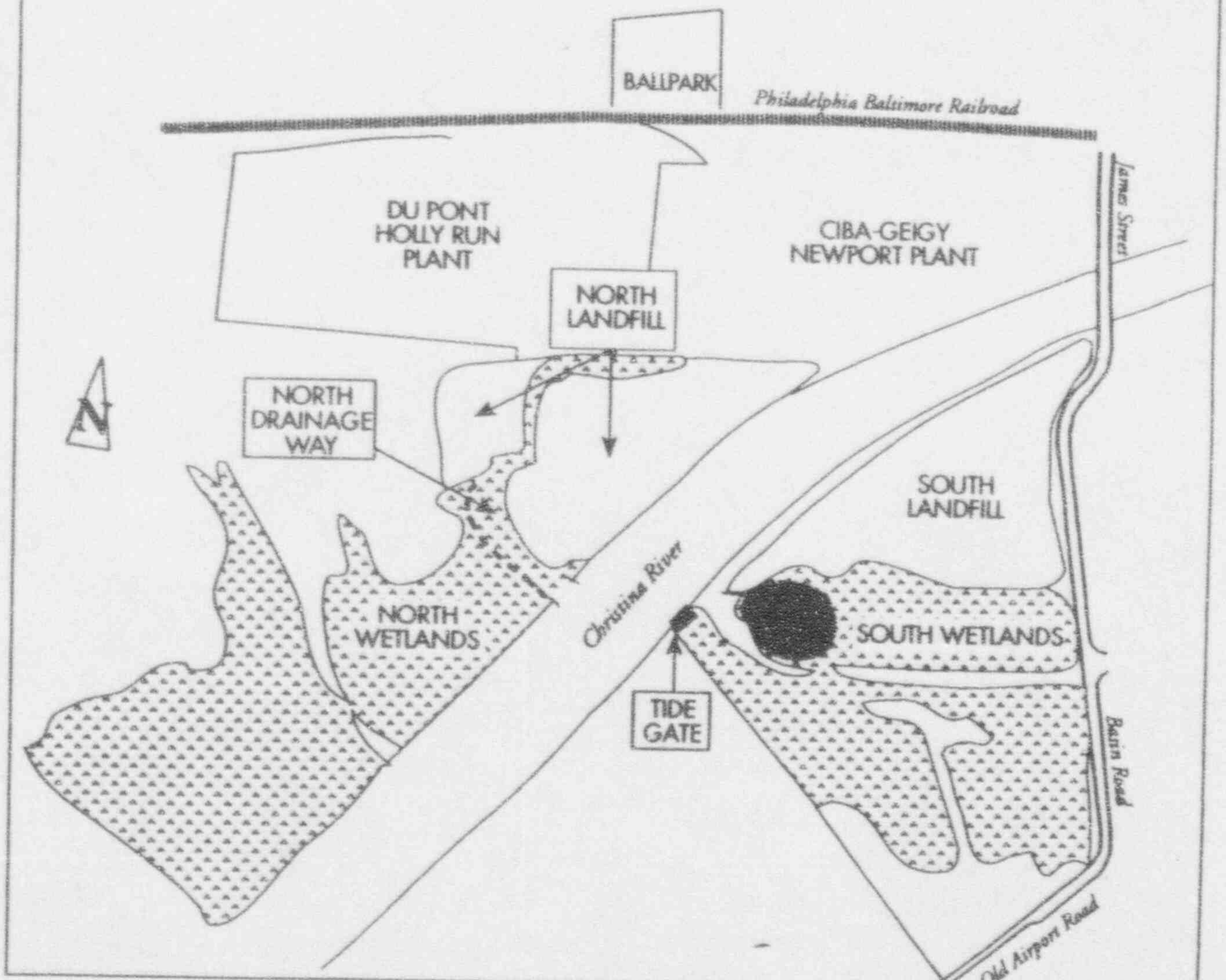
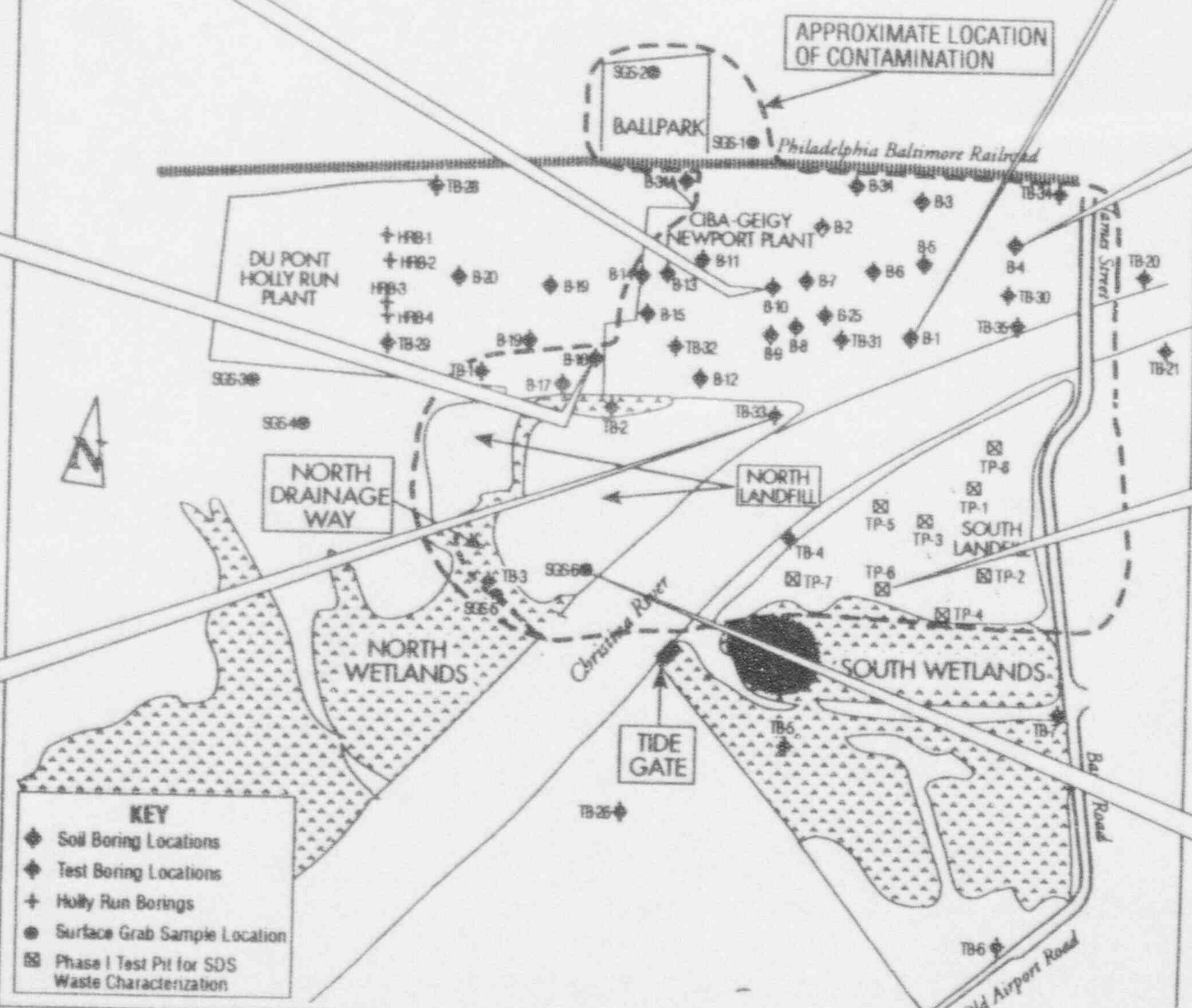


FIGURE 3*
Site Characteristics: Soil Contamination



*Complete data can be found in the Administrative Record.

B-10 PHASE III DATA

TOTAL METALS	CONCENTRATION (μg/kg)
Arsenic	8,500
Barium	525,000
Beryllium	970
Cadmium	12,700
Chromium	36,500
Cobalt	15,400
Lead	1,620,000
Manganese	284,000
Mercury	ND
Nickel	18,600
Vanadium	41,200
Zinc	777,000

Sample depth = 28 feet
July 18, 1990

B-16 PHASE III DATA

TOTAL METALS	CONCENTRATION (μg/kg)
Arsenic	ND
Barium	14,900
Beryllium	ND
Cadmium	NA
Chromium	8,100
Cobalt	ND
Lead	2,500
Manganese	30,200
Mercury	ND
Nickel	ND
Vanadium	14,500
Zinc	7,300

Sample depth = 16 feet
July 29, 1990

TB-33 PHASE III DATA

TOTAL METALS	CONCENTRATION (μg/kg)
Arsenic	39,000
Barium	56,500,000
Beryllium	670
Cadmium	6,400
Chromium	18,400
Cobalt	139,000
Lead	41,080
Manganese	4,080,000
Mercury	ND
Nickel	81,300
Vanadium	29,500
Zinc	1,150,000

Sample depth = 10 feet
July 8, 1990

B-1 PHASE III DATA

TOTAL METALS	CONCENTRATION (μg/kg)
Arsenic	10,200
Barium	4,490,000
Beryllium	470
Cadmium	19,600
Chromium	33,700
Cobalt	8,400
Lead	38,900
Manganese	77,500
Mercury	ND
Nickel	14,600
Vanadium	41,700
Zinc	445,000

Sample depth = 5 feet
July 25, 1990

B-4 PHASE III DATA

TOTAL METALS	CONCENTRATION (μg/kg)
Arsenic	19,500
Barium	85,200,000
Beryllium	1,300
Cadmium	15,200
Chromium	20,900
Cobalt	42,290
Lead	142,000
Manganese	1,390,000
Mercury	210
Nickel	19,290
Vanadium	32,400
Zinc	3,410,000

Sample depth = 4 feet
July 25, 1990

TP-6 PHASE I DATA

TOTAL METALS	CONCENTRATION (μg/kg)
Arsenic	30,000
Barium	86,200,000
Beryllium	1,600
Cadmium	294,000
Chromium	47,000
Cobalt	12,000
Lead	5,780,000
Manganese	3,580,000
Mercury	540
Nickel	113,000
Vanadium	69,000
Zinc	16,000,000

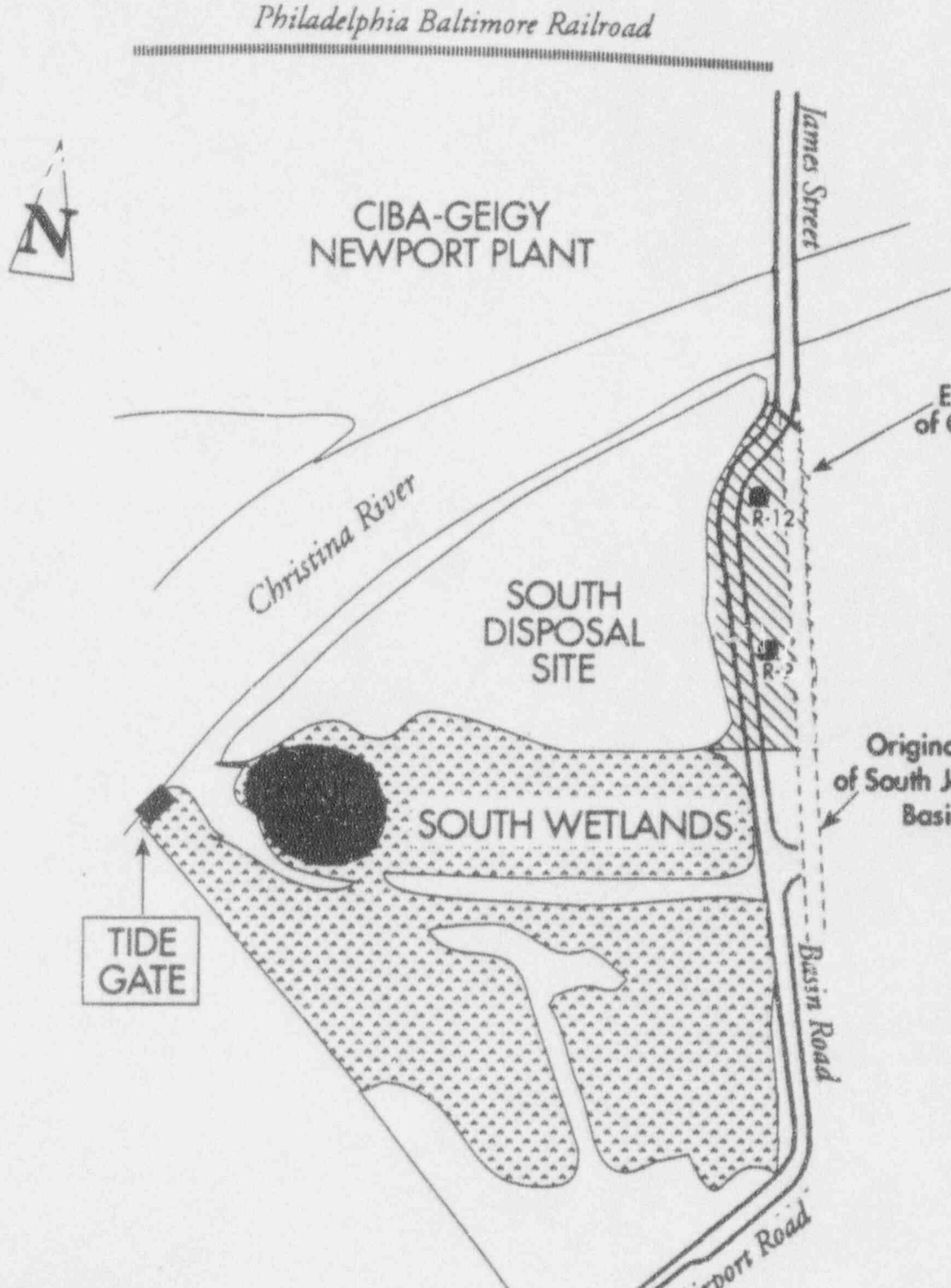
December 17, 1987

SGS-6 PHASE III DATA

TOTAL METALS	CONCENTRATION (μg/kg)
Arsenic	14,800
Barium	3,550,000
Beryllium	200
Cadmium	36,000
Chromium	44,000
Cobalt	9,500
Lead	761,000
Manganese	291,000
Mercury	1,600
Nickel	35,000
Vanadium	82,000
Zinc	8,240,000

Sample Depth = 0 - 6 inches

FIGURE 4
Relocated South James Street/Basin Road Through Newport



REFERENCE MAP: DelDOT
Contract No. 71-02-007
Sheet No. 150 of 198
Page 500047f of The Administrative Record.
NOTE: Boring locations are approximate.

FIGURE 5
Configuration of Borings R-9 and R-12

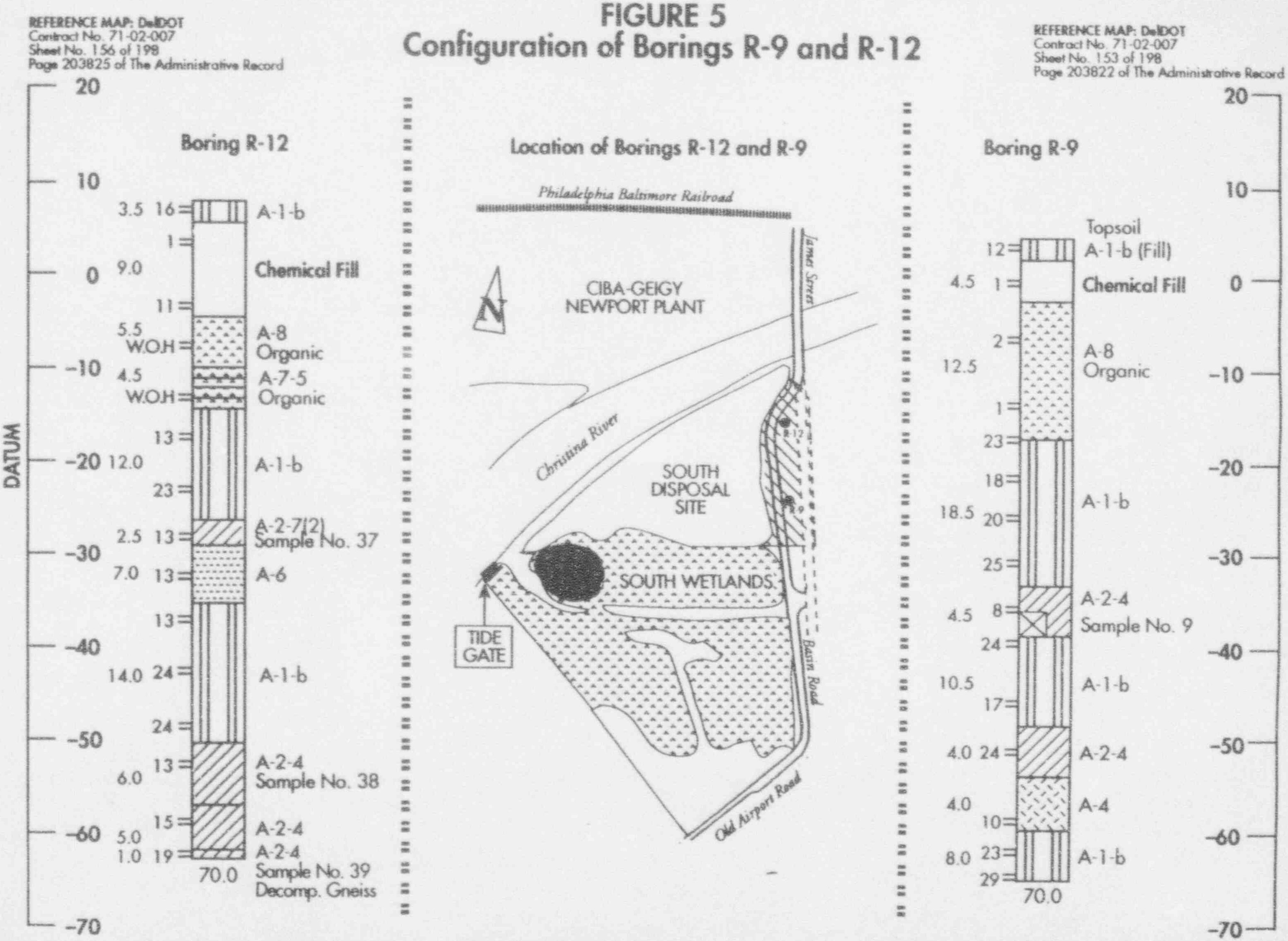
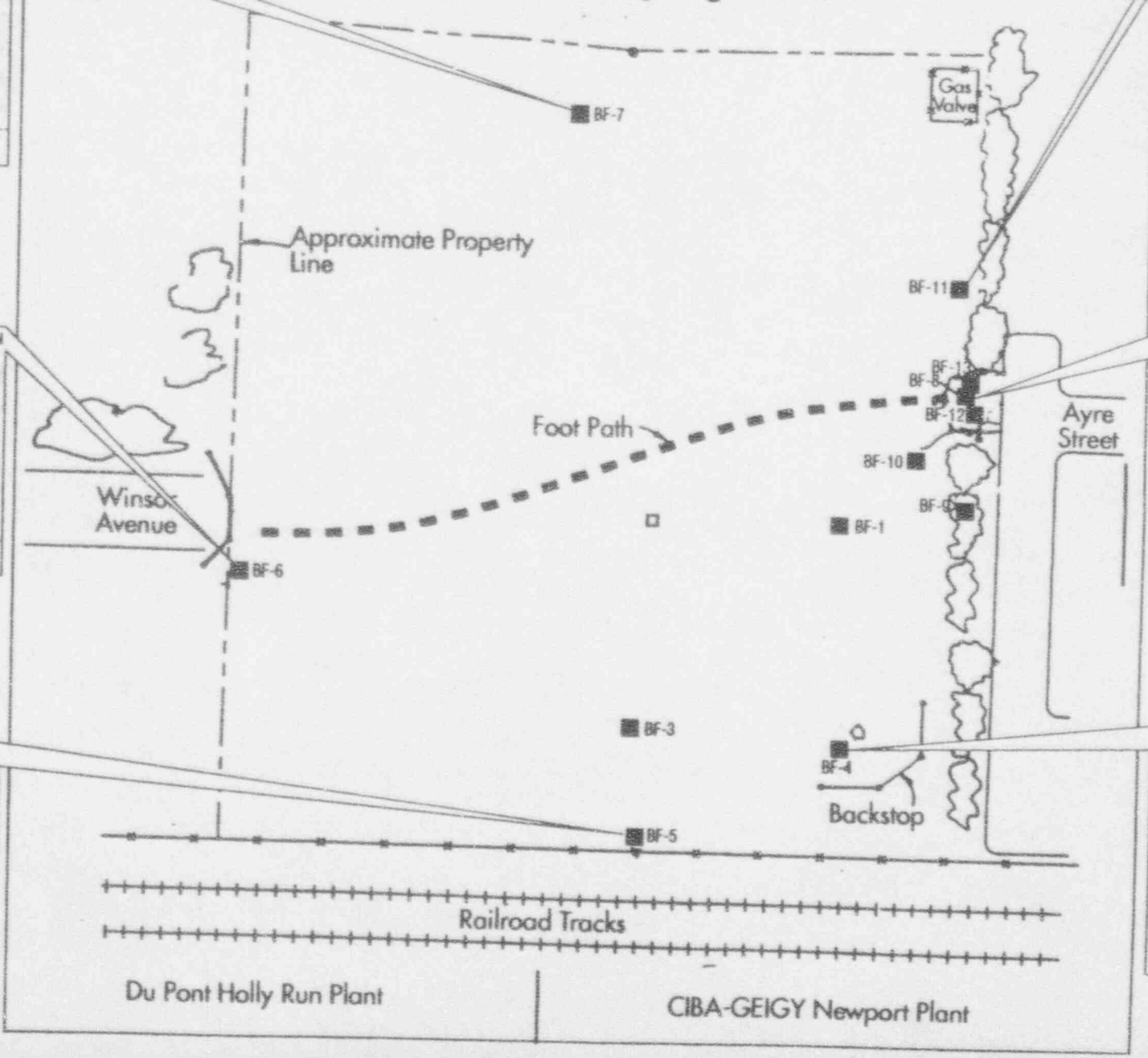


FIGURE 6
Ballpark Soil Sampling Locations



BF-7

TOTAL METALS	CONCENTRATION (µg/kg)
Arsenic	4,900
Barium	635,000
Beryllium	890
Cadmium	ND
Chromium	15,800
Colbalt	5,900
Lead	48,100
Manganese	755,000
Mercury	ND
Nickel	10,400
Vanadium	24,900
Zinc	72,800

Sample Depth = 12 inches
February 23, 1991

BF-6

TOTAL METALS	CONCENTRATION (µg/kg)
Arsenic	4,800
Barium	682,000
Beryllium	790
Cadmium	ND
Chromium	18,300
Colbalt	6,500
Lead	12,800
Manganese	361,000
Mercury	150
Nickel	11,400
Vanadium	29,200
Zinc	73,500

Sample Depth = 6 inches
February 23, 1991

BF-5

TOTAL METALS	CONCENTRATION (µg/kg)
Arsenic	1,800
Barium	465,000
Beryllium	370
Cadmium	100
Chromium	35,100
Colbalt	13,800
Lead	26,000
Manganese	424,000
Mercury	ND
Nickel	24,100
Vanadium	62,500
Zinc	135,000

Sample Depth = 6 inches
February 23, 1991

BF-11

TOTAL METALS	CONCENTRATION (µg/kg)
Arsenic	2,600
Barium	360,000
Beryllium	1,100
Cadmium	ND
Chromium	22,400
Colbalt	6,600
Lead	80,800
Manganese	925,000
Mercury	ND
Nickel	17,300
Vanadium	34,000
Zinc	77,200

Sample Depth = 6 inches
April 9, 1991

BF-8

TOTAL METALS	CONCENTRATION (µg/kg)
Arsenic	6,200
Barium	10,100,000
Beryllium	8,900
Cadmium	65,800
Chromium	24,400
Colbalt	17,800
Lead	390,000
Manganese	1,070,000
Mercury	290
Nickel	35,600
Vanadium	33,800
Zinc	5,530,000

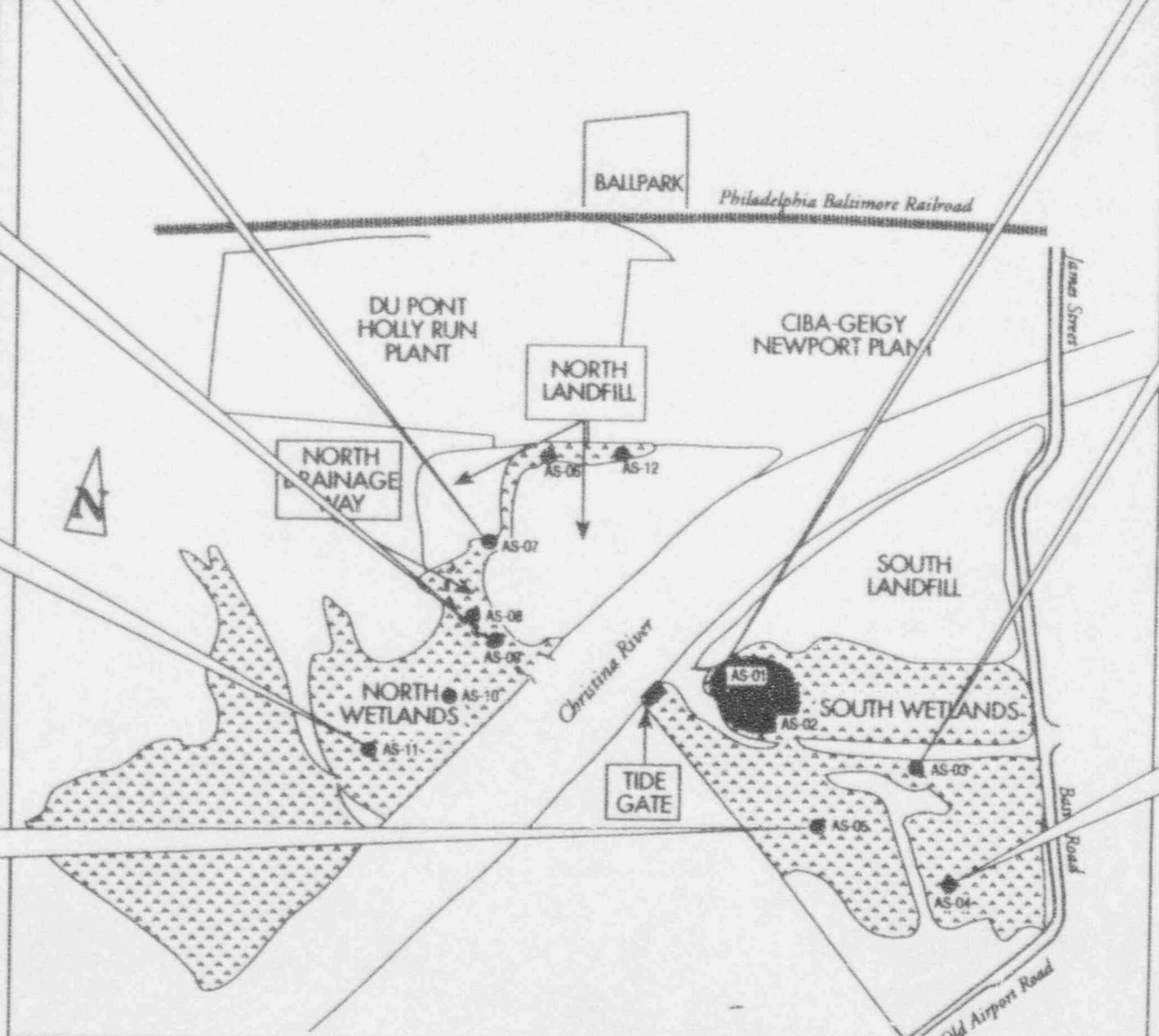
Sample Depth = 6 inches
April 9, 1991

BF-4

TOTAL METALS	CONCENTRATION (µg/kg)
Arsenic	2,500
Barium	138,000
Beryllium	640
Cadmium	ND
Chromium	15,700
Colbalt	7,400
Lead	13,100
Manganese	482,000
Mercury	ND
Nickel	7,300
Vanadium	24,700
Zinc	41,800

Sample Depth = 18 inches
February 23, 1991

FIGURE 7
Site Characteristics: Wetlands Sediment Contamination



AS-07

TOTAL METALS	[ppm]
Arsenic	117.0
Barium	4,510.0
Cadmium	95.7
Chromium	362.0
Copper	3,070.0
Iron	24,400.0
Lead	27,000.0
Manganese	2,070.0
Mercury	8.8
Nickel	49.2
Zinc	15,300.0

AS-09

TOTAL METALS	[ppm]
Arsenic	NA
Barium	1,610.0
Cadmium	48.0
Chromium	576.0
Copper	827.0
Iron	63,400.0
Lead	8,490.0
Manganese	2,170.0
Mercury	1.8
Nickel	47.0
Zinc	6,200.0

AS-11

TOTAL METALS	[ppm]
Arsenic	NA
Barium	500.0
Cadmium	NA
Chromium	66.2
Copper	157.0
Iron	35,200.0
Lead	395.0
Manganese	541.0
Mercury	NA
Nickel	36.9
Zinc	2,530.0

AS-05

TOTAL METALS	[ppm]
Arsenic	NA
Barium	21,900.0
Cadmium	46.4
Chromium	72.4
Copper	281.0
Iron	64,500.0
Lead	593.0
Manganese	983.0
Mercury	NA
Nickel	43.1
Zinc	3,910.0

AS-01

TOTAL METALS	[ppm]
Arsenic	NA
Barium	14,300.0
Cadmium	77.0
Chromium	54.0
Copper	283.0
Iron	32,500.0
Lead	1,470.0
Manganese	603.0
Mercury	NA
Nickel	38.0
Zinc	6,360.0

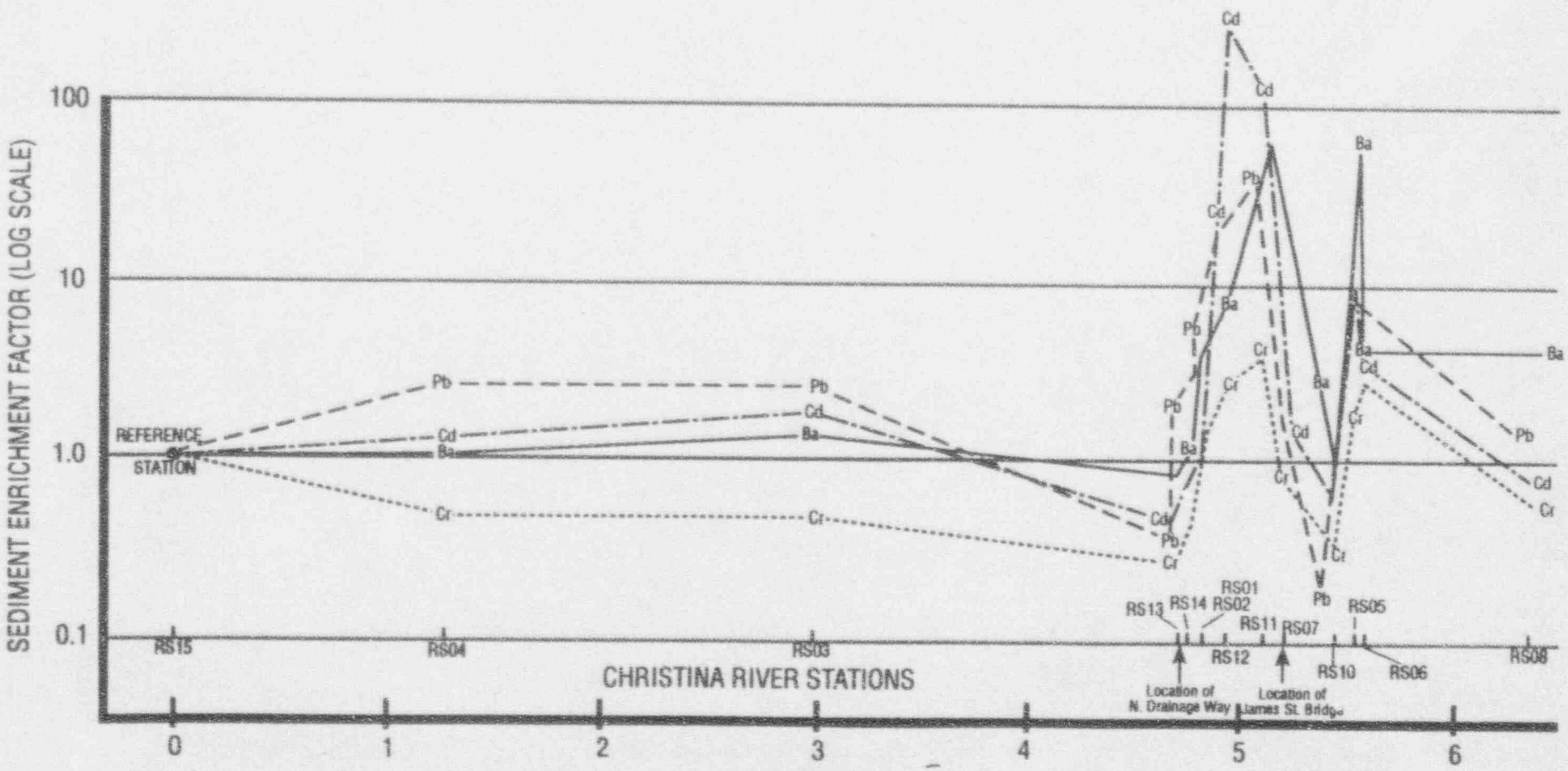
AS-03

TOTAL METALS	[ppm]
Arsenic	NA
Barium	34,700.0
Cadmium	49.5
Chromium	57.0
Copper	1,190.0
Iron	51,900.0
Lead	5,550.0
Manganese	1,510.0
Mercury	0.0
Nickel	37.0
Zinc	12,800.0

AS-04

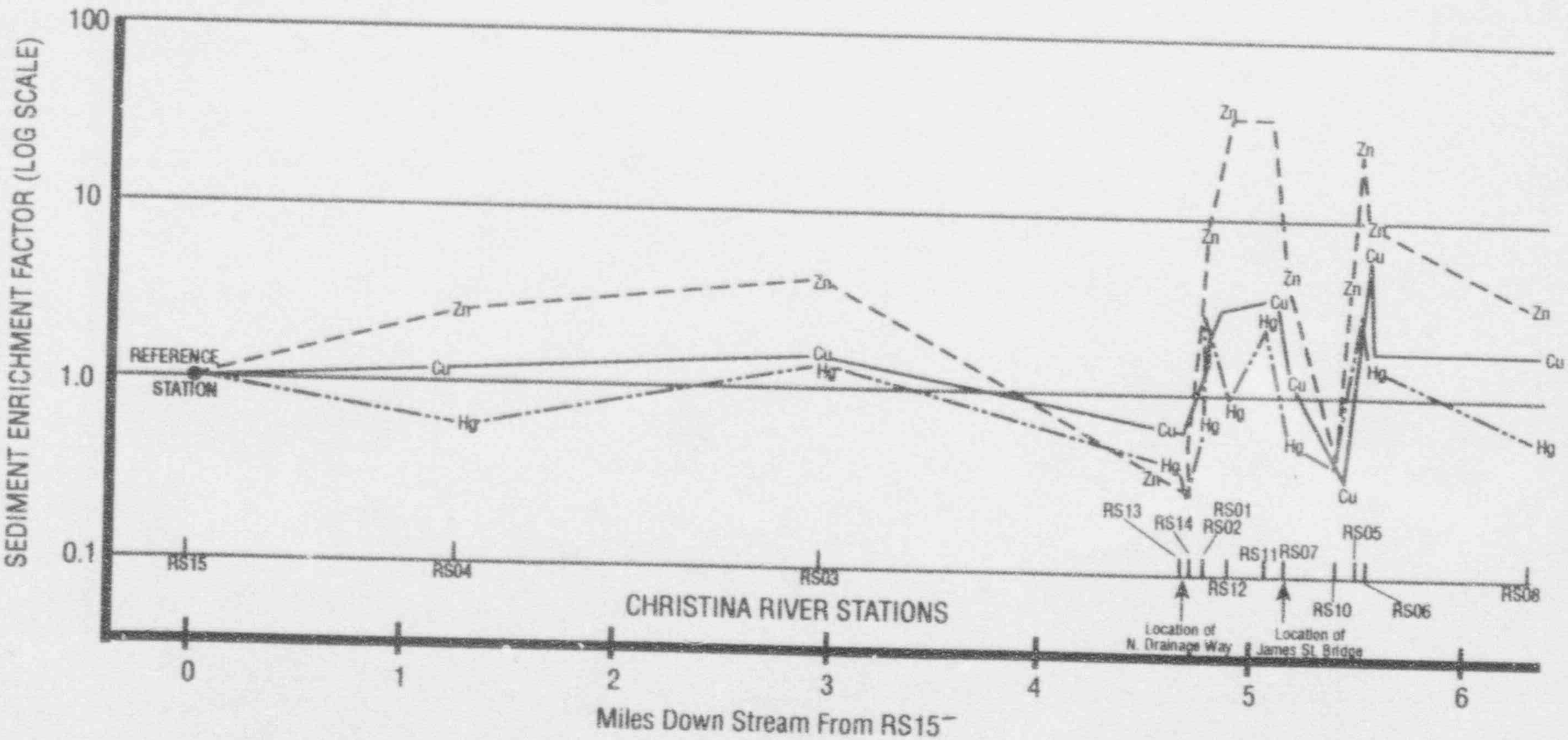
TOTAL METALS	[ppm]
Arsenic	NA
Barium	21,500.0
Cadmium	NA
Chromium	60.0
Copper	307.0
Iron	49,500.0
Lead	904.0
Manganese	NA
Mercury	NA
Nickel	30.0
Zinc	1,380.0

FIGURE 8
Distribution of Sediment Contamination Enrichment Factors for Metals in the Christina River



NOTE: The Enrichment Factor is the ratio of a normalized contaminant concentration to a normalized contaminant concentration at a reference station (in this case RS-15).

FIGURE 8
(Continued)



NOTE: The Enrichment Factor is the ratio of a normalized contaminant concentration to a normalized contaminant concentration at a reference station (in this case RS-15)

FIGURE 9
Simplified Geological Cross-Section of Site

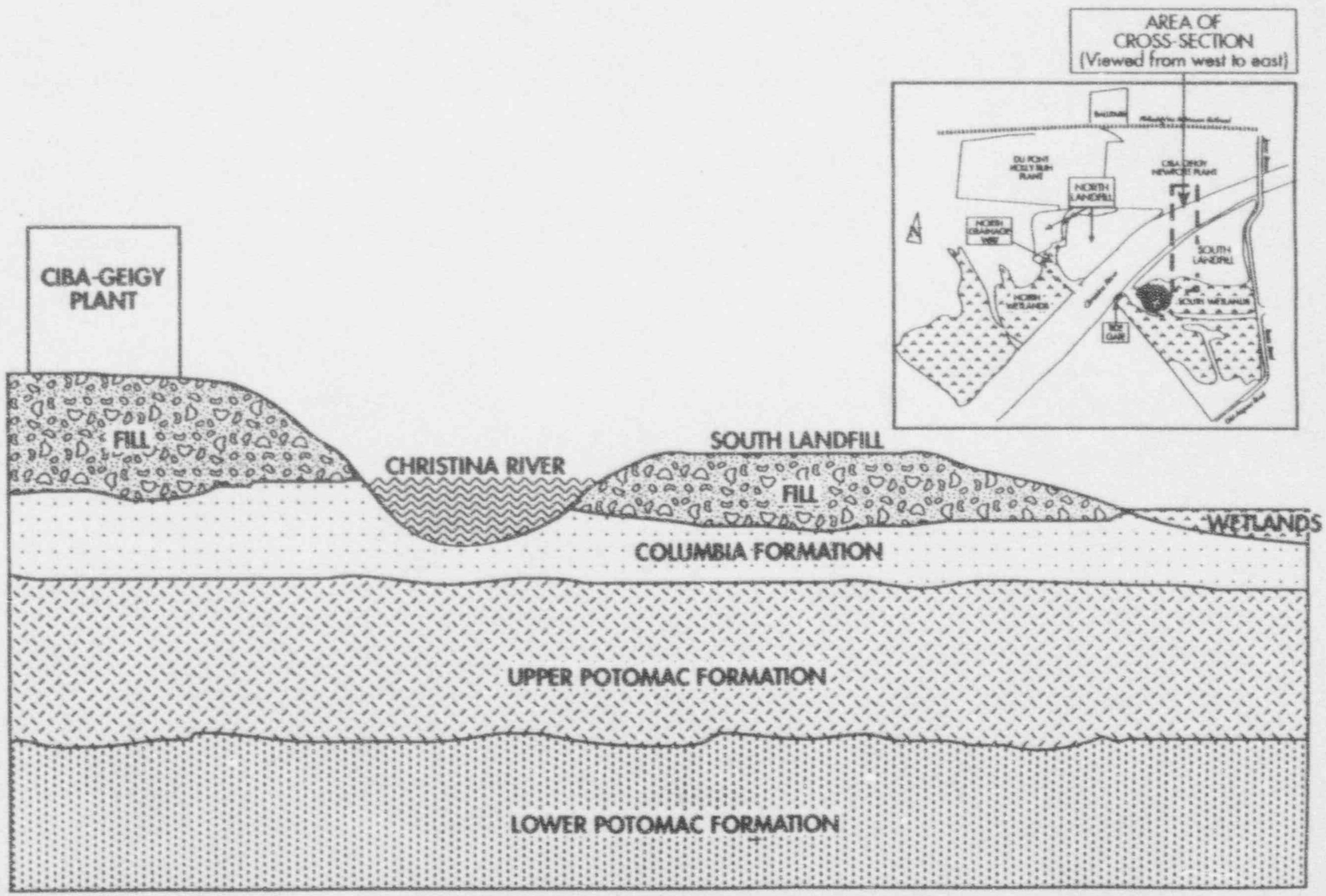
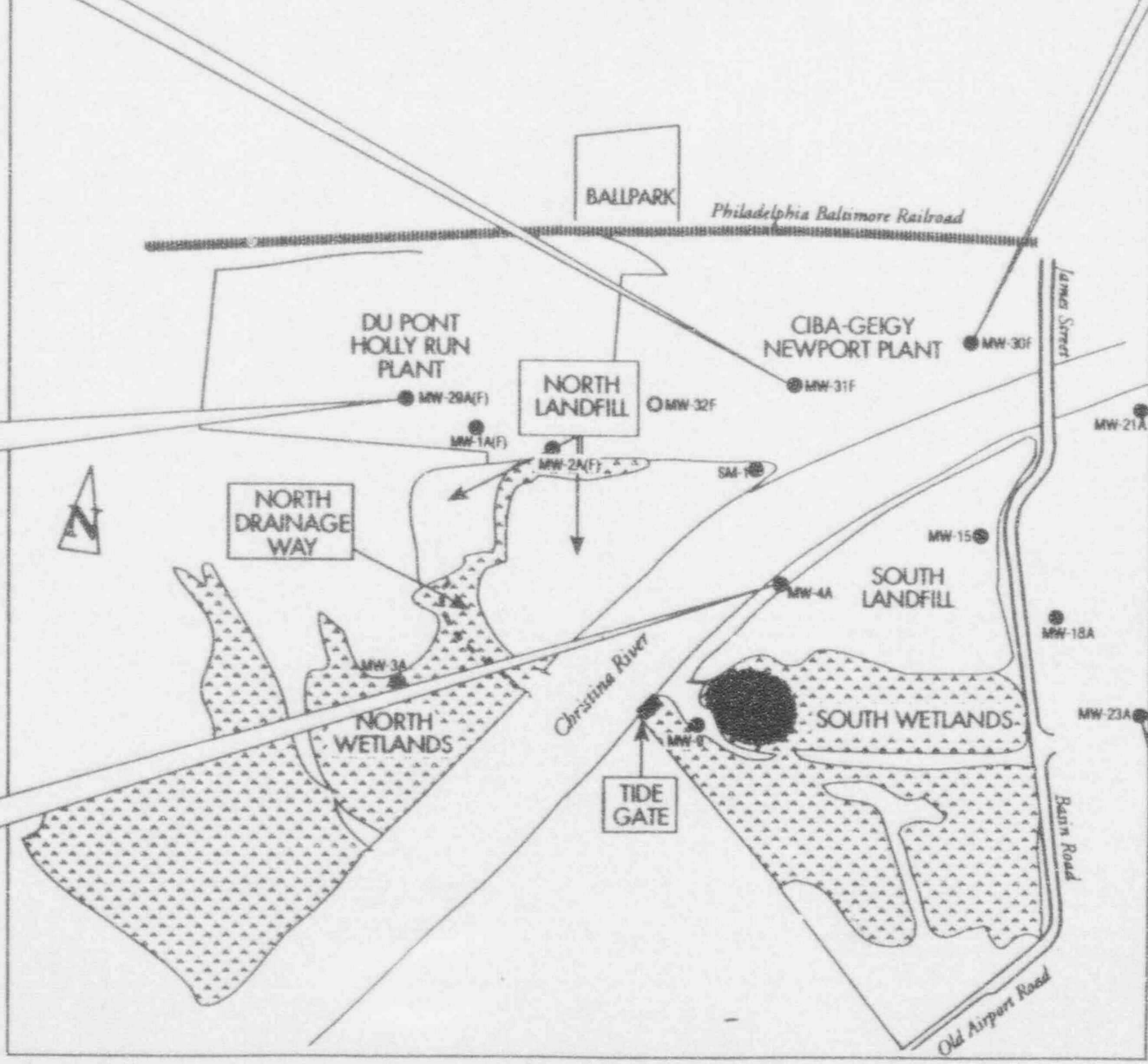


FIGURE 10*
Fill Zone Well Locations



MW-31F PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	40.3
Cadmium	366.0
Chromium	ND
Cobalt	43.8
Copper	14.2
Lead	ND
Manganese	1,970.0
Nickel	32.0
Vanadium	ND
Zinc	20,900.0
VOCs**	
1,2-Dichloroethene	8.0
Tetrachloroethene	76.0
Trichloroethene	7.0
SEMI-VOCs	
1,2-Dichlorobenzene	11.0
bis (2-Ethylexyl) Phthalate	30.0

MW-29A(F) PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	157.0
Cadmium	ND
Chromium	18.9
Cobalt	18.8
Copper	17.3
Lead	ND
Manganese	3,260.0
Nickel	ND
Vanadium	29.8
Zinc	86.1

MW-4A PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	37.0
Barium	104,000.0
Cadmium	ND
Chromium	ND
Cobalt	32.8
Copper	5.6
Lead	ND
Manganese	3,500.0
Nickel	ND
Vanadium	ND
Zinc	65.2

MW-30F PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	57,000.0
Cadmium	ND
Chromium	ND
Cobalt	9.9
Copper	ND
Lead	ND
Manganese	270.0
Nickel	ND
Vanadium	5.3
Zinc	58.4
VOCs**	
1,2-Dichloroethene	110.0
Vinyl Chloride	9.0
SEMI-VOCs	
bis (2-Ethylexyl) Phthalate	22.0

MW-21A PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	86.4
Cadmium	ND
Chromium	ND
Cobalt	ND
Copper	8.0
Lead	3.3
Manganese	2,380.0
Nickel	ND
Vanadium	ND
Zinc	42.6
VOCs**	
Toluene	2.0

MW-23A PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	365.0
Cadmium	ND
Chromium	ND
Cobalt	13.7
Copper	5.1
Lead	5.1
Manganese	3,810.0
Nickel	ND
Vanadium	ND
Zinc	40.6

*Chemical concentrations as reported for November 1990 sampling event. Complete data can be found in the Administrative Record.
**VOCs = Volatile Organic Compounds

FIGURE 11*
Columbia Aquifer & Shallow Well Locations

MW-33A PHASE III DATA

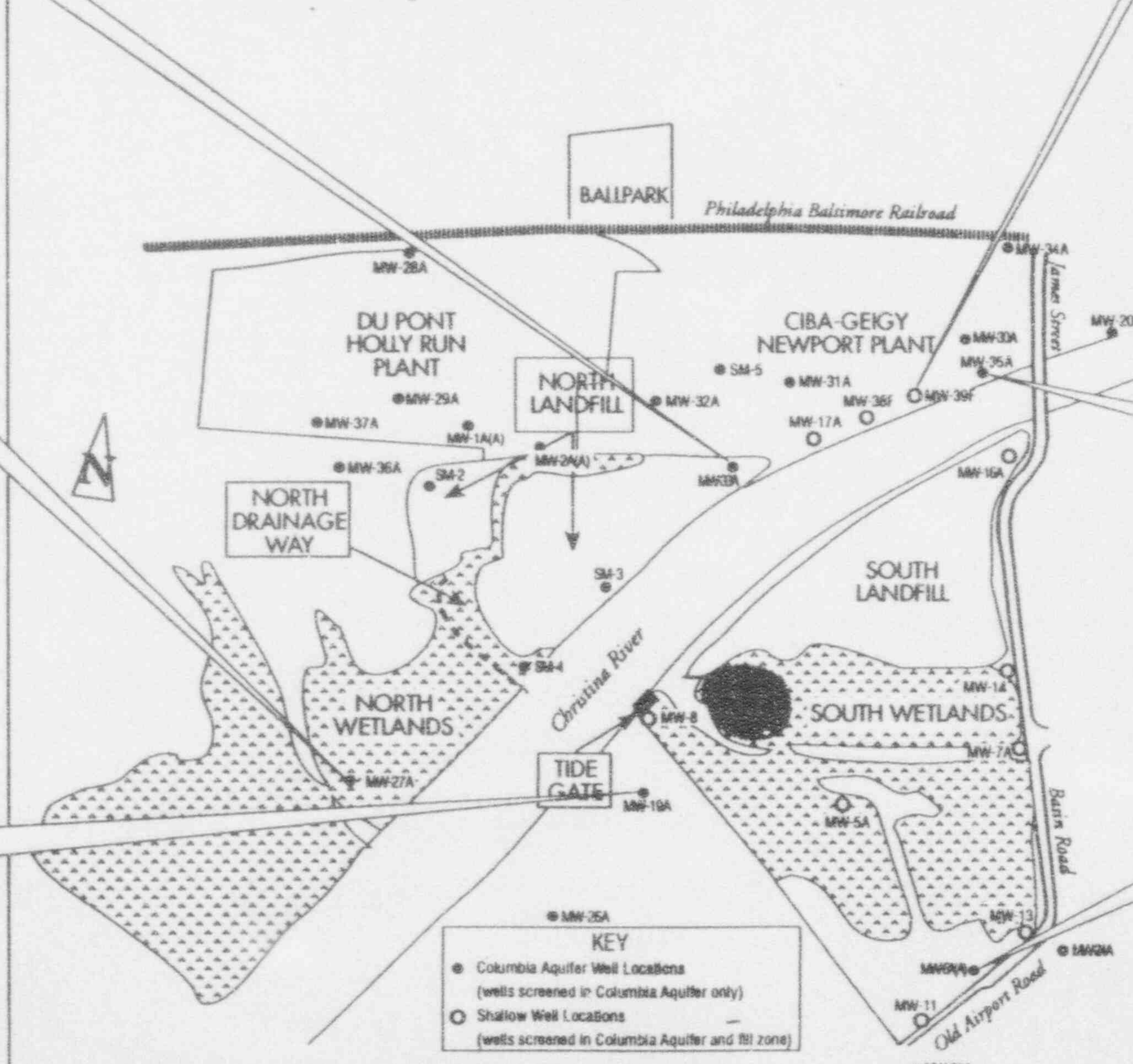
TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	1,390.0
Cadmium	431.0
Chromium	ND
Cobalt	30.7
Copper	5.1
Lead	ND
Manganese	1,610.0
Nickel	30.7
Vanadium	5.0
Zinc	26,600.0
VOCs**	
Tetrachloroethene	300.0
Trichloroethene	27.0

MW-27A PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	63.7
Cadmium	ND
Chromium	ND
Cobalt	ND
Copper	5.4
Lead	ND
Manganese	307.0
Nickel	ND
Vanadium	ND
Zinc	41.3
VOCs**	
1,2-Dichloroethene	1.0

MW-19A PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	183.0
Cadmium	ND
Chromium	ND
Cobalt	40.2
Copper	12.2
Lead	ND
Manganese	7,470.0
Nickel	ND
Vanadium	11.2
Zinc	418.0
VOCs**	
1,2-Dichloroethene	56.0
Tetrachloroethene	12.0
Trichloroethene	18.0



*Chemical concentrations as reported for November 1990 sampling event. Complete data can be found in the Administrative Record.

** VOCs = Volatile Organic Compounds

MW-39F PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	15.5
Barium	362.0
Cadmium	ND
Chromium	ND
Cobalt	ND
Copper	ND
Lead	ND
Manganese	1,420
Nickel	.0ND
Vanadium	9.3
Zinc	26.0
VOCs**	
1,2-Dichloroethene	68.0
Benzene	2.0
Chlorobenzene	4.0
Tetrachloroethene	27.0
Toluene	12.0
Trichloroethene	8.0
SEMI-VOCs	
1,2-Dichlorobenzene	130.0
bis (2-Ethylexyl) Phthalate	6.0
4-Chloroaniline	160.0

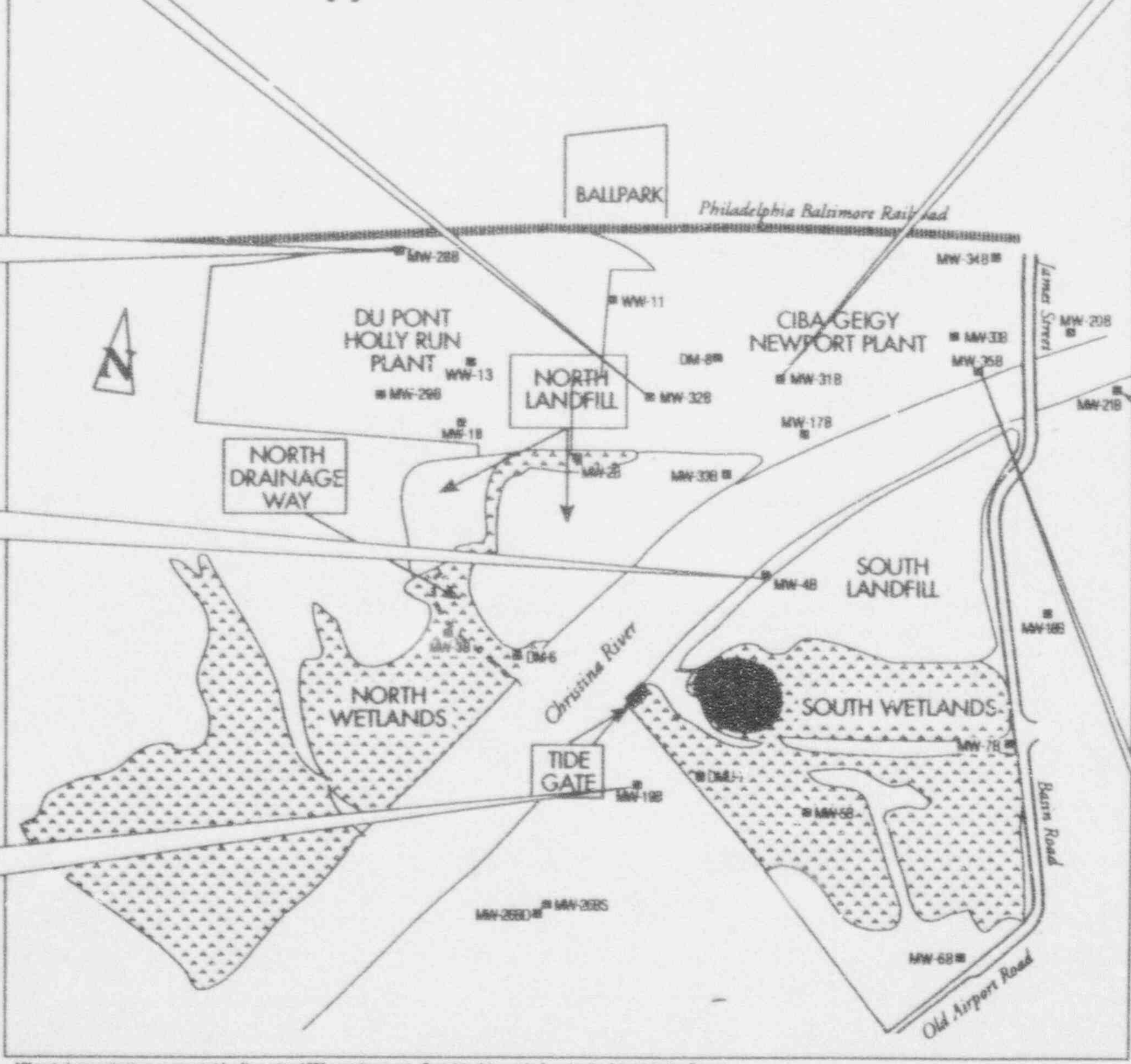
MW-35A PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	142.0
Cadmium	6.3
Chromium	ND
Cobalt	185.0
Copper	6.7
Lead	ND
Manganese	191.0
Nickel	67.7
Vanadium	ND
Zinc	1,080.0
VOCs**	
1,2-Dichloroethene	2.0
Tetrachloroethene	52.0
Trichloroethene	2.0

MW-6A(A) PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	2.9
Barium	93.9
Cadmium	ND
Chromium	4.1
Cobalt	ND
Copper	11.7
Lead	4.0
Manganese	401.0
Nickel	ND
Vanadium	ND
Zinc	84.9

FIGURE 12*
Upper Potomac Well Locations



MW-32B PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	44.5
Cadmium	143.0
Chromium	ND
Cobalt	17.7
Copper	25.1
Lead	ND
Manganese	564.0
Nickel	21.4
Vanadium	ND
Zinc	10,400.0
VOCs**	
Tetrachloroethene	10.0
Tricholoroethene	3.0
SEMI-VOCs	
bis (2-Ethylhexyl) Phthalate	6.0

MW-28 PHASE III DATA*

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	52.5
Cadmium	ND
Chromium	ND
Cobalt	ND
Copper	23.2
Lead	3.2
Manganese	29.7
Nickel	ND
Vanadium	ND
Zinc	54.9

MW-4B PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	89.3
Cadmium	ND
Chromium	ND
Cobalt	8.3
Copper	6.7
Lead	ND
Manganese	24.0
Nickel	34.9
Vanadium	ND
Zinc	73.9
VOCs**	
Tetrachloroethene	200.0
Trichloroethene	44.0
Xylene	2.0

MW-19B PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	114.0
Cadmium	3.1
Chromium	ND
Cobalt	26.6
Copper	28.5
Lead	75.4
Manganese	507.0
Nickel	19.4
Vanadium	ND
Zinc	202.0

MW-31B PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	70.5
Cadmium	702.0
Chromium	ND
Cobalt	46.2
Copper	22.7
Lead	ND
Manganese	422.0
Nickel	101.0
Vanadium	ND
Zinc	54,200.0
VOCs**	
Tetrachloroethene	12.0
SEMI-VOCs	
bis (2-Ethylhexyl) Phthalate	15.0

MW-21B PHASE III DATA

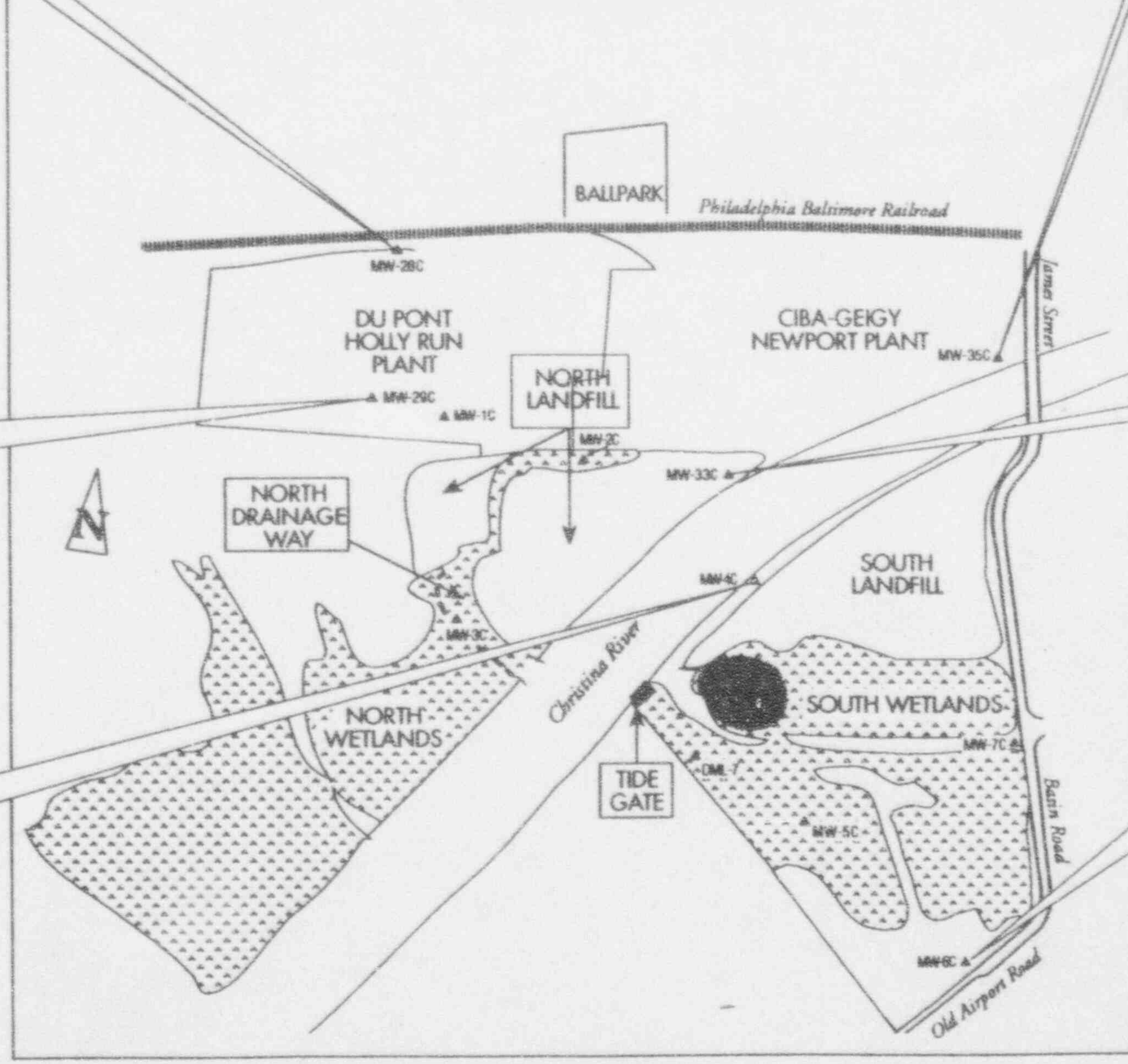
TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	27.7
Cadmium	ND
Chromium	19.2
Cobalt	5.7
Copper	16.1
Lead	ND
Manganese	14.8
Nickel	ND
Vanadium	14.2
Zinc	22.7

MW-35B PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Arsenic	ND
Barium	73.6
Cadmium	ND
Chromium	ND
Cobalt	ND
Copper	6.7
Lead	8.8
Manganese	58.8
Nickel	ND
Vanadium	ND
Zinc	22.7
VOCs**	
Tetrachloroethene	11.0
Trichloroethene	1.0

*Chemical concentrations as reported for November 1990 sampling event. Complete data can be found in the Administrative Record.
** VOCs = Volatile Organic Compounds

FIGURE 13*
Lower Potomac Well Locations



MW-28C PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Barium	37.7
Cadmium	ND
Chromium	ND
Cobalt	ND
Copper	9.5
Lead	ND
Manganese	120.0
Nickel	ND
Vanadium	ND
Zinc	62.9
SEMI-VOCs	
bis (2-Ethylhexyl) Phthalate	21.0

MW-29C PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Barium	34.5
Cadmium	ND
Chromium	ND
Cobalt	6.6
Copper	9.0
Lead	3.0
Manganese	41.4
Nickel	ND
Vanadium	6.7
Zinc	34.4

MW-4C PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Barium	503.0
Cadmium	ND
Chromium	ND
Cobalt	ND
Copper	ND
Lead	6.9
Manganese	56.7
Nickel	ND
Vanadium	ND
Zinc	20.9

MW-35C PHASE III DATA

TOTAL METALS	CONCENTRATION (µg/l)
Barium	46.8
Cadmium	ND
Chromium	5.2
Cobalt	78.0
Copper	55.9
Lead	ND
Manganese	21.4
Nickel	ND
Vanadium	ND
Zinc	33.8
VOCs**	
Tetrachloroethene	2.0

MW-33C PHASE III DATA

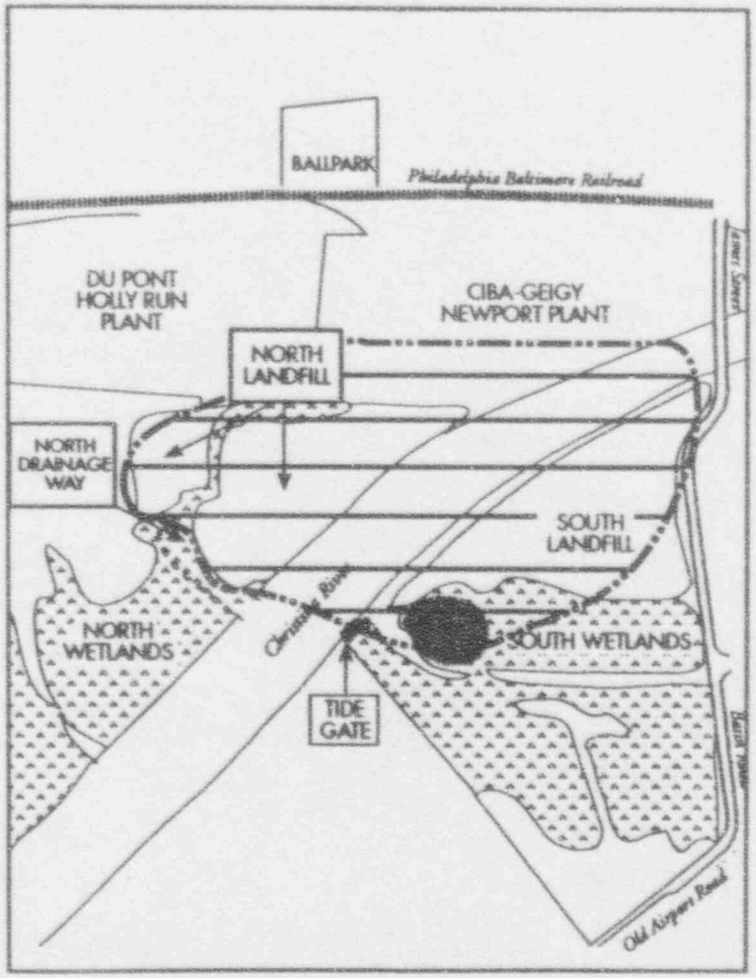
TOTAL METALS	CONCENTRATION (µg/l)
Barium	45.1
Cadmium	358.0
Chromium	ND
Cobalt	33.7
Copper	15.4
Lead	ND
Manganese	185.0
Nickel	62.2
Vanadium	ND
Zinc	22,000.0
VOCs**	
Tetrachloroethene	32.0
Trichloroethene	10.0
SEMI-VOCs	
1,2-Dichlorobenzene	4.0
bis (2-Ethylhexyl) Phthalate	4.0

MW-35C PHASE III DATA

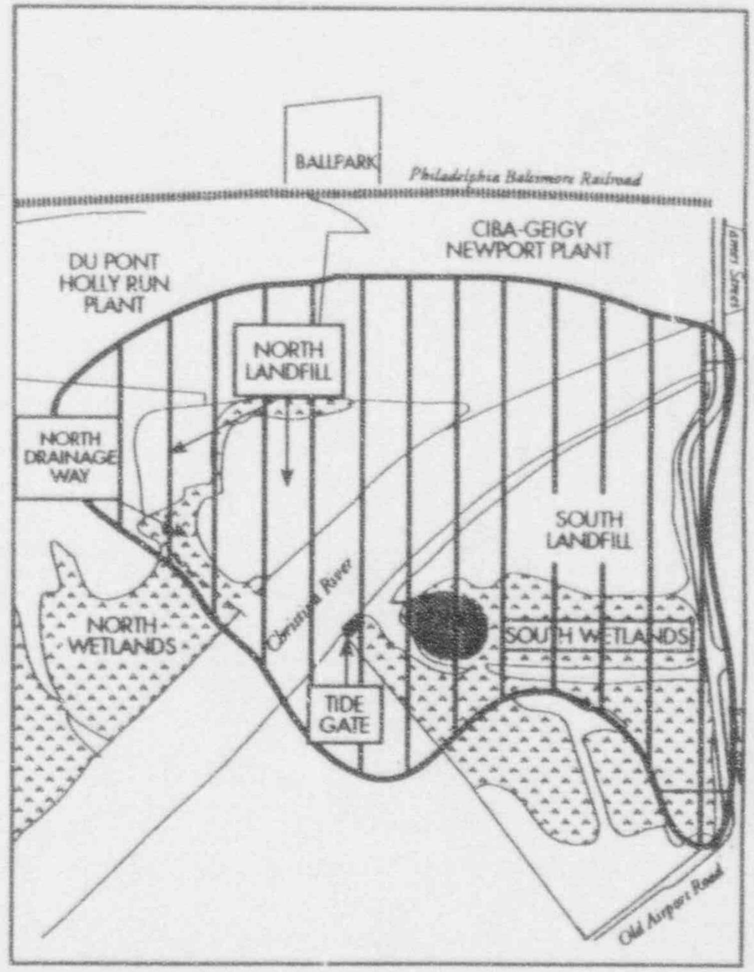
TOTAL METALS	CONCENTRATION (µg/l)
Barium	27.6
Cadmium	ND
Chromium	ND
Cobalt	ND
Copper	ND
Lead	ND
Manganese	17.1
Nickel	ND
Vanadium	ND
Zinc	15.7

*Chemical concentrations as reported for November 1990 sampling event. Complete data can be found in the Administrative Record.
**VOCs = Volatile Organic Compounds

FIGURE 14
Ground Water Contamination in Columbia and Potomac Aquifers



Extent of ground water contamination in the Potomac aquifer that exceeds MCLs and non-zero MCLGs



Extent of ground water contamination in the Columbia aquifer that exceeds MCLs and non-zero MCLGs

FIGURE 15
Direction of Vertical Ground Water Flow Columbia vs. Upper Potomac Zones
(Low Tide–December 13, 1990)

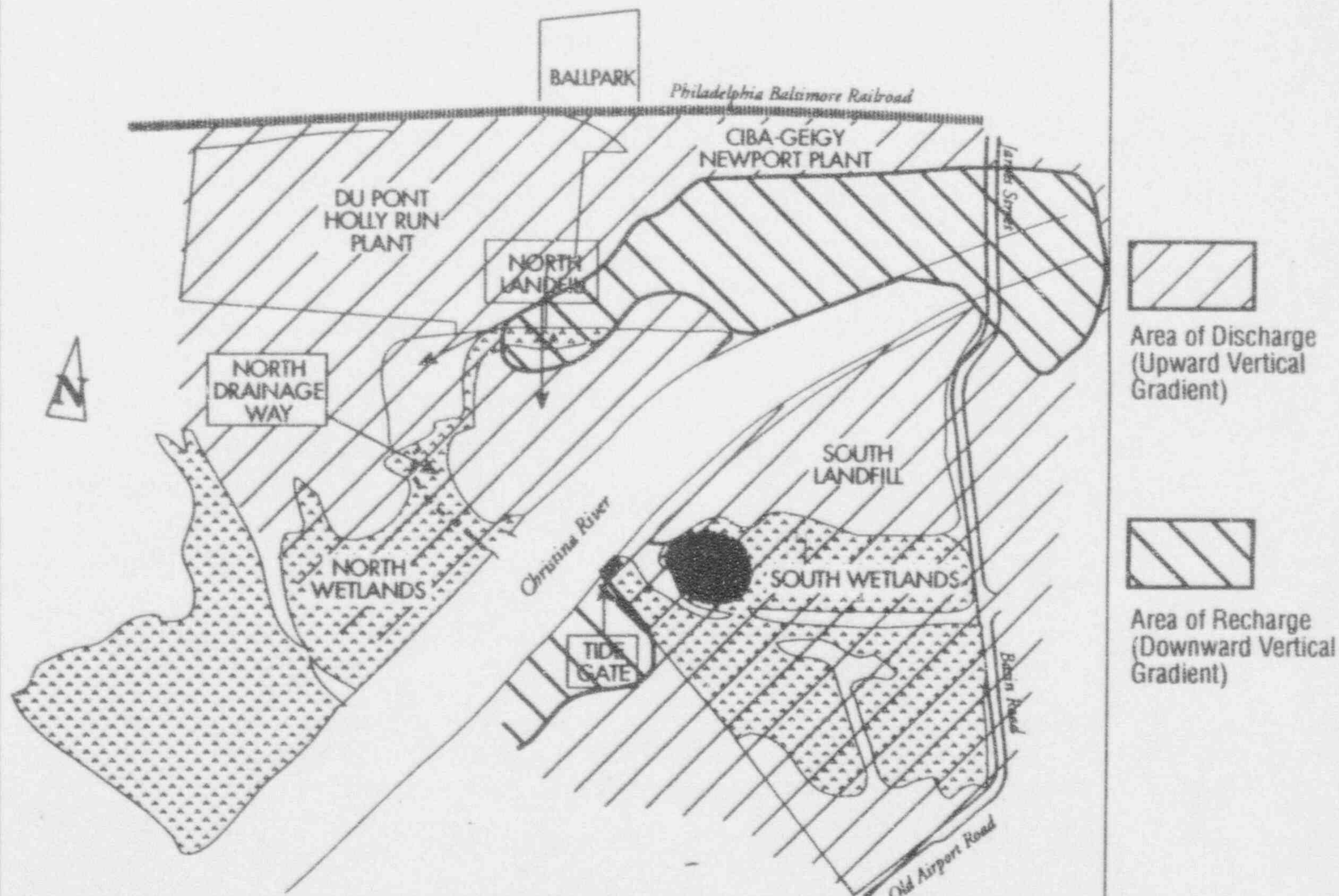


FIGURE 16
Direction of Vertical Ground Water Flow
Upper Potomac vs. Lower Potomac
(HIGH Tide–December 13, 1990)

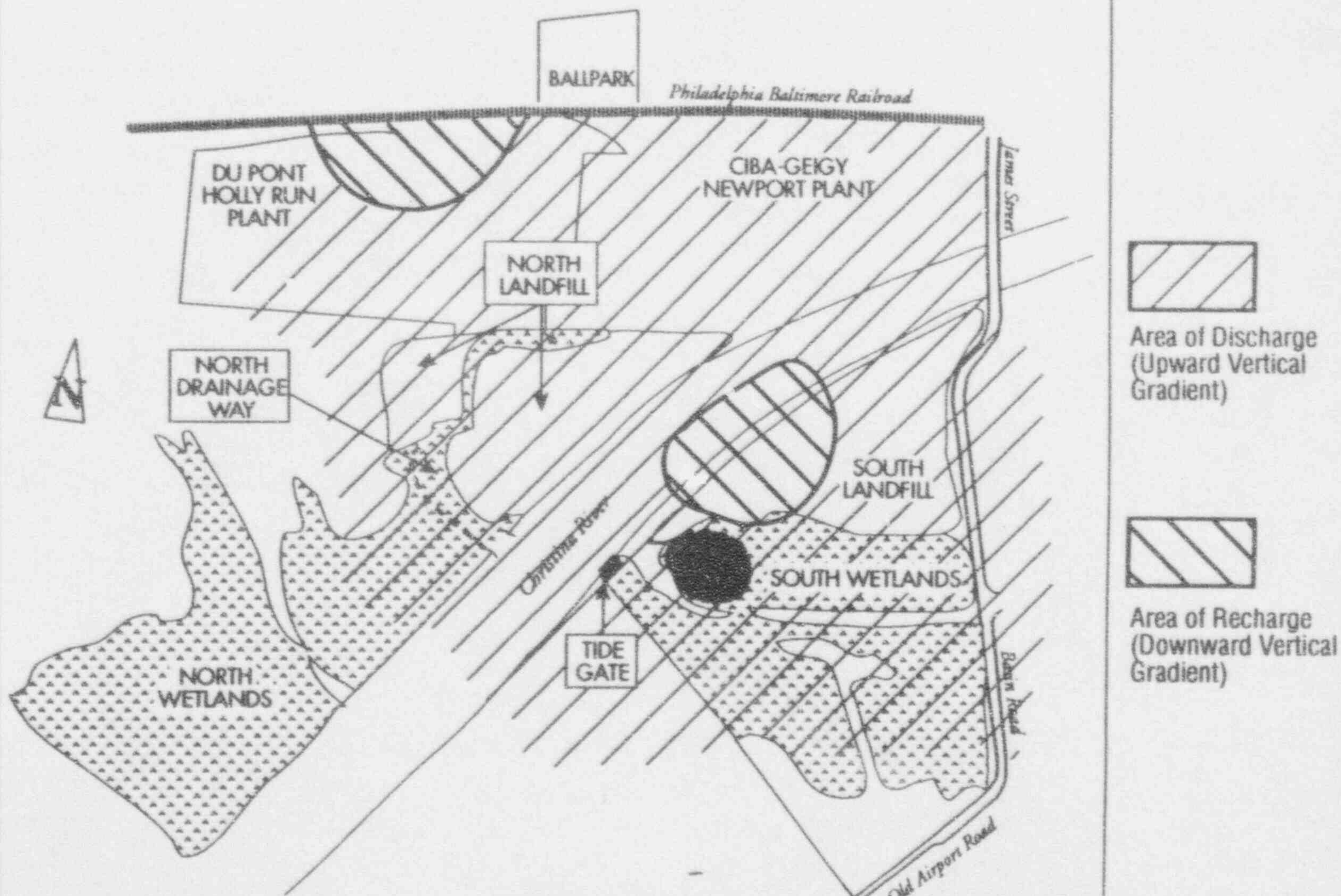
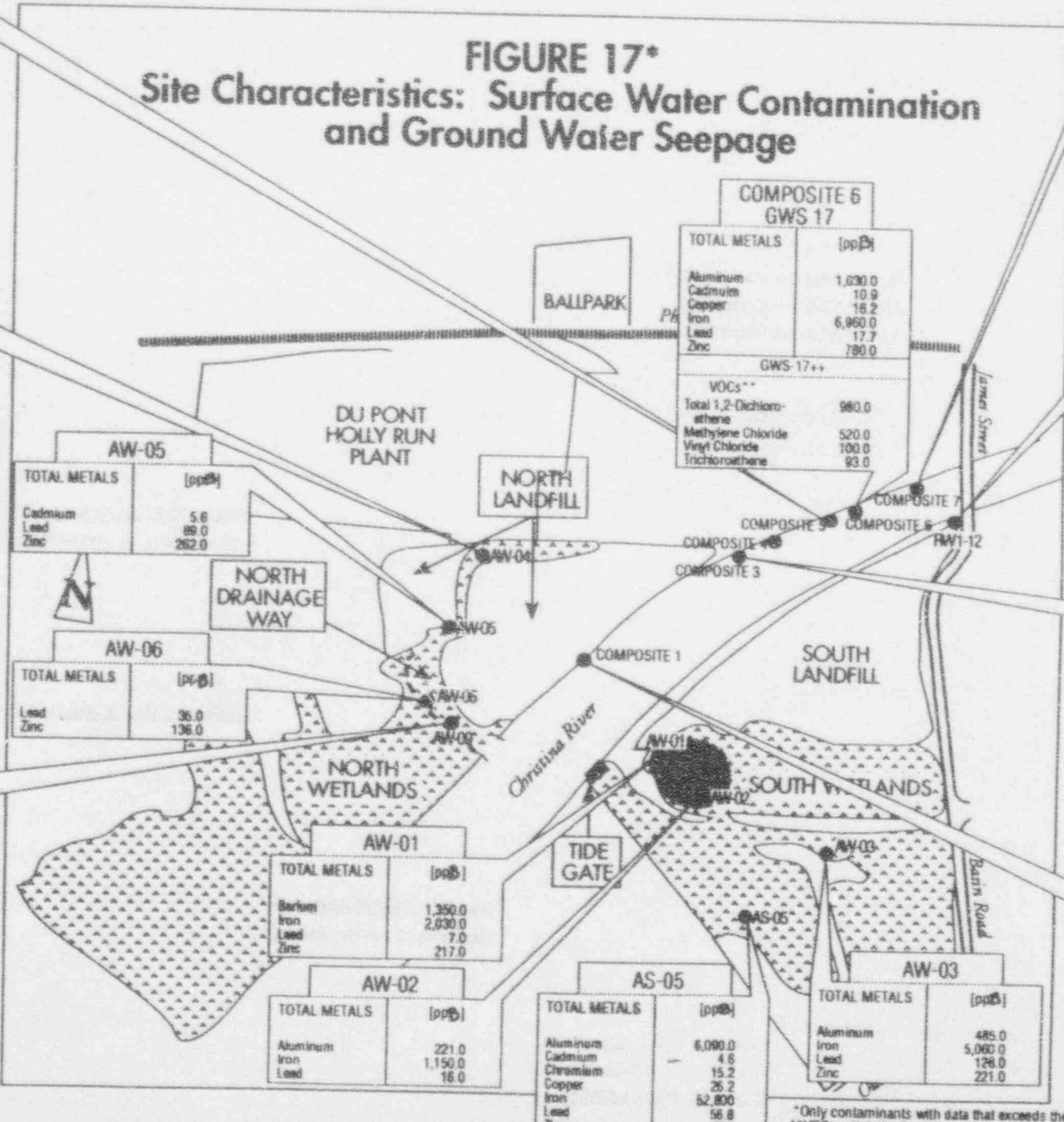


FIGURE 17*
Site Characteristics: Surface Water Contamination and Ground Water Seepage



COMPOSITE 5 — GWS 14,16

TOTAL METALS	[ppB]
Aluminum	3,280.0
Cadmyim	31.2
Chromium	11.8
Copper	17.2
Iron	22,800.0
Lead	474.0
Zinc	7,330.0
GWS-16++	
Semi-VOCs	
Total 1,2-Dichloro-ethene	330.0
Chlorobenzene	1,500.0
Vinyl Chloride	650.0

COMPOSITE 4 — GWS 12,13

TOTAL METALS	[ppB]
Aluminum	10,800.0
Cadmuim	20.8
Chromium	58.3
Copper	431.0
Iron	38,200.0
Lead	1,220.0
Mercury	1.1
Zinc	19,100.0
GWS-12++	
Semi-VOCs	
Total 1,2-Dichloro-ethene	520.0
1,4-Dichlorobenzene	87.0
4-Chloroaniline	85.0
VOCs**	
Total 1,2-Dichloro-ethene	130.0
Chlorobenzene	800.0
Trichloroethene	31.0

AW-05

TOTAL METALS	[ppB]
Cadmium	5.6
Lead	89.0
Zinc	262.0

AW-06

TOTAL METALS	[ppB]
Lead	36.0
Zinc	136.0

AW-09

TOTAL METALS	[ppB]
Aluminum	545.0
Cadmium	9.9
Copper	54.2
Iron	3,170.0
Lead	286.0
Zinc	14,000.0

WATER QUALITY CRITERIA

Parameter	Acute (ppb)	Chronic (ppb)
Aluminum	750.0†	87.0†
Cadmium	3.9+	1.1+
Copper	18.0+	12.0+
Iron	–	1,000.0
Lead	82.0+	3.2+
Mercury	2.4	012
Zinc	120.0+	110.0+

† DNREC Data
+ Hardness Dependent: value listed is based on 100 ppm as $CaCO_3$; measured values in wetlands near the North and South Disposal sites range from 104 to 183 ppm CaCP₃

AW-01

TOTAL METALS	[ppB]
Barium	1,350.0
Iron	2,030.0
Lead	7.0
Zinc	217.0

AW-02

TOTAL METALS	[ppB]
Aluminum	221.0
Iron	1,150.0
Lead	16.0

AS-05

TOTAL METALS	[ppB]
Aluminum	6,090.0
Cadmium	4.6
Chromium	15.2
Copper	26.2
Iron	52,800
Lead	56.8
Zinc	391

AW-03

TOTAL METALS	[ppB]
Aluminum	485.0
Iron	5,060.0
Lead	126.0
Zinc	221.0

COMPOSITE 6 — GWS 17

TOTAL METALS	[ppB]
Aluminum	1,030.0
Cadmuim	10.9
Copper	16.2
Iron	6,960.0
Lead	17.7
Zinc	780.0
GWS-17++	
VOCs**	
Total 1,2-Dichloro-ethene	980.0
Methylene Chloride	520.0
Vinyl Chloride	100.0
Trichloroethene	93.0

COMPOSITE 7 — GWS 19,20

TOTAL METALS	[ppB]
Aluminum	7,680.0
Cadmuim	25.5
Copper	27.6
Lead	16.3
Zinc	5,480.0
GWS-20++	
VOCs**	
Total 1,2-Dichloro-ethene	30.0
Trichloroethene	15.0

RW1-12

TOTAL METALS	[ppB]
Aluminum	2,060.0
Barium	100
Cadmium	9.6
Chromium	12
Copper	NA
Iron	2,840.0
Lead	72.0
Zinc	287.0

COMPOSITE 3 — GWS 9,11

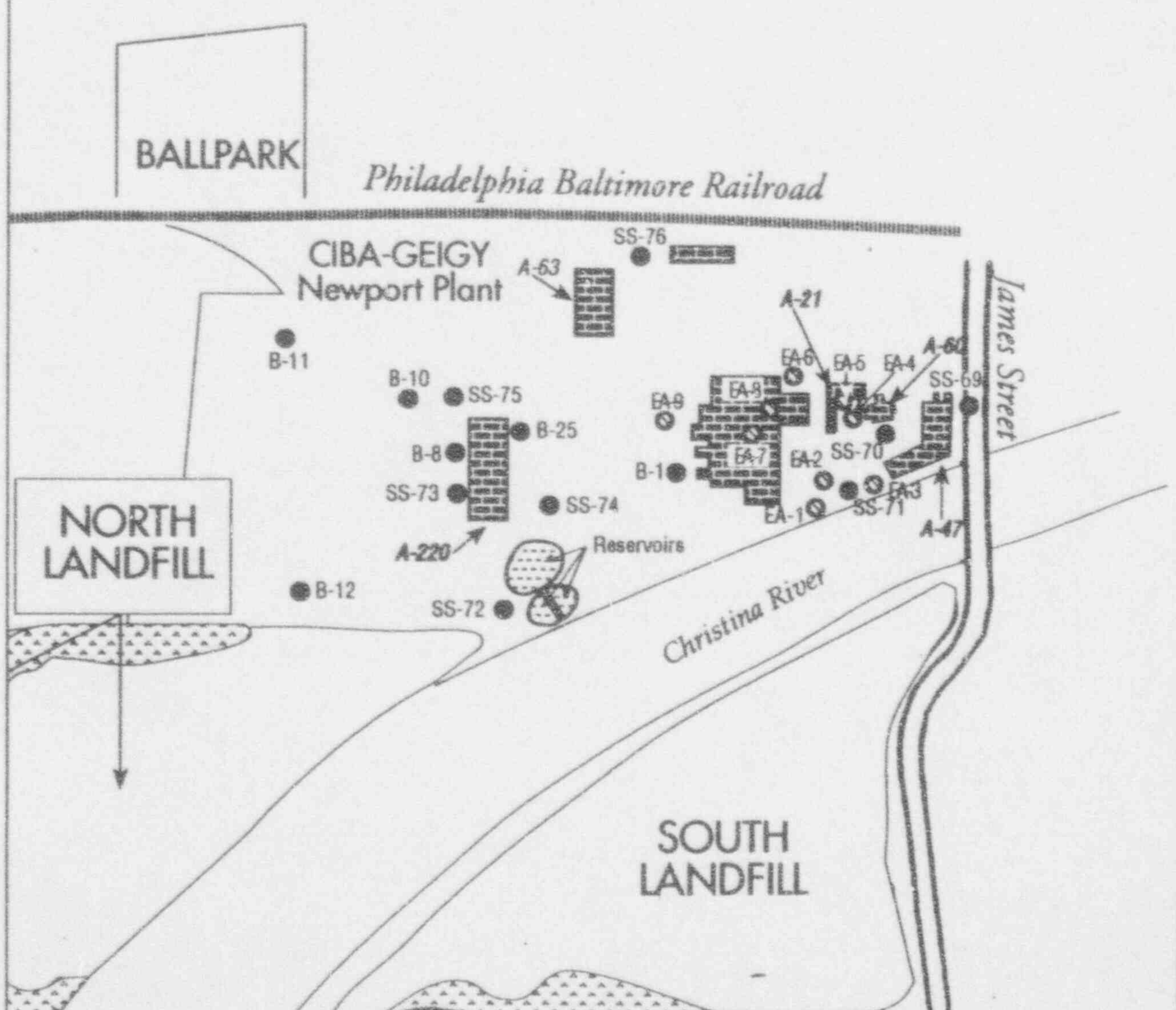
TOTAL METALS	[ppB]
Aluminum	388.0
Cadmuim	151.0
Iron	21,000.0
Lead	13.9
Zinc	64,700.0
GWS-9++	
VOCs**	
Total 1,2-Dichloro-ethene	440.0
Carbon Tetrachloride	310.0
Chlorobenzene	340.0
Tetrachoroethene	3,200.0

COMPOSITE 1 — GWS 2,3,4

TOTAL METALS	[ppB]
Aluminum	377.0
Cadmuin	124.0
Copper	79.6
Lead	17.1
Zinc	22,000.0
GWS-2++	
VOCs**	
Tetrachloroethene	100.0
Trichloroethene	21.0

*Only contaminants with data that exceeds the Ambient Water Quality Criteria are listed.
**VOCs = Volatile Organic Compounds
++One of the seeps constituting the composite.

FIGURE 18
Lead Data for Surficial Soil Samples at the CIBA-GEIGY Newport Plant



SAMPLE LOCATION	TOTAL LEAD (ppm)
SS-69	100
SS-70	30
SS-71	150
SS-72	1,400
SS-73	150
SS-74	1200
SS-75	20
SS-76	830
B-1	39
B-8	127,000
B-10	67,700
B-11	414
B-12	414
B-25	19,800
EA-1	143
EA-2	322
EA-3	43
EA-4	71
EA-5	No Data
EA-6	528
EA-7	21
EA-8	17
EA-9	679

KEY

Buildings

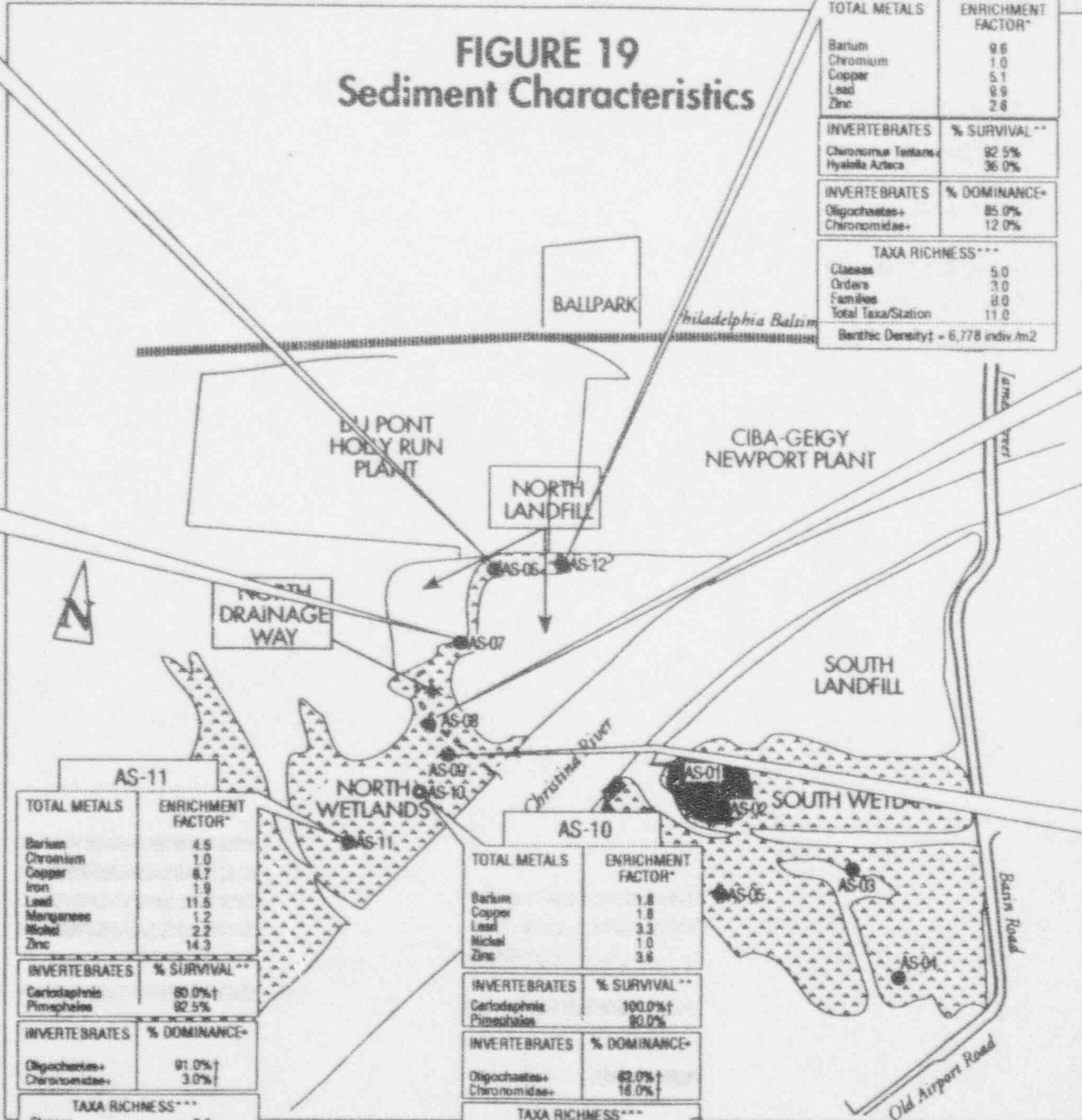
Non-validated Soil Sample Locations and Data

Samples taken by Du Pont and shown in Fig. 64 of the RI

Non-validated Soil Sample Locations and Data (Fig. 64A in the RI)

ppm = parts per million

FIGURE 19
Sediment Characteristics



AS-06

TOTAL METALS	ENRICHMENT FACTOR*
Barium	4.7
Chromium	2.1
Copper	12.6
Lead	9.5
Manganese	1.8
Mercury	1.7
Nickel	1.8
Zinc	4.3

INVERTEBRATES	% SURVIVAL**
Chironomus Tentans+	82.5%
Hyalella Azteca	70.0%

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	84.0%
Chironomidae+	16.0%

TAXA RICHNESS***	
Classes	3.0
Orders	2.0
Families	7.0
Total Taxa/Station	11.0

Benthic Density‡ = 17,200 indiv./m²

AS-07

TOTAL METALS	ENRICHMENT FACTOR*
Arsenic	11.0
Barium	35.4
Cadmium	33.3
Chromium	5.7
Copper	115
Iron	1.1
Lead	858.7
Manganese	4.2
Mercury	32.0
Nickel	3.2
Zinc	75.8

INVERTEBRATES	% SURVIVAL**
Chironomus Tentans+	40.0%
Hyalella Azteca	0.0%

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	26.0%
Chironomidae+	57.0%

TAXA RICHNESS***	
Classes	4.0
Orders	4.0
Families	8.0
Total Taxa/Station	13.0

Benthic Density‡ = 329 indiv./m²

AS-12

TOTAL METALS	ENRICHMENT FACTOR*
Barium	9.6
Chromium	1.0
Copper	5.1
Lead	9.9
Zinc	2.6

INVERTEBRATES	% SURVIVAL**
Chironomus Tentans+	92.5%
Hyalella Azteca	36.0%

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	85.0%
Chironomidae+	12.0%

TAXA RICHNESS***	
Classes	5.0
Orders	3.0
Families	8.0
Total Taxa/Station	11.0

Benthic Density‡ = 6,778 indiv./m2

AS-08

TOTAL METALS	ENRICHMENT FACTOR*
Barium	14.7
Chromium	5.1
Copper	26.1
Iron	1.0
Lead	148.3
Manganese	1.8
Mercury	4.5
Nickel	1.4
Zinc	15.0

INVERTEBRATES	% SURVIVAL**
Chironomus Tentans+	17.5%
Hyalella Azteca	2.5%

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	27.0%
Chironomidae+	30.0%

TAXA RICHNESS***	
Classes	4.0
Orders	3.0
Families	3.0
Total Taxa/Station	5.0

Benthic Density‡ = 433 indiv./m²

AS-11

TOTAL METALS	ENRICHMENT FACTOR*
Barium	4.5
Chromium	1.0
Copper	6.7
Iron	1.9
Lead	11.5
Manganese	1.2
Nickel	2.2
Zinc	14.3

INVERTEBRATES	% SURVIVAL**
Ceriodaphnia	80.0%†
Pimephales	92.5%

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	91.0%†
Chironomidae+	3.0%†

TAXA RICHNESS***	
Classes	8.0
Orders	7.0
Families	10.0
Total Taxa/Station	27.0

Benthic Density‡ = 14,789 indiv./m²

† Phase II Data

AS-10

TOTAL METALS	ENRICHMENT FACTOR*
Barium	1.8
Copper	1.8
Lead	3.3
Nickel	1.0
Zinc	3.6

INVERTEBRATES	% SURVIVAL**
Ceriodaphnia	100.0%†
Pimephales	90.0%

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	82.0%†
Chironomidae+	16.0%†

TAXA RICHNESS***	
Classes	5.0
Orders	3.0
Families	5.0
Total Taxa/Station	19.0

Benthic Density‡ = 5,864 indiv./m²

AS-09

TOTAL METALS	ENRICHMENT FACTOR*
Barium	8.2
Cadmium	15.7
Chromium	4.7
Copper	20.0
Iron	1.9
Lead	105.9
Manganese	2.7
Mercury	3.1
Nickel	1.6
Zinc	16.6

INVERTEBRATES	% SURVIVAL**
Chironomus Tentans+	42.5%
Hyalella Azteca	68.8%

INVERTEBRATES	% DOMINANCE+
Chironomidae+	20.0%

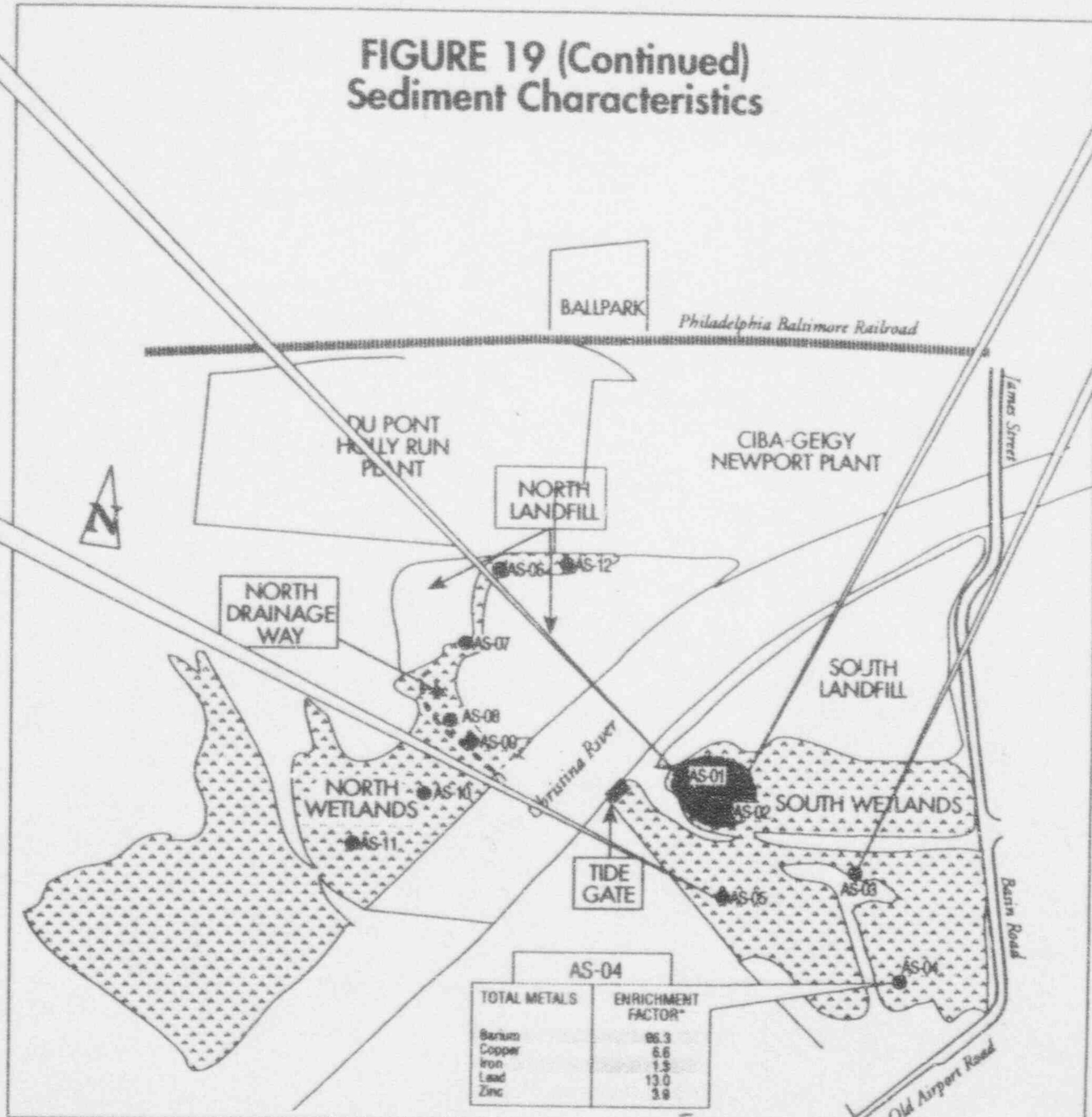
TAXA RICHNESS***	
Classes	3.0
Orders	2.0
Families	1.0
Total Taxa/Station	4.0

Benthic Density‡ = 71 indiv./m²

NOTES

*, **, ***, +, ‡ See notes on page 2 of this Figure

FIGURE 19 (Continued)
Sediment Characteristics



AS-01

TOTAL METALS	ENRICHMENT FACTOR*
Barium	62.8
Cadmium	21.7
Copper	5.9
Lead	20.6
Nickel	1.1
Zinc	18.4

INVERTEBRATES	% SURVIVAL**
Cariodaphnia	80.0%†
Pimephales	90.0%

INVERTEBRATES	% DOMINANCE•
Oligochaetes+	30.0%†
Chironomidae+	47.0%†

TAXA RICHNESS***	
Classes	3.0
Orders	6.0
Families	9.0
Total Taxa/Station	20.0

Benthic Density‡ = 22,245 Indiv./m²

† Phase II Data

AS-05

TOTAL METALS	ENRICHMENT FACTOR*
Barium	103.4
Cadmium	14.1
Copper	6.3
Iron	1.8
Lead	9.0
Manganese	1.1
Nickel	1.4
Zinc	11.2

INVERTEBRATES	% SURVIVAL**
Chironomus Tentans+	75.0%
Hyalella Azteca	57.5%

TAXA RICHNESS***	
Classes	4.0
Orders	4.0
Families	10.0
Total Taxa/Station	13.0

Benthic Density‡ = 9,110 Indiv./m²

Taxa Richness and Benthic Density for AS-06 are based on two replicate grab samples, whereas all other Taxa Richness and Benthic Density data for these figures is based on three replicate grab samples.

AS-04

TOTAL METALS	ENRICHMENT FACTOR*
Barium	86.3
Copper	6.6
Iron	1.3
Lead	13.0
Zinc	3.9

AS-02

TOTAL METALS	ENRICHMENT FACTOR*
Barium	36.1
Cadmium	10.5
Copper	6.2
Lead	26.6
Nickel	1.0
Zinc	11.3

AS-03

TOTAL METALS	ENRICHMENT FACTOR*
Barium	165.1
Cadmium	15.1
Copper	26.8
Iron	1.5
Lead	84.3
Manganese	1.8
Mercury	1.6
Nickel	1.2
Zinc	38.1

INVERTEBRATES	% SURVIVAL**
Cariodaphnia	80.0%†
Pimephales	85.0%
Chironomus Tentans+	82.5%
Hyalella Azteca	15.0%

INVERTEBRATES	% DOMINANCE•
Oligochaetes+	35.0%†
Chironomidae+	57.0%†

TAXA RICHNESS***	
Classes	4.0
Orders	3.0
Families	6.0
Total Taxa/Station	13.0

Benthic Density‡ = 1,791 Indiv./m²

† Phase II Data

NOTES

* Enrichment Factor: the ratio of normalized contaminant concentrations onsite to concentrations at a reference location. It should be noted that RS-15 was used as the reference station.

** % Survival: based on the number of individuals that survived continual exposure to Christina River and North and South Disposal site wetland sediments. Based on four replicate grab samples.

*** Taxa Richness: total number of species found in the sample.

• % Dominance: percent contribution of individuals of the most numerous species in the sample.

\+ Pollution-tolerant organisms.

‡ Benthic Density: total number of individuals collected per sampling station based on a mean number of 3 replicate grab samples.

FIGURE 20
River Sampling Data

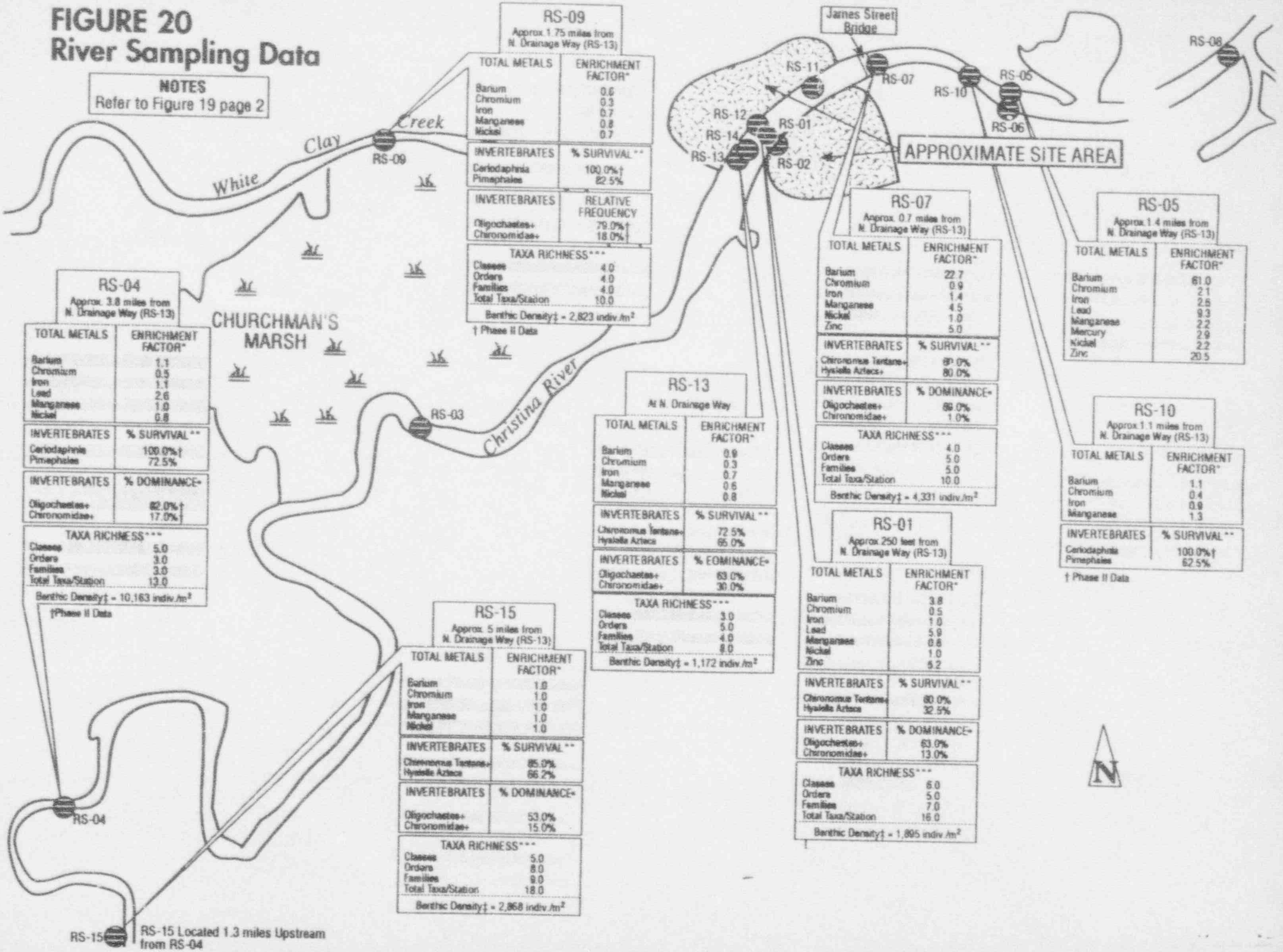
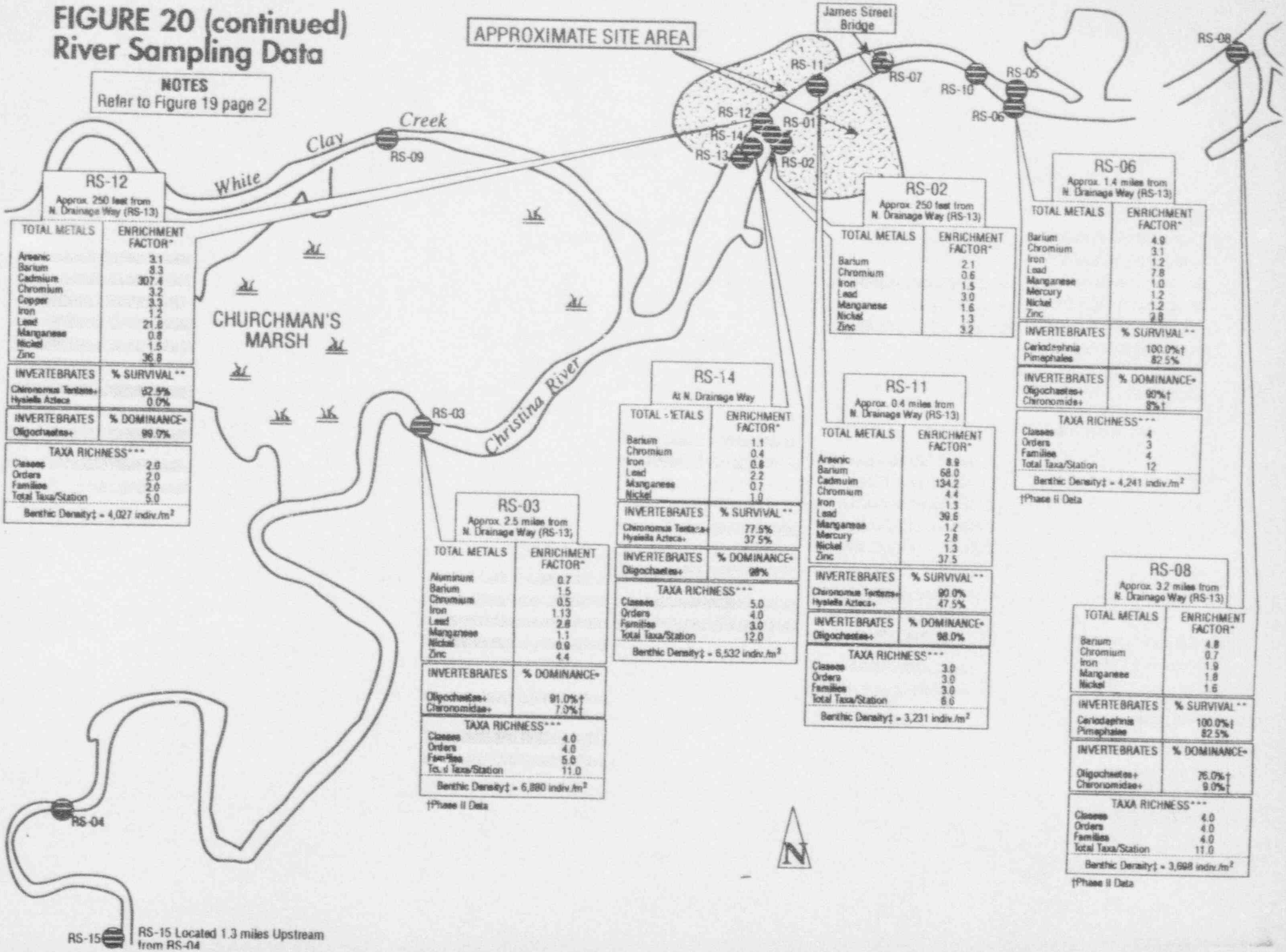


FIGURE 20 (continued)
River Sampling Data

NOTES
Refer to Figure 19 page 2



RS-12
Approx. 250 feet from N. Drainage Way (RS-13)

TOTAL METALS	ENRICHMENT FACTOR*
Arsenic	3.1
Barium	8.3
Cadmium	307.4
Chromium	3.2
Copper	3.3
Iron	1.2
Lead	21.8
Manganese	0.8
Nickel	1.5
Zinc	36.8

INVERTEBRATES	% SURVIVAL**
Chironomus Tentans+	82.5%
Hyalella Azteca	0.0%

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	99.0%

TAXA RICHNESS***	
Classes	2.0
Orders	2.0
Families	2.0
Total Taxa/Station	5.0

Benthic Density‡ = 4,027 indiv./m²

RS-03
Approx. 2.5 miles from N. Drainage Way (RS-13)

TOTAL METALS	ENRICHMENT FACTOR*
Aluminum	0.7
Barium	1.5
Chromium	0.5
Iron	1.13
Lead	2.8
Manganese	1.1
Nickel	0.9
Zinc	4.4

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	91.0%†
Chironomidae+	7.0%†

TAXA RICHNESS***	
Classes	4.0
Orders	4.0
Families	5.0
Total Taxa/Station	11.0

Benthic Density‡ = 6,880 indiv./m²

†Phase II Data

RS-14
At N. Drainage Way

TOTAL METALS	ENRICHMENT FACTOR*
Barium	1.1
Chromium	0.4
Iron	0.8
Lead	2.2
Manganese	0.7
Nickel	1.0

INVERTEBRATES	% SURVIVAL**
Chironomus Tentans+	77.5%
Hyalella Azteca+	37.5%

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	98%

TAXA RICHNESS***	
Classes	5.0
Orders	4.0
Families	3.0
Total Taxa/Station	12.0

Benthic Density‡ = 6,532 indiv./m²

RS-02
Approx. 250 feet from N. Drainage Way (RS-13)

TOTAL METALS	ENRICHMENT FACTOR*
Barium	2.1
Chromium	0.6
Iron	1.5
Lead	3.0
Manganese	1.6
Nickel	1.3
Zinc	3.2

RS-11
Approx. 0.4 miles from N. Drainage Way (RS-13)

TOTAL METALS	ENRICHMENT FACTOR*
Arsenic	8.9
Barium	68.0
Cadmuim	134.2
Chromium	4.4
Iron	1.3
Lead	39.6
Manganese	1.2
Mercury	2.8
Nickel	1.3
Zinc	37.5

INVERTEBRATES	% SURVIVAL**
Chironomus Tentans+	90.0%
Hyalella Azteca+	47.5%

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	98.0%

TAXA RICHNESS***	
Classes	3.0
Orders	3.0
Families	3.0
Total Taxa/Station	6.6

Benthic Density‡ = 3,231 indiv./m²

RS-06
Approx. 1.4 miles from N. Drainage Way (RS-13)

TOTAL METALS	ENRICHMENT FACTOR*
Barium	4.9
Chromium	3.1
Iron	1.2
Lead	7.8
Manganese	1.0
Mercury	1.2
Nickel	1.2
Zinc	2.8

INVERTEBRATES	% SURVIVAL**
Ceriodaphnia	100.0%†
Pimephales	82.5%

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	90%†
Chironomide+	8%†

TAXA RICHNESS***	
Classes	4
Orders	3
Families	4
Total Taxa/Station	12

Benthic Density‡ = 4,241 indiv./m²

†Phase II Data

RS-08
Approx. 3.2 miles from N. Drainage Way (RS-13)

TOTAL METALS	ENRICHMENT FACTOR*
Barium	4.8
Chromium	0.7
Iron	1.9
Manganese	1.8
Nickel	1.6

INVERTEBRATES	% SURVIVAL**
Ceriodaphnia	100.0%‡
Pimephales	82.5%

INVERTEBRATES	% DOMINANCE+
Oligochaetes+	76.0%†
Chironomidae+	9.0%†

TAXA RICHNESS***	
Classes	4.0
Orders	4.0
Families	4.0
Total Taxa/Station	11.0

Benthic Density‡ = 3,698 indiv./m²

†Phase II Data

FIGURE 21
Ecological Habitats

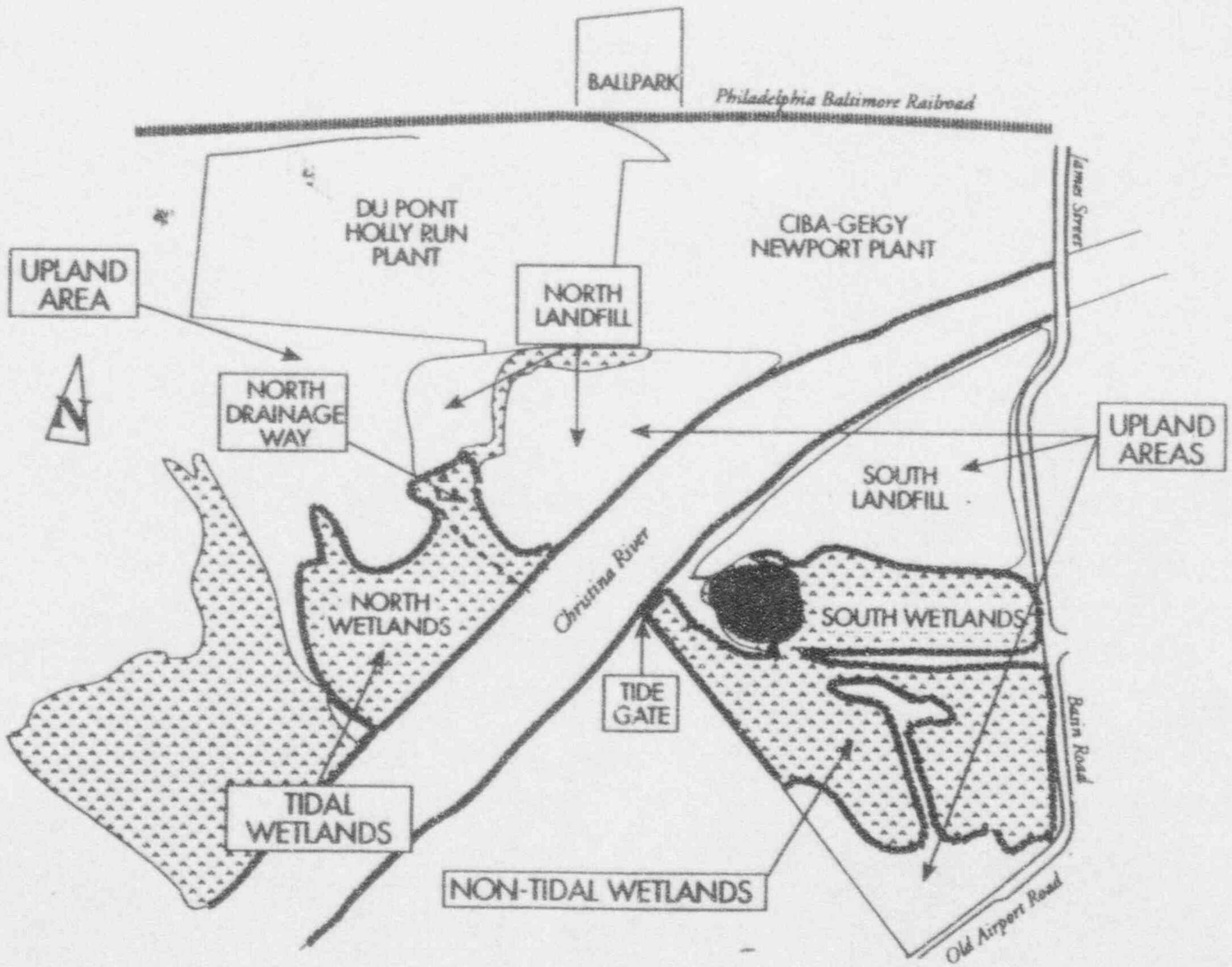


FIGURE 22
Estimated Wetland and River Areas Requiring Remediation

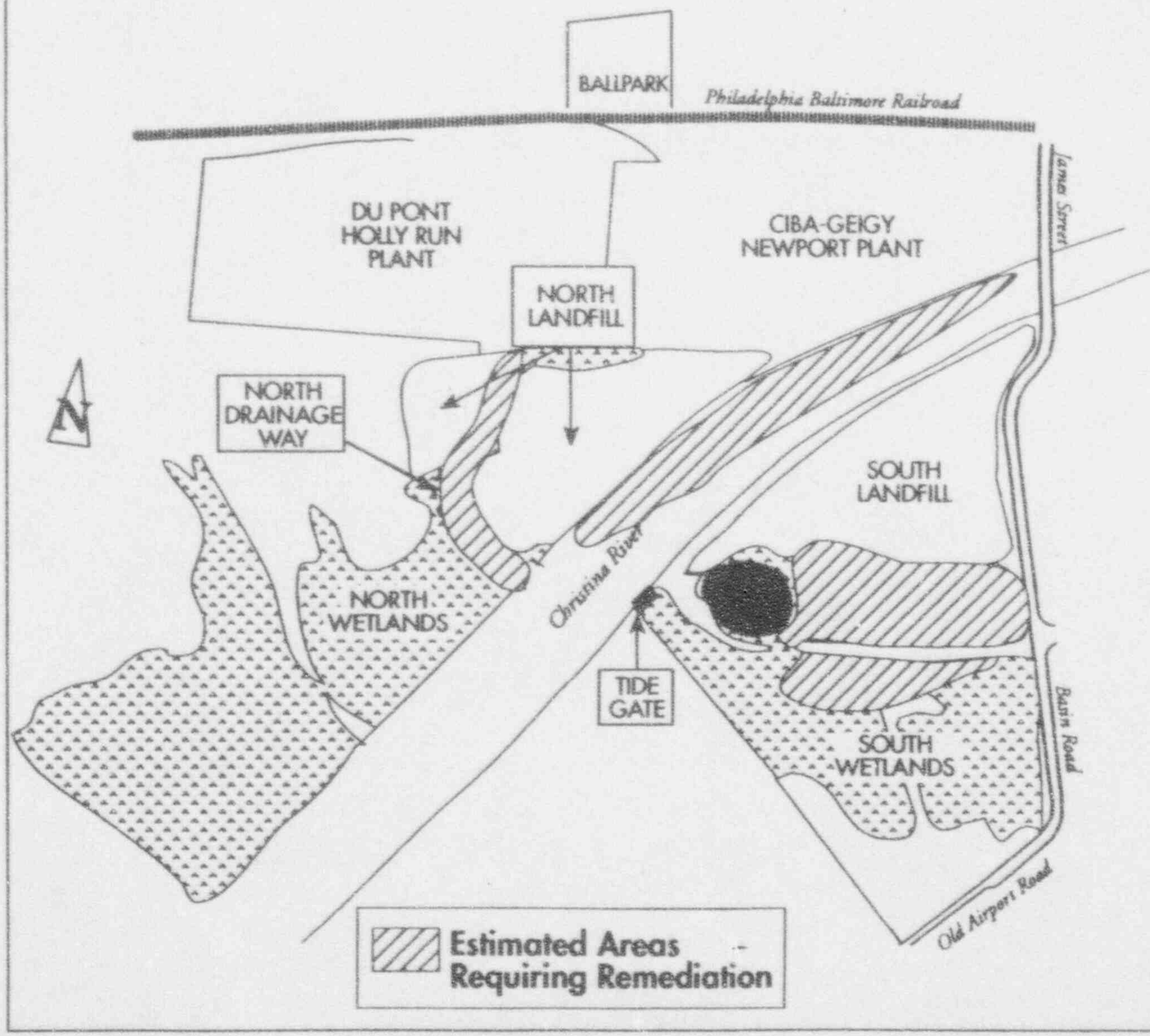


FIGURE 23
Site Area Requiring Sediment Sampling to Delineate Exact Areas for Remediation

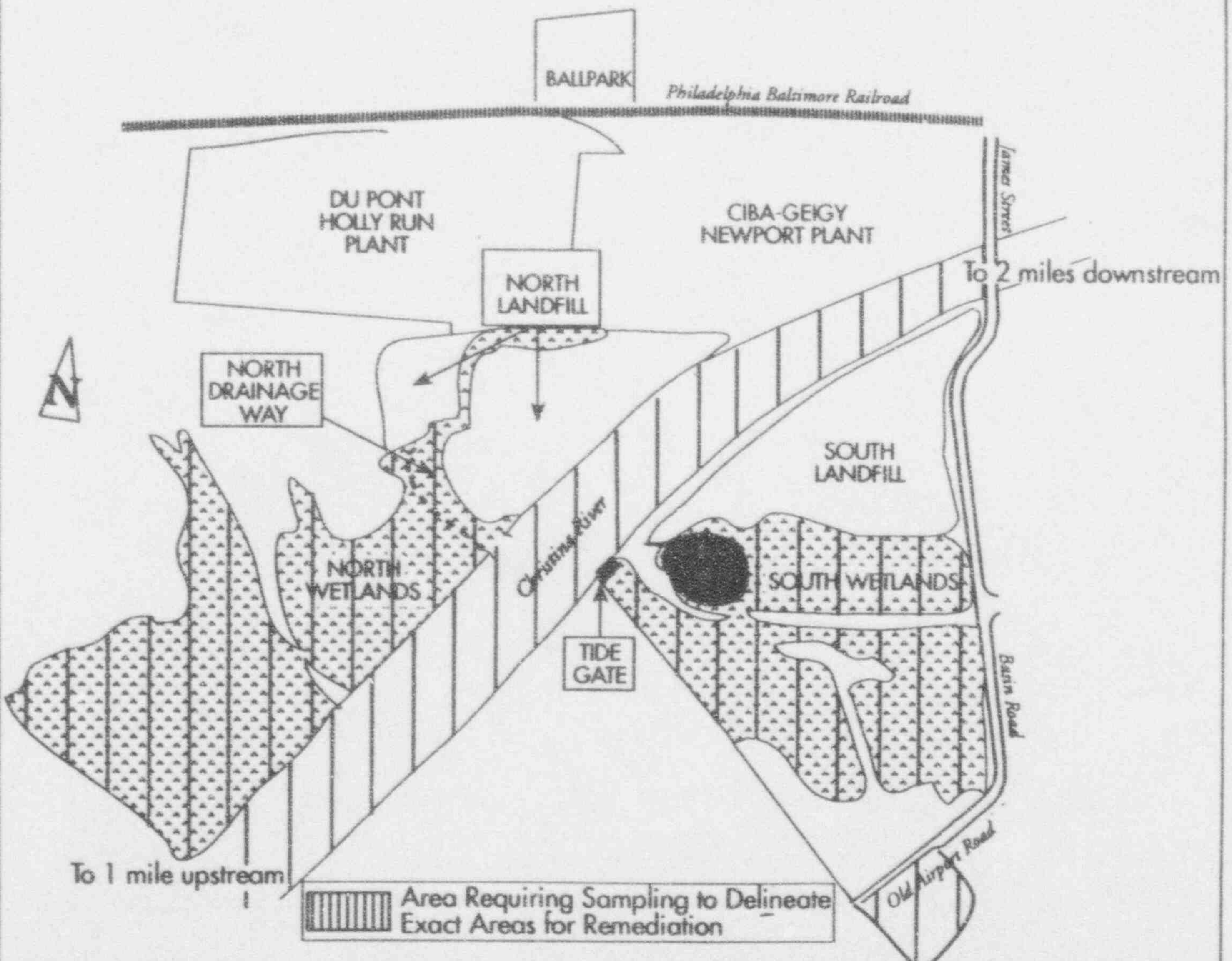


FIGURE 24
Ballpark

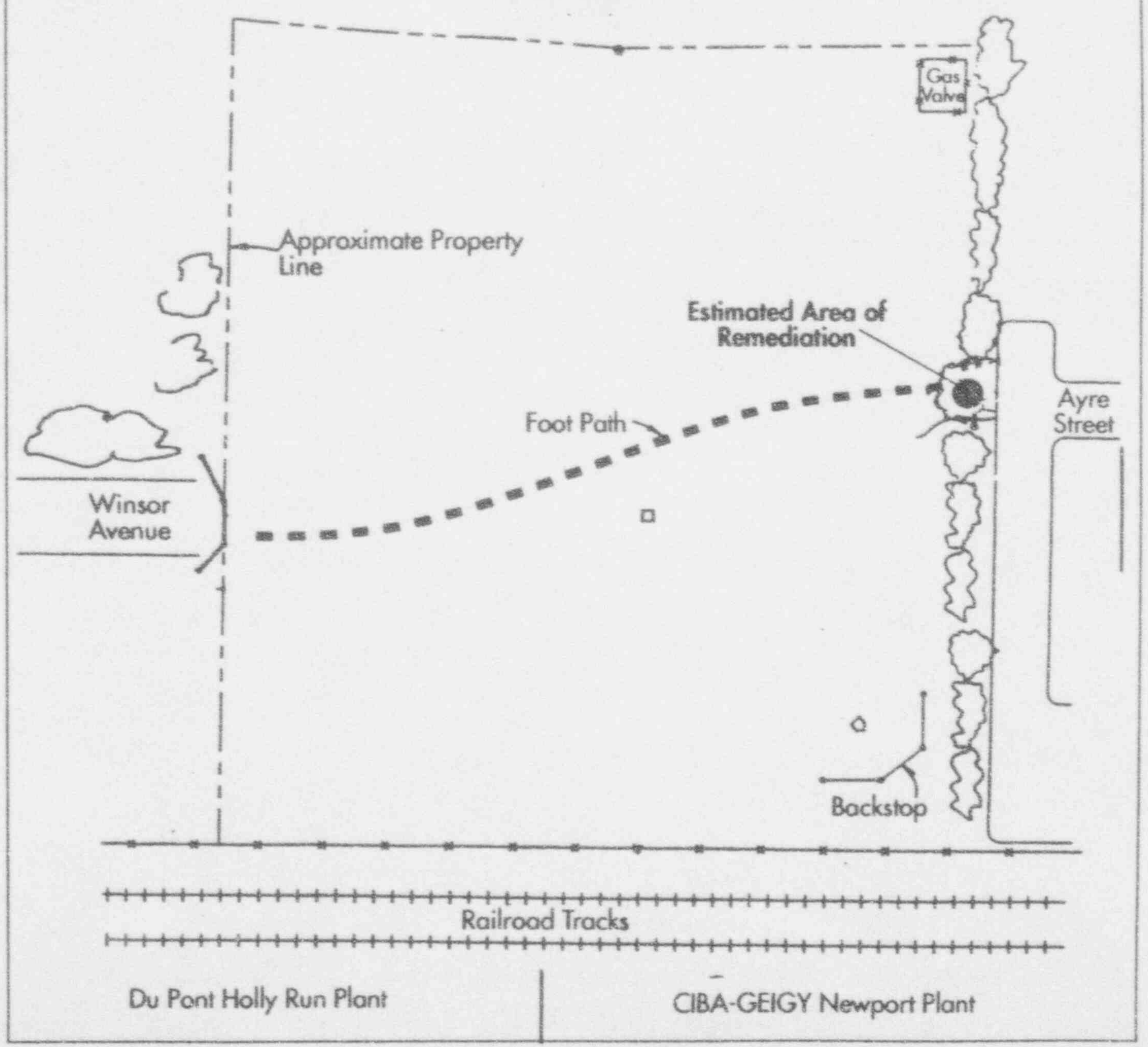


FIGURE 25
North Landfill Cap

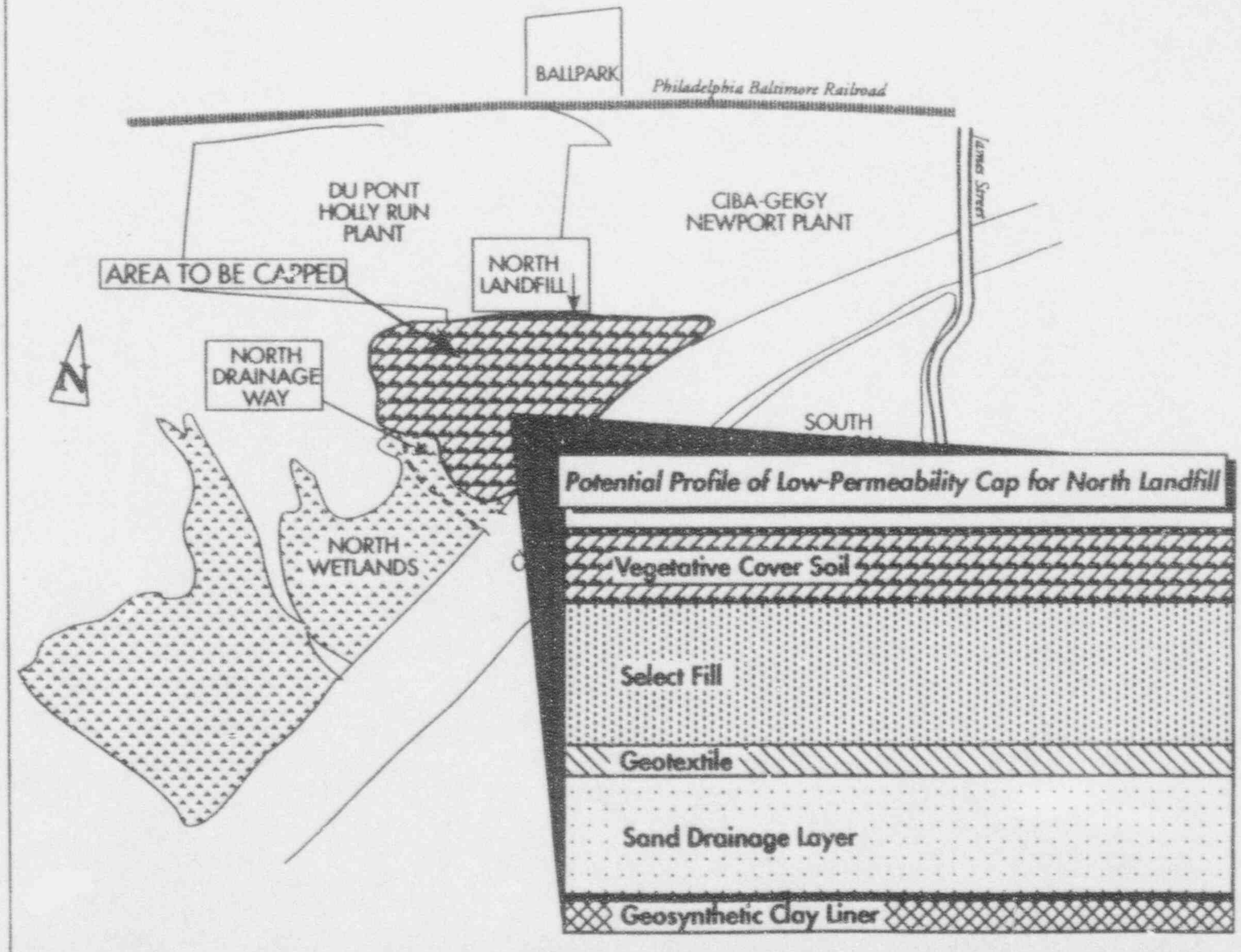
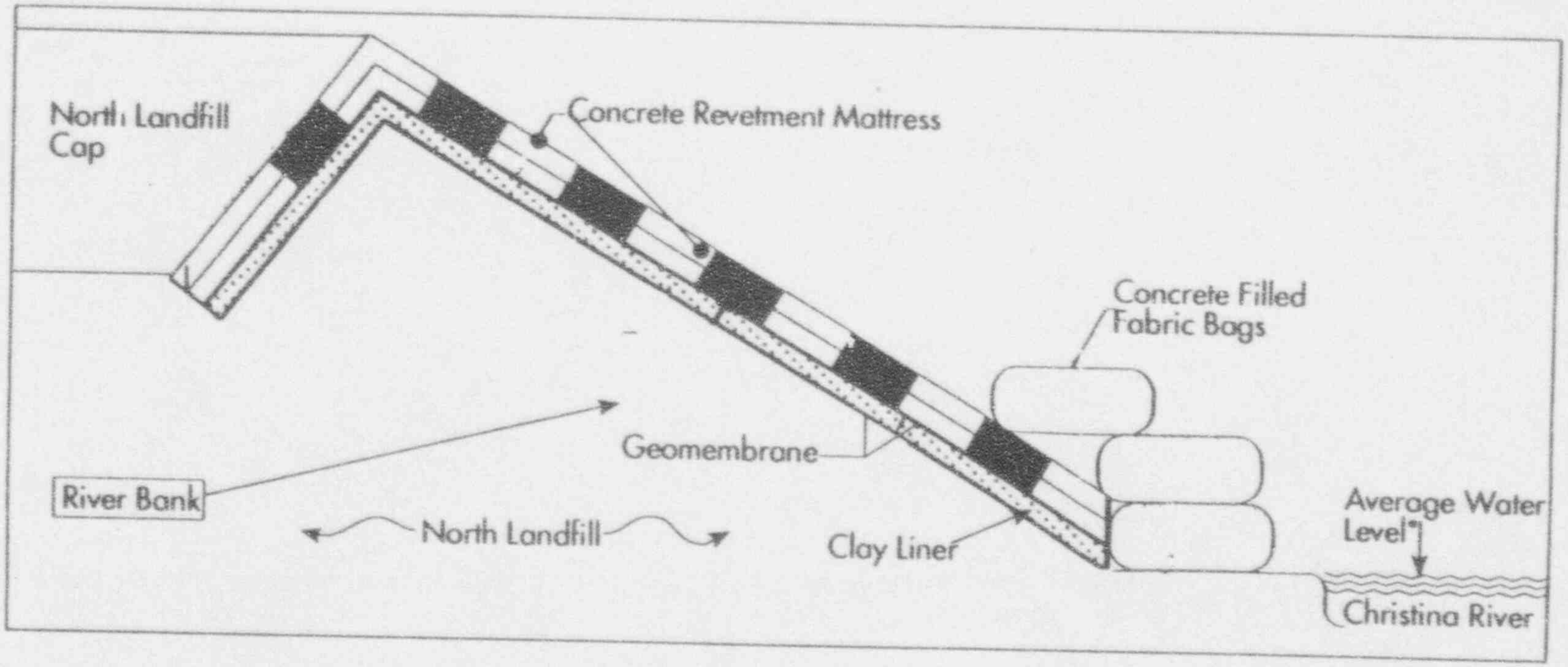
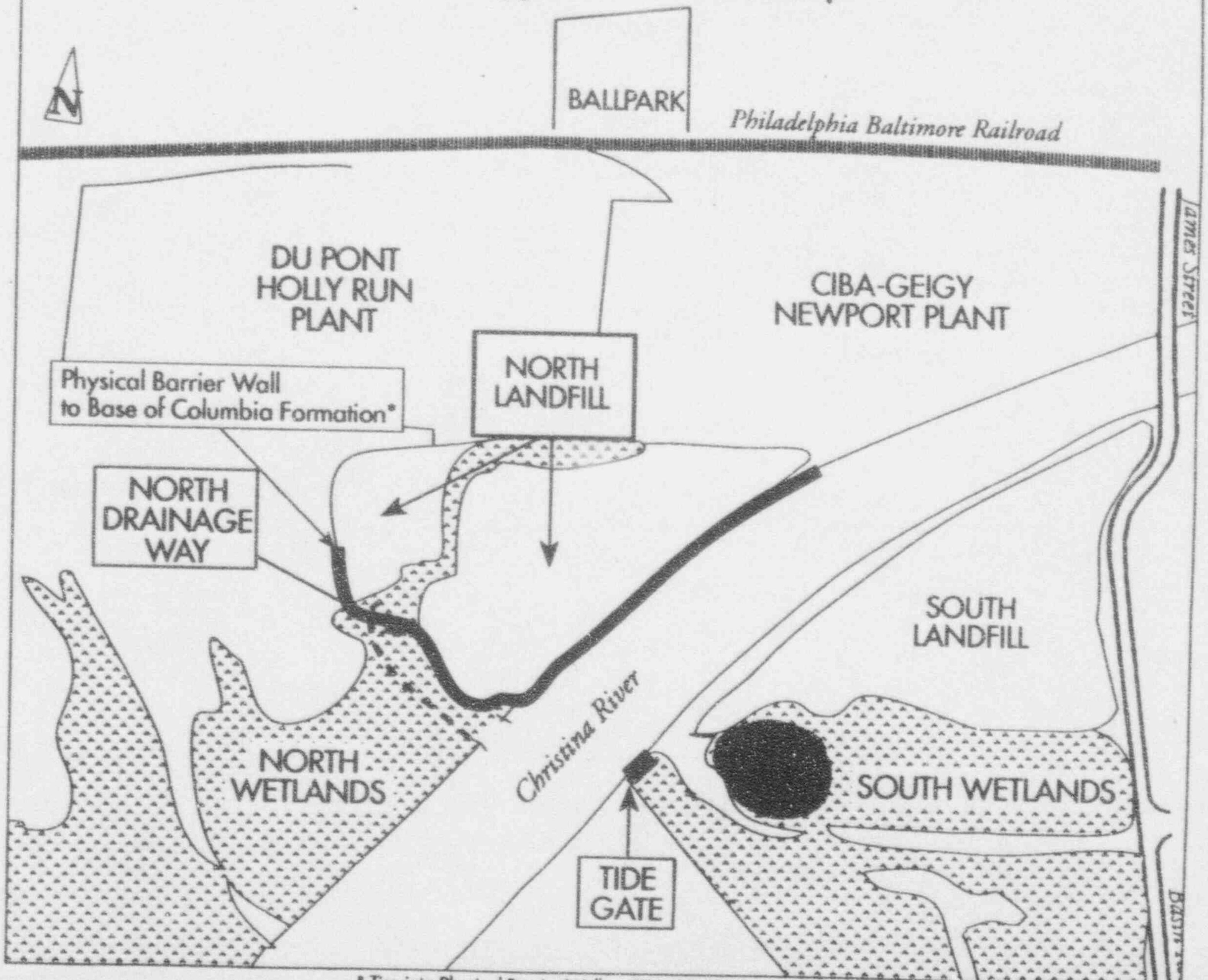


FIGURE 26
Potential Cross-Section of River Bank Cover System



* The average water level is based on a high tide elevation of 4.5 ft. and a low tide elevation of -1 ft.

FIGURE 27
North Landfill Physical Barrier Wall
(Approximate Location)



* Ties into Physical Barrier Wall at CIBA-GEIGY Pl

FIGURE 28
South Landfill Cap and Excavation Area

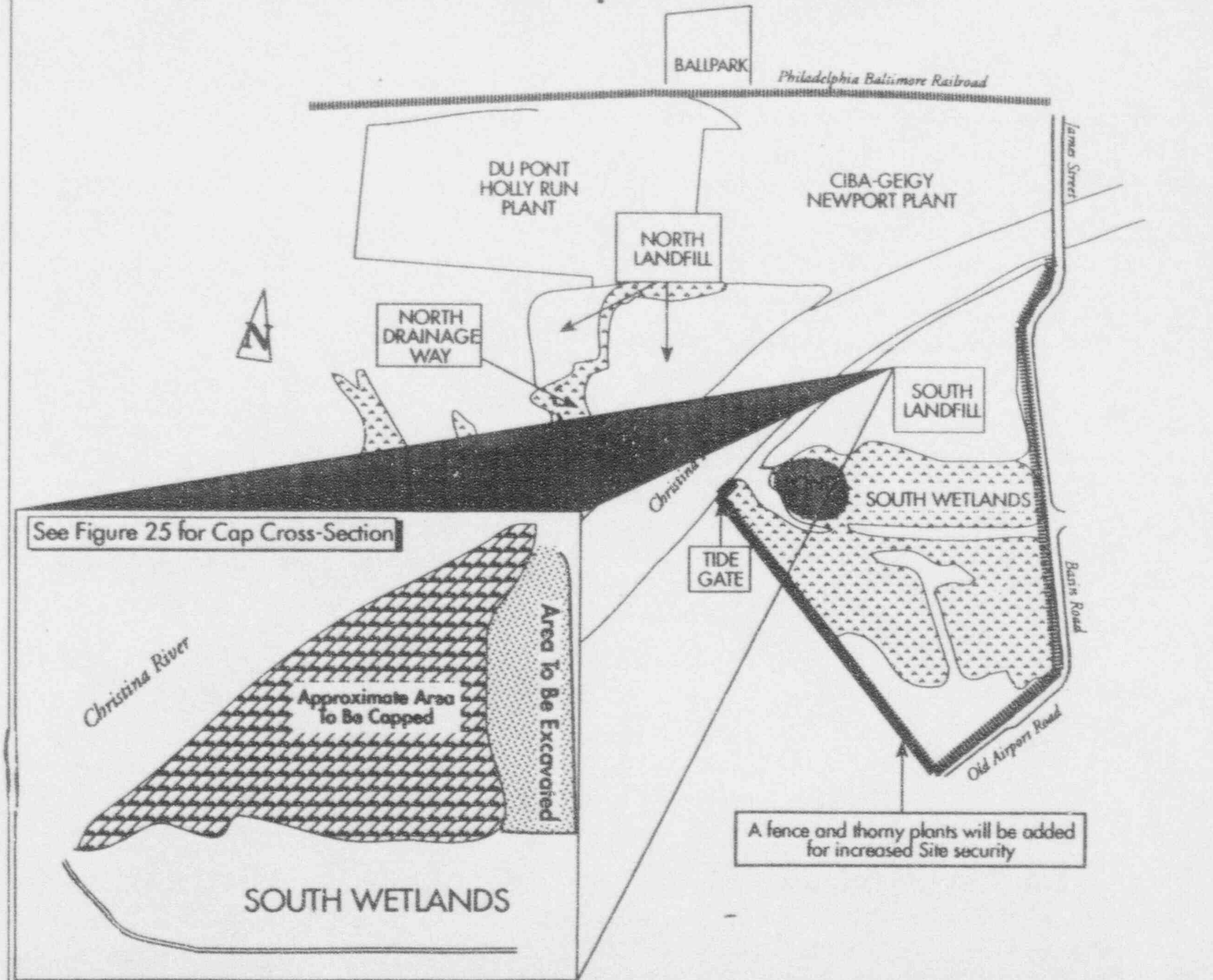


FIGURE 29
Estimated Sediment Removal in South Wetlands

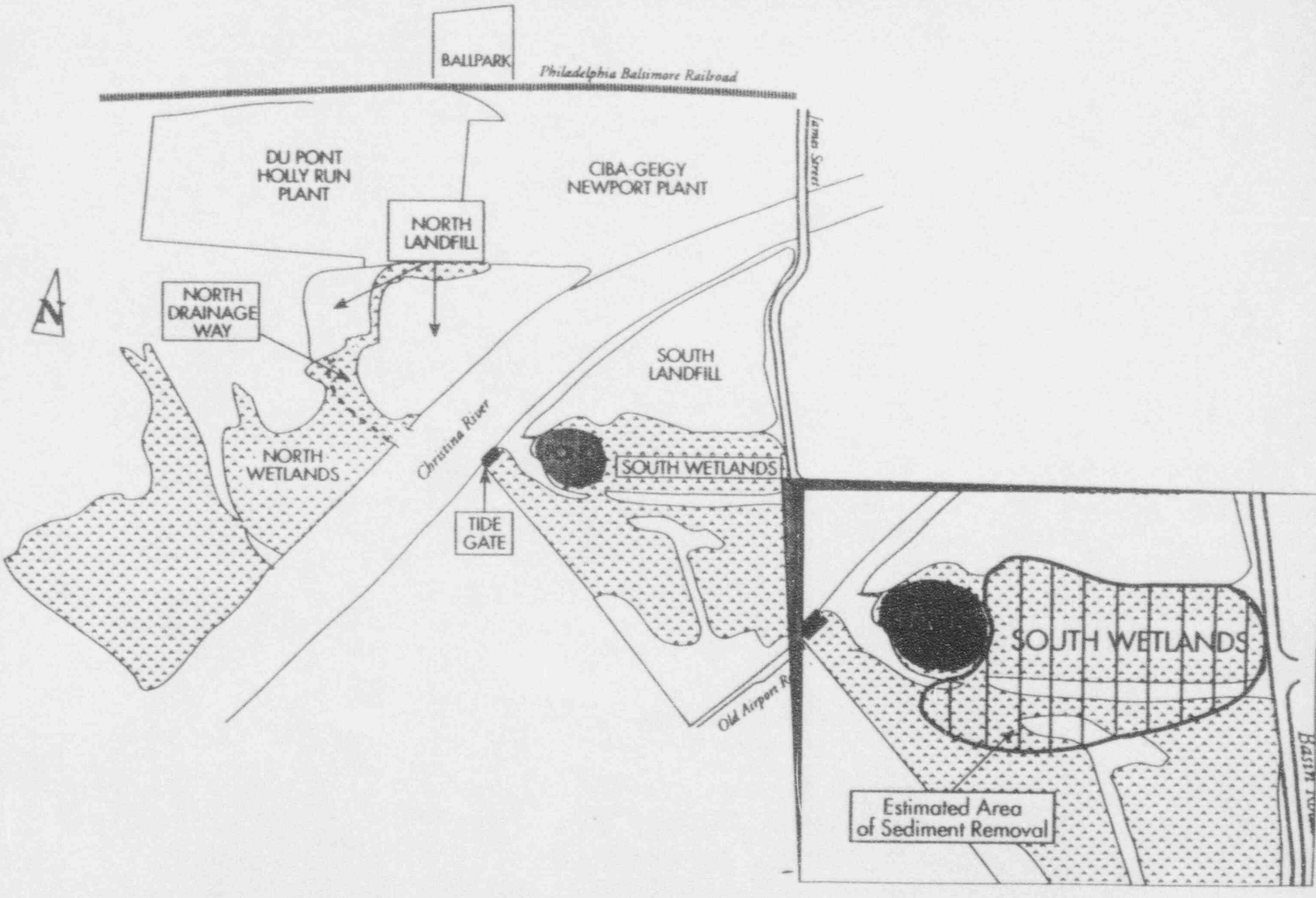


FIGURE 30
CIBA-GEIGY Newport Plant and Du Pont Holly Run Plant

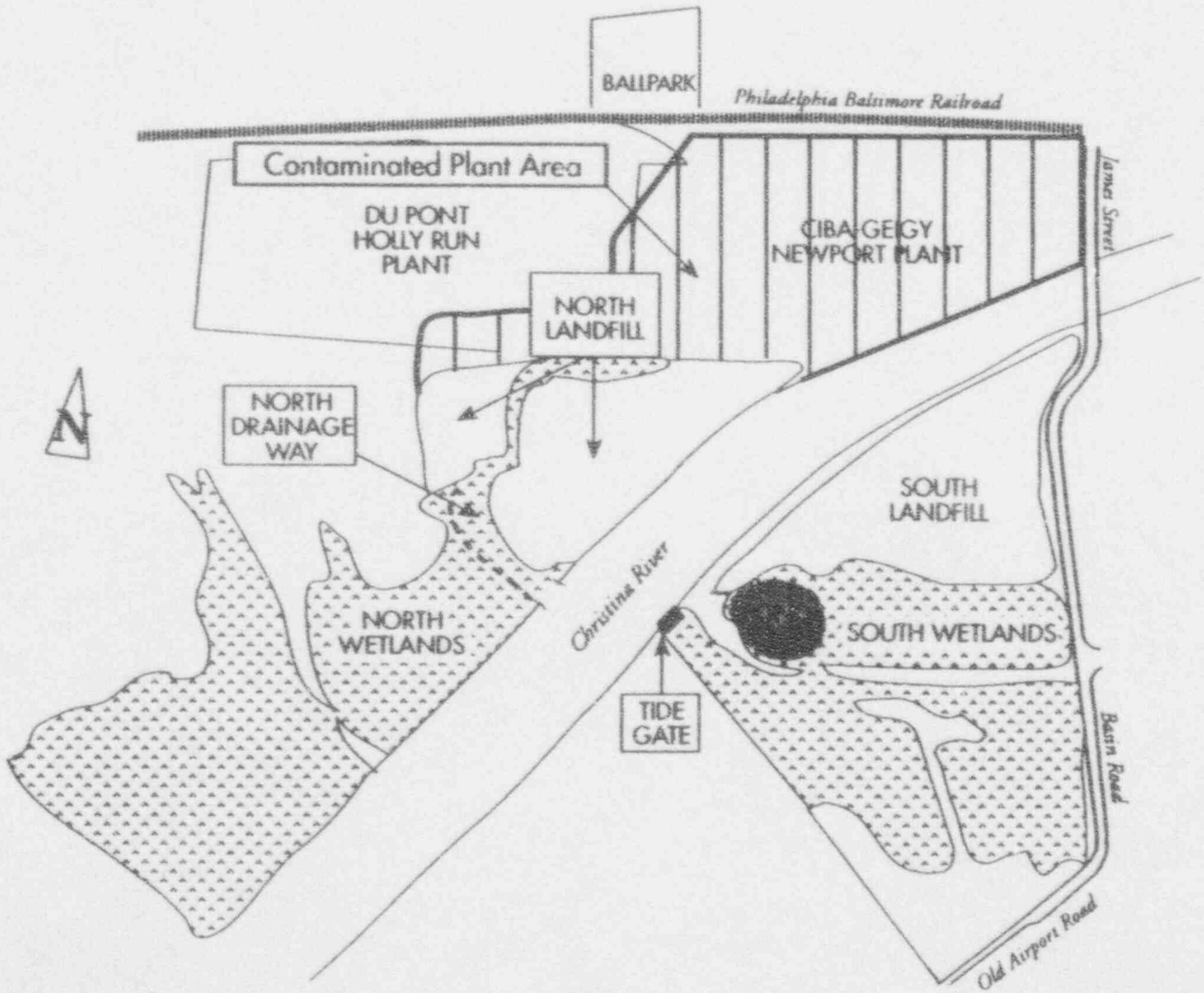


FIGURE 31
Estimated Area Requiring Ground Water Recovery (due to Circumscribing Wall)

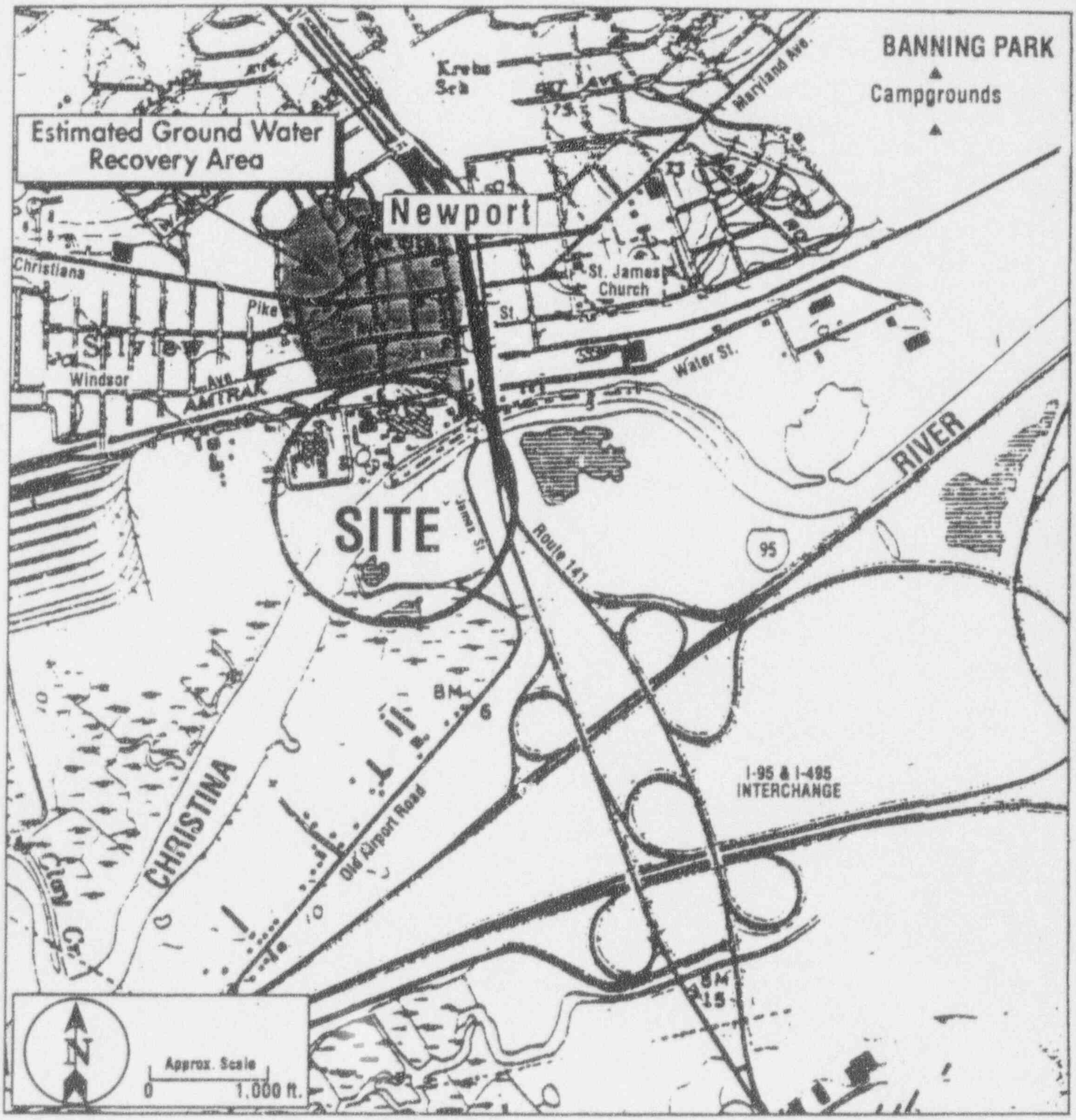


FIGURE 32
Points of Compliance

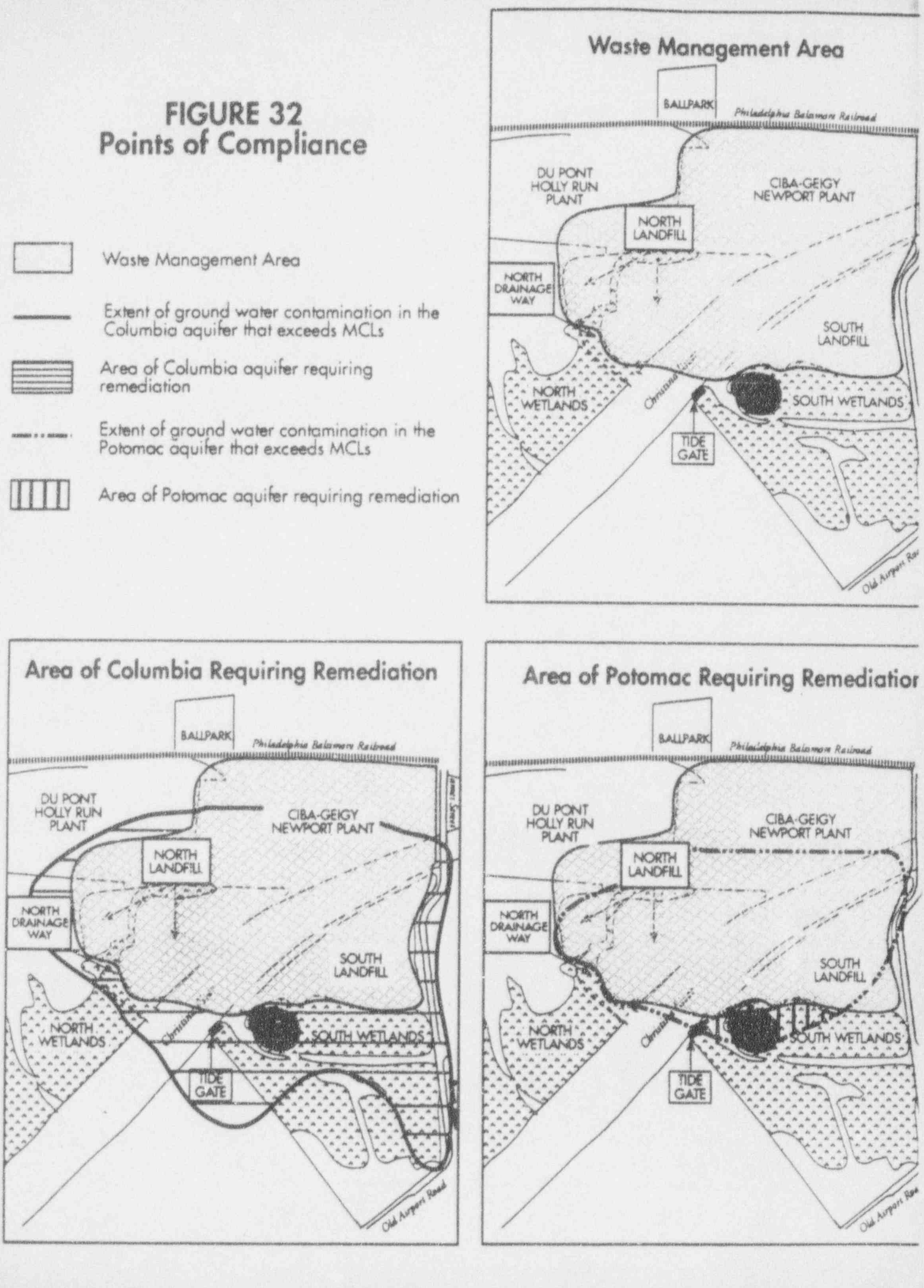


FIGURE 33
Approximate Area of Ground-Water Management Zone

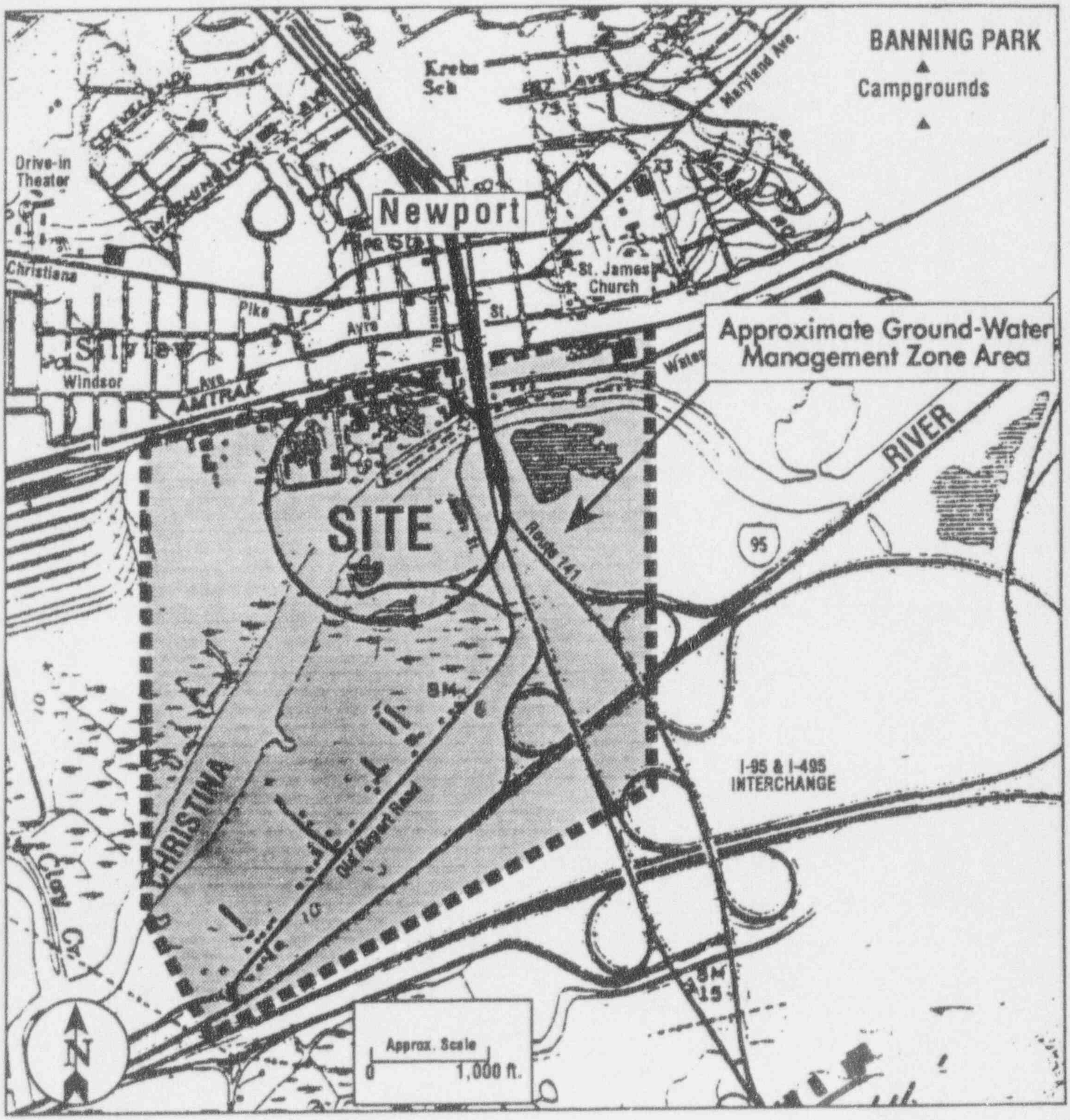


FIGURE 34
Estimated Well Locations for Remediating the Columbia Aquifer

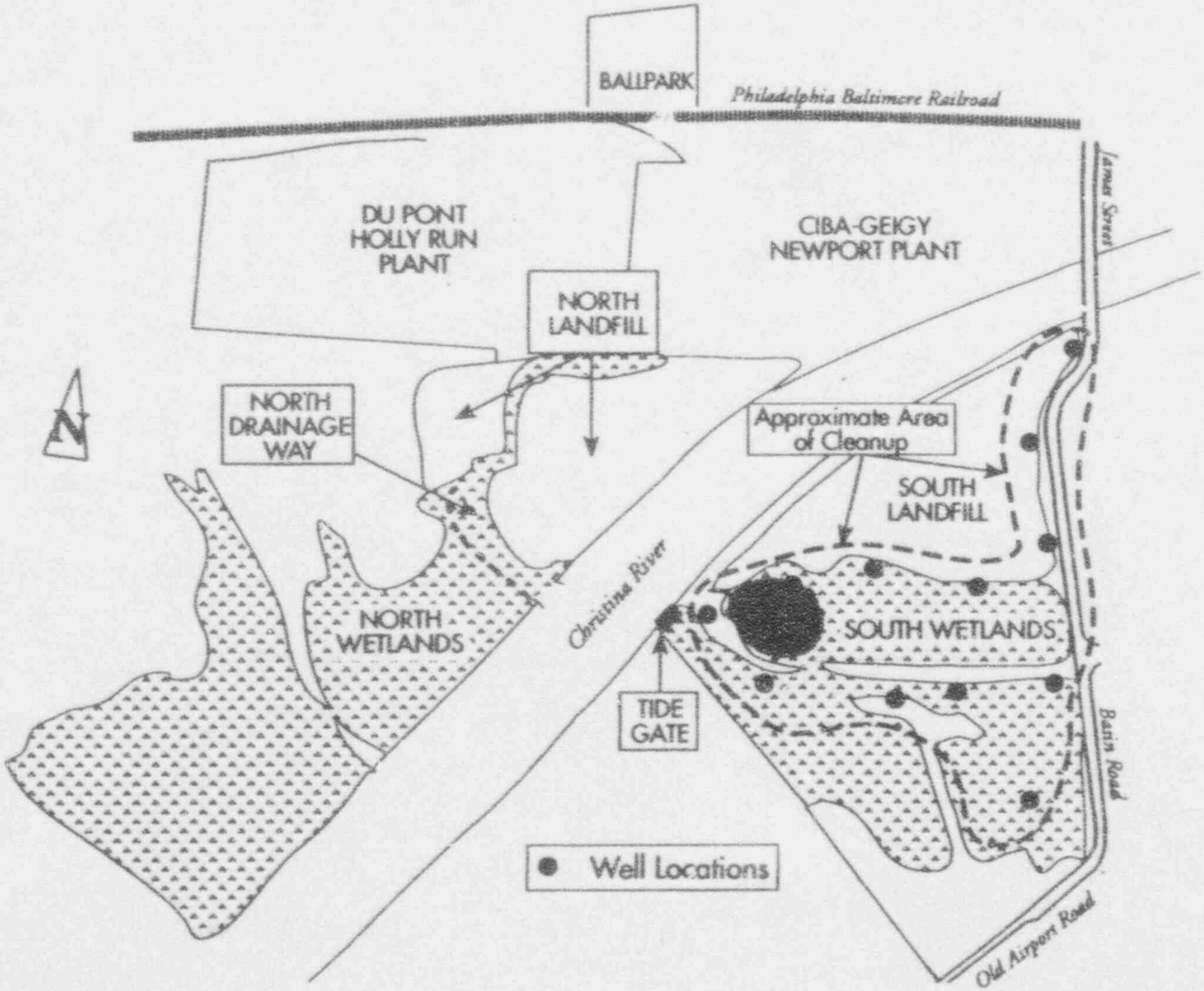


FIGURE 35
Estimated Well Locations: Potomac Hydraulic Barrier

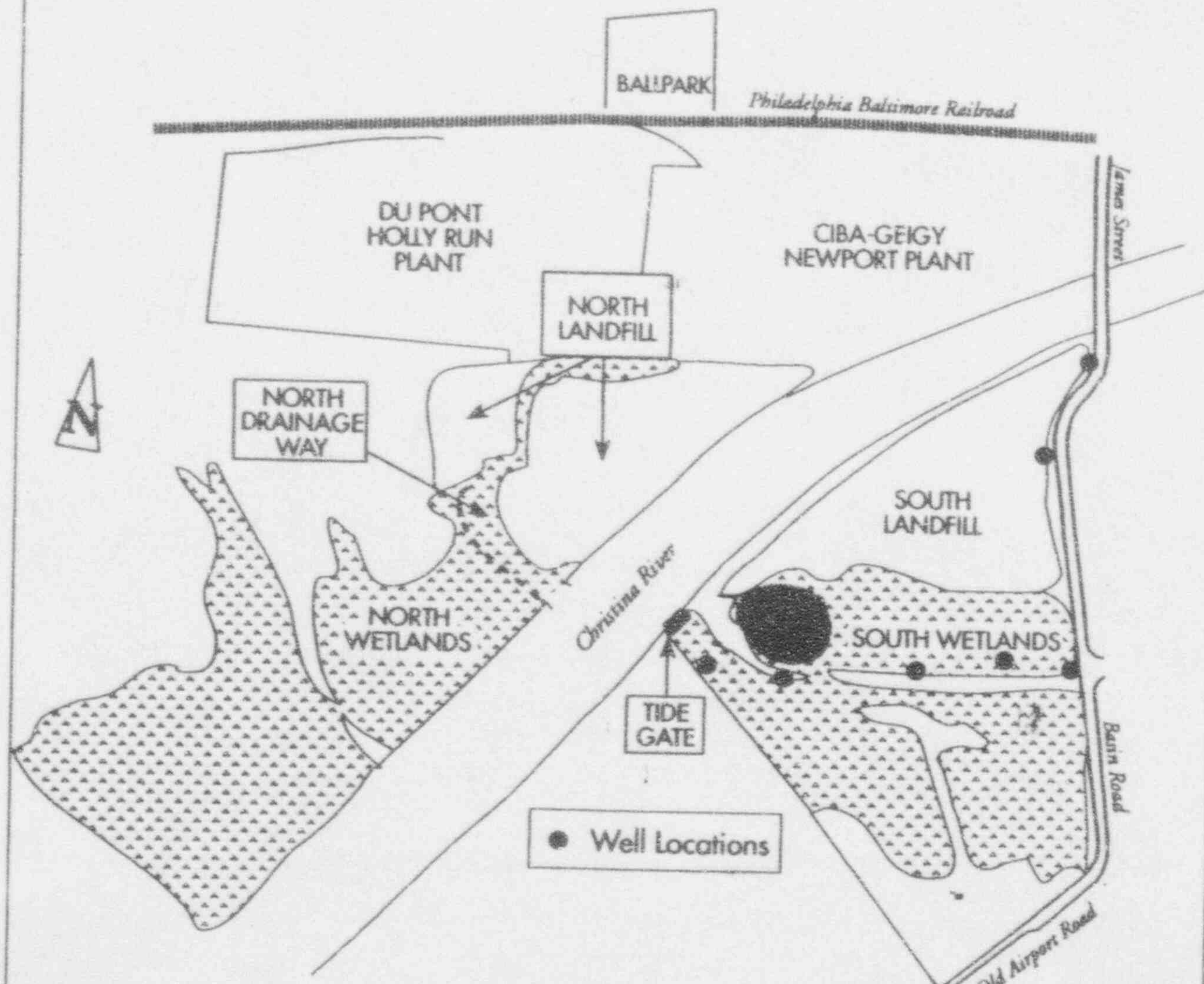


FIGURE 36
North Wetlands Area Requiring Sediment Sampling to Delineate Exact Areas for Remediation

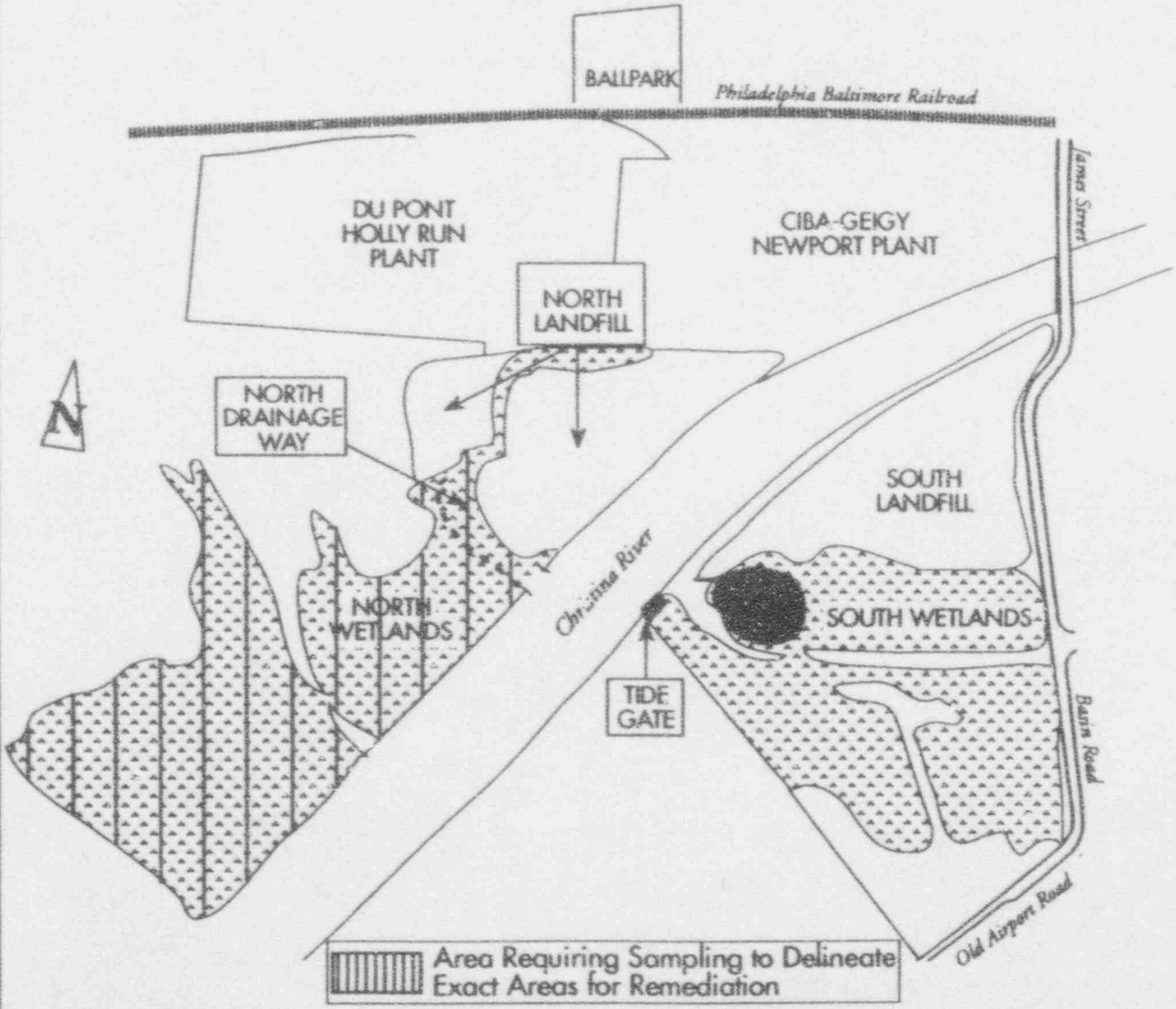
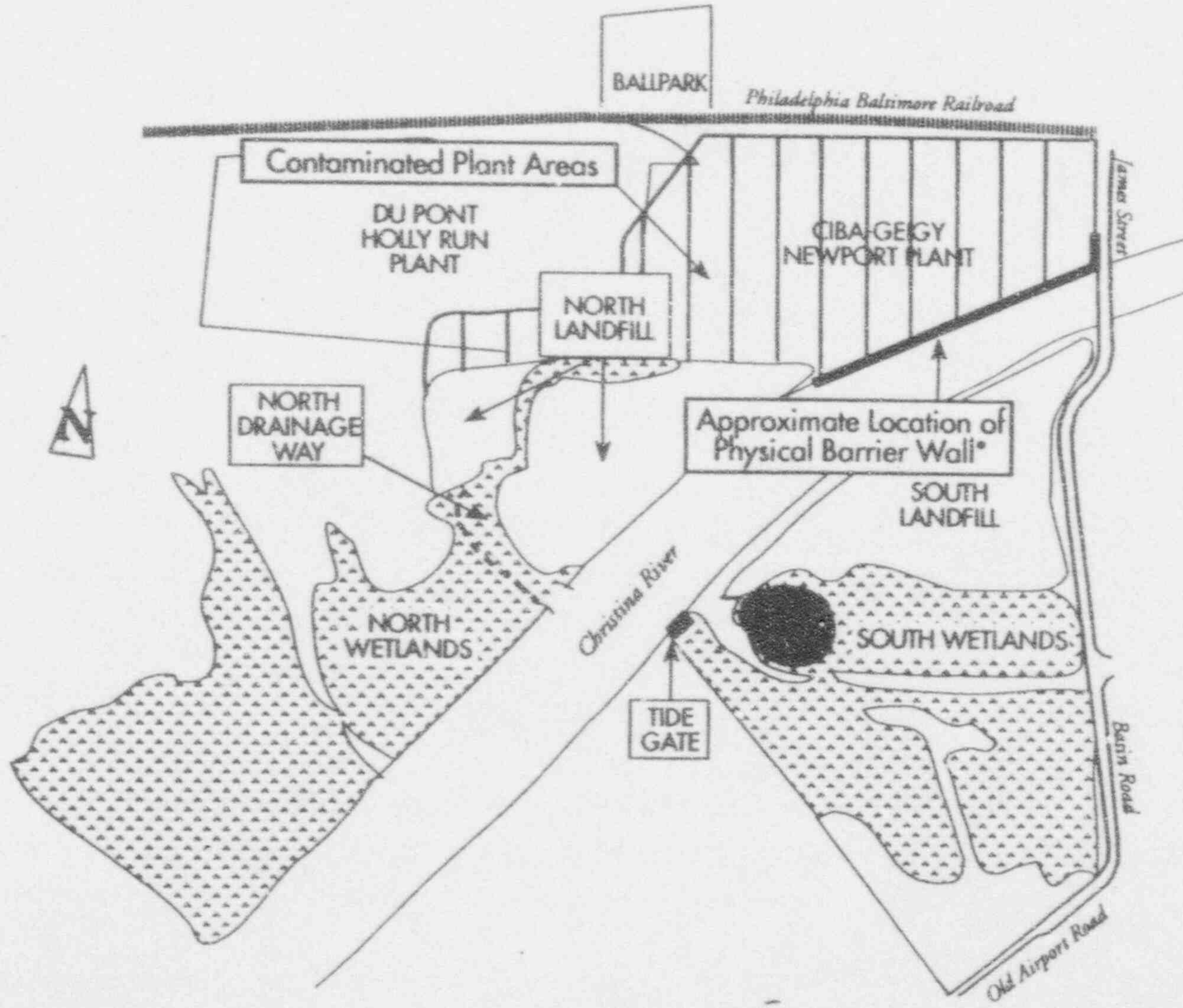


FIGURE 37
CIBA-GEIGY Newport Plant and Du Pont Holly Run Plant



* Ties into Physical Barrier Wall at North Landfill

FIGURE 38
South Wetlands Area Requiring Sediment Sampling to Delineate Exact Areas for Remediation

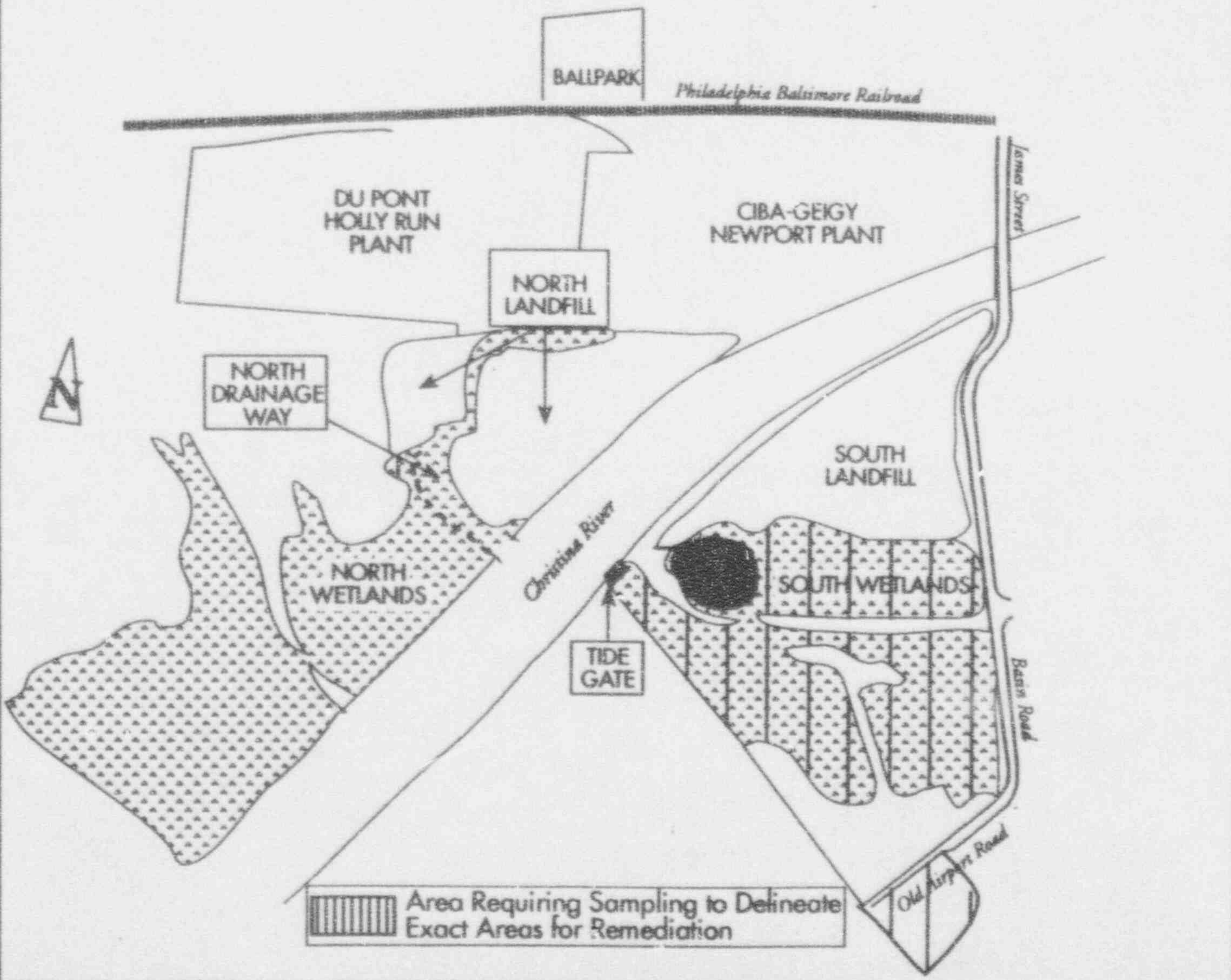


FIGURE 39
Christina River Area Requiring Sediment Sampling to Delineate Exact Areas for Remediation

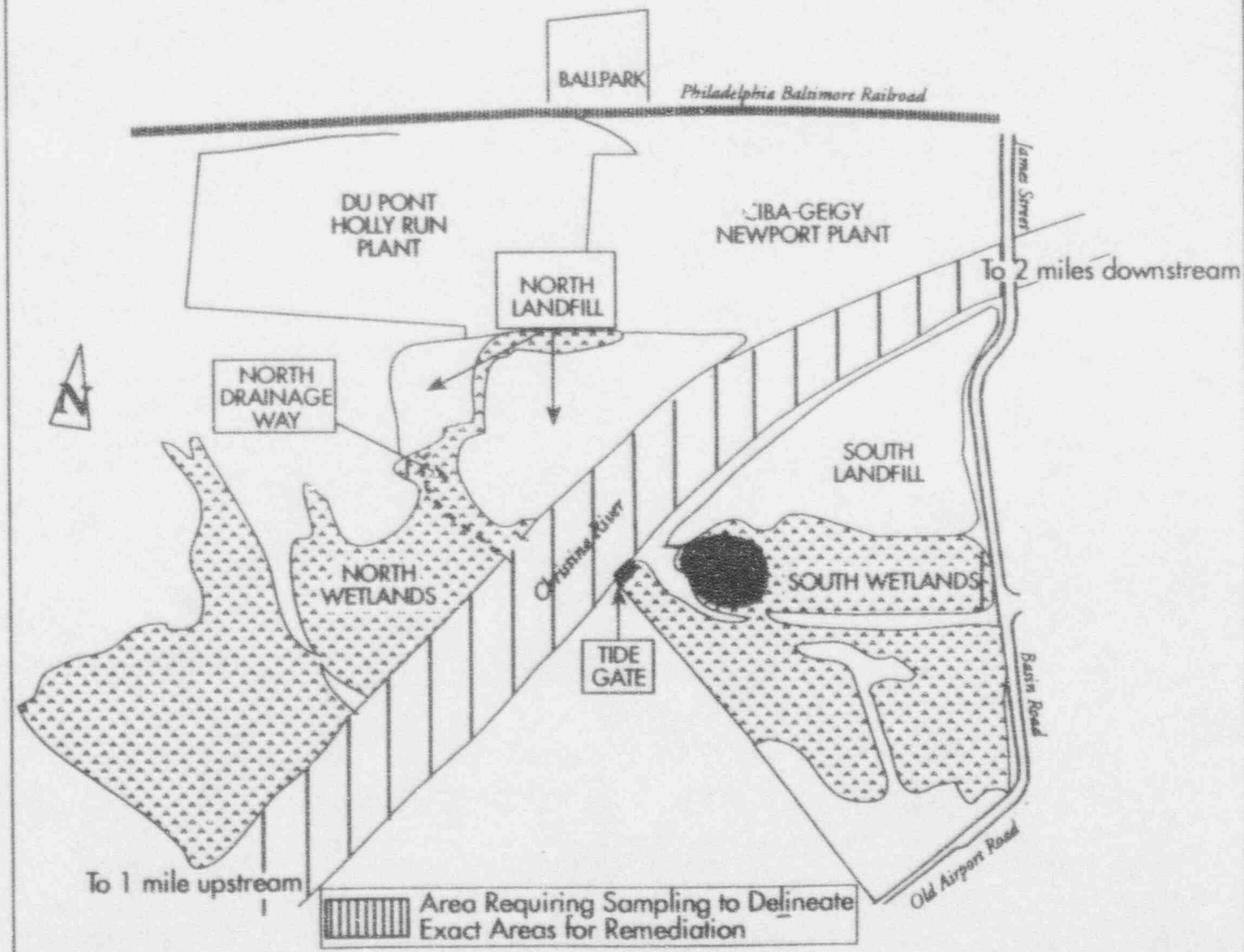
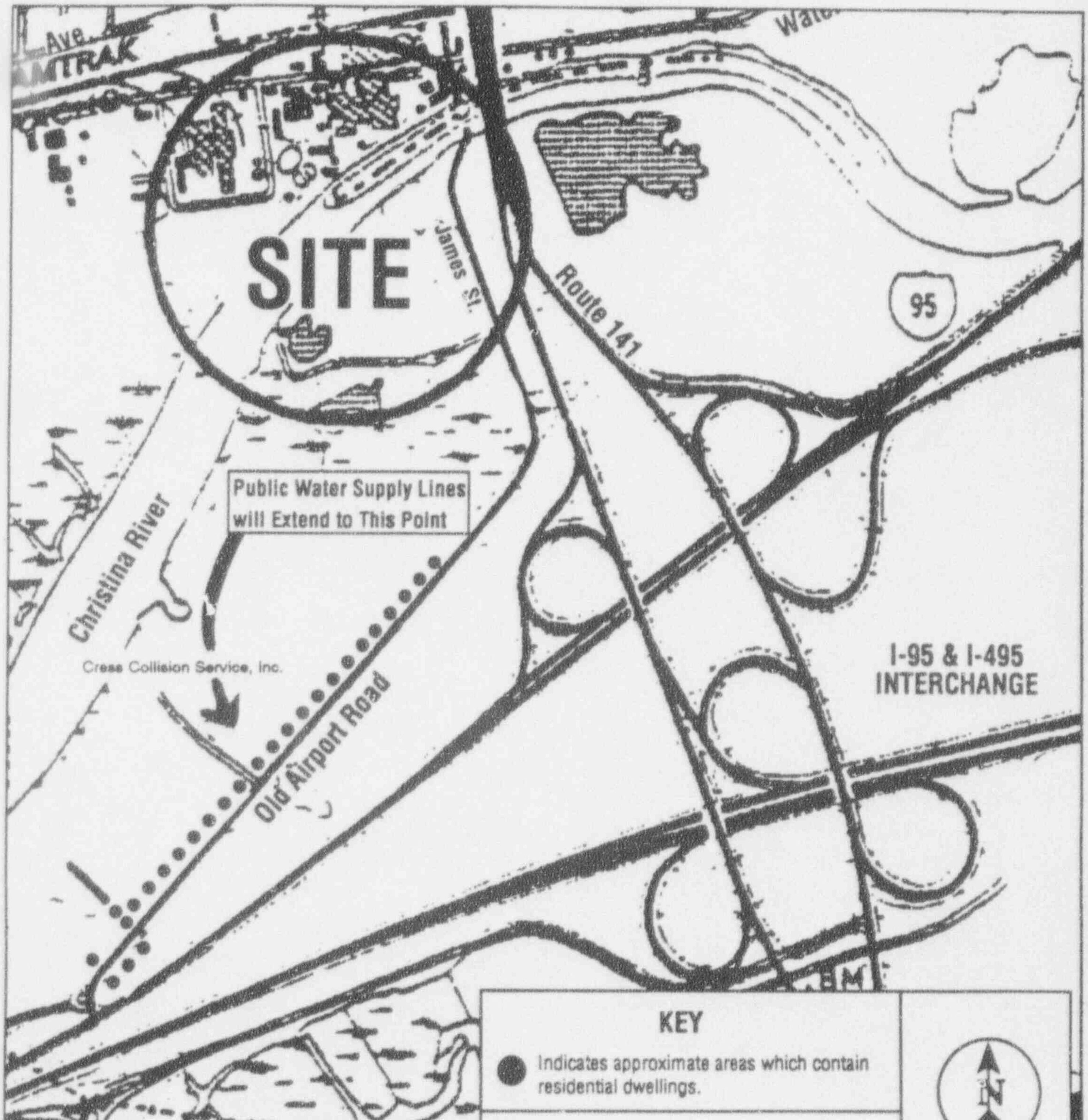


FIGURE 40
Location of Public Water Supply Line



Responsiveness Summary
E.I. Du Pont, Newport Superfund Site
Newport, New Castle County, Delaware

The Responsiveness Summary for the E.I. Du Pont, Newport Superfund Site (Du Pont-Newport Site or Site) is divided into the following sections:

SECTION I Overview

The overview summarizes recent actions at the Site and the public's response to the remedial alternatives listed in the Proposed Remedial Action Plan (Proposed Plan). The Proposed Plan outlines EPA's preferred alternative for the seven areas of Site contamination and discusses EPA's reasons for recommending this alternative.

SECTION II Background on Community Involvement

The background section reviews the history of community awareness and interest in the Du Pont-Newport Site.

SECTION III Summary of Comments and Questions Received During the Public Comment Period and EPA Responses

This section documents comments and questions raised during the comment period regarding the Site and EPA responses to them. These questions are categorized by topic.

I. Overview

In August 1992, the final Remedial Investigation and Feasibility Study reports for the Du Pont-Newport Site were submitted. In November 1992, after reviewing the reports, EPA released its Proposed Plan. EPA conducted a public meeting on December 2, 1992 to present the Proposed Plan to the community. At this meeting, community members had an opportunity to ask questions and make comments regarding the results of the Remedial Investigation and Feasibility Study and the remedial alternatives outlined in the Proposed Plan.

The preferred alternative specified in the Proposed Plan addressed seven areas of Site contamination; the ballpark, the south landfill, the north landfill, the south wetlands, the Christina River, the CIBA-GEIGY and Du Pont Holly-Run plants, and ground water. The preferred alternative would involve: excavating and disposing of contaminated soil from the ballpark, a cover-system (cap), barrier wall, and ground-water recovery and treatment system installed on the north landfill, stabilization and excavation of contaminated soil prior to capping at the south landfill, excavating contaminated sediments, restoring and monitoring the south wetlands, dredging a section of the Christina River, paving the remaining portions of the CIBA-GEIGY and Du Pont Holly Run plants, installing a circumscribing physical ground water barrier wall[1] around the north landfill and the CIBA-GEIGY plant (with associated ground-water recovery systems), establishing a ground-water management zone, and connecting residences to the public water supply. (See the Proposed Plan for more information on EPA's preferred alternative).

The public comment period for the Site originally ran from November 13, 1992 to December 14, 1992. However, due to a timely request for an extension of the comment period, EPA extended the public comment period an additional 45 days to January 28, 1993.

The comments and questions received during the public meeting and comment period, along with EPA responses, are summarized in Section III of this document.

II. Background on Community Involvement

In February and April 1990, EPA conducted community interviews with local residents and officials to determine public awareness of and concerns about the Du Pont-Newport Site. EPA used these community interviews in developing a Community Relations Plan. The Plan addresses community concerns and guides two-way communications between EPA and the community. Residents and local officials expressed concern about the impact of Site contamination on the Town of Newport. The major concern was the quality of the drinking water and the water in the Christina River. Community members were generally unfamiliar with the Superfund process and concerned about the duration of the Site cleanup.

In September 1990, EPA held a public meeting to discuss the Superfund process and future activities planned at the Site. Attendance at this meeting was moderate and consisted of mostly local officials and residents who lived near the Site. EPA distributed informational fact sheets in August 1991, August 1992, and December 1992 to update the community on work at the Site. EPA will revise the Community Relations Plan as needed and produce additional fact sheets as Site work progresses.

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[1]The term often used by Du Pont in its comments is hydraulic barrier wall for what EPA considers a physical barrier wall. EPA uses "hydraulic barrier wall" to denote use of ground-water gradient controls to prevent the migration of ground water.

III. Summary of Comments and Questions Received During the Public Comment Period and EPA Responses

Comments raised during the comment period for the E.I. Du Pont, Newport Proposed Remedial Action Plan (Proposed Plan or PRAP) are summarized below. The comment period was held from November 13, 1992 to January 28, 1993. Written and verbal comments received during this period are summarized below including those received at the public meeting held on December 2, 1992. Comments received during the public meeting are marked with an "*". E.I. du Pont de Nemours Company (Du Pont) submitted comments on January 27, 1993 (Du Pont, 1/27/93) and on March 12 (Du Pont, 3/12/93) and March 30, 1993 (Du Pont, 3/30/93), submitted revisions and/or clarifications to these comments. EPA is responding to all of these comments including the Du Pont comments which submitted after the comment period was closed.

The comments are divided into the following major areas: the ballpark, the north landfill, the south landfill, the wetlands and sediment clean-up criteria, the Christina River, the physical barrier wall, the ground water, and other comments.

A. BALLPARK

A.1. The Town of Newport (the Town) commented that the Town supports Du Pont's request to allow Du Pont to proceed with the cleanup of the Ballpark. "The Town is negotiating with Du Pont regarding our desire to obtain the Ballpark and develop the site as a community park."

<u>EPA's RESPONSE</u>: EPA supports cleaning up the ballpark as soon as possible. The remedial process for the ballpark is estimated to take about 12 months to complete.

A.2. Du Pont commented, in regard to page 15, item 1 of the Proposed Plan, that only the entrance to the ballpark has elevated lead levels.

<u>EPA's RESPONSE</u>: EPA agrees and has modified the sentence in the ROD.

B. NORTH LANDFILL

B.1. Du Pont commented that a discussion of the possibility of disturbing the thorium drums during installation of the physical barrier wall be added to the evaluation of alternatives for the north landfill.

EPA's Response: EPA appreciates Du Pont's concern about the possibility of disturbing the drums. However, since the physical barrier wall will be very close to the edge of the crest of the north landfill, EPA does not expect installation of the barrier wall to disturb the drums since we do not believe that the drums are buried near the crest of the river bank. To make sure the drums are not accidently disturbed, the ROD requires that the drums be located prior to construction of the physical barrier wall. Markers shall be placed in the soil cover on the cap. Also, the health and safety plan for the remedial action at the north landfill will have to address any potential worker safety concerns caused by the thorium.

B.2. Du Pont commented that in Table 1 of the Proposed Plan the risks listed for the maintenance worker for the north landfill and the Holly Run plant should be split into the risks for the maintenance worker at the north landfill and the risks for the maintenance worker at the Holly Run plant.

EPA's RESPONSE: Since the same worker will likely perform maintenance at both the north landfills and the Holly Run plant, EPA has decided not to separate the risks in the referenced table. This approach is consistent with the way these risks were evaluated in Table 6-1 of the Human Health Evaluation (3/18/92).

C. SOUTH LANDFILL

C.1.* A resident asked if EPA was aware of the Delaware Department of Transportation's (DelDOT) plans to expand Route 141 near the Site.

EPA RESPONSE: EPA has had several discussions with DelDOT regarding the Site and DelDOT has not made EPA aware of any expansion plans. Any plans for expansion or construction involving the contaminated area will be discussed between EPA and DelDOT to minimize any potential impacts on the Site.

C.2.* A resident asked if the sewer line that runs through the south landfill would have to be removed during the clean-up process.

EPA RESPONSE: The sewer line can be left in place with the proposed cover system placed on top. If there is a problem with the line in the future, access to the sewer line may be obtained through the cap. When any maintenance is finished, the cap will be repaired.

C.3.* Several residents expressed concern about the flooding of Route 141 and the water runoff being impacted by contaminants in the south landfill.

EPA RESPONSE: EPA proposed capping the contaminants in the south landfill and adding clean soil on top of the landfill. This will prevent any rain water from coming into contact with Site contaminants. Also, if past storm water run-off has transported contamination, a new area on the south side of Old Airport Road has been added to the area where pre-design sampling will occur to determine where remediation will take place.

C.4. Active Crane Rental commented that it was concerned that if excavating the Basin Road area causes a temporary closing of the road, its business could be severely impacted because some of its equipment may not fit under the Amtrak bridge over James Street. The Town also commented that any closing of Basin Road will negatively impact residents and property owners of the Town by causing traffic to be re-routed through the Town potentially causing public safety problems.

EPA's RESPONSE: EPA has added to the ROD a performance standard which states that access through the Basin Road area must be available during remediation. This may require construction of a temporary road or performing remediation during "non-business" hours. Access is required to be maintained only for those vehicles which have no alternative routes. The duration of construction in this area should be less than four months. EPA realizes that during this time there may be an increase in truck traffic in part of Newport. EPA, and any responsible parties performing the remedial work, will coordinate with the Town to ensure that its concerns regarding traffic patterns are taken into account in the design of the remedy.

C.5. DelDOT asked why the Basin Road area had to excavated and consolidated to the south landfill instead of being treated in place as was proposed for the rest of the south landfill.

EPA's RESPONSE: EPA believes excavation and consolidation to the south landfill is preferred for several reasons. One, the road and utility lines make capping difficult on the State of Delaware property. Two, the volume increase associated with stabilization may also present problems for the road reconstruction. Three, institutional controls would be easier to implement and enforce if all of the waste is on one piece of property. See also Comment C.9.

C.6. Du Pont commented that a low-permeability cap would be adequate to address the risks posed by the south landfill (excluding the Basin Road area). Du Pont believes that either stabilization or capping would provide adequate reduction in contaminant migration but that doing both would not provide any extra benefits.

EPA's Response: EPA believes that capping alone would not provide adequate reduction in contaminant migration.[2] The estimated two feet of waste material that would remain in the water table, once the ground-water mound dissipated, potentially will provide a continuing source of contamination to the aquifer. EPA does not agree with Du Pont that there will be no movement of the ground water underneath the landfill once the cap is installed. The changing tide in the river will cause ground-water movement in this area and it is possible that some of the regional Columbia ground water will pass underneath the landfill and discharge into the river instead of discharging into the south wetland.

Prevention of further contamination of the wetlands and the river, and the need to minimize any potential for expansion of the ground-water plume (in order to prevent the necessity for active ground-water remedial measures) make it necessary to limit, to the maximum extent practicable, the continued migration of contaminants to the ground water.

EPA also believes that capping is necessary in conjunction with stabilization. Stabilization reduces migration of contaminants in two ways. One, stabilization reduces the leachability of the contaminants. Two, stabilization greatly reduces the surface area where leaching can occur. Capping will prevent infiltration of rainwater through cracks in the treated waste and across the surface of the treated waste, thereby serving to reduce the surface area of the waste available for leaching. However, EPA has reduced the requirements for the cap by determining that a RCRA Subtitle D cap would be protective. This change reduced the estimated cost by $1,000,000.

C.7. Du Pont commented that stabilization may not work when there are multiple metals present. Some of the metals may become more leachable. Du Pont also commented that "EPA has not shown

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[2]EPA does not agree with Du Pont's statement that "there is currently little or no flow of contaminants" (Du Pont, 1/27/93, pg. 3-13) from the south landfill. Data reported during the RI/FS showed metals can leach from the waste material. No decrease in the contaminant levels in the ground water in this area have been noted as would be expected over time if a continuing source did not exist.

that stabilization will reduce the toxicity of South Landfill wastes." (Du Pont, 1/27/93, pg. 3-14)

EPA's RESPONSE: EPA agrees with Du Pont that stabilization can, depending on the particular process used and the waste characteristics, increase the leachability of some metals. Because of this possibility, treatability tests will be done during the remedial design to determine the type and quantity of stabilization agent necessary to adequately reduce the leachability of all of the contaminants. EPA believes successful treatability tests can be performed for the material in the south landfill and that this will provide a solid basis for selecting an appropriate process that will achieve the performance standards. For an example of tests where wastes containing multiple metal contaminants were successfully stabilized, see "Solidification of Model City Lagoon Waste," Chemical Waste Management Technical Report No. 87-109, 1987.[3]

EPA incorrectly stated in the Proposed Plan that the toxicity of the metals would be reduced as a result of the stabilization process. The toxicity of the metals will remain the same with only their mobility being reduced. The word "toxicity" should not have been included. This has been corrected in the ROD.

C.8. Du Pont commented that stabilization ranks "poorly in terms of its short-term effectiveness and its implementability when compared to the alternative recommended in the FFS." (Du Pont, 1/27/93, pg. 4-6)

EPA's RESPONSE: EPA acknowledges that there are more short-term impacts and an increased degree of difficulty in implementing stabilization and capping as opposed to just capping the south landfill. However, *in-situ* stabilization can be implemented through available technologies/equipment. Through the proper design and implementation of a remedial action health and safety plan, stabilization of the south landfill can be implemented in a manner which is safe to workers and to the public. Therefore, concerns about short-term impacts and implementability do not affect EPA's conclusion that stabilization is practicable at the south landfill.

C.9. Du Pont commented that the best alternative for the Basin Road area would be to establish institutional controls only instead of excavation and consolidation to the south landfill.

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[3]As reported in: Jeffrey Means *et al*, "Final Report on Solidification/Stabilization Data Base: Compilation of Metal Fixation Data From Bench Scale Treatability Tests," June 1991.

One reason discussed in detail was "because the depth to potentially contaminated material is 8 to 9 feet" (Du Pont, 1/27/93, pg. 3-15) routine road repairs would not require any special precautions. Institutional controls (such as implementation of special health and safety plans) could be used for extensive work at depth. Du Pont also commented that "no reduction of toxicity, mobility, or volume would be achieved by this alternative." (Du Pont, 1/27/93, pg. 3-16)

EPA's RESPONSE: EPA believes that the rationale for why remediation is necessary at the south landfill applies here as well because the Basin Road area is part of the south landfill (the human health risk assessment for the south landfill also applies to this area). EPA's concerns regarding this area are not limited to direct contact only during subsurface work,[4] but also include the potential for release of metals from the contaminated material to ground water. Although stabilization and capping were selected as the appropriate remedy for the south landfill, they are not practical in this area because of Basin Road itself.

Whatever uncontaminated fill material is on top of the contaminated material will not have to be consolidated to the remaining portion of the south landfill.[5] EPA believes that risks to workers and the public can be adequately controlled. If the material must be stabilized (i.e., it fails the toxicity characteristic leaching procedure [TCLP] test), there will be a reduction in mobility due to the stabilization.

C.10. Du Pont commented that EPA should note that easements will be necessary for work in the Basin Road area because the Delaware Department of Transportation (DelDOT) is the owner.

EPA's RESPONSE: Access will be secured for the work either by a responsible party or the United States.

C.11. Du Pont commented that the south landfill is not a principal threat as defined by the NCP and therefore treatment is not necessary.

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[4]EPA agrees that for routine road repairs such as resurfacing the road, institutional controls would not be necessary.

[5]The amount of fill material above the waste at DelDOT boring R-12 is only 3.5 feet with 9 feet of waste material (reported on DelDOT's engineering drawing as "chemical fill", see ROD Figure 5) being encountered.

EPA's RESPONSE: Section 300.430(a)(iii)(A) of the NCP[6] states that one of the criteria used to determine whether an area is a principal threat is where there are "areas contaminated with high concentration of toxic compounds." EPA's definition of a principal threat includes areas that have contaminants that are several orders of magnitude above levels that allow for unrestricted use and unlimited exposure (Preamble to the NCP, 55 Fed. Reg. 8703). The south landfill has lead levels as high as 160,000 parts per million (ppm) which is several orders of magnitude above lead concentrations that would allow for unrestricted use and unlimited access. The south landfill is also a major source of contamination to the ground water since some of the waste is in the water table.

Because the material in the south landfill constitutes a principal threat, treatment is appropriate since EPA "expects to use treatment to address principal threats posed by a site, wherever practicable" (Section 300.430(a)(iii)(A) of the NCP). EPA has determined that treatment is practicable at the south landfill and has selected the best demonstrated available technology (BDAT) for heavy metal contamination. EPA does not believe that the costs for stabilization make treatment impracticable in light of the benefits of: 1) meeting the statutory preference for treatment; 2) minimizing, to the maximum extent practicable, the release of metals to the ground water which will help protect the adjacent wetlands and river; and 3) increasing the degree of long-term effectiveness.

C.12. Du Pont commented that stabilization plus a RCRA-style cap at the south landfill "is inconsistent with provisions of the NCP." (Du Pont, 1/27/93, pg. 4-6)

EPA's RESPONSE: EPA's response to comments C.6 to C.9 and the discussion in the ROD show that EPA has followed the provisions of the NCP in selecting stabilization and capping for the south landfill.

D. WETLANDS/SITE-SPECIFIC SEDIMENT CLEAN-UP CRITERIA

D.1. Du Pont commented that it agrees with EPA's waiver of the Site-specific clean-up criteria for sediments in the south pond, but that the waiver should apply to other areas of the north and south wetlands where the collective results of the test data indicate that remediation is not necessary.

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[6]National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300

EPA's RESPONSE: The spatial distribution of the sampling stations in the RI for the north and south wetlands was so great that, by themselves, they are not nearly enough to direct remedial activities. For example, the two stations in the north wetlands, AS10 and AS11, while not requiring remediation themselves, are too few in number to warrant a decision not to remediate the 7-acre wetland area, and therefore apply the waiver to the north wetlands as well. There may be areas of the north wetlands which require remediation, particularly areas near the north drainage way. EPA's Site-specific clean-up criteria are a simple, relatively inexpensive way (compared to performing toxicity tests and benthic studies on a grid) of predicting the results of the numerous tests used to build the "weight-of-evidence" which EPA used to determine when remediation was warranted (see the "Memo to File: River & Wetland Remediation Goals (Sediment Clean-up Criteria), Third and Final Edition, dated 7/9/93 which is attached to the ROD as Attachment B).

D.2. Du Pont commented that river sampling station RS05 exceeds the Site-specific clean-up criteria but was not included in the area to be remediated in Figure 5 of the Proposed Plan.

EPA's RESPONSE: EPA has always understood that RS05 was above the Site-specific sediment clean-up criteria. However, EPA expects that once the pre-design delineation of areas requiring remediation is completed, the area around RS05 will be below the criteria and will not need to be remediated. EPA's view is based on the distance of RS05 from the Site and the fact that RS06 (adjacent to RS05) is below the criteria. The ROD (especially Figure 22) presents the area EPA expects will require remediation. However, the results of the pre-design sampling will provide the final delineation of area(s) for dredging.

D.3. Du Pont commented that mercury should be eliminated from the list of Site-specific clean-up criteria because it is not a Site-related contaminant and that there is little evidence of anthropogenic loading.

EPA's RESPONSE: Mercury is a Site-related contaminant. An enrichment factor (EF) of 32 at AS-07, a north drainage way sampling station, is in Du Pont's words caused by "substantial anthropogenic loading." (Du Pont, 1/27/93, pg. A-2) AS-07 is in an area that would not be impacted by sources other than those at the Site. Any mercury in the barium and zinc ores could have been concentrated and disposed of as part of the Lithopone waste. Du Pont's statement that AS-07 had the only mercury AWQC exceedance is misleading. The detection limit used for mercury was often an order of magnitude above the AWQC meaning that non-detects could have been exceedances.

EPA has removed mercury from the list of the Site-specific sediment clean-up criteria. EPA has determined that criteria for cadmium, lead, and zinc are adequate to protect the environment since the area(s) where mercury is present in unacceptable levels will be remediated due to the cadmium, lead, and/or zinc levels.

D.4. Du Pont commented that, as described in EPA's 10/27/92 Memo To File, the application of the sediment clean-up criteria should have been stated in the Proposed Plan. The 10/27/92 memo stated that if any one of the sediment clean-up criteria is exceeded in a sample from the top 6" of sediment then the top 12" of sediment shall be excavated and backfilled to original grade in the area represented by that sample.

EPA'S RESPONSE: EPA has included a revised version of the 10/27/92 memo as an appendix to the ROD (see Attachment B), and the performance standards clearly state how the criteria apply.

D.5. Du Pont reanalyzed an archived benthic sample from AS05, a south wetlands sampling station, and commented that the results of this analysis show that this area does not need to be remediated.

EPA's RESPONSE: EPA agrees with Du Pont that AS05 does not require remediation based on the results of all the testing done at the station (not just the analyses of the archived benthic sample). The determination of EPA's Site-specific clean-up criteria took into account the results of the testing at AS05.

D.6. Du Pont proposed using the acid volatile sulfide (AVS) and the simultaneously extracted metals (SEM) techniques in conjunction with EPA's metals criteria to determine if the metals are bioavailable and require remediation.

EPA's RESPONSE: EPA believes that its Site-specific sediment clean-up criteria are an adequate indication of metals bioavailability because "these metals clean-up levels are impact-based criteria that take into consideration ecological concerns at the Site, such as bioavailability." (Du Pont, 1/27/93, pg. 3-6)

D.7. Du Pont proposed using a "cumulative Sediment Risk Index (SRI) based on the sediment criteria in the PRAP" in order to "rank different Site areas." "Locations with higher values should accordingly be given higher ranking for the need for remediation." "The resulting ranking mandates that cost-effective remediation can be obtained by focusing remedial efforts in those higher priority areas, while less aggressive remedial options would be appropriate for lower priority areas." (Du Pont, 1/27/93, pg. 3-8, 3-9)

<u>EPA's RESPONSE</u>: While Du Pont's SRI is a way of ranking the severity of the hazards posed by the sediments, EPA does not believe that the SRI adds anything to the remedy. The collective test results indicate whether or not a station requires remediation to protect the environment. The only remedial technology proposed for the sediments (by either EPA or Du Pont) was stripping the top layer (except for parts of the north drainage way which will be capped along with the north landfill). Cost-effectiveness becomes a consideration once a remedy provides overall protection of human health and the environment (see comment H.20). The term "less aggressive remedial options" is very vague, and EPA cannot evaluate whether these options would provide an appropriate level of protection. EPA's selected remedy does provide an appropriate level of protection.

D.8. Du Pont commented that in most of the figures, "the western-most wetland area shown on these figures is not part of the Du Pont-Newport Superfund Site, and should be omitted from the figures to avoid confusion." (Du Pont, 1/27/93, pg. A-6)

<u>EPA's RESPONSE</u>: The western portion of the wetlands may or may not be part of the Site depending on the extent of the contamination. The sampling in the RI did not extend to the edge of the contamination in this area. This area is included in the pre-design delineation step in order to determine if portions of this area do require remediation.

D.9 Du Pont commented that "the terrestrial impact assessment requirements are arbitrary and capricious. They have no basis in mammalian pathology, nor have the results be (sic) linked to any adverse impact. Du Pont proposes monitoring such as blood or hair analysis that will not require mass killings of muskrats or other destructive measures to detect impacts." (Du Pont, 1/27/93, pg. 2-8)

<u>EPA's RESPONSE</u>: EPA disagrees, and therefore, the proposed muskrat study is included in the selected remedy. Although the sediment toxicity tests and the benthic studies at the south pond showed acceptable results, the uptake of metals in plants that may be consumed by muskrats may pose a threat to the muskrats. The results of the hazard index calculation performed as part of the environmental risk assessment (which EPA believes is an acceptable manner for estimating risks for animals, especially since the toxicological studies used to obtain information for human risk assessments comes from animal studies) ranged from acceptable to very unacceptable depending on the assumptions made in the calculations. Since modeling of this type is not as

widely performed for animals as it is for humans, the results led to the need for monitoring. The remedial design will specify the details of the monitoring, such as liver growth.

Muskrat monitoring for metals has been done successfully at another Superfund site, the Kin-Buc Landfill Site in New Jersey. EPA disagrees with Du Pont's statement that the monitoring has "no basis in mammalian pathology," and Du Pont provided no support showing that the metals do not have an impact on muskrats. EPA continues to believe that there are enough muskrats at the south pond to perform monitoring using limited destructive tests, however, if non-destructive tests such as hair and blood analysis can be done, then they are an acceptable option. EPA does not believe that the information is as useful as whole body, liver, or kidney tests (and non-destructive tests may be dangerous for the sampler), but hair and blood tests are acceptable.

D.10. Du Pont commented that if the pond does not need remediating and surrounding wetlands do, then an acceptable method of deciding where the pond ends and the wetlands begin must be established.

EPA's RESPONSE: EPA agrees that a method to differentiate between the pond and the surrounding wetlands may need to be established. This will be part of the remedial design.

E. CHRISTINA RIVER

E.1.* A resident asked if contamination was present in the Christina River and if EPA was just treating the portion of the river near the Site.

EPA RESPONSE: There are Site-related contaminants in the river water and the river sediments. There are also other sources of some of these contaminants upstream of the Site. EPA's selected remedy calls for removing the highly-contaminated sediments from the river and taking other measures necessary to limit, to the maximum extent practicable, the continued discharge of contaminants from the Site to the river.

E.2. Du Pont commented that EPA should omit statements about the Christina River sediments being contaminated by ground water because it has not been "scientifically substantiated." (Du Pont, 1/27/93, pg. A-3)

EPA's RESPONSE: The extremely high levels of contamination in the fill zone and the Columbia aquifer ground water discharge to the river where, due to differences in the chemistry of the river water, the metals do precipitate and contaminate the sediments. This process was discussed in Du Pont's Environmental Evaluation (pg. 4-26, 8/7/92):

> The metals will likely co-precipitate out of solution by chemical complexation with the abundant ion hydroxide precipitates that form by oxygenation of seepage water. This mechanism can transfer metals from the dissolved phase to particles that may settle to the river bottom in areas where low current rates allow net deposition of sediment. In addition, the high level of natural turbidity in the river can enhance this transfer to the particulate phase since most metallic cations strongly bind to the fine-grained clay particles and to organic particles rich in fulvic and humic substances from the decomposing marsh vegetation.

According to Du Pont's comments the Christina River "is well oxygenated at both the upstream and downstream location." (Du Pont, 1/27/93, pg. B-4)

E.3. Du Pont commented that EPA's area for pre-design sampling in the river (see ROD Figure 39) was too large and should be shortened to the portion of the river from the north drainage way to the location of RS05 (approximately 1/2 mile below the James Street Bridge). Du Pont also commented that EPA's proposed area of dredging was "based on over-conservative and unsubstantiated premises and assumptions." (Du Pont, 1/27/93, pg. 3-12)

EPA's RESPONSE: Although the most significant contamination is believed to be between the north drainage way and the James Street Bridge, further delineation is required to guide the remedial action. Further sampling is required to make sure there are not other areas to be dredged besides the area in front of the north landfill and the CIBA-GEIGY plant. For example, river sampling station RS08, the furthest downstream sampling station, still exhibited contamination, although below EPA's clean-up criteria. Also, since high levels of contamination exist several feet below the surface adjacent to the north landfill, there exists a need to sample subsurface sediments which may have been silted over. The extent of any subsurface contamination is currently unknown.

Upstream of the north drainageway, the first sampling station is almost two miles away. Due to the tidal currents, extensive contamination may have been carried upstream and deposited between the drainageway and RS03. Therefore, delineation above the drainageway is necessary.

Although pre-design sampling will occur over a wide area of the river, EPA expects that the only area requiring dredging will be that depicted in ROD Figure 22. This is EPA's best estimate of the area that will exceed the Site-specific sediment clean-up criteria. This area may prove to be larger or smaller once the pre-design sampling is performed.

E.4. Du Pont objected to EPA's proposed use of dredging due to the potential for transport of contaminated sediments away from the dredging area which will, in Du Pont's estimation, cause chronic and acute AWQC exceedances and cause severe environmental impact.

EPA's Response: By limiting the dredging to about one hour before and after slack tide, silt curtains can be used to reduce sediment transport because the velocities will stay below 1.5 feet per second (fps).

Limiting the time of dredging to approximately four hours per day (two slack tides per work period) will extend the number of days that dredging will occur but will make handling of the dredge spoils easier. Du Pont's estimate of a production rate of 91.4 tons per day of in-place sediment for a Mudcat dredge (giving a duration of dredging of 151 days) appears in error. Using the US Army Corp of Engineers estimate that a Mudcat can dredge at a rate of 60 to 150 cubic yards per hour (this range was obtained from a USACE reference supplied by Du Pont as part of its comments on 1/27/93), the Mudcat averages a production rate of 91 tons per hour of in-place sediments (using Du Pont's estimate of 40% in-place solids by volume and a specific gravity of the sediments of 2.6 on page D-1 of its 1/27/93 comments). Using Du Pont's estimate that 13,800 tons of in-place sediments require dredging, approximately 150 hours or less than 40 work days will be needed to dredge the river.

Using EPA's estimated dredging production rate in Du Pont's calculations for the surface water concentrations (see Appendix D, Du Pont, 1/27/93) would cause the calculated concentrations to be significantly higher than indicated by Du Pont. Some of Du Pont's estimates of the concentration of metals in the surface water are already in excess of chronic and acute AWQC. However, EPA believes that by limiting the period of dredging to when the current is low, by using controls such as silt curtains, and by carefully controlling the dredging operation (including production rates, water to sediment ratios, etc.), the transport of sediment can be minimized. Dredging will also be limited to a period of November through March to avoid anadromous fish runs and the time of greatest benthic activity. EPA and DNREC also believe that some temporary impacts are acceptable in order to remove the long-term threat of the contamination from the river. However, to avoid Du Pont's prediction of "elimination of individuals, communities and populations of fish and benthic macroinvertebrates," (Du Pont, 1/27/93, pg. 3-10), the remedial design will have to describe activities to take place during dredging to minimize any adverse impacts to the aquatic life in the river.

E.5. Du Pont commented that the dredging alternative did not specify evaluation of potential adverse impacts associated with the mobilization of metals. Du Pont also stated that the method of handling the water associated with the dewatering of the sediments and the disposal of the dredge spoils must be considered in the remedy selection process.

EPA's RESPONSE: The remedial design for the dredging will thoroughly address minimizing and monitoring sediment transport. The disposal of the wastewater and dredge spoils were considered in the Proposed Plan. Information for the cost estimate in the Proposed Plan was mainly obtained from Table H-21 in Du Pont's Focused Feasibility Study (8/7/92) which had costs associated with wastewater treatment and disposal of dredge spoils.

E.6. Du Pont commented that the reasoning for backfilling the dredged area of the river with clean fill needs more explanation.

EPA's RESPONSE: EPA believes that backfilling the dredged area is important for several reasons. One, it provides a much cleaner substrate for habitation than the bottom of the dredged area which will be at the Site-specific clean-up criteria. Two, it keeps the dredged area from being a "sediment sink" which may cause any upstream contamination to preferentially settle in the dredged area.

E.7. Du Pont claims that capping of the contaminated sediments is a viable alternative for remediating the river and that EPA's concerns about losing habitat and concerns about the stability of the sediment cap are unwarranted.

EPA's RESPONSE: EPA also spoke to James Sekela, the U.S. Army Corp of Engineers' Fabriform revetment specialist referred to in Du Pont's 1/27/93 comments (pg. 3-11). Mr. Sekela said he has used Fabriform revetments numerous times for erosion control but only in small streams, never in a river as wide as the Christina. He had not heard of it being used to prevent contact with contaminated sediments. He pointed out that the revetments have weepholes to relieve hydrostatic pressure so that if contamination is entering a river bottom via ground-water, the revetment would not prevent contamination from entering the system.

M.E. Bendoff and Mr. George Bergman of Contech (the Fabriform manufacturer) were also contacted by EPA. In response to an inquiry regarding the suitability of the surface of the revetment as a habitat for benthic organisms, Mr. Bergman said sediment deposition would depend upon the velocity of the river and sediment particle size. In slow moving or partially submerged areas, he has seen plants grow through the weep holes in the filter point mat style over time. He said it would be necessary to conduct pilot tests to determine if benthic habitat could be developed on the mat in the Christina River. He also said there will be some displacement of sediments during the installation of the cap. Du Pont has not provided any information in the Focused Feasibility Study (FFS: 8/27/93) or its Proposed Plan comments to support its claim that the habitat would re-establish.

EPA continues to believe that dredging offers many advantages over capping. Capping would require continuous maintenance while dredging would remove the contamination from the river. EPA can not ensure that capping would comply with the policies of Delaware's Coastal Zone Management Program, and therefore, capping would not meet the threshold criteria of "compliance with ARARS." However, dredging would create conditions which would allow return of a viable habitat. It remains questionable whether a cap could support sediment accumulation, much less benthic activity.

E.8. Du Pont commented that EPA's concern about the revetment blanket destroying habitat is not valid in light of the fact that dredging will destroy the habitat also.

EPA's RESPONSE: Benthic organisms can rehabitate the dredged area. But it remains questionable whether sufficient sediment would ever accumulate on the revetment blanket to support benthic activity.

E.9. Du Pont commented on EPA's proposed river dredging remedy that, in Du Pont's opinion, "it is expected that exceedances in acute water quality criteria and further migration of contaminated sediment will take place explicitly as a result of implementing the alternative" (Du Pont, 1/27/93, pg. 4-8) in the Proposed Plan and "therefore, the alternative in the PRAP is not consistent with the criteria for implementability and short-term effectiveness cited in the NCP for remedy selection; and should not be implemented." (Du Pont, 1/27/93, pg. 4-8)

EPA's RESPONSE: As discussed in comment E.4, EPA believes that the risks caused by any resuspended sediments can be adequately controlled during remediation. Therefore, dredging is readily implementable and is acceptable in terms of short-term effectiveness.

E.10. Du Pont commented that the revetment mattress for capping contaminated sediments, which it proposed as the preferred alternative in its Focused Feasibility Study (8/27/92), is an "innovative application of existing technology. Both the NCP (Section 300.430 (a)(iii)(E)) and CERCLA guidance mandate a preference for the use of innovative technology such as this." (Du Pont, 1/27/93, pg. 4-8)

EPA's RESPONSE: Section 300.430(a)(1)(iii)(E) of the NCP states that "EPA expects to consider using innovative technology when such technology offers the potential for comparable or superior treatment performance or implementability, fewer or lesser adverse impacts than other available approaches, or lower costs for similar levels of performance than demonstrated technologies." EPA has considered using the revetment mattress, but has not selected the revetment mattress as the appropriate technology for this portion of the Site. The dredging alternative was selected based on an evaluation of the nine criteria outlined in Section 300.430(e)(9)(iii) of the NCP.

E.11. Du Pont commented that the $17,300,000 cost for dredging would not accurately represent off-site disposal costs even though off-site disposal is provided as an option.

EPA's RESPONSE: Most of the information used to arrive at the cost estimate came from Table H-21 "Christina River Alternative CR-3, Sediment Removal Area 1 & 2 - Offsite Disposal" in Du Pont's Focused Feasibility Study (8/27/92). The off-site disposal cost estimate in Table H-21 amounted to approximately $11,000,000 out of $15,000,000. The Proposed Plan cost estimate was revised and the estimate in the ROD is substantially lower because EPA anticipates that the dredge spoils can be disposed of on-site.

E.12. Du Pont commented with regard to page 13, paragraph 3 of the Proposed Plan, that "the Christina River does not divide the north and south landfills, but flows between them." (Du Pont, 1/27/93, pg. A-7)

EPA's RESPONSE: EPA believes either wording is acceptable but has modified the referenced sentence in the ROD.

F. PHYSICAL GROUND WATER BARRIER WALL

F.1.* Several residents at the public meeting expressed concerns about a possible rise in the water table, caused by the proposed circumscribing wall, and its potential impact on homes in the area. The Town commented that the circumscribing physical barrier wall around the contaminated plant areas "will create serious short- and long-term negative impacts on the Town's residents, businesses and property owners." Du Pont also commented that the ground-water recovery system could adequately control the vertical migration of ground water between the Columbia and Potomac aquifers such that the circumscribing wall offered no advantages over the wall along the river only.

EPA's RESPONSE: EPA agrees and has selected the physical barrier wall along the river only. This eliminates the need for a ground-water recovery system in the Town. The narrower scope for the physical barrier wall will also cause fewer disruptions for CIBA-GEIGY during installation. No other business disruptions will occur due to the installation of the wall. EPA believes that the physical barrier wall along only the river coupled with extraction of ground water on the upgradient side of the wall will be sufficient to protect the river and the Potomac aquifer as well as prevent any Columbia ground water from migrating underneath the Christina River. This alternative will also eliminate the need for a ground water control system in the Town.

F.2.* A resident asked why a French drainage system could not be installed to prevent a possible rise in the water table.

EPA's RESPONSE: EPA considered putting a French drainage system on the plant side of the railroad tracks; however, there is not enough room between the railroad and the actual buildings to accommodate the system.

F.3. Du Pont commented (dated 1/27/93) that it believes the physical barrier wall is not necessary because the ground water from the Site that discharges into the Christina River is not contributing significantly to the environmental degradation of the river. To support its comments, Du Pont collected Christina River surface water samples during the public comment period upstream of the Site at the Churchman's Road boat launch (2.7 miles upstream on the Christina River) and at the downstream edge of the Site (the James Street Bridge). Du Pont stated that "if ground water discharge from the Site was causing the elevated concentrations of metals in the river, then higher concentrations of Site target metals would be expected at James Street Bridge than at Churchman's Road boat launch," and that "the affects (*sic*) of any potential discharges of Site groundwater to the River is so small that it is not discernable." (Du Pont, 1/27/93, pg. 3-2) Du Pont also submitted comments on 3/12/93 and 3/29/93 further clarifying (mainly by identifying other sources of zinc contamination in the Christina River basin upstream of the Site) its arguments as to why it believes that the barrier wall is not necessary.

EPA's RESPONSE: After thoroughly reviewing Du Pont's comments, EPA has determined that the comments do not alter EPA's original proposal to use a physical barrier wall to limit, to the maximum extent practicable, ground water from the Columbia aquifer and the fill zone containing Site-related contamination from entering the Christina River.

First, EPA disagrees with Du Pont's assertion that the data collected during the public comment period indicated that the effects of the ground water were not discernable for the following reasons:

a. Some of Du Pont's data was not of sufficient quality to support Du Pont's comment, and some of Du Pont's data supports the opposite conclusion. For barium, all of Du Pont's samples, except for one, were below the method detection limit (MDL) of 100 parts per billion (ppb) at both the upstream and downstream stations. The Hazardous Substance Data Base (HSDB, 1992) states that the average background barium concentration is 43 ppb (with a range of 2 to 340 ppb) in surface water. This average level was confirmed by EPA split samples which showed the barium levels to be in the range of 40 to 60 ppb at both the upstream and downstream stations. However, the MDL was too high for the samples to be of value in determining if the Site is affecting the barium levels in the river. In order to have been of value, the MDL needed to be low enough to detect barium at both stations so any difference could be evaluated.

For cadmium, the MDL of 10 ppb was also too high to be of value. The ambient water quality criteria (AWQC) ranged from 0.7 ppb upstream to 0.9 ppb at the downstream station which is an order of magnitude below the MDL.

For lead, it does appear that contamination observed downstream is lower than upstream by an average of 0.5 ppb. However, Du Pont's evaluation of the number of AWQC exceedances is misleading. First, the MDL was above the AWQC so non-detect levels may have exceeded the AWQC, and second, the AWQC was higher downstream due to an increase in hardness of the water.

For zinc, the data did show that there were consistently higher levels of zinc downstream than upstream. The seven days that Du Pont sampled at low, mid- and high tide showed an average increase of 23 ppb at the James Street Bridge. Also, the discussion of which station had the most number of AWQC exceedances was misleading. The AWQC was higher at the James

Street Bridge because of an increase in hardness levels. In addition, the detection limits were above the AWQC for three samples at the James Street Bridge so once again, non-detects could actually have been exceedances of AWQC.

Du Pont stated that upstream sources of zinc were the reason for the increase in zinc levels observed during the public comment period sampling event. EPA acknowledges that the data provided by Du Pont in its comments of 3/12/93 and 3/29/93 indicates significant amounts of zinc are entering the Christina River from the White Clay Creek and the Red Clay Creek. This has been confirmed through information obtained from DNREC. This may account for the observed increase in the zinc levels between the Churchman's Road station and the James Street Bridge station since the White Clay Creek and the Red Clay Creek empty into the Christina River between the stations. However, some percentage of the zinc observed at the Churchman's Road station may be due to zinc in the incoming tide at White Clay Creek and Red Clay Creek. Therefore, the use of the 54 ppb average at the upstream station to calculate a load of 330 pounds per day (lb/day) of zinc which was then added to the loads from the two creeks to arrive at a Site background load of 460 lb/day may not be appropriate. Another problem in the calculation of the 330 lb/day zinc load at Churchman's Road is the use of a 100,000,000 ft^3/day flow. This flow was a calculated flow for the Christina River at the Site after the addition of the creeks and should not be used to calculate a zinc mass flow rate in the Christina River upstream of the White Clay Creek and the Red Clay Creek.[7] Also, since the velocity measurements for the flow calculation for the Christina River were taken during a period of elevated flow, the subtraction of only 19,600,000 ft^3/day for the White Clay Creek and Red Clay Creek (estimated from 10/89 flow data) from the 100,000,000 ft^3/day calculated at the Site to determine the Christina River flow upstream of the creeks would likely overestimate the upstream Christina River water and zinc flow since they may have had higher flows in January 1993 compared to

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[7]EPA also disagrees with some of the assumptions used in calculating the 100,000,000 ft^3/day river water flow rate. First, a depth of six feet at low tide was used while Table 8 (Du Pont, Supplementary Technical Data Summary Report of a Christina River Water Quality Investigation at the Du Pont-Newport Superfund Site, 2/12/93) shows that the depth at low tide was approximately 2.7 feet. Second, the assumption that the river cross section is a rectangle causes the calculated flow to be high. A more reasonable beginning assumption would be to consider the river cross section to be a triangle with a base of 255 feet and a height of 2.7 feet. With a velocity of 7.5 ft/sec, the calculated flow would be 22,300,000 ft^3/day which is significantly less than Du Pont's value of 100,000,000 ft^3/day which was used throughout its comments in various calculations.

October 1989. Thus the contribution of zinc in the Christina River upstream of the Site, and therefore the Site background load, is significantly less than that reported by Du Pont.

b. Du Pont's claim that the "reverse tidal currents do not appear to be transporting site-related metals this far upstream" (to the Churchman's Road boat ramp), was not adequately supported. Zinc was consistently detected at higher levels at high tide at the upstream station compared to low tide. This shows that zinc transport from downstream to upstream may be occurring. Since the MDL of barium and cadmium was too high for the contaminants to be detected, a comparison of high tide and low tide data was not possible. Also, the velocities of the river suggest that it is possible for the reverse tidal current to carry contaminants from the Site to the upstream sampling station. If the upstream location is impacted by the Site, the data can not be used as a background station to determine whether or not the Site is contributing significantly to the degradation of the river.

c. The timing of Du Pont's sampling was during high flow conditions due to heavy rainfall. Data from the U.S. Geological Survey collected on the Christina River at Cooch's Bridge, Delaware (far upstream of the site) showed that the average flow rate at this point for the month of December 1992 was over twice the average flow rate for December for the years 1943 to 1991. Also, the maximum flow measured during December 1992 was over 10 times the average maximum during December from 1943 to 1992. The sampling conditions were not representative of ambient conditions for a typical month of December. The higher the flow rate, the greater the dilution capacity of the river, thus decreasing the effect of the metal loading from the Site ground water on the river.

The extra dilution caused by the heavy rainfall is also supported by data collected in August 1987 by Du Pont at the James Street Bridge. The late summer is typically a low flow period. The average level of zinc measured at the James Street Bridge was over 50% higher, the average level of lead was over 500% higher, the average level of cadmium was over 400% higher, and the average level of barium was close to 100% higher in August 1987 (lower flow) compared to the sampling done during the public comment period (higher flow). EPA questions Du Pont's statement that "the higher concentration of these metals in the August 1987 data is consistent with the expected seasonal discharge variations, and further confirms the existence and magnitude of non-Site contributors to the river burden". (Du Pont, 1/27/93, pg. 3-3) EPA's view is that at lower flow conditions the impacts of the Site to the river water quality are greater.

d. The sampling technique used by Du Pont at the James Street bridge (a bailor with a bottom ball stop lowered with a rope) sampled only the upper portion of the water column. Since the downstream sampling location was located at the edge of the site, the sampling technique may not have allowed for thorough mixing of the ground water and the river water, thus not allowing the full impact of the ground water on the river water to be measured.

The problems expressed in the above paragraphs with respect to Du Pont's river study performed during the public comment period[8] do not allow conclusions to be drawn as to whether or not the physical barrier wall is necessary.

Second, during the RI/FS process Du Pont performed several sets of loading calculations to estimate the effects of the metals on the river. Du Pont's Data Sufficiency Memorandum (DSM) of 4/27/89 contained the following estimated loading rates:

Cadmium:	0.0055	to	0.06	lb/day
Barium:	36	to	127	lb/day
Zinc:	1.4	to	50	lb/day

In the RI report (8/26/92), Du Pont presented what it considered a "worst possible case" scenario with the following loading rates:

Cadmium:	0.007 lb/day (corresponding to a 0.61 ppb increase in cadmium levels in the river)
Barium:	4.5 lb/day (corresponding to a 70 ppb increase in barium levels in the river)
Zinc:	3.0 lb/day (corresponding to a 46 ppb increase in zinc levels in the river)

EPA believes that the DSM (4/27/89) presented a good range of potential loading rates.

EPA does not agree with Du Pont's comments that the calculations presented in the RI, while in EPA's opinion at the low end of the range, were "higher than reality" (Du Pont, 1/27/93, pg. 3-3) because of the use of conservative assumptions including that "full hydraulic communication between Columbia Formation and River," that "metals discharge at groundwater rates," and that "no dilution by river" was accounted for (Du Pont, 1/27/93, pg. 3-3). In regards to Du Pont's claim that it was assumed that full hydraulic communication existed between the Columbia aquifer and the river, Appendix I of the RI contains

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[8]Although EPA agreed to the concept of Du Pont's sampling of the river during the public comment period, no work plan was submitted to EPA, nor reviewed or approved by EPA.

loading calculations assuming both no underflow and about 10% underflow. Contrary to Du Pont's claim, the RI narrative and Table 3-4 of the Proposed Plan comments discussed results from the calculations which assumed underflow (i.e., the less conservative results). Any metals that would go under the river would be discharged to the south wetlands and any of the metals that were not filtered out of the water by the sediments would flow into the river anyway because the south wetlands discharges to the river.

EPA also believes that the assumption that the metals migrate at the same rate as the ground water is only slightly conservative at best. Since the contamination has been in the ground water for close to a century and the river is in the middle of the plume, the system should be in equilibrium. As a result, the dissolved contaminants should migrate in the ground water with little to no retardation.[9]

Du Pont's statement that river dilution was not taken into account in the RI calculations is incorrect. The ground water was diluted by 1,000,000 ft^3/day of river water in the RI calculation. Paragraph C above discusses the impact of the rainfall on the river water flow.

Overall, EPA has determined that the loading calculations performed by Du Pont as part of the RI/FS process continue to be useful in making remedial decisions.[10] These calculations show that the ground water potentially can have a significant effect on the river during low-flow periods. The physical barrier wall will limit, to the maximum extent practicable, the discharge of ground water to the river. At low flow conditions, these discharges have been calculated to contribute significantly to the zinc concentrations in the river that, during the public

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[9]Review of Appendix I of the RI shows that sometimes the dissolved concentration was used for calculating loading rates and sometimes the total. Review of the original data in the DSM 4/27/89 shows that at times the dissolved concentration was slightly higher and at times significantly lower. EPA acknowledges that the overall effect of using a combination of total and dissolved concentrations would probably be to somewhat overstate the calculated loading rate. This impact, however, may have been offset by other assumptions which tended to lower the calculated loading rates (e.g., assuming that the discharge to the south wetlands does not affect the river and using well water data for the seep concentrations when actual seep data was available.

[10]EPA understands that "Du Pont maintains that loading calculations in the RI Report are the best estimate of actual impact." (Du Pont, 3/12/93)

comment period and August 1987 Du Pont sampling events, exceeded the AWQC.

Third, all of the calculations performed during the RI related to overall river water quality and assumed a well mixed river. EPA is also concerned about toxicity caused by ground water prior to it mixing completely in the river. The ground-water seeps along the north bank of the river would require as high as a 600 to 1 dilution for zinc, as high as a 400 to 1 dilution for lead and as high as a 140 to 1 dilution for cadmium in order to reach their respective AWQCs (see Figure 66, RI report, 8/26/92). These seeps are very likely to cause near-field AWQC exceedances[11] and must be controlled in order to protect the environment.

Fourth, another concern with the Site ground-water loading to the river and wetlands is the potential for contamination of the river and wetland sediments. Du Pont states that "surficial sediments have not been shown to be contaminated as a result of ground water," (Du Pont, 1/27/93, pg. 3-1), the "data collected during the three phases of the RI provided empirical support for Du Pont's position that the contaminants of concern found in Christina River sediments are due to historical Site operations, river bank erosion, and plant outfalls," (Du Pont, 1/27/93, pg. 3-5) and that "EPA provided no technical assessment beyond the work in the RI to support their contention" (Du Pont, 1/27/93, pg. 3-5) that the ground water is impacting the sediments.

EPA has not in the past, nor has it at this time, determined what percentage of the metals in the ground water discharging to the river and wetlands will precipitate in the sediments. However, it is a commonly known phenomena that the oxygen in surface water can cause precipitation of metals. This process was discussed in Du Pont's Environmental Evaluation (pg. 4-26, 8/7/92):

> The metals will likely co-precipitate out of solution by chemical complexation with the abundant ion hydroxide precipitates that form by oxygenation of seepage water. This mechanism can transfer metals from the dissolved phase to particles that may settle to the river bottom in areas where low current rates allow net deposition of sediment. In addition, the high level of natural turbidity in the river can enhance this transfer to the particulate phase since most metallic cations strongly bind to the fine-grained clay particles and to organic particles rich in

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[11]Interview with Rick Green, Water Resources Division, Delaware Department of Natural Resources and Environmental Control (DNREC), 5/27/93.

fulvic and humic substances from the decomposing marsh vegetation.

According to Du Pont's comments the Christina River "is well oxygenated at both the upstream and downstream location." (Du Pont, 1/27/93, pg. B-4)

EPA does not agree with Du Pont's assertion that river bank erosion is a cause of the sediment contamination in the river. EPA has only observed small signs of some very localized erosion: nothing that could contribute significantly to the observed sediment contamination. In regards to the contribution by the plant outfalls to the sediment contamination, Du Pont has not provided any evidence in support of its comments.

EPA also does not agree that past historical practices are the cause of the current surficial sediment contamination observed in the river sediments. EPA does agree with Du Pont's statement in the RI that "current metals inputs to the river are lower than during historic operation." However, this does not mean that the current inputs are insignificant. When one considers the fact that lithophone production and lithophone waste disposal stopped in the early 1950's, and that the north landfill has been closed for almost twenty years, coupled with the fact that the Christina River has a high sediment load from Churchman's Marsh to the Delaware River (which would presumably result in deposition of surficial sediments which were not contaminated with Site-related contaminants), it is difficult to believe that past operations are the cause of the surficial sediment contamination. On the other hand, when you consider that the heavily contaminated ground water (from both the fill zone seeps and the Columbia aquifer) will precipitate metals, and the fact that surficial sediments are still contaminated today, it indicates to EPA that, in fact, ground water is having an adverse impact on the river sediments. Thus, installation of the physical barrier wall is warranted.

Fifth, the barrier wall will prevent Site ground water from recontaminating the dredge area once clean fill has been placed in the dredged area. Recontamination of this area from the Site ground water is a valid concern. If Du Pont's RI calculation of 3 lb/day of zinc to the river is accurate, and one assumes that 50% of this zinc goes to the water column and 50% remains in the fresh sediments, that the fresh sediments consist of 75% fines, then in one year an area of over 3000 ft^2 and six inches deep of the river bottom will be recontaminated to a level that would trigger the clean-up criteria of 5600 ppm (on a normalized basis). While these assumptions can vary in either direction, it is clear that the physical barrier wall must be installed to limit the metals loading to the river.

In summary, EPA believes that the data generated at the Site supports its conclusion that Site-related ground-water contamination has impacted, and will continue to impact, river sediments and surface water quality unless remedial measures are taken. Du Pont's comments that EPA's remedy will be ineffective because the remedy may not improve the environmental conditions in the river due to upstream sources is not warranted. This is because EPA and DNREC are committed to addressing the other sources as well. Addressing each of the sources, including the Site ground-water, will help restore the sediment and surface water quality of the river.

F.4. Du Pont commented that its "recommended remedy (the River bank cover system) is a straightforward approach to providing environmental protectiveness." (Du Pont, 1/27/93, pg. 3-5)

EPA'S RESPONSE: The river bank cover system would not be effective in controlling the fill zone seeps since the seeps would travel under the end of the cover and into the river. Therefore, EPA does not consider the river bank cover system alone effective enough to meet the threshold criteria of providing overall protectiveness of human health or the environment. In fact, EPA has not included it in the selected remedy because it would destroy valuable habitat along the banks of the north landfill.

F.5. Du Pont commented that a physical barrier wall to limit the discharge of the fill zone and the Columbia aquifer into the Christina River is not consistent with the NCP and is not cost-effective because in Du Pont's opinion, "there is no clearly defined, scientifically defensible relationship between ground water discharges from the areas of concern and alleged exceedances in water quality criteria and contamination present in River sediments" and the Proposed Plan "does not consider the numerous non-Site related potential sources for River and sediment contamination." (Du Pont, 1/27/93, pg. 4-6, 4-7)

EPA's RESPONSE: EPA has addressed Du Pont's comments about the need for the physical barrier wall to protect the environment in comment F.3. In summary, EPA has determined that any remedy that does not limit the discharge of contaminants in the Columbia aquifer and the fill zone to the river does not provide overall protection of human health and the environment, one of the threshold criteria, and therefore can not be chosen. The physical barrier wall was the only remedy to adequately mitigate the risks posed by the ground water to the river. Section 300.430(f)(1)(ii)(D) of the NCP states that "each remedial action selected shall be cost-effective, provided that it first satisfies the threshold criteria...." Therefore, one cannot use cost as the basis in deciding whether to select the physical barrier wall or Du Pont's preferred alternative of a river bank cover system since the river bank cover system does not meet the threshold criteria.

F.6. Du Pont commented that "elimination of groundwater flow will not achieve ARARs, therefore the EPA goal of controlling groundwater migration to eliminate degradation of the River and the wetlands due to groundwater discharge is not a valid NCP based remedial goal." (Du Pont, 1/27/93, pg. 3-4)

EPA's RESPONSE: It has been shown that the release of contaminants from the Site contributes to AWQC exceedances. While it is possible that controlling releases from this Site may not correct each and every exceedance of the AWQC, controlling ground-water releases to the maximum extent practicable is the most that can be done at this Site to achieve compliance with the AWQC. As mentioned previously, EPA and DNREC are committed to taking action against other possible sources of contamination to the river as well. Certainly the NCP should not be interpreted to mean that unless one can completely correct all AWQC exceedances within a water body, then no efforts should be made to incrementally reduce contaminant releases.

G. GROUND WATER

G.1.* A resident asked if the hookup to the public water supply for residents on Airport Road would have higher priority than remediating the other areas of the Site.

EPA RESPONSE: Yes, EPA intends design and installation of the public water supply lines to residents on Airport Road to start as soon as possible. Although it may have to wait until after the remedial action along Basin Road is completed.

G.2.* Several residents asked if the two businesses at the very west end of Old Airport Road would be connected to the public water supply line along with the other residents. Du Pont also commented (not at the public meeting) that with all of the other remedial work at the south disposal area and with the extensive proposed ground-water monitoring, it was not necessary to extend the public water supply line to the end of Old Airport Road.

EPA's RESPONSE: After considering the comments and reviewing Site data, EPA has determined that it is not necessary to extend the public water supply line to the end of Old Airport Road in order to protect human health. The line will extend only approximately one-half the distance from the south wetlands to the west end of the road. All of the residences and businesses along Old Airport Road from the Site to, and including, the Cress Collision Service, Inc. business that so desire will be tied into the public water supply line. (See Figure 40 in the ROD)

G.3.* A resident asked how to determine if a residential well is in the Columbia or Potomac aquifer.

EPA RESPONSE: According to DNREC, all wells installed in Delaware since July 14, 1969 have a permit. EPA suggests that residents contact DNREC with the permit number of the well to obtain that information.

G.4. Du Pont commented that the Potomac aquifer should be monitored only as part of the 5-year review process since other components of the remedy would eliminate potential receptors.

EPA's RESPONSE: EPA believes that monitoring the Potomac aquifer only every five years is not adequate. Additionally, the purpose of a five-year review is to evaluate data that has been collected during that period, rather than to wait five years and then collect data. EPA is not concerned only about potential receptors, but EPA is also concerned about the ground water as a resource. If the plume spreads, active remedial measures will be necessary long before the plume approaches a drinking water well for several reasons. One, the larger the plume, the larger the area that is unavailable in the future for someone to drill a drinking water well, and two, the larger the plume, the more difficult remediation becomes. If the early results of monitoring indicate that the interval between monitoring events can be lengthened, then EPA may adjust the interval. It should also be noted that a 5-year review may be conducted at shorter intervals than every five years.

G.5. Du Pont commented that it did not agree with the reference dose (RfD) for cobalt which EPA specified for Du Pont to use in calculating the risk caused by ingestion of ground water. (Du Pont, 1/27/93, pg. A-1)

EPA's RESPONSE: Du Pont and EPA discussed this issue a number of times during the RI/FS. Below is an excerpt from review comments provided by EPA to Du Pont on 12/2/91 on a draft version of the Human Health Risk Assessment:

> The text implies that EPA's recommended RfD for cobalt is inappropriately conservative. However, protection is specifically included in the RfD definition. Furthermore, Region III did not recommend applying an intraspecies uncertainty factor of 10 to the RfD for cobalt because in our judgement the tested individuals were already sensitized

by prior exposure. The EPA Environmental Criteria and Assessment Office in Cincinnati, on the other hand, did recommend the additional uncertainty factor which would have produced an RfD which was ten times lower. The Region III recommendation was therefore an intermediate position and not the most protective suggestion.

EPA continues to believe that $1x10^{-4}$ mg/kg-body weight/day is an appropriate RfD for use in the human health risk assessment developed for the Site.

H. GENERAL COMMENTS

H.1.* Several residents asked how long it would take to implement the Proposed Plan.

EPA RESPONSE: After issuance of the Record of Decision, EPA intends to take enforcement action to ensure that the cleanup is undertaken. The enforcement process is estimated to take about 12 months. EPA estimates that the clean-up will take five to seven years to complete.

H.2.* A resident asked how long the proposed caps over the north and south landfills would last and how long the proposed remedies would be monitored.

EPA RESPONSE: The caps are estimated to have an initial useful life of between 20 and 50 years. However, maintenance would be performed on a regular basis to ensure their long-term integrity.

H.3.* A resident asked if the alternatives not preferred by EPA were less effective than the preferred alternatives.

EPA RESPONSE: EPA chose its preferred alternative based upon the following nine evaluation criteria: overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost; State acceptance; and community acceptance. EPA's selected remedy takes into account public comments and EPA believes its ROD provides the best balance among the alternatives with respect to the nine evaluation criteria based on current information.

H.4.* A resident asked if the preferred alternative in the Proposed Plan is always adopted.

EPA RESPONSE: No. EPA believes, at the issuance of the Proposed Plan, the preferred alternative provides the best balance with respect to the evaluation criteria. EPA may modify the preferred alternative, select another response action, or develop and/or select another alternative in response to public comment. In this case, comments received during the public comment period have resulted in EPA selecting a remedy which includes components which are slightly different from those described as the preferred alternative in the Proposed Plan. These are described in the "Documentation of Significant Changes" section of the ROD.

H.5.* A resident asked what health-related threats the contamination posed.

EPA RESPONSE: The Site presents an endangerment to human health and the environment. EPA has identified 11 contaminants of concern that present threats to humans. Seven are metals and four are organic compounds. The organic compounds were found in the water samples, and all are carcinogens. Although the levels of exposure for humans to the contaminants is low enough not to require immediate action (except for special health and safety precautions for subsurface work), long-term exposure to the contaminants does pose a threat to human health. Long-term exposure to some of the contaminants may cause cancer, edema, and loss of muscle control.

H.6.* A resident asked if Site soil containing heavy metals would have to be removed and replaced with new soil.

EPA RESPONSE: Except for the portion of the Site owned by the State of Delaware and portions of the ballpark, the contaminated soil will be left in place. Remedial alternatives were selected to prevent exposure to soil and to prevent migration of contaminants from the soil. It should be noted that the ROD does call for a large amount of sediments contaminated with heavy metals to be removed and replaced with clean sediments in the wetlands and the Christina River.

H.7.* A resident asked if the community will continue to be informed of clean-up progress after negotiations with the responsible parties are completed and if the community will be financially impacted as a result of the cleanup.

EPA RESPONSE: EPA is announcing the release of its Record of Decision in The Wilmington News Journal and it will continue to produce fact sheets and hold meetings, as necessary, to inform the community of activities at the Site. In addition, citizens are always welcome to call the Site public affairs contact (215-

597-9800) directly for information. The finances needed to fund the cleanup will be obtained from the responsible parties and/or from the Superfund trust.

H.8. The Water Resources Agency for New Castle County (WRA) commented that an Environmental Impact Statement is being prepared regarding the conversion of Churchman's Marsh to a public water supply reservoir. The WRA's understanding from State of Delaware officials was that the E.I. Du Pont, Newport Superfund Site "would have no impact on the feasibility of the proposed Churchman's Reservoir site," and requested that the ROD reflect this understanding.

EPA's RESPONSE: EPA does not expect the Site to have any impact on the Churchman's Marsh but can not state so definitively at this time because the Site pre-design sampling and the design itself have not been completed. The ROD acknowledges the potential that Churchman's Marsh may become a public water supply reservoir.

H.9. CIBA-GEIGY Corporation commented that it generally supports Du Pont's comments and is particularly concerned about any closure of Basin Road as it is used for truck traffic to and from the plant.

EPA's RESPONSE: EPA has addressed all of these concerns in other comments. See especially comment C.4.

H.10. The U.S. Department of the Interior (DOI) commented that:

> The Proposed Plan outlines disturbance of wetlands at the North Landfill, South Wetlands, and Christina River areas. We request that EPA support our requirement for detailed plans that specify how these areas would be restored to pre-disturbance values plus value to compensate for the recovery period. This would include planning by qualified wetland restoration specialists, and development of strong performance standards to measure and assure success.

EPA's RESPONSE: The ROD includes performance standards which meet many of DOI's needs. As part of the remedial design, a complete restoration program and long-term monitoring plan shall be developed. The ROD also includes performance standards to assure success of the restoration program.

H.11. DOI commented that:

> The proposed Christina River bank cover system would result in permanent losses of habitat and we are not convinced that other cover systems would be less suitable. The design detailed in the Plan does not allow for growth medium necessary for establishment of a diverse plant community vital to fish and wildlife resources. In addition, the Proposed Plan does not provide for compensation for this permanent loss, something necessary if a more environmentally sensitive alternative is determined to be infeasible.

EPA's RESPONSE: EPA has decided not to include the river bank cover system in the selected remedy in order to preserve the habitat along the river bank. This habitat can be used for spawning, nursery, feeding, and cover for fish and for feeding, breeding, roosting and cover for migratory birds. EPA believes that the vegetation on the river bank provides adequate slope stability and erosion control.

H.12. DOI commented that:

> In general, we believe that EPA should employ a "balance sheet" method to simply and clearly present the public with the habitat and land use changes due to site remediation. The pre-remediation habitat values for each habitat/land use type would be listed along with expected changes from each of the remedial alternatives. Then EPA would explain how losses of habitat values would be addressed through enhancement measures or habitat development requirements. In this manner, you would achieve NEPA equivalency for those environmental values not protected by a specific ARAR.

EPA's RESPONSE: In response to the comment, EPA has added 40 CFR 1500.2(f) [regulation under the National Environmental Policy Act (NEPA)] as a relevant and appropriate requirement (i.e., an ARAR) for the north and south landfills to the extent that remedial actions at these landfills shall take into account the remedial action's impact upon the environment at the landfills. As a result, one of the institutional controls at each of these landfills is that the surface shall remain vegetated so they can retain habitat value for wildlife.

The ROD also has a performance standard requiring that a balance sheet be prepared to assess habitat values both pre- and post-remedial action.

H.13. The Town commented that EPA should "give due consideration of Du Pont's alternate proposals, in light of the significant negative impact the Proposed Plan will have on the quality of life and property within the Town.

<u>EPA's RESPONSE</u>: EPA's response to comments C.4 and F.1 should alleviate many of the Town's concerns about the remedy decreasing the quality of life for Newport residents. EPA has given consideration to Du Pont's comments as can be seen by the majority of this Responsiveness Summary. The selected remedy outlined in the ROD is required to adequately address (current and future) risks to humans and to the environment, and if anything, should contribute to an increase in the quality of life for residents of the Town over the long term.

H.14. Du Pont commented that EPA's preliminary outline of the long-term monitoring program outlined in its 10/30/92 letter to DNREC is excessive. Du Pont stated that the level of detail in the Proposed Plan was appropriate and that the specifics would be determined in the remedial design. (Du Pont, 1/27/93, pg. A-3)

<u>EPA's RESPONSE</u>: EPA outlined a long-term monitoring plan to provide DNREC and the remedial designer with an idea of what EPA expected in the long-term monitoring plan in the remedial design. The outline is not intended to be the plan. EPA believes that the amount of monitoring described in the outline is warranted. Since the ground water is not being remediated, monitoring is required to make sure the plume does not become unacceptably large and require active remedial measures. Monitoring of the ground water is also necessary to make sure there is no release of thorium since the thorium drums are not being removed. Monitoring of the remediated portions of the wetlands is required to ensure the success of the remediation. Monitoring of the unremediated areas is necessary to make sure the bioavailability of the metals does not increase to unacceptable levels and to make sure that the remedy remains protective.

H.15. Du Pont commented that if other metal loadings to the river are not adequately characterized then "ARAR exceedances during post-remediation monitoring" will "be erroneously ascribed to the Du Pont-Newport Site." (Du Pont, 1/27/93, pg. A-4)

<u>EPA's RESPONSE</u>: The post-remediation monitoring for the river and the wetlands will be examining mainly biological endpoints rather than ARAR exceedances (although it is likely that surface water quality will be monitored). Also, DNREC and EPA are planning to deal with the other major sources of contaminant loadings to the river and additional information about these other sources should be available during the remedial design/remedial action process.

H.16. Du Pont commented that "the final approved version of the Focused Feasibility Study (FFS) for this Site, dated August 27, 1992, was completed in accordance with applicable provisions of the NCP, and outlines the specific remedial goals which are to be attained by the selected remedy. Table 4-1 summarizes the remedial goals for the areas of interest at this Site, as summarized in the FFS report, approved by EPA." (Du Pont, 1/27/93, pg. 4-1)

<u>EPA's RESPONSE</u>: EPA modified the FFS after its submission. The modifications included:

1. "Therefore, controlling the groundwater discharge from the Columbia aquifer and the fill zone is a remedial goal for this Site." (EPA: 10/7/92)

2. "Attached are several alternatives that were not analyzed in the FFS. One involves excavation of the portion of the south landfill underneath and to the east of Basin Road. The other involves remediation of the Columbia aquifer underneath the south wetlands." (EPA: 10/7/92)

EPA's selection of a remedy for this, or any other site, need not be based only on the information contained in the remedial investigation and feasibility study reports prepared by a potentially responsible party (PRP). It is EPA's responsibility to determine the remedial alternative for a Site.

H.17. Du Pont commented that "the PRAP does not replace the RI/FS, it supplements the RI/FS," and "a PRAP that is radically different than the approved RI/FS is not consistent with a description of a PRAP cited in the NCP." (Du Pont, 1/27/93, pg. 4-3)

<u>EPA's RESPONSE</u>: EPA's Proposed Plan did supplement the RI/FS and, as described in the NCP, briefly described "the remedial alternatives analyzed by the lead agency," proposed "a preferred alternative," and summarized "the information relied upon to select the preferred alternative." (Section 300.430(f)(2) of the NCP).

H.18. Du Pont commented that it addressed all of the remedial action objectives defined in the FFS with recommended remedial alternatives." (Du Pont, 1/27/93, pg. 4-4)

<u>EPA's RESPONSE</u>: Du Pont's preferred alternative as outlined in the FFS failed to address impacts caused by the Columbia aquifer ground water on the river which was identified by EPA as a remedial action objective in EPA's approval letter for the RI/FS (see comment H.16). The information used in selecting a

remedy for a site is not limited to the information contained in the RI/FS reports themselves, but rather includes all information contained in the Administrative Record file.

H.19. Du Pont commented that "an explicit requirement of the NCP as provided for in NCP Section 300.430(f)(5)(ii)(D), is that the PRAP must state how the remedy is cost effective." (Du Pont, 1/27/93, pg.4-4)

<u>EPA's RESPONSE</u>: NCP Section 300.430(f)(5)(ii)(D), states that the ROD must describe how the remedy is cost-effective. The ROD does this.

H.20. Du Pont commented that "the cost comparisons ($7 million versus a minimum of $67 million) between the different sets of alternatives is so striking that enormous increases in protectiveness achieved would have to be realized in order for the PRAP to meet NCP requirements for cost-effectiveness," and that "EPA has not provided any information or explanation on how the cost-effectiveness determination in the PRAP was reached." (Du Pont, 1/27/93, pg. 4-8)

<u>EPA's RESPONSE</u>: EPA does believe that the remedy selected in the ROD (at $50,000,000 vs. $67,000,000 in the Proposed Plan) does provide significant increases in overall protection of human health and the environment, especially since Du Pont's preferred alternative does not meet the statutory mandate that remedies provide overall protection to human health and the environment.

EPA disagrees that it has not provided any information or explanation on how the cost-effectiveness determination was made. The preamble to the NCP states that "EPA believes that the remedy selection process promulgated today effectively harmonizes the somewhat competing requirements of CERCLA, and ensures that remedial actions will fulfill each statutory mandate." (55 Fed. Reg. 8724 (1990)) EPA has used the nine criteria (including an evaluation of costs) for selecting the remedy, and therefore, has complied with the statutory mandate with respect to cost-effectiveness. Du Pont's contention that its preferred remedy is more cost-effective is not meritorious because cost-effectiveness is only one factor when selecting from alternatives that meet the threshold criteria (Section 300.430(f)(1)(ii)(D) of the NCP) and Du Pont's proposed remedy does not meet the threshold criteria.

H.21. Du Pont commented that a phased remedial approach, one that would delay decisions about the wetlands, the river, and the physical barrier wall pending further studies regarding the impacts of the ground water on the wetlands and the river and regarding which portions of the wetlands and river require remediation, is appropriate at the Site. Part of Du Pont's reasoning included its contention that there is insufficient data at this time to determine the fate and transport of the metals in the Site ground water.

EPA's RESPONSE: EPA has determined that the studies performed to date are adequate to provide the basis upon which to select a remedy which addresses the whole Site. EPA does not believe it would be appropriate to delay implementation of the remedy for those obviously contaminated portions of the Site, and therefore, EPA has determined that there is no need to divide the Site into operable units.

H.22. Du Pont commented that on page 5 of the Proposed Plan in the last paragraph that the sentence stating "'soil beneath the CIBA-GEIGY plant' should be revised to "'soil from the CIBA-GEIGY plant area' as soil samples were not actually collected beneath the plant." (Du Pont, 1/27/93, pg. A-6)

EPA's RESPONSE: EPA believes either wording is acceptable as the "chemical plant" is not limited just to the buildings. Therefore, the wording remains as is.

H.23. Du Pont commented that on page 9, paragraph 3, sentence 1 of the Proposed Plan, the words "and hazards" should be added after the word "risks." Du Pont also commented that in this paragraph the construction worker risks should be further described as future construction worker risks.

EPA's RESPONSE: "Risks" as used here include both carcinogenic and non-carcinogenic impacts and therefore the words "and hazards" are not necessary. EPA will add the word "future" into this paragraph to further describe the construction workers.

H.24. Du Pont commented that in Table 1 of the Proposed Plan, the construction worker for the CIBA-GEIGY plant should be flagged as "Potential future use only." Du Pont also commented that in Table 1 "the hazard index without lead is 2.5, not 6.0, and the hazard index with lead is 22 not 26" for the CIBA-GEIGY construction worker, the hazard index with lead for the south landfill construction worker is 1.6, not 3.0, and "the ** note should indicate that the total hazard index presented includes lead." (Du Pont, 1/27/93, pg. A-6)

EPA's RESPONSE: EPA agrees that the CIBA-GEIGY construction worker should be flagged as "Potential future use only" and that "the ** note should indicate that the total hazard index presented includes lead." EPA has determined that the hazard indices were correct as presented in Table 1 of the Proposed Plan (see ROD Table 10). EPA used the chronic hazard index calculation instead of the sub-chronic calculation which would have resulted in Du Pont's number.

H.25. Du Pont commented that on page 11, paragraph 3, sentences 2 and 3 of the Proposed Plan, the sentences which read "contamination is prevalent throughout... and widespread..." should read "contamination was observed at the two stations sampled... contamination at the stations sampled is most likely widespread."

<u>EPA's RESPONSE</u>: EPA does not believe the sentences, as written in the Proposed Plan, are "misleading" as Du Pont states (1/27/93, pg A-6). However, they have been changed in the ROD to read "contamination was detected at the two sampling stations....," and "these two stations are located in such a way as to indicate that the contamination is prevalent throughout the area." The third sentence has been changed to "contamination is most likely widespread due..."

H.26. Du Pont commented that on page 12, paragraph 1 of the Proposed Plan, that the "benthic density should be described as the number of macroinvertebrates per unit area, not micro-organisms." (pg. A-7, 1/27/93)

<u>EPA's RESPONSE</u>: EPA agrees.

H.27. Du Pont commented that on the last line on page 15 of the Proposed Plan, it should be indicated that arsenic, cobalt, manganese, and zinc contributed to unacceptable human health risks in the Columbia aquifer.

<u>EPA's RESPONSE</u>: EPA agrees.

H.28. Du Pont commented that the Human Health Evaluation date is 6/11/92.

<u>EPA's RESPONSE</u>: EPA acknowledges that Du Pont sent to EPA several corrected pages including a new cover with a 6/11/92 date. However, EPA saw no need to change the cover, and still considers the 3/18/92 date to be accurate.

H.29.* A resident asked if EPA's preferred alternative would address the high bacterial count in the Christina River.

EPA's RESPONSE: The high bacterial count is not being caused by the Site and therefore will not be addressed by the selected remedy described in this ROD.

H.30.* A resident asked if the community would be impacted financially by the remediation due, for example, to possible increased public safety costs.

EPA's RESPONSE: There may be some costs to the Town associated with the remediation but the remediation itself will be funded by potentially responsible parties or EPA and not the Town.

ATTACHMENT A

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF AIR & WASTE MANAGEMENT
89 KINGS HIGHWAY
P.O. BOX 1401
DOVER, DELAWARE 19903

OFFICE OF THE DIRECTOR

TELEPHONE: (302) 739 - 4764

August 17, 1993

Mr. Stanley L. Laskowski (3DA00)
Acting Regional Administrator
U.S. EPA, Region III
841 Chestnut Building
Philadelphia, PA 19107-4431

SUBJECT: DuPont-Newport Record of Decision, July 1993

Dear Mr. Laskowski:

The Delaware Department of Natural Resources and Environmental Control ("Department") has completed its review of the July, 1993 Record of Decision (ROD) document for the DuPont-Newport Superfund site. This correspondence represents the Department's position regarding the issues described in this ROD.

The Department has elected not to concur on portions of the remedy described in the ROD. The attachment (Attachment A) discusses the areas of the ROD which the Department does not concur along with the rationale for its position.

Thank you for the opportunity to comment on this document.

Sincerely,

Mary L. McKenzie

Mary L. McKenzie
Acting Director

KFK:dw
KFK2364.wp
Attachment

pc: Christophe A.G. Tulou
N.V. Raman
Karl Kalbacher
Anna Hiller
Dave Carter
Bob Kuehl

Delaware's good nature depends on you!

Attachment A

RECORD OF DECISION FOR DUPONT-NEWPORT SITE
COMMENTS OF THE DELAWARE DEPARTMENT OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL

1. South Landfill: The Department has elected not to concur with this portion of the remedy. The Department supports the installation of a low permeability cap over the south landfill. We do not, however, support the stabilization component of the remedy which is not cost effective, because it provides hardly any benefit to the environment at an expense of approximately $10-12 million. In DNREC's opinion the stabilization component of the remedy is redundant. EPA's rationale for the double remedy provided in the responsiveness summary is not very convincing.

   The Department questions this double remedy for the following reasons:

   a. Likely redundancy of the stabilization.

   b. The waste constituents in the south landfill have a low mobility, and therefore, monitoring of groundwater quality by DuPont should provide enough protection to the environment.

   c. In its comments on the Proposed Plan (January 28, 1993) DuPont has raised reasonable concern about the possibility of stabilization increasing the leachability of some metals in the waste material. The Department is concerned that little or no benefit to the environment will be obtained by stabilizing the waste material if the stabilization process increases the mobility of some contaminants.

   d. In the responsiveness summary groundwater flow is used as the basis to dispute DuPont's contention that "there is currently little or no flow of contaminants from the south landfill". Groundwater flow alone may not cause contaminant flow. The contaminant must also be mobile to cause its migration. In the second draft of the ROD, the impression is given that EPA agrees with the concept that the metals contamination in the groundwater does not move very quickly. This impression is supported by EPA's selection of monitoring as the remedy for groundwater on the south side of the Christina River. If the monitoring of the groundwater is considered protective enough to address the concern of metals contamination in the groundwater, the necessity to stabilize the waste seems superfluous. The low permeability cap will considerably reduce the infiltration of surface water.

2. South Wetlands: The Department does not concur with this portion of the remedy. The Department has provided to EPA on numerous occasions its position regarding the use of sediment cleanup criteria to determine areas of the south wetlands requiring remediation. The Department's concerns with the use of sediment cleanup criteria for remedial decision making are based upon:

a. The limited number of sampling stations used to determine the sediment chemistry based cleanup values, especially for the wetlands. It appears that the data is not sufficient to be used for setting quantitative cleanup levels. As this document states (i.e., Page 3 of the River and Wetland Remediation Goals memo), "there is not one single biological test performed at the site that correlates statistically well to the sediment chemistry (either a single contaminant or suite of contaminants)."

b. The Department is concerned by the observation that the sampling stations in the south wetlands where both biological testing and metals chemistry analysis were performed (AS01, AS03, and AS05), the results indicate that very limited toxicity occurred to the test organisms even though elevated levels of site related contaminants were found in the sediments. Statistically significant sampling should be conducted in the area to better assess the relationship between the sediment chemistry values and the biological testing results. Setting sediment cleanup criteria using the data currently available would not be appropriate.

c. The Department questions the approach of combining the Christina River and wetlands sediment toxicity and chemistry data to determine one set of sediment chemistry based cleanup levels that are applicable to both ecosystems, the river and the wetlands. In the referenced memo (i.e., River and Wetland Remediation Goals memo) the south pond is discussed as a special area where differences in environmental conditions between the pond and the wetlands may account for sediment toxicity differences (page 5). If differences in bioavailability exist between the south pond and the wetlands, it would be reasonable to assume that differences in bioavailability and impacts would exist between the wetlands and the Christina River. The sediment chemistry may be different and the sensitivity of different organisms that inhabit the two ecosystems may also differ. Concerns exist that the limited data does not adequately reflect the natural variability at the site.

d. It is the Department's understanding that two basic methods exist for normalizing sediment data: normalizing to grain size (Forstner, 1990; Horowitz, 1991) and normalizing data to "conservative elements" in the sample, such as aluminum (Horowitz, 1985; Windon, et al, 1989, Forstner, 1990) and iron (Smith, et al, 1987). The procedures used in analyzing site sediment samples for chemistry values and grain size have raised serious concerns. Strictly speaking, normalizing to grain size may not be valid if separate sediment aliquots were analyzed for grain size and metals chemistry. Although it is possible to attempt to thoroughly homogenize sediments before preparing separate aliquots, the results of field duplicates typically reveal considerable variability. Such variation introduces an unacceptable amount of error when interpreting data based on chemical analyses from one aliquot and grain size to a different aliquot. The procedures to determine the sediment chemistry based cleanup levels have not been explained in the ROD.

The Department's concerns with the use of the sediment cleanup criteria have been documented on several correspondences to EPA. As a result of the Department's concerns with the use of the sediment cleanup criteria, EPA requested that the Department prepare a sediment cleanup scheme for the DuPont-Newport site. On June 21, 1993, the Department submitted to EPA its sediment cleanup scheme for the DuPont-Newport site. The scheme described a process for testing sediments for chemistry through use of the acid-volatile sulfide/simultaneously extracted metals (AVS/SEM) analysis and testing sediments for toxicity to organisms (i.e., solid phase toxicity testing). The scheme called for testing to be conducted in a grid network such that a statistically significant number of samples would be collected, and therefore, a valid assessment could be made with respect to the areas of the wetlands requiring remediation.

The Department's sediment cleanup scheme was not incorporated into this ROD.

3. Christina River: The Department does not concur with this portion of the remedy. The rationale for not supporting this portion of the remedy is consistent with the comments included for the south wetlands remedy with respect to the use of sediment cleanup criteria to determine areas of the river requiring remediation.

   The Department does not believe there is sufficient data available from the Remedial Investigation of the Christina River to establish sediment cleanup criteria for the river. The limited data which has been collected in the Christina River does indicate that an adverse impact has occurred in the river area of the Ciba Geigy portion of the site. This determination was based upon biological tests which indicated a low survivorship percentage. The Department supports the use of AVS/SEM and solid phase toxicity testing in a statistically valid approach to assess impacts and areas requiring remediation in the Christina River.

4. Groundwater: The Department concurs with most of the remedy described in this section of the ROD. However, the Department does not support EPA's position regarding long term monitoring. EPA has not provided in the ROD a decision point from which corrective actions would be taken with respect to contaminated groundwater migration. Quoting from page 47 of the ROD;

   > "If any of the site-related contaminants migrated to any one of these wells at a level sufficient to produce a risk of either 10^{-4} for carcinogenic risks or 1 for non-carcinogenic risks, further remedial action (such as restoration or containment of groundwater) will be considered at that time."

The Department had requested that a decision-making process for remedial action, based on the groundwater monitoring results, be included in the ROD.

5. Coastal Zone Management Act: The Department has been coordinating with EPA regarding the consistency determination for the Federal Coastal Zone Management Act (CZMA). To date, the Department has supplied EPA with

comments on their draft consistency determination; however, the consistency determination has not been finalized.

Consistency with the Federal CZMA is performed by the Department's Delaware Coastal Management Program (DCMP). Since the remediation is a direct federal activity, it must comply with the policies of the DCMP as required by the CZMA. Since EPA has not finalized its consistency determination for the project, the DCMP cannot determine if the ROD is consistent with its policies, especially those regarding wetlands.

ATTACHMENT B

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107

SUBJECT: River & Wetland Remediation Goals (Sediment Clean-up Criteria) Du Pont-Newport Site Third and Final Edition

DATE: 7/9/93

FROM: Randy Sturgeon, RPM DE/MD Section (3HW42) *Randy Sturgeon*

TO: File

Introduction

This memo describes the determination of the wetland and river sediment clean-up criteria at the Du Pont-Newport Superfund Site. This is the third edition of this memo. Previous editions were issued 10/27/92 and 4/29/93. Discussions over the past ten months with the Biological Technical Assistance Group of EPA Region 3 (BTAG), the US Fish and Wildlife Service (FWS), the State of Delaware, the National Oceanic and Atmospheric Administration (NOAA), and EPA's Environmental Response Team (ERT) have led to the development of these criteria. In general, because the State of Delaware has had serious reservations with the original derivation of these criteria (mainly that they are based on what it considers an insufficient amount of data) discussions have continued in an effort to determine criteria with which every one could agree. Delaware's Department of Natural Resources and Environmental Control (DNREC) proposed to EPA sediment criteria dated 6/21/93. DNREC's criteria centered around using acid-volatile sulfide (AVS) and the three toxicity tests described in the second edition to determine areas of unacceptable impact. Decisions about which areas to be remediated would be made once then new sampling data was collected. EPA did not agree with relying heavily on an approach (the AVS) which is largely still in the research stage and has not been used at the Site and in essence issuing a ROD which did not make a decision about the remediation. A meeting with DNREC on 6/22/93 did not bring resolution to these issus. EPA also had serious reservations about the criteria as outlined in the second edition. EPA did not believe that the overall cost of the extra toxicity tests (around two million dollars) was warranted for the amount of benefit to gained.

At this time EPA is issuing the final sediment clean-up criteria to be used in the ROD. These criteria have been accepted (through verbal discussions although this document has not been formally reviewed) by the Biological Technical Assistance Group of EPA Region 3 (BTAG), the US Fish and Wildlife Service (FWS), the State of Delaware, the National Oceanic and Atmospheric Administration (NOAA), and EPA's Environmental Response Team (ERT) with the condition that the contaminated, yet unremediated areas, undergo long-term monitoring.

The criteria are the chemistry criteria that were developed in the first edition and revised in the second edition. All areas of wetlands and the river which exceed these values will be remediated. Since these values are high compared to other published sediment guidelines, areas of the Site where the sediment chemistry is below the chemistry criteria outlined below but above "apparent effects threshold" (AET) values, a limited number of toxicity tests (solid phase *Hyallela azteca*) will be done to make sure that the criteria are protective. Results of the testing may lower the chemistry criteria. **It is imperative to recognize that these clean-up levels are based on Du Pont-Newport Site-specific conditions and are absolutely not to be used at other sites.**

Background

The determination of sediment clean-up criteria has been a difficult process. Results of the biological testing during the RI (sediment toxicity testing and benthos studies) indicate that large portions of the Site have heavy metals that, while exceeding published guidelines,[1] are apparently not producing unacceptable biological impacts.

Numerous reviews of Du Pont documents by and discussions with the BTAG, (which has NOAA, FWS, ERT, and EPA Environmental Services Division (404 enforcement) representation), NOAA-Seattle, and others have concluded (DNREC has been heavily

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[1]To date, there are no promulgated regulations for sediment clean-up criteria. Several organizations have published levels that can be used as guidelines to help indicate when toxic effects may be expected. These include Threshold Value Guidelines or TVGs by EPA (set at levels which are expected to produce interstitial water contaminant levels at Water Quality Criteria), the biological effects guidelines or ER-Ls and ER-Ms by Long & Morgan (1991), and the Great Lakes Harbor Sediment Guidelines by the U.S. Army Corps of Engineers.

involved in these discussions as well) that certain areas of the Site exhibit unacceptable environmental impacts and warrant remediation (see Figures 1 and 2 for various test results and Table 1 for the determination of which stations exhibit impacts that warrant remediation). The conclusions took into account current conditions and possible future conditions. At this Site, a process of building a "weight-of-evidence" was used to draw the conclusions. Many aspects were considered:

A. Levels of toxicity as indicated by four different toxicity tests (two elutriate and two solid phase) measuring mortality, reproductivity and growth (not necessarily each for every test)

B. Density, diversity, and richness of benthic organisms

C. Contaminant levels in sediment and surface water

D. Field observations

E. Aerial Photographs

F. Fish tissue analysis

G. Plant tissue analysis

H. Modeling of potential future conditions

I. Sediment consumption by terrestrial animals

J. Type and value of wetland habitat

The factors which were most relied upon where the benthos studies and the toxicity test. It should be noted that EPA considers any area containing elevated levels of Site-related contaminants to be impacted by the Site. However, not all impacts warrant remediation. At this Site, stripping all areas of the river and the wetlands that exhibit elevated levels of Site-related contaminants could cause more harm to the environment than leaving all or some of the contamination in place. Since there are not any promulgated clean-up criteria for sediments, the determination of when impacts are acceptable or unacceptable and, therefore, when remediation is warranted, becomes one of professional judgement.

As discussed above, data from the RI was used to determine the general areas requiring remediation. However, due to the broad spacing of samples taken during the RI/FS, the exact areal extent of remediation is currently unknown but will be determined during the remedial design (RD) phase. In order to define the exact areal extent of remediation, clean-up criteria must be set.

Discussion

Clean-up criteria are set to provide the remedial designer with a relatively simple and practical way to delineate of areas which require remediation. The simplest, most practical test to use would be a sediment chemistry test only. Using a triad approach (the combination of sediment chemistry, benthic studies, and toxicity tests done at each particular station which was heavily relied upon to determine the general areas requiring remediation) at numerous nodes on a grid becomes expensive and impracticable to implement during RD/RA (for example, Du Pont and EPA had a very hard time agreeing to what areas demonstrated unacceptable impacts during the writing of the Environmental Evaluation). However, efforts to date by Du Pont during the RI/FS and by NOAA (personal communication with Don McDonald, 4/23/93 and 4/26/93) show that there is not one single biological test performed at the Site that correlates well statistically to the sediment chemistry (either a single contaminant or suite of contaminants) thus providing an easy way of determining sediment chemistry criteria that are predictive of biological stress.

Therefore, EPA reviewed the triad data to see if patterns, which although not correlating statistically to one single contaminant, existed between elevated levels of Site-related sediment contaminants and the most sensitive indicators of unacceptable impact (at this Site, benthos studies and toxicity tests). Chemistry data was reviewed on a normalized basis.[2]

Trends were seen for cadmium, lead, and zinc. When these metals were high (not necessarily all at once[3]), unacceptable

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[2]Extreme variability can occur in sediment contaminant levels due to naturally occurring physical/chemical conditions such as deposition rates, sediment types, grain-size and organic matter content. Therefore, comparing sediment chemistry from different sampling stations and sampling events to determine where anthropogenic loading has occurred becomes difficult. Normalizing the data allows a more direct comparison of sediment chemistry between different stations to take place. In this case it was determined that the grain size of the sediments was the greatest cause of natural variability (see Environmental Evaluation, 8/7/92, page 4-6). By normalizing the data to grain size (dividing the actual contaminant levels by the percentage of sediments from that sample that pass through a 64 micron sieve) the affect of grain size on the sediment chemistry is removed.

[3]NOAA also attempted to correlate sediment contaminant levels with each other and arrived at the conclusion that only lead and copper levels were related to each other (there was a

impacts were observed. Barium did not appear to be causing measurable impacts to aquatic life (i.e., at some stations, AS05 for instance, very high levels of barium did not cause toxicity that warranted remediation). Other Site-related contaminants such as copper, mercury, nickel, arsenic, chromium, and manganese either did not exhibit trends or exhibited trends of increasing levels associated with increasing impacts but were determined not to add to the usefulness of the criteria set for cadmium, lead, and zinc.

Figures 3 to 5 are bar charts containing the normalized concentrations of cadmium, lead, and zinc for the sediment stations where biological testing was conducted. On the right side of the chart are those stations where EPA has determined that the results of the biological testing indicates that remediation is warranted. On the left side are those stations where the results did not indicate that remediation was warranted. The charts also show the "lowest possible criteria" or "LPC" and the "maximum possible criteria" or "MPC" for each of these three contaminants.[4] The LPC for a particular contaminant is at the highest level of any station where the biological test results indicated that remediation was not warranted. The MPC for each particular contaminant is the maximum level of that contaminant for those stations where the biological tests indicated that remediation was warranted. The LPC and the MPC dictate the range of available contaminant levels from which the actual clean-up criteria may be set. Setting a clean-up criteria below the LPC would trigger remediation at stations where remediation is not warranted, and setting a criteria above the MPC would serve no purpose in directing remediation since remediation would not be triggered at any of the sampling locations where EPA has determined remediation is warranted.

The criteria ranges from Figures 3 to 5 are (on a normalized basis):

Cadmium	67	to	1121	ppm
Lead	1443	to	51860	ppm
Zinc	6853	to	32558	ppm

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correlation coefficient of approximately 0.7). This means that, overall, high levels of one contaminant are independent of other contaminants and means that measured toxicity could be caused by different contaminants at different stations perhaps singularly or in varying combinations with other Site-related contaminants.

[4]The "lowest possible criteria" and the "maximum possible criteria" are terms relative only to the data presented in Figures 3 to 5.

The above lowest possible criteria came from station AS01 in the south wetlands pond. However, this station also had the best biological test results of any station at the Site indicating that the contaminants are potentially less bioavailable in the pond. The test results and field observations (muskrat lodges, turtles, and the best stand of vegetation in the south wetlands) indicate that there may not be a need to remediate this area in spite of the high concentrations of metals that generally have caused unacceptable toxicity at other stations at the Site. The difference in the environmental conditions between the pond and the marshy wetlands may be causing a difference in the bioavailability of the contaminants, thereby causing unacceptable environmental impacts in the marshy wetlands to occur at lower contaminant levels than in the south pond. Limiting the LPC to the levels found at AS01 is therfore not protective because these levels have generally been found to cause toxicity at other sampling stations. Therefore, station AS01 will not be used to develop sediment chemistry clean-up criteria for the rest of the Site, and the sediment clean-up criteria will not apply to the south pond.

The criteria ranges from Figures 3 to 5 without AS01 are:

	LPC		MPC	
Cadmium	52	to	1121	ppm
Lead	1060	to	51860	ppm
Zinc	5350	to	32558	ppm

The absolute values for the above LPCs (the pre-normalized value for the station from which the LPC was derived) are:

Cadmium	648	ppm
Lead	509	ppm
Zinc	2520	ppm

These values are generally high compared to other sediment guidelines that have been developed such as EPA's Threshold Value Guidelines (TVGs), ER-Ls/ER-Ms (Long & Morgan, 1991), and apparent effects threshold (AET) levels[5] which are listed below:

	AET	TVG	ER-L	ER-M	
Cadmium	9.6	31	5	9	ppm
Lead	660	132	35	110	ppm
Zinc	1600	760	120	270	ppm

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[5]"Briefing Report to the EPA Science Advisory Board: The Apparent Effects Threshold Approach." US EPA Region 10 (prepared by PTI Environmental Services, EPA Contract No. 68-03-3534/PTI Contract No. C714-01) September 1988.

The fact that the LPCs are generally higher than other guidelines may mean that the bioavailibilty of the metals is lower than what could generally be expected. Although, it should be noted that the LPCs above are not levels below which toxicity is not present, but are levels at which remediation is definitely warranted at the Du Pont-Newport Site based on biological testing. As such, the actual clean-up criteria shall be set only slightly above the lowest possible criteria. Sediment chemistry clean-up criteria are (on a normalized basis):

Cadmium	60	ppm
Lead	1200	ppm
Zinc	5600	ppm

Areas where the normalized surficial sediment chemistry in the wetlands and the river is above these criteria shall be remediated.[6]

Since the LPCs are relatively high and the number of samples taken compared to the area of sediments is relatively small, further biological testing shall be performed to make sure that the Site-specific clean-up criteria are protective. Solid phase sediment toxicity tests using *Hyallela azteca* and measuring survivability shall be used to make sure that the sediment criteria described above are protective. A minimal number of sampling stations shall be performed in each of four different areas: the north wetlands, the south wetlands, the south pond, and the Christina River (four sampling stations in each of four areas with four replicates per station for a total of 64 tests will be used in the cost estimate for the ROD). These stations shall be located in areas where the chemistry levels fall between the Site-specific clean-up criteria and the AET values for zinc, cadmium, or lead. A 30% drop in survival compared the appropriate reference and/or control sample will be considered unacceptable (reference attached Dynamac letter). EPA may lower the sediment clean-up criteria depending on the results of the toxicity testing.[7] The toxicity test results will be reviewed

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[6] One concern, especially in the river, is that if an area is sampled and the % fines is very low, then the normalized values will be very high even if there is only minor contamination present. Therefore, samples are to be collected from depositional areas. If a node of the grid fall in a area that is predominately gravel the location of the node should be adjusted to an area expected to have at least 50% fines. For the purposes of these criteria, all samples should have at least 50% fines.

[7] Since the criteria do not apply to the south pond and since it is small, either the whole pond would be or would not be remediated depending on the results of the toxicity tests in the south pond along with the other data collected during the RI.

independently for each area. This may lead to different clean-up criteria for the north wetlands, the south wetlands, and the Christina River.

Since the contaminant levels that potentially will remain in the wetland and river sediments are relatively high, long-term monitoring will be required to make sure the contaminants do not become excessively bioavailable in the future. The requirements of the long-term monitoring program shall take into account the results of the delineation activities. See the attached suggestions from NOAA regarding the monitoring. **Also, due to possible impacts to terrestrial receptors at the south pond caused by plant uptake of contaminants,[8] muskrats should be monitored.**

Application

Use the criteria in the following manner:

1. Set up a sampling grid of the north and south wetlands and the river for the initial chemistry analyses. See Figure 6 for the area in which sediment chemistry tests must be taken in order to delineate the exact areas requiring remediation.[9] The chemistry criteria do not apply to the south pond as discussed above.

2. Due to the possibility of river sediments becoming mobile during a major storm event (such as a hurricane), sampling at each river station shall be done to a depth of two feet with discrete samples taken every six inches.

3. Sample the top 6" of sediment for TAL metals. Also determine the percent fines.

4. Divide the chemistry analyses of each of the above contaminants at each sampling location by the percent fines (expressed on a decimal basis) from that sampling station (i.e., normalize to grain size).

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[8]Risk assessment calculation similar to that for determining the Hazard Index for humans show there is a potential impact to animals who consume plants from this area.

[9]The number of nodes should be statistically significant and small enough to be able to guide the remedial equipment. The cost estimate for the ROD used a 100′ x 100′ grid in the wetlands and the river with the spacing becoming 500′ x 500′ in the river one-half mile up and down stream of the facilities.

5. Compare the normalized results to the following chemistry criteria:

Cadmium	60	ppm
Lead	1200	ppm
Zinc	5600	ppm

If any one is exceeded, the area represented by that sample shall be remediated.

6. If very isolated hot spots are found, EPA may elect to resample that area using a smaller grid and/or not remediate that area due to chemistry levels, or may elect to remediate the hotspot.

7. Once the chemistry screening has been completed and the areas which exceed the sediment chemistry clean-up criteria defined, solid phase sediment toxicity tests measuring the survival of *Hyallela azteca* shall be performed in the areas of the north wetlands, the south wetlands, and the Christina River where the zinc, lead or cadmium levels fall between the above chemistry clean-up criteria and their respective AET values. This same type of testing shall be performed in the south pond.

8. Four replicates shall be performed at each station. Two suitable reference locations shall be sampled. Laboratory control samples shall be run also.

9. The reference and the control samples must meet at least 80% survival for the *Hyallela azteca* test or the tests must be redone.

10. EPA shall review the *Hyallela azteca* results and decide whether or not to lower the chemistry criteria for each of the north wetlands, the south wetlands, and the Christina River. EPA shall also determine whether the results from the south pond indicate that pond should be remeidiated. A 30% drop in survival compared to the minimum survival of the reference station shall be considered unacceptable. However, it should be noted that an unacceptable result in one or two stations does not necessarily mean that the criteria must be lowered.

11. Once remediation is complete, long-term monitoring along the lines of that suggested by NOAA in the attached memo shall be performed. **The muskrat monitoring may include the following:**

a. a reference station and a station at the pond; trapping 5 to 7 muskrats per station

b. pelt off, whole body tissue analysis for TAL metals

c. **histeopaths on kidneys and/or livers**

d. **samples collected at the 1, 3, and 5 year interval starting during RD.**

A formal review and report of this data would be prepared as part of the 5 year review process unless deemed necessary at an earlier date by EPA.

Conclusion

EPA, in consultation with NOAA, and the USFWS, has developed Site-specific sediment clean-up criteria for the Du Pont-Newport Superfund Site. The determination of the criteria was based mainly on the results of the toxicity tests and the benthic studies which were performed during the Remedial Investigation. The criteria involve delineating areas of unacceptable toxicity using sediment chemistry levels for cadmium, lead, and zinc (with a minimal number of toxicity tests to ensure that the criteria are protective). **It is imperative to recognize that these clean-up levels are based on Du Pont-Newport Site-specific conditions and are absolutely not to be used at other sites.** These tests shall be performed early in the remedial design process to determine areas of the wetlands and the Christina River which require remediation.

TABLE 1

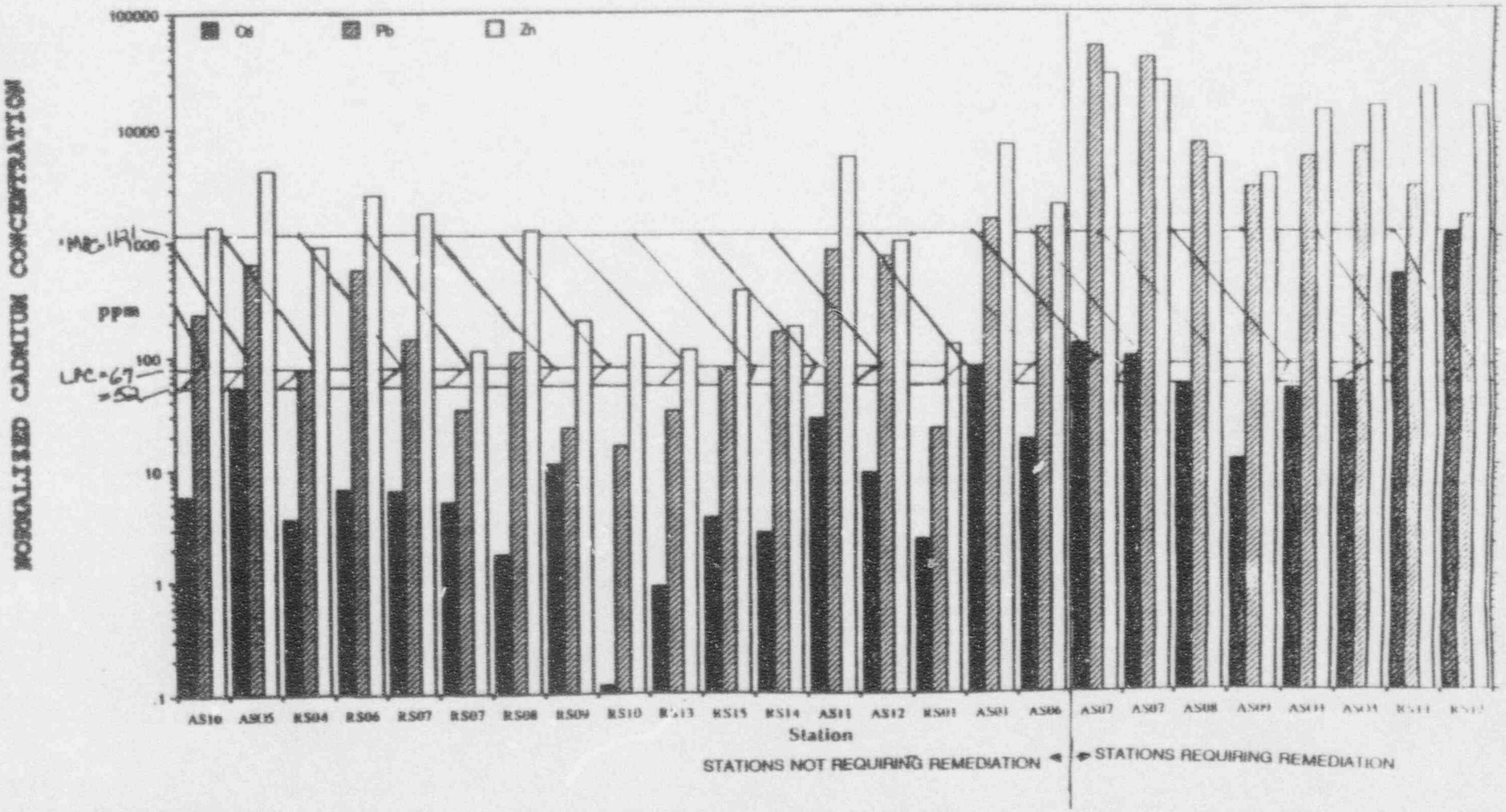
MAJOR REASONS WHY STATIONS REQUIRE REMEDIATION

1. AS07: Extremely low benthic density, low *Chironomus tentans* survival, no vegetation present
2. AS08: Extremely low benthic density, extremely low *Chironomus tentans* survival, low taxa richness
3. AS09: Extremely low benthic density, low taxa richness, low *Chironomus tentans* survival
4. AS03: Low benthic diversity, expected low *Hyallela azteca* survival (very low survival occurred in the RI but problems with the laboratory control of this test has decreased the validity of the data), high percent dominance of pollution tolerant benthos
5. RS11: Low taxa richness, extremely high percent dominance of pollution tolerant benthos
6. RS12: Low taxa richness, extremely high percent dominance of pollution tolerant benthos, low *Chironomus tentans* survival

NOTE: The 0% survival of fathead minnows at RS07 is considered an outlier in light of the relatively low levels of contamination present. This area will under further toxicity testing as part of the delineation for the dredging.

RS01 was previously included on this list but further review of the data indicated that it should be removed. In Phases II and III, RS01 was sampled on a mid-channel bar. In Phases II there was high levels of contaminants but no toxicity tests were performed. In Phase III, the contaminant levels were low and the toxicity test results were good but the percent fines was too low (8.3%) such that the normalized values were abnormally high and should not be used. For Supplemental Phase III, the *Hyallela azteca* test results were not good but the contaminant levels were so low that the toxicity may have been caused by other problems. Also not the high variability of the replicate results (0, 10, 50, and 70% survival).

CADMIUM



NORMALIZED CADMIUM CONCENTRATION
ppm
Cd
Pb
Zn
100000
10000
1000
100
10
1
.1
AS10
AS05
RS04
RS06
RS07
RS07
RS08
RS09
RS10
RS15
RS14
AS11
AS12
RS01
AS01
AS06
AS07
AS07
AS08
Station
STATIONS NOT REQUIRING REMEDIATION
STATIONS REQUIRING REMEDIATION

LEAD

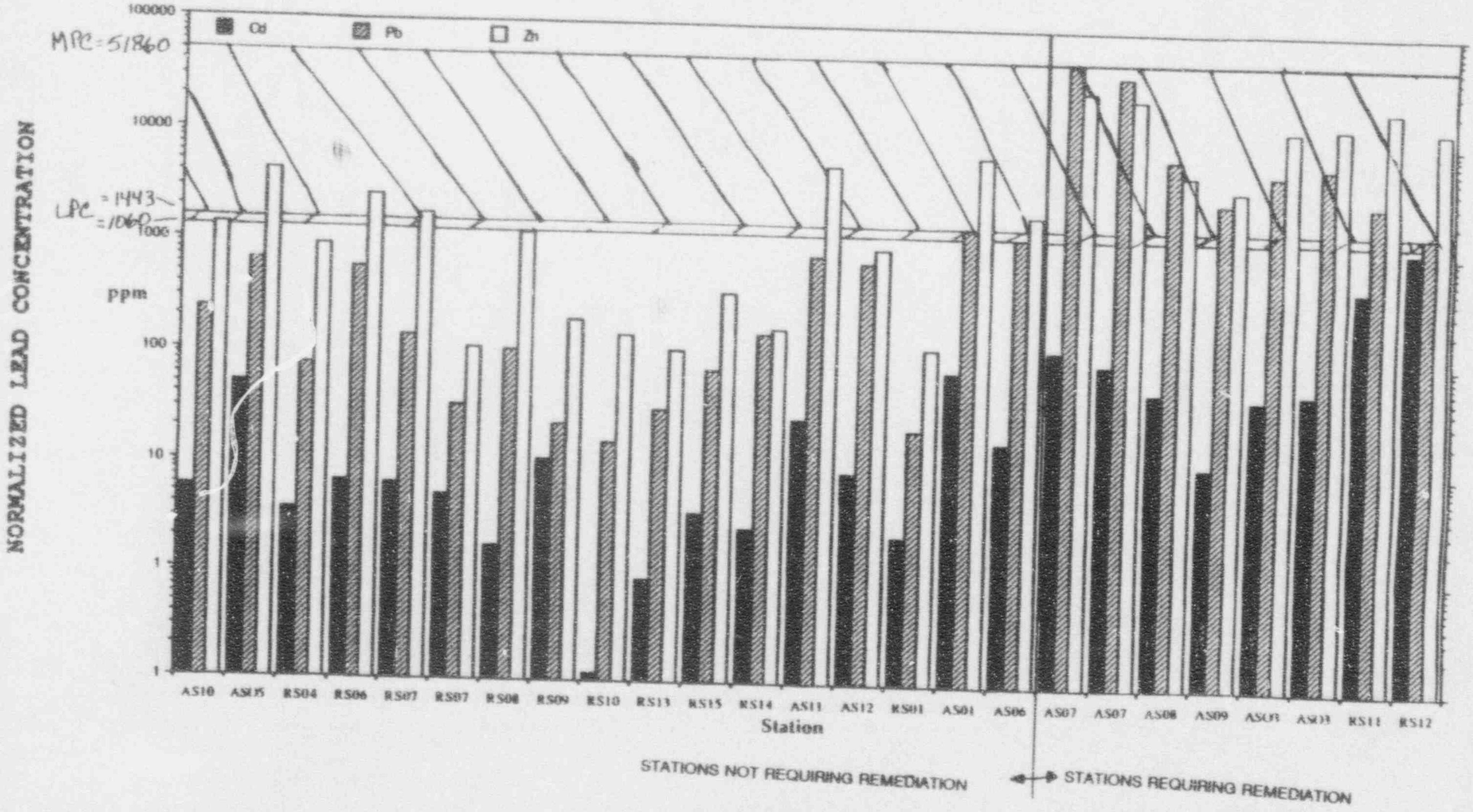
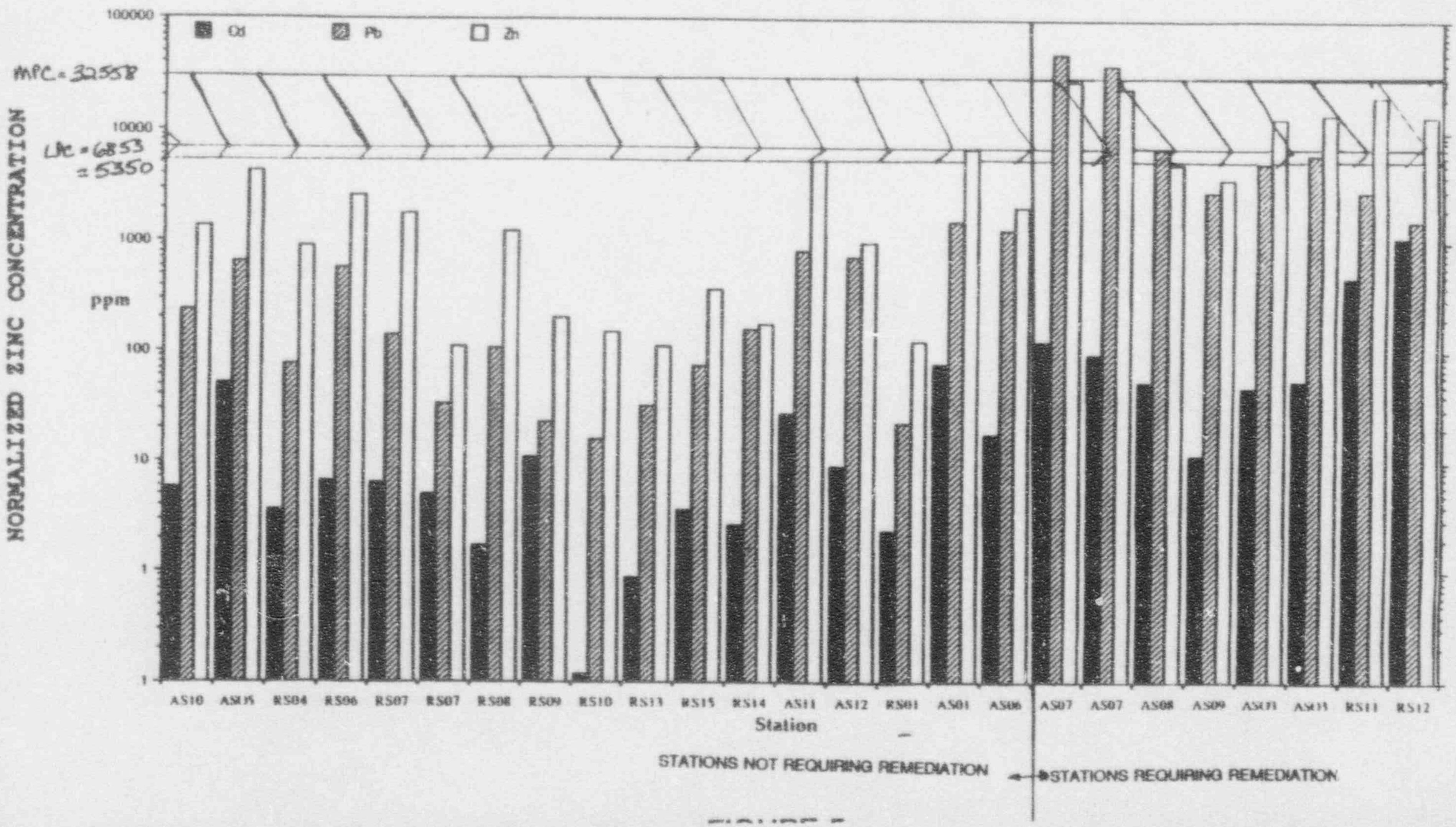


FIGURE 4

ZINC



Cd
Pb
Zn
100000
10000
1000
100
10
1
1
MPC = 32558
LAC = 6853
= 5350
NORMALIZED ZINC CONCENTRATION
ppm
AS10
AS05
RS04
RS06
RS07
RS07
RS08
RS09
RS10
RS13
RS15
RS14
AS11
AS12
RS01
AS01
AS06
AS07
AS07
AS08
AS09
AS03
AS03
RS11
RS12
Station
STATIONS NOT REQUIRING REMEDIATION
STATIONS REQUIRING REMEDIATION

DYNAMAC
CORPORATION
Environmental Services

80 W. Lancaster Avenue
Devon, PA 19333

Telephone: 215-989-9400
Fax: 215-989-9414

Mr. Randy Sturgeon
U.S. EPA Region III
841 Chestnut Building
Philadelphia, PA 19107

Reference: Contract No. 68-W9-0005
Work Assignment No. C03034
DuPont Newport, Newport, Delaware

Subject: Revised Performance Schedule

Dear Mr. Sturgeon:

As per your request and discussions of the teleconference held on May 7, 1993, Dynamac has revised the document submitted to you on April 29, 1993.

Attachment 1 provides an Explanation of Procedures used to develop the Performance Standards as well as proposed the Sampling Plan.

Attachment 2 provides a Cost Estimate for the implementation of the proposed Sampling Plan.

If you have any questions, please call me at (215) 989-9400.

Sincerely,

Camille Costa, P.E.
Manager, Engineering

cc: Ms. Donna McGowan, US EPA Region III, CERCLA RPO
Mr. Robert Stecik, Vice President, Northeast Operations

SAMPLING PLAN AND PERFORMANCE STANDARDS FOR THE DUPONT-NEWPORT SITE

A systematic sampling plan has been developed for the SDS wetlands, NDS wetlands, and Christina River at the DuPont-Newport site. The sampling plan has been designed to provide a statistically sound basis for testing the following hypothesis:

The growth of Chironomus tentans, survival of Chironomus tentans, and survival of Hyalella azteca are reduced in site sediments relative to the same endpoints for these organisms in sediments from an area unaffected by the DuPont-Newport site but otherwise the same.

Stratification of Site

To increase precision, the SDS wetlands, SDS pond, NDS wetlands, the Christina River upstream from the North Drainageway, and the Christina River downstream from the Nor Drainageway are considered to be different statistical strata or domains at the site, and systematic sampling has been designed for each stratum. The north drainageway, the northern half of the SDS wetlands and the north bank of the river along the NDS and CIBA-GEIGY were not included because it is anticipated that these areas will be remediated due to very high sediment contamination levels.

The statistical design developed for this report is based in part on a careful evaluation of the results of preliminary sediment toxicity testing conducted during the RI. The within-station variance and the coefficients of variation for sets of samples in each stratum were used in selecting the appropriate number of samples for each stratum and the necessary number of replicates at each station, as described below.

Replicates

In the RI sediment toxicity tests, four (4) replicate samples were collected at each sampling station. There was relatively little dispersion in the observed survival rates for *Chironomus tentans* and *Hyalella azteca*. Given that the average standard deviation across the site was 19% or lower in the RI tests, and assuming that the same standard deviation will be seen in future tests, it can be further assumed that six (6) replicates at each station will be sufficient to discern impacts related to contamination from other impacts. The choice of six (6) replicates is based on a statistical power analysis, given that the specified significant difference in survival rates is 32.5% relative to reference for *Chironomus tentans*, and 30% relative to reference for *Hyalella azteca*, as described below. That is, six (6) replicates will be sufficient to discern between significant differences and variation caused by background causes, given a standard deviation of less than 19%.

EPA guidance on performance standards for toxicity tests for these two organisms to be published this autumn will be recommending use of eight (8) replicates per station when the tightness of the variance is unknown; therefore the decision to use only six replicates is based largely on the small standard deviations in the preliminary data (Ankley, 1993; Norberg-King, 1993).

Number of Samples to be Collected from Each Stratum
The number of samples required to obtain a given precision with a specific confidence level can be obtained from the following equation:

$$n = \frac{(CV)^2\ (t_\alpha^2)}{p^2}$$

where
n= number of stations
CV= coefficient of variation
p= allowable margin of error expressed as a percent
t= the two tailed t value obtained from standard statistical tables at the α level of significance and at (n-1) degrees of freedom. (Mason, B.J., 1983).

For this sampling plan, a confidence level of 95% has been chosen. The selected allowable margin of error is +/- 10%; this means that a +/- 10% precision is considered reasonable in making a determination for each stratum of the need for remediation based on the results of sediment toxicity tests. The coefficient of variation was developed from the preliminary *Chironomus tentans* and *Hyalella azteca* sediment toxicity tests presented in the RI (see Tables A, B,and C, which provide statistical summaries of the RI sediment toxicity data). Based on the RI data, the average coefficient of variation for each stratum is 39% or less (when 0% survival values are ignored). While the average coefficients of variation are different for each stratum, the average coefficient of variation across the site for survival for both organisms is 27.1%. To be conservative a coefficient of variation of 29% was used in the above equation to calculate the required number of samples in each stratum. Ignoring the 0% survival results in calculating the coefficient of variation for each stratum is assumed to be a reasonable step, because the sediments with extremely high mortality will clearly have to be remediated.

Using these values for the variables in the above equation (95% confidence, 10% error, and 29% site-wide coefficient of variation) yields 35 stations for each stratum. However, since the SDS pond is small and the whole pond will either be cleaned up or not, 35 stations will not be necessary there. Therefore, five (5) stations (locations based on professional judgement) will be placed in the SDS pond. The 35 stations in each of the other strata besides the SDS pond should be placed in a rectangular grid. The grids will be expanded or contracted to fit the size and approximate shape of the stratum. Based on maps provided in the RI, the approximate dimensions between nodes of the grids will be: SDS wetlands, 150' X 250'; NDS wetlands, 300' X 120'; Christina River upstream, 480' X 175'; Christina River downstream, 960' X 175'.

Total Number of Samples
As described above, six (6) replicates will be collected from each station for each organism (six (6) for *Chironomus tentans* and six (6) for *Hyalella azteca*). An additional sample will be collected from each station to be analyzed for physical and chemical characteristics (grain size, Ph, and the suite of TAL metals). At approximately 10% of the stations in each stratum, (four

(4) stations), duplicates for sediment physical and chemical characteristics will be collected to increase precision.

In addition, sediment toxicity tests, benthic community analyses, physical and chemical analyses will be conducted at two appropriate reference locations that will be as similar as possible to site sampling stations, particularly with respect to sediment physical characteristics, except for the absence of site influence.

Performance Standards for Conducting the *Hyalella azteca* survival, *Chironomus tentans* survival, and *Chironomus tentans* growth tests are as follows:

Background Station Survival *Chironomus tentans*: 70% (ASTM, 1992).

Background Station Survival *Hyalella azteca*: 80% (ASTM, 1992).

These background station survival rates are published in the American Society for Testing and Materials Standard Guide for Conducting Sediment Toxicity Tests with Freshwater Invertebrates (Standard E 1383-92). If the average survival rates fall below either of these percentages, the test is considered unacceptable.

Note: If these control survival rates are not achieved, the test will have to be repeated. Results from any tests with less than the above-specified survival rates for the controls will be considered invalid.

The need for remediation at different stations has been established based on the results of sediment toxicity tests and the performance standards set for this site. The performance standards for sediment toxicity tests at the DuPont-Newport site are based on a thorough review of the data presented in the RI (especially Tables C-10, C-12, C-13, and C-14; Woodward Clyde, 1992) and a statistical analysis. These standards are wholly consistent with the recommendations of EPA sediment toxicity experts (Norberg-King, 1993; Ankley, 1993), and provide a statistically sound indication of the need to remediate different portions of the site. These performance standards, when applied to the sediment toxicity tests conducted during the RI, support existing decisions to remediate the stations described in Table 1.

The sediment toxicity test performance standards are:

- 32.5% drop (difference of 32.5%) in relative *Chironomus tentans* survival (Figure 1),
- 30% drop (difference of 30%) in relative *Hyalella azteca* survival (Figure 2), and
- 35% reduction (factor of 35%) in relative *Chironomus tentans* growth (Figure 3).

Detailed statistical analyses of the sediment toxicity tests from the RI showed that an observed decrease is probably related to contamination, and not to other sources of variation, when there is a 32.5% or more drop in *Chironomus tentans* survival relative to the reference station (see Attachment A for an in-depth discussion of the statistical analysis of variance performed), a 30% drop in *Hyalella* survival, and a 35% reduction in *Chironomus* growth. It should be noted that while the analysis of variance indicates that an 18.7% drop in *Hyalella azteca* survival is the

TABLE 1

MAJOR REASONS WHY STATIONS REQUIRE REMEDIATION

1. AS03: Low benthic diversity, expected low *Hyalella azteca* survival (very low survival occurred in the RI but problems with the laboratory control of this test has decreased the validity of the data), high percent dominance of pollution tolerant benthos.

2. AS07: Extremely low benthic density, low *Chironomus tentans* survival, no vegetation present.

3. AS08: Extremely low benthic density, low taxa richness, extremely low *Chironomus tentans* survival.

4. AS09: Extremely low benthic density, low taxa richness, low *Chironomus tentans* survival.

5. RS01: Low benthic diversity, expected low *Hyalella azteca* survival (very low survival occurred in the RI but problems with the laboratory control of this test has decreased the validity of the data), high percent dominance of pollution tolerant benthos.

6. RS11: Low taxa richness, extremely high percent dominance of pollution tolerant benthos.

7. RS12: Low taxa richness, extremely high percent dominance of pollution tolerant benthos, low *Chironomus tentans* survival.

* This table was prepared by U.S. EPA Region III.*

minimum that could be detected with four replicates, a 30% drop has been set as the performance standard to be conservative,because the *Hyalella azteca* survival test in the RI was flawed by low survival of the control (Woodward Clyde, 1992).

The values chosen for the performance standards are the result of careful examination of the preponderance of evidence for the need to remediate particular stations at the site, as well as of the variation in the RI sediment toxicity test results. The following factors limited the choice of the selected performance standard values.

If the performance standard were set too low, then the result would be that, for example, stations AS09 and AS07 might not appear to need remediation, when ecological evidence indicates that they do require remedial action (see Figure 1). That is, stations AS09 and AS07 exhibit low benthic density and low benthic taxa richness, and high levels of chemical contamination (see Table 1). If a very large drop in relative survival was set as the standard, some stations might not be remediated where real ecological effects were being observed.

If the performance standard were set too high, then the result would be that some areas, which do not require remedial action, would appear to require such action. For example, if the performance standard for *Chironomus tentans* survival was set at a 10% decrease relative to the reference, then stations RS13 and AS12 would appear to need remediation (sec Figure 1); however, the rest of the ecological evidence presented in the RI is not consistent with this result. That is, the RI indicates there is no need for remediation at these two stations.

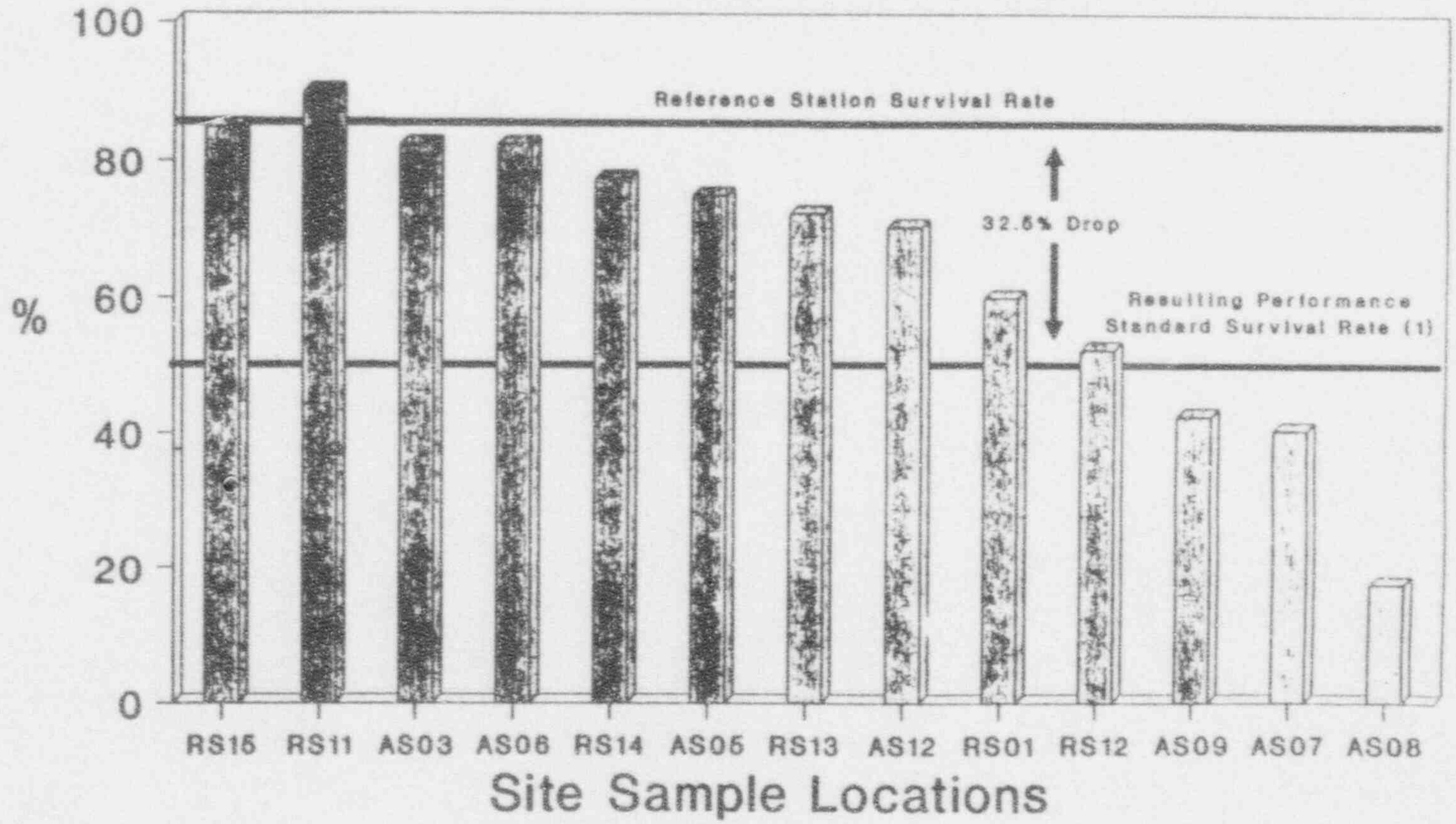
The statistical analysis behind setting the minimum difference for the performance standards can be summarized as follows (see Attachment A for a detailed explanation). Four (4) replicates were collected from each station for sediment toxicity tests in the RI. The variation between replicates at each station was measured. The average standard deviation for *Chironomus tentans* survival rates was approximately 19%, (the standard deviations for replicates for *Hyalella* survival and *Chironomus* growth were even lower; see Tables A, B, and C, which summarize data presented in the RI). Using this standard deviation, we conducted an analysis of variance (ANOVA) test to decide what amount of a difference could be attributed to contamination alone, given that there were four replicates from each station. This test was evaluated at a 95% confidence level, that is, with 95% confidence that when a pollutant effect is indicated by the results of the sediment toxicity tests, it is highly probable that there is a pollution effect at the site. (See calculations in Attachment A). As a result of the ANOVA tests, a 32.5% difference in relative *Chironomus tentans* survival was calculated as the minimum detectable difference. Similarly, we calculated an 18.7% difference in relative *Hyalella azteca* survival, and a 35% reduction in relative *Chironomus* growth, as the minimum detectable differences based on the RI data.

Again, while the analysis of variance indicates that an 18.7% drop in *Hyalella azteca* survival is the minimum that could be detected with four replicates, a 30% drop has been set as the performance standard to be conservative, because the *Hyalella azteca* survival test in the RI was flawed by low survival of the control (Woodward Clyde, 1992).

It is important to note that these performance standards have been approved by EPA sediment toxicity experts as discernable differences between reference and site stations (Norberg-King, 1993; Ankley, 1993), when an adequate number of replicates are used.

The use of six (6) replicates per station is recommended to ensure a powerful statistical test of the hypothesis that site sediments are adversely impacted. The more replicates are used, the more certain it will be that areas that appear to be unimpaired based on the results of the toxicity tests are, in fact, unimpaired at the site.

Figure 1
Survival (%) of Chironomus tentans Relative to RS15
(From Table C-10, DuPont/Newport RI, 1992)

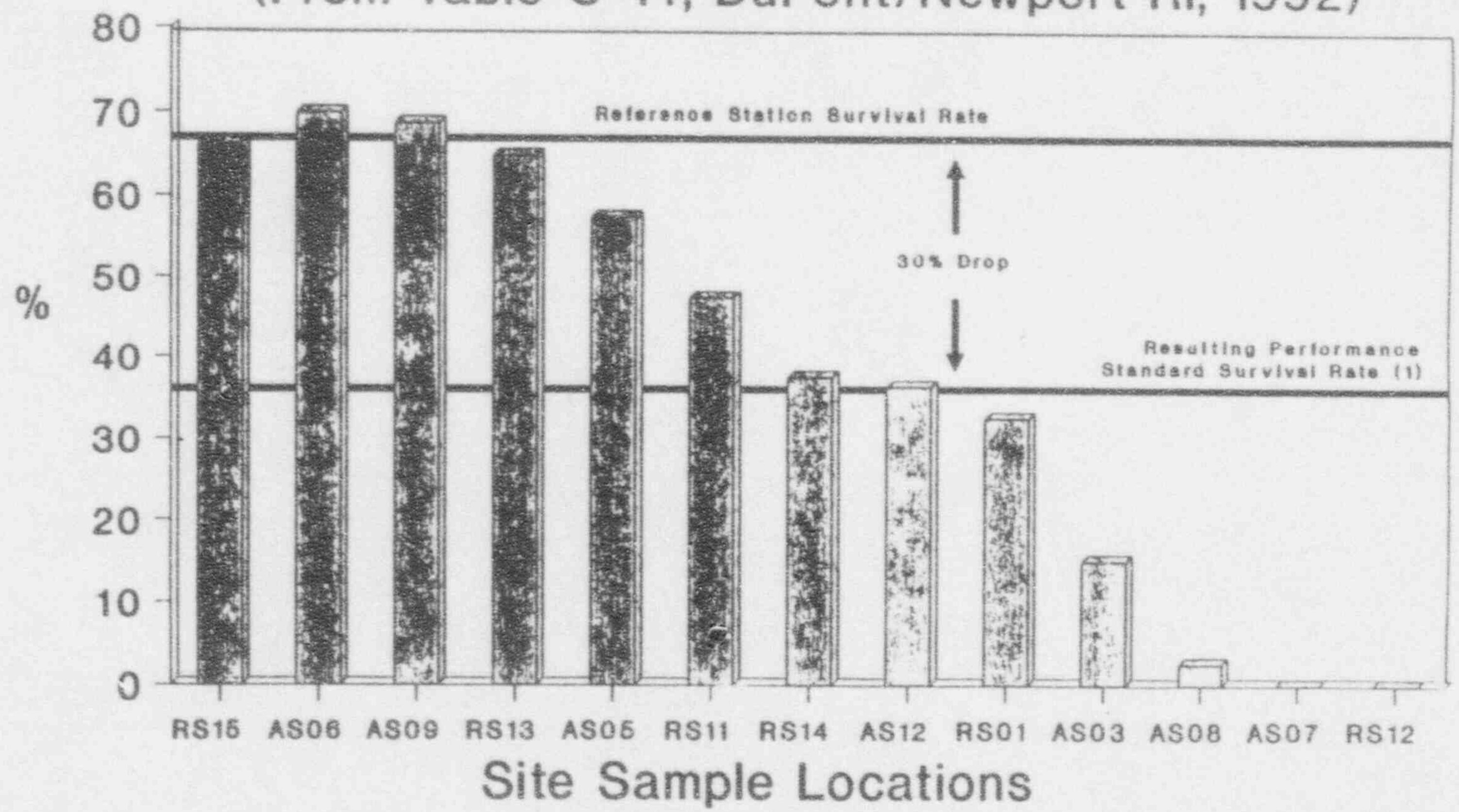


(1) Performance Standard Calculation:
85%(Reference Station RS15) - 32.5% = 52.5%

Figure 2

Survival (%) of Hyalella azteca Relative to RS15

(From Table C-14, DuPont/Newport RI, 1992)



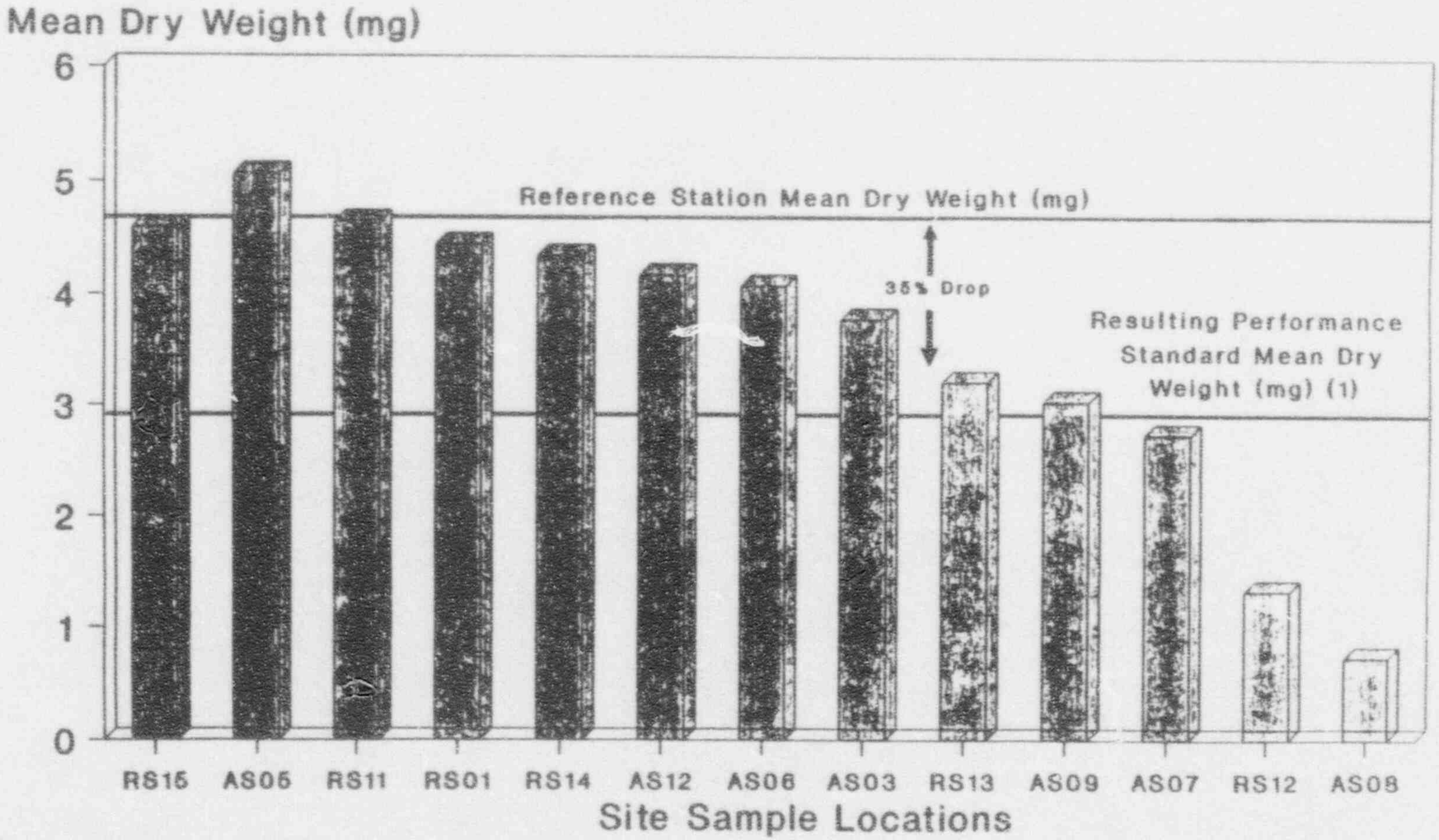
(1) Performance Standard Calculation:

66.5%(Reference Station RS15) - 30% = 36.5%

Figure 3

Summary of Weight Data for Chironomus tentans Relative to RS15

(From Table C-11, DuPont/Newport RI, 1992)



(1) Performance Standard Calculation:
4.592(Reference Station RS15) - 1.600(35%) = 2.992

TABLE A – COEFFICIENT OF VARIATION AMONG THE SURVIVAL RATES OF CHIRONOMUS TENTANS FROM THE NORTH AND SOUTH DISPOSAL SITES, AND CHRISTINA RIVER[1]

North Disposal Site						
Station Location	Rep. #	Survival (%)	Average Survival (%)	Drop in % Survival[5]	SD[2]	CV (%)[3]
RS15 Reference Station	A	70	85		13	15
	B	90				
	C	100				
	D	80				
AS06	A	60	82.5	2.5	17	20
	B	90				
	C	100				
	D	80				
AS07 *	A	60	40	45	18	45
	B	50				
	C	20				
	D	30				
AS08 *	A	0	17.5	67.5	20	114
	B	30				
	C	0				
	D	40				
AS09 *	A	50	42.5	42.5	33	77
	B	40				
	C	80				
	D	0				
AS12	A	90	70	15	40	57
	B	90				
	C	10				
	D	90				
Average Drop in % Survival Rates[6]				34.5		
Average Standard Deviation of Survival Rates among Stations[7]					25.6	
Average Coefficient of Variation[8]						38.5

Chistina River						
Station Location[4]	Rep. #	Survival (%)	Average Survival (%)	Drop in % Survival[5]	SD	CV (%)
RS15 Reference Station	A	70	85		13	15
	B	90				
	C	100				
	D	80				
RS11	A	90	90		14	15
	B	100				
	C	70				
	D	100				
RS12 *	A	50	52.5	32.5	13	24
	B	40				
	C	70				
	D	50				
RS01 *	A	60	60	25	8.1	13
	B	50				
	C	70				
	D	60				
RS13	A	80	72.5	12.4	17	23
	B	70				
	C	90				
	D	50				
RS14	A	100	77.5	7.5	17	22
	B	60				
	C	80				
	D	70				
Average Drop in % Survival Rates[6]				19.4		
Average Standard Deviation of Survival Rates among Stations					13.8	
Average Coefficient of Variation[8]						20

South Disposal Site						
Station Location	Rep. #	Survival (%)	Average Survival (%)	Drop in % Survival[5]	SD	CV (%)
RS15 Reference Station	A	70	85		13	15
	B	90				
	C	100				
	D	80				
AS03	A	100	82.5	2.5	28	34
	B	40				
	C	90				
	D	100				
AS05	A	80	75	10	5.7	8
	B	80				
	C	70				
	D	70				
Average Drop in % Survival Rates[6]				6.3		
Average Standard Deviation of Survival Rates among Stations					16.9	
Average Coefficient of Variation[8]						21

(1) Table C–10, Woodward Clyde. 1992. Risk Assessment DuPont–Newport Site. Volume 2, Environmental Evaluation. August 7, 1992.
(2) Standard Deviation
(3) Coefficient of Variation
(4) RS07 is considered an outlier and was not considered in the coefficient of variation equation as requested by U.S. EPA.
(5) Indicates drop in % survival between reference station (RS15) and site stations.
(6) Indicates a 20.06% average reduction in survival rates between reference station (RS15) and site stations ((34.5% + 19.4% + 6.3%)/3).
(7) Indicates an 18.76 average standard deviation of survival rates among stations ((25.6 + 13.8 + 16.9)/3).
(8) Coefficient of variation averages were calculated without stations where 0% survival was recorded in Hyalella azteca or Chironomus tentans (*).

Sample Calculation: Site Station AS06

Standard Deviation formula:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1}}$$

Where: $X_1 = 60,\ X_2 = 90,\ X_3 = 100,\ X_4 = 80,\ \bar{X} = 82.5,\ n = 4.$

Standard Deviation (s) = 17

Sample Calculation: Site Station AS06

Coefficient of Variation formula: $CV = \frac{s}{\bar{X}} * 100$

Where: $s = 17,\ \bar{x} = 82.5$

Coefficient of Variation (CV) = 20

TABLE B – COEFFICIENT OF VARIATION AMONG THE SURVIVAL RATES OF HYALELLA AZTECA
FROM THE NORTH AND SOUTH DISPOSAL SITES, AND CHRISTINA RIVER[1]

North Disposal Site

Station Location	Rep. #	Survival (%)	Average Survival (%)	Drop in % Survival[5]	SD[2]	CV (%)[3]
RS15 Reference Station	A	65	66.25		2.5	3.8
	B	65				
	C	70				
	D	65				
AS06	A	65	70		12.2	17
	B	80				
	C	55				
	D	80				
AS07 *	A	0	0	66.25	0	0
	B	0				
	C	0				
	D	0				
AS08 *	A	5	2.5	63.75	2.9	115
	B	5				
	C	0				
	D	0				
AS09 *	A	85	68.8		16	24
	B	80				
	C	50				
	D	60				
AS12	A	35	36.3	29.9	12	33
	B	45				
	C	20				
	D	45				
Average Drop in % Survival Rates[6]				53.3		
Average Standard Deviation of Survival Rates among Stations[7]					8.8	
Average Coefficient of Variation[8]						25

Chistina River

Station Location[4]	Rep. #	Survival (%)	Average Survival (%)	Drop in % Survival[5]	SD	CV (%)
RS15 Reference Station	A	65	66.25		2.5	3.8
	B	65				
	C	70				
	D	65				
RS11	A	55	47.5	18.8	6.5	14
	B	40				
	C	45				
	D	50				
RS12 *	A	0	0	66.25	0	0
	B	0				
	C	0				
	D	0				
RS01 *	A	10	32.5	33.8	33	102
	B	50				
	C	70				
	D	0				
RS13	A	50	65	1.25	23.5	36
	B	85				
	C	85				
	D	40				
RS14	A	35	37.5	28.8	22	59
	B	10				
	C	65				
	D	40				
Average Drop in % Survival Rates[6]				29.8		
Average Standard Deviation of Survival Rates among Stations[7]					17.0	
Average Coefficient of Variation[8]						36.3

South Disposal Site

Station Location	Rep. #	Survival (%)	Average Survival (%)	Drop in % Survival[5]	SD	CV (%)
RS15 Reference Station	A	65	66.25		2.5	3.8
	B	65				
	C	70				
	D	65				
AS03	A	20	15	51.3	4	27
	B	15				
	C	10				
	D	15				
AS05	A	50	57.5	8.8	9.6	17
	B	50				
	C	70				
	D	60				
Average Drop in % Survival Rates[6]				30.1		
Average Standard Deviation of Survival Rates among Stations[7]					6.8	
Average Coefficient of Variation[8]						22

(1) Table C–14, Woodward Clyde. 1992. Risk Assessment DuPont–Newport Site. Volume 2, Environmental Evaluation. August 7, 1992.
(2) Standard Deviation
(3) Coefficient of Variation
(4) RS07 is considered an outlier and was not considered in the coefficient of variation equation as requested by U.S. EPA.
(5) Indicates drop in % survival between reference station (RS15) and site stations.
(6) Indicates a 37.7% average reduction in survival rates between reference station (RS15) and site stations ((53.3% + 30.1% + 29.8%)/3).
(7) Indicates a 10.8 average standard deviation of survival rates among stations ((8.8 + 17.0 + 6.8)/3).
(8) Coefficient of variation averages were calculated without stations where 0% survival was recorded in Hyalella azteca or Chironomus tentans (*).

Sample Calculation: Site Station AS06

Standard Deviation formula:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1}}$$

Where: $X_1 = 65$, $X_2 = 80$, $X_3 = 55$, $X_4 = 80$, $\bar{X} = 70$, $n = 4$

Standard Deviation (s) = 12.2

Sample Calculation: Site Station AS06

Coefficient of Variation formula: $CV = \frac{s}{\bar{X}} * 100$

Where: $s = 12.2$, $\bar{X} = 70$

Coefficient of Variation (CV) = 17

TABLE C – SUMMARY OF WEIGHT DATA FOR CHIRONOMUS TENTANS EXPOSED FOR 12 DAYS
TO CHRISTINA RIVER, NORTH AND SOUTH DISPOSAL SITE WETLAND SEDIMENTS[1]

North Disposal Site

Station Location	Rep. #	Avg. Dry Wt. (mg)	Mean Dry Wt. (mg)	Drop in Dry Wt. (mg)[5]	SD[2]	CV[3]
RS15	A	4.876	4.592		0.247	5.378
	B	4.548				
	C	4.661				
	D	4.283				
AS06	A	4.89	4.078	0.514	0.687	16.84
	B	3.38				
	C	3.657				
	D	4.383				
AS07	A	1.003	2.733	1.859	2.238	81.88
	B	0.888				
	C	3.465				
	D	5.577				
AS08	A	0	0.726	3.866	0.859	118
*	B	1.68				
	C	0				
	D	1.223				
AS09	A	4.903	3.031	1.561	2.110	69.64
*	B	3.563				
	C	3.658				
	D	0				
AS12	A	4.554	4.174	0.418	0.308	7.387
	B	3.88				
	C	4.289				
	D	3.971				
Average Drop in Weight (mg)[6]				1.6438		
Average Standard Deviation of Mean Dry Weight Among Stations[7]					1.24	
Average Coefficient of Variation[8]						35.4

Christina River

Station Location[4]	Rep. #	Avg. Dry Wt. (mg)	Mean Dry Wt. (mg)	Drop in Dry Wt. (mg)[5]	SD	CV
RS15 Reference Station	A	4.876	4.592		0.247	5.378
	B	4.548				
	C	4.661				
	D	4.283				
RS11	A	4.8	4.647		0.623	13.41
	B	5.188				
	C	3.788				
	D	5.012				
RS12	A	1.724	1.328	3.264	0.449	33.88
	B	1.258				
	C	1.607				
	D	0.722				
RS01	A	5.54	4.444	0.148	0.765	17.21
	B	4.212				
	C	3.76				
	D	4.262				
RS13	A	3.055	3.208	1.384	1.132	35.30
	B	4.18				
	C	3.926				
	D	1.67				
RS14	A	4.677	4.341	0.251	0.445	10.25
	B	3.982				
	C	4.773				
	D	3.933				
Average Drop in Weight (mg)[6]				1.26175		
Average Standard Deviation of Mean Dry Weight Among Stations[7]					0.68	
Average Coefficient of Variation[8]						21.98

South Disposal Site

Station Location	Rep. #	Avg. Dry Wt. (mg)	Mean Dry Wt. (mg)	Drop in Dry Wt. (mg)[5]	SD	CV
RS15 Reference Station	A	4.876	4.592		0.247	5.378
	B	4.548				
	C	4.661				
	D	4.283				
AS03	A	3.81	3.781	0.811	0.498	13.17
	B	3.23				
	C	3.653				
	D	4.431				
AS05	A	5.98	5.069		1.078	21.26
	B	3.513				
	C	5.241				
	D	5.58				
Average Drop in Weight (mg)[6]				0.811		
Average Standard Deviation of Mean Dry Weight Among Stations[7]					0.788	
Average Coefficient of Variation[8]						17.22

(1) Table C–11, Woodward Clyde. 1992. Risk Assessment DuPont–Newport Site. Volume 2, Environmental Evaluation. August 7, 1992.
(2) Standard Deviation
(3) Coefficient of Variation
(4) RS07 is considered an outlier and was not considered in the coefficient of variation equation as requested by U.S. EPA.
(5) Indicates drop in dry weight (mg) between reference station (RS15) and site stations.
(6) Indicates an average drop in dry weight of 1.24 mg between the reference station (RS15) and site stations (1.642+1.261+.811)/3).
(7) Indicates a 0.903 average standard deviation of mean dry weight among stations ((1.052+.610+.608)/3).
(8) Average coefficient of variation was calculated without stations where average dry weights of 0 mg were recorded in Chironomus tentans (*).

Sample Calculation: Site Station AS06

Standard Deviation formula:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1}}$$

Where: $X_1 = 4.89,\ X_2 = 3.38,\ X_3 = 3.657,\ X_4 = 4.383,\ \bar{X} = 4.078,\ n = 4$

Standard Deviation (s) = .687

Sample Calculation: Site Station AS06

Coefficient of Variation formula: $CV = \frac{s}{\bar{X}} * 100$

Where $s = 0.687,\ \bar{x} = 4.078$

Coefficient of Variation (CV) = 16.84

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Attachment A

A factorial analysis of variance (ANOVA) was utilized to determine the minimum detectable change in growth and survivability of *Chironomus tentans* and the survivability of *Hyalella azteca* in sediments collected from the allegedly impaired areas due to contamination, when compared to data obtained for the reference location when four (4) replicates per station are collected. H_0 asserts that the test area is not impaired when compared to the reference location. The equation used to compute the changes in averages is based on a 1 X 2 (1 sampling event by 2 areas: reference location and allegedly impaired area) factorial analysis of variance and is presented below (Green, 1979).

$$F_{0.95}(1,2(r-1)\,df) = \frac{SS_{calc} \div 1\ df}{SS_{err} \div 2(r-1)\,df}$$

Where:

$F_{0.95}(1,2(r-1)\ df)$ = F-value for α = 0.95 at 1 df (numerator); 2(r-1) df (denominator).

$$SS_{calc} \div 1\ df = (\Delta\overline{X}\ r)^2 \div 2r$$

$$SS_{err} \div 2(r-1)\ df = s^2$$

df = degrees of freedom,
r = number of replicates, and
s^2 = variance among stations in all three strata per organism per test.

H_0 = The area is not impaired when compared to the reference location.

This equation simplifies to:

$$F(1,2(r-1)\,df) = \frac{(\Delta\overline{X}\ r)^2}{2r * s^2}$$

Since the change in the average is the only unknown variable, the equation is rearranged to:

$$\Delta\overline{X} = \sqrt{\frac{F_{0.95}(1,2(r-1)\,df) * 2 * s^2}{r}}$$

Table A-1
Parameters and Results for the Factorial ANOVA

Test	$F_{0.95}(1,2(r-1)df)$	r	s^2	Resulting $\Delta\overline{X}$
Chironomus survival	5.99	4	352	> 32.5%
Chironomus growth	5.99	4	0.815	> 1.6 mg (35%)
Hyalella survival	5.99	4	117	> 18.7%

Results

A change greater than the minimal detectable change will result in the rejection of the null hypothesis, therefore asserting that the area in question is impaired when compared to the reference location and requires clean-up. The minimal detectable change in *Chironomus* survival is a difference of 32.5%, in *Hyalella* survival is a difference of 18.7%, and in *Chironomus* growth is a factor of 35%. These values can be used as performance standards for the RI. In summary, because of the observed differences (variances, or standard deviations) in the four replicates per stations used in the RI sediment toxicity tests, a statistical analysis as described above shows the minimum differences that can be discerned from background variation at the site. These performance standards are consistent with the advice from EPA sediment toxicity experts.

ATTACHMENT 2

Cost Estimates for Sediment Tests at DuPont, Newport

Laboratory	Physical Tests		Chemical Test	Toxicity Tests		Benthic Macroinvertebrate Community Structure (m)	Totals
				10-day Toxicity Test			
	pH	Grain Size	TAL Metals	*Chironomus* (i)	*Hyalella* (l)		
ENSR, Inc.	NA	NA	NA	$1,300.00	$1,000.00	NA	
ATI Corp.	$15.00	$27.50 (h)	$493.75	NA	NA	NA	
Analytikem, Inc.	$5.00	$150.00	$345.00	$1,600.00 (j) $400.00 (k)	$1,800.00 (j) $400.00 (k)	NA	
RMC	$8.00	NA	$390.00	$900.00	$900.00	NA	
IT Corp.	NA	$159.00	NA	NA	NA	NA	
Dynamac	NA	NA	NA	NA	NA	$2,500.00	
Average Cost/Test	$9.33	$112.17	$409.58	$878.10	$780.00	$2,500.00	$4,689.18
Cost/Area (a)	$326.67	$3,925.83	$14,335.42	$30,733.33	$27,300.00	NR	$76,621.25
Cost of Dups or Reps/Area (b)	$37.33	$448.67	$1,638.33	$153,666.67	$136,500.00	NR	$292,291.00
Total Cost/Area (c)	$364.00	$4,374.50	$15,973.75	$184,400.00	$163,800.00	NR	$368,912.25
South Disposal Site (SDS) Pond Cost (d)	$46.67	$560.83	$2,047.92	$4,733.33	$4,300.00	NR	$11,688.75
SDS Pond Dups or Reps Cost (e)	$9.33	$112.17	$409.58	$23,666.67	$21,500.00	NR	$45,697.75
Total SDS Pond Cost	$56.00	$673.00	$2,457.50	$28,400.00	$25,800.00	NR	$57,386.50
Cost/Reference Location (f)	$18.67	$224.33	$819.17	$6,400.00	$6,000.00	$15,000.00	$28,462.17
Total Cost (g)	$1,549.33	$18,619.67	$67,990.83	$778,800.00	$693,000.00	$30,000.00	$1,589,959.83

(a) Excluding the south disposal site (SDS) pond. Utilizes Average Cost/Test and assumes 35 stations from each area. Does not include duplicates for sediment chemistry and physical properties or replicates for sediment toxicity and benthic community study.

(b) Excluding the SDS pond. Assumes 4 duplicates/area (approximately 10% of samples collected/area) for sediment chemistry and physical properties and 6 replicates for each sediment toxicity and benthic community study.

(c) Excludes SDS pond.

(d) Utilizes Average Cost/Test and assumes 5 stations. Does not include duplicates for sediment chemistry and physical properties or replicates for sediment toxicity and benthic community study.

(e) Assumes 1 duplicate (approximately 10% of samples collected in the SDS pond) for sediment chemistry and physical properties and 6 replicates for each sediment toxicity and benthic community study.

(f) Assumes 1 station/reference location and 1 duplicate/location for sediment chemistry and physical properties and 6 replicates for each sediment toxicity and benthic community study.

(g) Assumes 4 areas, the SDS pond, and 2 reference locations.

(h) Price equals the average of the pipette method ($30) and the hydrometer method ($25).

(i) Test yields both growth and survival data.

(j) For the first sample. (Based on approximately 16 samples.)

(k) For each additional sample. (Based on approximately 16 samples.)

(l) Test yields survival data only.

(m) Benthic Macroinvertebrate Community Structure study yields percent (%) dominance, abundance, and diversity.

NA – Not Applicable. No quote for this service was obtained from this company.

NR – Not Requested. Community structure will be analyzed at the reference locations only.

Note: Every company will give quantity discounts. Therefore, actual prices may be lower.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Ocean Resources Conservation and Assessment
Hazardous Materials Response and Assessment Division
Coastal Resources Coordination Branch
7600 Sand Point Way NE, BIN C15700
Seattle, WA 98115

October 20, 1992

Mr. John R. Sturgeon (3HW42)
Office of Superfund Programs
EPA - Region III
841 Chestnut Street
Philadelphia, PA 19107

RE: DuPont-Newport
Wetlands Remediation Goals

Dear Mr. Sturgeon:

Thank you for the opportunity to provide comments on the subject memorandum to the files regarding the DuPont-Newport Superfund Site in Newport, New Castle County, Delaware. The following comments are made on behalf of the National Oceanic and Atmospheric Administration (NOAA). NOAA will support the sediment clean-up criteria described in this document if the comments described in this memo are incorporated. Although the criteria allow relatively high levels of metals to remain in wetland and river sediments, they are based on available site-specific biological assessment information and chemical concentrations near the site. These criteria will most likely protect NOAA resources from future injury since natural recovery will be enhanced by removing large amounts of site-related sediments contamination in combination with control of groundwater/leachate from landfill areas. Monitoring needs to be required to demonstrate that the remedy is effective.

An additional paragraph describing the potential remediation in the Christina River needs to be included. This paragraph needs to address the following:

The sediment criteria established for the wetland sediments will also be applied to river sediments. Sampling of river sediments will occur on a grid system between stations RS-13 and RS-06. Sediments will be sampled down to a depth of 1.5 to 2.0 feet. This is the portion of the sediment that may become mobile during a major regional storm event. Core sediment samples will be taken which will be separated into 4 - 6 inch sediment sections. Each of these sections will be analyzed to determine the extent of contamination in river sediments. If the clean-up criteria are exceeded, sediments will be removed down to a level where contamination is below the criteria set for this site. The placement of clean fill in remediated areas will not be required. Application of these clean-up criteria to river sediments should remove the major portion of site-related contamination, and because the river is a dynamic environment, natural recovery will be enhanced.

Additional language needs to be included regarding the site-specific nature of these sediment cleanup criteria. These criteria have been established based on the available information pertaining to the DuPont-Newport Superfund site. These criteria are site-specific and are not intended to be applied at any other sites. These criteria were derived using site-specific chemistry as well as bioassay data. In addition, remediation activities are expected to prevent further contamination via groundwater and leachate. In some areas, the south disposal site pond for example, removal is not warranted. With the source of contamination removed, isolated, or stabilized, conditions are expected to improve over time. Because cleanup criteria for sediments will be normalized to grain size, cleanup levels on a dry-weight basis are expected to be lower than the established sediment contaminant criteria.

Throughout the document, the words "unacceptable impact" are used relative to footnote 2 on page 1. Given site-specific conditions, the remedy described here is acceptable to NOAA. Perhaps the footnote should be modified to include the river and to clarify that "at this site, stripping the entire wetland could cause more harm to the environment".

The monitoring suggestion provided by NOAA should be summarized in this document. The following could be included:

Although the details would be determined during remedial design, a monitoring program might include:

1. Sediment chemistry and toxicity testing (*Hyallela* survival and chironomid survival and growth) at a total of 18 stations.

2. 7 stations in the river (1 station adjacent to north landfill; 2 stations adjacent to the south landfill; 2 stations downstream of remediated area; 1 station upstream of remediated area; and 1 reference station)

3. 6 stations in the south wetland (AS-03, AS-05, 2 stations in the lower wetland that will not be remediated; 1 station in the pond; 1 station between the fill area and the berm)

4. 5 stations in the north wetland and drainage ditch area (AS-07; near AS-09 in the ditch; AS-10; AS-11; 1 station in the newly created wetland).

5. A baseline sampling round should also be conducted before remediation begins. Long term monitoring should be conducted at a decreasing frequency: for example, years 1, 2, 3, 5, 7, 9, 11, 15, 20, 25, and 30.

6. Sediment grain size and total organic carbon content should be measured for all samples. 3 field replicate samples should be collected for chemical analysis and toxicity testing. No more than the top 5 centimeters of sediment should be collected for chemical analysis and toxicity testing. Toxicity tests should be conducted on subsets of the same sediment analyzed for trace element concentrations.

Additional Specific Comments:

Page 3, Footnote 3: Grain size should be normalized to the fraction of sediment that will pass through a 64 micron sieve.

Page 4, item 3: Concentrations should be divided by percent fines (expressed on a decimal basis).

Page 4, first full paragraph: "the biological tests indicated no significant environmental impacts" should be changed to "severe".

Page 5: This muskrat study is probably excessive. Taking 16-20 muskrats from the pond in three different years will remove up to 60 muskrats from the wetland. Two stations are not needed at the pond, it is unlikely that two separate muskrat populations exist in such a small area. This study should be scaled back to one station (in addition to the reference station) and only 3-5 muskrats per year. If it is not known how many muskrats are in the wetland, only adult males should be taken.

If you have any questions, please contact me at (215) 597-3636.

Sincerely,

Alyce S. Fritz for
Peter T. Knight
NOAA - Coastal Resource Coordinator