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Draft
Phase I Environmental Assessment Report

North Penn Area 6 Site - OU1
Lansdale, Montgomery County, Pennsylvania

Prepared For:
The U.S. Environmental Protection Agency
Region III - Philadelphia

Prepared By:
Black & Veatch Waste Science, Inc.
BVWS Project N° 21910.005

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AR301103

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1.0 Introduction

BLACK & VEATCH Waste Science, Inc. (BVWS) was tasked by the U.S. Environmental Protection Agency (EPA) to perform a Phased Environmental Assessment (EA) of five properties of the North Penn Area 6 Site in Lansdale, Montgomery County, Pennsylvania. This Phase I EA was performed as part of a Remedial Investigation/Feasibility Study (RI/FS) under the authorization of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendment Reauthorization Act of 1986 (SARA).

The Phase I EA is composed of four components: (1) Regulatory Agency Review, (2) Field Survey (3) Literature-Based Initial Toxicity Assessment and (4) Recommendations.

Federal, state, and local resource agencies were contacted to collect information on significant bodies of water, wetlands, threatened and endangered species, and cultural, historical, and archaeological resources at and near the sites.

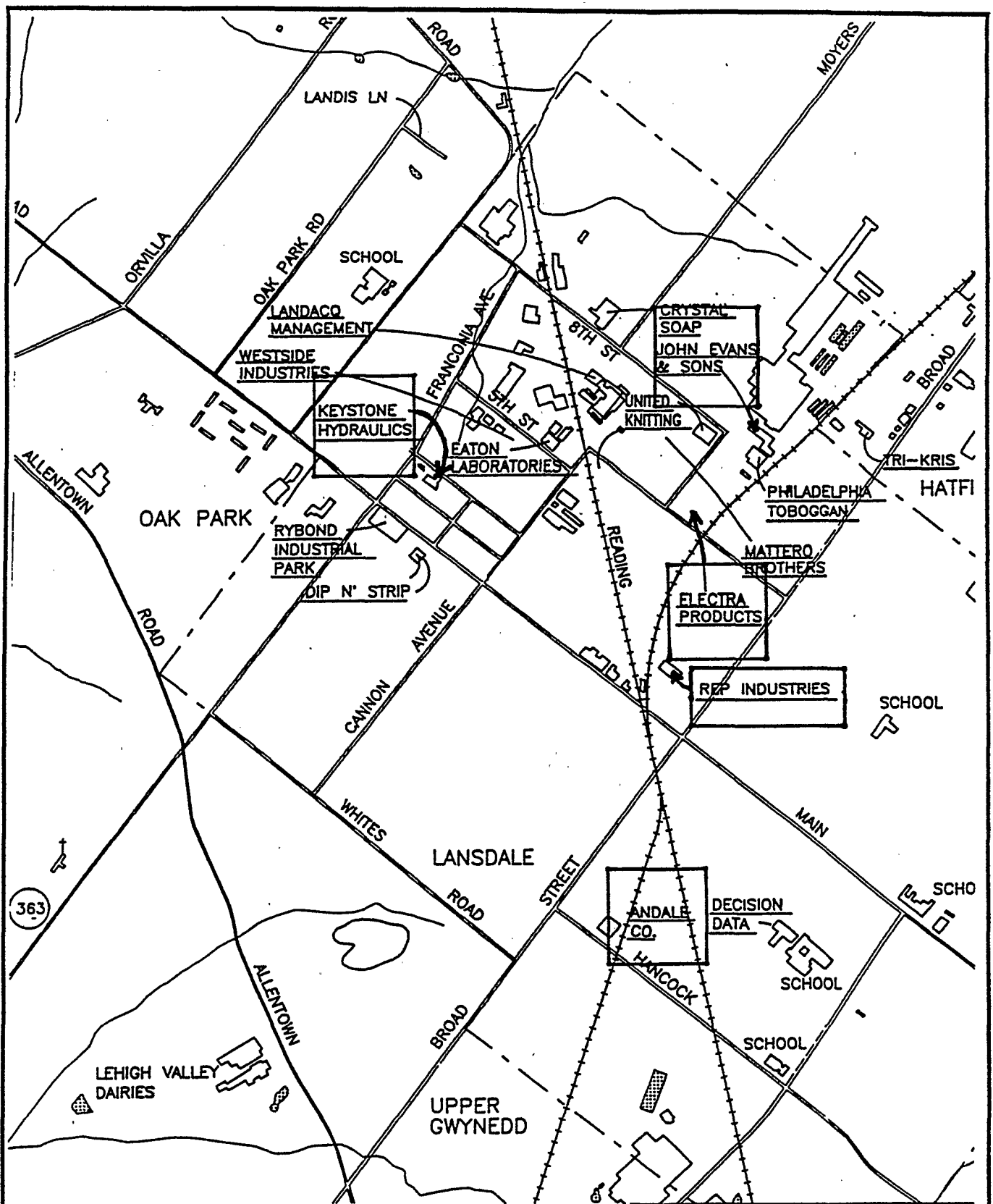
A field survey was performed by a BVWS ecologist on November 15, 1993 to determine the site specific flora and fauna, drainage, land use, and other significant ecological features that could potentially be affected by contaminants from the sites. This site investigation also included the characterization of the environment along main surface water drainage pathways and in areas where groundwater might be expected to become surface water such as springs, seeps, and streams.

A literature review of the toxicological effects of site contaminants was performed. This review was performed to determine the toxicological effects that these contaminants may have on the environmental receptors identified during the agency data review and the field investigation.

The recommendations section of this EA discusses further activities that may be performed in a Phase II EA to address data gaps that may not have been addressed in the Phase I EA.

1.1 Site Location

The five North Penn Area 6 properties under evaluation are located in the Borough of Lansdale, Montgomery County, Pennsylvania between the latitude/longitude coordinates of 40°15'00"/75°16'51" and 40°13'59"/75°17'30". These five sites are identified as Keystone Hydraulics, Tate Andale Company, Electra Products, John Evans & Sons, and REP. The locations of these sites is shown in Figure 1.



Site Location Map
Five Subject Properties at North Penn Area 6 Site

Figure
1



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Lansdale, Montgomery County, Pennsylvania

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1.2 Operational History and Waste Products

Most of the information on hazardous-material handling was obtained from Techlaw,¹ and the most recent information was from 1986. Updated information for some sites was provided by EPA.² Keystone Hydraulics is located on the south side of 3rd Street between Franconia Avenue and Mitchell Avenue in the western portion of Lansdale. The currently inactive facility occupies 1 acre and is located at 834 West Third Street.³ The Keystone Hydraulics plant was built in the 1940s and was operated by J.W. Rex Company until 1959, when it was sold to Allied Paint Company. Allied Paint operated the plant between 1959 and 1979. Keystone Hydraulics has owned and operated the facility since 1979.¹ At various times the following chemicals have been used on property: trichloroethene (TCE), alkyd resins, linseed oils, toluene, xylene, various alcohols, mineral spirits, naphthas, and machine cleaners of unknown composition.

Tate Andale Company is located on the north side of Hancock Street, west of the South Eastern Pennsylvania Transit Authority (SEPTA) railroad tracks in the southern portion of Lansdale. The facility occupies 10 acres and is located at 135 East Hancock Street. The former Andale facility consists of approximately 10 buildings on 10 acres purchased by Rogers Mechanical in 1985.^{4,7} Most of the structures and paved areas are concentrated in the southern portion of the property. There are two large buildings located in the northern portion of the property. There was an area along the eastern portion of the property used for trailer parking. Andale used bulk 1,1,1-TCEA for degreasing. The solvent was pumped into a 200-gallon storage tank located inside a building and then pumped to the 500-gallon vapor degreaser. Andale switched from TCE to 1,1,1-TCEA in 1972. Before 1972, spent solvents were disposed of by being poured on an ash pile at the rear of the facility.^{5,2} The ash pile has subsequently been leveled. Andale removed the tank before the facility was sold.^{1,4,7} Hazardous wastes generated by Andale included unreported quantities of the following materials:³

- Waste-solvent still bottoms (hazardous waste number D001)
- Waste corrosive liquids and solids (D002)
- Waste 1,1,1-TCEA and TCE (F002)
- Waste liquid containing chromium at levels exceeding its extraction-procedure (EP) toxicity criteria (D007)

The Electra Products property is located at 200 West 5th Street in the central portion of Lansdale, south of the intersection of Maple Ave and 5th Street. This property

encompasses approximately 1 acre. Electra used a tetrachloroethene (PCE)-based product for the manufacture of industrial furnaces and ovens.

The John Evans & Sons property is located north of the intersection of Maple Avenue and Spring Avenue in the central portion of Lansdale. The John Evans & Sons property is located north of the intersection of Maple Avenue and Spring Avenue in the central portion of Lansdale. The John Evans & Sons property encompasses approximately 0.75 acre. Evans, a spring manufacturer, purchased its facility at Maple and Spring Avenues, from Ametek (a PRP at the North Penn Area 2 Site) on an unreported date and began operations in 1973. Evans uses TCE and PCE for degreasing and annually disposes of approximately 2,700 gallons of spent TCE and 1,000 gallons of spent PCE to a waste recycler. Unused PCE is stored in a tank inside the plant adjacent to the degreaser. Ametek, a past site owner, also used TCE for degreasing. Analytical results of groundwater samples collected from a well onsite indicated the presence of both contaminants in the past.¹

The REP property is located at 312 Walnut Street in the central portion of Lansdale. The property is situated on the southwest corner of the intersection of Linden and Walnut Streets. The property encompasses approximately 0.75 acre. REP has been operating for over 20 years. Paints and paint thinners containing toluol are used, and in the past, TCE and products containing acetone, methyl ethyl ketone, 1,1,1-TCEA, acetone, and methylene chloride were used.

1.3 Previous Sampling Investigations

Most of the information covered in this section was obtained from a summary prepared by CH2M Hill.⁴ The North Penn Water Authority (NPWA) began groundwater sampling in 1979. In July 1986, NUS Corporation completed a site investigation for EPA. The site was scored using the Hazard Ranking System in October 1986, and proposed for the NPL in January 1987. In 1989, CH2M HILL collected residential well samples under a Phase I investigation and the NPL listing became final in March 1989.

1.3.1 Groundwater Sampling

Groundwater samples have been collected at several locations at the North Penn Area 6 Site over varying periods of time. In all municipal well samples containing detectable volatile organics, the major contaminant is TCE. PCE, vinyl chloride, and cis-1,2-dichloroethene (DCE) were also detected in municipal well samples. Among the industrial well samples, PCE, TCE, and cis-1,2-DCE were the most common contaminants

detected; vinyl chloride was also detected at a concentration of as high as 3,008 µg/l at Keystone Hydraulics. Among residential well samples, the predominant contaminants are TCE, cis-1,2-DCE, and PCE.¹

1.3.2 Soil Sampling

Analytical results of surficial soil sampling performed at the five properties detected elevated levels of TCE, PCE, polycyclic aromatic hydrocarbons (PAHs), aldrin, heptachlor epoxide, endosulfan sulfate, 4,4'-DDT, endrin aldehyde, PCBs, and inorganic chemicals.⁵

2.0 Regulatory Agency Review

Federal, state, and local resource agencies were contacted to collect information concerning: (1) rare, threatened, and endangered species and (2) cultural, historical, and archaeological resources at and near the sites. Requests for site-specific information concerning these resources at or near the site were made to the following agencies:

- U.S. Fish and Wildlife Service
- Pennsylvania Game Commission, Bureau of Land Management
- Pennsylvania Fish Commission, Division of Fisheries Management
- Pennsylvania Department of Environmental Resources, Bureau of Forestry
- Pennsylvania Historical and Museum Commission

At the time of this printing, responses for the data request have been received from three of the five agencies solicited. Responses are still pending from:

- Pennsylvania Department of Environmental Resources, Bureau of Forestry
- Pennsylvania Historical and Museum Commission

2.1 Rare, Threatened and Endangered Species

Data received from the regulatory agencies has indicated that there are no known occurrences of rare, threatened, or endangered species on or adjacent to the North Penn Area 6 properties. However, there are records of the following Pennsylvania State-Endangered and State-Threatened animal and plant species on the Neshaminy Creek, within 15 miles of the Keystone Hydraulics property:⁶

- | | | |
|------------------------|-------------------------------|---------------|
| • Bog Turtle | <i>Clemmys muhlenbergii</i> | PA Endangered |
| • Red-bellied Turtle | <i>Pseudemys rubriventris</i> | PA Threatened |
| • Eared False Foxglove | <i>Tomanthera auriculata</i> | PA Endangered |

While these are the only species known to actually occur within the study area, an additional 32 rare, threatened, or endangered species may utilize habitat within the study area.⁷ These species are listed on Table 2-1, at the end of the report, after page F-47.

2.2 Cultural, Historical, and Archaeological Resources

Data concerning the actual or potential presence of significant cultural, historical, and archaeological resources on the five North Penn Area 6 properties had not been received at the time of this printing.

3.0 Field Investigations

This EA for the North Penn Area 6 Site includes five individual properties within the Borough of Lansdale, Pennsylvania and the surrounding areas of concern. The description of the habitat provided by the individual properties is based on a field visit, performed in November 1993. The study area includes the five North Penn Area 6 Site properties, all areas within a one-mile radius of the five properties, and areas along the Neshaminy and Towamencin Creeks within 15 flow miles of the five properties. Potential receptors along the Neshaminy and Towamencin Creeks, further than one mile from the properties, were determined using reference material. The size and configuration of the study area is based on the potential for discharges of contaminated surface water and sediment into the creeks, the potential for direct exposure to contaminants, and a conservative area that may be impacted by contaminant migration from groundwater to surface water migration and air migration. The field investigations, together with reference materials, identified potential ecological receptors including those that may be impacted by site contamination and remedial activities.

This section includes a discussion of the physical characteristics, location, and the dominant vegetation in each habitat identified on each individual property and within the area of concern. This section also includes a brief description of any wildlife observed in each habitat during the field investigation. A comprehensive listing of all wildlife common to the region that may inhabit the available habitat within in the area of concern is included in Tables 3-1 through 3-9,^{6,8,9,10,11,12} all located at the end of the report, after page F-47.

3.1 Habitat on the Five North Penn Area 6 Properties

Limited amounts of natural habitats were found at the five properties. All of the properties, with the exception of Tate Andale Company, are fully developed urban uplands with little or no pervious area. There is a small area behind the Electra Products property that is a disturbed area, covered in weeds. At the Tate Andale Company property, there are small areas of agricultural (oldfield) upland and an adjacent forested wetland habitat. It should be noted that these areas were relatively small and did not appear to support large populations of any wildlife species. A summary of the wildlife observed on the five properties is included in Table 3-10,¹³ also located after page F-47.

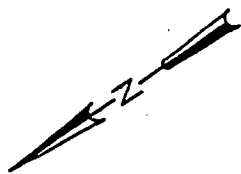
3.1.1 Keystone Hydraulics

Keystone Hydraulics is bordered on the west by residential row-type housing; on the south by an alley and residential row-type housing; on the east by single family residential homes; and on the north by 3rd Street. The area surrounding the Keystone Hydraulics property is generally a residential neighborhood, with an increase in manufacturing facilities toward the east. A sketch of the property layout is shown in Figure 2. Keystone Hydraulics is a predominantly developed site covered almost entirely by structures and pavement. The eastern portion of the site is completely vegetated with grasses. There are some exposed areas in the western portion of the property that are sparsely vegetated with grasses and weeds. During the November 1993 property visit, BVWS observed an area of broken concrete foundation with weeds growing through the cracks. A creek was observed flowing from under the property. The property is surrounded by a chain-link fence.

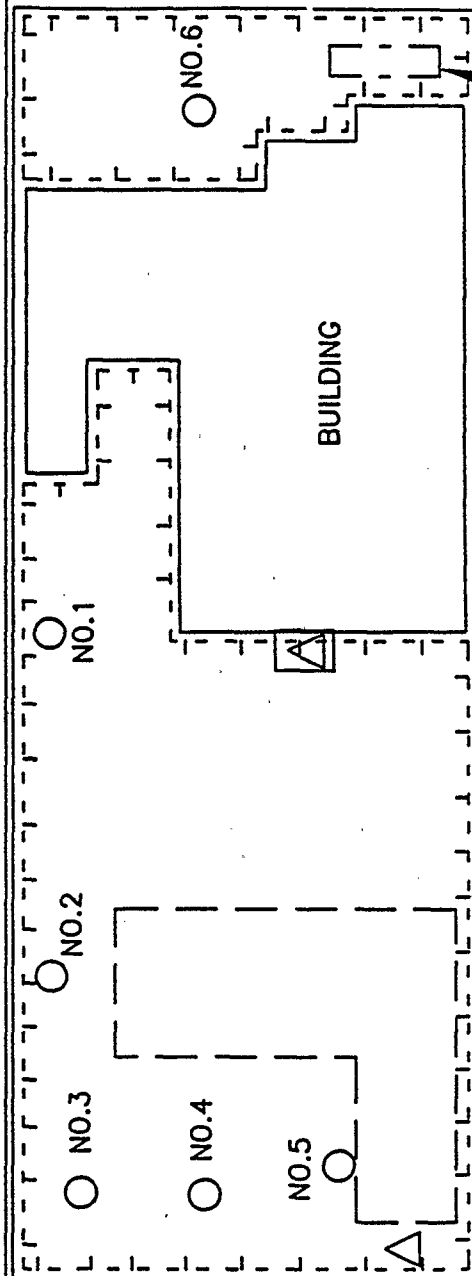
3.1.2 Tate Andale Company

The Tate Andale Company property is bounded to the west by a SEPTA railroad line; to the north by an electrical substation and another SEPTA railroad line; to the east by an open field and a bike shop; and to the south by Hancock Street. The area surrounding the Tate Andale Company property is generally commercial and light industrial. A ball field is located south of the property, across Hancock Street. A sketch of the property layout is shown in Figure 3. Most of the non-developed areas of the property were covered with maintained lawn. There were a few scattered areas of red maple (*Acer rubrum*) in isolated stands on the property. Areas between the property and the SEPTA tracks on the western boundary were dominated by red maples, white oak (*Quercus alba*), privet (*Ligustrum vulgare*), giant reed (*Phragmites australis*), and multiflora rose (*Rosa multiflora*). Some off-site areas adjacent to the property along the western boundary appeared to exhibit wetland characteristics. A swale north of the two northernmost buildings directs surface water from the property into this wetland area. A lightly forested area located adjacent to the northwestern portion of the property, was dominated in the overstory by eastern sycamore (*Platanus occidentalis*) and red maple (*Acer rubrum*). Dominant understory species in this area included silky dogwood (*Cornus amomum*), reed canary grass (*Phalaris arundinacea*), cinnamon fern (*Osmunda cinnamomea*), and poison ivy (*Toxicodendron radicans*).

WEST BRANCH OF NESHAMINY CREEK
DIRECTION OF FLOW



THIRD STREET



ALLEY

Site Sketch of Keystone Hydraulics Property
Five Subject Properties at North Penn Area 6 Site

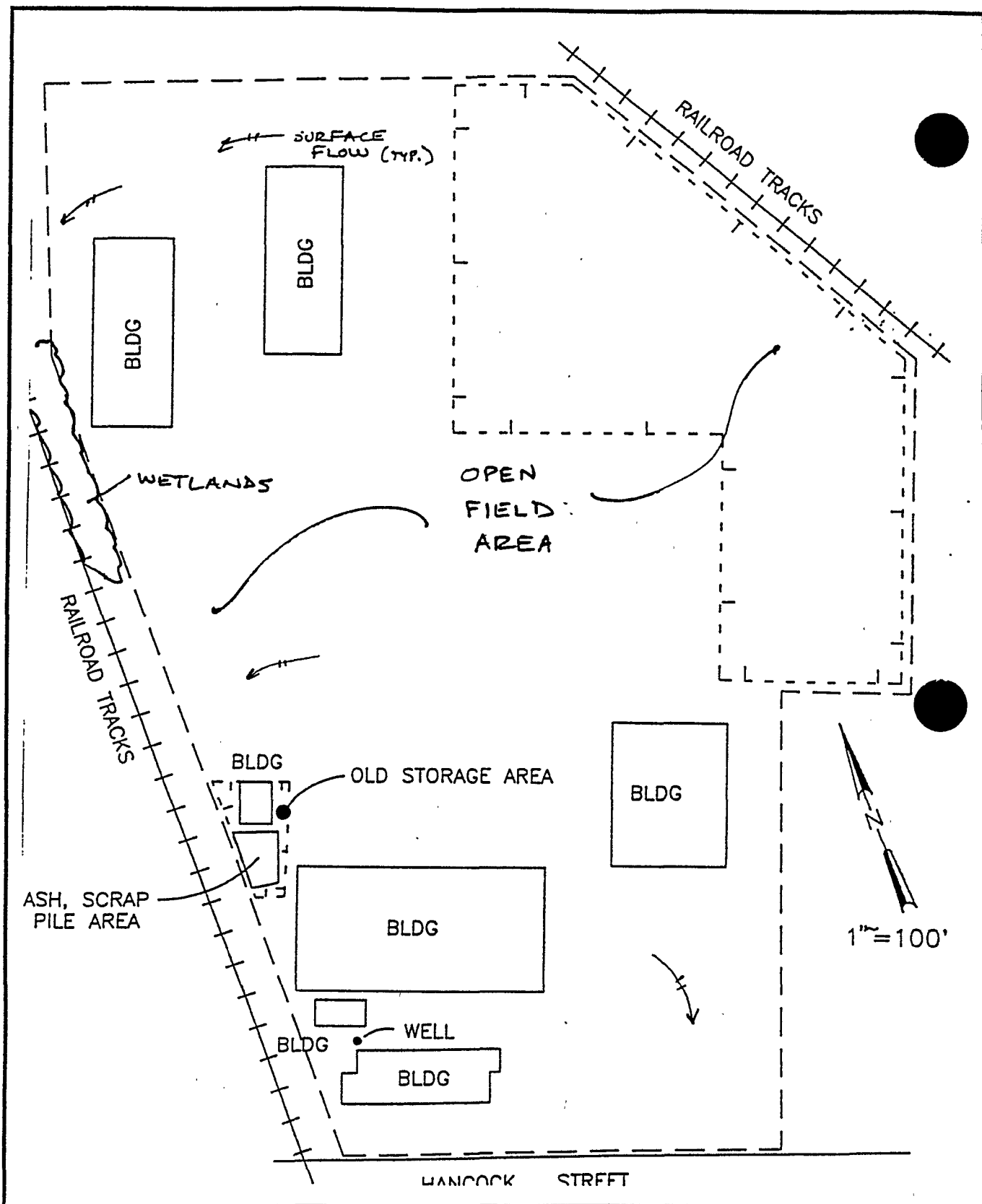
Figure
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Site Sketch of Tate Andale Property
Five Subject Properties at North Penn Area 6 Site

Figure
3



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3.1.3 Electra Products

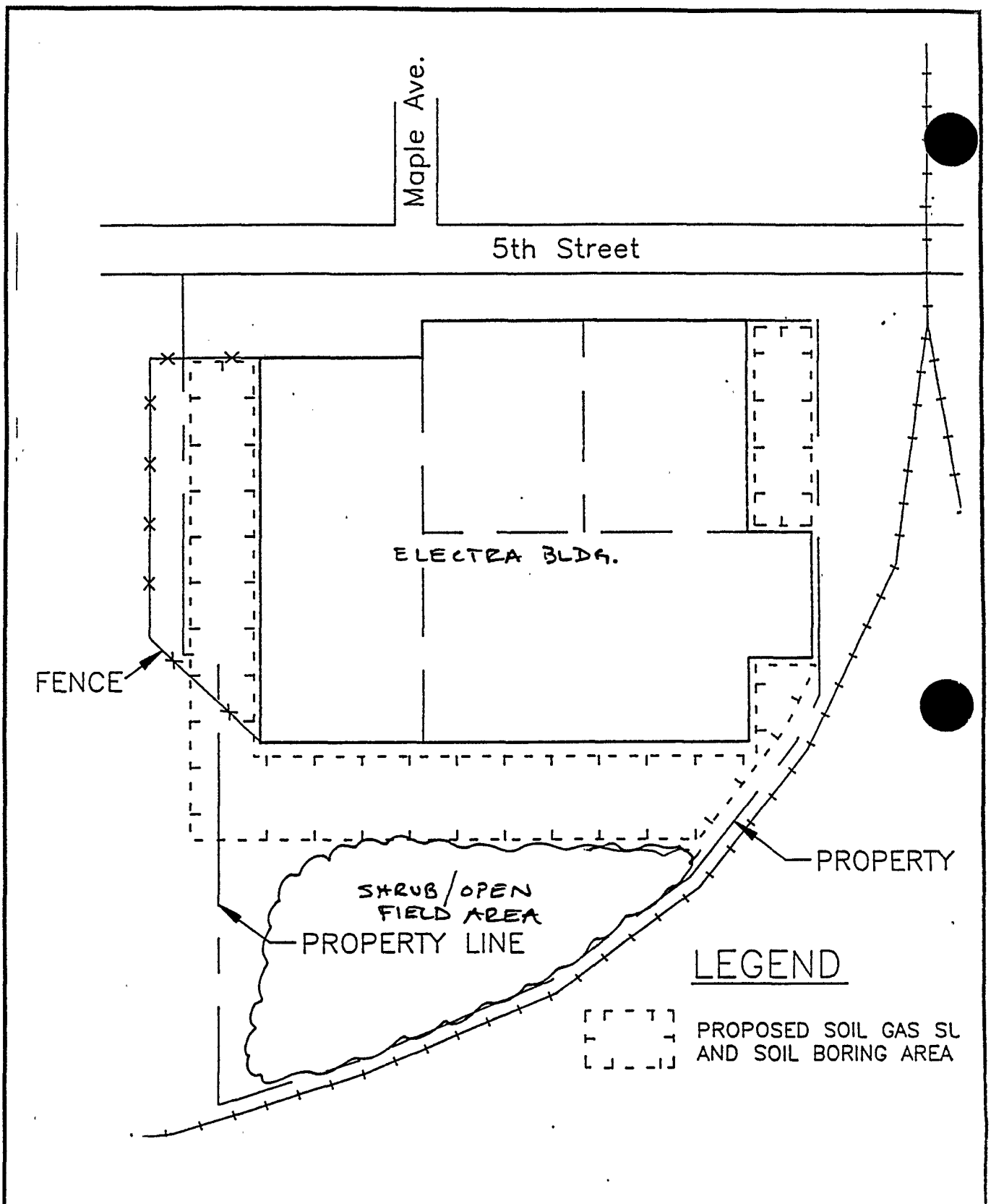
The Electra Products property is bounded to the west by a Lansdale Department of Parks and Recreation office building and residential areas; to the south by a SEPTA railroad line and a soccer/football field; to the east by another SEPTA railroad line; and to the north by 5th Street. The area west and north of the Electra Products property is generally residential while the areas east and south consist of commercial and light industrial facilities. A sketch of the property layout is shown in Figure 4. The Electra Products facility consists of a single building surrounded by paved areas on the north and west sides and hard packed gravel on the south and east. The southern portion of the property was an open field with scattered piles of concrete debris. This field was dominated by various herbaceous species including goldenrod, multiflora rose, staghorn sumac (*Rhus typhina*), and common milkweed (*Asclepias syriaca*). Surface water runoff appears to accumulate in large puddles just to the south of the Electra building. The remainder of the property consists of impervious, non-vegetated cover.

3.1.4 John Evans & Sons

The John Evans & Sons property is bounded to the west by single family residential homes and Kenilworth Road; to the south by one single family residence and the Philadelphia Toboggan Company factory; to the east by a SEPTA railroad line; and to the north by American Olean, a large industrial facility. The area west and south of the John Evans & Sons property is generally residential while the areas north and east consist of commercial and light industrial facilities. A sketch of the property layout is shown in Figure 5. The John Evans & Sons property is a long narrow lot with a building occupying the eastern two-thirds of the property. The western portion of the property is a hard packed dirt and gravel field used as a parking area. Unused portions of this field are vegetated with grasses. A narrow strip of land between the property and the SEPTA tracks to the east are dominated with aster (*Aster sp.*), goldenrod, and staghorn sumac. The remainder of the property consists of impervious, non-vegetated cover.

3.1.5 REP

The REP property is bounded to the west by a SEPTA railroad line and stockyard; to the north by Linden Street and other old industrial buildings; to the east by Walnut Street; and to the south by a light industrial facility. The area around the REP property is a mix of light industry and residential homes. A sketch of the property layout is shown in Figure 6. The REP property consists of a large building occupying the entire northern



Site Sketch of Electra Property
Five Subject Properties at North Penn Area 6 Site

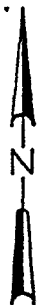
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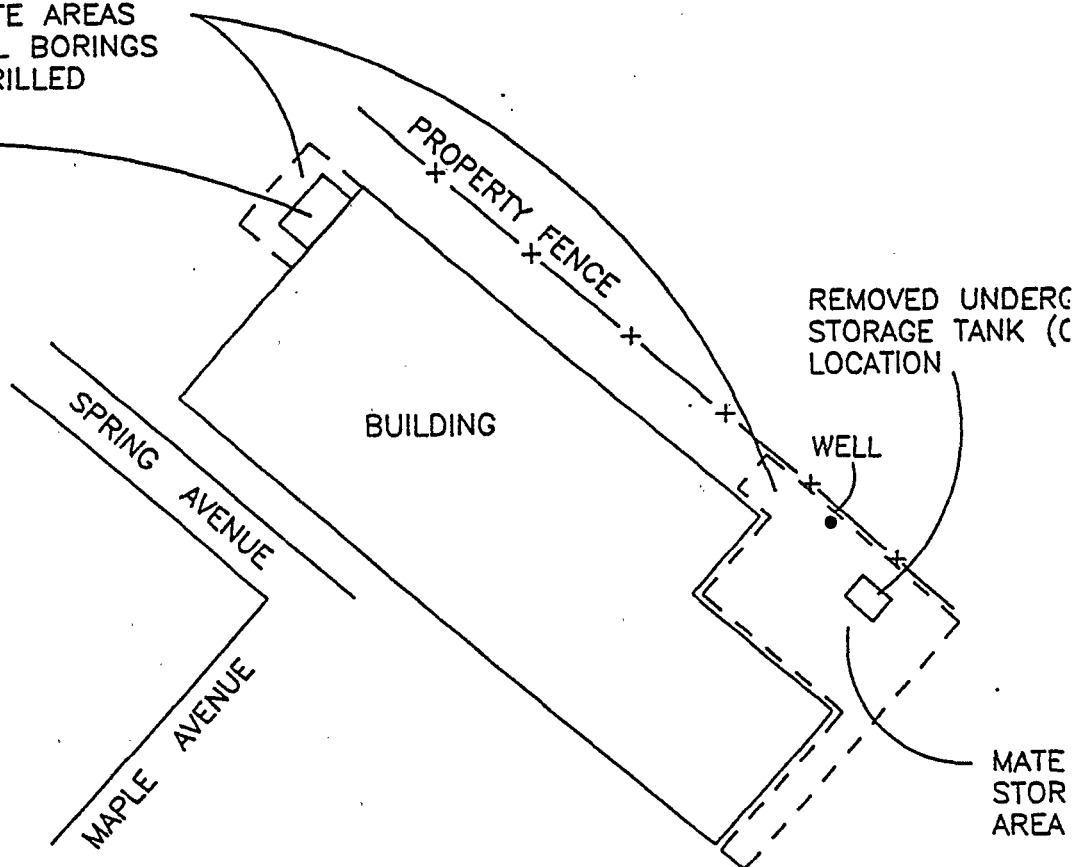
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1"=50'

APPROXIMATE AREAS
WHERE SOIL BORINGS
WILL BE DRILLED

TCE
STORAGE
AREA



Site Sketch of Evans Property
Five Subject Properties at North Penn Area 6 Site

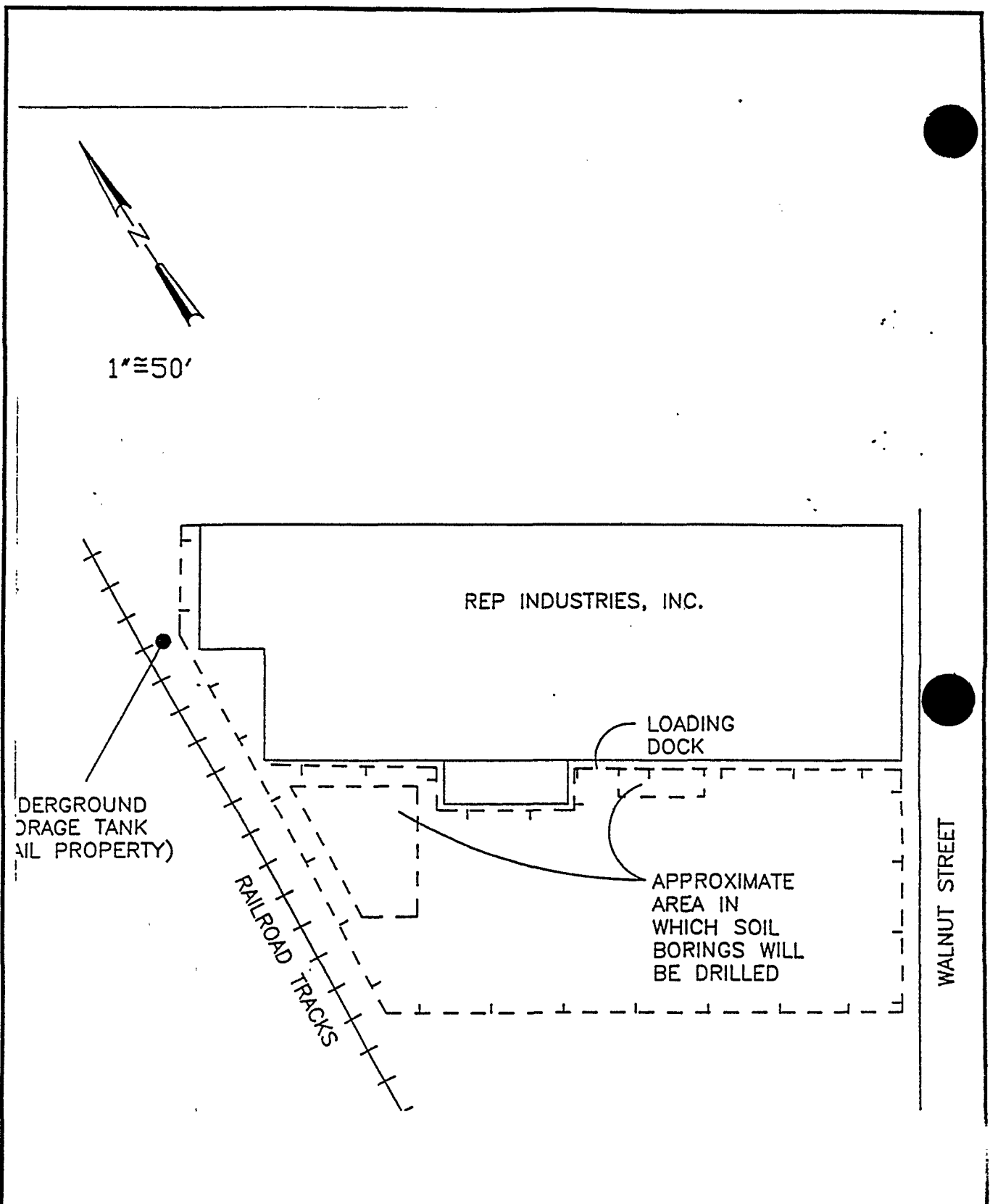
Figure
5



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Site Sketch of REP Property
Five Subject Properties at North Penn Area 6 Site

Figure
6



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portion of the property and a hard packed gravel parking area in the southern portion of the property. The property is surrounded by a 6-foot high, chain-link, barbed-wire fence. There is a shallow swale located outside the fence along the western property line that is sparsely vegetated with grasses, pokeweed (*Phytolacca americana*), and asters. The remainder of the property consists of impervious, non-vegetated cover.

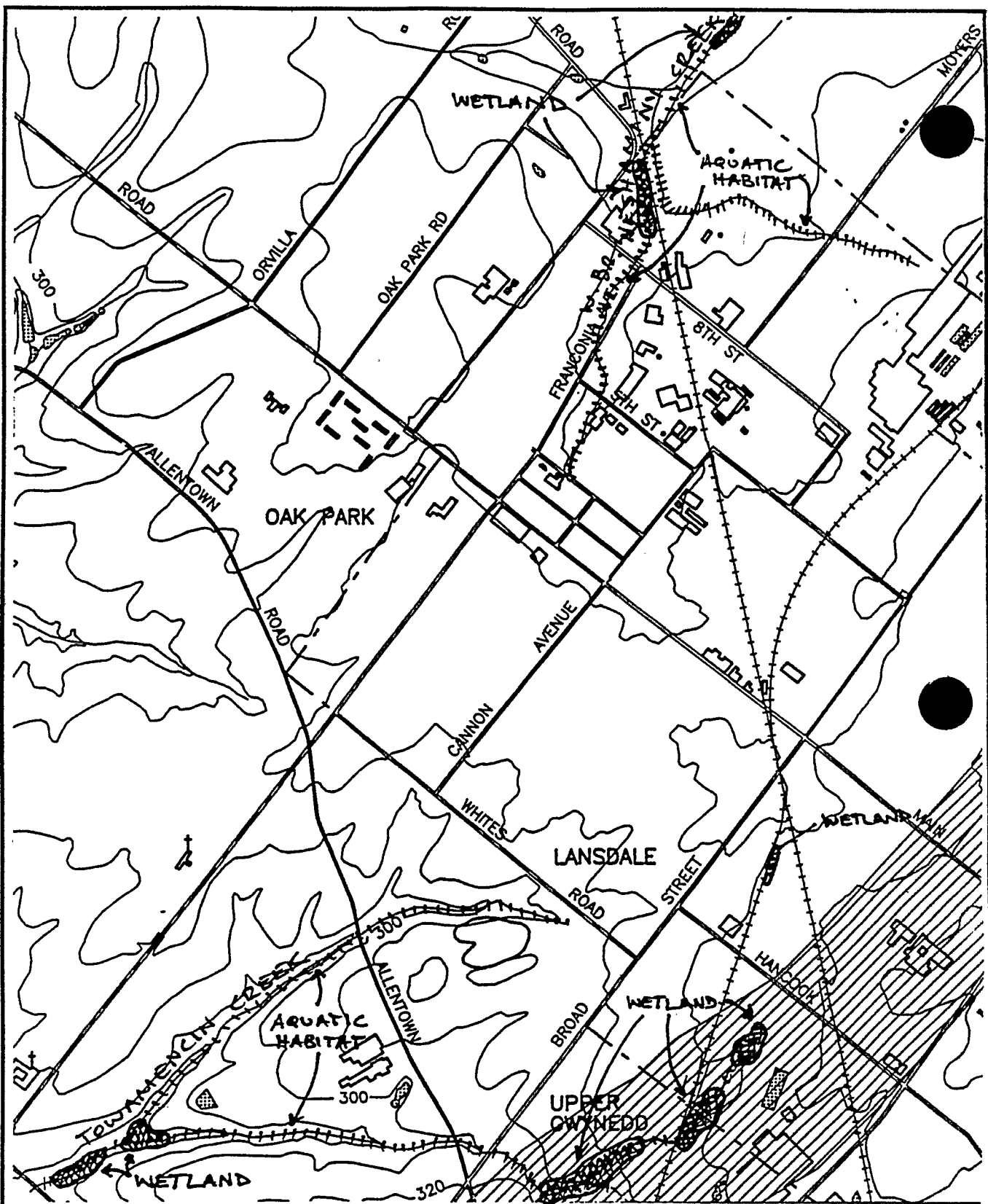
3.2 Habitat within the North Penn Area 6 Study Area

There were several areas of wildlife habitat identified within the North Penn Area 6 Site area of concern. These include various types of aquatic, wetland, and upland habitat. The locations of the various habitats observed are shown in Figure 7. Aquatic habitat includes perennial streams that drain the watersheds of the contaminated sites. Wetland habitat is primarily located along the surface water pathway, although smaller, isolated wetlands areas are located throughout the area of concern. Upland habitat is the predominant habitat type within the area of concern. A summary of the wildlife observed within the study area during the field investigation is included in Table 3-11, located after page F-47.

3.2.1 Aquatic Habitat

There were no areas of aquatic habitat located on any of the five sites evaluated in this EA; however, surface water runoff and contaminated groundwater from these properties may potentially flow into the headwaters of streams within the area of concern. Additionally, a headwater tributary of the Neshaminy Creek flows under the Keystone Hydraulics property. There were two types of aquatic habitat identified within the area of concern: riverine and small pond habitat. The most significant aquatic habitat within the area of concern is the riverine habitat of the perennially flowing tributaries to the Neshaminy, Towamencin, and Wissahickon Creeks and the creeks themselves. The small ponds within the area of concern are generally small agricultural ponds which are common throughout the region.

There are two significant streams that drain the southern area of concern to the southwest (Towamencin and Wissahickon Creeks) and one significant stream that drains the northern area of concern to the east (West Branch Neshaminy Creek). These three streams are fed by numerous small tributaries that originate as intermittent ditches or storm sewer outfalls in the Borough of Lansdale. Surface water runoff and contaminated groundwater from the five properties may potentially flow into the headwaters of these



Map of Habitat Within the North Penn Study Area
Five Subject Properties at North Penn Area 6 Site

Figure
7



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streams within the area of concern. Many of these headwater tributaries are also fed by groundwater discharge where they become perennially flowing streams.

3.2.1.1 West Branch Neshaminy Creek. Surface water runoff from four of the five properties (Keystone Hydraulics, REP, Electra Products and John Evans & Sons) may potentially flow into unnamed tributaries of the West Branch Neshaminy Creek. This is particularly true at Keystone Hydraulics, where a creek flows under the property. The West Branch Neshaminy Creek, and all tributaries, are classified as a warm water and migratory fishery (WWF-MF) under the Pennsylvania Clean Water Act, Section 93.1.¹⁴ A WWF-MF stream is protected under this Act for the propagation and maintenance of warm water freshwater fish species, and anadromous and catadromous marine fish species.

An unnamed tributary of the West Branch Neshaminy Creek begins under the Keystone Hydraulics property in a storm water enclosure. This stormwater enclosure may receive surface water runoff from the REP and Electra Products properties. This unnamed tributary emerges from a culvert are located across 3rd Street from the property. The unnamed tributary flows through a heavily urbanized area for approximately 0.8 mile in a northwesterly direction. Surface water runoff from the John Evans & Sons property may enter this tributary through a ditch that flows in at this point. Water in this section of the unnamed tributary was approximately 6 feet wide and 6 inches deep, with stream banks 4 to 5 feet high. The substrate was predominately silty, with some concrete debris and concrete channel improvements. Some minnows (Family Cyprinidae) were observed in this section of the tributary, although they were not identified to species level. The portion of the creek under the Keystone Hydraulics property would not be expected to support aquatic life, since there is no sunlight to support and maintain an actively functioning ecosystem.

The unnamed tributary flows for approximately 0.7 mile northward, through deciduous forest, where it converges with the West Branch Neshaminy Creek. Water in this section of the unnamed tributary was approximately 10 feet wide and 6 to 12 inches deep, with stream banks 1 to 2 feet high. The substrate was predominately cobbles, with some silty reaches and pools near road crossings. A belted kingfisher (*Mergaceryle alcyon*) was observed along this section of the unnamed tributary during the field investigations.

The West Branch Neshaminy Creek flows eastward for approximately 1.2 miles, where it exits the area of concern of the North Penn Area 6 Site. Water in this section of the unnamed tributary was approximately 10 to 15 feet wide and 1 to 2 feet deep, with

stream banks 1 to 5 feet high. The substrate was predominately cobbles, with some silty reaches and deep pools near road crossings.

3.2.1.2 Towamencin Creek. Surface water runoff from the Tate Andale Company property may potentially flow into the headwaters of the Towamencin Creek. The Towamencin Creek is a tributary of the Skippack Creek and is classified as a trout-stocked, warm water fishery (TSF) under the Pennsylvania Clean Water Act, Section 93.1.¹⁴ A TSF stream is protected under this Act for the propagation and maintenance of warm water freshwater fish species, and is periodically stocked with trout between February and September.

The Towamencin Creek begins as a small ditch draining a forested wetland area adjacent to the Tate Andale Company property. This ditch flows to the southwest for approximately 500 feet where it enters an underground stormwater drainage system. The ditch reemerges approximately 400 feet north of Whites Road, in Lansdale, flows through a culvert, and emerges at a small park on Whites Road. This appears to be the beginning of perennial flow based on the field investigation and the USGS map of the region. The Towamencin Creek continues to flow southeast through deciduous forest for approximately 3 miles, where it exits the area of concern of the North Penn Area 6 Site. Water in this section of the Towamencin Creek was approximately 10 feet wide and 6 inches deep, with stream banks 2 to 3 feet high. The substrate was predominately silty, with some cobble areas and pools near stream bends, except in stream sections near commercial developments, where the substrate becomes silty and the stream bank become more eroded.

3.2.1.3 Wissahickon Creek. Surface water runoff does not appear to enter the Wissahickon Creek from any the five North Penn Area 6 properties; however, this stream is still located within the area of concern for air contaminants. The Wissahickon Creek is classified as a trout-stocked, warm water fishery (TSF) under the Pennsylvania Clean Water Act, Section 93.1.¹⁴ A TSF stream is protected under this Act for the propagation and maintenance of warm water freshwater fish species, and is periodically stocked with trout between February and September. A field investigation of the aquatic habitat along the Wissahickon Creek was not performed as part of this EA.

3.2.1.4 Small Pond Habitat. There are numerous small ponds located within the area of concern. None of these small pond habitats are directly impacted by site contaminants,

but are still located within the area of concern for air contaminants. Most of these small ponds have been constructed in excavations of by damming headwater streams in the area for agricultural purposes. Some of these ponds are stocked by local fishermen for recreational fishing purposes. A field investigation of the small pond habitat was not performed as part of this EA.

3.2.2 Wetland Habitat

There were no areas of wetland habitat located on any of the five sites evaluated in this EA. However, there are numerous small wetlands, encompassing over 300 acres, mapped on the NWI within three miles of the North Penn Area 6 site.¹⁵ These wetlands include palustrine forested (PFO), shrub-scrub (PSS), emergent (PEM) wetlands, and combinations of all of these wetland types. The overall ratio of wetland to upland area increases from west to east in the study area. There are few wetlands associated with the small tributaries and streams to the west of the North Penn Area 6 site; however, east of the site where these tributaries and small streams converge to form larger stream, elevations are lower and the areas are more conducive to wetland development. Approximately 30 acres of these wetlands are located west of the study area, with the remaining 270 acres located to the east. The wetland areas located west of the study area are divided between forested, emergent, and shrub-scrub wetlands. The majority of the wetlands located east of the study area are forested wetlands, with smaller areas of emergent and shrub-scrub wetlands. A summary of the vegetation observed in the wetland habitat is included in Table 3-12, located after page F-47.

There were four areas of wetlands observed or mapped along the Towamencin Creek between the North Penn Area 6 site and Sumneytown Pike, approximately 1 mile downstream along the Towamencin Creek. There were two areas of wetlands observed or mapped along the Neshaminy Creek between the North Penn Area 6 site and Cowpath Road, approximately 1 mile downstream along the Neshaminy Creek.

3.2.2.1 Palustrine Forested/Scrub-Shrub Wetlands. An area, located adjacent to the Tate Andale Company property, between the property and the SEPTA tracks on the western boundary, is a palustrine forested/scrub-shrub wetland. A swale north of the two northernmost buildings directs surface water from the site into this wetland area. This is a lightly forested area dominated in the overstory by eastern sycamore and red maple. Dominant understory species in this area included silky dogwood, privet, giant reed, multiflora rose, reed canary grass, cinnamon fern, and poison ivy. An area of palustrine

forested/scrub-shrub (PFO/SS1A) wetlands is located approximately 0.4 mile south of the Tate Andale Company property on the headwaters of the Towamencin Creek. This wetland was not mapped on the National Wetlands Inventory (NWI) but was observed in a field investigation performed by BVWS in November 1993. A second area of PFO/SS1A wetlands was observed approximately 1,200 feet further downstream, approximately 0.6 mile south of the Tate Andale Company property. The presence of this wetland was confirmed by BVWS in the November 1993 investigation.

The dominant overstory species in these wetlands included white ash (*Fraxinus americana*), red maple, and black walnut (*Juglans nigra*). Dominant understory species in this wetland included southern arrowwood (*Viburnum dentatum*), privet, and silky dogwood. Dominant herbaceous species in this wetland included goldenrod, cinnamon fern, and violet (*Viola sp.*).

During the field investigation, bird species were observed but not identified. A mammalian species, eastern gray squirrel (*Sciurus carolinensis*) was observed and white-tailed deer (*Odocoileus virginicus*) tracks were identified in this habitat.

3.2.2.2 Palustrine Forested Wetlands. An area of palustrine forested (PFO1A) wetlands is located approximately 1.3 miles west of the Tate Andale Company property on the Towamencin Creek. An area of PFO1A wetlands was observed approximately 0.8 mile north of the Keystone Hydraulics and John Evans & Sons properties, on the Neshaminy Creek. The presence of these wetlands was confirmed by BVWS in the November 1993 investigation.

The dominant overstory species in this wetland included white ash, eastern sycamore, silver maple (*Acer saccharum*), weeping willow (*Salix babylonica*), red maple, and black walnut. The dominant understory species in this wetland included arrowwood, wild grape (*Vitis sp.*), privet, tatarian honeysuckle (*Lonicera tatarica*), and poison ivy. Dominant herbaceous species in this wetland included goldenrod, white avens (*Geum canadense*), and violet.

During the field investigation, bird species were observed but not identified. A mammalian species, eastern gray squirrel (*Sciurus carolinensis*) was observed and white-tailed deer (*Odocoileus virginicus*) tracks were identified in this habitat.

3.2.2.3 Palustrine Emergent Wetlands. An area of palustrine emergent (PEM5A) wetlands was observed approximately 1.5 miles west of the Tate Andale Company property, along the headwaters of the Towamencin Creek. The presence of this wetland

was confirmed by BVWS in the November 1993 investigation. An area of PEM5A wetland is located approximately 0.6 mile north of the Keystone Hydraulics property, along a tributary of the Neshaminy Creek. This wetland was not mapped on the National Wetlands Inventory (NWI) but was observed in a field investigation performed by BVWS in November 1993. This wetland area was behind a shopping center and was highly disturbed.

There was no woody vegetation dominating in these wetlands. The herbaceous vegetation in these wetland appeared to be dominated by giant reed, cattail (*Typha latifolia*), sedges, reed canary grass, goldenrod, aster, and frost-killed vegetation that could not be identified.

There was no wildlife observed or their sign observed during the field investigation in this emergent wetland habitat.

3.2.3 Terrestrial Habitat

The majority of the land within the area of concern is terrestrial habitat. All five of the North Penn Area 6 site properties were terrestrial upland habitat. Terrestrial upland habitat has been broken into three major groupings: developed/urban uplands, forested uplands, and agricultural uplands. Within the area of concern, the vast majority of the upland habitat is developed/urban habitat and includes the Borough of Lansdale, outlying suburban areas including residential subdivisions and commercial shopping areas. All five properties evaluated consist of developed/urban upland habitat. The next largest upland habitat type is the forested habitat, followed by the agricultural upland habitat. A summary table of the vegetation observed within the terrestrial habitat is included in Table 3-13.

3.2.3.1 Developed/Urban Uplands. The developed/urban upland habitat is the most diverse habitat in the area of concern. This habitat includes all non-wetland habitat that was created by human conversion of wetland, aquatic, forested upland, or agricultural upland habitat into non agricultural uses. Examples of common types of sub-habitats found in this area include public transportation corridors, residential housing, commercial development, industrial parks, urban infrastructure, parks, and lawns. These areas all generally include structures, impervious surfaces, and grassed or landscaped areas that may include both indigenous and exotic plant and animal species. Developed/urban uplands provide a very diverse habitat for numerous wildlife species that are well suited

to adaptation. Numerous species of passerine birds, waterfowl, small mammals, and insects have adapted well to these habitats.

During the field investigation, bird species including the dark-eyed junco (*Junco hyemalis*), house sparrow (*Passer domesticus*), rock dove (*Columba livia*), and American crow (*Corvus brachyrhynchos*) were observed on some of the five properties. A mammalian species, the eastern gray squirrel (*Sciurus carolinensis*), was observed on two of the five properties. No other wildlife was observed on the properties during our field investigation.

3.2.3.2 Forested Uplands. The forested upland habitat observed in the area of concern was dominated by mixed deciduous tree species including red maple, black cherry (*Prunus serotina*), honey locust (*Gleditsia triacanthos*), red oak (*Quercus rubra*), white oak, black gum (*Nyssa sylvatica*), sugar maple (*Acer saccharum*), American elm (*Ulmus americana*), and black walnut. The understory vegetation was dominated by shrub/vine species including poison ivy, privet, Japanese honeysuckle, and multiflora rose. The sparse herbaceous layer in these forested uplands was dominated by goldenrods, asters, wild garlic (*Allium canadense*), violets, and ground ivy (*Glechoma hederacea*).

Most areas of forested uplands were associated with the major drainageways through the area of concern. This results in a network of forested corridors along streams, broken by roads and bridges, traversing the corridors. There were two large areas of forested uplands within the area of concern that were of significant size. Some areas of this forested upland habitat were observed being converted into residential and commercial development, which appears to be the land use trend in this area since wetland habitat is more heavily regulated.

During the field investigation, bird species were observed but not identified. A mammalian species, eastern gray squirrel (*Sciurus carolinensis*) was observed and white-tailed deer (*Odocoileus virginicus*) tracks were identified in this habitat. No other wildlife was observed in this habitat during the field investigation.

3.2.3.3 Agricultural Uplands. The agricultural upland habitat, which may include abandoned agricultural areas called "oldfield" was scattered throughout the area of concern, with the majority of acreage located to the northwest of the five properties. Most of the agricultural fields observed were cultivated with field corn, although soybean was also frequently observed. Oldfield areas were dominated by goldenrod, asters, and thistles (*Cirsium sp.*).

During the field investigation, bird species including the red-winged blackbird (*Agelaius phoeniceus*), house sparrow (*Passer domesticus*), and American crow (*Corvus brachyrhynchos*) were observed in this habitat. No other wildlife was observed in this habitat during the field investigation.

4.0 Literature-Based Initial Toxicity Assessment

A review of scientific literature addressing the physical and chemical characteristics, fate and transport, and environmental toxicity characteristics of the chemicals of concern identified in previous sampling investigation was performed.

Ecological receptors potentially impacted from contaminants at the North Penn Area 6 site are generally terrestrial flora and fauna. These receptors may be exposed to the contaminants by ingestion, dermal contact, and inhalation. Inhalation is probably insignificant compared to ingestion and dermal contact because contaminant levels in air are expected to be very low. Ingestion and dermal contact of these contaminants may occur when they are transported to the receptors through groundwater and surface water.

Ecologically significant media of concern generally include surficial soils, surface water, sediments, air, and shallow groundwater. At the five properties evaluated at the North Penn Area 6 site, the list of media reduces to surficial soils, surface water, and sediments because groundwater in the area is generally deep. Terrestrial ecological receptors may become exposed to contaminated surficial soils on each property. Terrestrial, wetland, and aquatic ecological receptors may become exposed to contaminated surface water along the Neshaminy and Towamencin Creek headwaters, which drain the study area and the subject properties. Additionally, wetland and aquatic ecological receptors along these two creeks may become exposed to contaminated sediment carried in surface water runoff from the subject properties.

Because the groundwater in this area is deep, and because the modeling results for the Remedial Investigation⁵ show no significant impact on groundwater quality by contaminated subsurface soils, the development of the list of chemicals of concern used in this ecological risk assessment is based on the surficial soil sampling results.

The toxicity assessment will address the toxicity of the chemicals of concern detected on the five properties to two main habitat types: aquatic (creeks, wetlands) and terrestrial (uplands). In the environment, contaminants tend to act at the organizational level of the individual organism; however, effects are more readily noticed at the organizational population level or higher, since it is difficult to find and observe representative individuals of each species in an ecosystem. Because toxicology data on ecosystems is lacking, effects data on individuals or populations of individuals was utilized. The toxicological data present in this assessment has been obtained from various literature sources and the AQUIRE database in the form of LC_{50} or EC_{50} values. An EC_{50} value is the concentration of a contaminant in an experimental environment at which a specific

effect is noted in 50% of the individuals present. The LC_{50} value is simply the EC_{50} value of a mortality effect.

4.1 Toxicity of Ecological Contaminants of Concern

The preliminary list of ecological chemicals of concern (ECOCs) initially included all chemicals detected in surficial soil samples obtained at each of the five subject properties during previous sampling events. These surficial soil samples, obtained in the top two feet of soil, were analyzed for volatile organic, semi-volatile organic, and inorganic chemicals. A list of ECOCs was prepared for each of the five properties evaluated. Individual chemicals were then eliminated from consideration as ecological chemicals of concern based on the following criteria:

- Chemicals with results qualified as "B", "R", and other types of data modifiers may be unreliable and were eliminated from consideration.
- Chemicals with results not significantly beyond the background ranges were eliminated from consideration.

Table 4-1 (located after page F-47) presents a preliminary list of ECOCs for surficial soils demonstrating elimination criteria used to determine the resulting list of ECOCs. A summary list of ECOCs for each of the five properties is presented in Table 4-2. The following sections describe the fate, transport, and toxicity of each ecological chemical of concern identified on the five North Penn Area 6 properties.

4.1.1 Volatile Organic Compounds

4.1.1.1 Trichloroethene (TCE). No ambient water quality criteria is available for this chemical, nor are there any applicable terrestrial benchmark concentrations.

Trichloroethene (TCE) rapidly volatilizes into the atmosphere where it reacts with hydroxyl radicals to produce hydrochloric acid, carbon monoxide, carbon dioxide, and carboxylic acid.¹⁶ This is probably the most important transport and fate process for trichloroethene in surface water and in the upper layer of soil in the early stage of spills. TCE adsorbs to organic materials and can be bioaccumulated to some degree. However, it is unclear whether trichloroethene bound to organic material can be degraded by microorganisms or must be desorbed before degradation may take place. There is some evidence that higher organisms can metabolize TCE. Trichloroethene leaches into the

groundwater fairly readily, and it is a common contaminant of groundwater around hazardous waste sites.

There was only limited data on the toxicity of trichloroethene to aquatic organisms. The acute toxicity to freshwater species was similar in three fish species tested, with LC_{50} values of about 50 mg/liter. No LC_{50} values were available for saltwater species. However, a dose of 2 mg/liter caused erratic swimming and loss of equilibrium in the grass shrimp. No chronic toxicity tests were reported.¹⁷

No information on the toxicity of trichloroethene to domestic animals or terrestrial wildlife was available in the literature reviewed.

4.1.1.2 Tetrachloroethene (PCE). No ambient water quality criteria is available for this chemical, nor are there any applicable terrestrial benchmark concentrations.

Tetrachloroethene (PCE) rapidly volatilizes into the atmosphere where it reacts with hydroxyl radicals to produce HCl, CO, CO_2 and carboxylic acid. In soils with high levels of organics, PCE adsorbs to these materials and can be bioaccumulated to some degree. However, it is unclear if tetrachloroethene bound to organic material can be degraded by microorganisms or must be desorbed before degradation occurs. There is some evidence that higher organisms can metabolize PCE.¹⁶

Tetrachloroethene was found to produce liver cancer in male and female mice when administered orally by gavage. Inhalation studies with rodents exposed to PCE have identified delayed ossification in animals, increased fetal absorptions, renal and hepatic toxicity and CNS depression.

Tetrachloroethene is the most toxic of the chloroethylenes to aquatic organisms but is only moderately toxic relative to other types of compounds. The limited acute toxicity data indicate that the LC_{50} value for salt water and fresh water fish species are similar, around 10,000 $\mu\text{g/l}$; the trout was the most sensitive ($LC_{50} = 4,800 \mu\text{g/l}$). Chronic values were 840 and 450 $\mu\text{g/l}$ for fresh water and salt water species, respectively, and an acute-chronic ratio of 19 was calculated.¹⁸

No information on the toxicity of tetrachloroethene to terrestrial wildlife or domestic animals was available in literature reviewed.

4.1.2 Metals

4.1.2.1 Arsenic. The ambient water quality criteria (AWQC) for this chemical is 190 ppb.¹⁹ Additionally, the National Oceanic and Atmospheric Administration (NOAA) has developed apparent effects thresholds for benthic organisms in aquatic sediments. The

lowest concentration (ER-L) of this chemical observed to produce effects in benthic organisms is 33.0 ppm.²⁰ There are no applicable terrestrial chemical benchmark concentrations.

Arsenic is generally quite mobile in the environment. In the aquatic environment, volatilization is important when biological activity or highly reducing conditions produce arsine or methylarsenics. Sorption by the sediment is an important fate for the chemical. Arsenic is metabolized to organic arsenicals by a number of organisms; this increases arsenic's mobility in the environment. Because of its general mobility, arsenic tends to cycle through the environment. Its ultimate fate is probably the deep ocean, but it may pass through numerous stages before finally reaching the sea.

Arsenic metabolism and effects are significantly influenced by the animal/plant tested, the route of administration, the physical and chemical form of the arsenic, and the dose. Inorganic arsenic compounds are more toxic than organic arsenic compounds. Arsenic has high acute toxicity to aquatic life, birds and land animals. Except where soil arsenic content is high (around smelters and where arsenic-based pesticides have been used heavily), arsenic does not accumulate in plants to toxic levels. Where soil arsenic content is high, growth and crop yields can be decreased. Arsenic has high chronic toxicity to aquatic life, and moderate chronic toxicity to birds and land animals.

Arsenic poisoning causes a toxic syndrome among domestic animals. Arsenic causes hyperemia and edema of the gastrointestinal tract, hemorrhage of the cardiac serosal surfaces and peritoneum, and pulmonary congestion and edema; and it may cause liver necrosis. Information on arsenic toxicity to terrestrial wildlife was not reported in the literature reviewed.²¹

4.1.2.2 Cadmium. The ambient water quality criteria (AWQC) for this chemical is 1.1 ppb.¹⁹ The NOAA lowest concentration (ER-L) of this chemical observed to produce effects in benthic organisms is 5.0 ppm.²⁰ There are no applicable terrestrial chemical benchmark concentrations.

Cadmium is relatively mobile in the aquatic environment compared to other heavy metals. The most common mechanism for removing cadmium from surface water is adsorption onto sediments. It appears that cadmium moves slowly through soil, but no site specific information is available to allow a detailed evaluation. Cadmium uptake by plants is not a significant mechanism for depletion of soil accumulations but may be significant for human exposure. Laboratory experiments suggest that cadmium may have

adverse effects on reproduction in fish at levels present in lightly to moderately polluted waters.

The acute LC_{50} for freshwater fish and invertebrates generally ranged from 100 to 1,000 $\mu\text{g/l}$; salmonids are much more sensitive than other organisms. Saltwater species were in general ten times more tolerant to the acute effects of cadmium. Chronic tests have been performed and show that cadmium has cumulative toxicity and acute chronic ratios that range of from 66 to 431. Bioconcentration factors were generally less than 1,000 but were as high as 10,000 for some freshwater fish species.²¹

No adverse effects on domestic or wild animals were reported in the studies reviewed.

4.1.2.3 Chromium. The ambient water quality criteria (AWQC) for this chemical is 11.0 ppb for the hexavalent form (Cr IV) and 210.0 ppb for the trivalent form (Cr III).¹⁹ The NOAA lowest concentration (ER-L) of this chemical observed to produce effects in benthic organisms is 80.0 ppm.²⁰ There are no applicable terrestrial chemical benchmark concentrations.

Hexavalent Cr is quite soluble, existing in solution as a component of a complex anion. It is not sorbed to any significant degree by clays or hydrous metal oxides. The anionic form varies with pH and may be a chromate, hydrochromate, or dichromate. Because all anionic forms are so soluble, they are quite mobile in the aquatic environment. Bioaccumulation and adsorption to sediment is the predominant fate of these anionic forms.

Chromium is an essential nutrient and is accumulated in a variety of aquatic and marine biota, especially benthic organisms, to levels much higher than in ambient water. Levels in biota, however, usually are lower than levels in the sediments. Passage of chromium through the food chain can be demonstrated. The food chain appears to be a more efficient pathway for chromium uptake than direct uptake from seawater.

Water hardness, temperature, dissolved oxygen, species, and age of the test organism all modify the toxic effects of chromium on aquatic life. Cr III appears to be more acutely toxic to fish than Cr VI; the reverse is true in long term chronic exposure studies.

None of the plants normally used as food or animal feed are chromium accumulators. Chromium absorbed by plants tends to remain primarily in the roots and is poorly translocated to the leaves. There is little tendency for chromium to accumulate along food chains in the trivalent inorganic form. Organic chromium compounds, about which little is known, can have significantly different bioaccumulation tendencies. Little

information concerning the toxic effects of chromium on mammalian wildlife and domestic animal species is available.²¹

4.1.2.4 Copper. The ambient water quality criteria (AWQC) for this chemical is 12.0 ppb.¹⁹ The NOAA lowest concentration (ER-L) of this chemical observed to produce effects in benthic organisms is 70.0 ppm.²⁰ There are no applicable terrestrial chemical benchmark concentrations.

Copper has two oxidation states, +1 (cuprous) and +2 (cupric). Cuprous copper is unstable in aerated water over the pH range of most natural waters (6 to 8) and oxidizes to the cupric state. Several processes determine the fate of copper in the aquatic environment; formation of complexes, especially with humic substances; sorption to hydrous metal oxides, clays, humic substances; and bioaccumulation.

As an essential nutrient, copper is accumulated by plants and animals, although apparently it is not generally biomagnified. Because copper is strongly bioaccumulated and because biogenic ligands play an important role in complexing copper, biological activity can be a major factor in controlling the distribution and occurrence of copper in surface water.

Because many copper compounds and complexes are readily soluble, copper is among the more mobile heavy metals in soil and other surface environments. The major process that limits the environmental mobility of copper is adsorption to organic matter, clays, and other materials.

Mean acute toxicity values for a large number of freshwater animals range from 7.2 µg/l for *Daphnia publicaria* to 10,200 µg/l for the bluegill. Chronic values for a variety of freshwater species range from 3.9 µg/l for brook trout to 60.4 µg/l for northern pike. The acute-chronic ratios for different species range from 3 to 156.

Bioconcentration factors in freshwater species range from zero for the bluegill to 2,000 for the alga *Chlorella regularis*.

Sheep are very susceptible to copper toxicosis, and poisoning may be acute or chronic. Acute poisoning is caused by direct action of copper salts on the gastrointestinal tract, resulting in gastroenteritis, shock, and death. The toxic dose is about 200 mg/kg and is usually obtained through an accidental overdose of an anthelmintic. Ingestion of excess copper over a long period of time results in absorption and accumulation of copper by the liver. This type of chronic cumulative poisoning may suddenly develop into an acute hemolytic crisis. Copper intake of 1.5 g/day for 30 days is known to be fatal for many breeds of sheep. Excessive copper may be stored in the liver as a result of excess

copper ingestion, as a consequence of impaired liver function, or in connection with a deficiency or excess of other trace elements. Sheep release accumulated copper very slowly after cessation of exposure.

Swine develop copper poisoning at levels of 250 mg/kg in the diet unless zinc and iron levels are increased. Toxicosis develops with hypochromic microcytic anemia, jaundice, and marked increases in liver and serum copper levels. However, swine rapidly eliminate copper once it is removed from the diet. Cattle are much more resistant to copper in the diet than sheep or swine. Copper toxicity in ruminants can be counteracted by including molybdenum and sulfate in the diet.²¹

4.1.2.5 Lead. The ambient water quality criteria (AWQC) for this chemical is 3.2 ppb.¹⁹ The NOAA lowest concentration (ER-L) of this chemical observed to produce effects in benthic organisms is 35.0 ppm.²⁰ There are no applicable terrestrial chemical benchmark concentrations.

Lead is a heavy metal with a common oxidation state, +2. Sorption processes appear to exert a dominant effect on the distribution of lead in the environment. Adsorption to inorganic solids, organic materials, and hydrous iron and manganese oxides usually controls the mobility of lead and results in a strong partitioning of lead to the bed sediments in aquatic systems. Over most of the normal pH range, lead carbonate, and lead sulfate control the solubility of lead in aerobic conditions, and lead sulfide control the solubility in anaerobic conditions. Lead is strongly complexed to organic materials present in aquatic systems and soil. Lead in soil is not easily taken up by plants, and therefore its availability to terrestrial organisms is somewhat limited.

Bioaccumulation of lead has been demonstrated for a variety of organisms, and bioconcentration factors are within the range of 100-1,000. Microcosm studies indicate that lead is not biomagnified through the food chain. Biomethylation of lead by microorganisms can remobilize lead to the environment.

Freshwater vertebrates and invertebrates are more sensitive to lead in soft water than in hard water. At a hardness of about 50 mg/liter CaCO₃, the median effect concentrations for nine families range from 140 µg/l to 236,600 µg/l. Chronic values for *Daphnia magna* and the rainbow trout are 12.26 and 83.08 µg/l, respectively, at a hardness of about 50 mg/l. Bioconcentration factors, ranging from 42 for young brook trout to 1,700 for a snail, were reported. Freshwater algae show an inhibition of growth at concentrations above 500 µg/l.

Although lead is known to occur in the tissue of many free-living wild animals, including birds, mammals, fishes, and invertebrates, reports of poisoning usually involve waterfowl. There is evidence that lead, at concentrations occasionally found near roadsides and smelters, can eliminate or reduce populations of bacteria and fungi on leaf surfaces and in soil. Many of these microorganisms play key roles in the decomposer food chain.²¹

4.1.2.6 Manganese. No ambient water quality criteria is available for this chemical, nor are there any applicable terrestrial benchmark concentrations.

Manganese occurs in many minerals that are widely distributed in the earth's crust and, in trace amounts, is an essential element for both plants and animals. Many different possible manganese compounds may enter the aquatic environment from natural and industrial sources.

Manganese occurs most commonly in the +2 and +4 oxidation states in aquatic systems. The +2 state is the soluble form while the +4 state is normally associated with precipitated solids. Its solubility depends to a great extent on pH, dissolved oxygen, and presence of complexing agents. In saltwater, it is estimated that 85% or more of the manganese present exists in a soluble form. In freshwater, manganese can occur as the soluble ion, in complex organic ions, or in colloidal suspensions. Manganese often occurs at higher concentrations near the bottom of stratified lakes because it can be released from sediments, in the +2 state, under reducing conditions.

In the soil, the concentration and chemical form in which manganese occur can be affected by pH, cation exchange capacity, drainage, organic matter content, and other factors. The solubility of manganese is increased at low pH and under reducing conditions. The presence of high concentrations of chlorides, nitrates, or sulfates may also increase solubility. Under these conditions, manganese is more easily taken up by plants or transported in aqueous solution. Lack of sufficient cation exchange sites, which are provided by organic matter or clay, can also result in greater leaching of manganese to surface or groundwater.

There are no epidemiological studies suggesting that manganese or its compounds are carcinogenic or have teratogenic or reproductive effects in humans. Exposure to manganese chloride by intraperitoneal or subcutaneous routes was reported to cause lymphomas in mice. Manganese sulfate was found to produce tumors after intraperitoneal administration in mice. No other reports of unequivocal carcinogenic activity are available for common manganese compounds. Some manganese, notably manganese

chloride, have exhibited mutagenic activity in a variety of test systems. Manganese compounds do not appear to be teratogenic, however.

In humans, manganese dusts and compounds have relatively low oral and dermal toxicity, but they can cause a variety of toxic effects after inhalation exposure. Acute exposure to very high concentrations can cause manganese pneumonitis, increased susceptibility to respiratory disease, and pathologic changes including epithelial necrosis and mononuclear proliferation. Chronic manganese poisoning is more common, but generally occurs only among persons occupationally exposed to manganese compounds. Degenerative changes in the central nervous system are the major toxic effects. Early symptoms include emotional changes, followed by a masklike face, retropulsion or propulsion, and a Parkinson's-like syndrome. Liver changes are also frequently seen. Individuals with an iron deficiency may be more susceptible to chronic poisoning.

Duplication of human exposure symptoms in experimental animals has only been partially successful. In rabbits exposed by inhalation to manganese dust, manganese pneumonitis did not develop, but fibrotic changes in the lungs were observed. Central nervous system effects characteristic of chronic exposure in humans have only been reproduced in monkeys. Manganese and its compounds have moderate acute and chronic toxicity to aquatic life. Insufficient data are available to evaluate or predict the short-term and long-term effects to plants, birds, or land animals.

Manganese and its compounds range in their respective water solubilities from very soluble to insoluble. It is also highly persistent with a half-life of greater than 200 days. Manganese is expected to be found at about the same levels in fish tissue, as in the surrounding waters.²¹

4.1.2.7 Mercury. The ambient water quality criteria (AWQC) for this chemical is 0.012 ppb.¹⁹ The NOAA lowest concentration (ER-L) of this chemical observed to produce adverse effects in benthic organisms is 0.15 ppm in sediments.²⁰ There are no applicable terrestrial chemical benchmark concentrations.

Mercury has been recognized as a toxic metal and a serious pollutant in the aquatic environment. As a heavy metal, mercury quickly sinks into the sediments in most aquatic environments. Elemental mercury, a heavy metal, is considered relatively inert. However, elemental mercury is oxidized in sediment to divalent mercury. Aerobic and anaerobic bacteria can both act on divalent mercury to form methylmercury. The divalent inorganic form of mercury and the methylmercury are both considered the most toxic forms of mercury. Once methylation of mercury has occurred, the uptake of mercury by

aquatic life is extremely rapid. Mercury demethylates at a extremely slow rate, and is probably responsible for the slow biological half-life of 2 to 3 years.²²

Acute toxicity data for freshwater organisms was measured in nine taxonomic groups ranging from rotifers to fish. These acute values range from 0.02 to 2,000 µg/l and the Final Acute Value is 0.0017 µg/l. Chronic toxicity data, based largely on tests of methylmercury, indicate chronic values of 1.0 µg/l for *Daphnia magna* and 0.52 µg/l for brook trout. Chronic toxicity data for inorganic mercury in *Daphnia magna* was 1.6 µg/l.²²

The toxicological effects of inorganic mercury on freshwater aquatic plants were observed to occur at concentrations ranging from 80 to 2,600 µg/l; however, adverse effects of methylmercury were observed in freshwater aquatic plants at concentrations as low as 4.8 µg/l.²²

The principal routes of mercury exposure for terrestrial wildlife are inhalation and dermal contact. Rabbits exposed to a concentration of mercury in air of 29 mg/m³ over a 30-hour started to show mortality (LC₁₀). Dermal exposure of 126 mg/kg over a 5-hour period started to show toxicological effects in humans.²³

4.1.2.8 Nickel. The ambient water quality criteria (AWQC) for this chemical is 160.0 ppb.¹⁹ The NOAA lowest concentration (ER-L) of this chemical observed to produce effects in benthic organisms is 30.0 ppm.²⁰ There are no applicable terrestrial chemical benchmark concentrations.

The commonly occurring valences of nickel are 0, +1, +2, and +3, with +4 rarely encountered. Although elemental nickel is seldom found in nature and is not soluble in water, many nickel compounds are highly soluble in water. Nickel is almost always found in the divalent oxidation state in aquatic systems.

In natural, unpolluted waters, sorption and coprecipitation processes involving hydrous iron and manganese oxides are probably at least moderately effective in limiting the mobility of nickel. In more organic-rich, polluted waters, it appears that little sorption of nickel is likely. The lack of other controls on nickel mobility probably makes incorporation into bed sediments an important fate of nickel in surface waters. However, much of the nickel entering the aquatic environment will be transported to the oceans.

In general, nickel is not accumulated in significant amounts by aquatic organisms. Bioconcentration factors are usually on the order of 100 to 1,000. Uptake of nickel from the soil by plants can also occur.

Mammalian cell transformation data indicate that several nickel compounds are mutagenic and can cause chromosomal alterations. Dermatitis and other dermatological effects are the most frequent effects of exposure to nickel-containing compounds. Dermatitis and other dermatological effects are the most frequent effects of exposure to nickel and nickel-containing compounds. Studies with experimental animals suggest that nickel and nickel compounds have relatively low acute and chronic oral toxicity.

In freshwater, toxicity depends on hardness; nickel tends to be more toxic in softer water. Acute values for exposure to a variety of nickel salts, expressed as nickel, range from 510 µg/l for *Daphnia magna* to 46,200 µg/l for banded killifish at comparable hardness levels. Chronic values range from 14.8 µg/l for *Daphnia magna* in soft water to 530 µg/l for the fathead minnow in hard water. Acute-chronic ratios for *Daphnia magna* range from 14 in hard water to 83 in soft water, and are approximately 50 in both hard and soft water for the fathead minnow. Residue data for the fathead minnow indicate a bioconcentration factor of 61. Freshwater algae experience reduced growth at nickel concentrations as low as 100 µg/l.²¹

4.1.2.9 Selenium. The ambient water quality criteria (AWQC) for this chemical is 36.0 ppb.¹⁹ There was no NOAA data available for this chemical. There are no applicable terrestrial chemical benchmark concentrations.

Selenium exists in four oxidation states (-2, 0, +4, and +6). Heavy metal selenoids (-2) are insoluble. The elemental form (0) is insoluble and is not rapidly oxidized or reduced in nature. The inorganic selenites (+4) have an affinity for iron and aluminum sesquioxides, forming stable absorption complexes. Under acid and reducing conditions, these inorganic selenites are reduced to elemental selenium. Alkaline and oxidizing conditions favor the formation of the selenates (+6), which are not tightly complexed. Because of these chemical properties, the selenates appear to represent a greater hazard to the natural environment than selenites. The databases for freshwater toxicity include only information for the inorganic selenites and selenates.²⁴

Acute toxicity data for freshwater organism ranges was measured in 13 species of freshwater animals from ten taxonomic groups. These acute values range from 340.0 to 42,400 µg/l and the Final Acute Value is 263.0 µg/l. The freshwater Final Chronic Acute Value is 35 µg/l.²⁴

The toxicological effects of selenium on five species of freshwater algae were observed. An unspecified selenium compound was observed to retard growth in two of these species at levels of 50 µg/l.²⁴

The principal routes of selenium exposure for terrestrial wildlife are inhalation, ingestion, and dermal contact. Laboratory rats exposed to a concentration of selenium dust in air of 33 mg/kg over a 8-hour period started to show mortality (LD_{Lo}). The oral LD₅₀ for laboratory rates was 6,700 mg/kg.²³

4.1.2.10 Thallium. No ambient water quality criteria is available for this chemical, nor are there any applicable terrestrial benchmark concentrations.

Thallium is a soft, malleable, bluish-white metal. Its oxidation state in soil, groundwater, and surface water is +3. Located in the same group as aluminum in the periodic table, natural thallium compounds generally have low water solubilities. There is limited information in the database concerning water quality effects on toxicity; however, there is sufficient information to indicate that thallium is chronically toxic to invertebrate and fish species.²⁵

Acute toxicity data for freshwater fish and invertebrate species indicates that these species are not significantly sensitive to thallium. Acute toxicity values for thallium range from a 96-hour LC₅₀ of 1,800 µg/l in the fathead minnow to a 96-hour LC₅₀ of 121,000 µg/l in bluegill. Chronic values of 130 µg/l were measured for *Daphnia magna*. Embryo-larval tests performed on the fathead minnow indicated adverse effects at the lowest tested thallium concentration of 40 µg/l.²⁵

The 96-hour EC₅₀ values of 40,800 µg/l inhibited oxygen evolution by the freshwater alga *Chlamydomonas reinhardi*. 96-hour EC₅₀ values ranging from 100 to 110 µg/l were observed to inhibit photosynthesis and cell number in the alga *Selenastrum caporicornutum*.²⁵

The principal routes of thallium exposure for terrestrial wildlife are undetermined; however, it is known to have toxicological properties. Ingestion of thallium at concentrations as low as 5,714 µg/l are known to cause toxic reactions to the peripheral nervous system and skin irritation to humans. There are no other data addressing wildlife toxicity of thallium.²³

4.1.2.11 Vanadium. No ambient water quality criteria is available for this chemical, nor are there any applicable terrestrial benchmark concentrations. EPA has proposed an ambient goal for vanadium in drinking water of 7 ppb.

Vanadium is a light-grey or white, lustrous powder or fused hard lump, insoluble in water. It is produced by roasting vanadium ore, heating vanadium iodide, from petroleum residues, or from oil burning soot. Vanadium is not readily adsorbed in the

gastrointestinal tract. The only adverse effects appear to be based on the inhalation of vanadium dust.²⁶

The only toxicity data concerning vanadium is based on subcutaneous exposure (injection) of vanadium indicating a LD₅₀ of 59 mg/kg in rabbits. There are no other data addressing wildlife toxicity of vanadium.²³

4.1.2.12 Zinc. The ambient water quality criteria (AWQC) for this chemical is 110.0 ppb.¹⁹ The NOAA lowest concentration (ER-L) of this chemical observed to produce effects in benthic organisms is 120.0 ppm.²⁰ There are no applicable terrestrial chemical benchmark concentrations.

Zinc can occur in both suspended and dissolved forms. The predominant fate of zinc in aerobic aquatic systems is sorption of the divalent cation by hydrous iron and manganese oxides, clay minerals, and organic material.

Since it is an essential nutrient, zinc is strongly bioaccumulated even in the absence of abnormally high ambient concentrations. Zinc does not appear to be biomagnified. Although zinc is actively bioaccumulated in aquatic systems, the biota appear to represent a relatively minor sink compared to the sediments. Zinc is one of the most important metals in biological systems.

Zinc produces acute toxicity in freshwater organisms over a range of concentrations from 90 to 58,100 µg/l and appears to be less toxic in harder water. Acute toxicity is similar for freshwater fish and invertebrates. Chronic toxicity values range from 47 to 852 µg/l and appear to be relatively unaffected by hardness. Although most freshwater plants appear to be insensitive to zinc, one species, the alga *Selenastrum capricornutum*, exhibited toxic effects at concentrations from 30 to 700 µg/l.

Based on relatively limited data, some researchers have speculated that exposure to excessive amounts of zinc may constitute a hazard to horses. Laboratory studies and findings in foals living near lead-zinc smelters suggest that excessive exposure to zinc may produce bone changes, joint afflictions and lameness.²¹

4.1.3 Semi-Volatile Organic Compounds

4.1.3.1 Polynuclear Aromatic Hydrocarbons. There have been no AWQC developed for this class of chemicals. The NOAA lowest concentration (ER-L) for this class of chemicals observed to produce effects in benthic organisms ranges from a minimum of 35 ppb for 2-methylnaphthalene to a maximum of 600 ppb for fluoranthene.²⁰ There are no applicable terrestrial chemical benchmark concentrations.

The information available for polycyclic aromatic hydrocarbons (PAH) may be applicable for the following compounds for which contaminant-specific data was not found:

Naphthalene	Fluoranthene
2-Methylnaphthalene	Pyrene
Benzo(b)fluoranthene	Benzo(a)pyrene
Fluorene	Acenaphthylene
Acenaphthene	Phenanthrene
Anthracene	Benzo(a)anthracene
Chrysene	Indeno(1,2,3-cd)pyrene
Dibenz(a,h)anthracene	Benzo(g,h,i)perylene.

PAHs are lipophilic and therefore are accumulated in plants. Plants have the ability to absorb PAHs from soil or by atmospheric deposition and translocate them to other parts of the plant. In vegetation, levels of benzo (a) pyrene (BaP) range from 10-20 $\mu\text{g/kg}$ dry weight; higher concentrations of BaP in fruits and vegetables have been reported in produce harvested from suburban gardens and gardens near industrial areas. Lettuce contained the largest amount: 23 $\mu\text{g/kg}$ dry weight in the suburbs; 150 $\mu\text{g/kg}$ dry weight in industrial areas. It has been reported that only 10% of the BaP content externally applied to a variety of garden vegetables can be removed by washing with cold water following external applications. In addition, PAHs have been found in phytoplankton, and specifically in diatoms and green algae.²⁷

Many PAHs are well-documented carcinogens in mammalian systems and mutagens in a variety of bioassays. Plants have been viewed as potential carriers or modifiers of PAHs in the food chain. Little attention has been paid to the effects of PAHs on plants. Neither the extent to which plant growth is altered by PAHs nor the biological consequences as a result of bioaccumulation has been elucidated. Graf and Nowak studied the growth effect of various PAHs on hydrocultures of tobacco, rye, radish, and algae. The PAH-induced growth stimulation of plants correlated with the relative carcinogenic potency of the PAHs in animals.²⁷

Contamination of soils with petroleum hydrocarbons has an influence on plant growth. It was reported that when soils are severely contaminated with petroleum hydrocarbons, vegetative growth usually is greatly decreased or eliminated. After the PAH source is removed, the growth of vegetation is often greater than on adjacent

uncontaminated soil. It was speculated that enhanced growth in the contaminated soil could be explained by an increase in nitrogen and water-holding capacity of the soil due to increased microbiological activity.²⁷

PAH-induced tumors have been reported in plants and fungi. It has been reported that PAH-containing mudwaste pollution from the coal chemical industry produced tumorous growth on the marine alga, *Porphyra tenera*. Two neutral-pH components were isolated and identified as the tumor-promoting factors. Mushrooms have also been reported to develop tumors as a result of growth on PAH-contaminated soil.²⁷

In two separate investigations, PAHs induced plant morphogenesis in vitro. Kochhar et al., reported vegetative bud induction by benzo(a)anthracene in tobacco callus in the absence of exogenous plant growth regulators. In a similar experiment, Majumdar and Newton observed 7,12-dimethylbenz(a)anthracene induction of vegetative bud formation in *Haworthia callus*.²⁷

In terrestrial species, the primary toxic effect of PAH exposure is tumor development. Chronic oral doses of 7,12-dimethylbenz(a)anthracene of 0.04 µg/kg have induced cancer in laboratory rodents. Much higher doses have induced cancer following short-term exposures. Food consumption in deer mice and house mice was decreased following oral exposure for 5 days to 825 or 1,213 mg/kg of 2-methoxynaphthalene. In birds, exposure to diets containing various PAHs at a total concentration of 4,000 ppm caused increased liver weights and blood flow to the liver.²⁷

4.1.3.2 Bis(2-ethylhexyl)phthalate. No ambient water quality criteria is available for this chemical, nor are there any applicable terrestrial benchmark concentrations.

EPA (1986) report acute and chronic LOELs for phthalate esters for aquatic organisms of 940 and 3 µg/l, respectively. *Daphnia magna* exposed to bis(2-ethylhexyl)phthalate had an LC₅₀ of 11,000 µg/l. Chronic toxicity was observed at 8.4 µg/l. in rainbow trout. *Daphnia magna* had significant adverse reproductive effects at 3 µg/l.

Information on the toxicity of bis(2-ethylhexyl)phthalate to wildlife is unavailable. The LD₅₀ for mice is 30,000 mg/kg. Bis(2-ethylhexyl)phthalate has caused cancer in laboratory animals. Other toxic effects in laboratory animals include decreased growth, increased liver and kidney weights, reduced fetal weight, and increased number of fetal resorptions. The lowest chronic effect level in lab animals is 19 mg/kg based on increased liver weights in guinea pigs.

Bioconcentration factors for fish and aquatic invertebrates range from 54 to 2,680. bis(2-ethylhexyl)phthalate has a log Kow of 5.11, indicating a high potential for bioaccumulation as is demonstrated by a BCF in scud *Gammarus pseudolimnaeus* of 13,600 after 7 days of exposure to 0.1 µg/l. While this is high, it is somewhat offset by a biologic half-life of about 4 weeks. A BCF of 800 was found by in fathead minnows exposed to 2.5 µg/l bis(2-ethylhexyl)phthalate for 28 days. The weighted average bioconcentration factor for the edible portions of all freshwater and estuarine species consumed in the U.S. was 130.²¹

4.1.3.3 Di-n-octylphthalate. No ambient water quality criteria is available for this chemical, nor are there any applicable terrestrial benchmark concentrations.

Although relatively little specific information concerning n-diethyl phthalate (DOP) is available, the environmental transport and fate of this compound can be largely inferred from data for phthalate esters as a group. DOP probably hydrolyzes in surface waters, but at such a slow rate that this process would not be significant under most conditions. Photolysis and oxidation do not appear to be important environmental fate processes. Some atmospheric dispersion of DOP that is vaporized during manufacture, use, or disposal can occur. However, volatilization does not appear to be a significant transport process, especially in aquatic systems.

A variety of unicellular and multicellular organisms take up and accumulate DOP, and bioaccumulation is considered an important fate process. Biodegradation is also an important fate process in aquatic systems and soil. DOP is biodegraded under most environmental conditions, and it can be metabolized by multicellular organisms. It is unlikely that long-term bioaccumulation or biomagnification occurs.

Analysis based on EPA's Exposure Analysis Modeling System indicates that chemical and biochemical transformation processes for DOP are slow and that transport processes will predominate both in ecosystems that have long retention times (ponds, lakes) and those that have short retention times (rivers). If the input of DOP remains constant, its concentration is expected to increase in aquatic ecosystems. If input stops, the DOP present is expected to persist for an undetermined length of time. The oceans are the ultimate sink for DOP introduced into unimpeded rivers.

There is no evidence to suggest that DOP is carcinogenic or mutagenic. Fetotoxicity and developmental abnormalities were observed in the offspring of rats administered 5 g/kg intraperitoneal injections on days 5 to 15 of gestation. No other evidence for reproductive or teratogenic effects has been reported.

Very little information exists concerning the chronic and acute toxicity of DOP. A chronic LD₅₀ value of 1.3 mg/kg was determined for mice receiving intraperitoneal injections of DOP 5 days/week for 10 weeks. DOP has a relatively low acute toxicity in mice with reported oral and intraperitoneal LD₅₀ value of 6.5 and 65 g/kg, respectively. This chemical is a severe eye irritant and a mild skin irritant in rabbits.²¹

4.1.3.4 Dibenzofuran. No ambient water quality criteria is available for this chemical, nor are there any applicable terrestrial benchmark concentrations. No toxicity information was located on the toxicity effects of dibenzofuran on the environment and wildlife.

4.1.3.5 Carbazole. No ambient water quality criteria is available for this chemical, nor are there any applicable terrestrial benchmark concentrations.

Carbazole is a white crystal used in making photographic plates sensitive to ultraviolet light. It is also used as a reagent for lignin, carbohydrates, and formaldehyde.²² There is very little information in the database concerning the toxicity of carbazole to the environment and wildlife. The oral LD₅₀ for rats was 500 mg/kg.²³

4.1.4 Pesticides/PCBs

4.1.4.1 Aldrin/Dieldrin. The ambient water quality criteria (AWQC) for aldrin is 3.0 ppb.¹⁹ There was no NOAA data available for this chemical. There are no applicable terrestrial chemical benchmark concentrations.

Aldrin evaporates rapidly from aquatic environments and also probably from soil. Photolysis probably occurs in the atmosphere after volatilization. Adsorption, especially by organic materials, is also an important fate process for this chemical. Aldrin is bioconcentrated by aquatic organisms by a factor of 10³ to 10⁴. Biotransformation by aquatic organisms and biodegradation are also important fate processes.

The primary product of aldrin degradation is its epoxide, dieldrin. Photolysis of aldrin also produces small amounts of photoaldrin, photodieldrin, and a polymerization product. Dieldrin is considered to be at least as toxic as aldrin and is quite persistent in the environment. Therefore, transformation of aldrin represents only a change of state and not detoxification of the chemical.

Dieldrin is one of the most persistent of the chlorinated hydrocarbons. Volatilization and possibly subsequent photolysis to photodieldrin are important transport and fate processes from surface water and probably from soil. Adsorption to sediments, especially organic materials, and bioaccumulation are also important in removing dieldrin from

water. Biotransformation and biodegradation of dieldrin occur very slowly but may be the final fate processes in sediment.

Aldrin and dieldrin are both acutely toxic to freshwater species at low concentrations. Tests in fish showed that the two chemicals had similar toxicities, with LC_{50} values ranging from 1 to 46 $\mu\text{g/l}$ for different species. Final acute values for freshwater species were determined to be 2.5 $\mu\text{g/l}$ for dieldrin and 3.0 $\mu\text{g/l}$ for aldrin. Saltwater species were also quite sensitive to aldrin and dieldrin. The range of LC_{50} values was similar to that for freshwater species: 2 to 100 $\mu\text{g/liter}$ for aldrin and 1 to 34 $\mu\text{g/l}$ for dieldrin. The saltwater Final Acute Values were 1.3 $\mu\text{g/l}$ for aldrin and 0.71 $\mu\text{g/l}$ for dieldrin.

Chronic studies have been conducted on the effects of dieldrin on freshwater and saltwater species. For freshwater organisms, chronic values as low as 0.2 $\mu\text{g/l}$ were obtained. The Final Acute Chronic Value was determined to be 3.5, and the calculated Freshwater Final Chronic Value was 0.29 $\mu\text{g/l}$. Only one chronic study was done on saltwater species. Therefore, the saltwater Final Chronic Value of 0.084 $\mu\text{g/l}$ was determined by dividing the Final Acute Value by the acute-chronic ratio. No chronic studies were performed on aldrin, but because its acute toxicity is comparable to that of dieldrin and because it is readily converted to dieldrin in animals and in the environment, it probably has similar chronic toxicity.

Both pesticides, and especially dieldrin, have been associated with large-scale bird and mammal kills in treated areas. Experimental feeding studies have shown that the chemicals are quite toxic to terrestrial wildlife and domestic animal at low levels.

4.1.4.2 Heptachlor Epoxide. No ambient water quality criteria is available for this chemical, nor are there any applicable terrestrial benchmark concentrations.

Heptachlor is a carbonated pesticide that has had wide usage in the United States as a crop insecticide. It has been shown to be toxic to aquatic life, to accumulate in plant and animal tissues, and to persist in aquatic ecosystems. The most common degradation product of heptachlor is heptachlor epoxide. Limited available data indicated that heptachlor epoxide is no more toxic than heptachlor itself.²⁹

Acute toxicity data are available for 18 freshwater invertebrate and fish species. Species mean acute values range from 0.9 to 78 $\mu\text{g/l}$ for invertebrate species and from 13.1 to 320 $\mu\text{g/l}$ for fish species. No chronic data were obtained for freshwater species. Bioaccumulation factors for fathead minnows are 9,500 for heptachlor and 14,400 for heptachlor epoxide. Adverse effects were observed on bluegills feeding at a rate of 10 mg/kg/day . EC_{50} values of 39.4 and 26.7 $\mu\text{g/l}$ are available for a freshwater algae species,

although hydroxychlorodene, present in the test solutions, may have contributed significantly to the observed toxicity.²⁹

Heptachlor is toxic to terrestrial organisms through ingestion and dermal contact. Oral LD₅₀ values of 40 mg/kg and 68 mg/kg were observed in rats and mice, respectively. Dermal contact LD₅₀ values of 2,000 mg/kg were observed in rabbits.²³

4.1.4.3 Endosulfan Sulfate. No ambient water quality criteria is available for this chemical, nor are there any applicable terrestrial benchmark concentrations.

Endosulfan is a broad spectrum chlorinated cyclodiene insecticide. Although the use of endosulfan has been restricted, significant commercial use still continues for insect control on vegetable, fruits, alfalfa, and tobacco. Technically endosulfan is a 94 to 96 percent mixture of two stereoisomers, endosulfan I and II, in the approximate ratio of 70:30. Some evidence does suggest some variability in the toxicity of these two isomers but data is not sufficient to determine which is more toxic.³⁰

Data on acute toxicity of endosulfan are available for 10 freshwater fish and invertebrate species that are involved in diverse community functions. Acute toxicity values ranged from 0.17 µg/l for rainbow trout to 740 µg/l for *Daphnia magna*, with invertebrate species being generally less sensitive than fish species. Five chronic tests with *Daphnia magna* gave chronic values ranging from 4.3 to 108 µg/l, and a single fathead minnow chronic test gave a value of 0.28 µg/l. The Freshwater Final Acute Value for endosulfan, based on 10 species, is 0.22 µg/kg. The Freshwater Final Chronic Value is 0.056 µg/l.³⁰

Endosulfan is highly toxic to terrestrial organisms through inhalation, ingestion and dermal contact. Oral LD₅₀ values of 18 mg/kg were observed in rats. There is little other data available on the LD₅₀ values through dermal exposure and inhalation.²⁶

4.1.4.4 Endrin. The ambient water quality criteria (AWQC) for this chemical is 0.0023 ppb.¹⁹ The NOAA lowest concentration (ER-L) of this chemical observed to produce effects in benthic organisms is 0.02 ppb.²⁰ There are no applicable terrestrial chemical benchmark concentrations.

Endrin is a cyclodiene insecticide that is an isomer of dieldrin. Endrin is quite persistent in the environment. Endrin is readily bioconcentrated by aquatic organisms, with concentration factors of 10³ and 10⁴. Biotransformation and biodegradation may also be important fate processes for endrin.

Endrin is very toxic to aquatic organisms. Freshwater fish were generally more sensitive than invertebrates, with species mean acute values ranging from 0.15 to 2.1 µg/l. Final acute values for fresh water and salt water species were 0.18 µg/l and 0.037 µg/l, respectively. An acute-chronic ratio of 4.0 was determined from chronic tests on fresh water and salt water species. Therefore, the fresh water final chronic value was calculated to be 0.045 µg/l.

Endrin is acutely toxic to terrestrial wildlife and domestic animals and has been used as a rodenticide and an avicide. It can also cause central nervous system effects and reproductive disorders following chronic exposure. Subtle effects observed in animals exposed to endrin include abnormal behavior, increased postnatal mortality, and increased fetal death.²¹

4.1.4.5 Polychlorinated Biphenyls (Aroclor 1260). The ambient water quality criteria (AWQC) for this chemical is 0.014 ppb.¹⁹ The NOAA lowest concentration (ER-L) of this chemical observed to produce effects in benthic organisms is 50.0 ppb.²⁰ There are no applicable terrestrial chemical benchmark concentrations.

The transport and fate of polychlorinated biphenyls (PCBs) has been studied extensively, and although individual chemicals vary in the rates at which processes occur, some generalizations can be made about PCBs as a class. PCBs are relatively inert, and therefore persistent, compounds, with low vapor pressures, low water solubility, and high log octanol/water partition coefficients.

In humans exposed to PCBs (in the workplace or via accidental contamination of food), reported adverse effects include chloracne (a long-lasting, disfiguring skin disease), impairment of liver function, a variety of neurobehavioral and affective symptoms, menstrual disorders, minor birth abnormalities, and probably increased incidence of cancer. Animals experimentally exposed to PCBs have shown most of the same symptoms, as well as impaired reproduction; pathological changes in the liver, stomach, skin, and other organs; and suppression of immunological functions. PCBs are carcinogenic in rats and mice and, in appropriate circumstances, enhance the effects of other carcinogens. Reproductive and neurobiological effects of PCBs have been reported in rhesus monkeys at the lowest dose level tested, 11 µg/kg body weight/day over a period of several months.

Polychlorinated biphenyls are bioaccumulated and can be biomagnified. Therefore, their toxicity increases with length of exposure and position of the exposed species on the

food chain. The toxicity of the various PCB mixtures is also dependent on their composition.

Three primary ways in which PCBs can affect terrestrial wildlife are outright mortality, adversely affecting reproduction, and changing behavior. PCB doses greater than 200 ppm in the diet or 10 mg/kg body weight (b) caused some mortality in sensitive bird species exposed for several days. Doses around 1,500 ppm (diet) or about 100 mg/kg (b) caused extensive mortality in these sensitive species. They generally caused some mortality in all species, with the level being dependent on the length of exposure and the particular PCB mixture. Some mammalian species are especially susceptible to PCBs. For example, mink died when fed as little as 5 ppm in the diet (equivalent to less than 1 mg/kg b/day). PCBs caused lower egg production; deformities; decreased hatchability, growth, and survival; and some eggshell thinning in reproductive studies on chickens fed doses of 20 ppm in the diet (1 mg/kg b). Mink fed 1 ppm in the diet (0.2 mg/kg b) had lower reproductive success, and there are indications that an increased incidence of premature births in some marine mammals was linked to PCB exposure. Behavioral effects on wildlife include increased activity, decreased avoidance response, and decreased nesting, all of which could significantly influence survival in the wild.²¹

4.2 Ecological Toxicity Assessment

A conceptual model illustrating potential contaminant migration and exposure pathways for ecological receptors from the five subject properties was prepared and is shown in Figure 8. Based on the regulatory agency data review (Chapter 2.0) and field investigations (Chapter 3.0), ecological receptors appear to be potentially impacted by activity and contamination at three of the five properties. There do not appear to be ecological receptors at risk on or from the REP property or the Evans property. Ecological receptors at potential risk from activities and contamination on the remaining three sites include the following:

- Electra Products

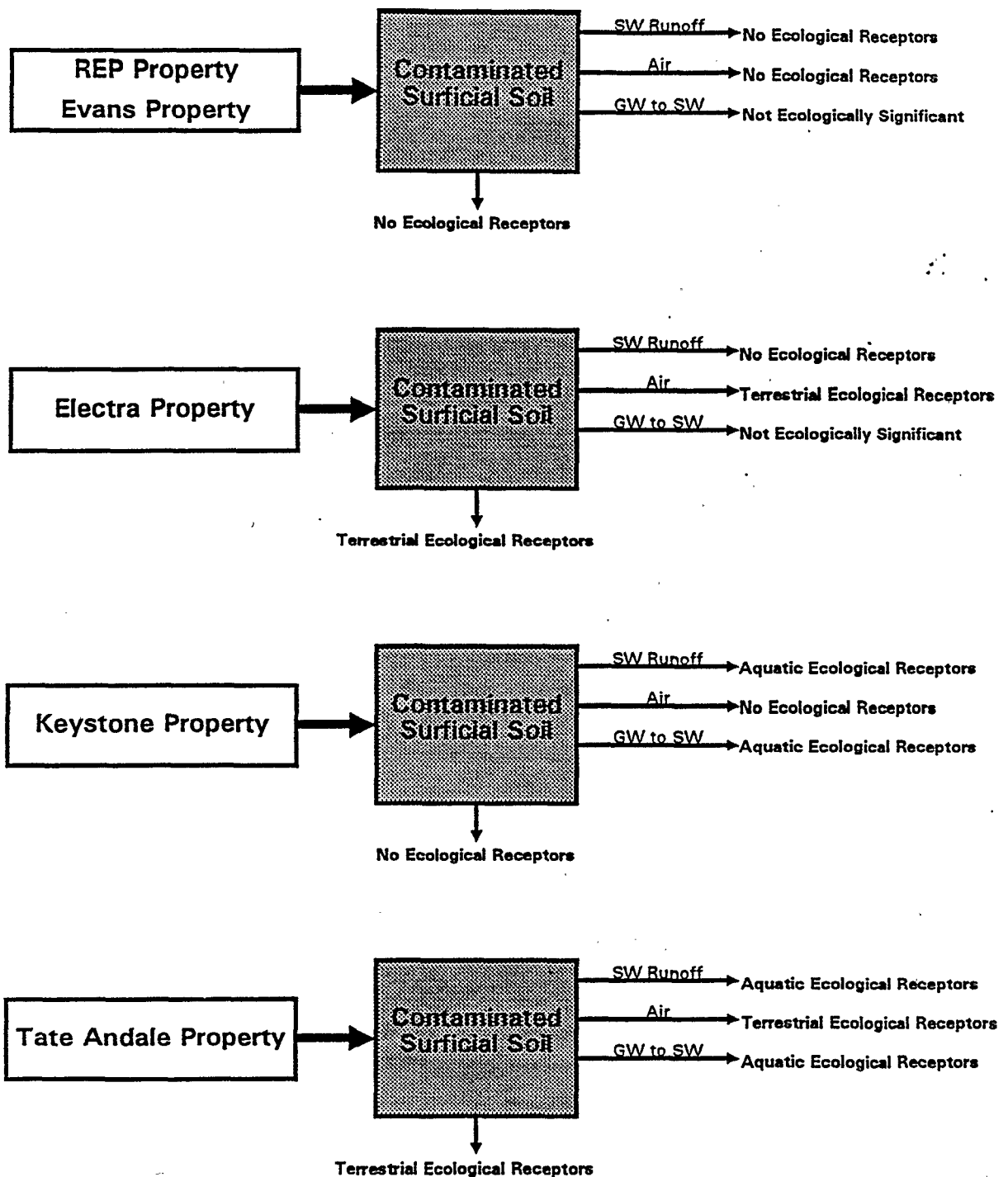
- Terrestrial organisms (soil organisms, worms, small mammals, reptiles, birds)

- Keystone Hydraulics

- Aquatic organisms (invertebrates, fish)

- Pennsylvania Endangered Animal Species (Bog Turtle, semi-aquatic)

- Pennsylvania Threatened Animal Species (Red-bellied Turtle, semi-aquatic)



**Conceptual Ecological Exposure Model
Five Subject Properties at North Penn Area 6 Site**

**Figure
8**



BLACK & VEATCH
Waste Science, Inc.
601 Walnut Street, Philadelphia, PA 10106

**Phase I Ecological Assessment
North Penn Area 6 Site - OU1
Lansdale, Montgomery County, Pennsylvania**

AR301153

Pennsylvania Endangered Plant Species (Eared false foxglove)
Wetlands

• Tate Andale Company

Terrestrial organisms (soil organisms, worms, small mammals, reptiles, birds)
Aquatic organisms (wetland plants)

The potential ecological receptors were evaluated based on the ECOCs for each of the associated properties to determine potential toxicological impacts. The following is a summary of the toxicological effects of ECOCs from each property on the ecological receptors associated with that property.

4.2.1 Electra Products

The contaminated soil area at the Electra Products only poses a threat to terrestrial ecological receptors through dermal contact, ingestion, and inhalation. The minimal surface water runoff is diverted into a city stormwater system. Groundwater to surface water discharge is not thought to provide a significant contaminant migration pathway. Terrestrial organisms that may be impacted by ECOCs include vegetation, soil organisms, earthworms, mice, voles, rats, snakes, and birds. Terrestrial habitat for these organisms would be found in the field to the south of the facility on site, adjacent to the known areas of contaminated soil.

There were no volatile organic contaminants detected in significant concentrations at the Electra property. The principal contaminants on this property were semi-volatile organic compounds (PAHs) and PCBs (Aroclor 1260). Surficial soils from this property were not analyzed for inorganic contaminants.

PAHs are highly bioaccumulative and also tend to readily sorb to sediments. The principal routes of exposure for terrestrial receptors to PAHs are dermal contact and ingestion. PAHs are readily uptaken by plants in terrestrial environments, where they are readily transferred to consumers. PAHs have been shown to decrease plant growth rates, although the concentration that produces these effects was not found in the literature. PAHs have also been shown to produce tumorous growth on mushrooms and fungi, two important components of the decomposer trophic level. PAHs have been shown to have low chronic cancer doses in laboratory animals and also reduced the appetite of exposed deer mice.

PCBs are persistent, highly bioaccumulative compounds that also tend to readily sorb to sediments. PCBs also can be biomagnified, increasing their toxicity based on exposure duration and the trophic level of the consumer. The principal route of exposure to PCBs is ingestion and dermal contact. There is no information addressing PCBs effects on terrestrial vegetation; however, the effects on wildlife are well documented. PCBs cause mortality, decrease reproductive ability, and change the behavior patterns of affected terrestrial wildlife. Dietary concentrations greater than 10 mg/kg of body weight caused mortality in birds over several days. Even lower dietary concentrations caused similar effects in mink and chicken.

The concentrations of PAHs and PCBs at the property may have some impact on the decomposer and consumer food chains at the property. The potential for adverse ecological impacts is greater for PCBs, which tend to biomagnify. These chemicals may have the following impacts at the Electra Products property:

- Increased mortality of primary consumers (mice, birds) - PCBs, PAHs
- Decreased effectiveness of decomposer food chain - PAHs
- Increased cancer incidence of primary consumers (mice, birds) - PAHs, PCBs
- Increased mortality of secondary consumers (snakes, birds) - PCBs, PAH
- Secondary contamination from predation and biomagnification - PCBs

4.2.2 Keystone Hydraulics Property

The contaminated soil area at the Keystone Hydraulics property only poses a threat to aquatic ecological receptors associated with the tributary to the Neshaminy Creek that originates under the property and to wetland areas along the tributary. All surface water runoff is diverted into this tributary under the site. Groundwater to surface water discharge would also be directly into this tributary. The majority of the site is covered with impervious surfaces and terrestrial habitat is non-existent or extremely limited. Aquatic organisms in and along the tributary that may be impacted by ECOCs at the Keystone Property include invertebrates, fish, one state threatened turtle species (Red-bellied turtle) and one state endangered turtle species (Bog turtle). Additionally, wetland areas along this tributary may be impacted by the ECOCs from the Keystone Property.

There were no volatile organic contaminants detected in significant concentrations at the property. The principal contaminants on this property were semi-volatile organic compounds (PAHs), PCBs (Aroclor 1260), and inorganic compounds (arsenic, copper, lead, manganese, selenium, and zinc).

PAHs are highly bioaccumulative and also tend to readily sorb to aquatic sediments. The principal routes of exposure for aquatic receptors to PAHs are dermal contact and ingestion. PAHs are readily uptaken by plants in aquatic environments, where they are readily transferred to consumers. PAHs have been shown to decrease plant growth rates, although the concentration that produces these effects was not found in the literature. PAHs have also been shown to produce tumorous growth on algae. PAH sediment concentrations as low as 35 ppb have been shown to produce effects in invertebrate species.

PCBs are persistent, highly bioaccumulative compounds that tend to readily sorb to sediments. PCBs also can be biomagnified, increasing their toxicity based on exposure duration and the trophic level of the consumer. The principal route of exposure to PCBs is ingestion and dermal contact. PCBs cause mortality, decrease reproductive ability, and change the behavior patterns of affected terrestrial wildlife. PCB sediment concentrations as low as 50 ppb have been shown to produce effects in invertebrate species.

The inorganic ECOCs at the site are all heavy metals that tend to sink in the aquatic environment. Some of these compounds are highly mobile in the aquatic environment (arsenic and copper) while others tend to readily sorb to sediments and move more slowly through the aquatic environment (lead, manganese, selenium, and zinc). Arsenic does not tend to bioaccumulate but is relatively toxic in aquatic organisms. Arsenic sediment concentrations as low as 33 ppm have been shown to produce effects in invertebrate species. Copper is strongly bioaccumulated and sediment concentrations as low as 70 ppm have been shown to produce effects in invertebrate species. Of the remaining metals, lead and zinc are the most toxicologically significant to aquatic organisms. These two compounds readily sorb to aquatic sediments and have relatively high bioaccumulation factors. Lead and zinc have been shown to produce adverse effects in invertebrates in concentrations as low as 35 and 120 ppm, respectively.

The concentrations of PAHs, PCBs, and inorganic chemicals at Keystone Hydraulics could have some adverse impact on invertebrate organisms, fish, and wetland vegetation associated with the Neshaminy Creek tributary, depending on the impacts of property soils on surface water and sediment quality. The potential for adverse ecological impacts is greatest for PCBs, which tend to biomagnify. These chemicals may have the following impacts:

- Decreased species diversity and species richness of the invertebrate community - PAHs, PCBs, Inorganics

- Potential mortality to State Threatened and Endangered animal species - PAHs, PCBs, Inorganics.
- Chronic effects to fish - PAHs, PCBs, Inorganics
- Potential mortality to State Endangered plant species - PAHs
- Deceased vegetative growth in exposed wetland areas - PAHs
- Secondary contamination from predation and biomagnification - PCBs

4.2.3 Tate Andale Company Property

The contaminated soil area at the Tate Andale Company property poses a threat to terrestrial ecological receptors through dermal contact, ingestion, and inhalation. The area of contaminated soil also poses a threat to aquatic ecological receptors associated with two headwaters of the Towamencin Creek that may receive surface water runoff from the contaminated soil areas. Groundwater to surface water discharge is not thought to provide a significant contaminant migration pathway.

Terrestrial organisms at the Tate Andale Company property that may be impacted by ECOCs include vegetation, soil organisms, earthworms, mice, voles, rats, snakes, and birds. Terrestrial habitat for these organisms would be found in the open field areas east of the contaminated soil areas and to the southeast, in a large forested upland and wetland area. The two tributaries do not flow perennially near the site, therefore, there is no real threat to aquatic organisms; however, there are wetland areas associated with both tributaries that are potential ecological receptors.

The principal contaminants on this property were volatile organic compounds (VOCs), semi-volatile organic compounds (PAHs), and PCBs (Aroclor 1260). Surficial soils from this site were not analyzed for inorganic contaminants.

VOCs detected in surficial soils on the site included trichloroethene (TCE) and tetrachloroethene (PCE). Due to the high volatility of these two VOCs, it is unlikely that they can impact aquatic environment associated with the site, they would tend to volatilize prior to reaching these water. There was little information available to document the toxicological effects of these two VOCs on wildlife; however, inhalation of PCE has been shown to decrease reproduction, affect liver and kidney function, and cause nerve effects in laboratory rodents. These two compounds do not significantly bioaccumulate and are not expected to cause significant effects on the environment.

PAHs are highly bioaccumulative and also tend to readily sorb to sediments. The principal routes of exposure for terrestrial receptors to PAHs are dermal contact and ingestion. The principal routes of exposure for aquatic receptors to PAHs are direct

dermal contact and uptake. PAHs are readily uptaken by plants in terrestrial and aquatic environments, where they are readily transferred to consumers. PAHs have been shown to decrease plant growth rates, although the concentration that produces these effects was not found in the literature. PAHs have also been shown to produce tumorous growth on mushrooms and fungi, two important components of the decomposer trophic level. PAHs have also been shown to produce tumorous growth on algae. PAHs have been shown to have low chronic cancer doses in laboratory animals and also reduced the appetite of exposed deer mice. PAH sediment concentrations as low as 35 ppb have been shown to produce effects in invertebrate species.

PCBs are persistent, highly bioaccumulative compounds that also tend to readily sorb to sediments. PCBs also can be biomagnified, increasing their toxicity based on exposure duration and the trophic level of the consumer. The principal route of exposure to PCBs is ingestion and dermal contact. There is no information addressing PCBs effects on terrestrial vegetation; however, the effects on wildlife are well documented. PCBs cause mortality, decrease reproductive ability, and change the behavior patterns of affected terrestrial wildlife. Dietary concentrations greater than 10 mg/kg of body weight caused mortality in birds over several days. Even lower dietary concentrations caused similar effects in mink and chicken. PCB sediment concentrations as low as 50 ppb have been shown to produce effects in invertebrate species.

The concentrations of PAHs and PCBs at the Tate Andale Company property may have some adverse impact on the decomposer and consumer food chains at the site, and wetland vegetation associated with the Towamencin Creek tributaries. As previously stated, the TCE and PCE are not expected to produce adverse ecological impacts. The potential for adverse ecological impacts is greatest for PCBs, which tend to biomagnify. These chemicals may have the following impacts:

- Increased mortality of primary/ secondary consumers (mice, birds) - PCBs, PAHs
- Decreased effectiveness of decomposer food chain - PAHs
- Increased cancer incidence of primary consumers (mice, birds) - PAHs, PCBs
- Secondary contamination from predation and biomagnification - PCBs
- Decreased vegetative growth in exposed wetland areas - PAHs
- Secondary contamination from predation and biomagnification - PCBs

5.0 Findings & Recommendations

5.1 Findings

Although the RI workplan for the North Penn Area 6 site OU1 did not include PAHs or PCBs as potential site contaminants, these contaminants were detected at the five properties evaluated. Of the contaminants targeted in the RI workplan, VOCs and inorganics, the VOCs were observed to have little ecological impact. Two of the properties evaluated, John Evans and Sons and REP, lacked any ecological habitat or the ability to impact ecological habitat and should have little ecological risk. As a result, this phase of the EA focused on the impacts of PAH, PCB, and inorganic contamination of the Electra, Keystone, and Andale properties on offsite and onsite aquatic and terrestrial ecological receptors.

The contamination on each property was adequately evaluated for the purposes of this investigation. Based on surficial soil contaminant concentrations, the exposure potential for terrestrial ecological receptors can be quantified to determine the risk level to these receptors.

5.2 Recommendations

The contamination of the aquatic environment has not been addressed in investigations to date. In order to adequately determine the risks posed by site contamination to aquatic receptors associated with the effects on Neshaminy and Towamencin Creek headwater tributaries, both surface water and sediment samples should be collected. These sampling locations should be based on the proximity of individual ecological receptors to the contamination sources. Sample location is particularly sensitive since there are reports of state Threatened and Endangered (T&E) species along the Neshaminy Creek. Well placed sampling stations can eliminate the necessity to perform wildlife surveys to determine the exact presence of these T&E species, if the sampling stations adequately characterize the stream.

The following steps are recommended to adequately determine the risks posed by the three properties to the environment:

Perform sediment and surface water sampling along the Neshaminy Creek tributary to determine if the contaminants at Keystone Hydraulics have migrated to aquatic ecological receptors. These samples should be analyzed for PAHs, PCBs, and inorganic compounds.

- Perform sediment sampling of closest wetland areas, along flow path of surface water runoff from the Tate Andale Company property to determine if contaminants have migrated to these ecological receptors. These samples should be analyzed for PAHs.

- Prepare a likely exposure model for terrestrial organisms typical at the Tate Andale Company and Electra Products properties to quantitatively determine risks to terrestrial receptors based on literature uptake, ingestion, and skin absorption data. This will determine if the doses received by these receptors is near the chronic or acute toxicity levels that may adversely affect terrestrial receptors.

- Evaluate the surface water and sediment analytical results by comparison to NOAA sediment effects data (ER-L) and AWQC limits. Data results that fall below these benchmarks can be assumed to pose no threat to aquatic receptors.

These tasks may be performed in a Phase II Ecological Assessment for the North Penn Area 6 site during OU2. Upon completion of these tasks, it will be possible to adequately determine if there are any remedial actions required for the three properties and off-site areas based on ecological risks.

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Tables

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TABLE 2-1
Potential Rare, Threatened, and Endangered
Species within the Area of Concern

Common Name	Scientific Name	Habitat	Regulatory Status
Bald Eagle	<i>Haliaeetus leucocephalus</i>	1 _a , 1 _b , 2 _b , 2 _c , 3	Federal/State Endangered
Peregrine Falcon	<i>Falco peregrinus</i>	1 _a , 1 _b , 2 _a , 2 _b , 2 _c , 3	Federal/State Endangered
New Jersey Chorus Frog	<i>Pseudacris triseriata kalmi</i>	1 _a , 1 _b , 2 _a , 2 _c	State Endangered
Bog Turtle	<i>Clemmys muhlenbergii</i>	1 _a , 2 _c , 3	State Endangered
Osprey	<i>Pandion haliaetus</i>	1 _a , 1 _b , 2 _a , 2 _b , 3	State Endangered
Short-eared Owl	<i>Asio flammeus</i>	1 _a , 2 _c	State Endangered
Black Tern	<i>Chlidonias niger</i>	1 _a , 3	State Endangered
American Bittern	<i>Botaurus lentiginosus</i>	1 _a , 1 _b , 3	State Threatened
Yellow-bellied Flycatcher	<i>Empidonax flaviventris</i>	1 _a , 2 _a	State Threatened
Upland Sandpiper	<i>Bartramia longicauda</i>	2 _a , 2 _b , 2 _c	State Threatened
Northern Harrier	<i>Circus cyaneus</i>	2 _a , 2 _c	At Risk
Common Barn Owl	<i>Tyto alba</i>	1 _a , 1 _b , 2 _a , 2 _b , 2 _c	At Risk
Common Snipe	<i>Gallinago gallinago</i>	1 _a , 1 _b , 2 _a , 2 _c	At Risk
Henslow's Sparrow	<i>Ammodramus henslowii</i>	1 _b , 2 _c	At Risk
Prothonotary Warbler	<i>Protonotaria citrea</i>	1 _a , 2 _a	At Risk
American Coot	<i>Fulica americana</i>	1 _a , 1 _b , 2 _c , 3	Rare
Northern Goshawk	<i>Accipiter gentilis</i>	1 _a , 2 _b , 2 _c	Rare
Pied-billed Grebe	<i>Podilymbus podiceps</i>	1 _b , 3	Rare
Summer Tanager	<i>Piranga rubra</i>	1 _a , 2 _b , 2 _c	Rare
Green-winged Teal	<i>Anas crecca</i>	1 _a , 1 _b , 2 _b , 2 _c , 3	Rare
Swainson's Thrush	<i>Catharus ustulatus</i>	1 _a , 2 _a , 2 _b	Rare

LEGEND:		
1 - Wetland Habitat	2 - Upland Habitat	3 - Aquatic Habitat
1 _a - PFO	2 _a - Developed/Urban	3 _a - West Branch Neshaminy Creek
1 _b - PFO/PSS	2 _b - Forested	3 _b - Towamencin Creek
1 _c - PEM	2 _c - Agricultural	3 _c - Wissahickon Creek
		3 _d - Small ponds

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TABLE 3-1
Benthic Invertebrates Likely to Occur
Within the North Penn Area 6 Site Area of Concern

Common Name	Scientific Name	Habitat
Damselflies and Dragonflies	Order Odonata	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Mayflies	Order Ephemeroptera	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Stoneflies	Order Plecoptera	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Adderflies, Dobsonflies, Fishflies	Order Megaloptera	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Flies	Order Diptera	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Caddisflies	Order Trichoptera	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Leaf Beetles	Family Chrysomelidae	1 _c
Water boatmen	Family Corixidae	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Backswimmers	Family Notonectidae	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Water bugs	Family Belostomatidae	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Waterscorpions	Family Nepidae	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Toad bugs	Family Gelastocoridae	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Water striders	Family Gerridae	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Mosquito larvae	Family Culicidae	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Phantom midges	Family Chaoboridae	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Diving Beetles	Family Dytiscidae	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Scavenger Beetles	Family Hydrophilidae	1 _c , 3 _a , 3 _b , 3 _c , 3 _d

LEGEND:		
1 = Wetland Habitat	2 = Upland Habitat	3 = Aquatic Habitat
1 _c = PFO	2 _a = Developed/Urban	3 _a = West Branch Neshaminy Creek
1 _b = PFO/PSS	2 _b = Forested	3 _b = Towamencin Creek
1 _c = PEM	2 _c = Agricultural	3 _c = Wissahickon Creek
		3 _d = Small ponds

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TABLE 3-2
Insects Likely to Occur
Within the North Penn Area 6 Site Area of Concern

Common Name	Scientific Name	Habitat
Springtails	Order Collembola	All
Jumping bristletails	Order Microcoryphia	All
Silverfish	Order Thysanura	All
Mayflies	Order Ephemeroptera	1, 3, 3 _b , 3 _c , 3 _d
Damselflies and Dragonflies	Order Odonata	1, 3, 3 _b , 3 _c , 3 _d
Roaches	Order Blattodea	All
Praying mantis	Order Mantodea	All
Termites	Order Isoptera	All
Earwigs	Order Dermaptera	All
Stoneflies	Order Plecoptera	1, 3, 3 _b , 3 _c , 3 _d
Crickets & Grasshoppers	Order Orthoptera	All
Walking Stick	Order Phasmatodea	All
Book Lice	Order Psocoptera	All
Chewing Lice	Order Mallophaga	All
Sucking Lice	Order Anoplura	All
Squash and water bugs	Order Hemiptera	All
Leafhoppers and cicadas	Order Homoptera	All
Adderflies, Dobsonflies, Fishflies	Order Megaloptera	1, 3, 3 _b , 3 _c , 3 _d
Lacewings	Order Neuroptera	All
Beetles	Order Coleoptera	All
Fleas	Order Siphonaptera	All
Flies	Order Diptera	1, 3, 3 _b , 3 _c , 3 _d
Caddisflies	Order Trichoptera	1, 3, 3 _b , 3 _c , 3 _d

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TABLE 3-2
Insects Likely to Occur
Within the North Penn Area 6 Site Area of Concern

Common Name	Scientific Name	Habitat
Moths and Butterflies	Order Lepidoptera	All
Bees, Wasps, Ants, and Sawflies	Order Hymenoptera	All
Spiders	Order Aranae	All
Daddy-long-legs	Order Opiliones	All
Ticks	Order Acarina	All

LEGEND:		
1 - Wetland Habitat	2 - Upland Habitat	3 - Aquatic Habitat
1 _a - PFO	2 _a - Developed/Urban	3 _a - West Branch Neshaminy Creek
1 _b - PFO/PSS	2 _b - Forested	3 _b - Towamencin Creek
1 _c - PEM	2 _c - Agricultural	3 _c - Wissahickon Creek
		3 _d - Small ponds

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TABLE 3-3
Fish Likely to Occur
Within the North Penn Area 6 Site Area of Concern

Common Name	Scientific Name	Habitat
American brook lamprey	<i>Lampetra appendix</i>	3 _a , 3 _b , 3 _c
Chain pickerel	<i>Esox niger</i>	1 _c , 3 _a , 3 _b
Muskellunge	<i>Esox masquinongy</i>	1 _c , 3 _a , 3 _b
Golden shiner	<i>Notemigonus crysoleucas</i>	1 _c , 3 _a , 3 _b , 3 _c , 3 _d
Creek chub	<i>Semotilus atromaculatus</i>	3 _a , 3 _b , 3 _c
Fallfish	<i>Semotilus corporalis</i>	3 _a , 3 _b , 3 _c
Cutlips minnow	<i>Exoglossum maxillingua</i>	3 _a , 3 _b , 3 _c
Blacknose dace	<i>Rhinichthys atratulus</i>	3 _a , 3 _b , 3 _c
Long nose dace	<i>Rhinichthys cataractae</i>	3 _a , 3 _b , 3 _c
Eastern silvery minnow	<i>Hybognathus placitus</i>	3 _a , 3 _b , 3 _c
Common shiner	<i>Luxilus cornutus</i>	3 _a , 3 _b , 3 _c
Spotfin shiner	<i>Cyprinella spiloptera</i>	3 _a , 3 _b , 3 _c
Satinfin shiner	<i>Cyprinella analostana</i>	3 _a , 3 _b , 3 _c
Fathead minnow	<i>Pimephales promelas</i>	3 _a , 3 _b , 3 _c
Bluntnose minnow	<i>Pimephales notatus</i>	3 _a , 3 _b , 3 _c
Comely shiner	<i>Notropis amoenus</i>	3 _a , 3 _b , 3 _c
Swallowtail shiner	<i>Notropis procne</i>	3 _a , 3 _b , 3 _c
Bridle shiner	<i>Notropis bifrenatus</i>	1 _c , 3 _a , 3 _b , 3 _c
Spottail shiner	<i>Notropis hudsonius</i>	3 _a , 3 _b , 3 _c
Quillback	<i>Carpio cyprinus</i>	3 _a , 3 _b , 3 _c
White sucker	<i>Catostomus commersoni</i>	3 _a , 3 _b , 3 _c
Creek chubsucker	<i>Erimyzon oblongus</i>	1 _c , 3 _a , 3 _b , 3 _c
Northern hog sucker	<i>Hypentelium nigricans</i>	3 _a , 3 _b , 3 _c
White catfish	<i>Ameiurus catus</i>	3 _a , 3 _b , 3 _c
Brown bullhead	<i>Ameiurus nebulosus</i>	3 _a , 3 _b , 3 _c
Margined madtom	<i>Noturus exilis</i>	3 _a , 3 _b , 3 _c
Fourspine stickleback	<i>Apeltes quadracus</i>	1 _c , 3 _a , 3 _b , 3 _c
Rock bass	<i>Ambloplites cavifrons</i>	1 _c , 3 _a , 3 _b , 3 _c
Bluespotted sunfish	<i>Enneacanthus gloriosus</i>	1 _c , 3 _a , 3 _b , 3 _c

TABLE 3-3
Fish Likely to Occur
Within the North Penn Area 6 Site Area of Concern

Common Name	Scientific Name	Habitat
Pumpkinseed	<i>Lepomis gibbosus</i>	1 _c , 3 _a , 3 _b , 3 _c
Redbreast sunfish	<i>Lepomis auritus</i>	1 _c , 3 _a , 3 _b , 3 _c
Yellow perch	<i>Perca flavescens</i>	1 _c , 3 _a , 3 _b , 3 _c
Shield darter	<i>Percina peltata</i>	3 _a , 3 _b , 3 _c
Tessellated darter	<i>Etheostoma olmstedii</i>	3 _a , 3 _b , 3 _c
Common carp	<i>Cyprinus carpio</i>	3 _a , 3 _b , 3 _c , 3 _d

LEGEND:		
1 = Wetland Habitat	2 = Upland Habitat	3 = Aquatic Habitat
1 _a = PFO	2 _a = Developed/Urban	3 _a = West Branch Neshaminy
1 _b = PFO/PSS	2 _b = Forested	3 _b = Towamencin Creek
1 _c = PEM	2 _c = Agricultural	3 _c = Wissahickon Creek
		3 _d = Small ponds

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TABLE 3-4
Amphibians Likely to Occur
Within the North Penn Area 6 Site Area of Concern

Common Name	Scientific Name	Habitat
Eastern Newt	<i>Notophthalmus viridescens</i>	2
Jefferson Salamander	<i>Ambystoma jeffersonianum</i>	2
Spotted Salamander	<i>Ambystoma maculatum</i>	2
Marbled Salamander	<i>Ambystoma opacum</i>	2
Dusky Salamander	<i>Desmognathus fuscus</i>	1, 2
Two-lined Salamander	<i>Eurycea bislineata</i>	all
Long-tailed Salamander	<i>Eurycea longicauda</i>	all
Spring Salamander	<i>Gyrinophilus porphyriticus</i>	3
Red-backed Salamander	<i>Plethodon cinereus</i>	2
Mud Salamander	<i>Pseudotriton montanus</i>	1
Red Salamander	<i>Pseudotriton ruber</i>	1
Eastern Spadefoot	<i>Scaphiopus holbrookii</i>	1, 2
Bullfrog	<i>Rana catesbeiana</i>	3 ₁
Green Frog	<i>Rana clamitas</i>	1
Pickereel Frog	<i>Rana palustris</i>	1
Wood Frog	<i>Rana sylvatica</i>	2 ₁
American Toad	<i>Bufo americanus</i>	2
Woodhouse's Toad	<i>Bufo woodhousei</i>	2
Northern Cricket Frog	<i>Acris crepitans</i>	1
Gray Treefrog	<i>Hyla versicolor</i>	1 ₁
Spring Peeper	<i>Hyla cruficer</i>	1 ₁
Chorus Frog	<i>Pseudacris triseriata</i>	1, 2

LEGEND:		
1 - Wetland Habitat	2 - Upland Habitat	3 - Aquatic Habitat
1 ₁ - PFO	2 ₁ - Developed/Urban	3 ₁ - West Branch Neshaminy Creek
1 ₂ - PFO/PSS	2 ₂ - Forested	3 ₂ - Towamencin Creek
1 ₃ - PEM	2 ₃ - Agricultural	3 ₃ - Wissahickon Creek
		3 ₄ - Small ponds

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TABLE 3-5
Reptiles Likely to Occur
Within the North Penn Area 6 Site Area of Concern

Common Name	Scientific Name	Habitat
Snapping Turtle	<i>Chelydra serpentina</i>	3
Mud Turtle	<i>Kinosternon subrubrum</i>	1, 3
Stinkpot	<i>Sternotherus odoratus</i>	3
Painted Turtle	<i>Chrysemys picta</i>	3
Spotted Turtle	<i>Clemmys guttata</i>	1, 3
Wood Turtle	<i>Clemmys insculpta</i>	1, 3
Bog Turtle	<i>Clemmys muhlenbergi</i>	1,
Eastern Box Turtle	<i>Terrapene carolina</i>	1,
Eastern Fence Lizard	<i>Sceloporus undulatus</i>	2
Ruin Lizard	<i>Podarcis sicula</i>	2,
Five-lined Skink	<i>Eumeces fasciatus</i>	2,
Broad-headed Skink	<i>Eumeces laticeps</i>	2,
Worm Snake	<i>Carphophis amoenus</i>	2,
Racer	<i>Coluber constrictor</i>	2,
Ringneck Snake	<i>Diaplophis punctatus</i>	2
Corn Snake	<i>Elaphe guttata</i>	2
Rat Snake	<i>Elaphe obsoleta</i>	2, 2,
Eastern Hognose	<i>Heterodon platyrhinos</i>	2,
Milk Snake	<i>Lampropeltis triangulum</i>	2
Northern Water Snake	<i>Nerodia sipedon</i>	1
Smooth Green Snake	<i>Opheodrys vernalis</i>	2,
Queen Snake	<i>Regina septemvittata</i>	1
Brown Snake	<i>Storeria dekayi</i>	1, 2
Red-bellied Snake	<i>Storeria occipitomaculata</i>	1, 2

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TABLE 3-5
Reptiles Likely to Occur
Within the North Penn Area 6 Site Area of Concern

Common Name	Scientific Name	Habitat
Eastern Ribbon Snake	<i>Thamnophis sauritus</i>	2, 3
Common Garter Snake	<i>Thamnophis sirtalis</i>	all
Smooth Earth Snake	<i>Virginia valeriae</i>	2
Copperhead	<i>Agkistrodon contortrix</i>	1, 2
Timber Rattlesnake	<i>Crotalis horridus</i>	1, 2

LEGEND:		
1 - Wetland Habitat	2 - Upland Habitat	3 - Aquatic Habitat
1 _a - PFO	2 _a - Developed/Urban	3 _a - West Branch Neshaminy Creek
1 _b - PFO/PSS	2 _b - Forested	3 _b - Towamencin Creek
1 _c - PEM	2 _c - Agricultural	3 _c - Wissahickon Creek
		3 _d - Small ponds

TABLE 3-6
Birds Likely to Occur
Within the North Penn Area 6 Site Area of Concern
Permanent Resident Species (January - December)

Common Name	Scientific Name	Habitat
Great Egret	<i>Casmerodias albus</i>	1, 3
Northern Harrier	<i>Circus cyaneus</i>	1, 3
Swamp Sparrow	<i>Melospiza georgiana</i>	1, 3
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	1 _c
Great Blue Heron	<i>Ardea herodias</i>	3
Mallard	<i>Anas platyrhynchos</i>	3
Killdeer	<i>Charadrius vociferus</i>	2 _c
Bobwhite	<i>Colinus virginianus</i>	2 _c
Common Nighthawk	<i>Chordeiles minor</i>	2 _c
Barn Owl	<i>Tyto alba</i>	2 _c
American Kestrel	<i>Falco sparverius</i>	2 _c
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	2 _b , 2 _c
American Goldfinch	<i>Ceruelis tristis</i>	2 _c
Eastern Meadowlark	<i>Sturnella magna</i>	2 _c
Eastern Bluebird	<i>Sialia sialis</i>	2 _c
Field Sparrow	<i>Spizella pusilla</i>	2 _c
Vesper Sparrow	<i>Pooecetes gramineus</i>	2 _c
Horned Lark	<i>Eremophila alpestris</i>	2 _c
Mourning Dove	<i>Zenaida macrora</i>	2 _s
Rock Dove	<i>Columba livia</i>	2 _s
Common Flicker	<i>Colaptes auratus</i>	2 _s
American Robin	<i>Turdus migratorius</i>	2 _s

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TABLE 3-6
Birds Likely to Occur
Within the North Penn Area 6 Site Area of Concern
Permanent Resident Species (January - December)

Common Name	Scientific Name	Habitat
House Finch	<i>Carpodacus mexicanus</i>	2 _a
Northern Mockingbird	<i>Mimus polyglottos</i>	2 _a
Blue Jay	<i>Cyanocitta cristata</i>	2 _a
Cedar Waxwing	<i>Bombycilla cedrorum</i>	2 _a
Brown-headed Cowbird	<i>Molothrus ater</i>	2 _a
House Sparrow	<i>Passer domesticus</i>	2 _a
Song Sparrow	<i>Melospiza melodia</i>	2 _a
European Starling	<i>Sturnus vulgaris</i>	2 _a
Common Grackle	<i>Quiscalus quiscula</i>	2 _a
American Crow	<i>Corvus brachyrhynchos</i>	2 _a
Rufous-sided Towhee	<i>Pipilo erythrophthalmus</i>	2 _b , 2 _c
Northern Cardinal	<i>Cardinalis cardinalis</i>	2 _b , 2 _c
Ruffed Grouse	<i>Bonasa umbellus</i>	2 _a
Screech Owl	<i>Otus asio</i>	2 _a
Barred Owl	<i>Strix varia</i>	2 _a
Red-Shouldered Hawk	<i>Buteo lineatus</i>	1 _a
Red-Tailed Hawk	<i>Buteo jamaicensis</i>	2 _a
Turkey Vulture	<i>Cathartes aura</i>	2 _a
Downy Woodpecker	<i>Picoides pubescens</i>	2 _a
Hairy Woodpecker	<i>Picoides villosus</i>	2 _a
Pileated Woodpecker	<i>Dryocopus pileatus</i>	2 _a
White-breasted Nuthatch	<i>Sitta carolinensis</i>	2 _a
Brown Creeper	<i>Certhia familiaris</i>	2 _a
Carolina Chickadee	<i>Parus carolinensis</i>	2 _a , 2 _b
Black-capped Chickadee	<i>Parus atricapillus</i>	2 _a

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TABLE 3-6
Birds Likely to Occur
Within the North Penn Area 6 Site Area of Concern
Permanent Resident Species (January - December)

Common Name	Scientific Name	Habitat
Tufted Titmouse	<i>Parus bicolor</i>	2 _b
Long-eared Owl	<i>Asio otus</i>	2 _b
Great Horned Owl	<i>Bubo virginianus</i>	2 _b
Winter Wren	<i>Troglodytes troglodytes</i>	2 _b

LEGEND:		
1 - Wetland Habitat	2 - Upland Habitat	3 - Aquatic Habitat
1 _a - PFO	2 _a - Developed/Urban	3 _a - West Branch Neshaminy Creek
1 _b - PFO/PSS	2 _b - Forested	3 _b - Towamencin Creek
1 _c - PEM	2 _c - Agricultural	3 _c - Wissahickon Creek
		3 _d - Small ponds

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TABLE 3-7
Birds Likely to Occur
Within the North Penn Area 6 Site Area of Concern
Breeding Season Resident (March - July)

Common Name	Scientific Name	Habitat
Least Bittern	<i>Ixobrychus exilis</i>	1, 3
Yellow-crowned Night Heron	<i>Nycticorax violacea</i>	1, 3
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	1, 3
American Bittern	<i>Botaurus lentiginosus</i>	1, 3
American Coot	<i>Filica americana</i>	2 _c
Blue-winged Teal	<i>Anas discors</i>	1, 3
Pied-billed Grebe	<i>Podilymbus podiceps</i>	1, 3
Common Gallinule	<i>Gallinula chloropus</i>	1, 3
Virginia Rail	<i>Rallus limicola</i>	1, 3
King Rail	<i>Rallus elegans</i>	1, 3
Short-billed Marsh Wren	<i>Cistothorus platensis</i>	1 _c
Green Heron	<i>Butorides striatus</i>	3
Common Tern	<i>Sterna hirundo</i>	3
Wood Duck	<i>Aix sponsa</i>	1, 2, 3
Spotted Sandpiper	<i>Actitis macularia</i>	all
Tree Swallow	<i>Iridoprocne bicolor</i>	all
Rough-winged Swallow	<i>Stelgidopteryx ruficollis</i>	2 _b , 3
Belted Kingfisher	<i>Megasceryle alcyon</i>	3
Cattle Egret	<i>Bubulcus ibis</i>	2 _c
Barn Swallow	<i>Hirundo rustica</i>	2 _c
Cliff Swallow	<i>Petrochelidon pyrrhonta</i>	2 _c
Loggerhead Shrike	<i>Lanius ludovicianus</i>	2 _c
Eastern Kingbird	<i>Tyrannus tyrannus</i>	2 _c
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	2 _c

TABLE 3-7
Birds Likely to Occur
Within the North Penn Area 6 Site Area of Concern
Breeding Season Resident (March - July)

Common Name	Scientific Name	Habitat
Henslow's Sparrow	<i>Passerherbulus henslowii</i>	2 _c
Savannah Sparrow	<i>Passerculus sandwichensis</i>	2 _c
Bobolink	<i>Dolichonyx oryzivorus</i>	2 _c
Purple Martin	<i>Progne subis</i>	2 _a
Chimney Swift	<i>Chaetura pelagica</i>	2 _a
Northern Oriole	<i>Icterus galbula</i>	2 _a
Gray Catbird	<i>Dumetella carolinensis</i>	2 _a
Eastern Phoebe	<i>Sayornis phoebe</i>	2 _a
Ruby-throated Hummingbird	<i>Archilochus colubris</i>	2 _a
House Wren	<i>Troglodytes aedon</i>	2 _a
Brown Thrasher	<i>Toxostoma rufus</i>	2 _a
Chipping Sparrow	<i>Spizella passerina</i>	2 _a
Yellow Warbler	<i>Dendrioca petechia</i>	2 _b , 2 _c
Yellow-breasted Chat	<i>Icteria vireus</i>	2 _b , 2 _c
Blue-winged Warbler	<i>Vermivora pinus</i>	2 _b , 2 _c
Prairie Warbler	<i>Dendrioca discolor</i>	2 _b , 2 _c
Common Yellowthroat	<i>Geothlypis trichas</i>	2 _b , 2 _c
Chestnut-sided Warbler	<i>Dendrioca pensylvanica</i>	2 _b , 2 _c
Golden-winger Warbler	<i>Vermivora chrysoptera</i>	2 _b , 2 _c
American Redstart	<i>Setophaga ruticella</i>	2 _b , 2 _c
White-eyed Vireo	<i>Vireo griseus</i>	2 _b , 2 _c
Indigo Bunting	<i>Passerina cyanea</i>	2 _b , 2 _c
Willow Flycatcher	<i>Epidomax traillii</i>	2 _b , 2 _c
Carolina Wren	<i>Thryothorus ludovicianus</i>	2 _b , 2 _c
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	2 _b , 2 _c

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TABLE 3-7
Birds Likely to Occur
Within the North Penn Area 6 Site Area of Concern
Breeding Season Resident (March - July)

Common Name	Scientific Name	Habitat
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	2 _b , 2 _c
American Woodcock	<i>Philohela minor</i>	2 _b
Whip-poor-will	<i>Caprimulgus vociferous</i>	2 _b
Broad-winged Hawk	<i>Buteo platypterus</i>	2 _b
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	2 _b
Prothonotary Warbler	<i>Protonotaria citrina</i>	1 _c
Yellow-throated Vireo	<i>Vireo flavifrons</i>	2 _b
Hooded Warbler	<i>Wilsonia citrina</i>	1 _a , 2 _b
Kentucky Warbler	<i>Oporornis formosus</i>	1 _a , 2 _b
Orchard Oriole	<i>Icterus spurius</i>	2 _b
Rose-breasted Grosbeak	<i>Pheucticus ludoricianus</i>	2 _b
Scarlet Tanager	<i>Piranga olivacea</i>	2 _b
Blue-gray Gnatcatcher	<i>Poliptila caerulea</i>	2 _b
Red-eyed Vireo	<i>Vireo olivaceus</i>	2 _b
Warbling Vireo	<i>Vireo gilvus</i>	2 _b
Acadian Flycatcher	<i>Empidonax virens</i>	2 _b
Least Flycatcher	<i>Empidonax minimus</i>	2 _b
Eastern Wood Pewee	<i>Contopus virens</i>	2 _b
Great-crested Flycatcher	<i>Myiarchus crinitus</i>	2 _b
Veery	<i>Catharus fuscescens</i>	2 _b
Wood Thrush	<i>Hylocichla mustelina</i>	2 _b
Ovenbird	<i>Seiurus aurocapillus</i>	2 _b
Louisiana Waterthrush	<i>Seiurus motacilla</i>	1 _a , 2 _b
Northern Waterthrush	<i>Seiurus noveboracensis</i>	1 _a , 2 _b
Black-and-white Warbler	<i>Mniotilta varia</i>	2 _b

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TABLE 3-7
Birds Likely to Occur
Within the North Penn Area 6 Site Area of Concern
Breeding Season Resident (March - July)

Common Name	Scientific Name	Habitat
Worm-eating Warbler	<i>Helmitheros vermivorus</i>	2 _b
Black-throated Blue Warbler	<i>Dendroica caerulescens</i>	2 _b
Solitary Vireo	<i>Vireo solitarius</i>	2 _b
Hermit Thrush	<i>Catharus guttatus</i>	2 _b

LEGEND:		
1 - Wetland Habitat	2 - Upland Habitat	3 - Aquatic Habitat
1 _a - PFD	2 _a - Developed/Urban	3 _a - West Branch Neshaminy Creek
1 _b - PFD/PSS	2 _b - Forested	3 _b - Towamencin Creek
1 _c - PEM	2 _c - Agricultural	3 _c - Wissahickon Creek
		3 _d - Small ponds

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TABLE 3-8
Birds Likely to Occur
Within the North Penn Area 6 Site Area of Concern
Winter Resident Bird Species (November - April)

Common Name	Scientific Name	Habitat
Ruddy Duck	<i>Oxyura jamaicensis</i>	3 _d
Gadwall	<i>Anas strepera</i>	3 _d
Common Snipe	<i>Capella gallingo</i>	1, 3
Short-eared Owl	<i>Asio flammeus</i>	1, 3
Common Merganser	<i>Mergus merganser</i>	2 _v , 3
Lesser Scaup	<i>Aythya affinis</i>	1, 3
Canada Goose	<i>Branta canadensis</i>	1, 3
Bald Eagle	<i>Haliaeetus leucocephalus</i>	3
Peregrine Falcon	<i>Falco peregrinus</i>	all
Rough-legged Hawk	<i>Buteo lagopus</i>	2 _c
Northern Shrike	<i>Lanius excubitor</i>	1, 2 _c
Tree Sparrow	<i>Spizella arborea</i>	2 _c
Snow Bunting	<i>Plectrophenax nivalis</i>	2 _c
Lapland Longspur	<i>Calcarius lapponicus</i>	2 _c
Dark-eyed Junco	<i>Junco hyemalis</i>	2 _s
White-throated Sparrow	<i>Zonotrichia albicollis</i>	1 _b , 2 _c
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	1 _b , 2 _c
Fox Sparrow	<i>Passerella iliaca</i>	1 _b , 2 _c
Saw-whet Owl	<i>Aegolius acadicus</i>	2 _b
Yellow-rumped Warbler	<i>Dendroica coronata</i>	2 _b

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TABLE 3-8
Birds Likely to Occur
Within the North Penn Area 6 Site Area of Concern
Winter Resident Bird Species (November - April)

Ruby-crowned Kinglet	<i>Regulus calendula</i>	2 ₁
Rusty Blackbird	<i>Euphagus carolinus</i>	2 ₁

LEGEND:		
1 - Wetland Habitat	2 - Upland Habitat	3 - Aquatic Habitat
1 ₁ - PFO	2 ₁ - Developed/Urban	3 ₁ - West Branch Neshaminy Creek
1 ₂ - PFO/PSS	2 ₂ - Forested	3 ₂ - Towamencin Creek
1 ₃ - PEM	2 ₃ - Agricultural	3 ₃ - Wissahickon Creek
		3 ₄ - Small pond

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TABLE 3-9
Mammals Likely to Occur
Within the North Penn Area 6 Site Area of Concern

Common Name	Scientific Name	Habitat
Opossum	<i>Didelphis marsupialis</i>	all
Masked Shrew	<i>Sorex cinerus</i>	1 _a , 2 _c
Smoky Shrew	<i>Sorex fumous</i>	2 _b
Least Shrew	<i>Cryptotis parva</i>	1 _c , 2 _c
Shorttail Shrew	<i>Blarina brevicauda</i>	all
Starnose Mole	<i>Condylura cristata</i>	1 _c , 3 _a , 3 _b , 3 _c
Eastern Mole	<i>Scalopus aquaticus</i>	2 _a , 2 _c
Hairytail Mole	<i>Parascalops breweri</i>	2 _c
Keen Myotis	<i>Myotis keeni</i>	2 _a , 2 _b
Little brown Myotis	<i>Myotis lucifugus</i>	2 _a , 2 _b
Small-footed Myotis	<i>Myotis subulatus</i>	2 _a , 2 _b
Silver-haired Bat	<i>Lasionycteris noctivagans</i>	2 _a , 2 _b
Eastern Pipistrel	<i>Pipistrellus subflavus</i>	2 _a , 2 _b
Red Bat	<i>Lasiurus borealis</i>	2 _b
Big brown Bat	<i>Eptesicus fuscus</i>	2 _a , 2 _b
Hoary Bat	<i>Lasiurus cinereus</i>	2 _b
Seminole Bat	<i>Lasiurus seminolus</i>	2 _b
Raccoon	<i>Procyon lotor</i>	2 _a , 2 _b
Shorttail Weasel	<i>Mustela erminea</i>	2 _b , 2 _c
Longtail Weasel	<i>Mustela frenata</i>	all
Mink	<i>Mustela vison</i>	2 _b
River Otter	<i>Lutra canadensis</i>	2 _b
Striped Skunk	<i>Mephitis mephitis</i>	2 _b , 2 _c
Red Fox	<i>Vulpes fulva</i>	2 _b , 2 _c
Gray Fox	<i>Urocyon cinereoargenteus</i>	2 _b , 2 _c
Bobcat	<i>Lynx rufus</i>	1 _a , 2 _b

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TABLE 3-9
Mammals Likely to Occur
Within the North Penn Area 6 Site Area of Concern

Common Name	Scientific Name	Habitat
Woodchuck	<i>Marmota monax</i>	2 _b
Eastern Chipmunk	<i>Tamias striatus</i>	2 _b , 2 _c
Eastern Grey Squirrel	<i>Sciurus carolinensis</i>	2
Southern Flying Squirrel	<i>Glaucomys volans</i>	2 _b
Beaver	<i>Castor canadensis</i>	1 _a , 3
White-footed Mouse	<i>Peromyscus leucopus</i>	2 _b , 2 _c
Rice Rat	<i>Oryzomys palustris</i>	1 _c
Southern Bog Lemming	<i>Synaptomys cooper</i>	1 _c
Meadow Vole	<i>Microtus pennsylvanicus</i>	1 _c , 2 _c
Pine Vole	<i>Pitymys pinetorum</i>	2 _b
Muskrat	<i>Ondatra zibethicus</i>	1 _c , 3
Norway Rat	<i>Rattus rattus</i>	2 _a , 2 _c
House Mouse	<i>Mus musculus</i>	2 _a , 2 _c
Meadow Jumping Mouse	<i>Zapus hudsonius</i>	all
Woodland Jumping Mouse	<i>Napaeozapus insignis</i>	1 _c
Snowshoe Hare	<i>Lepus americanus</i>	1 _a , 2 _b
European hare	<i>Lepus europaeus</i>	2 _c
Eastern Cottontail	<i>Sylvilagus floridanus</i>	2
New England Cottontail	<i>Sylvilagus transitionalis</i>	2
White-tailed Deer	<i>Odocoileus virginianus</i>	1 _a , 2 _b

LEGEND:		
1 - Wetland Habitat	2 - Upland Habitat	3 - Aquatic Habitat
1 _a - PFO	2 _a - Developed/Urban	3 _a - West Branch Neshaminy Creek
1 _b - PFO/PSS	2 _b - Forested	3 _b - Towamencin Creek
1 _c - PEM	2 _c - Agricultural	3 _c - Wissahickon Creek
		3 _d - Small ponds

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TABLE 3-10
Wildlife Observed on the five
North Penn Area 6 Properties

Common Name	Scientific Name	Site Observed On	Indication
Gray squirrel	<i>Sciurus carolinensis</i>	4, 5	sighting, tracks
Dark-eyed junco	<i>Junco hyemalis</i>	1, 3, 4, 5	sighting
House sparrow	<i>Passer domesticus</i>	1, 2, 3, 4, 5	sighting
American crow	<i>Corvus brachyrhynchos</i>	5	sighting
Minnows	Family Cyprinidae	1	sighting
Rock dove	<i>Columba livia</i>	2	sighting

LEGEND:

- 1 - Keystone Hydraulics;
- 2 - REP Industries;
- 3 - Electra Auto Care;
- 4 - John Evans & Sons;
- 5 - Tate Andale

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TABLE 3-11
Wildlife Observed in the North Penn Area 6 Site
Area of Concern

Common Name	Scientific Name	Habitat	Indication
Gray squirrel	<i>Sciurus carolinensis</i>	1 _b , 2 _a , 2 _b	sighting, tracks
Dark-eyed junco	<i>Junco hyemalis</i>	2 _a	sighting
House sparrow	<i>Passer domesticus</i>	1 _b , 2 _a , 2 _c	sighting
Belted kingfisher	<i>Mergaceryle alcyon</i>	1 _a , 3 _a	sighting
White-tailed deer	<i>Odocoileus virginianus</i>	2 _b , 2 _c	tracks, scat
Red-winged blackbird	<i>Agelaius phoeniceus</i>	1 _b , 2 _c	sighting, song
Rock dove	<i>Columba livia</i>	2 _a	sighting
American crow	<i>Corvus brachyrhynchos</i>	2 _a , 2 _c	sighting
Minnows	Family Cyprinidae	3 _a	sighting

LEGEND:		
1 - Wetland Habitat	2 - Upland Habitat	3 - Aquatic Habitat
1 _a - PFO	2 _a - Developed/Urban	3 _a - West Branch Neshaminy Creek
1 _b - PFO/PSS	2 _b - Forested	3 _b - Towamencin Creek
1 _c - PEM	2 _c - Agricultural	3 _c - Wissahickon Creek
		3 _d - Small ponds

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TABLE 3-12
Dominant Vegetation Observed in
Wetland Habitat within the Area of Concern

Common Name	Scientific Name	Stratum
Aster	<i>Aster sp.</i>	Herbaceous
Goldenrod	<i>Solidago sp.</i>	Herbaceous
White avens	<i>Geum canadense</i>	Herbaceous
Violets	<i>Viola spp.</i>	Herbaceous
Common milkweed	<i>Asclepias syriaca</i>	Herbaceous
Kentucky bluegrass	<i>Poa pratense</i>	Herbaceous
Giant reed	<i>Phragmites australis</i>	Herbaceous
Cinnamon fern	<i>Osmunda cinnamomea</i>	Herbaceous-
Reed canary grass	<i>Phalaris arundinacea</i>	Herbaceous
Cattail	<i>Typha latifolia</i>	Herbaceous
Sedges	<i>Carex spp.</i>	Herbaceous
Grapes	<i>Vitis spp.</i>	Shrub/Vine/Sapling
Tatarian honeysuckle	<i>Lonicera tatarica</i>	Shrub/Vine/Sapling
Arrowwood	<i>Viburnum dentatum</i>	Shrub/Vine/Sapling
Privet	<i>Ligustrum vulgare</i>	Shrub/Vine/Sapling
Multiflora rose	<i>Rosa multiflora</i>	Shrub/Vine/Sapling
Poison ivy	<i>Toxicodendron radicans</i>	Shrub/Vine/Sapling
Silky dogwood	<i>Cornus amomum</i>	Shrub/Vine/Sapling
Silver maple	<i>Acer saccharinum</i>	Tree
Weeping willow	<i>Salix babylonica</i>	Tree
White ash	<i>Fraxinus americana</i>	Tree
Red maple	<i>Acer rubrum</i>	Tree
Black walnut	<i>Juglans nigra</i>	Tree
Eastern Sycamore	<i>Platanus occidentalis</i>	Tree

TABLE 3-13
Dominant Vegetation Observed in
Terrestrial Habitat within the Area of Concern

Common Name	Scientific Name	Stratum
Aster	<i>Aster sp.</i>	Herbaceous
Goldenrod	<i>Solidago sp.</i>	Herbaceous
Queen Anne's lace	<i>Daucus carota</i>	Herbaceous
Pokeweed	<i>Phytolacca americana</i>	Herbaceous
Foxtail grass	<i>Setaria glauca</i>	Herbaceous
Kentucky bluegrass	<i>Poa pratense</i>	Herbaceous
Wild garlic	<i>Allium canadense</i>	Herbaceous
Ground ivy	<i>Glechoma hederacea</i>	Herbaceous
Violets	<i>Viola spp.</i>	Herbaceous
Thistle	<i>Sonchus sp.</i>	Herbaceous
Poison ivy	<i>Toxicodendron radicans</i>	Shrub/Vine/Sapling
Japanese honeysuckle	<i>Lonicera japonica</i>	Shrub/Vine/Sapling
Privet	<i>Ligustrum vulgare</i>	Shrub/Vine/Sapling
Multiflora rose	<i>Rosa multiflora</i>	Shrub/Vine/Sapling
Staghorn sumac	<i>Rhus typhina</i>	Shrub/Vine/Sapling
American elm	<i>Ulmus americana</i>	Tree
Red oak	<i>Quercus rubra</i>	Tree
Black gum	<i>Nyssa sylvatica</i>	Tree
Black walnut	<i>Juglans nigra</i>	Tree
Honey locust	<i>Gleditsia triacanthos</i>	Tree
Red maple	<i>Acer rubrum</i>	Tree
Silver maple	<i>Acer saccharinum</i>	Tree
Sugar maple	<i>Acer saccharum</i>	Tree
White oak	<i>Quercus alba</i>	Tree
Black cherry	<i>Prunus serotina</i>	Tree
Eastern Sycamore	<i>Platanus occidentalis</i>	Tree

AR301187

Table 4-1
Chemicals in Surface Soil (0-2') Retained and Eliminated from List of
Ecological Chemicals of Concern

Compound or Analyte	Rationale for Elimination					Max. Conc. (ppb)
	Evans Property	Electra Property	Keystone Property	Andale Property	REP Property	
Volatile Organics						
Methylene Chloride	ND	ND	BC	BC	ND	n/a
Acetone	ND	ND	BC	BC	ND	n/a
2-Butanone	ND	ND	BC	ND	ND	n/a
Trichloroethene	Once	ND	ND	I	I	180
Tetrachloroethene	Once	ND	ND	I	I	29
1,1,1-Trichloroethane	ND	ND	ND	Once	ND	n/a
1,1,2-Trichloroethane	ND	ND	ND	Once	ND	n/a
Total Xylenes	ND	ND	ND	Once	ND	n/a
Semi-volatile Organics						
Phenol	ND	ND	Once	ND	ND	n/a
4-Methylphenol	ND	ND	Once	ND	ND	n/a
Dimethylphthalate	ND	ND	Once	ND	ND	n/a
Naphthalene	ND	I	BC	Once	BC	78
2-Methylnaphthalene	Once	I	I	Once	I	1300
Acenaphthylene	ND	I	Once	Once	ND	88
Acenaphthene	ND	I	ND	ND	ND	120
Dibenzofuran	ND	I	ND	ND	ND	230
Fluorene	ND	I	Once	ND	I	92
Phenanthrene	I	I	I	I	I	1400
Anthracene	ND	I	ND	Once	ND	250
Carbazole	ND	I	ND	Once	I	170
Fluoranthene	I	I	I	I	I	1700
Pyrene	I	I	I	I	I	1500
Benzo(a)anthracene	I	I	I	I	I	940
Chrysene	I	I	I	I	I	1000
Bis(2-Ethylhexyl)phthalate	BC	BC	BC	BC	I	5700
Butylbenzylphthalate	Once	ND	Once	ND	ND	n/a
Di-n-butylphthalate	BC	ND	BC	BC	ND	n/a
Di-n-octylphthalate	ND	ND	I	I	I	3400
Benzo(b)fluoranthene	I	I	I	I	I	2100
Benzo(a)pyrene	ND	I	I	I	I	690
Indeno(1,2,3-cd)pyrene	ND	I	I	Once	I	250
Dibenz(a,h)anthracene	ND	I	ND	ND	ND	110
Benzo(g,h,i)perylene	ND	I	I	Once	I	460
Pesticides/PCBs						
Aldrin	ND	Once	ND	ND	I	5.4
Dieldrin	ND	Once	ND	ND	ND	n/a
gamma-BHC	Once	ND	ND	ND	ND	n/a
Heptachlor epoxide	ND	ND	ND	ND	I	2.5
Endosulfan Sulfate	ND	ND	ND	ND	I	4.3
4,4'-DDE	ND	ND	Once	ND	ND	n/a
4,4'-DDT	ND	ND	Once	Once	I	n/a
Endrin Aldehyde	ND	ND	ND	Once	I	5.4
Arochlor-1260	I	I	I	I	ND	830

ND - Eliminated, not detected
 NTS - Eliminated, not toxicologically significant
 <5% - Eliminated, detected in less than 5% of the samples
 <2X - Eliminated, concentration less than 2 times background

BC - Eliminated, possible blank contamination
 Once - Eliminated, detected only once
 I - Included in the risk assessment
 NS - No samples collected

FILE ELM

AR301188

Table 4-2
Ecological Chemicals of Concern at Five Properties
on the North Penn Area 6 Site

Evans Property	Electra Property	Keystone Property	Andale Property	REP Property
<u>Semi-Volatiles</u> Phenanthrene Fluoranthene Pyrene Benzo(a)anthracene Chrysene Benzo(b)fluoranthene <u>Pesticides/PCBs</u> Arochlor 1260 <u>Inorganics</u> Arsenic Cadmium Chromium Copper Lead Manganese Mercury Nickel Selenium Thallium Vanadium Zinc	<u>Semi-Volatiles</u> Naphthalene 2-Methylnaphthalene Acenaphthylene Acenaphthene Dibenzofuran Fluorene Phenanthrene Anthracene Carbazole Fluoranthene Pyrene Benzo(a)anthracene Chrysene Benzo(b)fluoranthene Indeno(123-cd)pyrene Benzo(g,h,i)perylene <u>Pesticides/PCBs</u> Arochlor 1260 <u>Inorganics</u> Arsenic Copper Lead Manganese Selenium Zinc	<u>Semi-Volatiles</u> 2-Methylnaphthalene Phenanthrene Fluoranthene Pyrene Benzo(a)anthracene Chrysene Di-n-octylphthalate Benzo(b)fluoranthene Benzo(a)pyrene Indeno(123-cd)pyrene Benzo(g,h,i)perylene <u>Pesticides/PCBs</u> Arochlor 1260 <u>Inorganics</u> Arsenic Copper Lead Manganese Selenium Zinc	<u>Volatiles</u> Trichloroethene Tetrachloroethene <u>Semi-Volatiles</u> Phenanthrene Fluoranthene Pyrene Benzo(a)anthracene Chrysene Di-n-octylphthalate Benzo(b)fluoranthene Benzo(a)pyrene <u>Pesticides/PCBs</u> Arochlor 1260	<u>Volatiles</u> Trichloroethene Tetrachloroethene <u>Semi-Volatiles</u> 2-Methylnaphthalene Fluorene Phenanthrene Carbazole Fluoranthene Pyrene Benzo(a)anthracene Chrysene bis(2-ethylhexyl)phthalate Di-n-octylphthalate Benzo(b)fluoranthene Benzo(a)pyrene Indeno(123-cd)pyrene Benzo(g,h,i)perylene <u>Pesticides/PCBs</u> Aldrin Heptachlor epoxide Endosulfan Sulfate Endrin Aldehyde

AR301190

Appendix G
Cost Calculations and Assumptions
Common for All Alternatives

AR301191



Owner NORTH PENN

Plant _____ Unit _____

Project No. _____ File No. _____

Title Cost Estimate for FS (SOIL)
(Per Lusheng's agreement)

Computed By GM

Date 5/20 19 94

Checked By LZ

Date 5-20 19 94

Page 1 of 1

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DO NOT WRITE

Assumptions For Alternatives 1 - 6

- 30 year period for O & M costs
- 5 % Infiltration rate } This was later change to
using only 5% as the net
discount rate. LZ

Sampling & Monitoring

- Quarterly for the first 10 years
- Semi-Annually for the second 10 years
- Annually for the last 10 years

Monitoring Wells

3 monitoring wells per property total of 12 wells
100 foot average depth



Owner EPA III Computed By GM
Plant North Penn Area 6 Unit Date 7/18 19 94
Project No. 21910 File No. 008 Checked By GIL
Title Ground Water Monitoring Date 7/18 19 94
Cost Summary Page of

Ground water monitoring will be necessary

for: Alternative 1 - No Action

Alternative 2 - Containment with Cap

Alternative 3 - Vapor Extraction

Monitoring costs include:

- Monitoring Well installation cost, = \$49,140
- Drummed contaminated soil disposal cost during monitoring well installation, and = \$6,000
- Ground water sampling/analysis cost = \$203,46

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AR301193



Owner EPA III Computed By GMM
Plant North Penn Area 6 Unit _____ Date 6/3 19 94
Project No. 21910 File No. 008 Checked By C/LAVELLE
Title Soil & GW Analytic Cost Date 7/13 19 94
Page 1 of 1

REF

Soil samples

Confirmation samples to show that the site is remediated after excavation of the assumed contaminated volume will be necessary.

Discussion
w/ Dr. YAN

Assume 15 samples per site. This assumes 3 samples per side of excavation and 3 samples from the bottom of excavation.

Samples will have a 24 hr turn around

Test → TCL (target compound list)
Volatile fraction only

assume normal detection limits for PCE & TCE.

Report will include test summary

Groundwater Samples

Groundwater samples will be taken for long term monitoring

Test - TCL, Volatile fraction
Normal turn around
Summary report
Normal detection limits for PCE & TCE

DO NOT WRITE IN THIS SPACE

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AR301194



Owner EPA III
Plant North Penn Area 6 Unit _____
Project No. 21910 File No. 008
Title Groundwater Monitoring Sampling
Cost

Computed By GM
Date 6/6 19 94
Checked By S/AVALLI
Date 7/13 19 94
Page 2 of 2

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PGN-172A

Sampling

To sample 3, 4 inch diameter monitoring wells
for each of the 4 properties

12 monitoring wells with an estimated depth
of 100 feet each

Estimated 2 days, 10 hrs each day
2 people

= 40 hrs @ \$60 hr = \$2400

2 pumps for 2 days rent
& sampling supplies
estimated cost

= \$200

Total sampling cost

\$2600

ETC lab &
Analyt kem
Proposals

Analysis cost 12 x 175

= \$2100

Total cost per event

= \$4700

AR301195



Owner EPA III Computed By GM
Plant North Penn Area 6 Unit _____ Date 6/7 19 94
Project No. 21910 File No. 00B Checked By C. LAVALLEE
Title No Action Date 7/13 19 94
Monitoring Cost Page 3 of 4

Sampling & Analysis Present Worth

Years 1-10

Quarterly Sampling

$$4 \times 4700 = 18,800/\text{yr}$$

Assume 5% interest

$$P = A (P/A, 5\%, 10)$$

$$= 18800 (7.7217) = \$145,168$$

Years 11-20

Semi-annually

$$2 \times 4700 = \$9400/\text{yr}$$

$$P = 9400 (P/A, 5\%, 20) - 9400 (P/A, 5\%, 10)$$

$$= 9400 (12.4622 - 7.7217) = \$44,561$$

Years 21-30

Annually

$$= \$4700/\text{yr}$$

$$P = 4700 (P/A, 5\%, 30) - 4700 (P/A, 5\%, 20)$$

$$= 4700 (15.3725 - 12.4622) = \$13,678$$

$$\text{Total present worth} = \underline{\underline{\$203,407}}$$

Monitoring Well Installation

$$= \$49,140$$

$$\left(\frac{4190 + 4000}{2} \right) 12$$

From
Christian
Leville

EPA/540/G-89

1004

P 6-13



Owner EPA III
Plant NORTH PENN AREA 6 Unit _____
Project No. 21910 File No. CCS
Title Soil and air analytic cost

Computed By G.M.
Date 2/5 19 94
Checked By C/LAVELLE
Date 1/13 19 94
Page 4 of 4

References

1. ETC Lab Price quote (6/5/94)
2. Analytical services quote (6/5/94)
3. EPA/540/G-89/004, Guidance for conducting RI/FS

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P-GN-172A

AR301197

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED,
AND DATED BY THE RESPONSIBLE INDIVIDUAL.

Friday, June 03, 1994



284 Raritan
Center Parkway

P.O. Box 7808

Edison, NJ
08818-7808

Telephone
(908) 225-6700

Facsimile
(908) 225-6777

Girma Mergia
B & V Waste science and Technology Corp.
The Curtis Center
Suite 705
601 Walnut St.
Philadelphia, PA 19106-3307

RE: TCE & PCE Feasibility Study
ETC Ref. #Q94374Q

Dear Girma:

As per your request the following is a price quote for the TCE and PCE Feasibility Study:

Matrix: Soil
Turnaround Time: 24hours Verbal
Report: Results with QC

<u>ANALYSIS</u>	<u>METHOD</u>	<u># SAMPLES</u>	<u>PRICE</u>	<u>TOTAL</u>
TCE & PCE	8240	1	400.00	400.00

Note: Price reflects a 100% mark up for 24hour turnaround time.

Matrix: Aqueous
Turnaround time: 14 day
Report: Results with QC

<u>ANALYSIS</u>	<u>METHOD</u>	<u># SAMPLES</u>	<u>PRICE</u>	<u>TOTAL</u>
TCE & PCE	624	12	175.00	2,100.00

ETC welcomes the opportunity to work with you on this project. Bottles, Coolers, and Chain of Custody forms for the sampling event will be supplied at no additional charge. If there are any questions please feel free to call me at (908) 225-6789.

Sincerely,

June Zampolito
June Zampolito
Account Executive

Environmental
Services, Inc.

AR301198

June 3, 1994

R & V Waste Science & Tech. Corp.
The Curtis Center, Suite 705
601 Walnut Street
Philadelphia, PA 19106

ATTENTION: Girma Mergia

REFERENCE: ANALYTICAL SERVICES PROPOSAL
Feasibility Study

ANALYTIKEM QUOTATION NO.: C03321

Dear Girma Mergia:

Thank you for the opportunity to provide a quotation for the project referenced above. Please review the quotation to ensure that all the technical requirements for the project have been met. This quotation reflects the information about your project entered into our laboratory information system.

To serve you better, please notify us immediately on award of the project. This notification will enable us to plan sample container shipment(s) and to schedule the project into our laboratory(s) to meet your turnaround requirements. The quoted turnaround is based on date of receipt of samples and will be met provided samples are received as scheduled.

Attached is the fee schedule for this project. The unit fees are fixed for 60 days. Field and trip blanks, if required, will be billed as individual samples. There is a minimum billing of \$100 per sample shipment receipt and terms are net 30 days.

AnalytiKEM is looking forward to working with you on this project. If you have any questions, please call me.

Sincerely,



Elizabeth Swanson

ANALYTIKEM, INC.

Attachment: Fee Schedule

AR301199

AnalytiKEM Customer Quotation

AnalytiKEM, Inc.

2R Springdale Road

Cherry Hill, NJ 08003

Phone: (800) 879-5221

Fax: (609) 751-0824

Client: D & V Waste Science & Tech. Corp.
Quote Date: 06/03/94
Quote #: C03321

Job Information

Client Contact: Girma Mergia Phone: (215) 928-0700
Project Name: Feasibility Study Fax: (215) 928-1780
AKEM Account Rep: Phil Cowley
AKEM Service Rep: Elizabeth Swanson

Sampling Information

Sampling Date: 07/01/94 Sat. Delivery: N
Est. Arrival Date: 07/01/94 Sampled By: Client

Report Information

Report Turnaround Time: 3 Weeks Verbal Turnaround Time: 1 Weeks
Report Type: Summary plus QC data Specific QA: N
Report Forms: None Dry Weight: Y
Data Package: None Disk Deliverable: None
Report Units In: ppb w J values

Analyses Specifications

Matrix	Samples	Parameter	Method	DL	Fee/Sample	Line Total
SOIL	1	Trichloroethene (TCE)	5030/8240A-LOW	5.00	160.00	160.00
SOIL	1	Tetrachloroethene	5030/8240A-LOW	5.00	0.00	0.00
WATER	1	Trichloroethene (TCE)	624	1.00	160.00	160.00
WATER	1	Tetrachloroethene	624	1.00	0.00	0.00
SOIL	1	Total Solids	160.3	0.10	5.00	5.00

Matrix	Samples	Parameter	Method	DL	Fee/Sample	Line Tot
Total:						\$325.00

Project Notes

Detection Limits (DLs) as follows:

Aqueous Non-aqueous

TCE 1ppb TCE 5ppb

PCE 1ppb PCE 5ppb

Typical mark up is 100% for 24 hr verbal TAT and 50% for 48 hr verbal TAT. Written report will follow 5-days after.



Owner EDA III Computed By GML
Plant NORTH DENN Area C Unit _____ Date 7/18 19 94
Project No. 21917 File No. CCB Checked By _____
Title _____ Date _____ 19 _____
Page _____ of _____

Contaminated Soil Weight Calculation

For Alternatives 2, 4, 5 and 6

DO NOT WRITE IN THIS SPACE

PGN-172A



REF

Calculate soil wt at each site

Bulk den.
Tate 4-2

P 4-4
(RE)

Soil Vol
From L. Rowels
Calc

L. Rowels
Calc

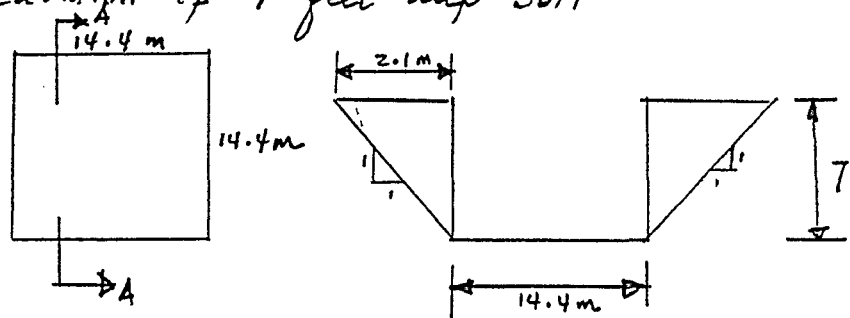
Property	Bulk density g/m ³	contaminated Soil Volume (ft ³)
Electra	1.55	3149
Evans	1.62	12,579
Keystone	1.37	15,514
Tate Andale	1.81	18,909

Estimation of peripheral excavated soil during excava
of the contaminated soil.

eg. Keystone Hydraulics contaminated area

Assume square area 14.4 m x 14.4 m

During excavation of 7 feet deep soil



Peripheral added soil volume based on a 1:1
slope estimate

$$= 14.4 \text{ m} \times 4 \times 2.1 \text{ m} \times \frac{2.1 \text{ m}}{2}$$

$$= 127 \text{ m}^2$$

$$\text{Actual contaminated Volume} = 206 \text{ m}^2 \times 7 \text{ m} \\ = 432.6 \text{ m}^3$$

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PGN-172A

AR301203



Owner EPA III Computed By GM
Plant North Penn Area 6 Unit Date 6/2 19 94
Project No. 21910 File No. 008 Checked By CJ LAMALLE
Title Calculation of soil wt Date 6/2 19 94
Page 2 of 3

$$\text{Percentage added} = \frac{127 \text{ m}^3}{432 \text{ m}^3} \times 100 = 29.4 \%$$

The percentage does not include extra soil at the 4 corners.

Percentage is larger for the smaller contaminated area eg Electra over 60%

Assume 30% added soil average for the 4 properties. This assumption is conservative for the the actual site conditions.

$$\text{eg. Electra} = 3149 \times 1.3$$

Property	Excavation Volume (ft ³)	Wt (tons)	Bulk density
Electra	4094	198	1.55
Evans	16,353	827	1.62
Keystone	20,168	863	1.37
Tate Andale	24,581	1389	1.81
Total		3277 tons	

Soil wt. is calculated from bulk density for each property as follows.

eg Electra

$$4094 \text{ ft}^3 \times 1.55 \frac{\text{g}}{\text{ml}} \times \frac{1 \text{ MI}}{\text{CC}} \times \frac{\text{CC}}{3.531 \times 10^{-5} \text{ ft}^3} \times \frac{1 \text{ lb}}{453.6 \text{ gm}} \times \frac{1 \text{ ton}}{2000 \text{ lb}}$$

∴ Total estimated wt of soil ≈ 3277 tons



Owner EPA III Computed By GM
Plant North Penn Area 6 Unit _____ Date 6/1 19 94
Project No. 21910 File No. 008 Checked By _____
Title Soil Weight Calculation Date _____ 19 ____
Page 3 of 3

References

1. Black & Veatch Waste Science, RE Report
Table 4-2, Soil Bulk densities
2. Leaf Rowels, BVUS, contaminated soil volume
calcs

DO NOT WRITE IN THIS SPACE

PGN-172A

AR301205

REVISIONS, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED,
AND DATED BY THE RESPONSIBLE INDIVIDUAL.



Owner FPA III Computed By LKR
 Plant North Penn Area 6 Unit _____ Date 5/10 19 94
 Project No. 21910.008 File No. _____ Checked By GM
 Title Calculation of Contaminant Volumes Date 5/20 19 94
and Soil Volumes Page 1 of 7

Purpose: to Calculate the volume of soil and average contaminant concentration (TCE or PCE) to be treated. Calculation for feasibility study.

References:

1. Draft Remedial Investigation Report for North Penn Area 6 Site Source Control Operable Unit, Black and Veatch Waste Science, Inc., March 31, 1994.

1, pg 4-16 Note: Only Properties which have contaminant concentrations above the cleanup levels are included.
 Table 4-4 REP and Andale-West are eliminated since cleanup levels are higher than contaminant levels.

REP has an isolated point, SB11, which is above clean-up level of 105 ug/kg. However, it drops out of the study since it is an isolated point.
 Andale West also drops out since 1,1,1-TCEA is not exceeded.

1, pg 4-16
Table 4-4

Contaminated Soil (ii)		Volume (ft ³)	m ² ft. 10.765 ft ³ /m ²
Property	Area (m ²)		
Electra	41.8	31.50	
Evans	167	12,584	
Keystone	206	15,523	
Andale-East	251	18,914	

Total = 50,171
 ✓ 1858 yd³

(ii) Assume 7' depth for all properties



Owner FPA III
Plant North Penn Area 6 Unit _____
Project No. 21910.008 File No. _____
Title Calculation of Contaminant Volumes
and Soil Volumes

Computed By LKR
Date 5/10 19 94
Checked By GMW
Date 5/20 19 94
Page 2 of 7

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Calculation of AVG. Contaminant Concentrations at Each Site

Estimated average concentrations for the clean-up contaminant of concern are shown on attached pages from RI. Only concentrations exceeding the clean-up levels from Table 4-4 of RI were used in calculating the averages.

Summary Table

Property	PCE (ug/kg)	TCE (ug/kg)
Electra	750	—
Evans	706	—
Keystone	—	29,057
Tate Ardale East	—	1,633

Contaminant Volume for the Feasibility Study is then Estimated as Soil Volume • Contaminant Concentration • Soil Density

Property	Bulk Density (g/ml)	Soil Volume (ft ³)	PCE (g)	TCE (g)
Ref 1 Table 4-2 Pg 4-4 Electra	1.55	3,150	103.7	—
Evans	1.62	12,584	407.6	—
Keystone	1.37	15,523	—	17,500
Tate Ardale East	1.81	18,914	—	1,583

Example Calc for Electra

$$3,150 \text{ ft}^3 \cdot \frac{750 \text{ ug}}{\text{kg}} \cdot \frac{1.55 \text{ g}}{\text{ml}} \cdot \frac{\text{kg}}{1000 \text{ g}} \cdot \frac{\text{ml}}{\text{cm}^3} \cdot \frac{\text{cm}^3}{3.53 \text{ ft}^3} = 103.7 \text{ g}$$

= exceeds 130 ug/kg cleanup level

3/7

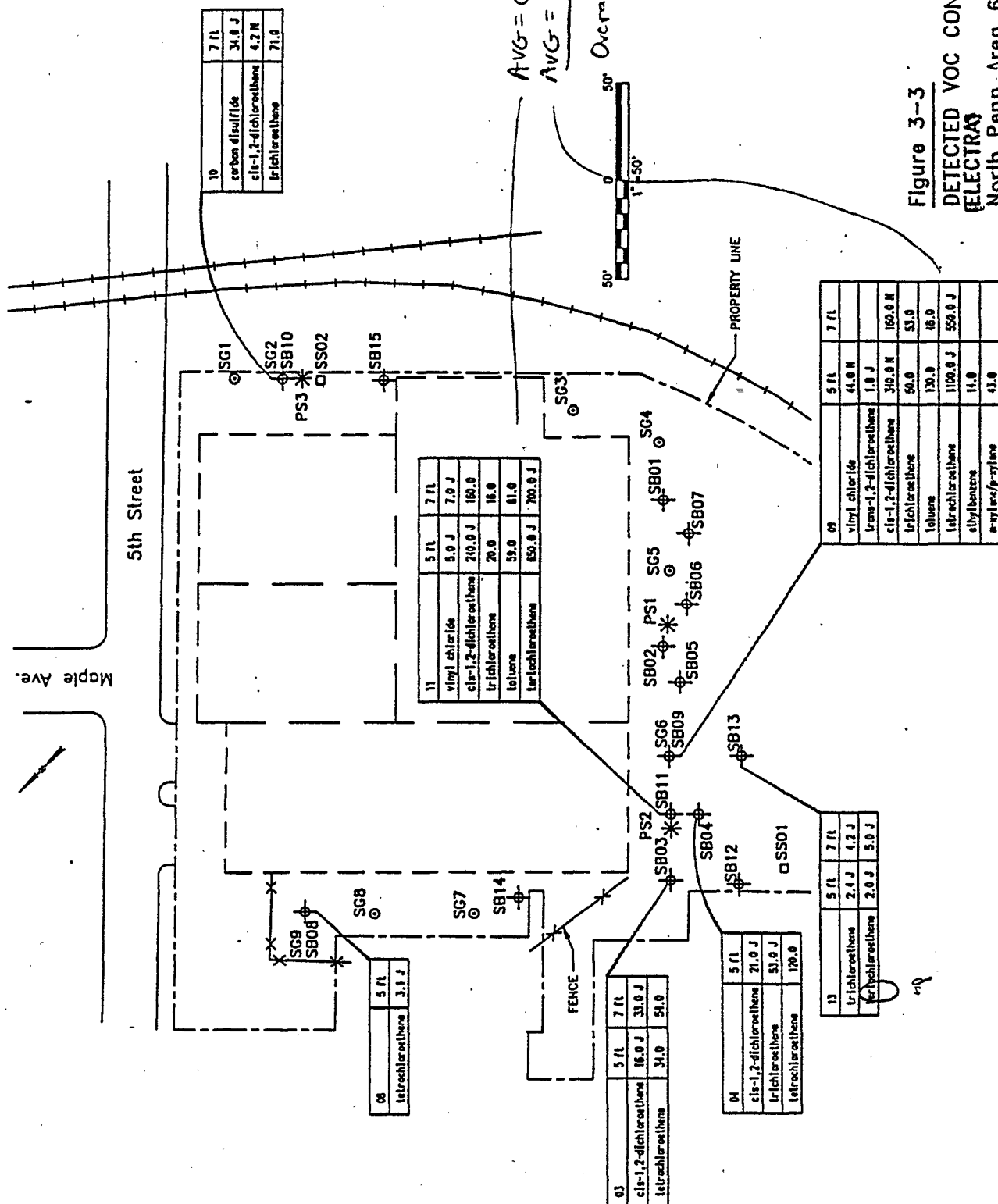
AVG = 675
AVG = 825
Overall AVG = 750 ug/kg
PCE

LEGEND

- Soil boring location
- Soil gas location
- Surface soil sample location
- Undisturbed sample location

Figure 3-3

DETECTED VOC CONTAMINANTS (ug/kg)
(ELECTRA)
North Penn Area 6 Site RI/FS



AR301208

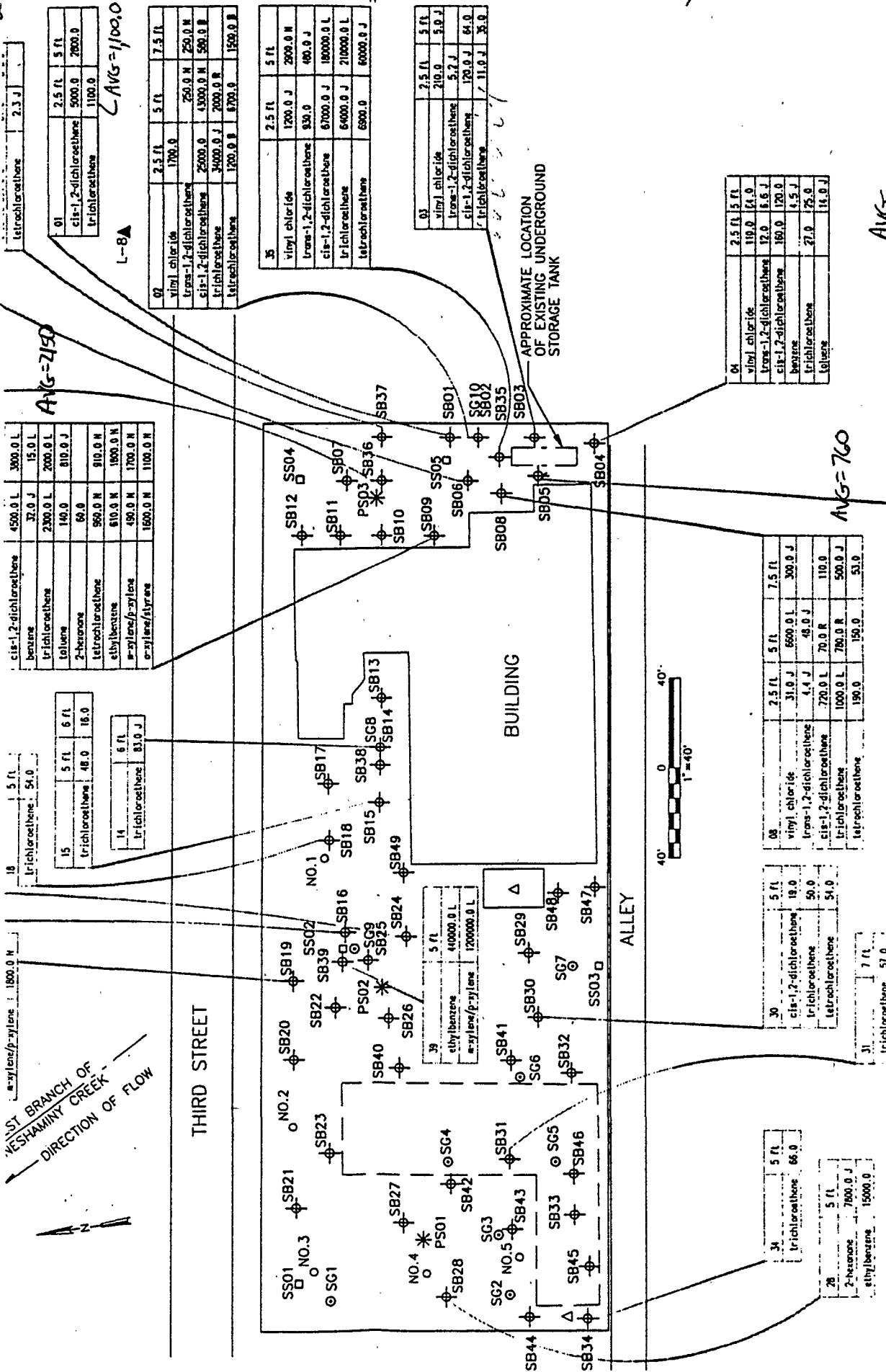
165 ug/kg



1st Cleanup Level = 142 ug/kg 1CE

AVG = 11,000

TCE < Cleanup Level



AVG = 41,000
 SBO6
 SBO1
 SBO9
 SG10/SBO2
 SBO35

AVG = 3388

AVG = 760

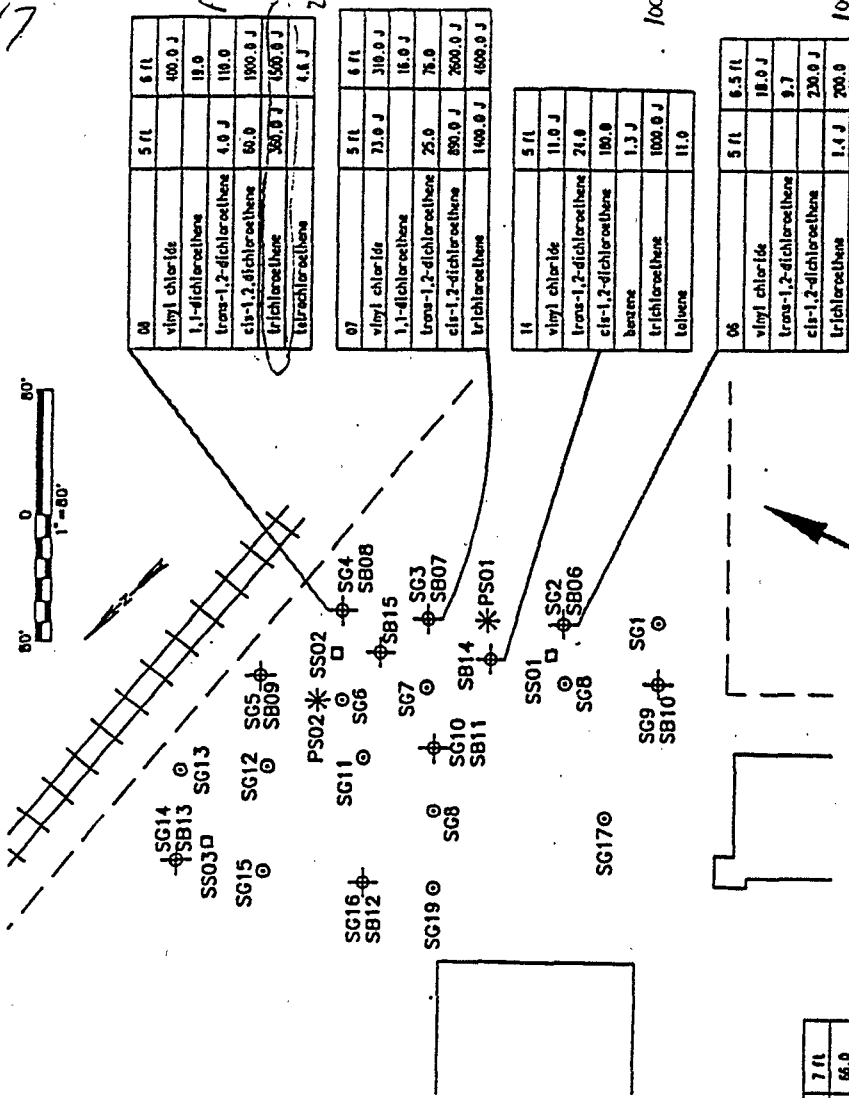
AVG = 29,057

AR301210

Ref Cleanup Level = 65 ug/kg at Andale East
 TLF

per 6/4 s/p/94
 mutate in TL

7/7



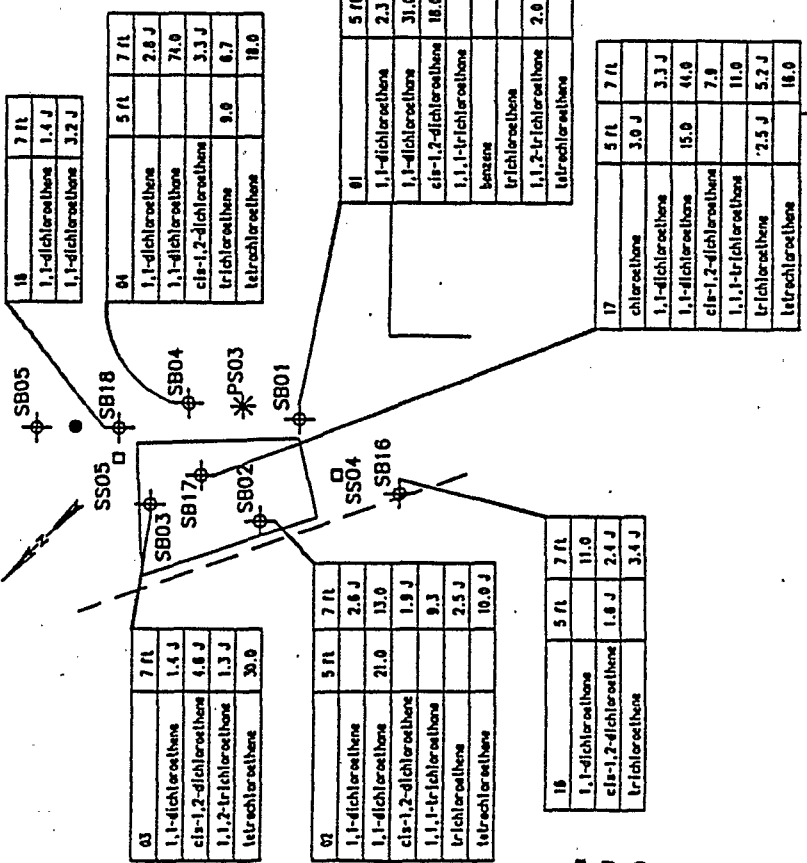
Overall Avg = 1633
 TLF

LEGEND

- Well
- ⊕ Soil boring location
- ⊙ Soil gas location
- Surface soil sample location
- * Undisturbed sample location

Figure 3-7

DETECTED VOC CONTAMINANTS (ug/kg)
 STATE ANDALE
 North Penn Area 6 Site RI/FS



AR301212



Owner FPH III
 Plant North Penn Area 6 Unit _____
 Project No. 21910.008 File No. _____
 Title Calculation of Contaminant Volumes
 and Soil Volumes

Computed By UKR
 Date 5/10 19 94
 Checked By _____
 Date _____ 19 ____
 Page 1 of 7

Purpose: to Calculate the Volume of soil and average contaminant concentration (TCE or PCE) to be treated. Calculation for Feasibility study.

References:

1. Draft Remedial Investigation Report for North Penn Area 6 Site Source Control Operable Unit Block and Veatch Waste Science, Inc., March 31, 1994.

1 pg 4-16 Note: Only Properties which have contaminant
 Table 4-4 concentrations above the cleanup levels are included.
 REP and Andale West are eliminated since clean-
 levels are higher than contaminant levels.

REP has an isolated point, SB 11, which is above
 clean-up level of 105 ug/kg. However, it drops out
 of the study since it is an isolated point.
 Andale West also drops out since 1,1,1-TCEA is
 not exceeded.

1 pg 4-16
Table 4-4

Contaminated Soil (1)		Volume (ft ³)	m ³ ft. 3.2
Property	Area (m ²)		
Electra	41.8	900 X 3.28 = 31.49	
Evans	16.7	3835 X 3.28 = 12,529	
Keystone	206	4,731 X 3.28 = 15,514	
Andale-East	251	5,765 X 3.28 = 18,909	

1858 cu. yd.

(1) Assume 7' depth for all properties.



Owner FPA III
 Plant North Penn Area G Unit _____
 Project No. 21910.008 File No. _____
 Title Calculation of Contaminant Volumes
and Soil Volumes

Computed By LKR
 Date 5/10 19 94
 Checked By _____
 Date _____ 19 _____
 Page 2 of 7

DO NOT WRITE IN THIS SPACE

Calculation of AVG Contaminant Concentrations at Each Site

Estimated average concentrations for the clean-up contaminant of concern are shown on attached pages from R.I. Only concentrations exceeding the clean-up levels from Table 4-4 of R.I. were used in calculating the averages.

Summary Table		
Property	PCE (ug/kg)	TCE (ug/kg)
Electra	750	—
Evans	706	—
Keystone	—	29,057
Tate Ardale East	—	1,633

Contaminant Volume for the Feasibility Study is then Estimated as Soil Volume · Contaminant Concentration · Soil Density

	Property	Bulk Density (g/ml)	Soil Volume (ft ³)	PCE (g)	TCE (g)
Ref 1 Table 4-2 Pg 4-4	Electra	1.55	3149 960	31.6	—
	Evans	1.62	12,519 3835	124.8	—
	Keystone	1.37	15,914 4731	—	5,334
	Tate Ardale East	1.81	18,909 5765	—	483

Example Calc for Electra

$$\begin{aligned}
 & \frac{3149}{960} \text{ ft}^3 \cdot 750 \frac{\text{ug}}{\text{kg}} \cdot 1.55 \frac{\text{g}}{\text{ml}} \cdot \frac{\text{kg}}{1000 \text{ g}} \cdot \frac{1 \text{ ml}}{\text{cc}} \cdot \frac{\text{cc}}{3.53 \times 10^{-5} \text{ ft}^3} \\
 &= 103.1 \frac{\text{kg}}{\text{kg}} \\
 &= 31.6 \text{ g}
 \end{aligned}$$

B&V WASTE SCIENCE AND TECHNOLOGY CORP.

TELEPHONE MEMORANDUM

Client USEPA

BVWST Project 21910

Project NORTH PENN

BVWST File _____

Subject F.S. MONITORING WELL COSTS

Date 6/3/01

Time 2:40 P

To/From: DAVID STOTHOFF

Company: WM. STOTHOFF INC

Phone No.: 708 782 2717

Recorded by: CJ LAVALLEE

SPOKE W/ ~~DAVID STOTH~~^{CJD} STOTHOFF ABOUT INSTALLING 12 WELLS
BASED ON THE FOLLOWING: 4 PROPERTIES, 3 WELLS/PROPERTY,
100 FT DEPTH, 4 INCH DIAMETER, PVC CASING, ^{3 FT SCREEN} AIR ROTARY
DRILLING, AND FRACTURED SHALE BEDROCK, LOCATED IN
MONTGOMERY CO. PA. D.S. GAVE A ROUGH ESTIMATE
OF \$4000 PER WELL. *CJ Lavallee*

cc:

AR301215

FOR HANDWRITTEN MEMORANDA ONLY

B&V WASTE SCIENCE AND TECHNOLOGY CORP.

TELEPHONE MEMORANDUM

Client USEPA

BVWST Project 21910

Project NORTH PENN

BVWST File _____

Subject F.S. MONITOR WELLS COST

Date 6/3/94

Time 2:50 p

To/From: ART TUCKER

Company: ENVIRONMENTAL DRILLING, INC (EDI)

Phone No.: 1800 962 7327

Recorded by: C. LAVALLEE

SPOKE W/ ART TUCKER ABOUT ROUGH COSTS TO INSTALL
12 MONITORING WELLS IN MONTGOMERY CO. PA: ~~4~~ PROPERTIES
3 WELLS EACH, 100 FT DEPTH, 4" DIAMETER, PVC CASING 3 FT
SCREEN, AIR ROTARY DRILLING, FRACTURED SHALE BEDROCK.
A.T. GAVE ME THE FOLLOWING COSTS:

MOBILIZATION: \$750

DRILLING: \$20 / LF

PVC CASING: \$18 / LF

PROTECTIVE CASING: \$250 EACH WELL

DECON. ~~PER~~ HR: \$175 / HR

DEVELOPMENT: \$75 / HR

STAND BY: \$175 / HR

DRUM CUTTINGS: \$50 PER DRUM, ABOUT 5 DRUMS PER WELL

NOTE: SPOKE W/ G. MERGIA - NO DECONING OR DRUMMING CUTTINGS

REQUIRED FOR THESE MONITORING WELLS. *C. Lavallee*

CC:

AR301216

TELEPHONE MEMORANDUM

Client USEPABVWST Project 21910Project NORTH PENN

BVWST File _____

Subject TEMPORARY EQUIPMENTDate 5/25/94DECONTAMINATION FACILITY

Time _____

To/From: GARRET ARAICompany: ARAI ENVIRONMENTALPhone No.: 302 731 7200Recorded by: CJ LAVALLER

SPOKE WITH ^(ASICED) MR ARAI ^(G.A.) ABOUT TEMPORARY EQUIPMENT
 DECONTAMINATION FACILITIES FOR SMALL HAZARDOUS
 WASTE SITES. G.A. STATED HE HAS SEEN PORTABLE
 STEEL DECON PLATFORMS. THEY ARE ABOUT 30 FT X 10 FT
 AND ARE TRANSPORTED BY TRACTOR TRAILER. THE
 SUBGRADE MUST BE GRADED FOR THE PLATFORM TO
 DRAIN TO A SELF CONTAINED SUMP. THEY ARE NOT FOR
 ALL SITES. SMALL SITES WITH RUBBER TIRE EQUIPMENT
 CAN BE MANAGED WITH HEAVY DUTY PLASTIC SHEETING OR
 WATER PROOF TARPS, SUMP PUMP AND DRUMS. MINOR
 GRADING AND STAKES CAN CONTROL THE RINSE WATER.
 THIS COSTS PENNIES COMPARED TO OTHER ALTERNATIVES.

CJ Lavall

cc:

AR301217

TELEPHONE MEMORANDUM

Client USEPA

BVWST Project 21910

Project NORTH PENN

BVWST File _____

Subject F.S. STONE BASE AND

Date 6/6/94

PAVING COST ESTIMATE

Time 10 AM

① From: MR CALLETTI

Company: CALLETTI PAVING

Phone No.: 215 272 0820

Recorded by: CJ LAVALLEE

ASKED FOR ROUGH ESTIMATE FOR MATERIAL AND
INSTALLATION COSTS FOR STONE BASE AND PAVING.
I EXPLAINED THAT THERE ARE FOUR LIGHT INDUSTRIAL
PROPERTIES THAT REQUIRE 6 INCHES OF 2A STONE BASE
AND 3 INCHES ASPHALT SURFACE AT THE NORTH END
OF LANSDALE. AREAS ARE 450 SF, 1800 SF, 2200 SF AND
2700 SF, ASSUME PREVIOUSLY PREPARED SUBGRADE. HE
NOTED THAT EACH PROPERTY LOCATION REQUIRES A
MOBILIZATION COST. HE ESTIMATED TOTAL COSTS TO
BE \$3000 FOR STONE BASE AND \$5000 FOR
ASPHALT PAVING, FOR ALL FOUR SITES. *SL*

cc:

AR301218

B&V WASTE SCIENCE AND TECHNOLOGY CORP.
Philadelphia Office

To: RCRA Hot Line ¹⁻⁸⁰⁰⁻⁴²⁴⁻⁹³⁴⁶ From: Lusheng Yan Date: 7-15/94
Subject: RCRA D Landfills Project #: 21910.008

L. Y. called to check to whether there are any limits for RCRA Subtitle D landfill for contaminated soils. The operator said that Subtitle D receives solid wastes that are not codified as hazardous waste or not characteristic RCRA waste. For trichloroethene, the TCLP limit is 0.5 mg/l and for tetrachloroethene, the limit is 0.7 mg/l. ~~Based on~~ Therefore, for contaminated soils that has ~~TO~~ TCLP results below 0.5 mg/l TCE or 0.7 mg/l PCB, they can be taken to a municipal landfill or Subtitle D.

Land Ban Regulation are for the Codified RCRA wastes.

AR301219



Owner EPR
Plant North Penn Area 6 Site Unit 001
Project No. 21910.008 File No. _____
Title Feasibility Study for Remedial Alternatives
Cost Estimate

Computed By L. Van
Date 7/19 19 94
Checked By [Signature]
Date 07/19 19 94
Page 1 of 2

EXCAVATION & OFFSITE DISPOSAL — ALTERNATIVE 6. — TYPE OF LANDFILL USED.

• PCE or TCE Contaminated Soils:

TCLP limits for characteristic Waste (RCRA)

PCE 0.7 mg/l

TCE 0.5 mg/l

The ratio of
TCLP Procedure normally takes 5 gram of solid sample
mixed with ^{every} 100 ml leaching liquid. which Therefore,
the minimum PCE or TCE concentrations in the contaminated
soils ~~are~~ required to generate TCLP results above the
characteristic hazardous wastes limit is

$$\text{TCLP (mg/l)} \times \frac{100 \text{ ml}}{5 \text{ gram}} \times 1000 \text{ gram/Kg} \times \frac{1}{1000 \text{ ml/l}} \\ = 20 \times \text{TCLP (mg/Kg)}$$

For TCE, the minimum level in soil that can generate
TCLP results greater than 0.5 mg/l is

$$0.5 \text{ mg} \times 20 = 10 \text{ mg/Kg}$$

For PCE, the minimum level in soil that can
generate TCLP results greater than 0.7 mg/l is

$$0.7 \text{ mg} \times 20 = 14 \text{ mg/Kg}$$

Owner EPA

Computed By L. Yan

Plant North River Area 6 Site Unit DUI

Date 7/19 19 94

Project No. 27410-008

File No. _____

Checked By (Signature)

Title Feasibility Study for Remedial Alternatives
Cost Estimate

Date 07/19 19 94

Page 1 of 1

It is expected that any contaminated soils with PCE < 14 mg/kg or TCE < 10 mg/kg should not be RCRA characteristic wastes and therefore can be disposed in a RCRA Subtitle D landfill. Only the soils with PCE > 14 mg/kg or TCE > 10 mg/kg would be considered RCRA characteristic and be disposed of at a RCRA Subtitle C landfill.

DO NOT WRITE IN THIS SPACE

AR301221

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

FOR NORTH FENN*Assumes transporting soil to about 3 miles**KFF 4**2/2***Girma Mergia****B & V Waste Science and Technology****UNIT COSTS****MOBILIZATION/DEMOBILIZATION** \$39,000**EXCAVATION** \$20/CY**TRANSPORTATION***\$8/CY use \$20/cy to include
transport to and from treatment
\$30/CY location and to a landfill
L.y.***BACKFILL**

I trust this meets your needs for the present time. If you have any questions or need further assistance, please call me at (610) 388 - 0721.

Tom McCracken**AR301222**



Drummed soil from contaminated soil

For 4 inch monitoring wells
8 inch hole

$$\text{Soil volume } \pi r^2 h = \pi \times \left(\frac{4}{12}\right)^2 \times h \text{ ft}^3$$

Assume 7 ft soil contamination

$$\text{Volume} = \pi \times \left(\frac{4}{12}\right)^2 \times 7 = 2.44 \text{ ft}^3$$

Add 20% for disturbed soil

$$V = 2.93 \text{ ft}^3 = 21.93 \text{ gallons} \approx 22 \text{ g}$$

For 3 monitoring wells per site

$$3 \times 22 \text{ gallons} = 66 \text{ gallons}$$

To separate and drum soil from each site
assume 2 drums per site.

(REF1)

<u>Costs</u>	<u>4 sites</u>	<u>Individual</u>
Transportation	400 = 400	400 = 400
Disposal	8500 + 4500 = 4000	600 + 405 = 1005
Analytic	4500 = 1600	600 = 600
Total	<u>6020</u>	<u>2005</u>

AR301223

DO NOT WRITE IN THIS SPACE

P-GN-172A



A.C. Schultes, Inc.
 664 S. Evergreen Ave.
 Woodbury, NJ 08096
 24 Hour Service
 (609) 845-5656
 Fax (609) 845-1335

FAX TRANSMITTAL

DATE: July 15, 1994FAX #: (215) 928-1780COMPANY: Black and Veatch Waste Sciences, Inc.ATTENTION: Girma MergiaFROM: Eric FoxCOMMENTS: Quote for monitor well installation at
four (4) sites near Quakertown, PA.

You should receive 4 sheets, including the cover sheet. If you do not receive the amount of sheets indicated, or if the copies are not clear, please telephone the sender at (609) 845-5656. Thank You.



A.C. Schultes, Inc.
664 S. Evergreen Ave.
Woodbury, NJ 08666
24 Hour Service
(609) 845-5656
Fax (609) 845-1335

July 14, 1994

Black and Veatch Waste Sciences, Inc.
Curtis Center
601 Walnut Street
Suite 705
Philadelphia, PA 19106

Attention: Girma Mergia
Engineer/Hydrologist

Reference: Monitor Well Installation at Four Sites Near
Quakertown, PA.
A. C. S. Quote #3967

Dear Sir:

As per your request in the information provided by telephone, A. C. Schultes, Inc. is pleased to provide a price quotation on the above project. A. C. Schultes, Inc. will mobilize necessary men, equipment, and material to perform the following scope of work.

Trained and licensed crew will mobilize to the above site with truck mounted drilling equipment and access each of the four (4) sites. At each site, crew will drill three (3) 2" diameter by approximately 100' deep monitoring wells. Two inch diameter OD split spoon samples are to be taken as directed. Upon completion of sampling, crew will furnish and install approximately 10' of 2" diameter schedule 40 PVC well screen and approximately 90' of 2" diameter schedule 40 PVC well casing in each bore hole grouted and gravel packed in place as per current PA DER specification. Two (2) flush mount man covers and ten (10) steel stickup protective well casings will be grouted in place as required. All downhole and sampling equipment is to be deconned into 55 gallon drums as required between each well location. Each well is to be developed a maximum of one (1) hour each by airlifting. All drill cuttings, spoils, and development fluids are also to be contained in 55 gallon drums at each well site. All work is to be performed in Level D PPE.

Black and Veatch Waste Sciences, Inc.
July 14, 1994
Page 2

Pricing for the above scope of work is as follows:

1. Mobilization/demobilization \$2,000.00
2. Drilling and construction of twelve (12)
2" diameter monitor wells as described above . . \$33,650.00
3. 2" diameter split spoon samples 0-20' depth . . \$24.00 each
4. 2" diameter OD split spoon samples 20-50' . . . \$30.00 each
5. Disposal of drummed drill cuttings,
spoils, and debris \$300.00 per drum
6. Disposal of drummed decon
and development waters \$405.00 per drum
7. Analytical fees for waste stream approval
at TSD facility \$300.00 per waste stream
Times two \$600.00
8. Transportation charge to TSD facility . . \$400.00 per load
Estimation one (1) load
9. Upgrade from Level D to Level C PPE . . . \$120.00/crew day

The following terms and conditions apply to the above project:

1. No applicable sales tax is included.
2. Complete site access for truck mounted drilling and support equipment must be provided.
3. No landscaping, sodding, seeding, blacktop, concrete, or any site restoration of any kind is included.
4. A competent and consistent source of potable water must be provided within 500' of each drilling location. It is our understanding that public water via fire hydrant is available as well as spigot water at the nearby industrial/commercial businesses.
5. Surveying is not included.
6. Air monitoring is not included.

Black and Veatch Waste Sciences, Inc.
July 14, 1994
Page 3

7. The above waste disposal pricing, analytical, etc. is based upon known F listed waste constituents to be in the materials to be disposed of. Certified analytical and/or a completed waste characterization form must be provided prior to proper disposal of these materials. In the event that certified analytical testing is required, this is to be done at a cost of \$2,000 per sample for full TCLP and Recra Waste analysis.

Our terms of payment are net upon presentation. An interest charge of 1.5% per month will be assessed to all unpaid balances in excess of thirty (30) days past due.

We thank you for the opportunity to quote you on this project. If you have any questions pertaining to the above, please do not hesitate to contact this office.

Sincerely,

A. C. SCHULTES, INC.

Eric N. Fox/wp

Eric N. Fox
Technical Sales Representative

ENF/wp

BLACK & VEATCH Waste Science, Inc.

TELEPHONE MEMORANDUM

Client EPA III

BVWS Project 21910

Project NORTH PENN Area 6

BVWS File 008

Subject Drummed soil during well
drilling (cost) for disposal

Date 7/13/94

Time 8:05

To/From: John O'Brien

Company: A.C. Shutes

Phone No.: 609 - 845 - 5656

Recorded by: Girma Mergia

a) Transportation \$ 600 load
per load 45 to 50 drum
5 gallon

8 inch hole for 4 inch well
~ 1/2 drum for 1 well

b) Disposal ~ \$ 250 per drum.

c) Analytic fee -

d) Load verification ~ \$ 100.00 per Load

For Exact cost call 215-822-2676

Lou O'Brien with Republic Environmental

Contaminated soil (the first 7 feet) will be
separated and drummed.

CC:

AR301228

TELEPHONE MEMORANDUM

Client USEPA
 Project NORTH PENN
 Subject F.S. STABILIZATION OF CONTAMINATED
SOIL

BVWST Project 21910
 BVWST File _____
 Date 5/31/94
 Time 330

To/From: GEORGE BERK
 Company: HAYWARD BAKER, INC.
 Phone No.: 410 551 1995
 Recorded by: CJ LAVALLÉE

I SPOKE WITH GEORGE BERK CONCERNING CHEMICAL STABILIZATION OF CONTAMINATED SOIL THROUGH CEMENT SOLIDIFICATION. I GAVE HIM THE APPROXIMATE SOIL QUANTITY (1880 cy) AND PCB AND TCE CONTAMINATION LEVELS. G.B. STATED THAT THESE CHEMICALS ARE HIGHLY VOLATILE AND CEMENT SOLIDIFICATION WOULD NOT ADEQUATELY STABILIZE THE MATERIAL FOR MUNICIPAL DISPOSAL. HE WAS NOT AWARE OF A SUITABLE REAGENT, BUT THAT ITS COSTS WOULD BE PROHIBITIVE. IT WOULD MOST LIKELY GO TO A HAZARDOUS WASTE FACILITY. HE STATED THAT STABILIZATION FOR THE CHEMICALS IS NOT A GOOD ALTERNATIVE BECAUSE THERE ARE OTHER MORE EFFECTIVE ~~AND~~ @ ALTERNATIVES SUCH AS VAPOR EXTRACTION, OR PUG MILL TREATMENT / AIR MIXING TO VOLATILIZE THE CHEMICALS. HE ALSO RECOMMENDED OFFSITE TREATMENT TO MINIMIZE RESIDENTAL DISTURBANCE AND MORE EFFECTIVE TREATMENT CONSIDERING THE TOTAL SOIL VOLUME. *(JL)*

cc:

AR301229

TELEPHONE MEMORANDUM

Client USEPA
Project NORTH PENN
Subject F.S. STABILIZATION OF CONTAMINATED
SOIL

BVWST Project 21910
BVWST File _____
Date 5/31/94
Time 200

To/From: ROB LAROSE
Company: GEO-CON
Phone No.: 1 609 848 2220
Recorded by: CJ LAMALLE

- ① I SPOKE WITH R. LAROSE CONCERNING CHEMICAL STABILIZATION OF CONTAMINATED SOIL THROUGH CEMENT SOLIDIFICATION. I GAVE HIM THE APPROXIMATE VOLUME OF 1880 CY, AND PCE ~~CONCENTRATIONS~~ LEVELS (750 AND 706 $\mu\text{g}/\text{kg}$) and TCE LEVELS (29,057 and 1,633 $\mu\text{g}/\text{kg}$). R.L. ~~STATED THAT~~ THE STABILIZED SOIL WOULD THEN GO TO A MUNICIPAL LANDFILL. R.L. STATED THAT A MUNICIPAL LANDFILL MAY NOT ACCEPT THE STABILIZED MATERIAL UNLESS IT WAS STABILIZED TO NON DETECTABLE LIMITS. HE DESCRIBED THE BASIC PROCESS TO ME: EXCAVATE SOIL, CONVEY TO PUG MILL, MIX WITH DRY CEMENT OR CEMENT GROUT, CONVEY TO STORAGE AREA FOR STABILIZATION, LOAD FOR TRANSPORTATION. THE DRAWBACKS INCLUDE DUST CREATION AND VOC'S FROM MIXING AND STOCKPILING. THE SECRET TO STABILIZATION IS THE CHEMISTRY FOR PASSING TCLP. HE'LL GIVE ME COSTS FOR PROCESSES, TREATABILITY STUDY, AND EXCAVATION.
- ② 5/31 4:00 CALLED R. LAROSE BACK AFTER CONVERSATION WITH GEORGE BERK AT HAYWARD BAKER. R. LAROSE CONFIRMED THAT A CEMENT REAGENT WOULD NOT BE ADEQUATE FOR THIS MATERIAL TO BE ACCEPTABLE FOR MUNICIPAL DISPOSAL AND THAT MUNICIPAL FACILITIES MAY NOT ACCEPT IT UNDER ANY CONDITIONS. I ASKED HIM TO DISCONTINUE HIS COST ESTIMATE

cc:

AR301230

TELEPHONE MEMORANDUM

Client USEPABVWST Project 20910Project NORTH PENN

BVWST File _____

Subject F.S. SOIL STABILIZATION COSTSDate 5/31 5/24/94Time 510To/From: MIKE SIMONSCompany: WASTE CONVERSION INCPhone No.: 215 822 2676Recorded by: CJ LAVALL

- ① I SPOKE WITH M. SIMONS ABOUT ^{ONSITE} ~~SOIL~~ STABILIZATION OF CONTAMINATED SOILS, FOR 4 LOCATIONS IN MONTGOMERY CO. I GAVE HIM VOLUMES FOR EACH SITE (3,150 cf, 12,580 cf, 15,515 cf, AND 18,910 cf) AND CONTAMINATION LEVELS. HE REQUESTED A FAX OF THE INFORMATION. HE'LL HAVE A SALES REPRESENTATIVE CONTACT ME FOR THE ESTIMATE NEXT WEEK. I SENT FAX (ATTACHED) WITH REQUESTED INFORMATION INCLUDING ESTIMATE, EQUIPMENT, GAS/OIL, CEMENT, WATER, PRODUCTION RATE, DURATION TO STABILIZATION.
- ② 5/31 4:20 PM - CALLED M. SIMONS AND ASKED HIM IF THE CEMENT REAGENT IS ADEQUATE TO PASS TCLP FOR MUNICIPAL DISPOSAL. HE'LL CONFER WITH HIS ENGINEER AND INFORM US OF THEIR ASSESSMENT.
- ③ 6/9/94 No one has returned call. *CJL*

cc: _____

AR301231

FOR HANDWRITTEN MEMORANDA ONLY



BLACK & VEATCH Waste Science, Inc.

The Curtis Center, Suite 705, 601 Walnut Street, Philadelphia, Pennsylvania 19106-3307, (215) 928-0700, Fax: (215) 928-1780

FAX
TRANSMITTAL SHEET

of Pages Including Cover Sheet 2

DATE: 5/26 PROJECT #: 21910.007

TIME: 530 FAX #: 215 997 1315

TO: MIKE SIMONS

FROM: CHRISTIAN LAVALLEE

COMMENTS: _____

If you do not receive all pages, please call (215) 928-0700 as soon as possible.

AR301232



Owner _____

Computed By C. LAVALLEE

Plant _____ Unit _____

Date 5/26 19 94

Project No. _____ File No. _____

Checked By _____

Title _____

Date _____ 19 _____

Page 1 of 1

TO: MIKE SIMONS, WASTE CONVERSION, INC.

FROM: CHRISTIAN LAVALLÉE, BLACK & VEATCH Waste Science

RE: Request estimate for FEASIBILITY STUDY REPORT
On-site Solidification of Soils
PCE & TCE CONTAMINATION

FOUR LOCATIONS IN MONTGOMERY CO.

<u>SITE</u>	<u>QUANTITY</u>	<u>PCE ug/kg</u>	<u>TCE ug/kg</u>
A.	3200 CF	750.	—
B.	12,800 CF	706	—
C.	15,700 CF	—	29,05
D.	19,100 CF	—	1,633

PLEASE GIVE AS MUCH DETAIL AS POSSIBLE:

EQUIPMENT

GAS / OIL

MAN POWER

CEMENT

WATER

PRODUCTION RATE

DURATION FOR STABILIZATION

NOTE: THIS A BALLPARK ESTIMATE FOR A
FEASIBILITY REPORT.

DO NOT WRITE IN THIS SPACE

AR301233

Appendix H
Cost Calculations and Assumptions
Alternative 2 Cap Containment

AR301234

Owner USEPA
 Plant NORTH PENN
 Project No. 21910 File No. _____
 Title F.S. CAP ALT.

Computed By CJLAVALLIE
 Date 6/3 19 94
 Checked By GM
 Date 6/22 19 94
 Page 1 of 12

NORTH PENN AREA 6

FEASIBILITY STUDY - COST SUMMARY MULTIMEDIA CAP ALTERNATIVE

REFS

THE CAP CROSS SECTION FROM TOP TO BOTTOM CONSISTS OF:

- A. GEOCOMPOSITE CLAY LINER
- B. 60 MIL HDPE GEOMEMBRANE
- C. GEONET DRAINAGE LAYER
- D. 16 OZ/SY NONWOVEN GEOTEXTILE
- E. CRUSHED STONE AGGREGATE BASE
- F. 3 INCHES ASPHALT SURFACING

1.

CAP COSTS ARE CALCULATED FOR FOUR SITES: ELECTRA (450 SF), EVANS (1797 SF), KEYSTONE (2216 SF), AND ANDALE EAST (2700 SF).
 TOTAL AREA = 7163 SF.

THREE GEOSYNTHETIC SUPPLIERS/INSTALLERS WERE CONTACTED FOR MATERIAL AND INSTALLATION UNIT COSTS. ALL THREE NOTED THAT MOBILIZATION COST ARE HIGH BECAUSE OF THE DISTANCE BETWEEN CAP AREAS.

MONITORING WELL INSTALLATION AND O&M COSTS ARE INCLUDED, AS IS MINOR EXCAVATION, TRANSPORT, TREATMENT, AND DISPOSAL OF CONTAMINATED SOIL.

1. GEOCOMPOSITE CLAY LINER (GCL)

	<u>MATERIAL COST</u>	<u>INSTALLATION COST</u>
2.	\$ 0.55 /sf	\$ 0.50 /sf
3.	\$ 1.00 /sf	\$ 1.00 /sf
4.	\$ 0.50 /sf	\$ 1,000 LUMP SUM PER LOCATION

$$\text{AVERAGE MATERIAL COST} = [(0.55_{\text{sf}} + 0.50_{\text{sf}} + 1.00_{\text{sf}}) \div 3] \times 7163_{\text{sf}}$$

$$= \$ 4,895$$

Owner USEPA
 Plant NORTH PENN Unit _____
 Project No. 21910 File No. _____
 Title F.S. CLP COST SUMMARY

Computed By CJ LALLER
 Date 6/3 19 94
 Checked By GM
 Date 6/22 19 94
 Page 2 of 1

AVERAGE INSTALLATION COST :

$$\text{TOTAL LUMP SUM INSTALLATION} = \$1,000 (4) \\ = \$4,000$$

$$\text{AVE. COST} = [(\$0.50_{/sf} + \$1.00_{/sf}) \cdot 7163_{sf} + \$4,000] \div 3 \\ = \$4,915$$

$$\text{TOTAL GCL COST} = \text{MATERIAL} + \text{INSTALLATION} \\ = \$4,895 + \$4,915 = \$9,810$$

$$\boxed{\text{GCL COST} = \$9,810}$$

2. 60 MIL HDPE GEOMEMBRANE

NOTE: COSTS WERE OBTAINED FOR BOTH HDPE AND PVC LINERS. HDPE IS MORE EXPENSIVE AND IS THE MORE CONSERVATIVE COST FOR THIS SUMMARY. PVC IS LESS EXPENSIVE BECAUSE IT CAN BE MANUFACTURED TO SIZE AND EASILY INSTALLED.

	MATERIAL UNIT COST	INSTALLATION UNIT COST
2.	\$ 0.22 _{/sf}	\$ 0.40 _{/sf}
3.	\$ 1.00 _{/sf}	\$ 1.00 _{/sf}
4.	\$ 0.30 _{/sf}	\$1,200 LS PER LOCATION

$$\text{AVERAGE MATERIAL COST} = [(0.22_{/sf} + 1.00_{/sf} + 0.30_{/sf}) \times 7163_{sf}] \div 3 \\ = \$3,629$$

DO NOT WRITE IN THIS SPACE



Owner USEPA Computed By ZJLAVALLEE
Plant NOTHPPANN Date 6/3 1994
Project No. 21910 File No. _____
Title F.S. CAP ALTERNATIVE Checked By GM
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AVERAGE INSTALLATION COST:

$$\text{LUMP SUM INSTALLATION: } \$1200(4) = \$4800$$

$$\begin{aligned}\text{AVE. COST} &= [(\$0.40_{/sf} + \$1.00_{/sf}) 7163_{sf} + \$4800] \div 3 \\ &= \$4943\end{aligned}$$

$$\text{TOTAL HDPE COST} = \$3629 + \$4943 = \$8572$$

$$\boxed{\text{HDPE COST} = \$8572}$$

3. GEONET DRAINAGE LAYER

<u>MATERIAL</u> <u>UNIT COST</u>	<u>INSTALLATION</u> <u>UNIT COST</u>
\$ 0.20 _{/sf}	\$ 0.20 _{/sf}
\$ 0.25 _{/sf}	\$ 0.25 _{/sf}
\$ 0.15 _{/sf}	\$1000 LS PER LOCATION

$$\begin{aligned}\text{AVERAGE MATERIAL COST} &= [(\$0.20_{/sf} + \$0.25_{/sf} + \$0.15_{/sf}) 7163_{sf}] / 3 \\ &= \$1433\end{aligned}$$

AVERAGE INSTALLATION COST:

$$\text{LUMP SUM COST} = \$1000(4) = \$4000$$

$$\begin{aligned}\text{AVER. COST} &= [(\$0.20_{/sf} + \$0.25_{/sf}) 7163 + \$4000] / 3 \\ &= \$2408\end{aligned}$$

$$\text{TOTAL GEONET COST} = \$1433 + 2408 = \$3841$$

$$\boxed{\text{GEONET COST} = \$3841}$$

Owner USEPAComputed By CU LAYALLERPlant NORTH PENN AREA 6 Unit _____Date 6/3 19 94Project No. 21910

File No. _____

Checked By G.M.Title FS CAP COST SUMMARYDate 6/22 19 94Page 4 of 44. 16 OZ/SY NONWOVEN GEOTEXTILE

	MATERIAL UNIT COST	INSTALLATION UNIT COST
2.	\$ 0.14/sf	\$ 0.20/sf
3.	\$ 0.22/sf	\$ 0.06/sf
4.	\$ 0.20/sf	\$ 1000 LS PER LOCATION

$$\text{AVE MATERIAL COST} = [(0.14_{\text{sf}} + 0.22_{\text{sf}} + 0.20_{\text{sf}}) \cdot 7163 \text{ sf}] / 3$$

$$= \$ 1337$$

$$\text{AVE. INSTALLATION COST} = [(\$0.20_{\text{sf}} + \$0.06_{\text{sf}}) \cdot 7163 + 1000(4)] / 3$$

$$= \$ 1954$$

$$\text{TOTAL GEOTEXTILE COST} = \$ 1337 + \$ 1954 = \$ 3291$$

$$\boxed{\text{GEOTEXTILE COST} = \$ 3291}$$

5. CRUSHED STONE BASEUNIT COST

5.	6 INCH BASE - MATERIAL AND INSTALLATION INCLUDING SEPERATE MOBILIZATIONS	\$ 3.80/sy
6.	6 INCH BASE - MATERIAL AND INSTALLATION (MEANS 1993: 022-308-0302 PG 44)	\$ 4.95/sy

$$\text{AVERAGE MATL \& INSTALL. UNIT COST} = [\$3.80_{\text{sy}} + \$4.95_{\text{sy}}] / 2$$

$$= \$ 4.38_{\text{sy}}$$

DO NOT WRITE IN THIS SPACE

AR301238

Owner USEPA Computed By CJ LAVELLE
 Plant N. PENN Date 6/6 19 94
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 Title F.S. LRP COST SUMMARY Checked By Grm
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TOTAL COST FOR 6" CRUSHED STONE BASE CONSTRUCTION

$$\text{AREA} = [450_{sf} + 1797_{sf} + 2216_{sf} + 2700_{sf}] \frac{sy}{9sf}$$

$$= 796 sy$$

$$\text{COST} = 796 sy \left(\$4.38/sy \right) = \$3486$$

CRUSHED STONE BASE COST = \$3486

6. 3 INCHES ASPHALT SURFACING

5. 3" ASPHALT SURFACING UNIT COST = \$6.30/sy
 INCLUDING SEPARATE MOBILIZATIONS

6. *4" ASPHALT SURFACING UNIT COST = \$7.60/sy
 (MEANS 1993: 022-308-0500 PG 44)

* DIFFERENCES IN THICKNESS FOR UNIT COST
 CONSIDERED MINOR FOR THIS COST SUMMARY

$$\text{AVERAGE UNIT COST} = \left[\$6.30/sy + \$7.60/sy \right] / 2$$

$$= \$6.95/sy$$

$$\text{TOTAL COST FOR ASPHALT PAVING} = 796 sy \left(\$6.95/sy \right)$$

$$= \$5532$$

ASPHAL PAVING COST = \$5530

Owner USEPA
 Plant N. PENN Unit _____
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 Title F.S. CAP COST SUMMARY

Computed By CJ VALUERE
 Date 6/6 19 94
 Checked By G.M.
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7. EXCAVATION, TRANSPORT, TREATMENT AND DISPOSAL

THE CAP ALTERNATIVE MAY REQUIRE 1 FOOT EXCAVATION TO MAINTAIN EXISTING GRADE AS THE CAP'S FINAL GRADE. THE EXCAVATED MATERIAL IS CONSIDERED CONTAMINATED AND MUST BE TRANSPORTED TO, TREATED, AND DISPOSED IN A HAZARDOUS WASTE FACILITY.

a) EXCAVATION

$$\begin{aligned}\text{SOIL VOLUME} &= [450\text{sf} + 1797\text{sf} + 2216\text{sf} + 2700\text{sf}] \text{ 1 FT} \\ &= 7163 \text{ CF} \\ &= 265.3 \text{ cy}\end{aligned}$$

11.
pg 1 of

ESTIMATED PRODUCTION RATE OF 125 CY/DAY INDICATES EACH SITE WILL TAKE ONE DAY TO EXCAVATE.

12.

USE
\$20/cy

For Excavation from
Vendors quote

$$\begin{aligned}&\$20 \times 265.3 \\ &= \$5306\end{aligned}$$

$$\text{ESTIMATED EXCAVATION COST} = \$4,000 / \text{DAY}$$

$$\text{EXCAVATION COST} = \$4000 / \text{DAY} (4 \text{ DAYS})$$

$$\text{COST FOR EXCAVATION} = \$16,000$$

MOBILIZATION COSTS ARE ASSUMED TO BE THE SAME AS FOR THE EXCAVATION ALTERNATIVE.

12.

$$\begin{aligned}\text{ESTIMATED COST OF MOBILIZATION AND} \\ \text{MISCELLANEOUS COSTS} &= \cancel{\$150,000}\end{aligned}$$

$$\$39,000 \text{ Ly.}$$

$$\begin{aligned}\text{TOTAL ESTIMATED COST} &= \text{MOBILIZATION} + \text{EXCAVATION} \\ &= \$39,000 + \$5,306 \\ &= \cancel{\$150,000} + \$16,000 \text{ Ly.}\end{aligned}$$

$$\boxed{\text{TOTAL EXCAVATION COST} = \$166,000} \leftarrow \$44,300 \text{ Ly.}$$

b) TREATABILITY STUDY

12

$$\text{ESTIMATED COST} = \$600 / \text{SITE} \times 4 \text{ SITES}$$

$$\boxed{\text{TREATABILITY STUDY COST} = \$2,400}$$

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Owner USEPA Computed By C J LAVALLER
 Plant N. PENN Date 6/9 19 94
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 Title F.S. CAP SUMMARY Date 6/22 19 94
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C.) TRANSPORTATION, TREATMENT, AND DISPOSAL (TT&D)

12

ESTIMATED TRANSPORT, TREAT, DISPOSE COST = \$450/TON

13.

ESTIMATED TRANSPORT, TREAT, DISPOSE COST = \$450, TON

AVERAGE COST = \$450/TON

APPROXIMATE WEIGHT OF EXCAVATED SOIL:

ASSUME CONSERVATIVE SOIL DENSITY = 125 lbs/cf

WEIGHT = $7163 \text{ cf} \left(\frac{125 \text{ lbs}}{\text{cf}} \right) = 895,375 \text{ lbs}$

= 448 TONS

TT&D COST = 448 TONS (\$450/TON) \$79,320 + trans.

TRANSPORT, ~~TREATMENT AND~~ DISPOSAL COST = \$201,600

Modify Based on: (1) Keystone Hydraulics to a hazardous landfill at \$450/ton

(2) Other 3 properties soils go to RCRA D landfill @ \$55/ton

L. y.

C. J. Lavaller 6/9/94

Owner USEPA
 Plant NORTH PENN Unit _____
 Project No. 21910 File No. _____
 Title FS CAP COST SUMMARY

Computed By CJLAVALLEE
 Date 6/6 19 94
 Checked By GIM
 Date 6/12 19 94
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B. MONITORING WELL INSTALLATION

THREE MONITORING WELLS WILL BE INSTALLED FOR EACH CAPPED PROPERTY.

MONITORING WELL ASSUMPTIONS:

100 FT AVERAGE DEPTH

4 INCH DIAMETER

PVC CASING

3 FT OF SCREEN

AIR ROTARY DRILLING

CUTTING ~~DO NOT~~ NEED TO BE DRUMMED OR DISPOSED
 \$6,020 lump sum ly

7. UNIT COST FOR MATERIAL & INSTALLATION = \$4,000

8. UNIT COST FOR MATERIAL & INSTALLATION = \$4,190/WELL

$$\text{AVERAGE UNIT COST} = [\$4,000 + \$4,190] / 2$$

$$= \$4,095/\text{WELL}$$

$$\text{TOTAL COST FOR WELL INSTALLATION} = \$4,095/\text{WELL} (12 \text{ WELLS})$$

$$= \$49,140$$

$$\boxed{\text{MONITORING WELL COST} = \$49,100}$$

DO NOT WRITE IN THIS SPACE

DO NOT WRITE

AR301242

Owner USEPA Computed By CJ CAVALIERE
 Plant NORTH PENNA Date 6/6 1994
 Project No. 21910 File No. _____
 Title F.S. CAP COST SUMMARY Checked By GM
 Date 6/22 19 94
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9. OPERATION AND MAINTENANCE COST

O&M COSTS FOR THE CAP ALTERNATIVE INCLUDE ASPHALT SURFACE MAINTENANCE, AND MONITORING WELL SAMPLING AND ANALYSIS.

a) ASPHALT SURFACE MAINTENANCE

ASSUME: • EMULSION SURFACE TREATMENT ONCE A YEAR
 • ASPHALT CRACK REPAIRS ONCE EVERY 5 YEARS

6. SURFACE TREATMENT UNIT COST = \$1.08/sy
 (MEANS 1993: 025-458-0100, pg 64)

TOTAL SURFACE TREATMENT COST = \$1.08/sy (796 sy) = \$860

YEARLY SURFACE TREATMENT COST = \$860 / YEAR

6. ASPHALT CRACK REPAIR UNIT COST = \$4.82/sy
 (MEANS 1993: 025-458-3200, pg 64)

TOTAL SURFACE TREATMENT COST = \$4.82/sy (796 sy)
 = \$3837

ASPHALT CRACK REPAIR = \$3840 / EVENT

b) PRESENT WORTH ANALYSIS

9. DISCOUNT RATE = i = 5% AFTER INFLATION & BEFORE TAXES.
 PG 6-12

TO DETERMINE PRESENT WORTH THE CRACK REPAIR COSTS MUST BE ANNUALIZED AND ADDED TO THE ANNUAL SURFACE TREATMENT. THIS ANNUAL COST FOR BOTH REPAIRS CAN THEN BE CALCULATED FOR PRESENT WORTH.



Owner USEPA
 Plant NORTH PLAIN Unit _____
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Computed By C J VALLE
 Date 6/6 19 94
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10.

$$A = F (A/F, i\%, n) \quad F = \text{CRACK REPAIR COST} \quad i = 5\% \quad n = 5$$

$$A = \$3840 (0.1810) = \$695/\text{YEAR FOR CRACK REPAIR}$$

ADD ANNUALIZED COSTS AND CALCULATE PRESENT WORTH

$$A = \text{SURFACE TREATMENT} + \text{CRACK REPAIR} =$$

$$= \$860 + \$695 = \$1550/\text{YEAR}$$

10.

$$P = A (P/A, i\%, n) \quad i = 5\% \quad n = 30$$

$$= \$1550 (15.3725) = \$23904$$

PRESENT WORTH FOR ASPHALT MAINT. = \$23,900

c.) MONITORING WELL SAMPLING AND ANALYSIS

ASSUME SAMPLING AND ANALYSIS:

- QUARTERLY: YEARS 1-10
- SEMI ANNUAL: YEARS 11-20
- ANNUAL: YEARS 21-30

SAMPLING COST: PER EVENT = \$2600

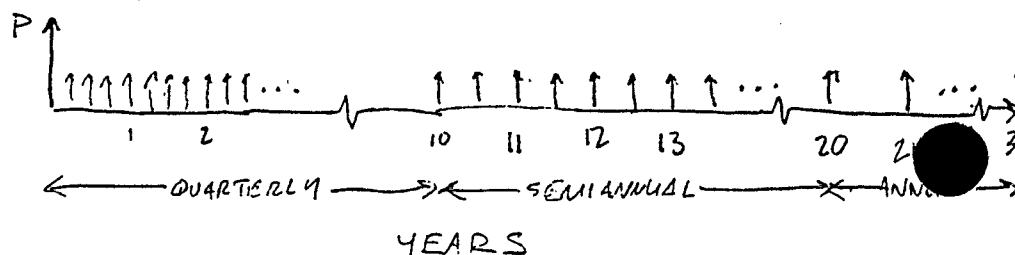
ANALYSIS COST PER EVENT = \$2100

TOTAL COST SAMPLING & ANALYSIS = \$4700/EVENT

d.) PRESENT WORTH ANALYSIS

THIRTY YEARS OF ANNUAL COSTS SHOULD BE ANALYZED FOR THE PRESENT WORTH VALUE.

COSTS ARE QUARTERLY FOR 10 YEARS, SEMI ANNUAL FOR 10 YEARS AND ANNUAL FOR 10 YEARS



Owner USEPA Computed By CJ LAMALLEE
 Plant NORTH PENN Date 6/6 19 94
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 Title F.S. CAP COST SUMMARY Date 6-1-94 19 94
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9.

PG 6-12

DISCOUNT RATE = $i = 5\%$ AFTER INFLATION AND BEFORE TAXES

FOR SIMPLIFICATION THE DISCOUNT ^{RATE} WILL NOT BE SUBDIVIDED FOR QUARTERLY OR SEMI ANNUAL COSTS; THEREFORE THESE COSTS ARE ASSUMED TO BE CHARGED ONCE A YEAR (i.e. COSTS FOR YEARS 1-10 ARE CONSIDERED TO BE \$4700 (4) = \$18,800/YEAR) THIS IS A CONSERVATIVE ASSUMPTION WITH REGARD TO PRESENT WORTH.

PRESENT WORTH YEARS 1-10 $i = 5\%$ $n = 10$ $A = \$18,800$

$$P = A \left(\frac{P}{A}, i\%, n \right) = \$18,800 (7.7217) = \$145,168$$

10.

PG 2-19, 27

PRESENT WORTH YEARS 11-20 $i = 5\%$ $n = 10$ $A = \$4700(2) = \$9400$

10.

PG 2-19, 27

$$P_0 = \left[A \left(\frac{P}{A}, i\%, n \right) \right] \left(\frac{P_0}{P_{10}}, i\%, n \right) \quad \text{where } P_{10} = \text{Value at Year 10, } P/P_{10} = P/F$$

$$= [9,400 (7.7217)] (0.6139)$$

$$= \$44,559$$

PRESENT WORTH YEARS 21-30 $i = 5\%$ $n = 10$ $A = \$4700$

10.

PG 2-19, 27

$$P_0 = \left[A \left(\frac{P}{A}, i\%, n \right) \right] \left(\frac{P_0}{P_{20}}, i\%, n \right) \quad \text{where } P_{20} = \text{Value @ Year 20, } P/P_{20} = P/F$$

$$= [\$4700 (7.7217)] (.3769)$$

$$= \$13,678$$

$$\text{TOTAL PRESENT WORTH} = \$145,168 + \$44,559 + \$13,678$$

$$= \$203,405$$

PRESENT WORTH OF SAMPLING AND ANALYSIS = \$203,000



Owner USEPA
Plant N. PENN Unit _____
Project No. 21910 File No. _____
Title E.S. CAP COST SUMMARY

Computed By C. J. LAVALLEE
Date 6/8 1994
Checked By GM
Date 6/22 1994
Page 12 of 12

REFERENCES

1. NORTH PENN AREA 6 REMEDIAL INVESTIGATION, BLACK & VEATCH WASTE SCIENCE, 3/31/94, PAGE 4-16, TABLE 4-4.
2. TELEPHONE MEMORANDUM OF CONVERSATION BETWEEN C. SCHMIDT OF HALLATON, INC AND C. LAVALLEE OF BVWS, 5/26/94, 2:15 PM
3. TELEPHONE MEMO BETWEEN M. RAMSDEN OF ENVIRONMENTAL GEOSYNTHETICS, INC AND C. LAVALLEE OF BVWS, 5/26/94, 4:00 PM
4. TELEPHONE MEMO BETWEEN J. HARTWELL OF THE LINER CO. INC. AND C. LAVALLEE OF BVWS, 5/26/94, 4:30 PM.
5. TELEPHONE MEMO BETWEEN MR CALETTI OF CALETTI PAVING AND C. LAVALLEE OF BVWS, 6/16/94, 10:00 AM
6. MEANS SITE WORK & LANDSCAPE COST DATA 1993, R.S. MEANS COMPANY, INC., EDITION 12, 1992.
7. TELEPHONE MEMO BETWEEN D. STOTHOFF OF WM. STOTHOFF, INC AND C. LAVALLEE OF BVWS, 6/3/94, 2:40 PM.
8. TELEPHONE MEMO BETWEEN A. TUCKER OF ENVIRONMENT DRILLING, INC AND C. LAVALLEE OF BVWS, 6/3/94, 2:50 PM
9. GUIDANCE FOR CONDUCTING REMEDIAL INVESTIGATIONS AND FEASIBILITY STUDIES UNDER CERCLA, INTERIM FINAL, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, EPA 7540/1-G-89/004, OCTOBER 1988.
10. CIVIL ENGINEERING REFERENCE MANUAL, M. LINDBERG P.E., PROFESSIONAL PUBLICATIONS, 6TH EDITION, 1992.
11. COST SUMMARY FOR NORTH PENN AREA 6 FEASIBILITY STUDY, EXCAVATION TREATMENT AND DISPOSAL ALTERNATIVE, CHRISTIAN LAVALLEE, BVWS, 6/8/94.
12. TELEPHONE MEMO BETWEEN L. O'BRIEN OF REPUBLIC ENVIRONMENTAL SYSTEMS AND C. J. LAVALLEE OF BVWS, 5/31/94, 11:25 AM.
13. TELEPHONE MEMO BETWEEN R. LEWIS OF GLOBAL SPILL MANAGEMENT ENVIRONMENTAL AND C. J. LAVALLEE OF BVWS 5/26/94, 5:00 PM

DO NOT WRITE IN THIS SPACE

TELEPHONE MEMORANDUM

Client EPA
 Project N. PENN
 Subject F.S. COST OPINION - CAPPING

BVWST Project 21910
 BVWST File _____
 Date 5/26/94
 Time 2:15 p

TO/From: CHRIS SCHMIDT
 Company: HALLATON, INC (GEOTEL)
 Phone No.: 410 583 7701
 Recorded by: CJ LAVALLEE

I ASKED C. SCHMIDT FOR AN ESTIMATE OF THE CAP COSTS, BASED ON MATERIALS AND SQUARE FOOTAGE OF EACH SITE. C.S. NOTED THAT IF EACH OF THE FOUR SITES REQUIRE SEPERATE MOBLIZATIONS THEN COSTS WILL INCREASE. C.S. GAVE ME MATERIAL AND INSTALLATION COSTS (1 DAY PER SITE).

	MATERIAL	INSTALLATION
GEOCOMPOSITE CLAY LINER	0.55/sf	0.50/sf
60 MIL HDPE GEOMEMBRANE	0.22/sf	0.40/sf
GEONET	0.20/sf	0.20/sf
16 OZ/5Y GEOTEXTILE (NONWOVEN)	0.14/sf	0.20/sf
	$\$1.11/sf + \$1.30/sf = \$2.41/sf$	

AS AN ALTERNATIVE TO 60MIL HDPE WE DISCUSSED 40MIL PVC GEOMEMBRANE. THE PVC CAN^{SD} BE MANUFACTURED TO SIZE UP FOR IMMEDIATE PLACEMENT IN THE FIELD. COST FOR THE 40MIL PVC ARE 0.30/sf MATERIAL AND 0.10/sf INSTALLATION. SUBSTITUTING FOR THE HDPE GEOMEMBRANE THE PVC MATERIAL REDUCES THE OVERALL MATERIAL AND INSTALLATION COST TO \$2.19/sf. C.S. ESTIMATED THAT IF EACH SITE MUST BE MOBILIZED SEPERATELY, MOBILIZATION COSTS WOULD BE ABOUT \$2000 PER SITE. CJ Lavallee

cc:

AR301247

TELEPHONE MEMORANDUM

Client USEPABVWST Project 21910Project NORTH PENN

BVWST File _____

Subject F.S. CAPPING COSTS.Date 5/26/94Time 4:30(10) From: JACK HARTWELLCompany: THE LINER CO., INCPhone No.: 708 946 9200Recorded by: CJ LAVALLEE

ASKED JACK HARTWELL FOR AN ESTIMATE OF THE CAP COSTS FOR
BASE ⁽¹⁰⁾ EACH SITE, BASED ON MATERIALS AND TREAS.

J.H. NOTED THAT MOBILIZATION COSTS WOULD INCREASE
COSTS IF EACH SITE DONE SEPERATELY. (SINGLE OR MULTIPLE)

	MATERIAL	INSTALLATION *
GEOCOMPOSITE CLAY LINER	\$ 0.50/SF	\$ 2,000 LS OR 4,000 LS
60 MIL HDPE LINER	0.30/SF	\$ 2,400 LS OR 4800 LS
GEONET	0.15/SF	\$ 1000 LS OR 2000 LS
16OZ/SY NONWOVEN GEOTEXTILE	0.20/SF	\$ 1000 LS OR 2000 LS
TOTAL	1.15/SF	\$ 6,400 LS OR \$ 12800 LS
(LUMP SUM COSTS INCLUDE ALL 4 SITES)		

40 MIL PVC LINER	0.30/SF	\$ 2,000 LS OR \$ 4000 LS
REVISED TOTAL	1.15/SF	\$ 6,000 LS OR \$ 12,000 LS
(LUMP SUM COSTS INCLUDE ALL 4 SITES)		

* INSTALLATION COSTS ARE BROKEN INTO SINGLE AND MULTIPLE
MOBILIZATION COSTS, AND ARE LUMP SUM TOTALS FOR ALL
FOUR SITES. MULTIPLE MOBILIZATIONS ARE MORE COSTLY.
INSTALLATION WOULD BE ABOUT 1/2 TO 1 DAY PER SITE.

cc:

AR301248

17 MAY 1994 11:11 AM

B&V WASTE SCIENCE AND TECHNOLOGY CORP.

TELEPHONE MEMORANDUM

Client USEPABVWST Project 21910Project NORTH PENN

BVWST File _____

Subject CAPPING COSTS FOR F.S.Date 5/26/94Time 400To/From: MARK RAMSDENCompany: ENVIRONMENTAL GEOSYNTHETICS INCPhone No.: 215 721 6340Recorded by: CJ CAVALIER

ASKED MARK RAMSDEN FOR AN ESTIMATE OF CAPPING COSTS FOR EACH SITE, BASED ON MATERIALS AND AREAS. M.R. NOTED THAT MOBILIZATION COSTS WILL BE HIGH BECAUSE EACH SITE IS SEPERATE. M.R. GAVE ME MATERIAL AND INSTALLATION COSTS INCLUDING PVC AS AN ALTERNATIVE TO HDPE GEOMEMBRANE. ONE DAY PER SITE FOR INSTALLATION

	MATERIAL	INSTALLATION
GEOCOMPOSITE CLAY LINER	1.00/sf	1.00/sf
60 MIL HDPE GEOMEMBRANE*	1.00/sf ⁽¹⁾	1.00/sf ⁽¹⁾
GEONET	0.25/sf	0.25/sf
16 OZ/SY GEOTEXTILE (NONWOVEN)	0.22/sf ⁽²⁾	0.06/sf ^(0.50/sy)
TOTAL	2.47/sf +	2.31/sf = 4.78/sf
*OR, 40 MIL PVC GEOMEMBRANE	0.50/sf	0.25/sf
REVISED TOTAL ⁽¹⁾	1.97/sf +	1.56/sf = 3.53/sf ⁽¹⁾

M.R. GAVE ME THEIR ~~AT~~ NEW ADDRESSES:

MAIL: PO BOX 221, TELFORD PA 18969

OFFICE: 49 N 4TH STREET, SOUDERTON PA 18964

(1) SUBSTITUTE PVC PRICES* FOR REVISED MATERIAL + INSTALLATION COST

cc:

AR301249

NORTH PENN AREA 6
FEASABILITY STUDY CAP ALTERNATIVE
8/4/94

BARE GROUND

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	3.00 INCHES
POROSITY	=	0.0500 VOL/VOL
FIELD CAPACITY	=	0.0300 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3110 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0000010000000 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.3178 VOL/VOL
FIELD CAPACITY	=	0.0393 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0393 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0005000000237 CM/SEC

LAYER 3

LATERAL DRAINAGE LAYER

THICKNESS	=	0.39 INCHES
POROSITY	=	0.8580 VOL/VOL
FIELD CAPACITY	=	0.2640 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	12.6200008392334 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	52.0 FEET

LAYER 4

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER
THICKNESS = 0.25 INCHES
POROSITY = 0.5500 VOL/VOL
FIELD CAPACITY = 0.4000 VOL/VOL
WILTING POINT = 0.3000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = 0.0000000010000 CM/SEC
LINER LEAKAGE FRACTION = 0.00005000

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER = 98.00
TOTAL AREA OF COVER = 2700. SQ. FT
EVAPORATIVE ZONE DEPTH = 6.00 INCHES
UPPER LIMIT VEG. STORAGE = 1.1034 INCHES
INITIAL VEG. STORAGE = 1.0509 INCHES
SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR PHILADELPHIA PENNSYLVANIA

MAXIMUM LEAF AREA INDEX = 0.00
START OF GROWING SEASON (JULIAN DATE) = 115
END OF GROWING SEASON (JULIAN DATE) = 296

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-----	-----	-----	-----	-----	-----
31.20	33.10	41.80	52.90	62.80	71.60
76.50	75.30	68.20	56.50	45.80	35.50

AVERAGE MONTHLY VALUES IN INCHES FOR 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

PRECIPITATION						

TOTALS	3.14 3.94	2.23 3.97	3.41 4.10	3.24 2.81	3.20 3.22	3.68 3.33
STD. DEVIATIONS	1.68 2.25	1.22 1.97	1.49 1.93	1.47 1.82	1.30 1.71	1.40 1.48
RUNOFF						

TOTALS	2.391 3.517	1.758 3.529	2.945 3.739	2.735 2.523	2.758 2.823	3.259 2.861
STD. DEVIATIONS	1.441 2.138	0.991 1.839	1.407 1.848	1.388 1.712	1.222 1.605	1.385 1.422
EVAPOTRANSPIRATION						

TOTALS	0.582 0.424	0.552 0.441	0.558 0.356	0.500 0.274	0.461 0.401	0.414 0.435
STD. DEVIATIONS	0.157 0.159	0.253 0.157	0.224 0.121	0.116 0.160	0.113 0.157	0.125 0.103
LATERAL DRAINAGE FROM LAYER 3						

TOTALS	0.0025 0.0017	0.0074 0.0014	0.0122 0.0012	0.0039 0.0010	0.0027 0.0009	0.0020 0.0008
STD. DEVIATIONS	0.0081 0.0019	0.0131 0.0015	0.0331 0.0012	0.0058 0.0011	0.0035 0.0009	0.0024 0.0008
PERCOLATION FROM LAYER 4						

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGE ANNUAL TOTALS (AND STD. DEVIATIONS) FOR				1 THROUGH	20
	(INCHES)		(CU. FT.)	PERCENT	
PRECIPITATION	40.27	(5.972)	9061.	100.00	
RUNOFF	34.838	(5.563)	7838.	86.51	
EVAPOTRANSPIRATION	5.399	(0.664)	1215.	13.41	
LATERAL DRAINAGE FROM LAYER 3	0.0377	(0.0618)	8.	0.09	
PERCOLATION FROM LAYER 4	0.0000	(0.0000)	0.	0.00	

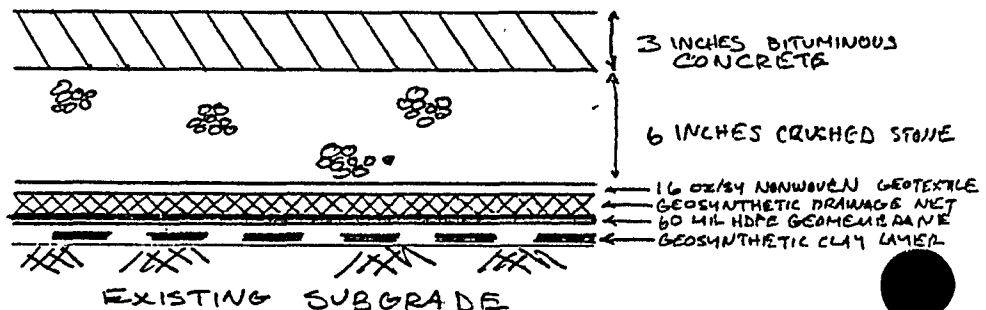
PEAK DAILY VALUES FOR			1 THROUGH	20
	(INCHES)	(CU. FT.)		
PRECIPITATION	5.75	1293.7		
RUNOFF	5.692	1280.8		
LATERAL DRAINAGE FROM LAYER 3	0.0186	4.2		
PERCOLATION FROM LAYER 4	0.0000	0.0		
HEAD ON LAYER 4	0.0			
SNOW WATER	2.68	603.3		
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.1751			
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0168			

Owner USEPAPlant NORTH PENN AREA 6 Unit _____Project No. 21910 File No. _____Title FS CAP HELP RUNComputed By CJ CAVALLESDate 6/7 19 94Checked By JBODate 8/5 19 94Page 1 of 1

INPUT PARAMETERS FOR 'HELP' MODELING

- BASED ON PROPOSED CAP ALTERNATIVE FOR
THE NORTH PENN AREA 6 FEASIBILITY STUDY

REFS I. CAP CROSS SECTION:



II. LAYER PROPERTIES

1. BITUMINOUS CONCRETE SURFACE

1. POROSITY = 0.05
1. FIELD CAPACITY = 0.03
1. WILTING POINT = 0.02 (MINIMUM "HELP" VALUE)
1. $K = 10^{-6}$ cm/sec (YEARLY MAINTENANCE OF ASPHALT SURFACE ASSUMED)

2. CRUSHED STONE

ASSUME A PADOT 2A STONE MATERIAL UNDER BITUMINOUS CONCRETE.

2. USE "HELP" SOIL TEXTURE NO. 1.

AR301254

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 Title F.S. CAP HELP RUN Date 8/5/94 1994
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3. GEOTEXTILE / GEOSYNTHETIC DRAINAGE NET

BASED ON AVAILABLE LABORATORY TRANSMISSIVITY DATA, THESE MATERIALS WILL BE MODELLED AS ONE GEOCOMPOSITE DRAINAGE LAYER.

ASSUME GEOTEXTILE IS 16oz/sy TREVIRA 1155 MATERIAL
 ASSUME DRAINAGE NET IS FLUID SYSTEMS POLY NET PN 3000

GEOTEXTILE THICKNESS = 185 MILS = 0.185 INCHES

NET THICKNESS = 0.2 INCHES

a. n - POROSITY: WEIGHTED AVERAGE

GEOTEXTILE POROSITY = 0.921

GEONET POROSITY = 0.80

$$\text{AVE } n = \frac{0.185(0.921) + 0.2(0.80)}{0.385}$$

$$n = 0.858$$

b. FIELD CAPACITY: WEIGHTED AVERAGE

GEOTEXTILE = 0.55

GEONET = ASSUME ZERO

$$\text{AVE. F. CAPACITY} = \frac{0.55(0.185) + 0.0(0.2)}{0.385}$$

$$= 0.264$$

c. WILTING POINT:

GEOTEXTILE = 0.01

GEONET = 0

ASSUME INITIAL WATER CONTENT IS ZERO

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d. PERMEABILITY:

PERMEABILITY IS BASED ON TRANSMISSIVITY VALUES FOR THE DRAINAGE NET

THE ALLOWABLE TRANSMISSIVITY OF A GEOCOMPOSITE DRAINAGE MATERIAL IS EQUAL TO THE ULTIMATE VALUE DIVIDED BY PARTIAL FACTORS OF SAFETY.

5
PG 554

$$\sigma_{\text{ALLOWABLE}} = \frac{\sigma_{\text{ULTIMATE}}}{F_{S_{IN}} \times F_{S_{CR}} \times F_{S_{CC}} \times F_{S_{BC}}}$$

5
PG 557

$F_{S_{IN}}$ - FACTOR FOR ELASTIC DEFORMATION OF THE ADJACENT GEOSYNTHETICS INTO THE GEOCOMPOSITE'S CORE SPACE

$F_{S_{CR}}$ - F.S. FOR CREEP DEFORMATION OF THE ADJACENT GEOSYNTHETICS AND/OR GEOCOMPOSITE INTO THE CORE SPACE

$F_{S_{CC}}$ - F.S. FOR CHEMICAL CLOGGING AND/OR PRECIPITATION OF CHEMICALS INTO THE CORE SPACE

$F_{S_{BC}}$ - F.S. FOR BIOLOGICAL CLOGGING INTO THE CORE SPACE

LANDFILL CAP SYSTEM FACTORS OF SAFETY:

$F_{S_{IN}} = 1.5$ (GEOTEXTILE INTRUSION)

$F_{S_{CR}} = 1.2$ (LOW STRESS, INSIGNIFICANT CREEP)

$F_{S_{CC}} = 1.2$ (OVERLYING CRUSHED STONE)

$F_{S_{BC}} = 1.3$

$$\sigma_{\text{ALLOWABLE}} = \frac{\sigma_{\text{ULTIMATE}}}{1.5(1.2)(1.2)(1.3)} = \frac{\sigma_{\text{ULTIMATE}}}{2.81}$$

σ_{ULTIMATE} IS AVAILABLE FROM MANUFACTURER'S PRODUCT INFORMATION. VALUES ARE BASED ON HYDRAULIC GRADIENT AND NORMAL STRESSES.

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Plant N. PENN

Project No. 21910

Title E.S. - CAP WELP RUN

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Date 8/5 19 94

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7.
Pg III-32

$$\text{HYDRAULIC GRADIENT } i = \frac{1 + B \sin \theta}{B / \cos \theta}$$

B = HORIZONTAL COMPONENT OF SLOPE LENGTH

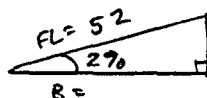
ASSUME 2% SLOPE FOR EXISTING CONDITIONS

MAXIMUM FLOW LENGTH:

$$\text{AREA} = 251 \text{ m}^2 = 2700 \text{ SF}$$

ASSUME AREA IS SQUARE AND FLOW LENGTH IS LENGTH OF ONE SIDE

$$\text{FLOW LENGTH} = \sqrt{2700} = 52 \text{ FT}$$



$$\tan \theta = \frac{2}{100} = \frac{2}{100}$$

$$\theta = \tan^{-1} \frac{2}{100} = 0.02 \text{ RAD} = 1.15^\circ$$

$$B = FL \cos \theta = 52 \cos 1.15^\circ$$

$$B = 47.5 \text{ FT} \quad 51.99 \text{ ft}$$

$$i - \text{HYDRAULIC GRADIENT} = \frac{1 + 47.5 \sin 1.15^\circ}{51.99 / \cos 1.15^\circ}$$

$$i = 0.38 \quad 0.04$$

NORMAL STRESSES

ASSUME BITUMINOUS CONCRETE $\rho = 150 \text{ lb/cf}$

ASSUME ZACRUSHED STONE $\rho = 135 \text{ lb/cf}$

$$\begin{aligned} \text{STRESS ABOVE NET} &= (1.25 \text{ FT}) 150 \text{ lb/cf} + (.5 \text{ FT}) 135 \text{ lb/cf} \\ &= 105 \text{ PSF} \end{aligned}$$

USE 2000 PSF FOR TRANSMISSIVITY TABLES

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Owner USEPA
 Plant NORTH PENN Unit _____
 Project No. 21010 File No. _____
 Title ES - CAP HELP RUN

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 Date 8/5 19 94
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FROM FLUID SYSTEMS' TRANSMISSIVITY CHARTS FOR
 POLY NET PN3000 IN A HDPE / PN3000 / GEOTEXTILE / SOIL
 CROSS SECTION, USING HYDRAULIC GRADIENT $i = 0.38 \times 0.04$
 AND NORMAL STRESS = 2000 PSF: *

A.

$$\text{ULTIMATE HYDRAULIC TRANSMISSIVITY} - \sigma_{ult} = 1.8 \times 10^{-3} \text{ m}^2/\text{s}$$

$$\sigma_{allowable} = \frac{1.8 \times 10^{-3} \text{ m}^2/\text{s}}{2.81}$$

$$\sigma_{allowable} = \frac{0.000391 \text{ m}^2/\text{s}}{6.41} = 3.91 \times 10^{-4} \text{ m}^2/\text{s}$$

CALCULATE PERMEABILITY:

THICKNESS OF DRAINAGE NET = 0.2 INCHES

$$0.2 \text{ INCHES} \left(\frac{2.54 \text{ cm}}{1 \text{ INCH}} \right) \left(\frac{1 \text{ m}}{100 \text{ cm}} \right) = 0.00508 \text{ m}$$

$$K = \frac{3.91 \times 10^{-4} \text{ m}^2/\text{s}}{0.00508 \text{ m}} = 0.076969 \text{ m/s}$$

$$K = \frac{12.62 \text{ cm/sec}}{7.697} = 1.63 \text{ cm/sec}$$

4. GEOMEMBRANE

ASSUME LINER LEAKAGE FRACTION = 0.00005

5. GEOSYNTHETIC CLAY LAYER.

8.

POROSITY = 0.55

FIELD CAPACITY = 0.4

WILTING POINT = 0.3

INITIAL SOIL WATER CONTENT = 0.2

$K = 10^{-9} \text{ cm/sec}$

THICKNESS = 0.25 INCH

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Owner USEPA Computed By CJ LAVALLEE
 Plant NORTH PLAIN Unit _____ Date 6/8 19 94
 Project No. 21910 File No. _____ Checked By J. B. J.
 Title F.S. - HELP SUN CAP ALTERN. Date 8/8 19 94
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III. OTHER PARAMETERS

1. SURFACE RUNOFF NUMBER = 9.8
 EVAPORATIVE ZONE DEPTH = 9 INCHES (REF. 1)²
 BARE GROUND
 (YEARLY MAINTENANCE OF BITUMINOUS CONCRETE ASSUMED)
 ALLOW COMPUTER TO INITIALIZE WATER CONTENT
 MAX. LEAF AREA INDEX = 0
 MAX DRAINAGE LENGTH = 50 FT⁵²
 DRAINAGE SLOPE = 2%
 TOTAL AREA = 2700 SF - LARGEST OF 4 CAP AREAS
 CLIMATE DATA IS BASED ON PHILADELPHIA
 - MEAN MONTHLY TEMPERATURES AND RAINFALL
 FOR PHILADELPHIA INPUTED TO INCREASE ACCURACY
 - MAXIMUM 25 YEAR 24 HOUR RAINFALL OF 5.75
 INCHES INPUTED INTO RAINFALL DATA IN PLACE
 OF SYNTHETICALLY COMPUTED MAXIMUM
- 9.
- 10.

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Owner USEPA
Plant NORTH PENN Unit _____
Project No. 21910 File No. _____
Title F.S.-CAP HELP RUN

Computed By CJLAVALLER
Date 6/12 19 94
Checked By JBY
Date 8/5 19 94
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REFERENCES

1. HELLER, Yael B., BLACK & VEATCH WASTE SCIENCE INC., HAND WRITTEN NOTES, FROM HYDRAULIC EVALUATION OF LANDFILL PERFORMANCE (HELP) VERSION 3 COURSE, AUGUST 1993.

2. INTERIM USER'S GUIDE FOR HELP VERSION 2 FOR EXPERIENCED USERS. (NOT ATTACHED)

3. TREVIRA SPONBOND MANUFACTURER'S DATA - PHYSICAL PROPERTIES, HOECHST CELANESE CORP., 1990.

4. POLY-NET TRANSMISSIVITY CHARTS, FLUID SYSTEMS, INC. 3/92

(SEE REF. 5) 7. RICHARDSON, G.N. AND KOERNER, R.M. "GEOSYNTHETIC DESIGN GUIDANCE FOR HAZARDOUS WASTE LANDFILL CELLS AND SURFACE IMPOUNDMENTS" FINAL REPORT, USEPA, CONTRACT NO. 68-03-3338, GEOSYNTHETIC RESEARCH INSTITUTE, PHILADELPHIA PA, 1987. (NOT ATTACHED)

6. TELEPHONE MEMO BETWEEN D. MESSMER OF GUNOLE AND Y.B. HELLER OF BWWS, 12/15/92, 9:30AM

(SEE REF. 7) 5. KOERNER, R.M. "DESIGNING WITH GEOSYNTHETICS" PRENTICE HALL, 2ND EDITION, 1990 (NOT ATTACHED)

8. TELEPHONE MEMO BETWEEN T. HOCK OF JAMES CLEM CORP. AND Y.B. HELLER OF BWWS, 12/12/92, 3:50 PM

9. LOCAL CLIMATOLOGICAL DATA ANNUAL SUMMARY WITH COMPARATIVE DATA FOR PHILADELPHIA PA, 1992, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

10. RAINFALL DURATION FREQUENCY TABLES FOR PENNSYLVANIA, OFFICE OF RESOURCE MANAGEMENT, DEPT. OF STORM WATER MANAGEMENT, DEPARTMENT OF ENVIRONMENTAL RESOURCES, COMMONWEALTH OF PA.

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Aug. 1993

REF. 1

Surface Slope effects on runoff. Tend to be small. If topsoil is $10^{-4} \rightarrow 10^{-3}$, it will.

Cobbled surfaces - ~~Can be treated as~~
Provide shading. Reduced evaporation.
→ Reduce solar radiation value.
Treat like runoff from soil below the cobbles occurs instead of off of the cobbles + reduce solar radiation.

Paved surfaces - There are measurements of k which are $\sim 10^{-6}$ cm/sec.
Bare ground. CN like compacted clay.
CN ~ 99. Evap. zone depth $\sim 6"$.
Poros. Field cap. wilt pt. are small, but P.S. doesn't have a #. Must make educated assumption. If cracked, increase k to maybe 10^4 .

Frozen soil - Model has a routine to change CN + cut off evap. from soil.
Built into model. Function of daily temp.
Allows for a mid-winter thaw + refreeze.
Problem is if your landfill produces a lot of heat, model will still freeze soil.
Only thing to do is adjust air temp. in weather data. Raise it.

Surface Run on - Model doesn't handle.
If you have it, get volume then divide by area of landfill, + add it to rainfall.

Irrigation - Don't let it affect solar radiation. Have rainfall data + save. Then add irrigation values to the rainfall files. This will keep solar radiation data correct.

AR30126

AR301262

Trevira® Spunbond nonwoven engineering products are highly needled fabrics with excellent tensile properties, high filtration potential and outstanding permeability.

Trevira® Spunbond Type 11 products are 100% continuous filament polyester nonwoven needlepunched engineering fabrics. They deliver a combination of advantages unmatched by any other spunbonded geotextiles. They're resistant to freeze-thaw, soil chemicals and ultraviolet light exposure.

Trevira® Spunbond nonwoven engineering fabrics offer excellent performance where the requirement is tensile reinforcement, planar flow, filtration, or separation. They are ideal for roadways, railbeds, drainage systems, pondliners, retaining walls. And much more.

TYPICAL PHYSICAL PROPERTIES OF TREVIRA® TYPE 11 PRODUCTS

Fabric Property	Unit	Test Method	1112	1114	1120	1125	1135	1145	1155
Fabric Weight	oz/yd ²	ASTM D-3776	3.5	4.2	6.0	7.5	10.5	13.5	16.5
Thickness, t	mils	ASTM D-1777	60	70	90	110	140	170	210
Grab Strength (MD/CD) ¹⁾	lbs	ASTM D-4632	120/95	150/115	230/180	300/235	420/350	540/450	650/570
Grab Elongation (MD/CD) ¹⁾	%	ASTM D-4632	65/75	75/85	75/85	75/85	75/80	80/80	85/85
Trapezoid Tear Strength (MD/CD) ¹⁾	lbs	ASTM D-4533	50/40	55/50	80/75	105/95	140/125	180/165	225/200
Puncture Resistance	lbs	ASTM D-4833	55	65	95	115	155	185	225
Mullen Burst Strength	psi	ASTM D-3786	195	225	320	400	560	700	855
Water Flow Rate	gpm/ft ²	ASTM D-4491	195	190	170	150	120	100	80
Permittivity, ψ	sec ⁻¹	ASTM D-4491	2.61	2.54	2.27	2.01	1.60	1.34	1.07
Permeability, k = ψt	cm/sec	ASTM D-4491	.40	.45	.52	.56	.57	.58	.57
AOS	Sieve Size mm	ASTM D-4751	70-100 210-149	70-100 210-149	70-100 210-149	70-100 210-149	100-120 149-125	120-140 125-106	140-170 106-088
Standard Roll Widths ²⁾	ft		12.5 and 15.0						
Standard Roll Length ²⁾	ft		400	400	300	300	300	300	300

¹⁾MD = Machine Direction, CD = Cross Machine Direction.

²⁾Other width and length rolls are available upon request.

MINIMUM† PHYSICAL PROPERTIES OF TREVIRA® TYPE 11 PRODUCTS

Fabric Property	Unit	Test Method	1112	1114	1120	1125	1135	1145	1155
Fabric Weight	oz/yd ²	ASTM D-3776	3.3	4.0	5.7	7.1	10.0	13.0	16.0
Thickness, t	mils	ASTM D-1777	50	55	75	95	125	150	185
Grab Strength	lbs	ASTM D-4632	80	100	160	210	305	390	500
Grab Elongation	%	ASTM D-4632	60	60	60	60	60	65	70
Trapezoid Tear Strength	lbs	ASTM D-4533	30	40	60	75	100	130	150
Puncture Resistance	lbs	ASTM D-4833	40	50	80	95	130	155	195
Mullen Burst Strength	psi	ASTM D-3786	170	190	275	360	510	640	780
Water Flow Rate	gpm/ft ²	ASTM D-4491	155	150	130	110	80	60	40
Permittivity, ψ	sec ⁻¹	ASTM D-4491	2.07	2.01	1.74	1.47	1.07	0.80	0.53
Permeability, k = ψt	cm/sec	ASTM D-4491	.26	.28	.33	.35	.34	.31	.25
AOS	Sieve Size mm	ASTM D-4751	50 300	50 300	70 210	70 210	70 210	100 149	100 149

†These minimum values represent minimum values determined from Q.C. testing on all lots produced in 1989. Certified "Minimum Average" values for each product are available upon request. The industry standard of a 95 percent confidence level (i.e. mean less two standard deviations) may be higher than these values and should be used for each production lot. Please contact your Trevira® Distributor or Hoechst Celanese Corporation for additional information.

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