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Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R03-91/110
March 1991

EPA

Superfund Record of Decision:

Brodhead Creek, PA

50272-101

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

The 12-acre Brodhead Creek site is a former coal gasification plant in the Borough of Stroudsburg, Monroe County, Pennsylvania. The site occupies the floodplain area at the confluence of Brodhead and McMichael Creeks. Surrounding land use is commercial and residential. Site features include two earthen levees constructed to protect a nearby sewage treatment plant from potential floodwaters. From approximately 1888 to 1944, the coal gasification plant was operated along the west bank of Brodhead Creek. These activities produced a liquid coal tar product comprised of PAHs, which was disposed of in an onsite open pit until the mid-1940s. In 1980, during construction repairs to the toe of the flood control levee, coal tar was observed seeping into Brodhead Creek. From 1981 to 1984, several state and federal emergency response measures and investigations were initiated onsite. These included installing filter fences and underflow dams to intercept coal tar seepage, installing a coal tar recovery pit on the bank of Brodhead Creek, and constructing a slurry wall to mitigate onsite coal tar migration toward Brodhead Creek. In addition, from 1982 to 1983, the State and EPA conducted a program designed to remove coal tar from a backwater channel area, which involved excavating and dewatering 900 cubic yards of

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Brodhead Creek, PA
First Remedial Action
Contaminated Medium: soil
Key Contaminants: VOCs (benzene, toluene, xylenes), other organics (PAHs), metals (arsenic)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 106
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse*

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

EPA/ROD/R03-91/110
Brodhead Creek, PA
First Remedial Action

Abstract (Continued)

sediment and backfilling the area with clay and clean soil. Also during this time period, the PRPs installed recovery wells in the main coal tar pool and subsequently removed 8,000 gallons of coal tar. This Record of Decision (ROD) addresses contaminated subsurface soil containing free coal tar, and provides an interim remedy for the site. A future ROD will address onsite ground water contamination and provide the final remedy for the subsurface soil. The primary contaminants of concern affecting the soil are VOCs including benzene, toluene, and xylenes; other organics including PAHs; and metals including arsenic.

The selected remedial action for this site includes an in-situ innovative enhanced recovery process which entails installing hot water injection and extraction wells in the free coal tar areas comprised of approximately 200 cubic yards of subsurface soil; recovering both coal tar and process water from extraction wells; separating the coal tar from the process water and disposing of the recovered coal tar at an offsite permitted incineration facility; treating the process water; discharging a portion of the treated process water to Brodhead Creek, and reinjecting the remainder of the treated water into the subsurface soil to enhance coal tar recovery; conducting a treatability study to evaluate the coal tar recovery process; monitoring ground water, sediment, and biota; and implementing deed restrictions, and site access restrictions such as fencing. The estimated present worth cost for this remedial action is $4,120,000, which includes a total O&M cost of $1,112,000.

PERFORMANCE STANDARDS OR GOALS: The enhanced recovery process will be applied to the free coal tar (i.e., coal tar at 100% pore volume saturation) areas, and will remove and treat 60-70% of the free coal tar. This process will prevent further leaching of contaminants into the shallow ground water.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region III
841 Chestnut Building
Philadelphia, PA 19107

SUBJECT: Record of Decision - Transmittal Memo **DATE:** March ~~25~~ 29, 1991

FROM: Abraham Ferdas, Director
Office of Superfund (3HW02)

TO: Edwin B. Erickson
Regional Administrator (3RA00)

Attached is the Record of Decision (ROD) for the Brodhead Creek Superfund Site. The decision outlines all necessary remedial actions which must be performed in order to be protective of the public health and the environment. There were no significant changes from Proposed Plan to the ROD. I recommend that you sign the attached document. The Commonwealth of Pennsylvania has concurred with this decision.

RECORD OF DECISION
BRODHEAD CREEK SITE
DECLARATION

Site Name and Location

Brodhead Creek Site
Stroudsburg, Pennsylvania
Operable Unit One

Statement of Basis and Purpose

This Record of Decision (ROD) presents a selected interim remedial action for a source of ground water contamination located in the subsurface soils at the Brodhead Creek Site (the "Site") in Stroudsburg, Pennsylvania, which was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300. This decision is based upon the administrative record file for the Brodhead Creek Site.

The Commonwealth of Pennsylvania concurs with the selected remedy.

Assessment of the Site

Pursuant to duly delegated authority, I hereby determine, pursuant to Section 106 of CERCLA, that actual or threatened releases of hazardous substances from this Site, as discussed under Summary of Site Risks in this document, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

Description of the Remedy

This interim remedy (Operable Unit One, or OU-1) addresses a source of ground water contamination located in the subsurface soils through recovery and treatment of the principal source of contamination. The primary objectives of this remedy are to minimize the migration of contaminants in the ground water, to initiate the reduction of toxicity, mobility, and volume of subsurface soil contaminants to ground water, and to collect data on contaminant response to remediation measures. This remedy is considered an interim action for subsurface soil contamination. A final action addressing subsurface soils and ground water will be selected in a later ROD after data generated during the implementation of the interim action is evaluated and further investigations are conducted on ground water for the Site. Further actions will address threats at the Site presented by additional contaminated soils and ground water.

The selected remedy includes the following major components:

(1) Installation of extraction wells and injection wells in the free coal tar areas of the subsurface soils

(2) Recovery of coal tar and process water from the extraction wells by using the innovative technology of enhanced recovery

(3) Separation of the coal tar from the process water followed by treatment of the process water

(4) Discharge of a portion of the treated process water to Brodhead Creek and the reinjection of the remaining treated process water into the subsurface soils to enhance coal tar recovery

(5) Disposal of the recovered coal tar at an offsite permitted incineration facility

(6) Installation of a fence to prevent public access during remedial activities

(7) Imposition of deed restrictions to limit future use of the Site

(8) Monitoring of ground water and biota in Brodhead Creek to ensure protection to human health and the environment.

Statutory Determinations

This interim action is protective of human health and the environment, complies with Federal and State applicable or relevant and appropriate requirements for this limited-scope action, and is cost-effective. This action is interim and is not intended to utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable for this Operable Unit. This interim action utilizes treatment and thus is in furtherance of the statutory preference for treatment. Because this action does not constitute the final remedy for the operable unit, the statutory preference for remedies that employ treatment (although partially addressed in this remedy) that reduces toxicity, mobility, or volume as a principal element will be addressed by a final response action. Subsequent actions are planned to address fully the threats posed by this Site.

Because this interim remedy will result in hazardous substances remaining onsite above health based levels, a review will be conducted within five years after commencement of the interim remedial action as EPA continues to develop final remedial

alternatives for this operable unit. The review will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment. Because this is an interim action ROD, review of this Site and of this remedy will be continuing as part of the development of the final remedy.

Edwin B. Erickson
Regional Administrator
Region III

3/25/91
Date

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DECISION SUMMARY

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RECORD OF DECISION
BRODHEAD CREEK SITE
DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

The Brodhead Creek Site encompasses approximately 12 acres in the Borough of Stroudsburg in Monroe County, Pennsylvania (Figure 1). The Site lies on the west bank of Brodhead Creek between the bridges of Route 209 (Interborough Bridge) and Interstate 80. The detailed site plan is shown on Figure 2.

The Site occupies the flood plain area at the confluence of Brodhead Creek and McMichael Creek. The natural topography over most of the Site is one of low relief. Surface elevations of the natural land surface over the flood plain areas of the Site range between about 377 feet above mean sea level (MSL) at the respective creek banks to 381 feet in the flood plain interior. This is contrasted in the northern one-third of the Site, where the land surface rises abruptly from the flood plain to an elevation of about 400 feet.

Superimposed over the natural topography is a large man-made earthen levee constructed to protect the Stroudsburg Municipal Sewage Treatment Plant from flood waters such as those experienced in the aftermath of Hurricane Hazel in 1955. On the Site proper, this levee is arcuate in plan, curving from out of the north and to the west, effectively blocking any potential flooding from either Brodhead Creek or McMichael Creek. The levee crown (elevation of 408 feet) is about 25 to 30 feet above the surrounding flood plain. The creek side of the levee is sloped at 2.5:1 while the opposite side is sloped at 2:1.

To the west, the levee extends out of the Site area. To the north, the levee abuts the natural land surface and a concrete flood wall which protects a Pennsylvania Power and Light Company (PP&L) substation. The concrete flood wall extends from the levee embankment northward and is keyed into the west abutment for the Interborough Bridge. The flood wall is a 22-foot tall reinforced, cast-in-place concrete wall constructed on top of an interlocking sheet pile foundation which extends down to elevation 361 feet. The elevation at the top of the concrete wall is about 407 feet above mean sea level.

A smaller, and presumably older earthen levee, which extends northward from the main flood control levee, separates the flood plain area of the Site from the grounds of the Stroudsburg Municipal Sewage Treatment Plant. This smaller levee rises about 13 feet above the flood plain with its crown reaching about elevation 394 feet above mean sea level.

Two small drainage channels enter the Site, join in the Site interior, and flow through the former flood plain area. The

FIGURE 1

Brodhead Creek Site Location Map

Brodhead Creek Remedial Investigation
Stroudsburg, Pennsylvania

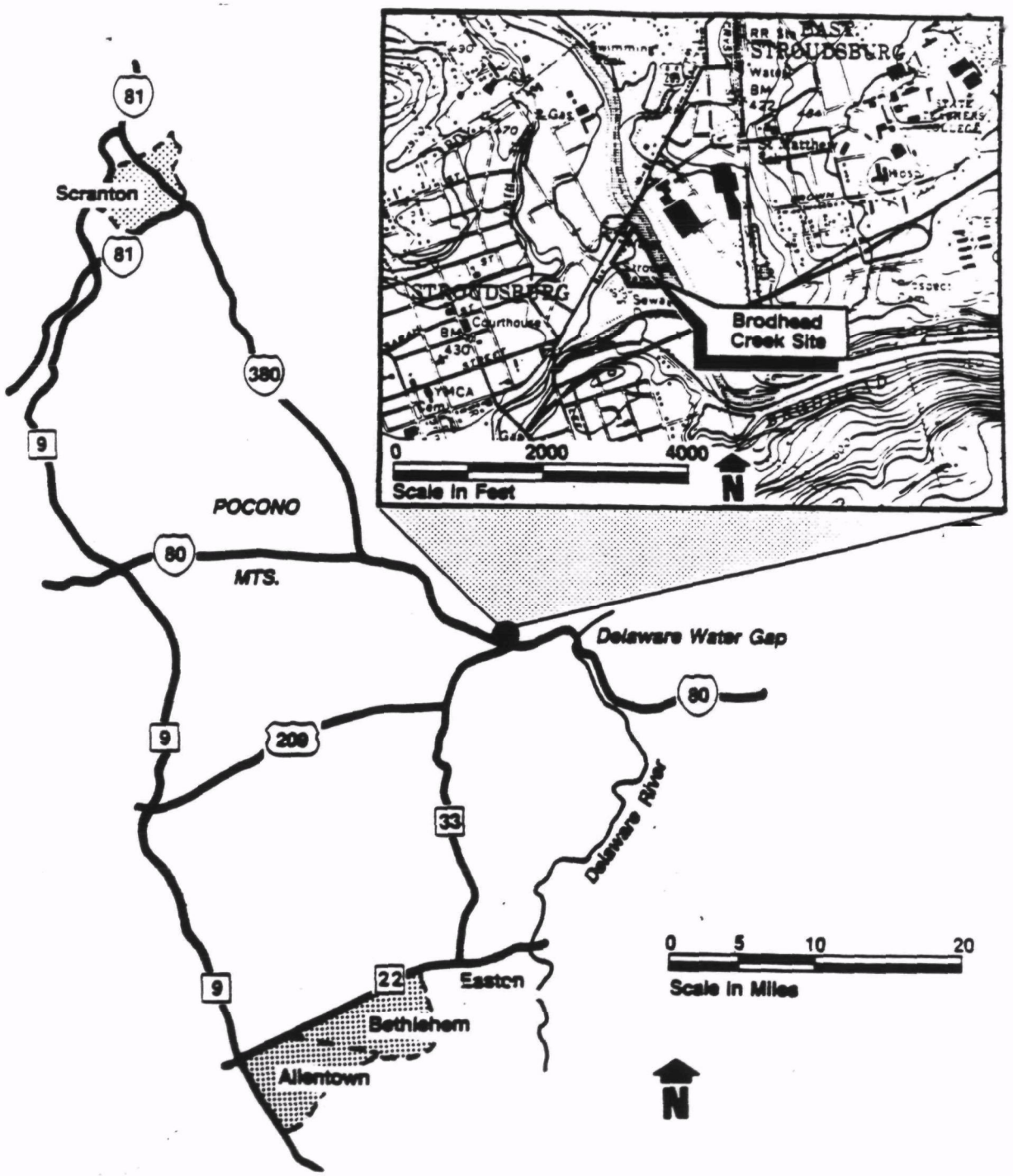

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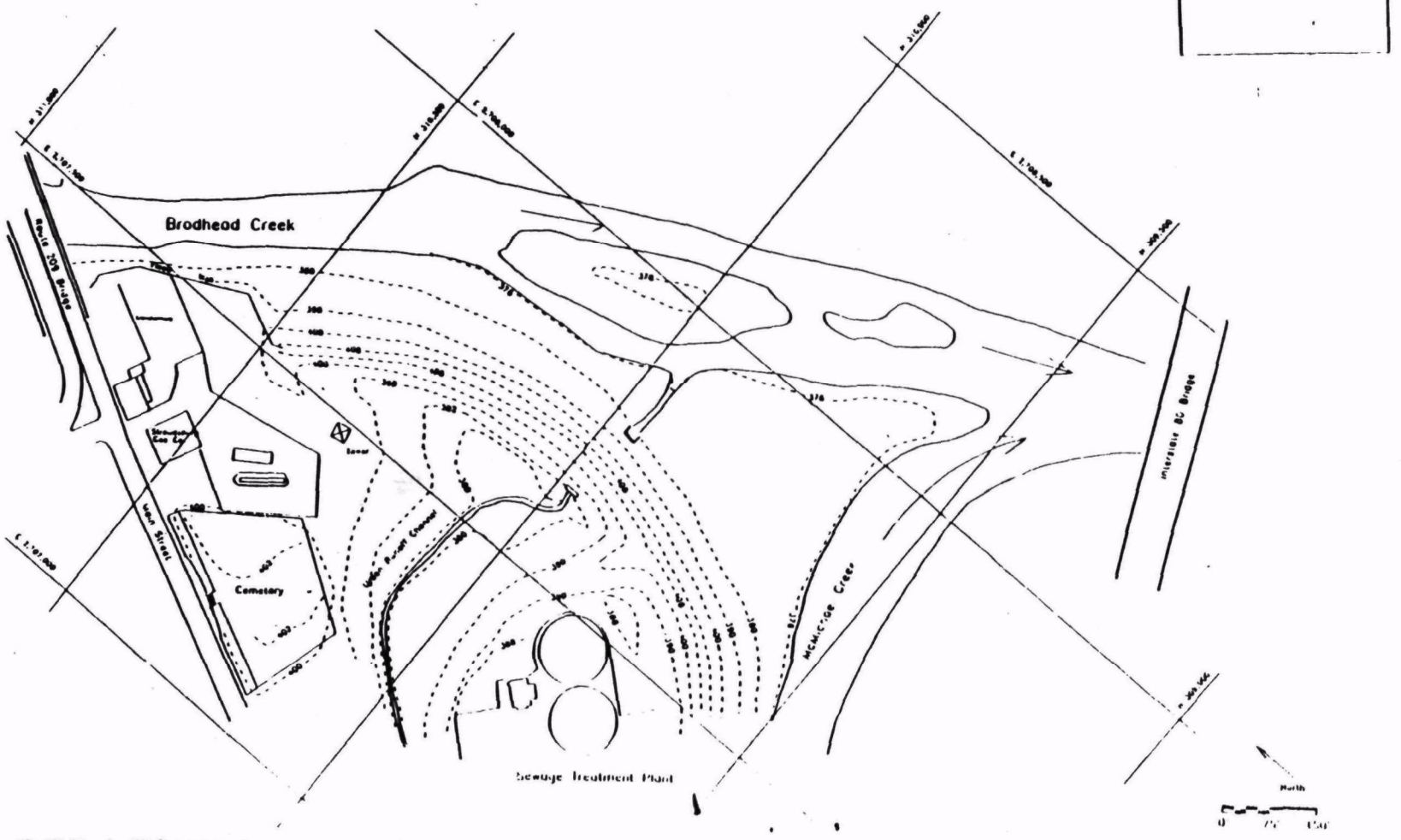
FIGURE 2

Site Plan

Brodhead Creek Remedial Investigation
Stroudsburg, Pennsylvania



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	Reviewed by / Date	Checked by / Date	

smaller of the two is intermittent in nature, as it carries storm run-off, entering the Site at the northeast corner via a storm sewer outfall. The smaller channel is not considered to be a major Site feature for this reason. The larger channel is perennial in nature and enters the Site from the west-northwest, flowing across the central portion of the Site through a flood gate in the levee to its-outlet on Brodhead Creek. It is referred to herein as the urban run-off channel.

The northern Site boundary is a combination of private commercial properties and a cemetery located along Main Street in Stroudsburg.

The Brodhead Creek Site is located within the Valley and Ridge physiographic province of the Appalachian Mountains. Bedrock at the Site is the Devonian Age Marcellus Shale which is described as a dark, fissile, carbonaceous shale, with some notably calcerous zones. Directly underlying the Marcellus Shale in the vicinity of the Brodhead Creek Site is the Devonian Age Buttermilk Falls Formation which is a viable water supply. This formation supplies the City of East Stroudsburg municipal wells #1 and #2. The areal structural geology of the bedrock is complex, with many small folds superimposed on major folds. However, the dominant alignment of major bedrock structures in the region is northeast to southwest.

The wide valley through which Brodhead Creek flows has been filled by up to 100 feet of unconsolidated glacial deposits. The Brodhead Creek Site is underlain by at least 60 feet of unconsolidated sediments of both glacial, recent fluvial, and huma origin. Four distinct strata can be identified within this interval: surficial fill, floodplain deposits, stream gravels, and silty sands.

Surficial fine sands and silts deposited during flood events of Brodhead and McMichael Creeks comprise the flood plain deposits. Fluvial origin stream gravels underlie the flood plain/fill deposits beneath much of the Site, and are the surficial materials in some areas of the Site. The lithology of the stream gravels can be characterized as loosely consolidated, stratified, well rounded, coarse gravels. These gravels are most likely reworked glacial drift transported and deposited by the streams as they migrated across the valley floor during the past; therefore, this gravel deposit correlates with the streambed gravels in the Brodhead Creek channel.

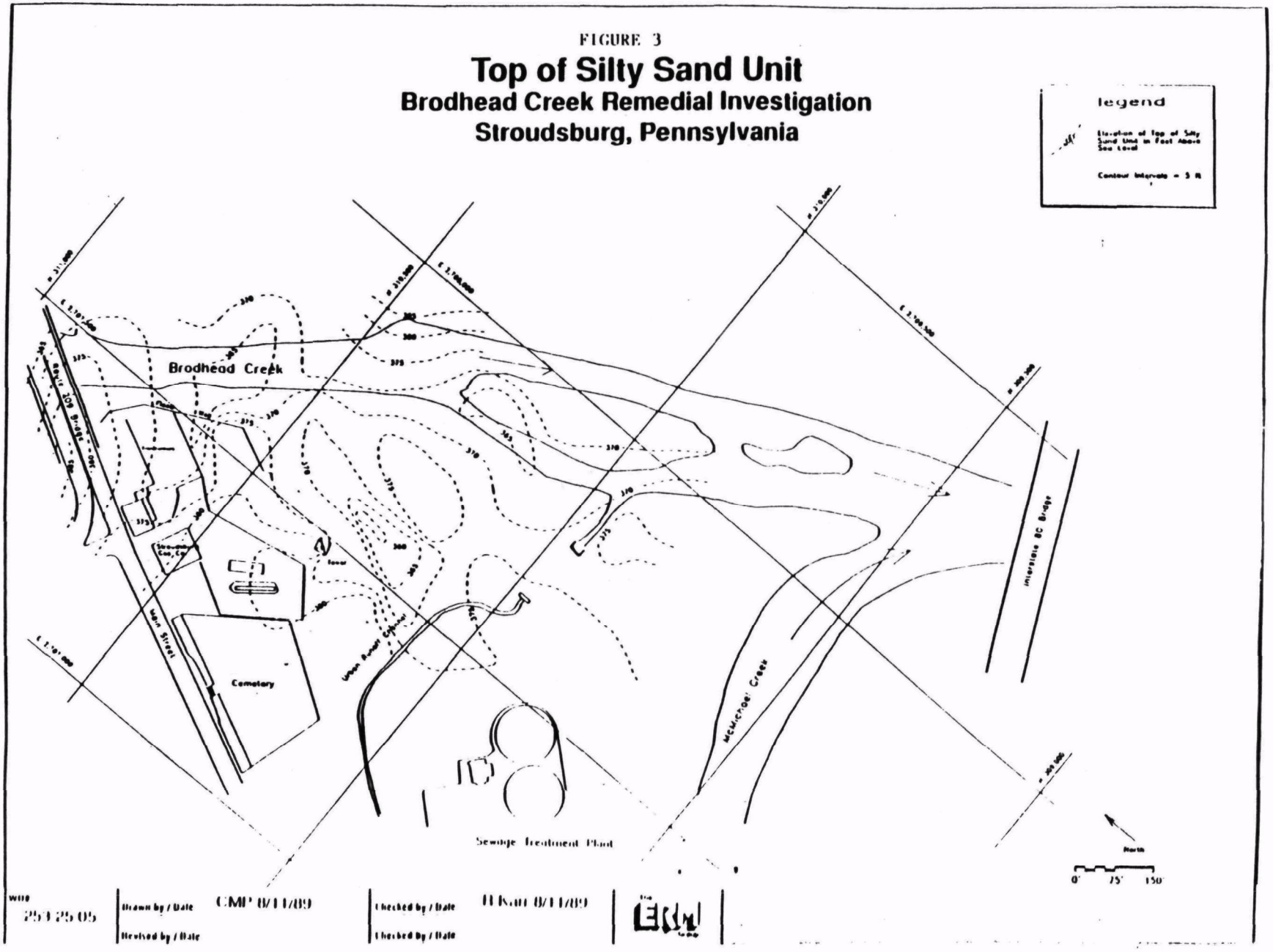
Historic site borings and test pit observations indicate that the stream gravel deposits are limited in horizontal extent, pinching out in the west-central and southern portion of the study area. The stream gravel thickness averages about 10 to 15 feet, but ranges from absent in some parts of the study area to a maximum of over 25 feet in a stratigraphic depression near the center of the Site. Figure 3 shows a contour map of the base of the stream

FIGURE 3

Top of Silty Sand Unit

Brodhead Creek Remedial Investigation

Stroudsburg, Pennsylvania



gravels (or the top of the underlying silty sands) which shows this stratigraphic depression. The shape and location of the stratigraphic depression suggest that it may have been coincident with a confluence of the ancestral Brodhead Creek and another ancestral drainage. However, it is postulated that the depression is a kettle feature created by the melting of a large block of glacial ice embedded in the silty sand.

The thickness of the stream gravel unit beneath and immediately east of Brodhead Creek is well defined. However, the extent of the stream gravel east of the eastern levee is not known. Because the stream gravel is a channel deposit, it is not expected to be extensive. The unit is thin in this area, ranging between approximately 10 feet thick on the north near the Interborough Bridge to approximately 16 feet thick across from the island located in Brodhead Creek. Borings and backhoe pits on the island indicated a significant thinning of the gravel unit beneath Brodhead Creek due to downcutting by erosion and/or dredging. Under the island, the unit thins to 4 to 6 feet thick. Since the stream bed itself is at a lower elevation than the island surface, the unit is even thinner under the stream, and may possibly be absent in some areas.

A deposit of stratified fine sands and silts, with some clayey and gravelly lenses underlies the stream gravels at the Site. These sediments have been described as fairly uniform silty sands with virtually no clay fraction present. Available data indicates that these sediments appear to be about 60 feet thick. Underlying the deposits is a glacial till deposit. The thickness of the till beneath the Site is presently not known, but buried valleys as deep as 300 feet occur in this region.

The Stroudsburg Borough is zoned with areas designated residential, commercial, and open space. At the Brodhead Creek Site, the creek, its eastern and western banks, and the small promontory at the confluence of Brodhead and McMichael Creeks are zoned as open space. The land from the top of the flood control levee westward through Main street is zoned as general commercial land. Land use at the Brodhead Creek Site is categorized as undeveloped, with some areas (sewage treatment plant and Stroudsburg Gas Company) being classified as utilities.

The region surrounding the Borough of Stroudsburg includes a Pocono Mountains recreational area used for skiing, hiking, camping, hunting, and fishing. Stroudsburg Borough occupies 1.3 square miles and has a population density of 4,571. In 1988, the borough had 5,943 residents. Stroudsburg Borough is served by a public water supply owned by the Stroudsburg Municipal Authority. The urban areas of Stroudsburg and East Stroudsburg are supplied by surface and ground water. The Stroudsburg Municipal Authority obtains its water supply from Brodhead Creek (upstream of the Site) from water that is pumped directly to the Municipal Authority

Plant. The Borough of East Stroudsburg receives its water via a gravity feed from two impoundment reservoirs in Smithfield Township, and from three wells in the City of East Stroudsburg. Two of the wells are located on the campus of East Stroudsburg while the third is a well screened at the top of bedrock and located over 2,000 feet upstream of the Site, on the opposite side of Brodhead Creek in Dansbury Park.

A total of forty potable wells are present within a two mile radius of the Brodhead Creek Site, of which 33 wells are domestic wells. Most of these wells are installed in bedrock. Because of Borough of Stroudsburg ordinances restricting their use, private wells cannot be used for drinking water or bathing purposes within the Borough. Residents must hook up to the municipal water supply.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

Union Gas Company is a successor to companies which operated a coal gasification plant along the west bank of Brodhead Creek in Stroudsburg, Pennsylvania, from approximately 1888 to 1944. A waste product from these operations was a black tar-like liquid (coal tar) with a density greater than water and principally composed of polynuclear aromatic hydrocarbons (PAHs). These wastes were placed in an open pit located on the property. This practice continued until the mid-1940's.

In 1917, Pennsylvania Power & Light Company (PP&L) purchased the electrical section of the Union Gas Company facilities. From 1917 until the 1960's, PP&L acquired adjoining properties in sections, among which was property owned by Union Gas Company.

On October 7, 1980, during construction repairs to the toe of the flood control levee at the Site, materials identified as coal tar were observed seeping into Brodhead Creek. As a result, several investigations and emergency response measures were initiated from 1981 through 1984 under the direction of EPA including:

(1) Installation of filter fences and underflow dams by the Pennsylvania Department of Environmental Resources (PADER) and EPA to intercept coal tar seepage;

(2) Installation of a coal tar recovery pit by PADER on the bank of Brodhead Creek;

(3) Construction of a slurry wall by EPA to mitigate coal tar migration from the Site toward Brodhead Creek;

(4) Excavation of backwater channel area where coal tar seepage appeared to be particularly significant; and

(5) Installation of recovery wells in the main coal tar pool by PP&L with subsequent recovery of approximately 8,000 gallons of coal tar.

The installation of filter fences and underflow dams were temporary measures to control the immediate discharges to Brodhead Creek. The installation of a coal tar recovery pit was discovered not to be a viable method of coal tar recovery.

The slurry wall installed at the Site was designed to halt the lateral flow of free phase coal tar to Brodhead Creek through the stream gravel unit at the Site. The wall is 648 feet in length, 1 foot wide, and 17 feet deep with the lower two feet keyed (i.e., penetrating) into the silty sand unit onsite. The surface elevation of the slurry wall is 380 feet except for a 100 foot section in the northern area of the Site where the surface elevation is 382 feet. The wall bottom elevation is 365 feet except for a section 170 feet in length across the stratigraphic depression where the wall bottom extends downward to 358.5 feet. The upstream end of the slurry wall abuts the sheet piling base of the concrete flood wall. The downstream end of the slurry wall is keyed into a cement/bentonite grout curtain 50 feet in length that joins the levee core. Since the wall is keyed at its base into the finer grained and lower permeability silty sand unit, the slurry wall prevents the migration of free phase coal tar. However, the wall does not constitute an absolute barrier to ground water flow toward Brodhead Creek since ground water may flow beneath and around it.

In January, 1982 EPA and PADER conducted a program designed to remove coal tar from a backwater-channel area formerly located just upstream of the urban runoff channel on the creek side of the levee. This program entailed the excavation of sediment from an area 350 feet long, 10 feet wide, and 7 feet deep. A total of about 900 cubic yards were removed with approximately 280 cubic yards drummed and disposed of at a secure landfill. Upon completion of the excavation programs, the excavation was dewatered and backfilled with 600 cubic yards of clay and 300 cubic yards of clean soil, overlain by stone rip rap. Thus, the backwater channel no longer exists.

PP&L began operation of a coal-tar recovery system in February 1982. The recovery of coal tar was conducted principally at the central recovery well nest (RCC) which intercepted a coal tar pool located in a stratigraphic depression onsite. A total of 8,000 gallons of relatively pure coal tar was removed from the stratigraphic depression. The recovery system was decommissioned in July 1983.

Under provisions of CERCLA, the Site was placed on the National Priorities List (NPL) in December, 1982 with a hazard ranking score (HRS) of 31.09. The regulations enacted pursuant to

CERCLA require that a Remedial Investigation and Feasibility Study (RI/FS) and baseline risk assessment be conducted at each NPL site. The purpose of an RI is to characterize conditions at the site. The subsequent FS then develops, screens, and analyzes a series of remedial alternatives for addressing contamination at the site. On August 20, 1987, PP&L and Union Gas Company entered into a Consent Order and Agreement with PADER to conduct the RI/FS for the Brodhead Creek Site. Field work for the remedial investigation was initiated on August 16, 1988 and was completed by April 4, 1989.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

The RI/FS and Proposed Plan for OU-1 were released for public comment as part of the administrative record file on February 15, 1991, in accordance with Sections 113(k)(2)(B), 117(a), and 121 (f)(1)(G) of CERCLA. These and other related documents were made available to the public in both the administrative record file located in EPA Region III offices and at the Stroudsburg Borough Building in Stroudsburg, Pennsylvania; a notice of their availability was published in the Pocono Record on February 15, 1991. A public meeting to discuss the Proposed Plan for OU-1 was held on February 27, 1991 in Stroudsburg, Pennsylvania. EPA's response to all comments on the Proposed Plan received during the comment period is included in the Responsiveness Summary in this ROD. In addition, a copy of the transcript of the public meeting has been placed in the administrative record file and information repository.

IV. SCOPE AND ROLE OF RESPONSE ACTION

Actual or threatened releases of hazardous substances from the Site, if not addressed through a remedial action, may present a current or potential threat to public health, welfare, or the environment.

Section 300.430(a)(1)(ii)(A) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR 300.430(a)(1)(ii)(A), provides that Superfund NPL sites "should generally be remediated in operable units when early actions are necessary or appropriate to achieve significant risk reduction quickly, when phased analysis or response is necessary or appropriate given the size or complexity of the site, or to expedite the completion of a total cleanup".

EPA has divided the remedial work to be undertaken at the Brodhead Creek Site into two manageable components called "operable units (OUs)". These are as follows:

OU-1: Contaminated subsurface soils containing free coal tar in the stream gravel unit

OU-2: All ground water in the subsurface units from the stream gravel to and including bedrock

This Record of Decision has been prepared to document the selected interim remedy for OU-1. The materials to be addressed in OU-1 present the principal threats posed by the Site. OU-2 will be addressed in a future Proposed Plan and Record of Decision after further investigations are conducted to assess all ground water in the subsurface units from the stream gravel to and including bedrock at the Site.

It has been determined that an interim remedial action should be taken under OU-1 to initiate reduction of toxicity, mobility, and volume of contaminants in the stream gravel unit at the Site. This interim action will entail the removal of the free coal tar (i.e., coal tar at 100% pore volume saturation) from the stream gravel unit. The free coal tar is a principal threat to human health and the environment as it imparts high levels of contaminants into the ground water in the stream gravel unit and may serve as a potential source of release of contamination to the ground water in bedrock. Implementation of this interim action will remove the source of the highest level of contamination and will also reduce further leaching of contaminants into the ground water.

In addition to minimizing the migration of contaminants by this interim action, data generated during the implementation of the interim remedial design and the further investigations for OU 2 will provide the information necessary to determine whether (and where) restoration of ground water to beneficial use and/or ground water "background" quality conditions is feasible. A final remedial action addressing ground water and subsurface soil contamination shall be selected through a subsequent Record of Decision (ROD).

V. SUMMARY OF SITE CHARACTERISTICS

A. Waste Characterization

The coal tar disposed of in the subsurface soils at the Brodhead Creek Site was the waste product of a coal gasification plant which operated at the Site between 1888 and 1944. No factual accounts of actual operations at the plant exist nor is there any certainty of the actual process or processes used to manufacture the gas. However, the tars generated by gas manufacturing plants have several general characteristics including: (1) a density slightly greater than water; and (2) a composition lacking tar acids (primarily phenolics) but containing large amounts of high molecular weight residual material with 40-75% of the tars boiling above 300·C.

The chemical constituents of coal tars are primarily polynuclear aromatic hydrocarbons (PAHs), including heterocyclic compounds. Coal tars typically consist of the following:

Composition	Distillation Range	Typical Composition
Light Oil	Up to 200•C	Monocyclic Aromatics
Middle Oil	200-250•C	Substituted monocyclic and dicyclic aromatics
Heavy Oil	250-300•C	Substituted dicyclic aromatics
Anthracene Oil	300-350•C	Substituted dicyclic aromatics; tri- and polycyclic aromatics
Pitch		Carbon, wax, bottoms

During the RI at the Site, a sample of coal tar from well RCC-C was collected and submitted for percent water and fractional distillation testing. The distillation data and specific gravity (which approached that of water) indicate that the coal tar at the Brodhead Creek Site consists of approximately 50% light and middle oil components. Based on the distillation data, the light and middle oil component would suggest that naphthalene and substituted naphthalene are the likely major component of the coal tar.

Metals analysis of the coal tar revealed slightly elevated arsenic concentrations in the tar. The remaining metals values were below average concentrations observed in the natural soil environment occupied by the coal tar.

Coal tar is not a Resource Conservation and Recovery Act, as amended, (RCRA) listed waste. However, the coal tar constituents are sufficiently similar to the RCRA listed K087 waste that it is both relevant and appropriate to meet some of the RCRA requirements for said listed waste.

B. Mechanics and Extent of Coal Tar Migration

The coal tar at the Brodhead Creek Site has a density slightly greater than water. Once coal tar was introduced into the subsurface at the Site, the density differential caused the coal tar to sink downward through both the unsaturated and saturated sections of the stream gravel unit to the interface with the silty sand unit.

The coal tar movement downward into the finer grained silty sand is prevented by the higher capillary pressures within the much smaller diameter pores of that unit. From the source area,

continued migration has been lateral downgradient along the sloping surfaces of the silty sand unit to lower points where it accumulated if sufficient coal tar volume was present. This process accounts for the historic accumulation of recoverable volumes of coal tar within the stratigraphic depression in the silty sand unit located directly downgradient of the former gasification plant facilities.

Figure 4 depicts the areas defined as the extent of the coal tar contamination. The area defined as the extent of the coal tar presence encloses all historical coal tar observations, and it cannot be inferred that the entire area is contaminated by a continuous layer of mobile coal tar. It is the area where coal tar may have migrated through coarser grained material in the stream gravel unit and where coal tar may remain at residual saturation levels. The region of the Site outside of the area defining the extent of coal tar presence, based on all available information, appears to be unaffected by coal tar and the coal tar does not appear to have migrated into these areas in the past. No coal tar was found to be present east of Brodhead Creek. This is consistent with the configuration of the surface of the silty sand unit.

The horizontal and vertical extent of potentially recoverable coal tar has been identified through periodic surveys of the RI monitoring wells for the presence of a free coal tar (i.e., coal tar at 100 % pore volume saturation) surface. Figure 4 depicts the likely extent of stratigraphically bound, but potentially recoverable coal tar based on the data that are available. This figure was compiled from stratigraphic data, the well measurements of the free coal tar surface during the RI, and the historic coal tar observations. As can be seen from Figure 4, potentially recoverable coal tar is trapped in a portion of the stratigraphic depression east of the slurry wall proximal to monitoring well-2 (MW-2) and in the lowest portion (below about elevation 360 feet) of the stratigraphic depression west of the slurry wall as measured in the central recovery well cluster (RCC). Both of these free coal tar accumulations can reasonably be considered to be immobilized by the configuration of the top of the silty sand, and thus are not capable of further migration as bulk non-aqueous phase. Based on the RI data, it has been concluded that the coal tar observed in MW-2 is currently immobile material which was present prior to construction of the slurry wall onsite, and which was trapped in the portion of the stratigraphic depression east of the slurry wall. It was also concluded that the coal tar observed in the area of RCC is material which has slowly drained into the stratigraphic depression west of the slurry wall from upgradient areas onsite. This pooled coal tar is effectively immobile. Figure 5 shows a stratigraphic cross-section depicting this configuration.

The total areal extent of subsurface stream gravel affected by free coal (areas MW-2 and RCC) is estimated to be 1,463 square feet

FIGURE 4

Maximum Probable Extent of Free Coal-Tar Surface

Brodhead Creek Remedial Investigation
Stroudsburg, PA

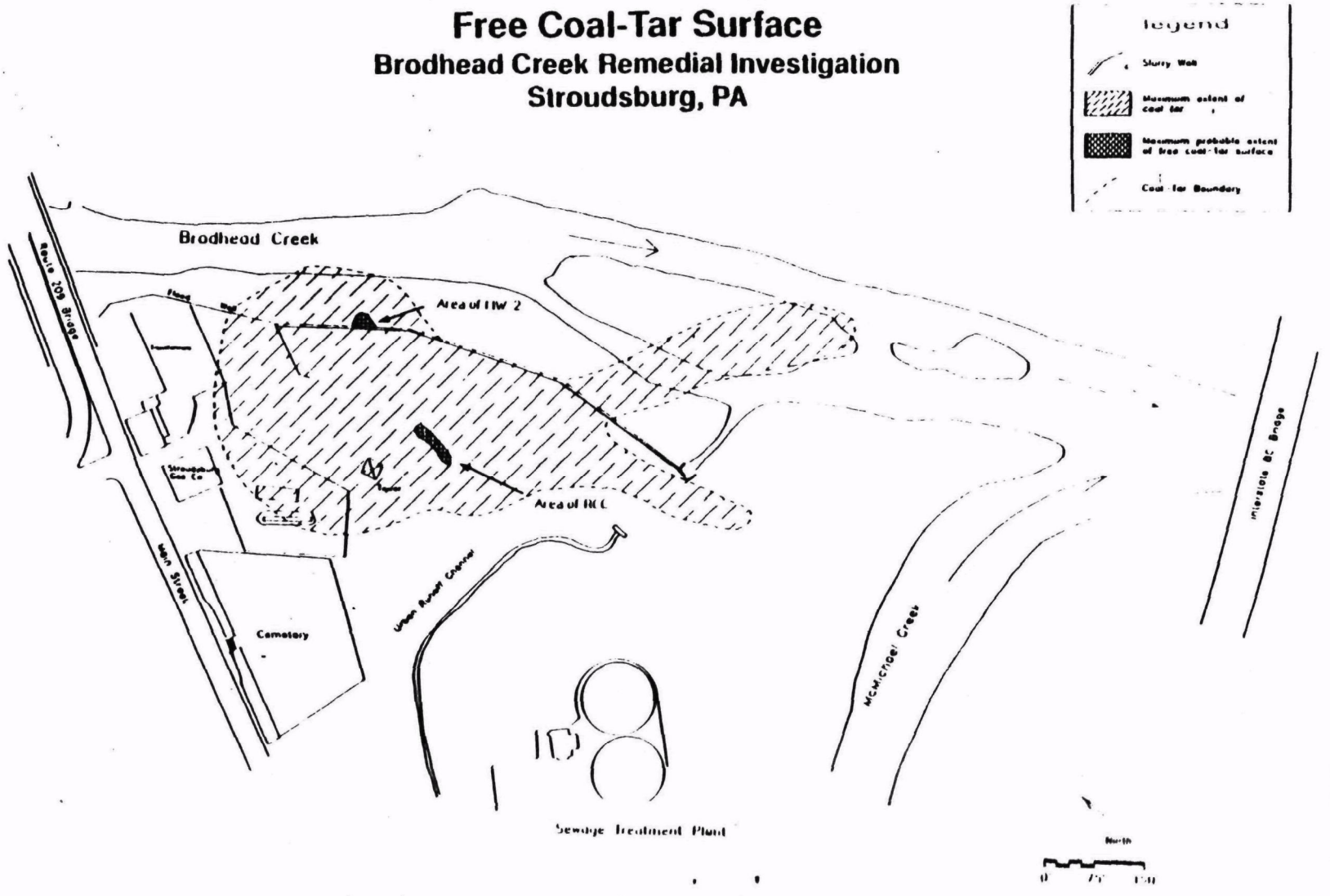


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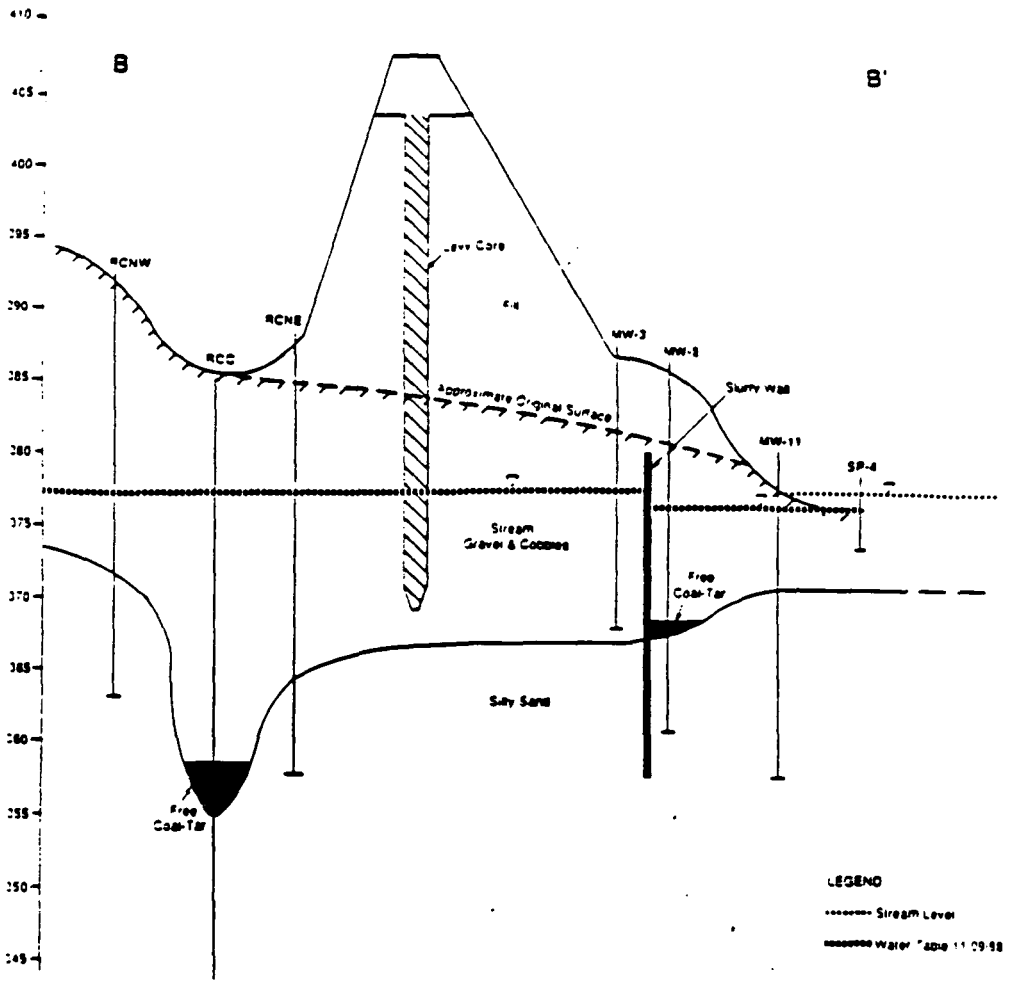
FIGURE 5

Cross Section B-B'

Brodhead Creek Remedial Investigation
Stroudsburg, PA



Note: Dimensions in Feet

25 0 25 50 100

Scale in Feet

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(0.03 acres), and the volume is estimated at 179 cubic yards. The total volume of free coal tar associated with these areas is estimated to be approximately 9,000 gallons, with 8,715 gallons and 338 gallons of free coal tar associated with the RCC and the MW-2 areas, respectively. Based on these volume estimates, the RCC area contains greater than 96% of the free coal tar present at the Brodhead Creek Site.

The extent of subsurface stream gravels affected by coal tar at residual saturation levels (i.e., coal tar at less than 100% pore volume saturation) is estimated to be 128,702 square feet (2.96 acres), and the volume is estimated at 27,558 cubic yards. The total volume of residual coal tar at the Site is estimated to range from 303,000 gallons to 409,348 gallons.

Therefore, the results of the total coal tar (both free and residual) volume estimates for the Site indicate that between 312,053 gallons and 418,053 gallons of coal tar are present in the subsurface soils at the Site. Details on the coal tar volume calculations are contained in the Brodhead Creek Feasibility Study Report.

C. Ground Water

The principal shallow water bearing strata at the Site are the stream gravel unit and the underlying silty sand unit. Together, they comprise a water table aquifer. While the two stratigraphic units of the water table aquifer differ with respect to hydraulic characteristics, they may be considered to be a single aquifer with regard to ground water flow direction and gradient as they are not separated by any intervening confining layers.

The median depth to ground water at the Site was 10 feet prior to the construction of the slurry wall. Construction of the slurry wall at the Site as a response measure to prevent coal tar migration has resulted in a significant alteration of the water table flow regimes. At present, the water table is nearly coincident with the ground surface in the flood plain areas upgradient of the slurry wall, and 3 to 7 feet below surface downgradient of the slurry wall. A ground water head loss of 2 to 3 feet across the slurry wall is present. The sheet pile base of the concrete flood wall extends (to a lesser extent) the head loss effect of the slurry wall northward from the slurry wall to at least the InterBorough Bridge abutment.

Hydraulic head levels appear to indicate that an upward flow component may exist between the water table and the underlying strata. Hydraulic head levels indicate that the urban run-off channel likely recharges the ground water system. Hydraulic head levels appear to indicate that Brodhead Creek and McMichael Creek are hydraulic boundaries, and, along Brodhead Creek the majority

of this boundary is characterized by ground water discharge conditions.

Ground water flow from the upgradient side of the slurry wall is both downward beneath the slurry wall/flood wall and southward to Brodhead Creek south of the urban run-off channel outlet. This ground water flow likely does carry aqueous phase coal tar constituents from the upgradient side of the slurry wall to the downgradient side with subsequent discharge to Brodhead Creek. North of the urban run-off channel outlet, the ground water system on the downgradient side of the slurry wall discharges to Brodhead Creek in the northern most portion, is recharged by Brodhead Creek in the middle portion of the study area, and discharges to Brodhead Creek in the southern portion. South of the urban run-off channel outlet to the confluence with McMichael Creek, the ground water system discharges to Brodhead Creek.

The recharge/discharge conditions along Brodhead Creek are altered by high creek stage at times of high precipitation. RI data indicates that at these times, the ground water system is recharged along the entire length of Brodhead Creek.

Two rounds of ground water sampling were conducted at the Site during the RI. Samples were collected from both monitoring wells and stream piezometers of the RI monitoring network (see Figure 6). The first round of sampling was conducted from October 17-21, 1988 and the second round of ground water sampling was conducted from December 13-15, 1988. A number of volatile, semivolatile, and inorganic constituents were detected in the sample analyses. Volatiles detected included benzene, toluene, ethylbenzene, and total xylenes; semivolatiles included naphthalene, acenaphthene, fluorene, anthracene, fluoranthene, pyrene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene; inorganics included cyanide, arsenic, barium, iron, and manganese. Maximum and average concentrations of those chemicals which exceeded Safe Drinking Water Act maximum contaminant levels (MCLs) are presented in Table 1.

The distribution of organic chemicals in the aqueous phase is the best representation of ground water contamination due to coal tar at the Site and is presented in Figure 7 as an isoconcentration map. It is evident from the sampling data that the highest concentrations of organic coal tar related constituents dissolved in the ground water are centered around the areas of known coal tar presence near MW-2 and RCC. Total organic concentrations in the range of 30,000 ppb to over 50,000 ppb were observed near MW-2 and the RCC area, diminishing rapidly to 10 ppb or less with distance away from these locations.

It is EPA's Superfund policy to use EPA's Ground Water Protection Strategy and Ground Water Classification Guidelines to

FIGURE 6

RI Monitoring Network
Well Locations
Brodhead Creek Remedial Investigation
Stroudsburg, PA

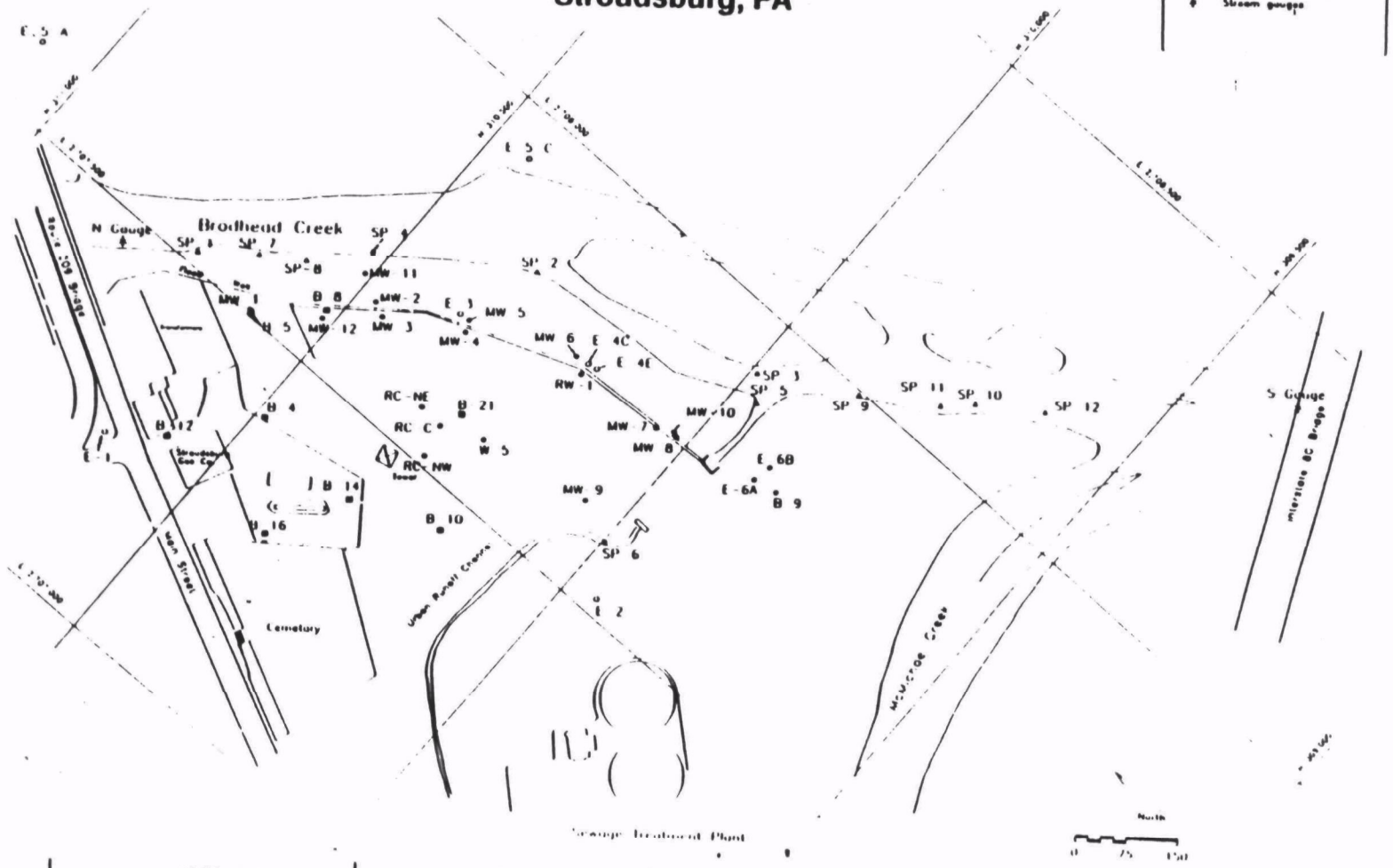

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TABLE 1

EXCEEDANCES OF MAXIMUM CONTAMINANT LEVELS
FOR CONTAMINANTS IN GROUND WATER
(all concentrations are in ug/l)

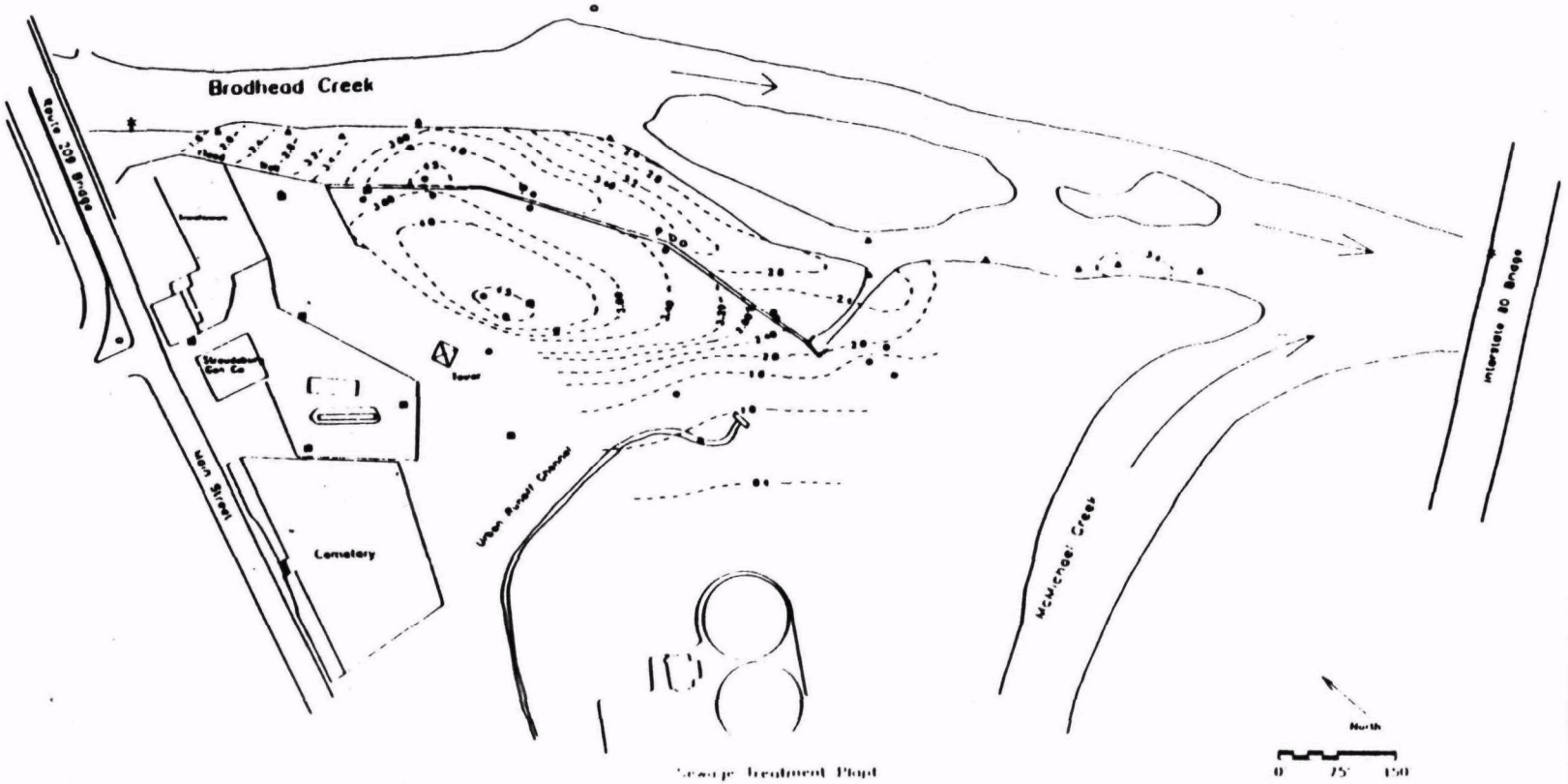
CHEMICAL	GROUND WATER CONCENTRATIONS MAXIMUM	AVERAGE	MCL
Benzene	1100	210	5
Benzo(a)anthracene	290	22.6	0.2 *
Chrysene	300	22.6	0.2 *
Benzo(b)fluoranthene	270	20.2	0.2 *
Benzo(k)fluoranthene	270	20.2	0.2 *
Benzo(a)pyrene	250	19.4	0.2 *
Indeno(1,2,3-cd)pyrene	68	8.36	0.2 *
Dibenz(a,h)anthracene	35	6.64	0.2 *
Arsenic	108	31.3	50

* Proposed MCLs

FIGURE 7

Log of Sum of Total Detected Organics

Brodhead Creek Remedial Investigation
Stroudsburg, PA



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assist in determining the appropriate type of remediation for a Superfund site. Three classes of ground water have been established on the basis of ground water value and vulnerability to contamination. Ground water at the Brodhead Creek Site may be classified as Class II. Class II ground water is ground water which is a current or potential source of drinking water and water having other beneficial uses.

D. Surface Water

Stream flow information for Brodhead Creek was obtained from two U.S. Geological Survey (USGS) gauging stations, one located upstream of the Site and one located downstream of the Site. The northerly (upstream) station is the Analomink Station; the southerly (downstream) station is near Minisink Hills. The drainage area of Brodhead Creek at the Minisink Hills station is 259 square miles. The mean discharge between the stations has varied between 150 and 570 cubic feet per second (cfs).

McMichael Creek, the tributary to Brodhead Creek which lies along the southern boundary of the Site, has a drainage area of 63.9 square miles. Discharge in this creek has ranged from 23.9 cfs, on September 11, 1985 to 2,890 cfs on September 27, 1985.

Samples of stream water were collected from Brodhead Creek on two occasions during the RI. Seven stream water samples (ST-1 to ST-7) were collected during the first sampling round on October 21, 1987 at the locations shown on Figure 8. All samples from thi round, with the exception of ST-2, were submitted for target compound list (TCL) coal tar related constituent analyses. The sample from ST-2 was submitted for full TCL volatile organic, semivolatile organic, inorganic and PCB/pesticide analyses.

Three stream water samples, designated ST-1, ST-2, and ST-4, were collected during the water sampling round on October 26, 1988. Each of these samples was submitted for TCL coal tar related constituent analyses. In addition, a sample of floating sheen material designated "Oily Sheen" was collected and submitted for TCL coal tar related constituent analyses during the second round.

Analytical results from the first round reveals no volatile organics. No semivolatile organics, pesticides, and PCBs were reported above detection limits. In the first round stream water samples, iron ranged from 39 ppb to 75 ppb, however, iron was detected in blank samples above these concentrations. Manganese was reported at 7.7 ppb to 28 ppb in the first round stream water samples. Barium was detected in the oily sheen sample at 510 ppb.

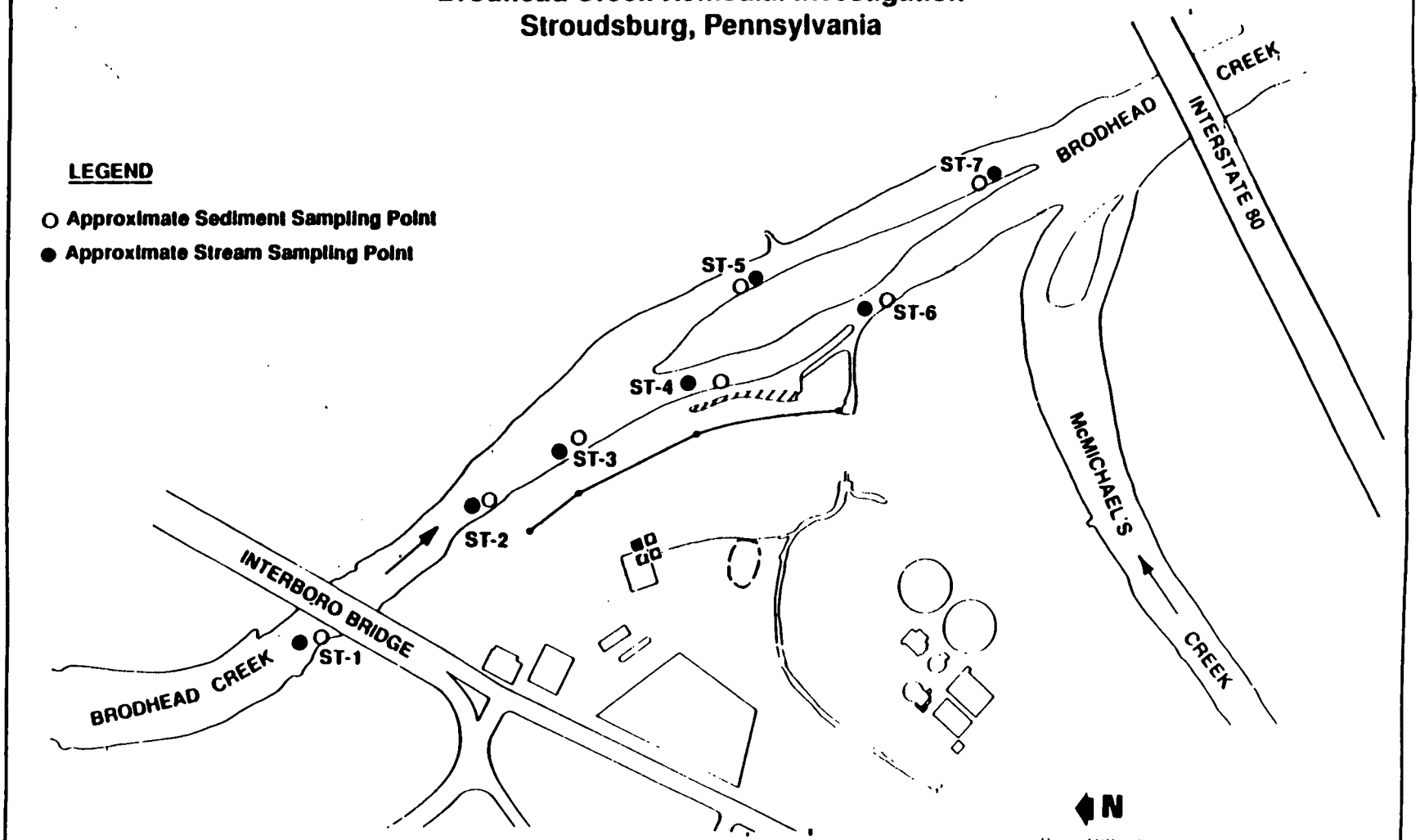
Analytical results from the second round stream water sampling report some low level concentrations of volatile organics. All of the detections occurred at ST-2 where benzene, ethylbenzene, and total xylenes were reported at 3 ppb, 1 ppb, and 2 ppb,

FIGURE 8

Approximate Stream/Sediment Sample Locations

Brodhead Creek Remedial Investigation

Stroudsburg, Pennsylvania



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respectively. The same volatile compounds were detected in the oily sheen sample at 32 ppb, 10 ppb, and 33 ppb, respectively. All of these compounds are components of petroleum fuels. Upstream influences of ST-2, such as highway run-off, may have been present. No semivolatile compounds were detected.

E. Soils

Analytical data are available for four samples of overburden materials collected during the drilling of wells MW-9, MW-10, MW-11, and MW-12. Soil samples from MW-9 and MW-10 were collected from the lowest depth reached during drilling (the silty sand unit) as no evidence of contamination was observed above the boring termination depth. Soil samples from MW-11 and MW-12 were collected from the gravel unit. Traces of coal tar were observed at very low residual saturation levels in the stream gravel unit in the MW-11 installation boring. Tables 2 and 3 give the data from volatile/semivolatile organics and inorganics, respectively.

Volatile organic compound analytical results from samples collected within the silty sand (MW-9 and MW-10) indicated the presence of chloroform at 2 ppb in MW-10. Volatile results from soil samples collected within the gravel unit (MW-11 and MW-12) show evidence of low level contamination in only MW-11 where traces of coal tar were noted in the sampled materials. Four volatile compounds were detected; ethylbenzene and total xylenes at 61 ppb and 100 ppb, respectively, were most prominent.

The semivolatile organic results for the four soil samples range from no detection in the silty sand of MW-9 to high concentrations in the gravel unit at MW-11 where traces of coal tar were observed. The semivolatile organic results from MW-9 showed total unidentified hydrocarbons at 170 ppb. These results suggest that the southerly extent of the contamination, if any, in the silty sand lies north of MW-9 on the west side of the slurry wall. Semivolatile results from the silty sand at MW-10 show low concentrations of acenaphthene, phenanthrene, and pyrene at 62 ppb, 130 ppb, and 58 ppb, respectively. Given the very low mobility of these compounds and their relatively low level concentrations, their detection within the silty sand may be the result of auger dragdown during drilling. However, their presence in the silty sand sample from MW-10, located immediately downgradient of the slurry wall, may also be the result of aqueous phase transport and ground water flow under the slurry wall.

The semivolatile organics results for gravel samples collected from MW-11 and MW-12 indicated the presence of site-related semivolatile organics. The concentration of individual semivolatile compounds present in the MW-11 results are very high, suggesting the presence of residual saturation coal tar within the sample matrix. The MW-12 results show much lower concentrations and are inconclusive. In MW-11, reported concentrations ranged

TABLE 2

SOIL SAMPLE RESULTS

TCL Organic Analyses

Collected 27-29 September 1988

Brodhead Creek Remedial Investigation

Stroudsburg, PA

(All concentrations reported in ug/Kg on a dry-weight basis)

ERM Traffic Report Number	12068		12066		12064		12061	
Sample Location	MW-9		MW-10		MW-11		MW-12	
CompuChem Number	220092		220083		219716		219706	
Date of Collection	9/29/88		9/28/88		9/28/88		9/27/88	
Percent Moisture	22		10		24		20	
VOLATILE ANALYSES								
Dilution Factor	1.0		1.0		1.0		1.0	
Methylene Chloride	12	B	7	B	14	B	22	B
Acetone	16	B	14	B	23	B	15	B
Chloroform	2	J						
Benzene					2	J		
Ethylbenzene					61			
Styrene					2	J		
Total Xylenes					100			
Tentatively Identified Compounds	ND		ND		ND		ND	
SEMIVOLATILE ANALYSES								
Dilution Factor	1.0		1.0		5/15		1.0	
pH	7.1		7.0		7.1		7.1	
Naphthalene					27000		49	J
2-Methylnaphthalene					54000			
Acenaphthylene					2700		140	J
Acenaphthene			62	J	19000		73	J
Dibenzofuran					2700			
Fluorene					15000		140	J
Phenanthrene			130	J	34000		310	J
Anthracene					9800		170	J
di-n-Butylphthalate							60	J
Fluoranthene					6400		310	J
Pyrene			58	J	15000		550	
Butylbenzylphthalate							1000	
Benzo(a)Anthracene					4500		220	J
Chrysene					3500		220	J
bis(2-Ethylhexyl)Phthalate	1100	B	2200	B	1000	B	970	B
Benzo(b or k)Fluoranthene*					2900		210	J
Benzo(a)Pyrene					2800		220	J
Indeno(1,2,3-cd)Pyrene					590	J	46	J
Benzo(g,h,i)Perylene					600	J	63	J
Tentatively Identified Compounds								
Total Unknown Hydrocarbons	170	J	150	J	25000	J	2300	J
Total Polynuclear Aromatics					450000	J	2400	J
Total Unknowns			300	J				
TOTAL PHENOLICS	NR		NR		130			

QUALIFIER CODES:

B - This result is qualitatively invalid since this compound was detected in a blank at a similar concentration.

J - This result is a quantitative estimate.

NR - Analysis for this parameter not required.

Note: No concentration is entered for compounds which were not detected.

* Unresolved isomers.

TABLE 3

SOIL SAMPLE RESULTS
Full TAL Total Inorganic Analyses
Collected 27-29 September 1988
Brodhead Creek Remedial Investigation
Stroudsburg, PA
(All concentrations reported in mg/Kg on a dry weight basis)

Traffic Report No.	12068		12066		12064		12061	
Sample Location	MW-9		MW-10		MW-11		MW-12	
CompuChem No.	220100		220099		219723		219721	
Date of Collection	9/29/88		9/28/88		9/27/88		9/27/88	
% Solids	78		90		82		80	
Aluminum	4570		6550		8350		5090	
Antimony								
Arsenic	3.9		3.8		4.1		2.3	
Barium	23		31		47		24	
Beryllium	0.49		0.42		0.44		0.48	
Cadmium								
Calcium	2100	J	2120	J	9790	J	381	J
Chromium	4.4		10		13		8.1	
Cobalt	6.0		6.0		8.3		7.4	
Copper	18	B	15	B	19	B	14	B
Iron	10800		15900		18000		11400	
Lead	8.9	J	8.4	J	15	J	7.6	J
Magnesium	1950	J	2460	J	7890	J	1920	J
Manganese	404	J	348	J	676	J	171	J
Mercury								
Nickel			14		20		14	
Potassium							730	B
Selenium	0.61	B						
Silver					2.3*	J		
Sodium					345	B	588	B
Thallium								
Vanadium	5.8		7.6		11		7.0	
Zinc	47	J	59	J	80	J	53	J
Cyanide								

QUALIFIER CODES: B - This result is qualitatively invalid since this analyte was detected in a blank at a similar concentration

J - This result is a quantitative estimate.

* This result is reported [illegible] duplicate analyses of this sample

Note: No concentration [illegible] for analytes which were not detected

from 590 ppb for indeno(1,2,3-cd)pyrene and up to 54,000 ppb for 2-methylnaphthalene. Total PAHs were tentatively identified as present at 450,000 ppb. The results from MW-12 indicate that concentrations ranged from 46 ppb for indeno(1,2,3-cd)pyrene up to 1,000 ppb for benzo(a)anthracene.

Total phenolics were analyzed only for the stream gravel sample from MW-11. They were reported at 130 ppb.

Inorganics analyses were performed for all collected soil samples. Most of the inorganic concentrations reported for the soil samples lie within normal ranges. Exceptions are aluminum, iron, and sodium, which appear to be somewhat below normal ranges.

F. Stream Sediments

RI analytical data are available for six stream sediment samples collected along the reach of Brodhead Creek directly adjacent to the Site. These were collected as "grab" samples at locations from upstream of the InterBorough Bridge to the confluence of McMichael Creek.

The results of volatile organic analyses indicate the detection of these chemicals in only one sample. Methylene chloride at 710 ppb at location ST-1, upstream of the Site. As methylene chloride is a common laboratory contaminant, this chemical is not considered to be of Site origin.

Coal tar related semivolatile organics were detected in samples from two locations, ST-1 and ST-6. At ST-1, phenanthrene, fluoranthene, pyrene, and chrysene were detected at 58 ppb, 85 ppb, 120 ppb, and 62 ppb, respectively. As ST-1 is upstream of the Site and well beyond the documented presence of coal tar presence, it is not considered to be of Site origin. Also, the absence of a larger suite of coal tar related compounds suggests an alternative origin from an upstream location.

The results from location ST-6 indicate that coal tar related compounds are present. Location ST-6 is downstream of the Site and is located just at the outlet of the urban run-off channel into Brodhead Creek (Figure 8). In view of the historic releases of coal tar from the former backwater channel with subsequent migration to Brodhead Creek via the urban run-off channel, detection of coal tar related compounds at this location is not unexpected. At ST-6, a larger suite of coal tar related compounds, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, and benzo(b)fluoranthene were detected at 55 ppb, 160 ppb, 180 ppb, 110 ppb, 110 ppb, and 59 ppb, respectively.

Inorganics were analyzed in all stream sediment samples collected at the Site. Most inorganics concentrations were within normally expected limits for soils except aluminum and calcium,

which appear to be below normal limits. Cyanide was not detected in any sample.

G. Air Quality

An air quality investigation was conducted to assess the presence of volatile organic compounds at the Site. No volatile organic compounds were detected during the investigation.

H. Biota

The results of the numerous aquatic biological surveys conducted at the Brodhead Creek Site indicate that the creek exhibits relatively diverse, healthy benthic and macroinvertebrate and fish communities (including trout), with no significant effect by the Site either within or downstream of the coal tar area.

Two species were sampled at the Site during the RI. The tissues of the sampled biota were submitted for TCL coal tar related constituent analyses to assess any Site contributions to the body burden of the biota. Both trout and sea lamprey larvae were collected from locations upstream and downstream of the Site.

Volatile organic compound results for both the upstream and downstream fish tissue samples indicate detection of these chemicals at low concentrations in all three upstream tissue samples and only one downstream sample. Four volatile organi compounds, carbon disulfide, 2-butanone, benzene, and total xylen were reported at maximum concentrations of 7 ppb, 41 ppb, 10 ppb and 11 ppb, respectively. Neither carbon disulfide nor 2-butanone are coal tar related and likely originate from a source other than the Site. It is commonly recognized that 2-butanone is a laboratory contaminant. These two compounds were detected in ground water only once at separate locations and at very low levels during the Site ground water survey. Similarly, although benzene and xylene are the most prevalent volatile organic compounds detected in onsite ground water, there presence in fish tissue may be due to an offsite source.

Semivolatile organic compound results from the fish tissue samples indicate detections of these chemicals in one upstream tissue sample and one downstream fish tissue sample. Analytical results indicate that bis(2-ethylhexyl)phthalate was present in an upstream tissue sample at 160 ppb, and 4-methylphenol was present in a downstream tissue sample at 380 ppb. Neither compound is a major constituent of coal tar. However, the latter could be a metabolite of PAHs. Twenty-nine other semivolatile organics were tentatively identified in upstream and downstream fish tissue samples. Of these, 16 are typical of fish tissue and do not represent contamination. Of the remaining 13, three were identified only in downstream fish tissue samples or were present at concentrations greater than upstream samples. No relationship

can be established between these and the coal tar at the Site, as these compounds are neither identified as constituents of coal tar nor are they naturally occurring in fish tissue.

There is no consistent relationship between coal tar at the Site and the number of organic compounds detected or the frequency of detection in either upstream or downstream fish tissue samples. Some of the compounds found in the fish tissue (such as phenols and diols) could represent metabolites of PAHs. In addition, the organic compounds detected are either typical of fish tissue or can be associated with many sources. Thus, their presence in fish tissue collected at the Site does not conclusively demonstrate an impact by the Site on fish in Brodhead Creek. If fish do uptake PAHs originating from the Site, they rapidly metabolize them, as evidenced by their absence in the fish tissue samples collected. It is to be noted that Brodhead Creek is periodically stocked, therefore, actual fish residence time may not be sufficiently long to reflect Site impacts.

Sea lamprey were also collected at the Site at both upstream and downstream locations. Sea lamprey larvae analytical results for TCL coal tar related constituents revealed the presence of coal tar constituents in the sea lamprey samples analyzed.

Volatile compounds in the sea lamprey larvae samples were found in nearly the same total concentration at both the upstream and downstream stations. Most of the compounds found were tentatively identified below their detection limit. Ethylbenzene, benzene, and 2-butanone were the only volatile compounds found above their detection limits in downstream samples. 2-butanone was the only compound found above its detection limit in the upstream sample and may be due to laboratory contamination. Ethylbenzene and benzene are found in coal tar but their presence in sea lamprey samples may be due to offsite sources.

Semivolatile compounds were also identified in both upstream and downstream samples. Compounds typical of the biochemical processes of fish were also identified and are not of concern. Semivolatile data from the sea lamprey tissue indicates that the sea lampreys have accumulated levels of PAHs above what would be expected at uncontaminated sites. The lampreys can be regarded as a worst-case scenario for fish flesh contamination. Their tendency to accumulate high levels of contaminants is due to their life cycle. Larval lampreys are relatively non-mobile, burrow in the sediments, and feed on algae and other organic particulates. These organic particulates readily absorb PAHs and other organic compounds.

Inorganic analyses were conducted for iron, manganese, and cyanides. None of these inorganics were detected at concentrations of concern.

During the aquatic biota sampling activities, no visible adverse effects on the biota were observed (such as tumors or skin lesions). The sea lamprey population was thriving, as well as the fish population in Brodhead Creek. Fish species that were observed included brown trout, American eels, blue gills and other panfish, white suckers, shiners, etc. In addition, the fish tissue sampling indicated no bioaccumulation of PAHs in tissues.

I. Wetlands

A majority of the land encompassed by the Site boundary is characteristic of wetlands except for the flood control levee itself which is elevated well above the flood plain.

The earthen flood control levee divides the functional flood plain adjacent to Brodhead Creek from the former and presently non-functional flood plain behind the levee. The former flood plain area behind the levee is covered by a dense growth of herbs, vines, shrubs, and saplings. No visual evidence of stressed vegetation was observed. The flood plain areas adjacent to Brodhead Creek are dominated by herbs, except for the area that also borders McMichael Creek, which is characteristic of young forest area. The islands in Brodhead Creek are dominated by herbs and saplings. Six areas designated Wetlands A through F were identified during the remedial investigation and are presented in Figure 9.

VI. SUMMARY OF SITE RISKS

The purpose of the risk assessment performed for the Brodhead Creek Site was to evaluate the human health risk posed by any releases from the Site. In order to estimate the human health risk, the risk assessment focused on the following: (1) the contaminants detected during the RI at the Site; (2) the potential environmental pathways by which populations might be exposed to compounds released from the Site; (3) the estimated exposure point concentrations of the compounds of concern; (4) applicable or relevant and appropriate requirements (ARARs), criteria, and advisories; (5) the estimated intake levels of the compounds of concern; and (6) the toxicity values of the compounds of concern. The level of risk that the Site poses to human health was then quantified.

A. Indicator Chemical Selection

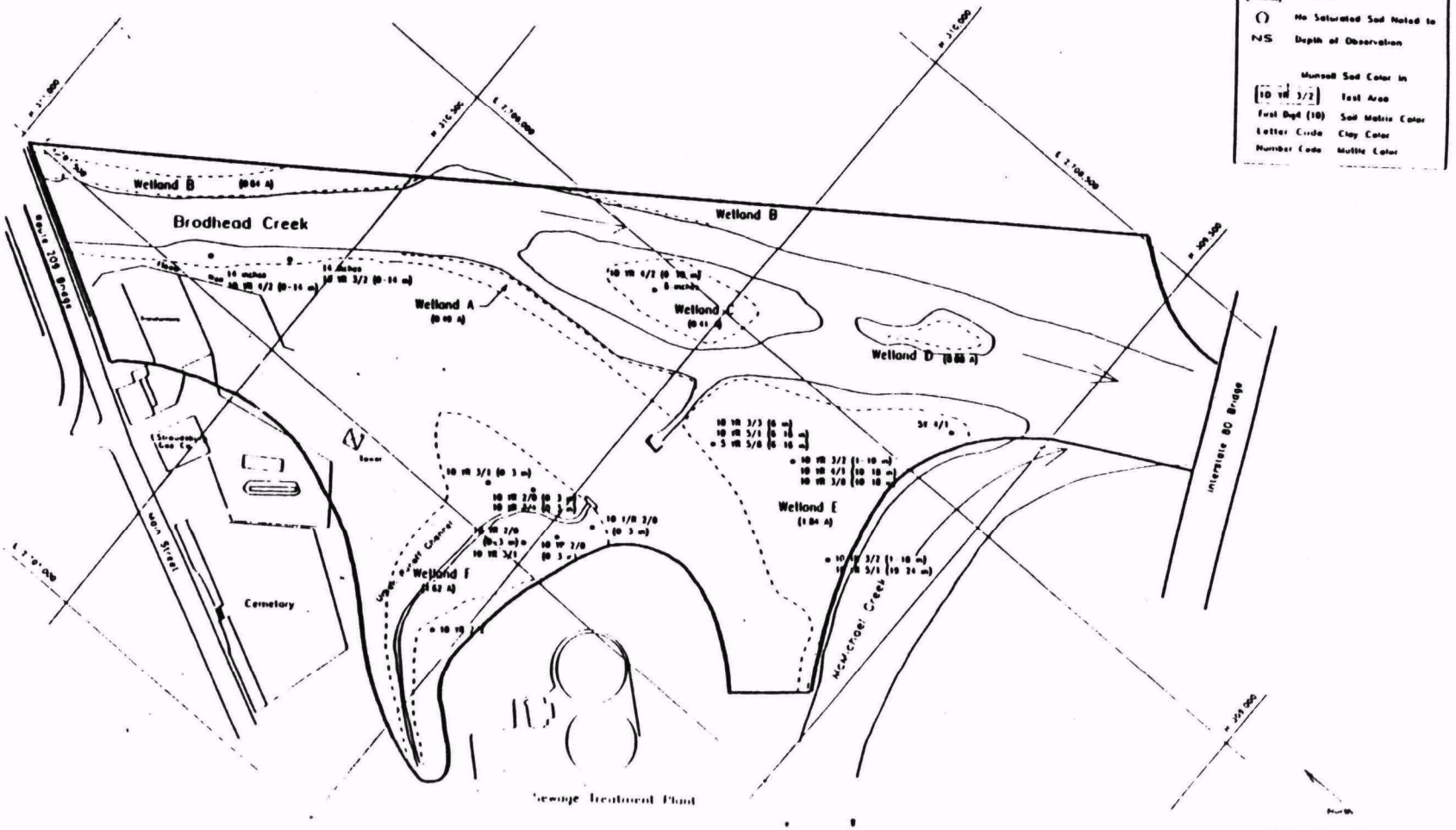
The contaminants identified in the Brodhead Creek Site RI are comprised of a diverse group of compounds with different physical, chemical, environmental, and toxicological properties. The extent of contamination varied widely in concentration and occurrence throughout the Brodhead Creek Site. Moreover, some contaminants represent a greater potential for risk to human health and the environment than others because of the differences in toxicity,

FIGURE 9

Wetlands Areas

Brodhead Creek Remedial Investigation

Stroudsburg, Pennsylvania



WO#	Drawn by / Date	Checked by / Date	
25125.05	CMP 8/11/89	RKatt 8/11/89	ERM
	Revised by / Date	Checked by / Date	

capacity to migrate to receptors, and likelihood of exposure concentrations at levels high enough to pose human health and environmental risks.

The indicator chemicals selected for the Brodhead Creek Site are: benzo(a)pyrene (to represent carcinogenic PAHs); naphthalene (to represent noncarcinogenic PAHs); benzene; and arsenic. The rationale for the selection of these indicator chemicals is presented in the Risk Assessment Report for the Brodhead Creek Site.

B. Exposure Pathways

This step in the risk assessment process involves determining the potential routes of exposure to the human population, the estimated concentrations to which the population is exposed, and the population at risk. The baseline risk assessment at the Brodhead Creek Site considered the potential exposure routes, which included: (1) dermal contact with surface soils, sediments, and surface water; (2) accidental ingestion of surface soils, sediments, and surface water; (3) ingestion of fish from Brodhead Creek; (4) vapor inhalation from surface water; and (5) dust inhalation from surface soils.

Currently, there are no significant risks associated with direct contact with the subsurface soils containing free or residual levels of coal tar. Long-term potential for direc contact with subsurface coal tar would be limited to worker excavating for utility and/or levee construction or maintenance. The infrequency of any such exposures would likely render the risks insignificant.

Due to the steady-state Site conditions, there would be no long term risks related to the recreational use of Brodhead Creek, nor via ingestion of fish from Brodhead Creek. Also, as shown in the Risk Assessment Report for the Site, there are no significant potential risks associated with flood scouring of the residual coal tar beneath the creek bed.

The risk assessment did not analyze the health effects associated with the ingestion of ground water at the Site. As identified in the RI/FS, the ground water in the stream gravel unit at the Site is highly contaminated. Peak concentrations of arsenic, benzene, and other organics measured in the surficial ground water exceed current and proposed Federal drinking water standards. Federal maximum contaminant levels (MCLs) are exceeded for benzene and arsenic in the ground water in the stream gravel unit. Proposed MCLs are exceeded in the ground water for the following PAHs: benzo(a)pyrene; benzo(a)anthracene; benzo(b)fluoranthene; benzo(k)fluoranthene; chrysene; dibenz(a,h)anthracene; and indeno(1,2,3-cd)pyrene (see Table 1).

The coal tar wastes are currently contaminating and/or would continue to contaminate this ground water. The RI data suggests that the free coal tar located in the stratigraphic depression is the principal source of the ground water contamination onsite. The stream gravel unit is not currently used as a water supply onsite. However, exposure to ground water in this stream gravel unit might occur. In addition, the free coal tar located in the stratigraphic depression may serve as a potential source of release of contamination to ground water in the bedrock which is currently used as a drinking water source offsite. Since contaminants detected in this stream gravel unit exceed current and proposed MCLs, there is a potential health risk associated with ingestion of ground water at the Site. Ground water will be the subject of further analysis in OU-2.

C. Toxicity Assessment

Cancer potency factors (CPFs) have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs, which are expressed in units of (mg/kg-day) -1, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the CPF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Cancer potency factors are derived from the results of human epidemiological studies or chronic animal bioassay to which animal-to-human extrapolation and uncertainty factors have been applied.

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs are exposure levels for humans, including sensitive individuals, that are likely to be without an appreciable risk of adverse health effects. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur.

Potential concern for noncarcinogenic effects of a single contaminant in a single medium is expressed as the hazard quotient (HQ) (or the ratio of the estimated intake to the reference dose). By adding the HQs for all contaminants within a medium or across all media to which a given population may reasonably be exposed, the Hazard Index (HI) can be generated. The HI provides a useful

reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media.

Excess lifetime cancer risks are determined by multiplying the intake level with the cancer potency factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1x10-6 or 1E-6). An excess lifetime cancer risk of 1E-6 indicates that, as a plausible upper bound, an individual has a one in one million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at a site.

A summary of the toxicological indices for the indicator chemicals selected for the Brodhead Creek Site are presented in Table 4.

D. Risk Characterization

The potential carcinogenic risks associated with the Brodhead Creek Site were calculated by multiplying chronic daily intakes by the appropriate carcinogenic potency factors. The resultant potential risks are presented in Tables 5 through 9. Table 9 also lists the potential Total Lifetime Carcinogenic Risk posed from exposure to all indicator chemicals and to all the evaluated potential exposure pathways (excluding ground water). This calculated risk, using a CPF of 11.5 (mg/kg/day)E-1 for calculating the carcinogenic risk posed by the PAHs, was found to be 1.98E-5 for adults, 4.02E-5 for children ages 6-12, and 2.84E-5 fo children ages 2-6. These calculated risks fall within EPA' recommended range of 1.0E-4 to 1.0E-6 for CERCLA sites.

This risk includes an increment of risk from arsenic which does not exceed background in surface waters at the Site. The current RI sampling data for arsenic indicates a maximum concentration of 23 ppb (less than the MCL of 50 ppb) and an average concentration equal to 7.5 ppb. Both of these results are well below the acute and chronic Federal Ambient Water Quality Criteria (AWQC). Therefore, no significant risk is posed by arsenic in surface water. In addition, the sediment data indicate arsenic levels (3.1 ppm) within the expected natural soil values (6.0 ppm). Furthermore, the ground water discharging to Brodhead Creek does not increase the arsenic levels in surface water due to the significant dilution at the stream/aquifer interface.

E. Worst Case Risk

Since no PAHs were detected in surface water or in fish tissue during the RI, the carcinogenic risk estimate assumed no PAH-related risk from fish consumption. However, due to the practical limitations of the fish tissue sampling/analysis methodologies, to obtain an absolute worst case carcinogenic risk resulting from fish ingestion, the sea lamprey tissue concentrations are assumed to

TABLE 4

TOXICOLOGICAL INDICES FOR BRODHEAD CREEK SITE INDICATOR CHEMICALS

Indicator Chemical	Federal MCL Value (mg/L)	Toxicologic Class	EPA Rating	CPF (1/mg/kg/day)		RfD or AIC (mg/kg/day)		Source
Arsenic, Inorganic	0.05	HC	A	1.75	Oral	1.4E-03*		CPF-IRIS
			A	50	Inhalation	4.0E-02*		CPF-IRIS
Benzene	0.005	HC	A	2.9 E-2	Oral	4.0E-01*		CPF-IRIS
		HC	A	2.9 E-2	Inhalation	4.0E-01*		
Benzo(a)pyrene to Represent Carcinogenic PAHs	NA	PC	B2	6.1 E+0 #	Oral	4.0E-01*		CPF-SPHEM
		PC	B2	6.1 E+0 #	Inhalation	4.0E-01*		CPF-SPHEM
Naphthalene to Represent Noncarcinogenic PAHs	NA	NC	NC	NA	Oral	4.0 E-1	Rfd	HEA

All RfDs are oral values unless otherwise specified.
NA - Not Available
ND - No Data
IRIS - USEPA's On-Line Integrated Risk Information System (Accessed 5/10/89)
HEA - Health Effects Assessment Manuals, 5/19/88
NC - Noncarcinogenic
HC - Human Carcinogen
PC - Potential Carcinogen
AIC - Acceptable Intake Chronic
PHRED - Public Health Risk Evaluation Database
SPHEM - Superfund Public Health Evaluation Manual
MCL - Maximum Contaminant Level
CPF - Carcinogenic Potency Factor
RfD - Reference Dose

* Either pending or no data available; values shown have been derived by ERM toxicologists. See text for explanation.

Oral and inhalation CPF's for benzo(a)pyrene have been withdrawn from IRIS and are being reevaluated by EPA. The carcinogenic risk posed by benzo(a)pyrene has been calculated using a CPF = 6.1 and CPF = 11.5. See Section 7 of the Risk Assessment Report for more information.

TABLE 5

PP&L BRODHEAD CREEK SITE
CALCULATION OF CARCINOGENIC RISK
FOR DERMAL EXPOSURE
NO ACTION SCENARIO

Exposure Scenario	Exposed Population	Route of Exposure	Area of Exposure	Chemical	Lifetime Adj Chronic Daily Intake (mg/kg/day)	CPF (1/mg/kg/day)	Contribution to Lifetime Carc Risk	Risk w/a CPF of 11 5 for B(a)P
No Action	Adults	Dermal Contact Soils	Surface Soils	Arsenic	NA	1 75	NA	
				Benzene	NA	0 029	NA	
				Benzo(a)Pyrene*	6.408E-10	6 1*	3.909E-9	7 369E 9
				Naphthalene	1 028E-8	NA	NA	
		Dermal Contact Sediments	Sediments	Arsenic	5.894E-8	1 75	1 031E-7	
				Benzene	0	0 029	0	
				Benzo(a)Pyrene	6.764E-09	6 1	4 126E-8	7 779E-8
				Naphthalene	0	NA	NA	
		Dermal Contact Surface Water	Surface Water	Arsenic	1 155E-7	1 75	2 021E-7	
				Benzene	2 226E 4	0 029	6 063E-6	
				Benzo(a)Pyrene	2 172E 7	6 1	1 325E 6	2 498E 6
				Naphthalene	3 568E-7	NA	NA	
	Children 6-12	Dermal Contact Soils	Surface Soils	Arsenic	NA	1 75	NA	
				Benzene	NA	0 029	NA	
				Benzo(a)Pyrene	1 783E-9	6 1	1 088E-8	2 05E 8
				Naphthalene	2.862E-8	NA	NA	
		Dermal Contact Sediments	Sediments	Arsenic	1 640E-7	1 75	2 870E 7	
				Benzene	0	0 029	0	
				Benzo(a)Pyrene	1.882E-8	6 1	1 148E-7	2 164E 7
				Naphthalene	0	NA	0	
		Dermal Contact Surface Water	Surface Water	Arsenic	1 430E-7	1 75	2 502E 7	
				Benzene	2 754E 4	0 029	7 986E 6	
				Benzo(a)Pyrene	2 686E 7	6 1	1 637E 6	3 089E 6
				Naphthalene	4 415E-7	NA	NA	

Partial Lifetime Carcinogenic Risk

Adults	7 738E 6	8 951E 6
Children 6 12	1 028E 5	1 185E 5

NA Not applicable
CPF Carcinogen Potency Factor
Note Numbers are presented in exponential notation 0 001 1 00E 01
*Calculations are based on a 6 1 CPF The calculations for a CPF of 11 5 are presented in the text

TABLE 6

PP&L - BRODHEAD CREEK SITE
CALCULATION OF CARCINOGENIC RISK
FOR VAPOR INHALATION
NO ACTION SCENARIO

Exposure Scenario	Exposed Population	Route of Exposure	Area of Exposure	Chemical	Lifetime Adj.* Chronic Daily Intake (mg/kg/day)	CPF (1/ mg/kg/day)	Contribution to Lifetime Carc Risk	CPF of 11 5 of B(a)P
No Action	Adults	Vapor Inhalation	Surface Water	Arsenic	NA	50 0	NA	
				Benzene	5 185E-6	0 029	1 504E 7	
				Benzo(a)Pyrene	1 08E-9	6 1	6 588E 9	1 242E-8
				Naphthalene	1.757E-7	NA	NA	
		Vapor Inhalation	Surface Soils	Arsenic	NA	50 0	NA	
				Benzene	2 376E-8	0 029	6 89E 10	
				Benzo(a)Pyrene	7.208E-10	6 1	4 397E 9	8 289E-9
				Naphthalene	4 45E 6	NA	NA	
	Children 6-12	Vapor Inhalation	Surface Water	Arsenic	NA	50 0	NA	
				Benzene	1.251E-5	0 029	3 628E 7	
				Benzo(a)Pyrene	9.30E-9	6 1	5 673E 8	1 07E-7
				Naphthalene	4.237E-7	NA	NA	
		Vapor Inhalation	Surface Soils	Arsenic	NA	50 0	NA	
				Benzene	5.73E-8	0 029	1 662E 9	
				Benzo(a)Pyrene	1.738E-9	6 1	1 060E 8	1 999E 9
				Naphthalene	1.074E-5	NA	NA	

NA Not applicable
CPF Carcinogen Potency Factor
Note Numbers are presented in exponential notation 0 001 = 1 00E 03

Partial Lifetime Carcinogenic Risk

Adults	1 621E 7	1 718E 7
Children 6 12	4 318E 7	4 915E 7

TABLE 7

PP&L BRODHEAD CREEK SITE
CALCULATION OF CARCINOGENIC RISK
FOR FISH INGESTION
NO ACTION SCENARIO

Exposure Scenario	Exposed Population	Route of Exposure	Area of Exposure	Chemical	Lifetime Adj Chronic Daily Intake (mg/kg/day)	CPF (1/mg/kg/day)	Contribution to Lifetime Carc Risk	CPF of 11 5 for B(a)P
No Action	Adults	Fish Ingestion	Brodhead Creek	Arsenic	3 062E-6	1 75	5 359E 6	
				Benzene	1 36E-6	0 029	3 944E 8	
				Benzo(a)Pyrene	0	6 1	0	
				Naphthalene	2 062E-5	NA	NA	
	Children 6-12	Fish Ingestion	Brodhead Creek	Arsenic	8 919E-6	1 75	1 561E 5	
				Benzene	3 962E-6	0 029	1 149E 7	
				Benzo(a)Pyrene	0	6 1	0	
				Naphthalene	6 008E-5	NA	NA	
	Children 2-6	Fish Ingestion	Brodhead Creek	Arsenic	1 616E-5	1 75	2 828E 5	
				Benzene	7.18E-6	0 029	2 082E 7	
				Benzo(a)Pyrene	0	6 1	0	
				Naphthalene	1 089E 4	NA	NA	

NA - Not applicable.
CPF - Carcinogen Potency Factor.
Note - Numbers are presented in exponential notation 0.001 = 1 00E-3.

Partial Lifetime Carcinogenic Risk
Adults = 5 398E 6
Children 6 12 = 1 572E 5
Children 2 6 = 2 849E 5

TABLE 8

PP&L - BRODHEAD CREEK SITE

CALCULATION OF CARCINOGENIC RISK FOR INGESTION

NO-ACTION SCENARIO

Exposure Scenario	Exposed Population	Route of Exposure	Area of Exposure	Chemical	Lifetime Adj.* Chronic Daily Intake (mg/kg/day)	CPF (1 mg/kg/day)	Contribution to Lifetime Carc. Risk	* CPF of 11 5 for B(a)P
No Action	Adults	Ingestion	Surface Water	Arsenic	2.211E-6	1 75	3 869E 6	
				Benzene	8.309E-6	0 029	2.41E-7	
				Benzo(a)Pyrene	0	6 1	0	
				Naphthalene	6.825E-6	NA	NA	
		Ingestion	Surface Soil	Arsenic	NA	1 75	NA	
				Benzene	NA	0 029	NA	
				Benzo(a)Pyrene	3 846E-9	6 1	2 346E 8	4 423E-8
				Naphthalene	6.173E 8	NA	NA	
		Ingestion	Sediment	Arsenic	3.537E-7	1 75	6 19E-7	
				Benzene	0	0 029	0	
				Benzo(a)Pyrene	4 060E-8	6 1	2 477E 7	4 669E 7
				Naphthalene	0	NA	NA	
	Children 6-12	Ingestion	Surface Water	Arsenic	5 332E-6	1 75	9 331E 6	
				Benzene	2 004E-5	0 029	5 812E-7	
				Benzo(a)Pyrene	0	6 1	0	
				Naphthalene	1.646E-5	NA	NA	
		Ingestion	Surface Soil	Arsenic	NA	1 75	NA	
				Benzene	NA	0 029	NA	
				Benzo(a)Pyrene	9.276E 9	6 1	5 658E 8	1 067E-7
				Naphthalene	1.489E-7	NA	NA	
		Ingestion	Sediment	Arsenic	8 532E-7	1 75	1 493E 6	
				Benzene	0	0 029	0	
				Benzo(a)Pyrene	9 792E 8	6 1	5 973E 7	1 126E 6
				Naphthalene	0	NA	0	

NA Not applicable

CPF Carcinogen Potency Factor

Note Numbers are presented in exponential notation 0 001 = 1 00E-3

Partial Lifetime Carcinogenic Risk

Adults	5 00E 6	5 24E 6
Children 6-12	1 148E 5	1 264E 5

TABLE 9

PP&L - BRODHEAD CREEK SITE
CALCULATION OF CARCINOGENIC RISK
FOR DUST INHALATION
NO ACTION SCENARIO

Exposure Scenario	Exposed Population	Route of Exposure	Area of Exposure	Chemical	Lifetime Adj * Chronic Daily Intake (mg/kg/day)	CPF (1 mg/kg/day)	Contribution to Lifetime Carc. Risk	CPF of 11.5 for B(a)P
No Action	Adults	Dust Inhalation	Surface Soils	Arsenic	NA	50	NA	
				Benzene	NA	0.029	NA	
				Benzo(a)Pyrene	1 875E-11	6 1	1.144E-10	2.156E-10
				Naphthalene	3 009E-10	NA	NA	
	Children 6-12	Dust Inhalation	Surface Soils	Arsenic	NA	50	NA	
				Benzene	NA	0 029	NA	
				Benzo(a)Pyrene	4.522E-11	6 1	2.758E-10	5 2E-10
				Naphthalene	7.258E-10	NA	NA	

Partial Lifetime Carcinogenic Risk

Adults	=	1.144E-10	2 156E-10
Children 6-12	=	2 758E-10	5 2E 10

Total Lifetime Carcinogenic Risk

Adults	=	1 83E 5	1 98E 5
Children 6 12	=	3 82E 5	4 02E 5
Children 2 6	=	2 854E 5	

NA - Not applicable.
CPF - Carcinogen Potency Factor
Note: Numbers are presented in exponential notation 0 001 = 1 00E 3

represent fish-flesh contamination. The resulting worst-case carcinogenic risk resulting from fish ingestion is shown in Table 10. It can be seen that the carcinogenic risk is 3.3E-6 for children ages 6-12, 6.0E-6 for children ages 2 to 6, and 1.4E-6 for adults. This results in a lifetime weighted risk equal to 1.8E-6. By adding this risk to the total site-related risk increment, it can be seen that under worst-case conditions, the total lifetime carcinogenic risk falls within the 1.0E-4 to 1.0E-6 EPA recommended risk range.

F. Non-Carcinogenic Risk

The noncarcinogenic hazard index is the ratio of the expected potential dose to acceptable exposure levels. Values of less than unity (1.0) indicates that no hazard exists. The noncarcinogenic hazard indices are listed in Tables 11 to 15 and were obtained by dividing the chronic daily intakes by the appropriate reference doses. As can be seen from Table 15, all noncarcinogenic chronic hazard indices are several orders of magnitude less than unity, therefore, no noncarcinogenic chronic risk is posed by the Site.

G. Environmental Risk Assessment

Potentially exposed nonhuman populations include the aquatic life in Brodhead Creek. The potentially exposed populations at the Site are the macroinvertebrates, fish, and benthic organisms such as the sea lamprey larvae collected during the RI. The exposures to these populations can occur from direct contact with contaminants in water and sediment or by bioaccumulation in the food chain. Both fish and sea lamprey tissue were analyzed during the Brodhead Creek RI. No PAHs were detected in the fish samples analyzed. However, the sea lamprey analysis indicated that the lampreys have bioaccumulated PAHs.

1. Aquatic Effects

During the past studies, several habitat factors were measured such as surface water temperature, dissolved oxygen, flow rates, organic content in surface waters/sediments, and physical characteristics of the substrate. The chemical water quality conducted at the site revealed the following:

- Dissolved oxygen readings were relatively high, which means that they are adequate for aquatic life sensitive to low dissolved oxygen levels.
- The pH measurements of the surface waters were within a range (6-8) where aquatic life would not be adversely impacted.

A comparison of indicator and other chemical concentrations in the waters of Brodhead Creek to available surface water quality

TABLE 10

CALCULATION OF WORST-CASE CARCINOGENIC RISK RESULTING FROM FISH INGESTION

Chemical in Sea Lampreys Tissue	Relative Potency (ICF-Clement, 1988)	Sea Lampreys Tissue Concentration (mg/kg)	B(a)P Equivalent (mg/kg)
Pyrene	0.081	0.150	0.012

$$\text{Dose} = \frac{(\text{Amt. Fish})(\text{Tissue Concen.})(\text{Exp. Duration})(\text{Diet Fract.})}{(\text{Body Weight})(\text{Lifetime})}$$

Dose to Children

Age 2-6

$$= \left(0.0065 \frac{\text{kg fish}}{\text{day}}\right)\left(0.012 \frac{\text{mgB(a)P}}{\text{Kg fish}}\right)\left(\frac{1}{16\ \text{kg}}\right)(0.2)$$

$$= 9.75\ \text{E-07}\ \frac{\text{mg}}{\text{kg-day}}$$

Risk to Children

Age 2-6

$$= (\text{Dose})(\text{CPF}) = \left(9.75\ \text{E-07}\ \frac{\text{mg}}{\text{kd-day}}\right)\left(6.1\ \frac{\text{mg}}{\text{kd-day}}\right) = 5.95\text{E-06}$$

Dose to Children

Age 6-12

$$= \left(0.0065 \frac{\text{kg fish}}{\text{day}}\right)\left(0.012 \frac{\text{mgB(a)P}}{\text{Kg fish}}\right)\left(\frac{1}{29\ \text{kg}}\right)(0.2)$$

$$= 5.38\ \text{E-07}\ \frac{\text{mg}}{\text{kg-day}}$$

Risk to Children

Age 6-12

$$= \left(5.38\ \text{E-07}\ \frac{\text{mg}}{\text{kd-day}}\right)\left(6.1\ \frac{\text{mg}}{\text{kd-day}}\right) = 3.28\text{E-06}$$

Dose to Adults

$$= \left(6.5 \times 10^{-3} \frac{\text{kg fish}}{\text{day}}\right)\left(0.012 \frac{\text{mgB(a)P}}{\text{Kg fish}}\right)\left(\frac{10950}{25550}\right)\left(\frac{1}{70\ \text{kg}}\right)(0.2)$$

$$= 2.23\ \text{E-07}\ \frac{\text{mg}}{\text{kg-day}}$$

Risk to Adults

$$= \left(2.23\ \text{E-07}\ \frac{\text{mg}}{\text{kg-day}}\right)\left(6.1\ \frac{\text{kg-day}}{\text{mg}}\right) = 1.36\ \text{E-06}$$

Total Lifetime Weighted Risk

$$= \left(5.95\ \text{E-06}\ \frac{4}{60}\right) + \left(3.28\ \text{E-06}\ \frac{6}{68}\right) + \left(1.36\ \text{E-06}\ \frac{58}{68}\right) = 1.80\text{E-06}$$

B(a)P = Benzo (a) pyrene

TABLE 11

PP&L BRODHEAD CREEK SITE
CALCULATION OF CHRONIC INTAKES FOR DERMAL EXPOSURE
NONCARCINOGENIC HAZARD INDICES
NO ACTION SCENARIO

Exposure Scenario	Exposed Population	Route of Exposure	Area of Exposure	Chemical	Lifetime Adj.* Chronic Daily Intake (mg/kg/day)	Reference Dose (RfD) (mg/kg/day)	Contribution to Lifetime Chronic Hazard Index
No Action	Adults	Dermal Contact Soils	Surface Soils	Arsenic	NA	1 40E-3	NA
				Benzene	NA	4 00E-1	NA
				Benzo(a)Pyrene	6 408E-10	4 00E 1	NA
				Naphthalene	1.028E-8	4 00E-1	2 570E 8
		Dermal Contact Sediments	Sediments	Arsenic	5 894E-8	1 40E-3	4 210E-5
				Benzene	0	4 00E-1	0
				Benzo(a)Pyrene	6 764E-9	4 00E-1	1 691E 8
				Naphthalene	0	4 00E 1	0
		Dermal Contact Surface Water	Surface Water	Arsenic	1.155E-7	1 40E-3	8.25E 5
				Benzene	2 226E-4	4 00E-1	5 565E 4
				Benzo(a)Pyrene	2 172E-7	4 00E-1	5 43E-7
				Naphthalene	3 568E 7	4 00E-1	8 92E 7
	Children 6-12	Dermal Contact Soils	Surface Soils	Arsenic	NA	1 40E 3	NA
				Benzene	NA	4 00E-1	NA
				Benzo(a)Pyrene	1 783E-9	4 00E 1	4 458E 9
				Naphthalene	2.862E-8	4 00E-1	7 155E 8
		Dermal Contact Sediments	Sediments	Arsenic	1.640E-7	1 40E 3	1 171E 4
				Benzene	0	4 00E-1	0
				Benzo(a)Pyrene	1.882E-8	4 00E-1	4 705E 8
				Naphthalene	0	4 00E-1	0
		Dermal Contact Surface Water	Surface Water	Arsenic	1 430E-7	1 40E 3	1 021E-4
				Benzene	2 754E 4	4 00E-1	6 885E 4
				Benzo(a)Pyrene	2 686E-7	4.00E 1	6 715E 7
				Naphthalene	4.415E-7	4 00E 1	1 104E 6

* Partial Lifetime Chronic Hazard Index
Adults 6 8E 04
Children 6 12 - 9 1E 04

NA Not applicable
Note Numbers are presented in exponential notation 0 001 - 1 00E 3

TABLE 12

PP&L - BRODHEAD CREEK SITE
CALCULATION OF CHRONIC INTAKES
FOR VAPOR INHALATION
NONCARCINOGENIC HAZARD INDICES
NO-ACTION SCENARIO

Exposure Scenario	Exposed Population	Route of Exposure	Area of Exposure	Chemical	Lifetime Adj * Chronic Daily Intake (mg/kg/day)	Reference Dose (RfD) (mg/kg/day)	Contribution to Lifetime Chronic Hazard Index
No Action	Adults	Vapor Inhalation	Surface Water	Arsenic	NA	1 40E-3	NA
				Benzene	5 185E 6	4 00E 1	1 296L 5
				Benzo(a)Pyrene	1 08E-09	4 00E 1	2 700L 9
				Naphthalene	1 757E-7	4.00E-1	4 392L 7
		Vapor Inhalation	Surface Soils	Arsenic	NA	1 40E-3	NA
				Benzene	2 376E-8	4 00E 1	5 940E 8
				Benzo(a)Pyrene	7 208E-10	4 00E-1	1 802E 9
				Naphthalene	4.45E-6	4 00E-1	1 112E-5
	Children 6-12	Vapor Inhalation	Surface Water	Arsenic	NA	1 40E-3	NA
				Benzene	1.251E-5	4 00E-1	3 128E 5
				Benzo(a)Pyrene	9 30E-9	4 00E 1	2 325E 8
				Naphthalene	4.237E-7	4 00E-1	1 059E 6
		Vapor Inhalation	Surface Soils	Arsenic	NA	1 40E 3	NA
				Benzene	5 73E 8	4 00E 1	1 433E 7
				Benzo(a)Pyrene	1 738E 9	4 00E 1	4 345E 9
				Naphthalene	1 074E-5	4 00E 1	2 685E 5

NA - Not applicable.
Note - Numbers are presented in exponential notation 0.001 = 1 00E-03

Partial Lifetime Chronic Hazard Index
Adults - 2 5E 5
Children 6 12 - 5 9E 5

TABLE 13

PP&L - BRODHEAD CREEK SITE
CALCULATION OF CHRONIC INTAKES
FOR FISH INGESTION
NONCARCINOGENIC HAZARD INDICES
NO-ACTION SCENARIO

Exposure Scenario	Exposed Population	Route of Exposure	Area of Exposure	Chemical	Lifetime Adj.* Chronic Daily Intake (mg/kg/day)	Reference Dose (RfD) (mg/kg/day)	Contribution to Lifetime Chronic Hazard Index
No Action	Adults	Fish Ingestion	Brodhead Creek	Arsenic	3.062E-6	1.40E-3	2.187E-3
				Benzene	1.36E-6	4.00E-1	3.400E-6
				Benzo(a)Pyrene	0	4.00E-1	0
				Naphthalene	2.062E-5	4.00E-1	5.155E-5
	Children 6-12	Fish Ingestion	Brodhead Creek	Arsenic	8.919E-6	1.40E-3	6.371E-3
				Benzene	3.962E-6	4.00E-1	9.905E-6
				Benzo(a)Pyrene	0	4.00E-1	0
				Naphthalene	6.008E-5	4.00E-1	1.502E-4
	Children 2-6	Fish Ingestion	Brodhead Creek	Arsenic	1.616E-5	1.40E-3	1.154E-2
				Benzene	7.18E-6	4.00E-1	1.795E-5
				Benzo(a)Pyrene	0	4.00E-1	0
				Naphthalene	1.089E-4	4.00E-1	2.723E-4

NA - Not applicable.
Note - Numbers are presented in exponential notation 0.001 = 1.00E-3.

Partial Lifetime Chronic Hazard Index

Adults	=	2.2E-3
Children 6-12	=	6.5E-3
Children 2-6	=	1.2E-2

TABLE 14

PP&L - BRODHEAD CREEK SITE
CALCULATION OF CHRONIC INTAKES
FOR INGESTION
NONCARCINOGENIC HAZARD INDICES
NO ACTION SCENARIO

Exposure Scenario	Exposed Population	Route of Exposure	Area of Exposure	Chemical	Lifetime Adj.* Chronic Daily Intake (mg/kg/day)	Reference Dose (RfD) (mg/kg/day)	Contribution to Lifetime Chronic Hazard Index
No Action	Adults	Ingestion	Surface Water	Arsenic	2.211E-6	1.40E-3	1 579E-3
				Benzene	8 309E 6	4 00E-1	2 077E-5
				Benzo(a)Pyrene	0	4 00E-1	0
				Naphthalene	6.825E-6	4 00E-1	1 706E 5
		Ingestion	Surface Soil	Arsenic	NA	1 40E-3	NA
				Benzene	NA	4 00E-1	NA
				Benzo(a)Pyrene	3 846E-9	4 00E 1	9 615E 9
				Naphthalene	6.173E-8	4 00E-1	1 543E 7
		Ingestion	Sediment	Arsenic	3 537E-7	1 40E-3	2 526E 4
				Benzene	0	4 00E-1	0
				Benzo(a)Pyrene	4.060E 8	4 00E-1	1 015E-7
				Naphthalene	0	4 00E-1	0
	Children 6-12	Ingestion	Surface Water	Arsenic	5 332E-6	1 40E-3	3 809E 3
				Benzene	2 004E-5	4 00E-1	5 010E 5
				Benzo(a)Pyrene	0	4 00E-1	0
				Naphthalene	1.646E-5	4.00E 1	4 115E 5
		Ingestion	Surface Soil	Arsenic	NA	1 40E-3	NA
				Benzene	NA	4.00E-1	NA
				Benzo(a)Pyrene	9 276E 9	4 00E-1	2 319E 8
				Naphthalene	1 489E-7	4.00E-1	3 723E 7
		Ingestion	Sediment	Arsenic	8 532E-7	1 40E-3	6 094E 4
				Benzene	0	4 00E-1	0
				Benzo(a)Pyrene	9 792E-8	4 00E 1	2 448E 7
				Naphthalene	0	4 00E-1	0

NA Not applicable
Note Numbers are presented in exponential notation 0 001 - 1 00E 3

Partial Lifetime Chronic Hazard Index
Adults - 1 9E 3
Children 6 12 4 5E 3

TABLE 15

PP&L - BRODHEAD CREEK SITE
CALCULATION OF CHRONIC INTAKES
FOR DUST INHALATION
NONCARCINOGENIC HAZARD INDICES
NO-ACTION SCENARIO

Exposure Scenario	Exposed Population	Route of Exposure	Area of Exposure	Chemical	Lifetime Adj * Chronic Daily Intake (mg/kg/day)	Reference Dose (RfD) (mg/kg/day)	Contribution to Lifetime Chronic Hazard Index
No Action	Adults	Dust Inhalation	Surface Soils	Arsenic	NA	1 40E-3	NA
				Benzene	NA	4 00E-1	NA
				Benzo(a)Pyrene	1 875E-11	4 00E-1	4 688E 11
				Naphthalene	3 009E-10	4 00E-1	7 520E 10
	Children 6-12	Dust Inhalation	Surface Soils	Arsenic	NA	1 40E 3	NA
				Benzene	NA	4 00E 1	NA
				Benzo(a)Pyrene	4 522E-11	4 00E 1	1 131E 10
				Naphthalene	7.258E-10	4 00E 1	1 814E 9

Partial Lifetime Chronic Hazard Index

Total Lifetime Chronic Hazard Index

Adults	=	4 8E 3
Children 6 12	=	1 2E 2
Children 2-6	=	1 2E 2

NA - Not applicable.
Note - Numbers are presented in exponential notation 0 001 = 1 00E 3

criteria indicates that the Site does not cause any exceedance of acute or chronic ambient water quality criteria (AWQC). The few chemicals exceeding their respective AWQC occur in both upstream and background locations; thus, the Site alone apparently does not cause the AWQC exceedances. The PAH concentrations were also compared with the acute LC50 values. None of these acute values was exceeded.

Review of the numerous historical surveys and studies, as well as recent observations during the RI, indicates that the fish and macroinvertebrate populations are not adversely impacted by the Site. The earliest studies on record were conducted in 1969, when the stream habitats had been destroyed by the floods and the rechannelization of Brodhead Creek. Since that time the conditions in the stream improved, as was found in the 1984 fish and macroinvertebrate studies. Sensitive macroinvertebrate species (stoneflies, mayflies) were found at all stations sampled. The same observations were made during the RI activities; the presence of stoneflies and mayflies is indicative of good water quality.

The species diversity index, a measure of species diversity, calculated for several station samples in the past, indicated no habitat differences between upstream, at the Site level, and downstream locations. Conditions observed during the RI field activities indicate the presence of healthy fish and macroinvertebrate populations.

There are no threatened or endangered species at the Site, nc are there any critical or unique habitats. Also, none of the fish, amphibians, or reptiles listed as endangered or threatened are known to occur at or in the vicinity of this Site.

2. Risk to Fish and Sea Lamprey

The fish collection and tissue analysis during the RI indicated the following:

- The fish collected or observed in the survey were robust and displayed good coloration. There were no signs of overt disease such as reddened areas, nodular growths, skin lesions, and fungus.
- There were no observations of fish displaying behaviors indicative of environmental stress or ill health.
- No PAHs or other coal tar related constituents were detected in the fish samples analyzed.

Conversely, the sea lamprey analysis data indicate that the lampreys have bioaccumulated PAHs. The ratios of the compounds detected are similar to those ratios in the Brodhead Creek Site coal tar; therefore, the PAH bioaccumulation appears to be site-

related. The lampreys can be regarded as a worst-case scenario for aquatic life exposure, due to their constant exposure to sediments and interstitial water, high lipid content, long larval exposure period (several years), and feeding habitats.

Adult sea lampreys migrate upstream and die soon after spawning in the spring. The larvae drift to pool areas and burrow into the substrate. The larvae feed by filtering minute plant and animal materials, such as filamentous algae, detritus, diatoms, desmids, and protozoans out of the water. They are sedentary and only protrude slightly from their burrows while feeding. The larval stage persists for about 4 to 7 years. The adults then begin a predatory lifestyle and migrate downstream to the ocean. The sea lamprey larvae captured in the Brodhead Creek during the RI were young adults who had not yet begun their migration downstream. They were therefore most likely exposed to Site conditions for 4 to 7 years.

Comparison of the lamprey and trout data show little if any similarity in the nature of the compounds detected. This is due in part to the lesser amounts of time the mobile trout would be exposed to Site-related compounds. Trout are also less exposed to sediments, feed on a wide variety of organisms, and have lower lipid content. In addition, PAHs are rapidly and extensively metabolized and will be eliminated from the fish unless the exposure is continuous.

No other species of fish inhabitating Brodhead Creek is expected to have the long-term and continuous exposure to site-related compounds as the sea lamprey. The implications of the PAH accumulations to the sea lamprey larvae are unknown. However, site-specific bioconcentration factors calculated for sea lamprey at the Site are indicative of rapid metabolism of PAHs by the lamprey and/or minimal amounts of PAHs discharging to the creek. In addition, comparison of aquatic life criteria with actual concentrations of chemicals in Brodhead Creek indicate that the criteria for protection of aquatic life are not exceeded at the Site. The comparison of concentrations of indicator chemicals detected in Brodhead Creek sediments with calculated sediment criteria revealed that the sediment criteria are not exceeded at the Site.

3. Terrestrial Effects

During the wetland delineation activities of the RI, all areas were surveyed for the presence of stressed vegetation. No areas of stressed vegetation were observed. All the wetland areas displayed healthy and diverse vegetative wetland species.

The terrestrial vegetation also appeared healthy and unimpacted from the Site. No stressed terrestrial vegetation was observed during the Site activities.

Historical surface soil sampling did not indicate the presence of elevated concentrations of PAHs. No carcinogenic PAHs were detected. The observed concentrations of indicator compounds should not have any adverse effect on the terrestrial fauna that may come into contact with Site-related contamination. The PAH and metal concentrations reported for sediments should not pose any risk to the terrestrial community, since they are within the naturally occurring concentration range.

Conclusion of Summary of Site Risks

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

VII. DESCRIPTION OF ALTERNATIVES

The Superfund statute and regulations (NCP) require that the alternative chosen to clean up a hazardous waste site meet several criteria. The alternative must protect human health and the environment, be cost effective, and meet the requirements of environmental regulations. Permanent solutions to contamination problems should be developed wherever possible. The solutions should reduce the volume, toxicity, or mobility of the contaminants. Emphasis is also placed on treating the wastes a the site, whenever this is possible, and on applying innovative technologies to clean up the contaminants.

The FS studied a variety of technologies to see if they were applicable for addressing the contamination at the Site. The technologies determined to be most applicable to these materials were developed into remedial alternatives. These alternatives are presented and discussed below. All costs and implementation timeframes provided for the alternatives below are estimates.

COMMON ELEMENTS: All of the alternatives being considered would include common components. Each alternative except the "no action" alternative would include the following: (1) imposition of deed, zoning, and/or ownership restrictions on the Site, to limit future Site use; (2) a ground water monitoring program to measure concentrations of coal tar related constituents and to ensure that the integrity of the existing slurry wall is maintained; (3) Brodhead Creek biota monitoring to ensure that the Site continues to have no significant impact on the aquatic ecological system in Brodhead Creek; and (4) construction and maintenance of a fence with posted warning signs to restrict public access to the Site. EPA would review the Site every five years to ensure continued protection to human health and the environment for each of the alternatives, including the no-action alternative.

Alternatives 3, 4, and 6 include excavation of contaminated subsurface soils. For each of these alternatives, sheet piling will be required in the excavation to provide for slope stabilization during the excavation component of these alternatives.

Alternative 1: No Action

Capital Cost:	$0
Operation & Maintenance:	$0
Present Worth:	$0
Months to Implement:	0

The NCP, EPA's regulations governing the Superfund Program, requires that the "no-action" alternative be evaluated at every site to establish a baseline for comparison with the other alternatives. In this alternative, no further remedial actions would be taken on the subsurface soils at the Site. The Site would be left in its current condition. EPA would review the Site every five years to assure continued protection to human health and the environment.

Alternative 2: Limited Action

Capital Cost:	$153,000
Operation & Maintenance:	$1,023,000
Present Worth:	$1,176,000
Months to Implement:	6

This alternative would entail intermittent pumping of free coal tar which accumulates in the stratigraphic depression west of the slurry wall (RCC area). It is estimated that approximately 4500 gallons of the free coal tar contained in the stratigraphic depression in the RCC area might be removed under this alternative. It is expected that the free coal tar would be removed once per year. The frequency of coal tar recovery might be increased or decreased based on observed recovery effectiveness. The recovered coal tar would be shipped to an offsite permitted incineration facility for disposal.

The implementation of this alternative will comply with the requirements under RCRA and the Pennsylvania Solid Waste Management Act.

Alternative 3: OnSite Stabilization/Solidification (RCC Area)

Capital Cost:	$1,455,000
Operation & Maintenance:	$1,023,000
Present Worth:	$2,478,000
Months to Implement:	9-12

This alternative includes excavation of approximately 1,000 cubic yards of contaminated subsurface soils with coal tar in the RCC area, stabilization/solidification of the excavated soils, and replacement of the treated material. The stabilization/ solidification process involves the onsite mixing of cementious or pozzolanic reagents with the contaminated soils thereby fixating the contaminants in an inert matrix and reducing their mobility. Approximately 1,300 cubic yards of clean soil would have to be removed and stored to reach the contaminated soil. This clean soil will then be used to backfill the excavation over the stabilized soil. Grading, revegetation, and surface water run-on/run-off controls will be provided in the area of the excavation. A treatability study would be conducted to determine the most appropriate stabilizing reagents for the contaminated soils and to determine the leachability of coal tar related constituents from the stabilized/solidified soils.

Dewatering during the excavation process would be necessary. It is expected that free draining coal tar would also be recovered during the dewatering process. The recovered coal tar and water would be stored in a tank onsite. After completion of the excavation and replacement operation, the coal tar would be shipped to an offsite permitted incineration facility and the water to a treatment, storage, disposal (TSD) facility for treatment/disposal.

The implementation of this alternative will comply with the requirements under RCRA and the Pennsylvania Solid Waste Management Act.

Alternative 4: Excavation of Contaminated Subsurface Soils and Soil Washing (RCC Area)

Capital Cost:	$2,931,000
Operation and Maintenance:	$1,023,000
Present Worth:	$3,954,000
Months to Implement:	12

The specific components of this alternative are similar to those for Alternative 3 differing only in the process used for treating the excavated materials. The subsurface soils with coal tar would be subjected to onsite soil washing. Soil washing is a physical/chemical process in which the excavated soils are mixed and agitated using surfactant/water solutions in an above ground treatment system. During this process contaminants in the soil are transferred to an aqueous solution which is then separated from the soil and treated. A treatability study would be conducted to select an appropriate soil washing procedure and surfactant/water solution. The treated soils would be backfilled in the area of the excavation and covered with clean soils.

An estimated 9,000 gallons of free coal tar and approximately 17,845 to 23,529 gallons of coal tar at residual saturation levels would be expected to be removed resulting in a 6% to 10 % decrease in total coal tar volume at the Site.

The implementation of this alternative will comply with the requirements under RCRA and the Pennsylvania Solid Waste Management Act.

Alternative 5: Enhanced Recovery for the Free Coal Tar

Capital Cost:	$3,008,000
Operation & Maintenance:	$1,112,000
Present Worth:	$4,120,000
Months to Implement:	6

Enhanced recovery is an in-situ application of contaminant extraction from soils. It would consist of the physical displacement of coal tar from the pore spaces within the soil through thermal mobilization coupled with hydraulic containment to exploit the apparent reduction in coal tar density to less than that of water thereby mobilizing the coal tar for recovery by pumping and extraction. The enhanced recovery process would entail the installation of extraction and injection wells in the free coal tar areas. Hot water will be injected into the subsurface soils to displace the coal tar from within the pore spaces of the soil. Recovered coal tar and process water from the extraction wells will be subjected to oil-water separation to remove the coal tar. The recovered process water will be treated to meet National Pollution Discharge Elimination Requirements (NPDES) with subsequent discharge of a portion of the process water to Brodhead Creek with the remainder being reinjected into the subsurface soils to enhance coal tar recovery. The recovered coal tar will be shipped to an offsite permitted incineration facility for disposal.

The enhanced recovery process would involve the treatment of approximately 200 cubic yards of subsurface soils containing free coal tar in the RCC area and take approximately three months to complete. Some treatment of the overlying soils containing residual coal tar would also occur. It is estimated that the enhanced recovery process could recover an estimated volume of 7,200 gallons of free coal tar and as much as 10,800 gallons of residual coal tar resulting in a 3% to 6% decrease in total coal tar volume at the Site.

The implementation of this alternative will also comply with the requirements under RCRA and the Pennsylvania Solid Waste Management Act.

Alternative 6: Excavation of Contaminated Subsurface Soils (RCC Area) and Offsite Incineration

Capital Cost:	$5,204,000
Operation & Maintenance:	$1,023,000
Present Worth:	$6,227,000
Months to Implement:	6-8

This alternative is similar to Alternatives 3 and 4, differing only in the process used for treating the excavated contaminated soils. The contaminated subsurface soils (approximately 1,000 cubic yards) would be shipped to an offsite permitted incineration facility for disposal. Incineration involves the thermal destruction of organic compounds. Additional clean fill material would have to be imported to replace the volume of subsurface soils removed from the Site for incineration.

The excavated subsurface soils would be stored in a staging area onsite for dewatering and drying prior to being shipped offsite for incineration. The water from the staging area would be collected and also shipped offsite to a permitted TSD facility.

The implementation of this alternative will comply with the requirements under RCRA and the Pennsylvania Solid Waste Management Act.

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

A detailed analysis was performed on the six alternatives using the nine evaluation criteria specified in the NCP in order to select an interim remedy for OU-1. The following is a summary of the comparison of each alternative's strength and weaknesses with respect to the nine evaluation criteria. These nine evaluation criteria are listed in Exhibit A.

OVERALL PROTECTION

All the alternatives, excluding the no action alternative (Alternative 1), would provide varying degrees of protection to human health and the environment by eliminating, reducing, or controlling risk through treatment, engineering controls, or institutional controls. Alternatives 4 and 6 may be slightly more protective than Alternative 5 since a significant portion of both the residual and free coal tar would be excavated in the RCC area and treated during the implementation of these alternatives likely resulting in a slightly greater reduction of the overall coal tar volume at the Site. Alternative 3 would also entail the excavation of contaminated soils in the RCC area. However, the excavated soil would be treated by onsite stabilization/solidification and replaced in the area of the excavation. Under Alternative 3, there would be no net reduction in volume of the coal tar, but its mobility in the environment would be greatly reduced.

EXHIBIT A

ALTERNATIVE EVALUATION CRITERIA

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

Compliance with ARARs - Refers to whether or not a remedy will meet all Applicable or Relevant and Appropriate Requirements (ARARs) of federal and state environmental statues and/or provides grounds for invoking a waiver.

Long-Term Effectiveness and Permanence - The ability of the remedy to maintain reliable protection of human health and the environment over time once the "clean-up" goals have been met.

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

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

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

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

State Acceptance - This indicates whether, based on its review of the Feasibility Study and the Proposed Plan, the State concurs with, opposes, or has no comment regarding the preferred alternative.

Community Acceptance - Will be assessed in the Record of Decision following a review of the public comments received on the Administrative Record and the Proposed Plan.

Alternative 2 would be less protective than the Alternative 5 since Alternative 2 does not have the potential for recovering as much coal tar from the subsurface soils as Alternative 5 which uses thermal - mobilization to achieve greater recovery than conventional pumping techniques.

The "no action" alternative is not protective of human health and the environment since it would not address the source of the contamination, and future releases and potential exposures might occur. Therefore, it is not considered further in this analysis for OU-1.

COMPLIANCE WITH ARARS

CERCLA requires that remedial actions meet applicable or relevant and appropriate requirements (ARARs) of other federal and state environmental laws. These laws may include: the Toxic Substances Control Act, the Clean Water Act, the Safe Drinking Water Act, and the Resource Conservation and Recovery Act.

A "legally applicable" requirement is one which would legally apply to the response action if that action were not taken pursuant to Sections 104, 106, or 122 of CERCLA. A "relevant and appropriate" requirement is one that, while not "applicable", is designed to apply to problems sufficiently similar that their application is appropriate.

All the alternatives, except for the no-action alternative (Alternative 1), will meet their respective applicable or relevant and appropriate requirements (ARARs) as referenced in the FS. These include compliance with the Clean Air Act and PADER Air Quality Standards for emissions from the Site. Offsite transport of coal tar would be conducted in accordance with the Department of Transportation rules for Hazardous Materials Transport and the Pennsylvania Hazardous Substances Transportation regulations. Onsite management of waste material at the Site would be conducted in accordance with the Resource Conservation and Recovery Act (RCRA), the Pennsylvania Solid Waste Management Act, and Pennsylvania Title 25 Chapter 260 to 270 (Hazardous Waste). All discharges of treated process water to Brodhead Creek from Alternative 5 and Alternative 4 should meet National Pollution Discharge Elimination System (NPDES) requirements developed pursuant to the Clean Water Act and PADER Bureau of Water Quality Management Standards. Alternatives 3 and 4 would also have to meet RCRA regulations for the replacement of treated soils onsite.

Since OU-1 does not address ground water, compliance with Maximum Contaminant Levels under the Safe Drinking Water Act and the Pennsylvania ARAR for remediation of ground water which contains hazardous substances to "background" quality are beyond the scope of this interim action and may not be met by any of the

alternatives. However, because free coal tar will be removed from the Site, some reduction in ground water contamination is expected with all the alternatives. These ARARs for ground water will be addressed in a subsequent ROD after further investigations are conducted at the Site during OU-2 to assess the quality of all ground water in the subsurface units from the stream gravel to and including bedrock.

LONG-TERM EFFECTIVENESS AND PERMANENCE

This criteria is not considered applicable in this case due to the interim short-term nature of the remedy, and therefore, will be addressed when the final remedy for the Site is selected. However, by eliminating the source of the contamination to the ground water, the principal threat posed by the Site will be addressed and some degree of long-term effectiveness and permanence will be offered.

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternatives 4, 5, and 6 provide for the reduction of toxicity, mobility, and volume by removing the source of the contamination and treating it. Alternative 5 would utilize enhanced recovery techniques to remove the free coal tar from the subsurface soils followed by incineration of the recovered coal tar. Alternative 4 would employ soil washing to remove the coal tar from the excavated soils followed by incineration of the coal tar and backfilling of the treated soils in the excavation area. Alternative 6 would entail the direct incineration of the excavated soils and backfilling of the excavation area with clean imported soils. Overall coal tar volume reduction for Alternatives 4 and 6 would be between 6% to 10%. Overall coal tar volume reduction for Alternative 5 would be between 3% and 6%.

Alternative 3, which would employ onsite stabilization/solidification, would not reduce the toxicity or the volume of the coal tar. However, the mobility of the contaminants in the subsurface would be significantly reduced thereby reducing the Site's impact to ground water in the stream gravel unit.

SHORT-TERM EFFECTIVENESS

Potential risks to onsite workers and the community might occur during excavation, transportation, and treatment activities for alternatives 3, 4, and 6. Exposure to coal tar and volatile releases could be minimized by the use of proper operating procedures and personal protective gear for onsite workers. Some emission of volatile organic compounds (VOCs) during the excavation, treatment, replacement and disposal activities is likely to occur. Precautions would be taken to ensure that these emissions would not impact the community.

For Alternative 5, potential risk to onsite workers and/or the community might occur during water treatment and free coal tar management. An advantage that Alternative 5 has over the other alternatives is that it would be conducted in-situ. There would be no large areas of excavation and stockpiled soils thereby minimizing the amount of VOC emissions from the Site and the potential of direct contact with any contaminated soils. During implementation of Alternative 5, the enhanced recovery process could promote mobility of coal tar related constituents into the ground water. Complete hydraulic controls would have to be maintained to minimize any impacts.

IMPLEMENTABILITY

Each of the alternatives under consideration would be implementable at the Site. However, the availability of professional services to implement Alternatives 4 and 5 may be limited since both these alternatives employ emerging technologies. Regulatory approval would be required for the replacement of treated soils back into the subsurface for Alternatives 3 and 4. The alternatives which employ excavation as a component must overcome several significant site-specific constraints associated with the excavation including several subsurface utilities, the flood control levee, slope stability during excavation, and upwelling of the silty sand unit. The ground water and Brodhead Creek monitoring programs could be easily implemented under any of the alternatives.

COST

The lowest cost alternative is Alternative 3 (onsite stabilization/solidification) at $2,478,000. The highest cost alternative would be Alternative 6 (offsite incineration) at a cost of $6,227,000. The oth[illegible] alternative costs are presented in the alternative descriptic[illegible]tions.

STATE ACCEPTANCE

The Commonwealth of Pennsylvania has concurred with the Selected Interim Remedy.

COMMUNITY ACCEPTANCE

Community acceptance is assessed in the attached Responsiveness Summary. The Responsiveness Summary provides a thorough review of the public comments received on the RI/FS and the Proposed Plan, and EPA's responses to the comments received.

IX. SELECTED REMEDY

Based upon the consideration of the requirements of CERCLA, the detailed analysis of the alternatives, and public comments, the

interim remedial remedy selected for implementation at the Brodhead Creek Superfund Site for OU-1 is Alternative 5, Enhanced Recovery via Thermal Mobilization.

Goals

The primary goals of this selected interim remedial alternative are to eliminate or reduce risks associated with the potential ingestion of ground water in the stream gravel unit and to reduce the potential for contaminant release to the ground water in the bedrock at the Site. Ground water in the bedrock in the Site vicinity is currently used as a source of drinking water. Additional goals are to meet the statutory preference for remedies that utilize permanent solutions and alternative treatment technologies to the maximum extent practicable, and that utilize treatment to reduce the mobility, toxicity, or volume of the source of the contamination.

Summary of the Interim Remedy

As discussed under the Description of Alternatives section, this Selected Interim Remedy employs enhanced recovery of free coal tar via thermal mobilization. The enhanced recovery process will be applied to the free coal tar (i.e., coal tar at 100% pore volume saturation) areas onsite at the RCC area and the MW-2 area. The enhanced recovery process shall involve the removal and treatment of approximately 60-70% of the free coal tar in both the RCC and MW-2 areas. Some additional recovery and treatment of the overlying soils containing residual coal tar (i.e., coal tar at less than 100% pore volume saturation) would also occur. The recovered coal tar shall be disposed of at an offsite permitted incineration facility. Process water used for flushing of the coal tar would be treated with part of it discharged to the creek and the remainder reinjected into the subsurface soils for further flushing of the contaminated soil. A conceptual model of the enhanced recovery process is shown in Figure 10.

The Feasibility Study for the Brodhead Creek Site evaluated the enhanced recovery process for the RCC area only. The estimated present worth cost as set forth in the Feasibility Study for applying the enhanced recovery process to the RCC area is $4,120,000. Extending the application of the enhanced recovery process to the area proximal to MW-2 may increase the estimated cost by approximately $600,000. A summary of the capital costs for the enhanced recovery process is presented in Table 16.

A treatability study will be conducted for the enhanced recovery process to confirm its effectiveness and remedial design parameters for its application in removing free coal tar from the subsurface soils located in the RCC area and the area proximal to MW-2. If the treatability study reveals that more than 60-70% of

FIGURE 10

Brodhead Creek Feasibility Study
Stroudsburg, PA

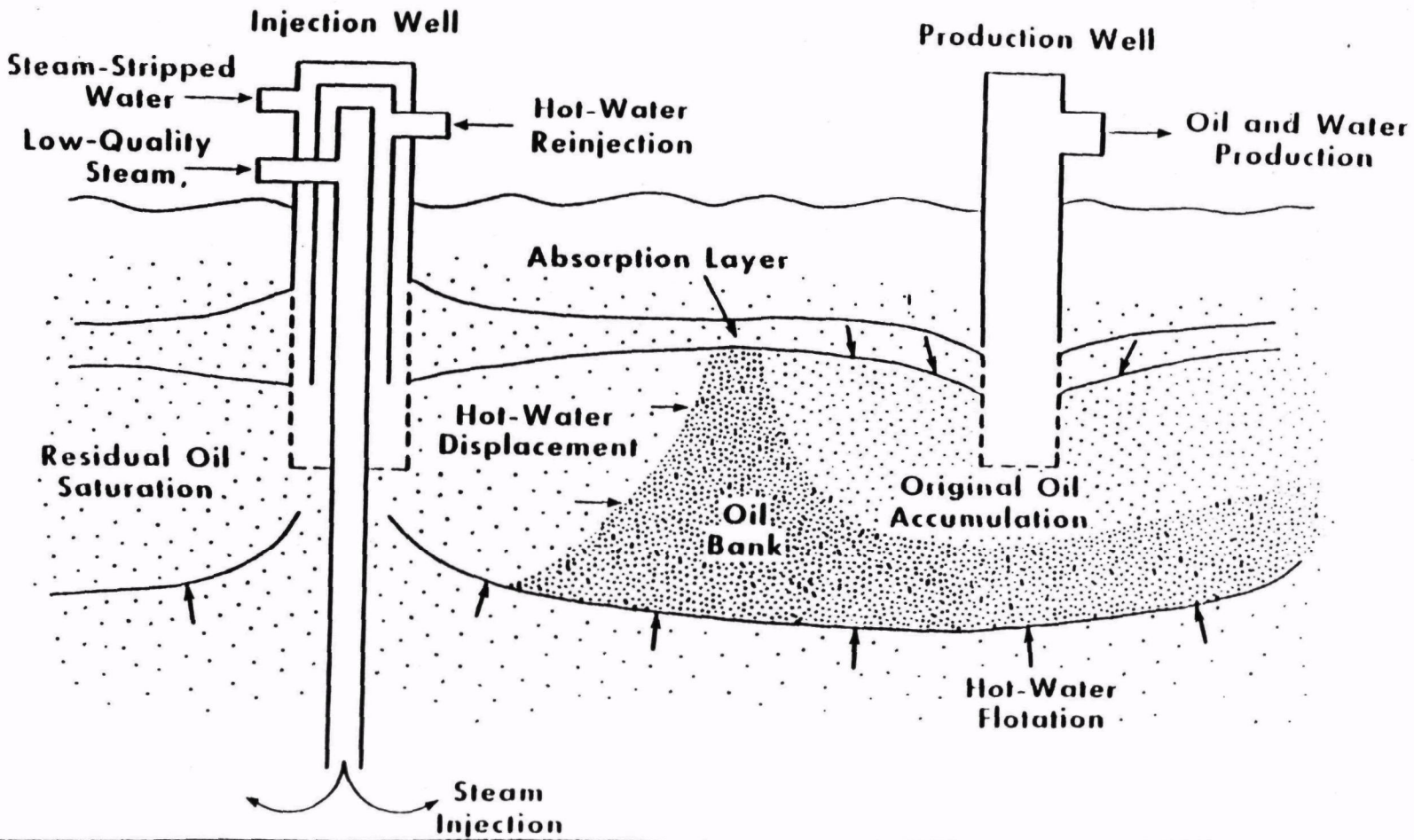


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TABLE 16

BRODHEAD CREEK
CAPITAL COST ESTIMATE
ALTERNATIVE 5-ENHANCED RECOVERY OF FREE COAL TAR

Item	Quantity	Unit Cost	Installed Cost
Site Preparation Mobilization/Demobilization	1 Ea	$200,000 00 /Ea	$200,000
Fencing	2,000 Lf	$15 00 /Lf	$30,000
Deed Restrictions	1 Ea	$5,000 00 /Ea	$5,000
Enhanced Recovery (Crow Process)	200 Cy	Lump Sum	$810,000
Wetlands Restoration	11,000 Sf	$2 00 /Sf	$22,000
Coal Tar Disposal	18,000 Gal*	$2 60 /Gal	$46,800
		Subtotal	$1,114,000
		Contingency @ 100.00%	$1,114,000
		Probable Construction Cost (PCC)	$2,228,000
		Engineering, Legal, Health & Safety, Construction Mgmt., and Insurance @ 35.00%, of PCC	$780,000
* Assumes maximum coal tar removal efficiency		Estimated Total Installed Cost	$3,008,000

** The above capital costs represent implementation of the enhanced recovery process at the RCC area only. Extending the application of the enhanced recovery process to the area proximal to MW-2 may increase the capital cost by approximately $600,000.

the free coal tar can be effectively recovered, the treatment shall continue until such additional recovery is achieved.

The Selected Interim Remedial Alternative will also include construction of a chain link fence to restrict public access to the Site during remedial activities, and the imposition of deed and zoning restrictions to limit future Site use. A ground water monitoring program will be initiated at the Site to ensure continued protection to human health and the environment. Ground water monitoring will be conducted during the implementation of the Selected Interim Remedy, quarterly for the first 18 months after completion of the enhanced recovery process, and annually thereafter for up to 30 years.

A Brodhead Creek biota monitoring program will also be implemented at the Site. Monitoring of the benthic community for species diversity and abundance will be conducted prior to the implementation of the enhanced recovery process and during the spring and fall seasons for a two year period thereafter. Likewise, resident fish will be sampled and analyzed during the spring and fall seasons for a two year period. The resident fish sampling will include histopathological examinations and an assessment of the levels of PAH metabolites in fish bile. Brodhead Creek sediment sampling will be conducted for TCL coal tar related constituents concurrently with the resident fish sampling and the benthic community monitoring. This data will then be evaluated to determine if further benthic community monitoring, resident fish sampling, or sediment sampling is required. In addition to these monitoring efforts, long-term monitoring of sea lamprey larvae for PAH bioaccumulation will be conducted once every five years for up to 30 years.

X. STATUTORY DETERMINATIONS

A. Protection of Human Health and the Environment

As identified in the RI/FS, the ground water in the stream gravel unit at the Site is highly contaminated. Peak concentrations of arsenic, benzene, and other organics measured in the surficial ground water exceed current and proposed Federal drinking water standards. The coal tar wastes are currently contaminating and/or would continue to contaminate this ground water. The RI data suggests that the free coal tar located in the stratigraphic depression is the principal source of the ground water contamination onsite. The stream gravel unit is not currently used as a water supply onsite. However, exposure to ground water in this stream gravel unit might occur. In addition, the free coal tar located in the stratigraphic depression may serve as a potential source of release of contamination to ground water in the bedrock which is currently used as a drinking water source offsite. Since contaminants detected in this stream gravel unit

exceed current and proposed MCLs, there is a potential health risk associated with ingestion of ground water at the Site.

Therefore, the risk reduction objectives are based on reduction of those risks associated with the ingestion of ground water in the stream gravel unit at the Site and the protection of the bedrock ground water from possible Site contamination.

This selected interim remedy for OU-1 will remove free coal tar from the subsurface soils onsite thereby minimizing the potential for the further leaching of contaminants into the shallow ground water and the potential for migration of contaminants to the ground water in bedrock underlying the Site and thus is protective of human health and the environment.

B. Compliance with Applicable or Relevant and Appropriate Requirements

The selected interim remedy of enhanced recovery and treatment of coal tar will comply with all applicable and relevant and appropriate chemical-, location-, and action-specific ARARs pertinent to this limited action. These ARARs are as follows:

1. Chemical-Specific ARARs

a. The National Emissions Standards for Hazardous Air Pollutants (NESHAPS) set forth at 40 CFR Part 61.64(b) and promulgated under the Clean Air Act, 42 U.S.C. Section 7401, contain emission standards for fugitive leaks from equipment containing greater than or equal to 10% benzene which is relevant and appropriate to the enhanced recovery process and treatment of process water. The benzene emission standard is no detectable emissions (approximately 500 ppm).

b. 25 Pa. Code Chapter 123 on "Standards for Contaminants" sets forth requirements for fugitive emissions, including open burning and demolition activities; specific limitations for particulate matter sulfur dioxide, odor, and visible emissions.

c. 25 Pa. Code Chapter 93 sets forth general and specific standards for the quality of Pennsylvania's waters, and includes specific water quality criteria and designated water use protection for each stream in Pennsylvania.

2. Location-Specific ARARs

a. Resource Conservation and Recovery Act requirements set forth at 40 CFR 264.18(b) contain relevant and appropriate requirements for RCRA hazardous waste treatment, storage, or disposal facilities located within a 100 year floodplain. Such facilities must be designed, constructed, operated, and maintained to avoid wash-out.

b. 40 CFR 6, Appendix A sets EPA policy for carrying out the provisions of Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands). These requirements are applicable for actions that will occur in a floodplain or actions involving construction of facilities or management of properties in wetlands.

c. Regulations promulgated under the Dam Safety and Encroachments Act at 25 Pa. Code Chapter 105 sets forth the provisions for the regulation and supervision of dams, reservoirs, water obstructions, encroachments, and wetlands in the Commonwealth of Pennsylvania.

3. Action-Specific ARARs

a. To the extent that new point source emissions result from the implementation of the interim remedial alternative, 25 Pa. Code Section 127.12(a)(5) will apply, requiring that emissions be reduced to the minimum obtainable levels through the use of best available technology (BAT), as defined in 25 Pa. Code Section 121.1.

b. Treatment and discharge of contaminated process water to Brodhead Creek will cause the requirements of the Pennsylvania NPDES program to apply. Those requirements, as set forth in 25 Pa. Code Chapter 92, include permitting, design, discharge, and monitoring requirements which will be met in implementing the selected interim alternative.

c. The process water extraction and treatment operations as well as the coal tar management activities would be implemented consistently with the requirements of 25 Pa. Code Part 262 (relating to generators of hazardous waste); 25 Pa. Code Part 263 (relating to transporters of hazardous wastes); and with the substantive requirements of 25 Pa. Code Part 264 Subparts A-E, I (in the event hazardous waste is stored or managed in containers), and J (in

the event hazardous waste generated as part of the interim remedy is treated or stored in tanks).

d. Pennsylvania Wastewater Treatment Regulations, Pa. Code, Title 25, Chapter 95, which regulate water quality and include treatment requirements and effluent limitations based on the best practical control technologies are applicable to the treatment of wastewater generated by the selected interim remedy.

e. 29 CFR 1910.120 sets forth applicable requirements regarding worker safety in the handling of hazardous substances,

f. Department of Transportation (DOT) regulations at 49 CFR 171.1-171.16 sets forth applicable requirements regarding offsite transportation of hazardous wastes.

g. Pennsylvania Erosion Control Regulations, Pa. Code, Title 25, Chapter 102, which govern erosion and sedimentation control resulting from remedial actions that may involve earth moving activities may be applicable to the selected interim remedy.

h. Underground Injection Control Program regulations promulgated at 40 CFR 144-148 would regulate the underground injection of the selected interim remedy's treated process water into the subsurface soils.

EPA does not consider the Land Disposal Regulations at 40 CFR Part 268 to be relevant and appropriate for the treated process water that will be injected into the subsurface soils as part of the selected interim remedy. The basis for this decision is contained in OSWER Directive # 9334.1-06 "Applicability of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment" dated December 27, 1989.

C. Cost-Effectiveness

The selected interim remedy is cost-effective because it has been determined to provide overall effectiveness proportional to its costs, the net present worth value being $4,720,000, which includes the additional capital cost of extending the enhanced recovery process to the area proximal to MW-2.

D. Preference for Treatment as a Principal Element

The Selected Interim Remedy utilizes treatment and thus is in furtherance of the statutory preference for treatment. However,

because this interim action does not constitute the final remedy for this operable unit, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element, although partially addressed in this remedy, will be addressed by the final response action.

E. Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

This action is interim and is not intended to utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable for this operable unit. However, the Selected Interim Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized while providing the best balance of tradeoffs among alternatives with respect to pertinent criteria, given the limited scope of the action.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES FROM THE PROPOSED PLAN

The Proposed Plan for the Brodhead Creek Site was released for comment in February, 1991. The Proposed Plan described the alternatives studied in detail in the Feasibility Study, and EPA reviewed all written and verbal comments submitted during the comment period and at the public meeting. Upon review of these comments, it was determined that no significant changes to the remedy, as presented in the Proposed Plan, were necessary.

APPENDIX A

RESPONSIVENESS SUMMARY
BRODHEAD CREEK SUPERFUND SITE
OPERABLE UNIT ONE

This Responsiveness Summary for Operable Unit One of the Brodhead Creek Superfund Site is divided into the following sections:

Section I **Overview** - A summary of the public's response to Alternatives for Operable Unit One.

Section II **Background Information on the Community's Involvement and Concerns** - A discussion of the history of community interest in the Site and the concerns expressed during the remedial planning activities at the Brodhead Creek Superfund Site.

Section III **A Summary of Major Comments Received During the Public Meeting, Public Comment Period and Agency Responses to Those Comments and Questions** - This summary addresses comments and EPA responses and is categorized by topic.

I. OVERVIEW

During the public comment period held from February 15 through March 18, 1991, written comments regarding the selection of a remedial alternative were received by EPA. A request for the extension of the comment period was denied by EPA because it was not received in a timely manner, as contemplated by the NCP. A public meeting was also held on February 27, 1991 which provided the opportunity for the public to ask questions and express opinions and concerns. The questions and comments expressed by local residents were few in number; however, numerous comments were made by several of the Potentially Responsible Parties (PRPs). The comments and EPA's responses will be summarized in Section III of this document.

II. BACKGROUND OF COMMUNITY INVOLVEMENT AND CONCERNS

The Brodhead Creek Superfund Site is located in the Stroudsburg Borough of Monroe County, Pennsylvania. This area of Pennsylvania is located between the Pocono Mountains and the Delaware River and is a popular winter and summer resort area with tourism as the mainstay of the area's economy. Brodhead Creek, which originates in the Pocono Mountains and flows past the Site, has been

identified as one of the best cold water trout fishing streams in Pennsylvania. Many of the area's conservation groups and tourism groups, as well as the local and county officials, are aware of the problems at the Site. However, there has been limited community interest and few inquiries about the Site.

Media coverage of the Site was extensive when the contamination was first discovered in the early 1980's but has decreased to sporadic newspaper articles. The media did cover the public meeting held on February 27, 1991 on the Proposed Remedial Action Plan for Operable Unit One. The meeting was also attended by approximately twenty residents, township council members and attorneys representing the Potentially Responsible Parties.

The concerns and questions expressed during that meeting, the comments received during the public comment period and EPA's responses to those comments are described in the following summary.

III. SUMMARY OF THE MAJOR COMMENTS EXPRESSED REGARDING THE PROPOSED REMEDIAL ACTION PLAN FOR THE BRODHEAD CREEK SUPERFUND SITE AND EPA RESPONSES TO THOSE COMMENTS

EPA's Preferred Alternative

1. Concerns were expressed over the selection of the enhanced recovery process and the newness of that technology over a more proven cleanup method. Comments were made stating that the preferred alternative is not cost effective, and not supported by the Risk Assessment, Remedial Investigation or Feasibility Study and not consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Specific questions asked included, where has this method been used before and, if it was used previously, what were the results?

EPA Response: Superfund law encourages the use of innovative technology such as the enhanced recovery process. Based on the nine criteria set forth in the NCP that EPA uses to select its preferred alternative, the enhanced recovery process has less disadvantages than the other available alternatives that were reviewed. Preliminary bench scale studies conducted on soil samples from the Site indicate that this process will be a successful cleanup method for the Site.

The enhanced recovery process has been used in the petroleum industry for years for increasing the recovery of oil from wells. Bench scale studies of the enhanced recovery process on Site soils indicate that it should also be effective in enhancing the recovery of coal tar from subsurface soils. To EPA's knowledge, this will be the first Superfund site at which the enhanced recovery process will be applied.

2. Comments were made questioning EPA's plan to conduct a treatability study after the Record of Decision is issued instead of prior to the Agency's final decision on a cleanup method. A statement reads that "this approach risks remedy selection without adequate consideration of key information on cost and implementability, in contravention of the NCP." Other specific questions on the treatability studies included: who will conduct the studies; who will pay for the studies; and how long will they take to complete?

EPA Response: As stated above, preliminary studies indicate that the enhanced recovery process should be successful in cleaning up the Site. EPA feels that there is enough information to support a Record of Decision. However, treatability studies will be conducted prior to the full scale implementation of the process to ensure that it will be successful, to determine the optimum performance of the process and to fine tune the process design. The treatability studies will be initiated and completed as expeditiously as possible to ensure that Site remediation may move forward.

The studies will be conducted either by the contractor hired by the PRPs with EPA oversight or by EPA itself. Depending on negotiations with the PRPS, the studies will be funded by the PRPs or EPA.

3. If the treatability study concludes that the enhanced recovery process will not be a successful cleanup remedy, can and will the Record of Decision be revised by EPA?

EPA Response: EPA believes that the process will be effective at this Site; however, if after site specific treatability studies it is concluded that the process will not be successful, the Agency will reconsider the alternatives and either issue an explanation of significant differences (ESD) or a ROD amendment. The results of the treatability study will be available to the public.

4. Several concerns were expressed regarding the temperature, volume and chemical composition of the water that will be injected into the subsurface soils and then discharged into the Creek and re-injected into subsurface soils during the cleanup. Each individual question is addressed in the following section:

> **A.** What will be the temperature of the water and will the temperature sterilize the micro-organisms in the soil?
>
> **EPA Response:** The subsurface soil is currently about 50 degrees Fahrenheit and the coal tar will have to be heated to approximately 86 degrees Fahrenheit in order to mobilize it. Bench scale studies reveal a water

temperature of approximately 150 degrees will be sufficient to mobilize the coal tar. EPA does not expect that the water temperature will pose a significant problem to subsurface soils and that the microbial population at those depths in the subsurface soil is not expected to be significant. EPA will, however, want to address the sterilization issue in the treatability study. EPA certainly does not want to cause more of an environmental impact trying to remediate the Site.

B. What will be the level of contamination in the water that is discharged and re-injected back into the soil?

EPA Response: EPA will meet the National Pollution Discharge Elimination System (NPDES) requirements under the Clean Water Act for discharging process water. There are several proven technologies available for water treatment. The quality of the water that is re-injected will be substantially better than the quality of ground water presently there. Also, the re-injection of water into the subsurface remediation cell will only continue until the remedy is complete, then the water will be treated and discharged.

C. A concern was expressed that the volume and temperature of the water discharged into the Creek could have a negative impact on the stock trout and wild trout populations of the Creek.

EPA Response: Reducing the volume and regulating the temperature of the process water will be considered during the design phase of the enhanced recovery process. EPA will recycle the enhanced recovery process water as much as possible to minimize the amount being discharged to Brodhead Creek. Current information indicates that the volume of water being discharged to Brodhead Creek will not be significant given the surface water flow data of Brodhead Creek. The majority of the process water will be recirculated through the enhanced recovery process.

D. A comment was submitted stating that any discharge to the Creek, although regulated, may be harmful to the stream biota. Therefore, EPA is urged to select a remedial action that does not include a stream discharge.

EPA Response: EPA understands the concern regarding discharging of process water to the stream. As stated above, the volume of water discharged to the Creek is not expected to be significant compared to stream flow. For an extra added degree of control, EPA has included Brodhead Creek biota monitoring as part of the selected

interim remedy. EPA will strive to minimize any impacts to the Creek from process water discharge.

E. The Pennsylvania Fish Commission and the Brodhead Chapter of Trout Unlimited requested a copy of the fish tissue analysis that was conducted during the Remedial Investigation for their file.

EPA Response: EPA will provide the Commission and Trout Unlimited with a copy of that report.

5. A concern was expressed regarding the possibility that the recovery process could increase the level of coal tar constituents in the Creek as a result of the injection of water at a very high temperature and under pressure into the ground. What precautions can be taken to prevent ground water contamination during implementation of the preferred alternative? Is there a provision for ground water monitoring during implementation? If ground water contamination is detected, what precautions will be taken to protect the community?

EPA Response: A subsurface remediation cell using sheet piling will be blocked off during the enhanced recovery process and hydraulic controls will be maintained within the remediation cell to ensure that the contaminated ground water will not escape the cell thereby minimizing the chance of coal tar constituents seeping into the ground water. Essentially, this hydraulic control will be maintained by extracting process water from the remediation cell at a rate faster than it is being re-injected. This will prevent process water from escaping the subsurface remediation cell.

Ground water will be monitored during testing. The treatability studies will determine what recovery role is necessary to ensure the control of both injected water and released waste. In the event that ground water contamination is detected, EPA will respond with an appropriate response action.

6. A concern was expressed over whether the enhanced recovery process could possibly pose a risk to maintaining the integrity of the existing slurry wall.

EPA Response: The slurry wall is an integral part of the interim remedy that would be implemented at the Site. Maintaining the integrity of the slurry wall is a primary concern. The selected alternative, in-situ enhanced recovery, should not pose a risk to the strength or stability of the existing slurry wall. As the free coal tar is thermally displaced from the soil pores, it will be recovered by pumping wells. Since the enhanced recovery process will be conducted within the confines of a subsurface remediation cell, this will minimize any impacts to the slurry wall or any other subsurface features such as buried utilities.

7. A statement was made regarding the implementation of the preferred alternative in the MW-2 area as well as the RCC area. The statement reads, "Application of the process in the MW-2 area is not feasible due to Site topography. In addition, it would not provide any significant recovery of coal tar because 96% of the free coal tar at the Site is in the RCC area. The RCC area should, therefore, be the only area at which the process is applied."

EPA Response: Although the free coal tar volume at the MW-2 area is small, this area also imparts high levels of contamination to the Site ground water and therefore should be remediated. The question as to whether the enhanced recovery process can be implemented at the MW-2 area will be addressed during the treatability studies and remedial design.

8. Several comments were made regarding the fact that EPA's preferred remedial alternative will only result in a three percent to six percent decrease in the total coal tar volume at the Site which appears to be a relatively low percentage. Statements were made to the effect that EPA's preferred alternative should be re-evaluated in terms of efficiency of the use of funds in light of the estimated volume of coal tar to be recovered.

EPA Response: The enhanced recovery process is the best remedy for the Site with respect to short-term effectiveness and implementability compared to the other alternatives under consideration. The enhanced recovery process may be conducted in situ, which will alleviate the need to stockpile large amounts of contaminated soil thereby increasing exposure. Although the estimated percentages for recovered coal tar may seem low, the free coal tar is the main source of contamination at the Site. The selected remedy is expected to remove between 60 to 70 percent of the free coal tar onsite. In addition, approximately 10,000 gallons of residual coal tar will be collected which will help prevent the coal tar from re-accumulating in the statagraphic sink. Therefore, although overall coal tar reduction may seem small, removal of free coal tar from the Site will significantly reduce ground water contamination.

9. A question was asked regarding how EPA's proposed remedial alternative would lower the Site's total carcinogenic risk.

EPA Response: The removal of the coal tar pools, by lowering the concentration of coal tar constituents in the ground water, will substantially reduce the threat to human health from ingestion of that ground water and the potential for contaminant release to ground water in the bedrock which is currently used as a drinking water supply.

10. A resident questioned what type of steps would be taken to minimize the possible threat to onsite workers and the community

during the remedial activities. Also, since the enhanced recovery process will be conducted in-situ, what types of risks are associated with a potential accident occurring within the mechanics of the process?

EPA Response: The selected alternative has been reviewed and evaluated for implementability and overall protection at the Site, which includes an assessment of possible risks to the community during field activities. (See Section VIII of the Record of Decision).

Before any remedial alternative is implemented, a site-specific Health and Safety Plan for onsite workers and the community will be reviewed by EPA and implemented by EPA or the PRPs. This Plan outlines the steps required to keep all personnel working onsite safe, and if an accident does occur, the Plan describes how to respond.

11. A question was asked regarding how long it will take for the activities outlined in the Proposed Plan to be completed and what type of work will residents be able to see going on at the Site.

EPA Response: It will take approximately six months to implement the enhanced recovery process and based on current information about three months of operation at the Site for completion. Remedial activities will include the installation of injection and recovery wells, one remediation cell, a boiler to heat the water to be injected into the subsurface soils, a phase separator to process the recovered coal tar, an onsite water treatment facility, and a holding tank to store recovered coal tar prior to its shipment off-site.

12. A resident asked if Alternative 5 could pose any residual problems in the future - "perhaps ten years down the road"?

EPA Response: The selected alternative will not be able to recover all of the coal tar in the ground so that some future risk may remain. However, that risk will be greatly reduced because of the reduction in the volume of coal tar and its hazardous constituents. In addition, EPA will be evaluating ground water further under a second operable unit for the Site to determine what other actions may be necessary at the Site to ensure protection to human health and the environment.

13. A resident questioned how Alternative 5 would improve a future ground water cleanup at the Site.

EPA Response: The selected alternative is an effective technique to reduce the volume, mobility and toxic constituents of the coal tar. This interim action will greatly reduce the potential for future release of high concentrations of hazardous compounds to the ground water and will assist in evaluating the feasibility of

restoring ground water at the Site to beneficial uses.

14. EPA was asked to compare the amounts of both free coal tar and residual coal tar that could be removed through Alternative 2: Limited Action as opposed to the Preferred Alternative 5: Enhanced Recovery for Free Coal Tar. A comment was made stating that it appears that "Alternative 5 costs more and poses more environmental risk than Alternative 2, but the cleanup effects of both of these treatments are expected to be slight".

EPA Response: The selected alternative will remove a significantly higher amount of free coal tar from the most highly contaminated area, about 60 percent to 70 percent of the free coal tar. It would also remove approximately 10,000 gallons of residual coal tar which will help prevent re-accumulation into the coal tar sink areas. Alternative 2 is estimated to remove about 50 percent of the coal tar in the Site's statagraphic depression but would remove virtually none of the residual coal tar at the Site.

15. A comment was submitted stating that the proposed remedy should be a final remedy, not an interim remedy. The statement reads "Nothing in the Remedial Investigation, Risk Assessment or Feasibility Study support EPA's decision to propose an interim remedy for this Site and address ground water as a second operable unit."

EPA Response: EPA decides on a remedial alternative afte reviewing the RI/FS and Risk Assessment reports, but is not bou or limited by the conclusions of these studies. EPA determine that ground water needs to be investigated further because the free coal tar may serve as a potential source of release to the ground water in bedrock. EPA will confirm the quality of the ground water in bedrock prior to making a final decision for addressing contamination at the Site.

16. A comment was made suggesting that the work needed for Operable Unit Two, which includes the installation of testing wells in the bedrock aquifer, be conducted prior to the selection of a recovery alternative.

EPA Response: It is not necessary to initiate Operable Unit Two prior to the selection of a recovery alternative. Current site data indicates that the ground water at the Site is highly contaminated. EPA has determined that it is appropriate to address the major source of this ground water contamination while at the same time confirming the quality of the bedrock ground water. Furthermore, the design and implementation of the selected alternative to start treatment for Operable Unit One in conjunction with the installation of additional bedrock monitoring wells under Operable Unit Two will assist EPA in making a final determination for Site remediation.

17. A comment was made regarding EPA's recommendation to expand the monitoring program beyond the monitoring outlined in the Feasibility Study. The statement termed the proposed long-term monitoring of biota, sediment, surface water and ground water excessive in both content and frequency of monitoring. It is believed that the monitoring program proposed in the Feasibility Study is sufficient to the monitor the impact of this Site.

EPA Response: EPA does not believe its monitoring program for ground water and stream biota/sediment is excessive in either content or frequency of monitoring. Macrobenthic community, resident fish sampling, and sediment sampling will be conducted biannually for a two year period. Data generated by this monitoring will be reviewed by EPA to determine if further monitoring is required. Sea lamprey will be sampled once every five years. The sea lamprey larvae are an excellent indicator, based on their lifestyle, of continuing effects, if any, of coal tar on the aquatic life in Brodhead Creek. Quarterly ground water monitoring for at least 18 months is necessary to form a statistical data base for evaluating sample results. Ground water monitoring will then revert to annual sampling and analysis.

EPA is not requiring the sampling and analysis of surface water as part of this alternative.

18. A question was asked regarding whether the Pennsylvania Department of Environmental Resources (PADER) has taken an official position on the Proposed Remedial Action Plan and selection of Alternative 5.

EPA Response: PADER supports the selection of Alternative 5 documented by its correspondence of March 29, 1991.

OTHER REMEDIAL ALTERNATIVES

1. A comment was made that the cleanup alternative recommended by the contractor who had conducted the Remedial Investigation/Feasibility Study was Alternative 2: Limited Action and that the contractor was very critical of EPA's choice of Alternative 5: Enhanced Recovery for the Free Coal Tar. The statement questioned why the contractor's conclusions were removed from the Feasibility Study and not part of the public record.

EPA Response: EPA disagrees with the characterization that the contractor was "very critical" of the enhanced recovery process. The purpose of the Feasibility Study is to have alternatives studied and presented for EPA, in consultation with PADER, to select a preferred alternative. We do not agree with the recommendation. There is no requirement that EPA accept recommendations made by PRPs' contractors. In fact, public policy requires that EPA exercise its best independent judgement to

determine what remedy will protect public health and the environment. EPA makes whatever changes necessary to any report including an FS in accordance with its authority in CERCLA and the NCP.

2. A comment was submitted stating a preference for Alternative 2: Limited Action over EPA's preferred Alternative 5: Enhanced Recovery Process. The statement reads "EPA's proposed remedy is no more protective of health and the environment and does not meet SARA mandates significantly more effectively than the Limited Action Alternative which is much less expensive. The most cost effective alternative evaluated in the Feasibility Study that would accomplish a reduction in toxicity, mobility and volume appears to be the Limited Action Alternative."

EPA Response: EPA is concerned with eliminating the source of contaminants that is mobile and therefore has the capability to migrate beneath the Site or possibly vertically to ground water in the bedrock. The enhanced recovery process will accomplish this task better than all other proposed remedies according to current information.

3. A question was asked regarding what EPA's position is on the cleanup remedy that would involve the excavation and removal of all onsite soil and its replacement with new soil.

EPA Response: Excavation and replacement of coal tar contaminate subsurface soils would entail overcoming several site-specif constraints associated with excavation including the re-routing o several subsurface utilities, the flood control levee, slope stability during excavation and upwelling of the silty sand unit. In addition, excavated contaminated soil would have to be stockpiled onsite prior to its shipment offsite for incineration. This may allow for the increased chance of someone coming in contact with the coal tar during the excavation process. Also, the stockpiled soils as well as the open excavation would be a source of volatile organic compound (VOC) emissions from the Site. With respect to these factors, excavation did not seem appropriate.

4. A resident asked for an explanation as to why Alternative 5 is better than Alternative 4 when it seems that Alternative 4 costs a little less and removes 6 percent to 10 percent of the total coal tar volume at the Site, which is more than the percentages quoted in Alternative 5.

EPA Response: Alternative 4 involves excavation of contaminated subsurface soils in the RCC area of the Site. The excavation process alone carries a number of site-specific constraints (See Response to #3) which would make it difficult to implement. In addition, due to the nature of the subsurface soils (i.e., cobbles and gravels), material handling problems would likely occur. The soils would have to be stockpiled onsite prior to soil washing

which may increase the chance of someone coming in contact with contaminated soils. Also, VOC emissions from the stockpiled soils and the excavation area would have to be addressed.

Therefore, although Alternative 4 does remove a slightly greater percentage of coal tar, the fact that Alternative 5 can be conducted in-situ without excavation, makes it a more preferable alternative.

5. A question was asked in regard to the excavation described in Alternative 6: Excavation of Contaminated Subsurface Soils and Off-Site Incineration being combined and/or supplemented with the pumping process described in Alternative 2: Limited Action.

EPA Response: The excavation in Alternative 6 is limited to the Site's bigger pool of coal tar because the second pool of coal tar abuts the slurry wall and excavation could cause damage to the wall. It is possible to take portions of alternatives and combine them. In this case, however, excavation would cause a problem because of the high water table and silty sand. This would cause a running sand problem which would create significant problems in addition to the other site-specific excavation constraints already mentioned.

6. A resident asked about the threat posed by the free coal tar to the environment if Alternative 1: No Action was selected.

EPA Response: The "No Action" alternative is not protective of human health or the environment of the Site. The free coal tar located in the subsurface soils is imparting high levels of contaminant into Site ground water. Possible future releases and the potential for exposure would not be controlled if Alternative 1 was selected. (See discussion in Section VIII of the Record of Decision.)

7. A question was submitted regarding Alternative 3: On-Site Stabilization/Solidification. The Summary of Alternatives section of the Proposed Remedial Action Plan does not indicate the quantity of free coal tar to be immobilized. This information would be useful in assessing the suitability of this alternative.

EPA Response: Alternative 3 (On-Site Stabilization/Solidification) would involve the excavation and treatment of approximately 1,000 cubic yards of contaminated soils (similar to the excavation volumes of Alternative 4 and 6). Therefore, it is expected that Alternative 3 would immobilize the same quantity of coal tar which would be excavated and treated under Alternatives 4 and 6, which is approximately 8,700 gallons of free coal tar and up to approximately 23,000 gallons of residual coal tar. However, unlike Alternatives 4, 5 and 6, the coal tar will not be permanently removed from the environment; it will only be immobilized in an inert matrix. Therefore, there will be no net reduction in the

volume of coal tar. Indeed, the volume of the treated materials replaced in the excavation will be greater due to the addition of the stabilizing reagents.

8. Questions were submitted regarding the dewatering/and or aqueous byproduct of processing described in Alternatives 3, 4, 5 and 6. Will these waters be treated onsite and discharged to the Creek? If so, what contaminants are proposed to be discharged and in what concentrations?

EPA Response: Contaminated water recovered during the dewatering of the excavations under Alternatives 3 and 6 will be shipped off-site to a treatment, storage or disposal (TSD) facility for treatment/disposal. Recovered process water from Alternative 4 (Soil Washing) and Alternative 5 (Enhanced Recovery) will be treated onsite and discharged to Brodhead Creek. The process water is expected to be contaminated with benzene and various PAHs in addition to other organic contaminants and metals. The discharge to Brodhead Creek of any treated process water must comply with the NPDES requirements for discharge to a surface water body.

9. Questions were submitted regarding the possibility of onsite stockpiling of contaminated soils described in Alternatives 3, 4 and 6. The following information is requested to help determine the alternative that is least harmful to the population and environment.

A. Once the soils are uncovered, do they pose a significant human health risk?

EPA Response: Contaminated soils should not be easily accessible to the public and any excavated contaminated soil must be stored in a restricted area. Some VOC emissions from the soils may occur. However, EPA will take all steps necessary to minimize any exposure to onsite workers and the surrounding community.

B. Can soils be protected from precipitation? Are the contaminants in the soil water soluble?

EPA Response: Soils can be protected from precipitation by placing a cover on them. Some of the contaminants in the soil are water soluble. Water leaching from the contaminated soils would be collected and shipped offsite for treatment.

C. How does exposure to VOC's compare to ground water contamination in terms of health risk? How would the community be protected from VOC's? Were specific precautions considered to reduce the threat of exposure to VOC's?

EPA Response: Exposure to air borne contaminants at the Site in its present condition was evaluated during the Risk Assessment of the Site and were determined not to be of a potential concern. Ground water, on the other hand, exceeds drinking water standards that are protective of human health. During Site remedial activities, some VOC emissions may occur. To the extent that new emissions occur, Pennsylvania regulations require that emissions be reduced to the minimum obtainable levels through the use of the best available technology.

10. A question was posed asking if aggressive action is warranted at the Brodhead Site. The statement reads: "The Proposed Remedial Action Plan identifies only one fact and one speculative concern at Brodhead that could warrant action. The fact identified is that ground water in the shallow aquifer fails drinking standards. This fact, however, is invoked only weakly as a basis for action: exposure to ground water in the stream gravel unit is considered an "unlikely" event that might occur."

EPA Response: Aggressive action is warranted at the Site. A source of hazardous constituents has been identified in the subsurface soils and has been shown to impact the quality of ground water. Maximum Contaminant Levels (MCLs), a health based standard for drinking water, were exceeded for selected compounds and poses a risk to the use of this ground water. In addition to any obligations we have to protect this ground water, a potential may exist for the release of contamination to the ground water in bedrock which is currently used as a drinking water source.

COMMENTS REGARDING OPERABLE UNIT TWO

1. A question was asked regarding what work will be involved during Operable Unit Two.

EPA Response: Work to be done under Operable Unit Two will involve further investigation to assess the quality of the bedrock ground water. That information will be used to help develop an overall Site plan. Alternative cleanup methods will be analyzed and EPA will then issue another Proposed Remedial Action Plan and Record Of Decision.

EPA will be the lead agency for Operable Unit Two in either implementing or overseeing the PRPs' implementation of a focused Remedial Investigation/Feasibility Study.

2. A comment was made suggesting that EPA's plan to divide the cleanup of the Site into two operable units "reflects a desire to move forward an engineering experiment rather than a logical first step in a cleanup plan."

EPA Response: The contamination problems at the Site are complex and may pose a current threat to human health and the environment. Addressing this complex problem in two phases is the best and most logical approach to reducing the immediate risks. Reducing the volume and mobility of the coal tar, the source of the contaminants, is the logical first step. Section 300.430(a)(i)(ii)(A) of the NCP contemplates the splitting of Site remediation into Operable Units.

3. Questions were posed as to why EPA cannot recommend a permanent solution for this Site based on the Remedial Investigation/Feasibility Study. Why does EPA plan to conduct future work on Operable Unit Two? Why would EPA want to go into the bedrock aquifer and look for something else?

EPA Response: EPA cannot recommend a permanent solution without additional data to be sure that there is no vertical migration of contaminants down to the bedrock. This information will be gathered by doing further work on Operable Unit Two.

4. A comment was submitted questioning the purpose of postponing any action on Operable Unit Two which will address ground water in the bedrock, the principal source of human exposure.

EPA Response: No data has been obtained on the bedrock aquifer except in areas located too far away from the Site. This information is necessary before a final strategy for addressir ground water can be adequately contemplated. However, addressing the subsurface soil contamination under this interi… remedy, EPA is taking the first step in an overall Site cleanup strategy.

COMMUNITY RELATIONS CONCERNS

1. A comment was made regarding the fact that EPA did not devote sufficient time to exploring and soliciting public comment on the five other proposed remedial action alternatives.

EPA Response: The Proposed Remedial Action Plan states that EPA is soliciting comments on all alternatives, the Remedial Investigation/Feasibility Study and the Administrative Record file. The purpose of a public meeting is to provide the community with a forum to pose questions and make comments. The NCP requires "a reasonable opportunity, not less than 30 calendar days," for public comment as stated in 40 CFR 300.430(f)(3)(C). The public comment period, during which EPA accepted written comments, was open from February 15, 1991 through March 18, 1991.

2. A question was asked regarding whether EPA will schedule another public meeting if the Agency decides to replace the preferred alternative with one of the other five alternatives listed in the Proposed Remedial Action Plan.

EPA Response: If any modification or substitution of the Preferred Alternative involves elements of the other five proposed alternatives, then another public comment period is not required.

3. A comment was submitted by an organization that had investigated the possibility of applying for a Technical Assistance Grant. The organization stated that they "found the grant application itself beyond the capability of a volunteer organization." They request that EPA review and simplify the process associated with applying for a Technical Assistance Grant.

EPA Response: EPA staff are available to assist applicants in filling out the application and in understanding and complying with Technical Assistance Grant requirements both before and after award of a Grant.

SECURITY CONCERNS

1. A question was asked as to why EPA has endorsed the erection of a security fence since the Site poses no present danger to the public and the public does not use the Site area on a regular basis.

EPA Response: Although the possibility of human exposure is limited, public access to the Site during remedial activities is a consideration that will be addressed during the remedial design phase. It may not be necessary to fence the entire Site area.

2. A question was asked regarding the possibility of EPA erecting a fence if the public is opposed to the idea. Also, what plans does EPA have for the Site after the remedial activities have been completed?

EPA Response: As discussed earlier, EPA's plans for the Site include issuing a subsequent Record of Decision for the Site. The posting of a Site guard is a possible alternative to fencing. Plans for long-term security will be determined at a later date.

OTHER ISSUES

1. One potentially responsible party is concerned that the selection of the preferred alternative is a result of communication between EPA and another potentially responsible party that indicates that the enhanced recovery process would suit the purposes of both EPA and the other potentially responsible party.

EPA Response: EPA selects a remedy for a site based on the evaluation of alternatives against the nine criteria listed in the NCP and what is best for the site. The criteria and basis for selection are fully discussed in the administrative record file.

EPA does not select a remedy on potentially responsible party's willingness to implement a particular remedy.

2. A commenter has asked that the Record of Decision be delayed until the Federal District Court for the Eastern District of Pennsylvania hears and decides the negligence liability theory presently being advanced in a suit against the Commonwealth of Pennsylvania.

EPA Response: The pending litigation, to which the EPA is not a party, addresses liability and has no effect on EPA's selection of a remedy for this Site. EPA is fulfilling, in part, its statutory and regulatory obligations with respect to the health and environmental concerns at the Site.

3. A potentially responsible party suggests that the procedure which would best serve the interests of all is to defer both the Record of Decision and special notice letters six months so that both EPA and the potentially responsible party are in an informed position to take appropriate action.

EPA Response: EPA believes it is in an informed position to take appropriate action at this time to mitigate potential threats posed by the free coal tar at the Site. There is no reason for delaying the Record of Decision or Special Notice Letters for six months.

APPENDIX B

BRODHEAD CREEK SITE
ADMINISTRATIVE RECORD FILE *
INDEX OF DOCUMENTS

I. SITE IDENTIFICATION

1. Report: Groundwater Development for the Borough of East Stroudsburg, East Stroudsburg, Pennsylvania, prepared by Moody and Associates, Inc., 6/71. P. 100001-100049.

2. Report: The Borough of East Stroudsburg Water Supply System and the Impact of East Stroudsburg State College on this System, prepared by R.K.R. Hess Associates, 3/81. P. 100050-100064.

3. U.S. EPA Potential Hazardous Waste Site Identification, 3/12/81. P. 100065-100065.

4. Report: A Preliminary Assessment of Brodhead Creek Coal Plant, Stroudsburg, Pennsylvania, prepared by Ecology and Environment, Inc., 6/10/81. P. 100066-100114.

5. U.S. EPA Potential Hazardous Waste Site Identification & Preliminary Assessment, 6/10/81. P. 100115-100118.

6. Report: Brodhead Extent of Contamination Report, prepared by Barrett E. Borry, 9/11/81. P. 100119-100162.

7. Report: A Site Inspection of Brodhead Creek, Stroudsburg, PA, prepared by Ecology and Environment, Inc., 6/29/82. P. 100163-100490.

8. Site Safety Plan, prepared by Ecology and Environment, Inc., 8/31/82. P. 100491-100500.

9. Memorandum to Mr. Robin Aiken, U.S. EPA, from Ms. Veronica Wancho O'Donnell, Ecology and Environment, Inc., re: Discharge from Redmond Manufacturing into Brodhead Creek, 11/23/82. P. 100501-100501.

10. Report: Brodhead Creek Drilling Program, prepared by Ecology and Environment, Inc., 12/30/82. P. 100502-100707.

* Administrative Record File available 12/12/90, updated 2/14/91.

II. REMEDIAL ENFORCEMENT PLANNING

1. Consent Order and Agreement, In the Matter of: Brodhead Creek Superfund Site, 8/20/87. P. 200001-200023.

Holland Thread Manufacturing

2. Letter to Mr. Ralph Matergia, Holland Thread Manufacturing Company, Inc., from Mr. William A. Sullivan, Jr., U.S. EPA, re: Possibility of EPA's spending public funds, 3/18/82. P. 200024-200025.

3. Letter to Holland Thread Manufacturing Company from Mr. Donald M. Becker, Pennsylvania Department of Environmental Resources (PADER), re: Notification of NPL status, 4/14/86. P. 200026-200027.

Lockwood Engineering Corporation

4. Letter to Mr. Mark Wolfe, Lockwood Engineering Corporation, from Mr. William A. Sullivan, Jr., U.S. EPA, re: Possibility of EPA's spending public funds, 3/18/82. P. 200028-200029.

5. Letter to Lockwood Engineering from Mr. Donald M. Becker, (PADER), re: Notification of NPL status, 4/14/86. P. 200030-200031.

Pennsylvania Power & Light (PP&L)

6. Notes of interview with Mr. Howard Lee, Stroudsburg Coal Tar Investigation, prepared by J. F. Villaume, 6/9/81. P. 200032-200033.

7. Letter to Mr. Edward M. Nagel, Pennsylvania Power & Light Company, from Mr. William A. Sullivan, Jr., U.S. EPA, re: Possibility of EPA's spending public funds, 3/18/82. P. 200034-200035.

8. Letter to Mr. Gene Gockley, Pennsylvania Power and Light Company, from J.E. Godfrey, PADER, re: Final Work Plan, 2/14/86. P. 200036-200182. The Work Plan is attached.

9. Letter to Mr. Gockley, Pennsylvania Power and Light Company, from J. E. Godfrey, PADER, re: Agreement to sponsor meeting, 3/3/86. P. 200183-200183.

10. Letter to Mr. J. Kozlosky, PADER, from Mr. Gene H. Gockley, Pennsylvania Power & Light Company, re: Agreement to undertake the RI/FS, 4/11/86. P. 200184-200184.

Penn Fuel Gas, Inc.

11. Letter to Mr. John Ware, Penn Fuel Gas, Inc., from Mr. William A. Sullivan, Jr., U.S. EPA, re: Possibility of EPA's spending public funds, 3/18/82. P. 200185-200186.

Union Gas Co.

12. Letter to Mr. Rae Cornwall, Union Gas Company, from Mr. William A. Sullivan, Jr., U.S. EPA, re: Possibility of EPA's spending public funds, 3/18/82. P. 200187-200188.

13. Letter to Mr. Nicholas DeBenedictis, Department of Environmental Resources, from Mr. Marc G. Brecher, Pennsylvania Office of the Attorney General, re: Hazardous waste clean-up of Brodhead Creek, 1/25/85. P. 200189-200191.

14. Letter to Union Gas Company from J.E. Godfrey, PADER, re: Final Work Plan, 2/14/86. P. 200192-200193.

III. REMEDIAL RESPONSE PLANNING

1. Report: Remedial Action Master Plan, Brodhead Creek Site, Stroudsburg, Monroe County, Pennsylvania, prepared by AEPCO, Inc., 10/83. P. 300001-300195.

2. Report: Case Studies 1-23: Remedial Response at Hazardous Waste Sites, prepared by U.S. EPA, 3/84. P. 300196-300246.

3. Report: Evaluation of Stream Morphology and Aquatic Biological Data Related to the Union Gas Site on Brodhead Creek in Monroe County, Pennsylvania, prepared by Energy & Environmental Management, Inc., 7/31/84. P. 300247-300254.

4. Letter to Mr. Mark Carmon, PADER, from Mr. Robert A. Swift, Kohn, Savett, Marion & Graf, re: Grounds for Union Gas Co.'s opposition to RI/FS Work Plan, 6/5/85. P. 300255-300287. A report entitled Remarks for the Public Record Concerning Streams Morphology and Aquatic Biological Data Related to the Union Gas Site on Brodhead Creek in Monroe County, Pennsylvania is attached.

5. Report: Brodhead Creek Site, Remedial Investigation/Feasibility Study, Final Work Plan, prepared by PADER, 1/86. P. 300288-300340.

6. Report: Technical Oversight Work Plan for Brodhead Creek Site, Stroudsburg, Pennsylvania, Volume I, prepared by Camp, Dresser & McKee, Inc., 6/86. P. 300341-300378.

7. Memorandum to Ms. Patricia Tan, U.S. EPA, from Mr. Nels Barrett, U.S. EPA, re: November 14, 1986 site visit, 12/2/86. P. 300379-300382. Four photos are attached.

8. Report: Site Operations Plan for the Remedial Investigation of the Brodhead Creek Site, prepared by Environmental Resources Management, 10/87. P. 300383-300534.

9. Report: Trip Report, Brodhead Creek, Site Visit Monroe County, Pennsylvania, prepared by CDM Federal Programs Corporation, 4/8/88. P. 300535-300543.

10. Report: September 1988 Monthly Summary, Remedial Investigation Oversight, Brodhead Creek Site, Stroudsburg, Pennsylvania, prepared by Versar, Inc., 10/14/88. P. 300544-300613.

11. Letter to Mr. John Mellow, PADER, from Mr. Michael F. Basta, Pennsylvania Power & Light Company, re: Transmittal of QA/QC validated chemical data, 10/27/88. P. 300614-300628. The data is attached.

12. Report: October Monthly Summary Report for the Remedial Investigation/Feasibility Study (RI/FS) at the Brodhead Creek Site, Stroudsburg, Pennsylvania, prepared by CDM Federal Programs Corporation, 11/21/88. P. 300629-300733. The transmittal letter is attached.

13. Report: November Monthly Report, Remedial Investigation Oversight at the Brodhead Creek Site, Stroudsburg, Pennsylvania, prepared by CDM Federal Programs Corporation, 12/14/88. P. 300734-300750.

14. Report: December Monthly Summary Report for the Remedial Investigation/Feasibility Study (RI/FS), Brodhead Creek Site, Stroudsburg, Pennsylvania, prepared by CDM Federal Programs Corporation, 1/16/89. P. 300751-300798.

15. Health Assessment for Brodhead Creek, Stroudsburg, Pennsylvania, prepared by Agency for Toxic Substances and Diseases Registry (ATSDR), 1/20/89. P. 300799-300802.

16. Letter to Ms. Patricia Tan, U.S. EPA, from Mr. James W. Geiling, Pennsylvania Power & Light Company, re: Request to eliminate sampling & analysis, 2/10/89. P. 300803-300807. Four pages of samples & analyses are attached.

17. Letter to Mr. James W. Geiling, Pennsylvania Power & Light Company, from Mr. Robert K. Lewis, PADER, re: Request to eliminate mussel sampling, 4/7/89. P. 300808-300808.

18. Letter to Mr. Robert K. Lewis, PADER, from Mr. Michael F. Basta, Pennsylvania Power & Light Company, re: Follow-up and response to April 7th letter, 5/8/89. P. 300809-300809.

19. Letter to Mr. Michael F. Basta, Pennsylvania Power & Light Company, from Mr. Robert K. Lewis, PADER, re: Request to eliminate 3rd round of surface water sampling, 5/22/89. P. 300810-300810.

20. Transmittal letter to Ms. Rose Harvell, U.S. EPA, from Mr. Bruce R. Pluta, CDM Federal Programs Corporation, re: Letter Report for Work Assignment 791 Oversight and Split Sampling, 6/21/89. P. 300811-300833. The Letter Report is attached.

21. Report: May Monthly Summary Report for the Remedial Investigation/Feasibility Study (RI/FS) at the Brodhead Creek Site, Stroudsburg, Pennsylvania, prepared by CDM Federal Programs Corporation, 6/23/89. P. 300834-300859.

22. Report: Brodhead Creek Site, Final Remedial Investigation Report, prepared by Environmental Resources Management, Inc., 9/25/90. P. 300860-301376.

23. Report: Risk Assessment, Brodhead Creek Site, Stroudsburg, Pennsylvania, 9/25/90. P. 301377-301779.

24. Report: Broadhead Creek, Feasibility Study, prepared by Environmental Resources Management, Inc., 1/91. P. 301780-302171.

25. Proposed Remedial Action Plan, Brodhead Creek Site, Borough of Stroudsburg, Monroe County, Pennsylvania, prepared by U.S. EPA, 2/14/91. P. 302172-302192.

IV. REMOVAL RESPONSE PROJECTS

1. Waste or Water Quality Report prepared by PADER, 3/4/81-4/21/82. P. 400001-400101.

2. Memorandum to Mr. Tom Massey, U.S. EPA, from Mr. Roger Mayer, U.S. EPA, re: Coal tar problem, 3/12/81. P. 400102-400102.

3. Letter to Mr. Barrett Borry, Department of Environmental Resorces [sic], from Mr. Tom Eveland, Monroe Community Conservation District, re: Data concerning erosion, 3/25/81. P. 400103-400103.

4. Memorandum to Mr. Merle H. Ryan, Pennsylvania Department of General Services (PADGS), from Mr. Richard Inhoffer, PADGS, re: Contamination problem, 3/26/81. P. 400104-400105.

5. Memorandum to Mr. Tom Massey, U.S. EPA, from Mr. Barrett Borry, PADER, re: Industrial waste, 3/31/81. P. 400106-400110. Three water or waste quality reports are attached.

6. Memorandum to Mr. Tom Massey, U.S. EPA, from Mr. Barrett E. Borry, PADER, re: Industrial waste, 3/31/81. P. 400111-400121. A memorandum and copies of photographs are attached.

7. Report: Federal On-Scene Coordinators Report, Water Pollution Incident, Stroudsburg, PA, March, 1981 - November, 1981. P. 400122-400486.

8. Brodhead Test Pits #1 - #22, 4/10/81 - 4/16/81. P. 400487-400489.

9. Letter to Mr. Bradley A. Wise, Pennsylvania Power and Light, from Bipin Patel, Roy F. Weston, Inc. re: Analytical results, 5/5/81. P. 400490-400497. The results are attached.

10. Sample Analyses, 6/4/81 - 7/31/81. P. 400498-400510.

11. Report: Pennsylvania Power & Light Stroudsburg Contamination Study, Prepared by TRC Environmental Consultants, Inc., 7/81. P. 400511-400553.

12. Safety Plan, prepared by Ecology and Environment, Inc., 8/4/81. P. 400554-400555.

13. Letter to Mr. Lawrence Pawlush, PADER, from Mr. Bradley A. Wise, Pennsylvania Power & Light Company, re: Laboratory results of the Stroudsburg Coal Tar Site, 8/14/81. P. 400556-400602. The results are attached.

14. Letter to Mr. Thomas Massey, U.S. EPA, from Mr. Allen Weichman, Monroe County Conservation District, re: Concern over the possibility of winter flooding at the Brodhead Creek, 8/20/81. P. 400603-400604.

15. Report: Pennsylvania Power & Light, Stroudsburg Contamination Study, Technical Control Recommendation, prepared by TRC Environmental Consultants, Inc., 9/81. P. 400605-400617.

16. Letter to Mr. Ken McGill, Ecology and Environment, Inc., from Mr. Andrew J. Drozda, J. E. Brenneman Company, re: Analysis of leachate samples, 9/24/81. P. 400618-400619.

17. Memorandum to Mr. Thomas I. Massey, U.S. EPA, f Royal J. Nadeau, U.S. EPA, re: Significance o toxicity tests, 11/4/81. P. 400620-400625.

18. Report: Federal On-Scene Coordinators Report, Major Pollution Incident, Stroudsburg, PA, prepared by Ecology and Environment, Inc., 11/81. P. 400626-400735.

19. Letter to Mr. Thomas I. Massey, U.S. EPA, from Mr. James F. Villaume, Pennsylvania Power & Light Company, re: Final Phase II Field Investigation Report, 12/18/81. P. 400736-400757. The report is attached.

20. Letter to United States Coast Guard from Mr. Thomas I. Massey, U.S. EPA, re: On-Scene Coordinator's Report for the oil spill, (undated) P. 400758-400870. The report is attached.

21. Memorandum to Mr. Walter Burkhart, PADER, from Mr. Craig W. Billingsley, PADER, re: Toxicity of coal tar discharge to rainbow trout, (undated). P. 400871-400871.

22. Memorandum to Mr. Walter Burkhart, PADER, from Mr. Craig W. Billingsley, PADER, re: Toxicity of coal tar discharge to rainbow trout, (undated). P. 400872-400872.

23. Report: Historical Background of Coal Tar Pollution Site, Brodhead Creek, Stroudsburg, PA, (author not cited), (undated). P. 400873-400876.

24. Amended Fund Authorization Report, (undated). P. 400877-400882. The Staged Planned Removal Alternative for Brodhead Creek is attached.

25. Fund Authorization Report, (undated). P. 400883-400885.

V. COMMUNITY INVOLVEMENT/CONGRESSIONAL CORRESPONDENCE/IMAGERY

1. Letter to Mr. Craig Billingsley, Pennsylvania Fish Commission, from Mr. Jim Bashline, Field & Stream, re: Historical significance of the Brodhead Creek, 3/23/81. P. 500001-500002.

2. Letter to Mr. Larry Comunale, Borough of East Stroudsburg, from Mr. Thomas I. Massey, U.S. EPA, re: Notice of federal interest in a pollution incident, 7/7/81. P. 500003-500004.

3. Letter to Mr. Nicholas DeBenedictis, U.S. EPA, from Rep. Joseph M. McDade, House of Representatives, re: Request for a status report of the Brodhead Creek cleanup, 7/22/81. P. 500005-500005.

4. Letter to Mr. Thomas Massey, U.S. EPA, from Mr. Patrick J. Calpin, Pocono Forestry Association, re: Support of the use of Superfund monies for Brodhead Creek cleanup, 7/28/81. P. 500006-500006.

5. Letter to Mr. Thomas Massey, U.S. EPA, from Ms. Nancy Shukaitis, Monroe County Board of Commissioners, re: Formal certification of the pollution problem at Brodhead Creek, 7/29/81. P. 500007-500007.

6. Letter to Mr. Thomas Massey U.S. EPA, from Mr. Steven Crane, Monroe County Office of Emergency Services, re: Support of the cleanup operation at Brodhead Creek, 7/30/81. P. 500008-500008.

7. Letter to Mr. Thomas Massey, U.S. EPA, from Mr. Edmund G. Flynn, Bensinger & Pentz, re: Support of Superfund cleanup at the site, 7/30/81. P. 500009-500009.

8. Letter to Mr. Thomas Massey, U.S. EPA, from Dr. Joel S. Samuelson, Pocono Allergy & Dermatology Associates, re: Support of a cleanup operation at the site, 7/30/81. P. 500010-500010.

9. Letter to Mr. Thomas I. Massey, U.S. EPA, from Dr. James M. Fox, Pennsylvania Department of Health, re: Health hazards concerning the site, 7/30/81. P. 500011-500011.

10. Letter to the Honorable Joseph M. McDade, House of Representatives, from Mr. Nicholas DeBenedictis, U.S. EPA, re: Response to request for a status report, 8/11/81. P. 500012-500015. A routing slip and a copy of the request are attached.

11. Letter to the Honorable Joseph M. McDade, House of Representatives, from Mr. Ralph W. Abele, Pennsylvania Fish Commission, re: Request for support of cleanup efforts at the site, 8/19/81. P. 500016-500016.

12. Letter to Mr. Thomas Massey, U.S. EPA, from Mr. Allen Weichman, Monroe County Conservation District, re: Transmittal of a chart depicting the Brodhead Creek's flow characteristics, 8/20/81. P. 500017-500019. A copy of the chart is attached.

13. Letter to the Honorable William B. Middendorf, PADER, from Mr. Ralph W. Abele, Pennsylvania Fish Commission, re: Visit to the site and extent of the problem, 8/28/81. P. 500020-500021.

14. Transmittal memo for letter to Ms. Anne Gorsuch, U.S. EPA, from Ms. Ann McManus, Monroe County League of Women Voters, re: Request for support of remediation project at the site, 9/20/81. P. 500022-500023. A copy of the letter is attached.

15. Transmittal memo for letter to Ms. Anna Gorsuch, U.S. EPA, from Ms. Nancy Shukaitis, Mr. Jesse D. Pierson, & Mr. Thomas R. Joyce, Monroe County Commissioner's Office, re: Request for Superfund monies for site cleanup, 9/24/81. P. 500024-500027. A copy of the letter and a table listing the percentage of carcinogens present are attached.

16. Transmittal memo for letter to Mrs. Anne M. Gorsuch, U.S. EPA, from Mr. Russell Kowalyshyn, Pennsylvania House of Representatives, re: Request for continued EPA funding at the site, 9/25/81. P. 500028-500029. A copy of the letter is attached.

17. Letter to Mr. Russell Kowalyshyn, Pennsylvania House of Representatives, from Mr. Michael B. Cook, re: Response to request for continued EPA funding at the site, 10/28/81. P. 500030-500031. A copy of the request is attached.

18. Letter to Ms. Nancy Shukaitis, Monroe County Board of Commissioners, from Mr. Michael B. Cook, re: Response to request for Superfund monies for site cleanup, 10/28/81. P. 500032-500035. A copy of the request and a table listing the percentage of carcinogens present are attached.

19. Press Release from U.S. EPA Environmental News, entitled "Joint Release by EPA and PADER for Release 1 PM, November 4, 1981, Funding Announced for Brodhead Creek." 11/4/81. P. 500036-500040. A design of the proposed slurry wall and a fact sheet are attached.

20. Community Relations Plan for Remedial Action, Brodhead Creek Superfund Site, Stroudsburg Borough, Monroe County, Pennsylvania, (undated). P. 500041-500055.

21. Press Release from Pennsylvania Power & Light Company, re: Plans to conduct studies to determine extent of subsurface contamination, (undated). P. 500056-500057.

22. Community Relations Plan for the Brodhead Creek Superfund Site, prepared by Dynamac Corporation, 2/15/91. P. 500058-500093.

SITE SPECIFIC GUIDANCE DOCUMENTS

1. Guidance for Conducting Remedial Investigations and Feasability Studies Under CERCLA, prepared by OSWER/OERR, 10/1/88. OSWER #9355.3-01.

2. Handbook Remedial Action at Waste Disposal Sites (Revised), prepared by ORD/HWERL and OSWER/OERR, 10/1/88. EPA-625/6-85/006.

3. CERCLA Compliance with Other Environmental Statutes, prepared by J.W. Porter, OSWER, 10/2/85. OSWER #9234.0-2. Potentially Applicable or Relevant and Appropriate Requirements are attached.

4. CERCLA Compliance with Other Laws Manual Draft Guidance, prepared by OERR, 8/8/88. OSWER #9234.1-01.

5. Integrated Risk Information Systems (IRIS) (A Computer-Based Health Risk Information System Available Through E-Mail--Brochure on Access is Included), prepared by OHEA, (undated).

6. Superfund Exposure Assessment Manual, prepared by OERR, 4/1/88. OSWER #9285.5-1.

7. Superfund Public Health Evaluation Manual, prepared by OERR and OSWER, 10/1/86. OSWER #9285.4-1.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
Office of Environmental Protection
90 East Union Street - 2nd Floor
Wilkes-Barre, Pennsylvania 18701-3296
(717) 826-2511

March 29, 1991

Mr. Edwin B. Erickson
Regional Administrator
U. S. Environmental Protection Agency
Region III
841 Chestnut Building
Philadelphia, PA 19107

Dear Mr. Erickson:

The Record of Decision received March 26, 1991 for Operable Unit 1, which addresses free coal-tar contaminated subsurface soils at the Brodhead Creek NPL Site in the Borough of Stroudsburg, Monroe County, has been reviewed by the Department.

The major components of the selected interim remedy include:

* The innovative technology of enhanced recovery entailing the installation of extraction wells and injection wells in the free coal tar areas of the subsurface soils;

* Recovery of coal tar and process water from the extraction wells;

* Separation of the coal tar from the process water followed by treatment of the process water;

* Discharge of a portion of the treated process water to Brodhead Creek and the reinjection of the remaining treated process water into the subsurface soils to enhance coal tar recovery;

* Disposal of the recovered coal tar at an off-site permitted incineration facility;

* Installation of a fence to prevent public access during remedial activities;

* Imposition of deed restrictions to limit future use of the Site; and

* Ground water and biota monitoring in Brodhead Creek to ensure protection to human health and the environment.

I hereby concur with the EPA's proposed interim remedy with the following conditions:

* The Department will be given the opportunity to concur with decisions related to the design of the Interim Remedial Action for the Operable Unit 1, to assure compliance with DER cleanup ARARs and design specific ARARs.

* The Department will be given the opportunity to concur with decisions related to subsequent operable units (specifically, the final remedies for Operable Unit 1 and Operable Unit 2), and evaluate appropriate remedial alternatives to assure compliance with DER cleanup ARARs and design specific ARARs.

* EPA will assure that the Department is provided an opportunity to fully participate in any negotiations with responsible parties.

* The Department will reserve our right and responsibility to take independent enforcement actions pursuant to state law.

* This concurrence with the selected remedial action is not intended to provide any assurances pursuant to SARA Section 104(c)(3).

* The Department continues to assert that our ARAR for groundwater for hazardous substances is that all groundwater must be remediated to "background" quality as specified by 25 Pa. Code §§264.90-264.100 and in particular by 25 Pa. Code §264.97(i), (j) and 264.100(a)(9). The Commonwealth of Pennsylvania also maintains that the requirement to remediate to background is found in other legal authorities. We also assert that contaminated soils must be remediated to prevent contamination of groundwater above "background" levels. Given the above, the Department expects that the final remedies for Operable Units 1 and 2 will meet these ARARs.

Thank you for this opportunity for the Department to states its concurrence with the interim remedy selected by EPA. The Department's concurrence is limited to its agreement that the proposed selected remedy is the appropriate one. The Department does not agree that every detail set forth in the Record of Decision is accurate. If you have any questions regarding this matter, please do not hesitate to contact me.

Sincerely,

Ed Shoener
Regional Environmental
Protection Director