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EPA Superfund Record of Decision:

Brodhead Creek Site, (O.U. 2) Stroudsburg, PA 6/30/1995

RECORD OF DECISION
BRODHEAD CREEK SITE
OPERABLE UNIT TWO
DECLARATION

Site Name and Location

Brodhead Creek Site
Stroudsburg, Pennsylvania
Operable Unit Two

Statement of Basis and Purpose

This decision document presents a selected remedy for residual coal tar contamination and ground water contamination in the subsurface soils at the Brodhead Creek Site (the "Site") in Stroudsburg, Pennsylvania, which was chosen in accordance with the requirements of 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. The information supporting this decision is contained in the administrative record for this Site.

The Commonwealth of Pennsylvania concurs with the selected remedy.

Description of the Remedy

The Brodhead Creek Site is the location of a former coal gasification plant which operated along the west bank of Brodhead Creek in the Borough of Stroudsburg, Monroe County, Pennsylvania, from approximately 1888 to 1944. A waste product from these operations was coal tar, a black tar-like liquid which had a density greater than water and was principally composed of polynuclear aromatic hydrocarbons ("PAHs"). This coal tar was placed in an open pit located on the property. This practice continued until the mid-1940s when the plant was abandoned.

A previous Record of Decision ("ROD"), issued on March 29, 1991, selected an enhanced recovery process as an interim remedial action for Operable Unit One ("OU-1") at the Site which addressed free coal tar in the subsurface soils at the Site. As part of the OU-1 interim remedial action, deed restrictions will be imposed to limit future use of the Site. The shallow ground water and Brodhead Creek will continue to be monitored to verify that no unacceptable risks posed by conditions at the Site occur in the future.

This ROD addresses ground water contamination and residual coal tar contamination in the subsurface soils (Operable Unit Two or "OU-2"). No further action is necessary for Operable Unit Two.

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with (or waives) federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective.

Because the interim remedy for Operable Unit One selected in the previous ROD will result in hazardous substances remaining on-site above health based levels, a review will be conducted within five years after commencement of the interim remedy. The review will be conducted to ensure that the interim remedy continues to provide adequate protection of human health and the environment. Review of this Site, the interim remedy for Operable Unit One and EPA's decision for Operable Unit Two, will be continuing as part of the development of a final remedy for Operable Unit One.

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Division Director
Hazardous Waste Management Division
Region III

6/30/91
Date

RECORD OF DECISION
BRODHEAD CREEK SITE

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DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

The Brodhead Creek Site ("the 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 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. As a result, the natural topography over most of the Site is one of low relief. Surface elevations in the flood plain area range from about 377 feet above mean sea level at the Creek banks to 381 feet in the flood plain interior. In the northern one-third of the Site by contrast, 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, which is located on the western boundary of the Site, from flood waters such as those experienced in the aftermath of Hurricane Hazel in 1955 (See Figure 2). 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 a ratio of 2.5:1 while the opposite side is sloped at a ratio of 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 Route 209 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 continue through the flood plain area. Flow in the smaller of the two is intermittent in nature, as that channel 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, continuing 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 Borough of Stroudsburg has zoned the Creek, its eastern and western banks, and the small promontory at the confluence of Brodhead and McMichael Creeks 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 primarily as undeveloped. Those areas containing the sewage treatment plant and the Stroudsburg Gas Company are classified as utilities.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

Union Gas Company is a successor company 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 coal tar, a black tar-like liquid which had a density greater than water and was principally composed of polynuclear aromatic hydrocarbons ("PAHs"). This coal tar was placed in an open pit located on the property. This practice continued until the mid-1940s when the plant was abandoned.

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, including some of the property owned by Union Gas Company.

On October 7, 1980, during construction repairs to the toe of a 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, including:

- o Installation of temporary filter fences and underflow dams by PADER and EPA to intercept coal tar seepage;

- Installation of a temporary coal tar recovery pit by PADER on the bank of Brodhead Creek;

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

- Excavation of a backwater channel area where coal tar seepage appeared to be particularly significant; and

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

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 original RI/FS for the Brodhead Creek Site.

Results of the Original RI

The original RI, completed in 1989, indicated the following:

- The Site is underlain by the following distinct strata (in descending order): fill, floodplain deposits, stream gravels, silty sands, and bedrock.

- The principal shallow water-bearing strata at the Site are the stream gravel unit and the underlying silty sand unit.

- Soil contamination due to coal tar-related compounds is limited both horizontally and vertically to the stream gravel unit.

- The total area of contamination is approximately 4.28 acres containing an estimated maximum volume of 418,000 gallons of coal tar.

- The likely extent of free coal tar accumulations is limited to a small area of a stratigraphic depression east of the slurry wall (the area around MW-2) and to the lowest portion of the stratigraphic depression located west of the slurry wall (the RCC area). (See Figure 3.) These two areas contain an estimated volume of 338 gallons and 8715 gallons of free coal tar, respectively. Free coal tar is defined as 100% of pore volume saturation in the soil. Coal tar at residual saturation levels is more extensive but limited to the extent of the stream gravel unit. Residual coal tar is defined as less than 100% of pore volume saturation in the soil.

- Ground water flow from the upgradient side of the slurry wall is both downward beneath the slurry wall and southward to Brodhead Creek.

- Migration of coal tar constituents as dissolved constituents in ground water may be constrained by upward flow gradients and by the hydraulic boundaries represented by Brodhead Creek and McMichael Creek.

- RI data suggest that surface waters of Brodhead Creek are not affected by the discharge of coal tar constituents. However, some sediment areas within the Creek channel are slightly contaminated with coal tar.

- There are currently no significant risks associated with the recreational use of Brodhead Creek or the ingestion of fish from the Creek.

Following completion of the original RI/FS in 1991, EPA divided the remedial work to be undertaken at the Site into two manageable components called "operable units (OUs)". These were as follows:

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

OU-2: Ground water in the stream gravel unit to and including bedrock

EPA determined that an interim remedial action should be taken for OU-1 to initiate reduction of the toxicity, mobility, and volume of contaminants in the stream gravel unit at the Site. In a Record of Decision issued on March 29, 1991, EPA selected an interim remedial action which included the following 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 process water into the subsurface soils to enhance coal tar recovery;

(5) Disposal of the recovered coal tar at an off-site 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; and

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

EPA entered into a Consent Decree with PP&L and Union Gas Company on September 2, 1992, under which PP&L and Union Gas Company agreed to implement the remedial design/remedial action ("RD/RA") for OU-1 at the Site. On July 14, 1994, an Explanation of Significant Differences ("ESD") was issued by EPA to revise the performance standards for the interim selected remedy for OU-1. The enhanced recovery process (referred to as the Contained Recovery of Oily Waste Process, or "CROW" process) has been constructed and is expected to become operational in the summer of 1995.

On June 3, 1992, PP&L and Union Gas Company entered into a Consent Order with EPA to conduct a Focused RI/FS for OU-2 to further investigate ground water contamination at the Site. This Record of Decision discusses the results of the Focused RI/FS.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

The Focused RI/FS and the Proposed Remedial Action Plan ("Proposed Plan") for OU-2 were released for public comment on May 25, 1995, 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 the administrative record file located in the EPA Region III office in Philadelphia and at the Stroudsburg Borough Building in Stroudsburg, Pennsylvania. A notice of their availability was published in the Pocono Record on May 25, 1995. A public meeting to discuss the Proposed Plan for OU-2 was held on June 6, 1995 in Stroudsburg, Pennsylvania. EPA's response to all comments on the Proposed Plan received during the comment period is included in the Responsiveness Summary section of this ROD. In addition, a copy of the transcript of the public meeting has been placed in the administrative record file and information repository located at the Stroudsburg Borough Building.

IV. SCOPE AND ROLE OF RESPONSE ACTION

As discussed above, the interim remedial action previously selected for Operable Unit One (enhanced recovery) addresses the areas of free coal tar contamination in the subsurface soils on-site. A final ROD for the Site addressing free coal tar contamination will be issued following completion of the OU-1 enhanced recovery program.

Once the enhanced recovery program is completed, there should be no principal threats from the former areas of coal tar accumulation at the Site since they should contain only residual levels of coal tar contamination. However, contaminants are leaching and will continue to leach from the subsurface soils containing residual coal tar at the Site. These contaminants will continue to contribute to ground water contamination on-site.

This second operable unit addresses ground water contamination and residual coal tar contamination in the subsurface soils on-site.

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.

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, subsequent testing of the coal tar utilizing the toxicity characteristic leaching procedure ("TCLP") during the remedial design phase of the OU-1 interim remedy revealed that the coal tar is a RCRA characteristic waste for toxicity.

B. Regional Geology

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 water for the City of East Stroudsburg municipal wells #1 and #2.

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 human origin. The geology at the Site can be divided into the following distinct strata (in descending order): surficial fill, floodplain deposits, stream gravels, silty sands, glacial till, and bedrock (See Figure 4).

The surficial fill is comprised of earthen fill material which was deposited for land reclamation and levee construction as well as stream bed modifications. 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 (See Figure 5). 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 6 shows a contour map of the base of the stream 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. Underlying the deposits is a glacial till deposit.

C. <u>Mechanics and Extent of Coal Tar Migration</u>

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. Recovering the free coal tar is the focus of the interim remedy for OU-1.

Figure 3 depicts the spatial area defined as the extent of the subsurface coal tar presence, based on all available information. The area defined as the extent of the coal tar presence encompasses all historical subsurface coal tar observations, but 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 in the past 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 appears to be unaffected by coal tar; 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 extent of subsurface stream gravels affected by coal tar at residual saturation levels (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. Figure 7 presents a 3-dimensional representation of the extent of the coal tar contamination.

D. <u>Ground Water</u>

Ground Water Classification and Local Water Use

It is EPA's Superfund policy to use EPA's Ground Water Protection Strategy and Ground Water Classification Guidelines to assist in determining the appropriate type of remediation for a Superfund Site. Three classes of ground water have been established on the basis of the value of ground water and its 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 or a water that has other beneficial uses.

The urban areas of Stroudsburg and East Stroudsburg are supplied by surface and ground water. Stroudsburg Borough is served by a public water supply owned by the Stroudsburg Municipal Authority. The Municipal Authority obtains its water supply from Brodhead Creek (upstream of the Site). The water 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 located in the City of East Stroudsburg. Two of the wells are on the campus of East Stroudsburg University (indicated as "State Teacher's College" on Figure 8) 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. These three wells are used on an intermittent basis only. One of the wells on the campus is only for emergency use (i.e., fire protection), and the second well was not used in 1994 except to exercise the pump. The well in Dansbury Park is used on an as-needed basis to supplement the surface water supplies. The location of the water supply wells is presented in Figure 8.

The Dansbury Park Well was examined closely during the original RI. The original RI concluded that migration of coal-tar constituents from the Site to the well was not possible for several reasons: (1) the well pumps water from a lower gravel unit and the upper portions of a limestone bedrock over 110 feet below the surface; (2) the lower gravel unit is not the same unit as the stream gravel unit of concern at the Site (the lower gravel unit is confined by less permeable overlying silts and clays) and it is not subject to contamination by the Site; and (3) significant hydraulic boundaries (Brodhead and Little Sambo Creeks) lie between the Site and the well. Furthermore, a review of the sampling data from the Dansbury Park well and the other two East Stroudsburg municipal supply wells did not reveal the presence of any coal tar-related compounds.

Shallow 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. To a lesser extent, the sheet pile base of the concrete flood wall extends the head loss effect of the slurry wall northward from the slurry wall to at least the Route 209 bridge abutment.

Hydraulic head levels appear to indicate: (1) that an upward flow component exists between the water table and the underlying strata; (2) that the urban run-off channel likely recharges the ground water system; (3) that Brodhead Creek and McMichael Creek are hydraulic boundaries; and (4) 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 does carry some dissolved 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 of the Site, is recharged by Brodhead Creek in the middle portion, 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 when the Creek rises 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.

Figure 9 is a 3-dimensional cross-section across the southern third of the Site that depicts the conceptual ground water flow paths resulting from all of the influences discussed above.

The shallow aquifer was extensively studied during the original RI/FS and is being monitored as part of the interim remedial action for OU-1. No additional data for the shallow aquifer was obtained during the OU-2 RI. The data from the original RI, the OU-1 monitoring program, and the OU-1 interim remedial action were evaluated in order to establish the most appropriate data set for the OU-2 risk assessment for the shallow aquifer.

The principal contaminants of concern in the ground water in the shallow aquifer are polynuclear aromatic hydrocarbons ("PAHs"), benzene, and arsenic. The concentrations of contaminants detected in the shallow aquifer during the original RI may be found in Table 1. Federal Maximum Contaminant Levels ("MCLs") for drinking water are exceeded for benzene, a range of PAHs, pentachlorophenol, cyanide and arsenic. These MCLs are codified at 40 C.F.R. Part 141 pursuant to the Safe Drinking Water Act, 42 U.S.C. § 300f et seq., and are indicated on Table 1.

The highest concentrations of organic coal tar-related constituents dissolved in ground water are centered around the areas of known coal tar presence near MW-2 and RCC (See Figure 10). Vertical distribution of dissolved-phase contamination is limited to the shallow aquifer and possibly to the uppermost portions of the silty sand unit.

Deep Ground Water

The purpose of the Focused RI for OU-2 was to further characterize the ground water contamination at the Site--in particular, the quality of the bedrock aquifer at the Site. The investigation of the bedrock aquifer included the installation of three bedrock wells at the Site, measurement of ground water elevations of the shallow, intermediate, and bedrock wells, and ground water sampling and analysis of the bedrock wells.

The installation of the three bedrock wells (designated as BR-1, BR-2, and BR-3) at the Brodhead Creek Site was completed in May of 1993. The purpose of the bedrock wells was to determine if the ground water in the bedrock aquifer was being impacted by the contamination at the Site. To the extent possible, the bedrock wells were to be located outside the shallow coal tar accumulation, so as to minimize the risk of cross-contaminating the deeper aquifer. In addition, bedrock wells were to be located adjacent to existing shallow wells, when possible. The location of the bedrock wells is presented in Figure 11.

Based on water level measurements, the bedrock system flow is southward (See Figure 12). On initial evaluation, this is not an expected condition, as flow would be expected northeastward either to discharge locally at Brodhead Creek, or deeper along the bedrock structural trend of the valley towards the Delaware River. However, a closer look at Regional structure explains this flow, as described below.

The topographic quadrangle of the area shows a regional fracture set oriented north-northwest/south-southeast perpendicular to regional bedrock orientation. The regional fracture pattern is shown in Figure 13. Along the course of Brodhead Creek north of Stroudsburg, one large fracture cuts across the regional structural trend, forming water gaps north of Stroudsburg. South of the Site, Brodhead Creek follows an apparent fracture orientation, and then turns 90 degrees toward the east at the contact with the resistant bedrock ridge to the south. However, the fracture appears to continue even across the bedrock ridge to the south.

Given the above structural conditions, it appears likely that bedrock flow from the Site follows the fracture south-southeastward, flowing beneath and parallel to Brodhead Creek. Discharge is likely to Brodhead Creek at or near contact with the ridge. The apparent southerly flow direction beneath the Site is probably a function of triangulation of the potentiometric surface of the three wells. Flow is actually either south-southeastward along the fracture, or southeastward into the fracture, if the Site does not lie directly on the fracture.

Two rounds of ground water sampling were conducted of the bedrock wells BR-1, BR-2, BR-3, and a residential well (hereinafter referred to as the "CS" well) during the weeks of June 1, 1993 and December 9, 1993, respectively. A third round of ground water sampling of the bedrock wells only was conducted on May 8 and 9, 1995. The CS well is a domestic well located in Smithfield Township, approximately 1-1/2 miles east of the Brodhead Creek Site. Based on a well survey conducted during the original RI, the CS well is the closest residential well to the Site that remains in use. For this reason, the CS well was selected as a monitoring point for the Brodhead Creek Site.

Ground water was sampled for volatile organic compounds ("VOCs"), semivolatile organic compounds ("SVOCs"), dissolved metals (on the first round of sampling only), and cyanide. With the exception of trichloroethene ("TCE") at well BR-3 and 1,1-dichloroethane at the CS well, no VOCs were detected at greater than 1 ug/l. TCE and 1,1-dichloroethane are not constituents of coal tar, and were not detected in any ground water samples taken during the original RI.

Trace levels of xylene and 1,2,4-trimethylbenzene were detected in BR-1 and BR-3, but not in BR-2 or the CS well. Naphthalene was detected at trace levels in BR-1, BR-2, and BR-3. Trace levels of toluene were detected in BR-1 and BR-2. In addition, arsenic and cyanide, two Brodhead Creek Site contaminants, were absent from all samples collected during the first round of sampling. Detected concentrations of contaminants for the bedrock wells are summarized in Table 2.

VI. SUMMARY OF SITE RISKS

As part of the Focused Remedial Investigation performed for OU-2 at the Brodhead Creek Site, a Risk Assessment ("RA") was conducted to evaluate the potential impacts of the Site on human health and the environment. In the RA, chemicals of potential concern were identified for detailed evaluation based on the OU-2 and OU-1 sampling results. The Risk Assessment then evaluated the potential health and environmental risks associated with exposure to these chemicals.

The risk assessment for OU-2 at the Brodhead Creek Site focused on the potential human health risks associated with ground water in both the shallow and deep aquifers underlying the Site. The potential for ground water discharges to Brodhead Creek and other surface water bodies was addressed during the original risk assessment and therefore was not re-evaluated. (See the Brodhead Creek Risk Assessment dated September 1990.) Likewise, potential impacts to ecological receptors were extensively evaluated during the original risk assessment and were not re-evaluated. The risks associated with ingesting ground water on-site are summarized below.

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. The first step involved in selecting indicator chemicals involved a comparison of reported constituent concentrations from upgradient sampling locations. Constituents which did not exceed background concentrations were not evaluated further.

For those constituents detected at concentrations greater than background concentrations, a comparison was made between the maximum downgradient concentrations and risk based screening levels developed by U.S. EPA Region III. This comparison was made to evaluate the potential for adverse human health effects resulting from the hypothetical use of ground water.

Based on a review of the data from the original and the focused RIs, a set of chemicals of potential concern were selected for detailed evaluation in the risk assessment. The results of the screening analysis for the shallow aquifer is presented in Table 3. Table 4 provides a justification for the selection or rejection of individual constituents from the risk assessment for the shallow ground water. The results of the deep aquifer screening is presented in Table 5. Table 6 provides a justification for the elimination of individual constituents from the risk assessment for the deep aquifer. No constituents of potential concern were identified in the deep aquifer. Therefore, a quantitative risk assessment was not performed to evaluate potential exposures to ground water in the deep aquifer.

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. Currently, there are no users of the ground water on-site. The risk assessment for OU-2 evaluated the potential risks associated with the hypothetical future use of on-site ground water as a residential water supply. The RA considered on-site ground water use by both adults and young children and evaluated all three potential routes of exposure associated with the residential use of ground water (i.e., ingestion, dermal contact during bathing, and inhalation of VOCs during showering).

C. Toxicity Assessment

Cancer potency factors ("CPFs") have been developed by EPA for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs, which are expressed in units of $(mg/kg\text{-}day)^{-1}$, 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.

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 $1x10^{-6}$ 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 7.

D. <u>Risk Characterization</u>

The potential carcinogenic risks associated with the Brodhead Creek Site were calculated by multiplying the calculated intakes by the appropriate carcinogenic potency factors. Concurrent exposures to more than one carcinogen or to one chemical through multiple exposure routes were evaluated by adding the individual risk estimates. Potential carcinogenic risks are identified by the risk level (i.e., a 1.0×10^{-6} risk level indicates one additional chance in 1,000,000 that an individual will develop cancer). EPA's acceptable risk range for Superfund cleanups is between 1.0×10^{-4} to 1.0×10^{-6}. If the risk exceeds 1.0×10^{-4}, EPA will generally take action to reduce the risk to within the acceptable risk range.

The potential risks associated with exposure to noncarcinogens were estimated by the calculation of the Hazard Index. An HI is equal to the estimated intake for a specific chemical divided by the appropriate RfD. HI's may be summed for each constituent and exposure route to which a receptor may be simultaneously exposed in order to evaluate exposure to multiple chemicals or exposure via multiple routes. The HI identifies the potential for the most sensitive individuals to be adversely affected by non-carcinogenic chemicals that damage human organs. If the HI exceeds one (1.0), there may be concern for potential systematic effects. As a rule, the greater the value of the HI above 1.0, the greater the level of concern.

The Risk Assessment used a statistical analysis concept called Reasonable Maximum Exposure ("RME") to predict the highest expected concentrations that a receptor might be exposed to, for use in the Risk Assessment. The risk assessment estimates the reasonable maximum exposure for possible receptors. This concept produces a very conservative and protective estimate of risk.

The risk calculations for both carcinogens and noncarcinogens are presented in Tables 8 and 9, and are summarized as follows:

(1) The estimated carcinogenic risks associated with the hypothetical residential use of shallow ground water by an adult and a child are 2.49×10^{-2} and 9.57×10^{-3}, respectively.

(2) The hazard indices calculated for the hypothetical residential use of shallow ground water by an adult and a child are 114 and 311, respectively.

E. <u>Uncertainty in Exposure Assessment</u>

It should be re-emphasized that, under current use conditions, there are no users of ground water from either the shallow or deep aquifers in the immediate vicinity of the Brodhead Creek Site. The Borough of East Stroudsburg does receive water from two wells located on the campus of East Stroudsburg University, and a third shallow gravel well located 2,000 feet from the Brodhead Creek Site, in Dansbury Park. However, the original RI concluded that the migration of coal tar-related constituents in ground water beyond Brodhead Creek to any nearby wells east of the Site is not possible under the hydraulic conditions at the Site. The water supply well located in Dansbury Park is separated from the Site by Brodhead Creek and draws its yield from a separate deeper gravel unit. A review of the sampling data from the Dansbury Park well and the other two East Stroudsburg municipal supply wells did not reveal the presence of any coal tar-related compounds.

Although hypothetical future use of on-site ground water would result in an unacceptable risk, such a scenario is extremely unlikely for several reasons. Several site-specific constraints limit the practicality of using the ground water at the Site as a drinking water source. These include the flood control levee and wetlands located on-site. In addition, the gravel unit is too limited in extent to serve as a viable long-term ground water supply at the Site. Brodhead Creek serves as a hydraulic boundary for shallow ground water contamination; it is not possible for ground water in the shallow aquifer to migrate east of Brodhead Creek. Furthermore, the Focused RI reaffirmed that upward flow gradients exist at the Site. Therefore, there is little probability that the bedrock aquifer underneath the Site will be impacted.

Finally, any use of ground water from the shallow aquifer is very unlikely in light of a municipal ordinance in the Borough of

East Stroudsburg which requires mandatory connection to the municipal water distribution system (East Stroudsburg Code §154-4). EPA understands that the Borough of Stroudsburg is presently in the process of developing a similar ordinance. In addition, deed restrictions will be imposed to limit future use of the Site as part of the OU-1 interim remedial action.

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 at the site, whenever this is possible, and on applying innovative technologies to clean up the contaminants.

The Focused FS studied a variety of technologies to see if they met these criteria and 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. Many other technologies were screened out. This process is fully detailed in the original FS dated January 1991 and the Focused FS for Operable Unit Two.

All costs and implementation timeframes specified below are estimates based on best available information. Present worth is the total cost of the remedy including capital costs and 30 years of operation and maintenance of the remedial action, in current dollars.

Regardless of the alternative chosen, EPA will review the Site every five years to ensure the continued protection of human health and the environment, as required by the ROD for OU-1.

Alternative 1: No Further Action

Time to Implement:	**0 months**
Capital Cost:	**$0**
Annual Ground Water O&M:	**$0**
Annual Site Maintenance:	**$0**
Present Worth:	**$0**

Under this alternative, no further action, beyond the OU-1 activities, would be taken to reduce the amount of residual coal tar in the subsurface soils or to remediate ground water. The ROD for OU-1 addressed free coal tar contamination at the Site. The enhanced recovery system to remove the free coal tar has been constructed and should become operational in the summer of 1995. Deed restrictions to limit future use of the Site will be imposed as part of the OU-1 interim remedial action. The OU-1 ground water and Creek monitoring will continue.

Alternative 2: In-Situ Stabilization/Solidification

Time to Implement:	**21 months**
Capital Cost:	**$11,830,000**
Annual Ground Water O&M:	**$35,000**
Annual Site Maintenance:	**$25,575**
Present Worth:	**$13,066,100**

This alternative would include the in-place mixing of stabilizing agents into the contaminated soils, thereby fixating the contaminants in an inert matrix and reducing their ability to leach into the ground water. A mathematical model was used to determine the extent of the coal tar-contaminated soil that would need to be treated in order to achieve cleanup criteria that would be protective of ground water. The results of this model revealed that all areas contaminated with residual coal tar would need to be remediated. The maximum extent of this area is depicted in Figure 3 and Figure 7. These areas include the soils beneath Brodhead Creek, the fill/highlands, the wetlands and the flood control levee on-site. A treatability study and pilot study to select the most appropriate stabilizing reagents for the soils and to determine the leachability of coal tar-related constituents from the stabilized/solidified soils would be required.

Alternative 3: In-Situ Bioremediation

Time to Implement:	**26 months**
Capital Cost:	**$3,515,000**
Annual Bioremediation O&M:	**$241,000**
Annual Ground Water O&M:	**$35,000**
Annual Site Maintenance:	**$25,575**
Present Worth:	**$6,617,100**

In-situ bioremediation involves enhancing the natural microbial degradation of contaminants in the subsurface soils and ground water without excavation of the overlying soil. This technology usually involves adding nutrients, oxygen, and in some cases microorganisms to stimulate biodegradation of the contaminants. A treatability study would be necessary to determine the rate and extent of biodegradation achievable and the oxygen and nutrient addition requirements of the biodegradation process. In addition, a pilot study would be necessary to confirm the results of the treatability study and to determine if the hydrogeologic conditions at the Site (e.g. well spacings, iron fouling problems) are amenable to in-situ bioremediation. As in Alternative 2, the maximum extent of coal tar-contaminated soils would need to be treated. The remediation process would include a network of air sparging wells to stimulate bioremediation of the residual levels of coal tar in the subsurface soils. The Focused FS assumed that multiple treatment "cells" would be required, that two cells would be operated simultaneously and that the well spacings would be approximately fifty feet. Approximately 100 wells would be required to remediate the entire Site. The wells would range in depth from 20 feet to 40 feet. The 40-foot wells would penetrate the levee.

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The Superfund process requires that the alternative chosen to cleanup a hazardous waste site meet two threshold criteria: protect human health and the environment, and meet the requirements of environmental regulations (Applicable or Relevant and Appropriate Requirements--"ARARs"). EPA's primary balancing criteria are: long-term effectiveness and permanence, short-term effectiveness, reduction of volume, toxicity, or mobility of the contaminants, cost effectiveness, and implementability. EPA's modifying criteria are state and community acceptance.

A detailed analysis was performed on the three alternatives using these nine evaluation criteria. The following is a comparison of the alternatives with respect to these criteria.

Protection of Human Health and the Environment

All of the alternatives, including Alternative 1 (No Further Action), would provide protection to human health and the environment by eliminating, reducing, or controlling risk through treatment, engineering controls, or institutional controls. Implementing Alternatives 2 or 3 would not increase human health protection over Alternative 1, as there is currently no significant potential for human health impact and no significant risk related to ground water exposure. Ground water is not currently used at the Site. Although hypothetical future use of on-site ground water could result in an unacceptable risk, such use is highly unlikely, as discussed in the section on "Summary of Site Risks," above. Brodhead Creek serves as a regional boundary to ground water flow; thus, no ground water across the Creek from the Site would be impacted by the Site. Upward flow gradients at the Site decrease the likelihood that the bedrock aquifer beneath the Site will be impacted. A municipal ordinance in the Borough of East Stroudsburg requires mandatory connection to the municipal water distribution system. EPA understands that the Borough of Stroudsburg is presently in the process of developing a similar ordinance. Finally, deed restrictions to limit future use of the Site will be imposed as part of the OU-1 interim remedial action.

Compliance with ARARs

CERCLA requires EPA to conduct its remedial actions in compliance with all environmental laws identified before the Record of Decision, if they are applicable or relevant and appropriate for the situation. These requirements are commonly referred to as ARARs.

Drinking Water and Ground Water ARARs

Alternative 1 would be in compliance with all identified ARARs except federal MCLs for drinking water and Pennsylvania's "background" ARAR which requires that contaminated ground water be restored to "background" levels. For the Brodhead Creek Site, "background" would be defined as the method detection limit for the method of analysis utilized with respect to a particular contaminant. The appropriate methods for the Brodhead Creek Site would be EPA Methods 524.2 and 525.1.

The results of the ground water modeling in the Focused RI/FS for OU-2 revealed that all areas contaminated with residual coal tar would need to be remediated to even attempt to meet MCLs or background levels. These areas include soils beneath Brodhead Creek and beneath the fill/highlands, the wetlands and the levee on-site.

Remediation of areas contaminated with residual coal tar is not technically practicable for a number of reasons. The existing earthen levee could be damaged during the stabilization process of Alternative 2 and might need to be removed and replaced. Implementation of either Alternative 2 or Alternative 3 would severely impact and/or destroy the wetland areas at the Site and on the south fork of Brodhead Creek, which would in turn impact the existing wildlife at the Site. The wetlands would need to be restored. In addition, it would be necessary to reroute Brodhead Creek temporarily to divert water from the south fork in order to access coal tar-impacted soils beneath the Creek bed. This would increase the flow velocity and height of the Creek. Therefore, it might be necessary to reinforce the existing I-80 bridge abutments in order to reduce scour. Work on Brodhead Creek would temporarily impact the aquatic habitat.

If, despite these problems, Alternatives 2 or 3 were implemented, they would provide some reduction in the concentrations of coal tar constituents in ground water over the long term. However, it is not likely that either Alternative 2 or 3 would allow reduction of the concentrations of coal tar-related constituents to background or MCL levels within a reasonable timeframe. Low levels of coal tar-related constituents would continue to leach from the stabilized soils and some constituents would remain recalcitrant to bioremediation.

Therefore, EPA is waiving the federal MCLs for drinking water and Pennsylvania's "background" ARAR on the basis of technical impracticability. Use of the "Technical Impracticability" (TI) waiver is appropriate when attainment of an ARAR would be illogical or infeasible from an engineering perspective and therefore would be "impracticable." (See "Technical Impracticability of Ground Water Restoration, Brodhead Creek Site" dated June 29, 1995)

Other ARARs

Alternatives 2 and 3 would comply with PADER requirements for air emissions set forth in 25 Pa. Code §§ 123.1 et. seq.. Off-site transportation of wastes would be conducted in accordance with the Department of Transportation Rules for Hazardous Materials Transport and Pennsylvania Hazardous Substance Transport regulations. Disposal of hazardous waste from the Site would be conducted in accordance with the requirements of the Resource Conservation and Recovery Act, Pennsylvania Solid Waste Management Act, and/or Pennsylvania Residual Waste Management Act. All discharges of treated process water under Alternative 3 would be conducted in accordance with the National Pollution Discharge Elimination System (NPDES) requirements developed pursuant to the Clean Water Act and PADER Bureau of Water Quality Standards.

As discussed above, implementation of Alternatives 2 or 3 would severely impact and/or destroy the wetland areas at the Site and the south fork of Brodhead Creek, which would in turn impact the existing wildlife at the Site. All regulatory requirements for the construction activities in the wetlands and the Creek would have to be met. Alternative 1 would not impact Site wetlands.

Long-Term Effectiveness and Permanence

Alternative 1 would be effective in the long term for several reasons. The slurry wall installed at the Site will continue to prevent free coal tar from discharging to Brodhead Creek. Implementation of the OU-1 enhanced recovery program for the free coal tar areas on-site will reduce the areas of highest subsurface soil contamination to residual saturation levels, which is expected to improve conditions for natural microbial degradation. The OU-1 monitoring program will provide the data required to evaluate the fate of the coal tar-related constituents, the integrity of the slurry wall and the "health" of the biological community in Brodhead Creek.

Alternatives 2 and 3 would both be effective in the long term in that both will reduce the amount of coal tar constituents in ground water. However, coal tar at residual saturation levels would continue to be a source for the release of low levels of coal tar-related constituents to the ground water in the shallow aquifer, thus precluding compliance with MCLs and Pennsylvania's "background" ARAR.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminants. However, the OU-1 enhanced recovery program will provide for reduction in the toxicity, mobility, and volume of the contaminants by removing the free coal tar and the source of the highest ground water contamination.

Alternative 2 would not reduce the toxicity or the volume of the residual coal tar. However, the mobility of the contaminants in the subsurface soils would be significantly reduced, thereby reducing their impact on ground water in the shallow aquifer.

Alternative 3 would reduce the toxicity and mobility of the coal tar contaminants in ground water in the long term. However, in the short term, the mobility of the contaminants could increase as a result of microorganisms producing surfactants as a "food source." Alternative 3 would not be expected to significantly reduce the volume of residual coal tar since some constituents would remain recalcitrant to bioremediation.

Short-Term Effectiveness

There are no short-term risks associated with implementing Alternative 1.

Potential risks to on-site workers and/or the community might occur during implementation of Alternatives 2 and 3. Exposure to releases of coal tar-related constituents could be minimized by the use of proper operating procedures and personal protective gear for on-site workers. Some emission of VOCs during the treatment activities is likely to occur. Precautions would have to be taken to ensure that these emissions would not impact off-site populations. Off-site transportation of any recovered coal tar and wastewater during the implementation of Alternatives 2 and 3 could create the potential for accidental releases, with attendant human health and environmental risks.

The wetland areas at the Site and the south fork of Brodhead Creek would be destroyed during implementation of Alternatives 2 and 3, which could subsequently impact the existing wildlife habitat.

Implementability

Each of the alternatives under consideration would be implementable at the Site. Alternative 1, No Further Action, would be the easiest to implement. The equipment and labor required for the implementation of Alternatives 2 and 3 is readily available. RCRA-permitted hazardous waste facilities are available to receive the recovered coal tar and wastewater.

Several Site-specific constraints would make the implementation of Alternatives 2 and 3 difficult. These include the need to: (1) reroute Brodhead Creek temporarily to divert water from the south fork in order to access coal tar-impacted soils beneath the Creek bed; (2) reinforce the existing I-80 bridge abutments in order to reduce scour due to the increased flow velocity and height of the Creek; and (3) restore wetlands which would be impacted by the implementation of Alternatives 2 and 3. In addition, the existing earthen levee could be damaged during the stabilization process of Alternative 2 and might need to be removed and replaced.

Cost

The present worth cost for Alternative 1 is $0, which is the lowest cost alternative. The highest cost alternative is in-situ stabilization (Alternative 2) at $13,066,100.

State Acceptance

The Commonwealth of Pennsylvania has concurred with the remedy.

Community Acceptance

Community acceptance of the various alternatives is reflected in the attached Responsiveness Summary. The Responsiveness Summary presents all of the public comments received on the RI/FS and the Proposed Plan, and EPA's responses to the comments.

IX. SELECTED REMEDY

After careful consideration of the requirements of CERCLA, the detailed analysis of the alternatives, and public comments, EPA has selected Alternative 1, No Further Action, for Operable Unit Two at this Site.

Although the hypothetical ingestion of on-site ground water reveals a risk above $1x10^{-4}$, this scenario is highly unlikely. As mentioned previously, several Site specific constraints limit the practicality of using the ground water at the Site as a drinking water source. These include the levee and wetlands located on-site. Furthermore, it should be noted that any use of ground water from the shallow aquifer is very unlikely in light of a municipal ordinance in the Borough of East Stroudsburg which requires mandatory connection to the municipal water distribution system (East Stroudsburg Code §154-4). EPA understands that the Borough of Stroudsburg is presently in the process of developing a similar ordinance.

In addition, the gravel unit is too limited in extent to serve as a viable ground water supply at the Site. Brodhead Creek serves as a hydraulic boundary for shallow ground water contamination; it is not possible for ground water in the shallow aquifer to migrate east of Brodhead Creek. Furthermore, the Focused RI reaffirmed that upward flow gradients exist at the Site. Therefore, there is little probability that the bedrock aquifer underneath the Site will be impacted.

X. STATUTORY DETERMINATIONS

A. Protection of Human Health and the Environment

The No Further Action Alternative, in conjunction with the OU-1 remedy, will be protective of human health and the environment. Implementation of the OU-1 enhanced recovery program for the free coal tar areas on-site will reduce the areas of highest subsurface soil contamination to residual saturation levels, which is expected to improve conditions for natural microbial degradation. The OU-1 monitoring program will provide the data required to evaluate the fate of the coal tar related constituents, the integrity of the slurry wall and the "health" of the biological community in Brodhead Creek. This will provide long term protection against the unlikely event that Site conditions might change and potential exposures increase. In addition, the slurry wall installed at the Site will continue to prevent free coal tar from discharging to Brodhead Creek.

There is currently no significant potential for human health impact and no significant risk related to ground water exposure. Ground water is not currently used at the Site. Although hypothetical future use of on-site ground water could result in an unacceptable risk, such use is highly unlikely, as discussed in the section on "Summary of Site Risks," above. Brodhead Creek serves as a regional boundary to ground water flow; thus, no ground water across the Creek from the Site would be impacted by the Site. Upward flow gradients at the Site decrease the likelihood that the bedrock aquifer beneath the Site will be impacted. A municipal ordinance in the Borough of East Stroudsburg requires mandatory connection to the municipal water distribution system. EPA understands that the Borough of Stroudsburg is presently in the process of developing a similar ordinance. Finally, deed restrictions to limit future use of the Site will be imposed as part of the OU-1 interim remedial action.

B. Compliance with Applicable or Relevant and Appropriate Requirements

The Record of Decision for Operable Unit One (March 29, 1991) addressed all the ARARs concerning the Site except for ARARs relating to ground water or drinking water. Reference can be made to the ROD for OU-1 for a full discussion of the ARARs discussed therein.

Since the selected remedy requires no further action for residual coal tar contamination and ground water contamination, action specific ARARs do not apply. The only ARARs that apply to ground water are the Safe Drinking Water Act MCLs promulgated at 40 C.F.R. 141 and the Pennsylvania ARAR for ground water which requires that all ground water be remediated to "background" quality, as specified by 25 PA Code §§ 264.90-264.100 and in particular 25 PA Code §§ 264.97(i), (j), and 264.100(a)(9). EPA is waiving Federal MCLs and Pennsylvania's "background" ARAR on the basis of "Technical Impracticability." Several site specific constraints as discussed earlier make the implementation of engineering solutions to the contamination impracticable.

The horizontal and vertical extent for which the TI waiver will be invoked is the shallow aquifer at the Site, including the area containing free and residual coal tar depicted in Figure 3, and the zones beneath Brodhead Creek, the island, the levee, the wetlands, and the fill/highlands on-site. The vertical extent includes the stream gravel unit between the fill and the silty sand units as depicted in Figure 7.

Several intermediate wells screened in the silty sand unit of the Site are currently being used to monitor the shallow aquifer (TI zone). In the Proposed Remedial Action Plan for the final ROD on OU-1, EPA will recommend adding more intermediate wells to the long-term monitoring network. These wells will monitor the TI zone and will also serve as early indicators in the unlikely event that contamination moves vertically downward toward the deeper ground water in bedrock.

C. Cost-Effectiveness

No additional cost would be incurred by the selected remedy.

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

This remedy is No Further Action and is not intended to utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable for this operable unit.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES FROM THE PROPOSED PLAN

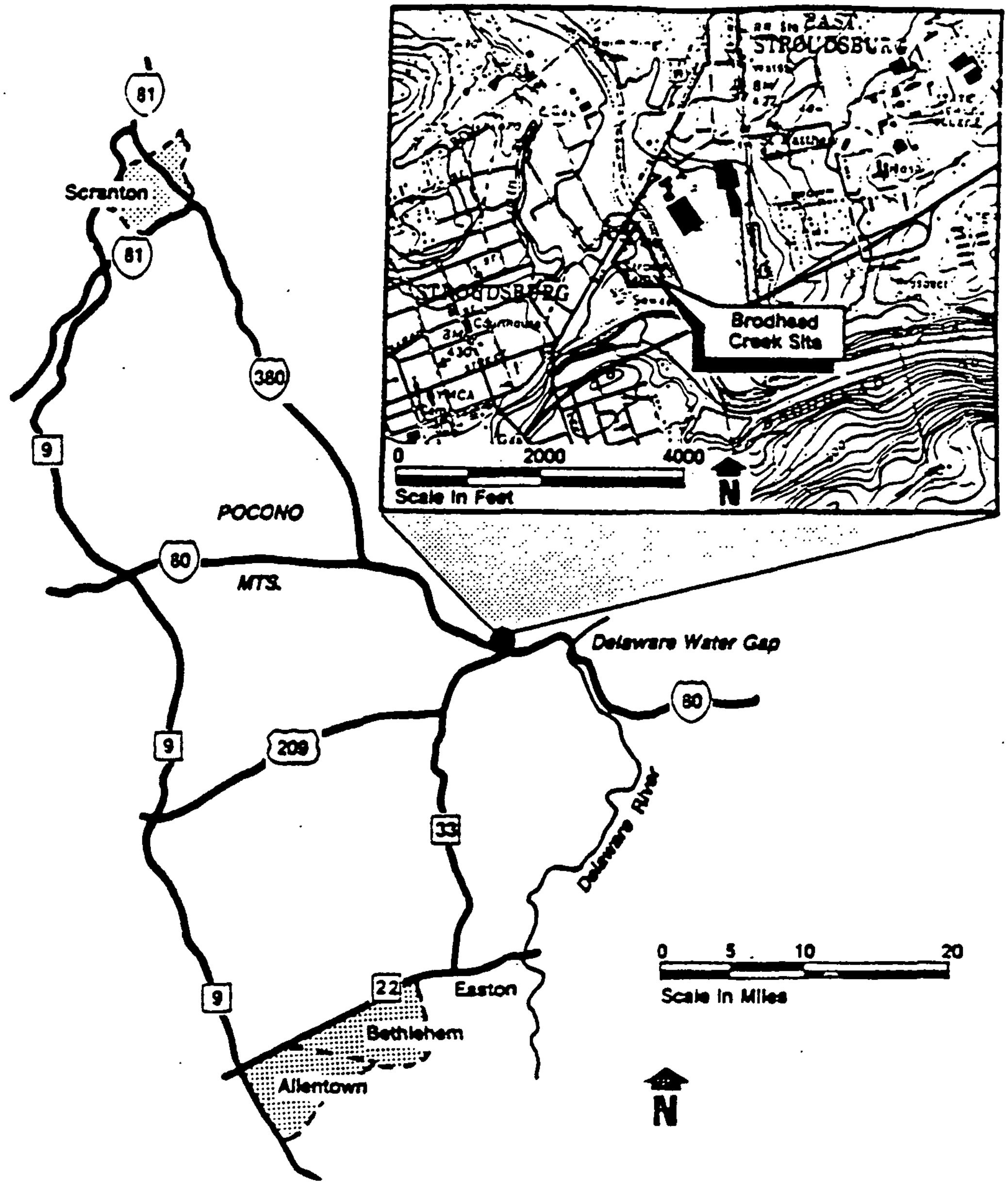
The Proposed Plan for the Brodhead Creek Site was released for comment in May of 1995. It described the alternatives evaluated in the Focused FS for OU-2 and identified Alternative 1 as EPA's Preferred Alternative. After reviewing all of the written and verbal comments submitted during the comment period and at the public meeting, EPA has determined that no significant changes to the Proposed Plan remedy are necessary.

APPENDIX A

FIGURE 1

Brodhead Creek Site Location Map

Stroudsburg, Pennsylvania



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25343.00.01	Revised by / Date: M. Smith 8.17.90	Checked by / Date: D. Ross 8.17.90	

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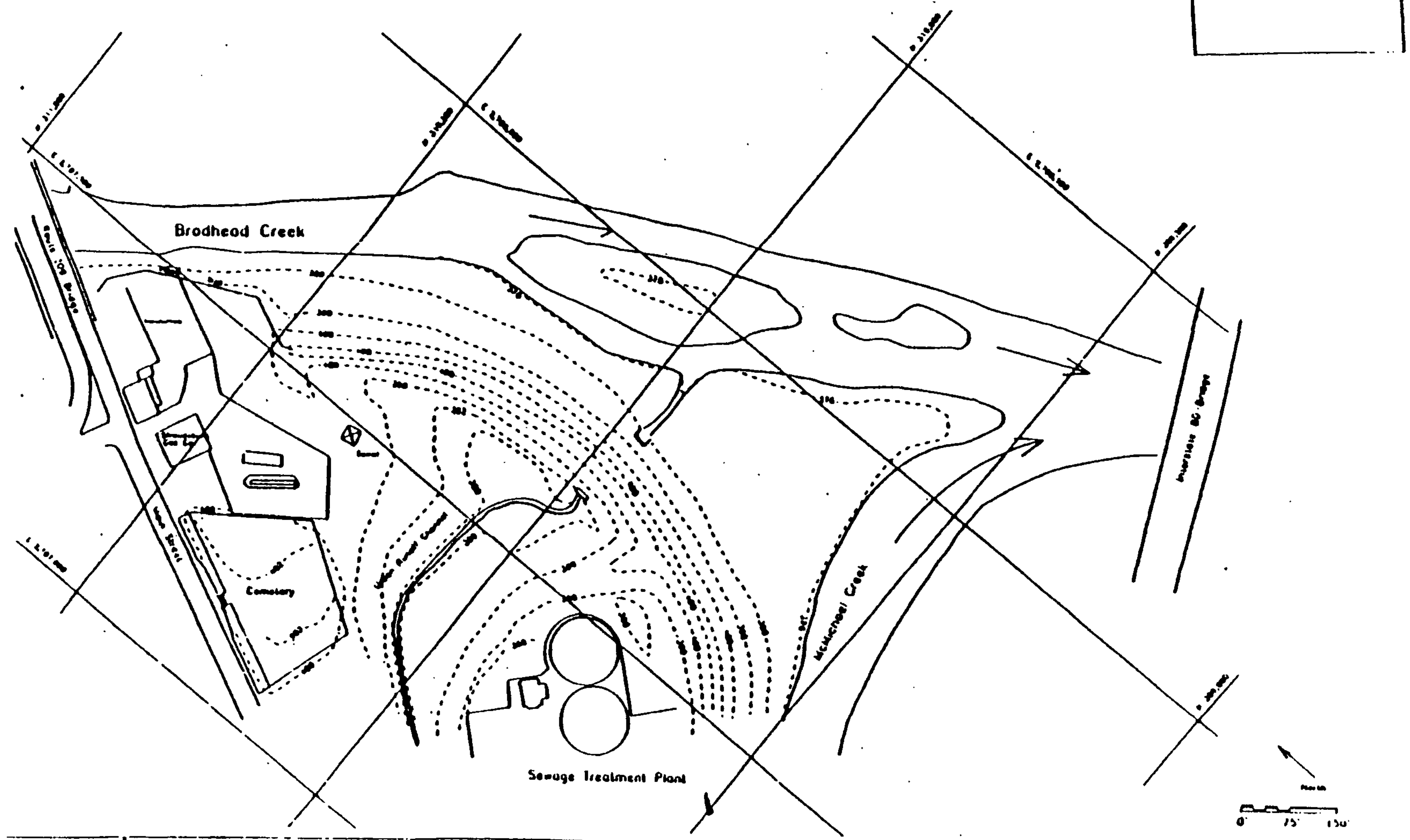
Figure 2
Site Plan
Brodhead Creek Remedial Investigation
Stroudsburg, Pennsylvania



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	Revised by / Date:	Checked by / Date:

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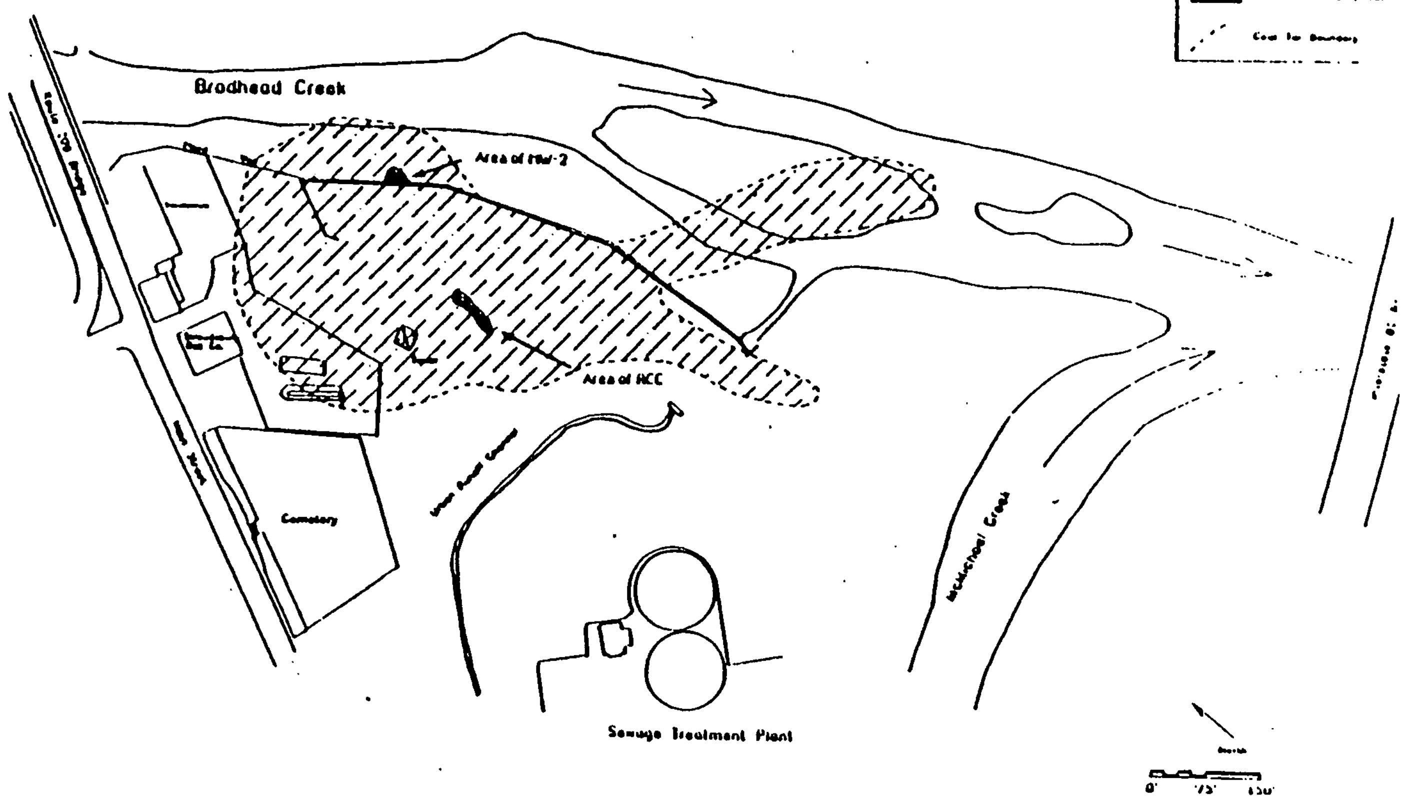
FIGURE 3

Maximum Probable Extent of Free Coal-Tar Surface

Brodhead Creek Remedial Investigation
Stroudsburg, PA



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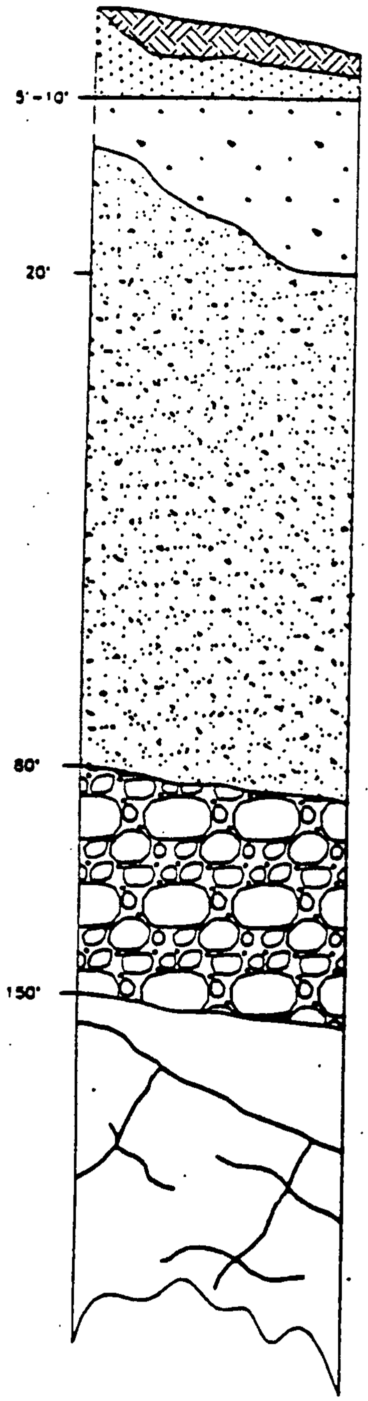
General Site Stratographic Column
Brodhead Creek Site
Stroudsburg, Pennsylvania



Surficial Fill
Flood Plain Deposit

Stream Gravel
This unit consists of fluvial deposited coarse sands and gravel. The hydraulic conductivity ranges from 1.5×10^{-3} ft/sec to 1.73×10^{-4} ft/sec. This unit is limited in horizontal extent pinching out in the west-central and southern portions of the site.

Glacial Overburden
This unit consists of fine, silty sands. The average hydraulic conductivity is 1.73×10^{-5} ft/sec. Running sand conditions are frequently encountered during drilling in this unit.

Glacial Till
This unit consists of dense, poorly sorted deposits of gravel, coarse sand, and silt.

Bedrock
Marcellus shale described as dark grey to black carbonaceous shale with some calcareous zones. Ground water flow through the bedrock follows the regional fractures in a south-southeastern direction.

Note: Drawing Not to Scale

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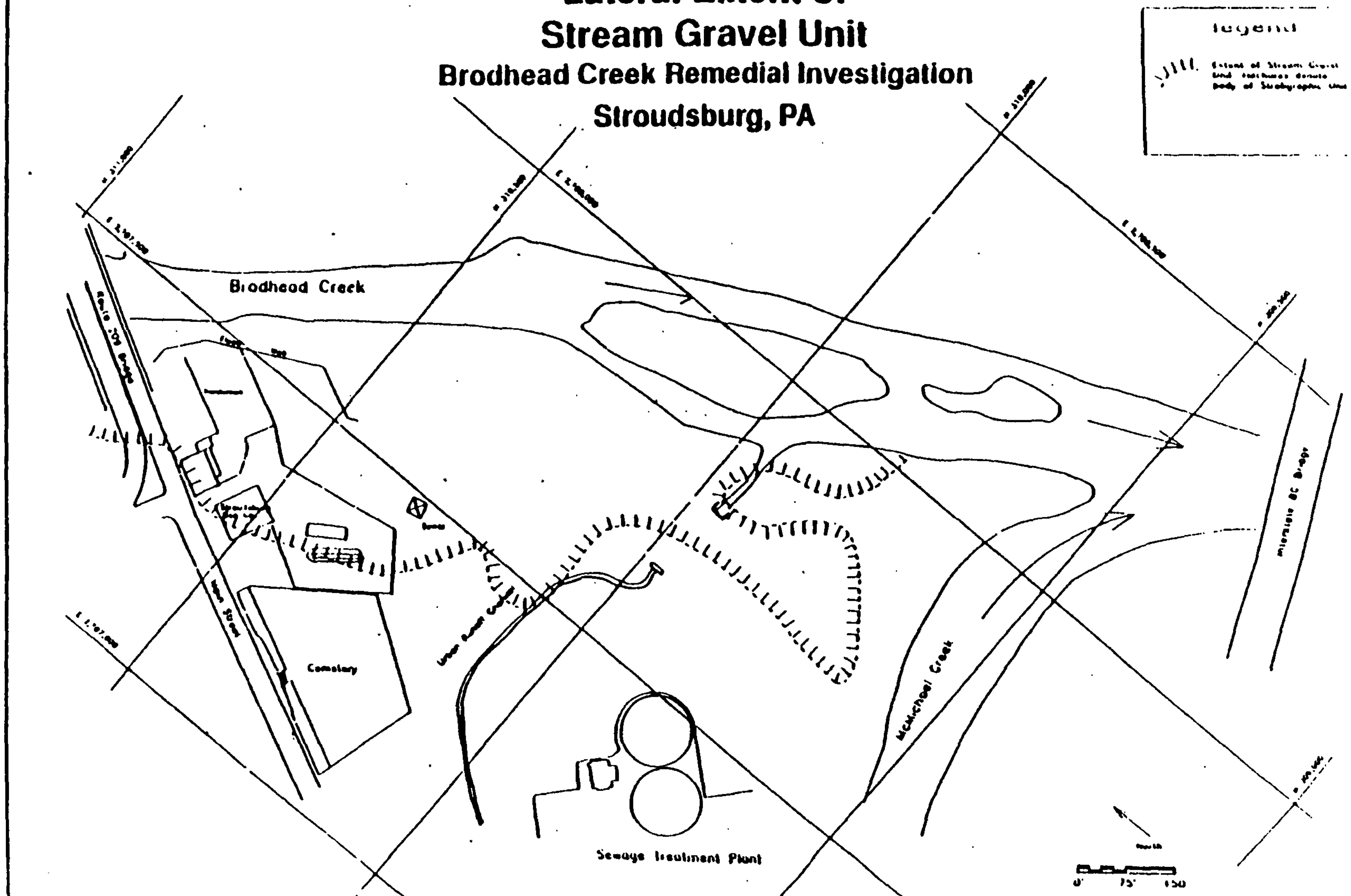
FIGURE 5

Lateral Extent of Stream Gravel Unit

Brodhead Creek Remedial Investigation

Stroudsburg, PA



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	Revised by / Date	Checked by / Date	

FIGURE 6

Top of Silty Sand Unit
Brodhead Creek Remedial Investigation
Stroudsburg, Pennsylvania

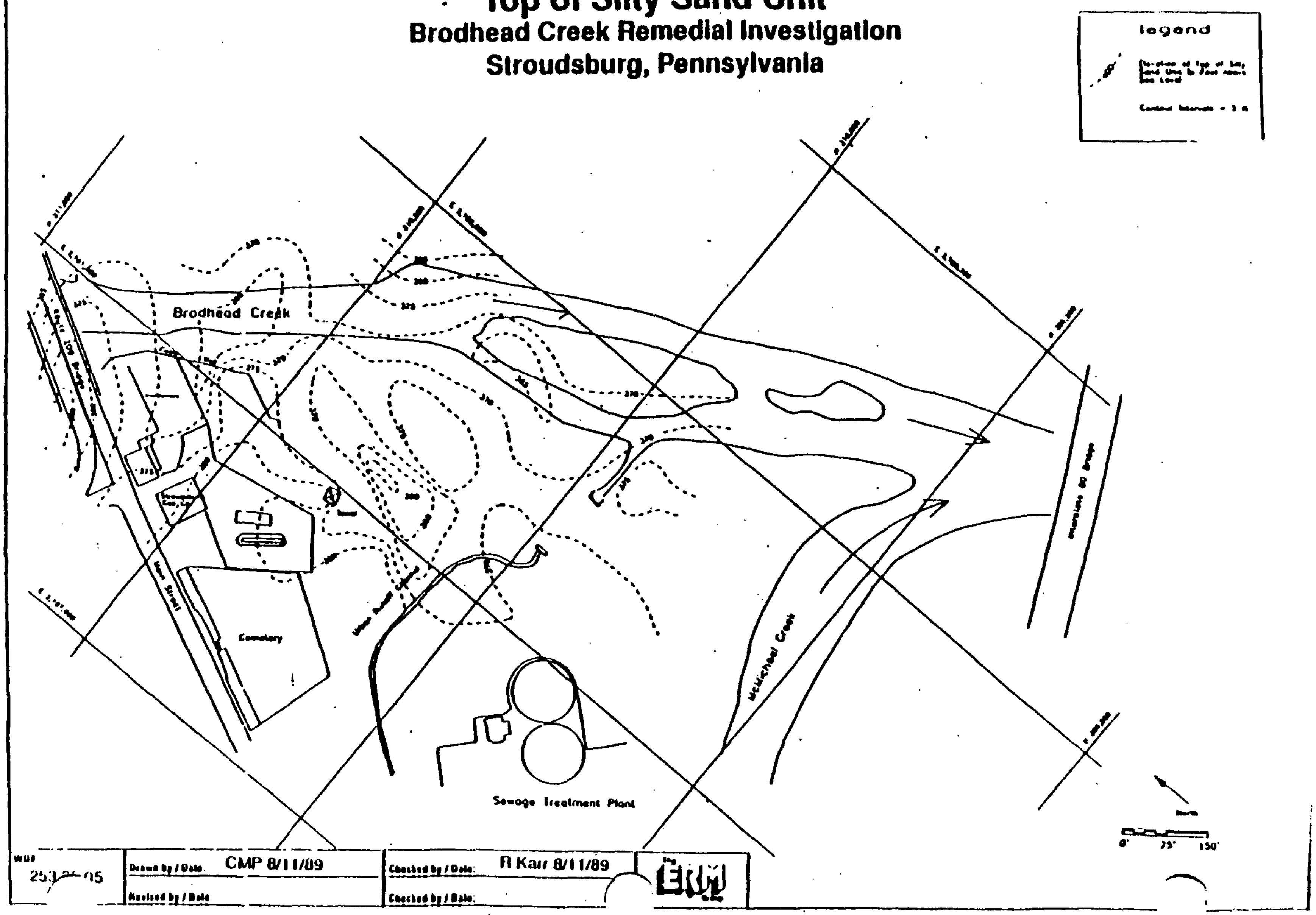

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Figure 7
Schematic of Extent of Free and Residual Coal Tar
Brodhead Creek Site
Stroudsburg, Pennsylvania

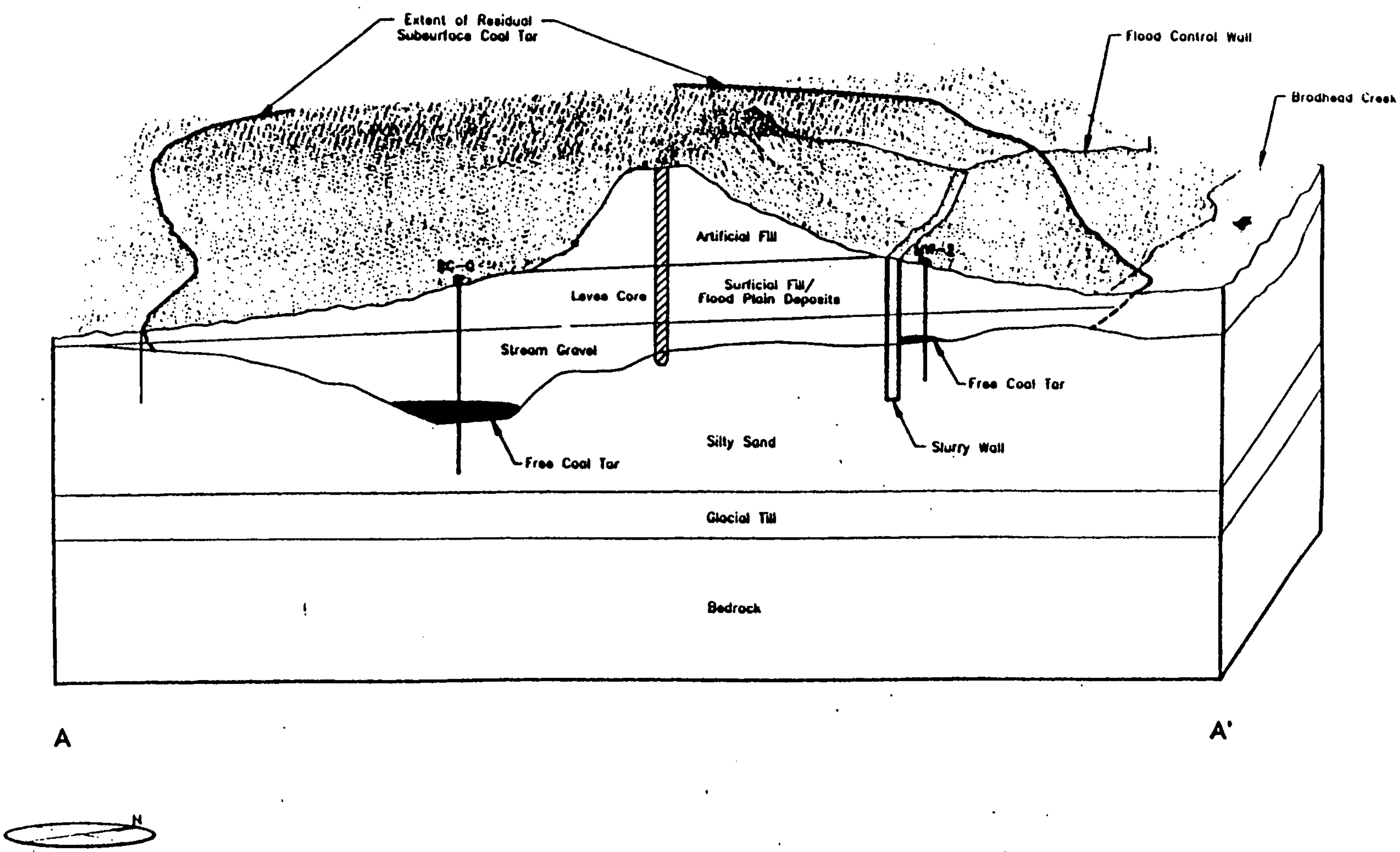

FIGURE 8

Water Supply Well Locations
Brodhead Creek Site OU-2
Stroudsburg, Pennsylvania

Source: U.S.G.S. Topographic Quadrangles. East Stroudsburg, PA and Stroudsburg, PA-NJ

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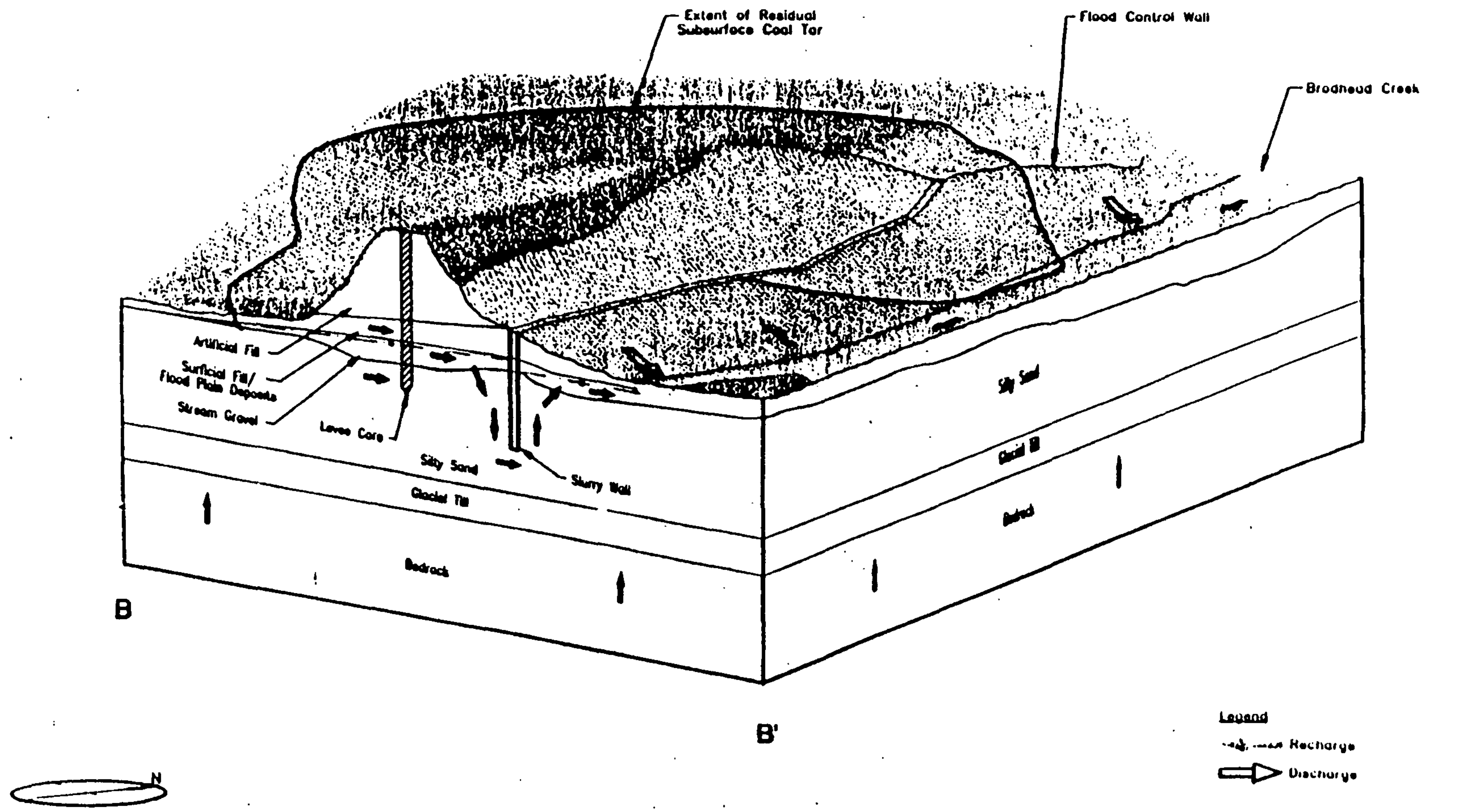
Figure 9
Ground Water Flow Schematic
Brodhead Creek Site
Stroudsburg, Pennsylvania

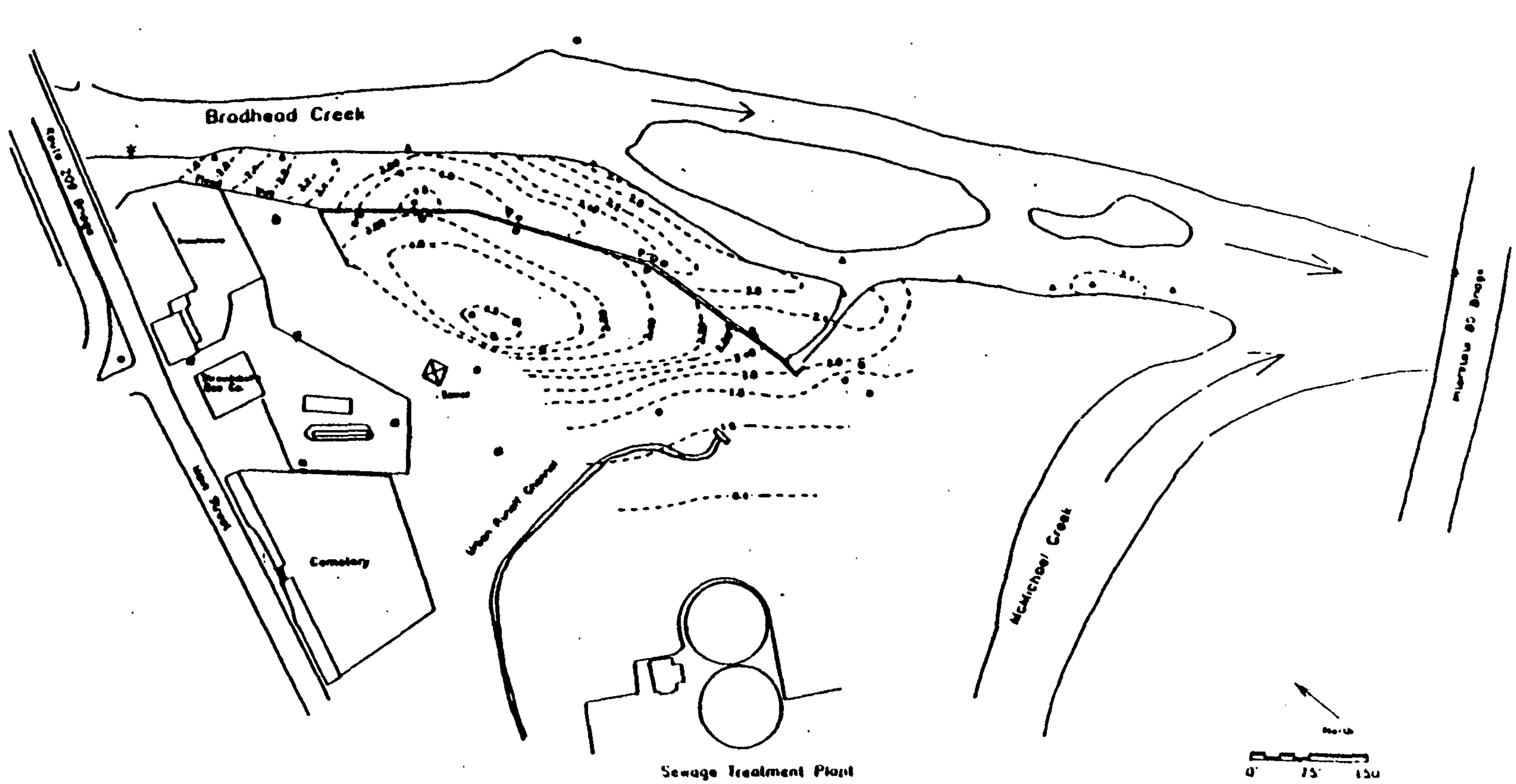


AR302040

FIGURE 10

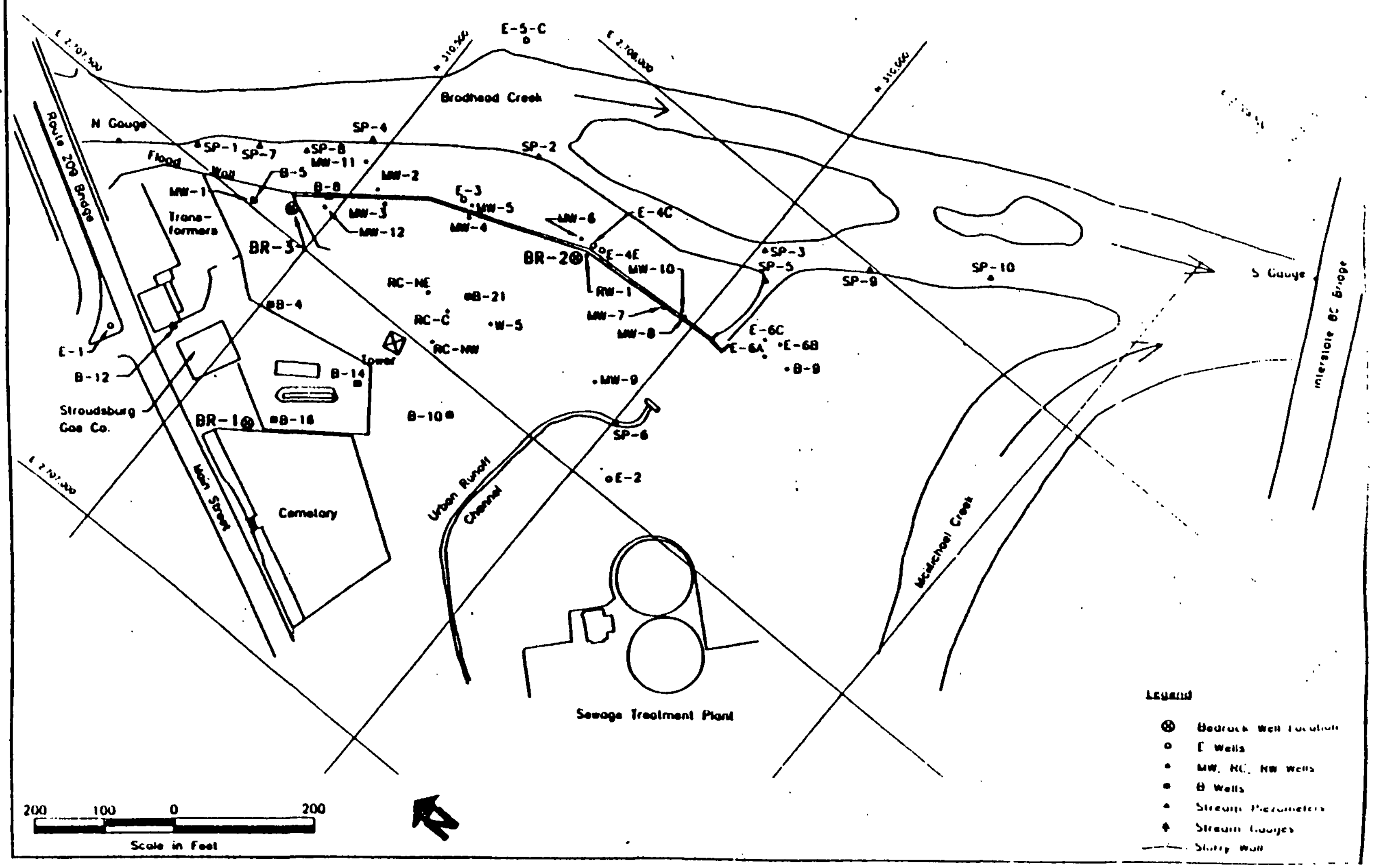
Log of Sum of Total Detected Organics

Brodhead Creek Remedial Investigation
Stroudsburg, PA



WO#	Drawn by / Date.	Checked by / Date.	
5.05	CMP 8/11/89	R.Karr 8/11/	ERM
	Revised by / Date	Checked by / Date:	

FIGURE 11
Site Plan with Monitoring Well Locations
Brodhead Creek Site
Stroudsburg, Pennsylvania



AR302042

25352.00 01/06 07 95-DST/06 08 95-DST/A101-3A

FIGURE 12
Flow in Bedrock System
7 September 1993
Brodhead Creek Site OU-2
Stroudsburg, Pennsylvania

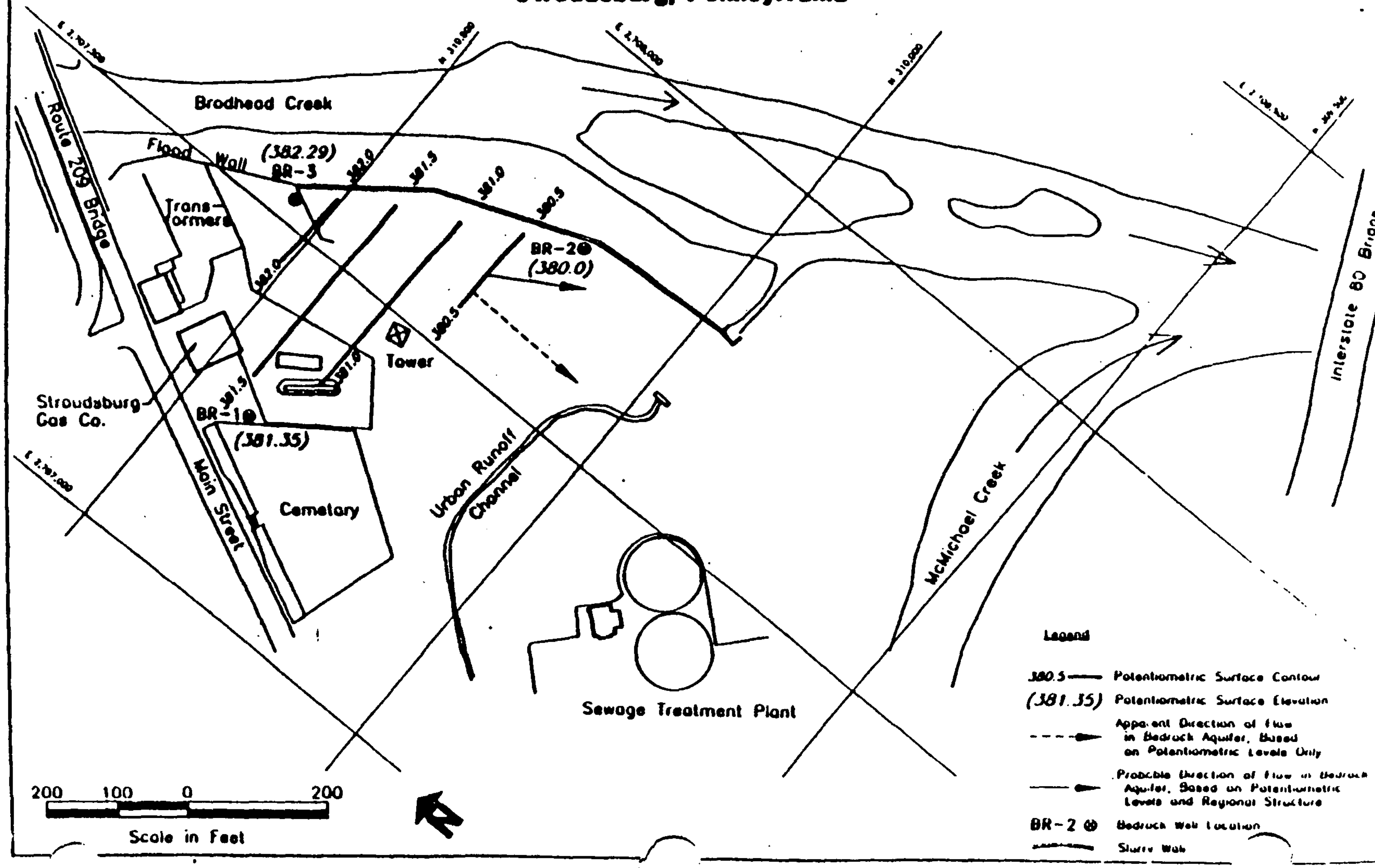
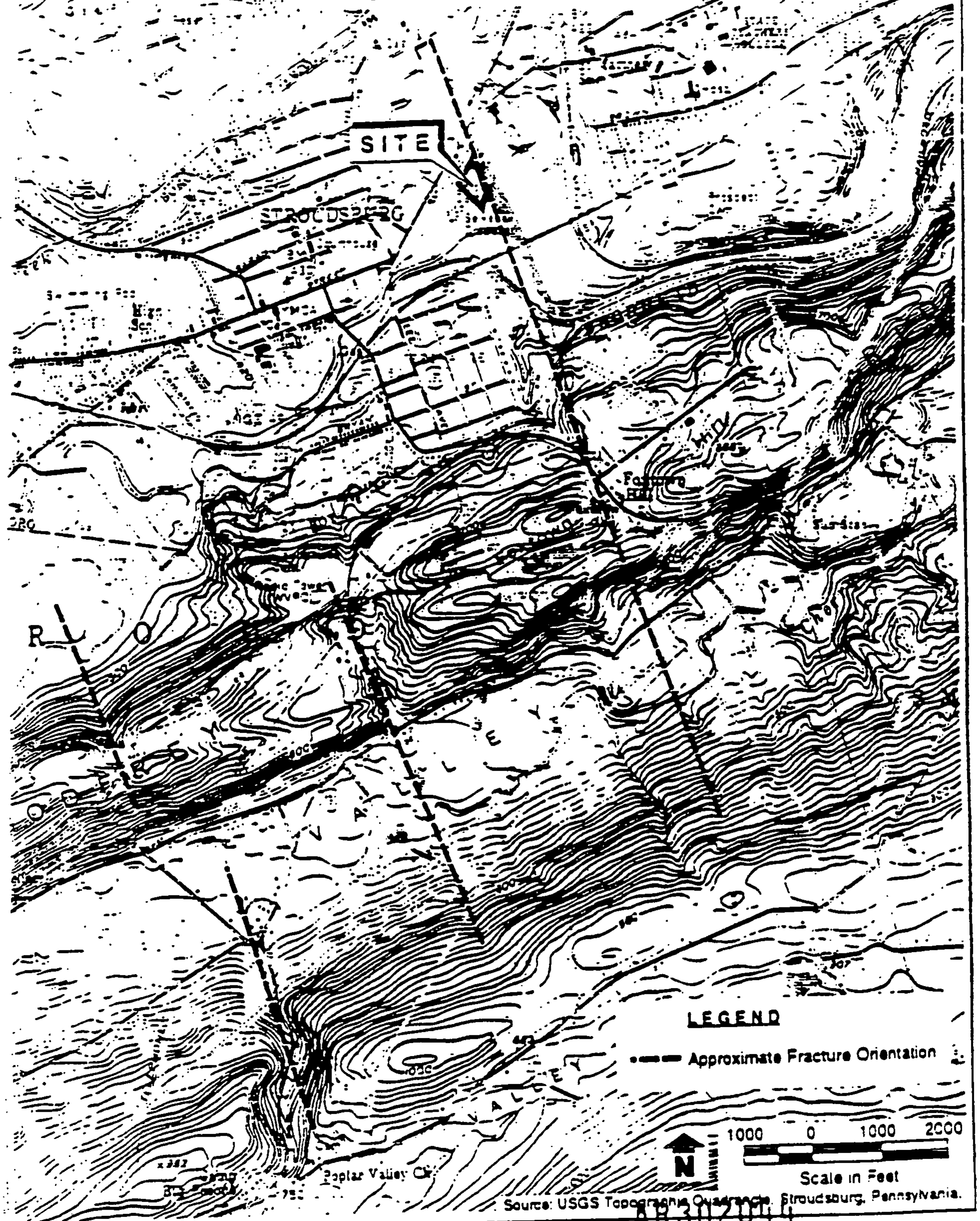


FIGURE 13
Regional Fracture Pattern
Brodhead Creek Site



ERM, INC

APPENDIX B

Relevant and Appropriate Requirements for Ground Water
Brodhead Creek Site Feasibility Study
(all concentrations are in mg/L unless otherwise specified)

CHEMICAL	Ground Water Concentrations Maximum	Ground Water Concentrations Average	MCL Acceptable Drinking Water Level (mg/l) EPA	MCL Acceptable Drinking Water Level (mg/l) PADER†	TBC US EPA Health Advisory (long-term adult) (mg/L)
Acetone	8.50E-02	8.65E-03	NA		NA
Carbon Disulfide	4.20E-02	6.29E-03	NA		NA
Chloroform	2.50E-02	5.44E-03	1.00E-01		4.00E-01
Methyl ethyl ketone	5.00E-02	9.70E-03	NA		8.60E+00
1,1,1-Trichloroethane	5.00E-02	5.20E-03	2.00E-01		1.00E+01
Benzene	1.10E+00	2.10E-01	5.00E-03		NA
Toluene	1.40E-01	1.24E-02	1.00E+00		7.00E+00
Chlorobenzene	2.50E-02	5.26E-03	NA		NA
Ethylbenzene	4.00E-01	9.15E-02	7.00E-01		3.00E+00
Styrene	2.70E-02	6.14E-03	1.00E-01		7.00E+00
Xylene	6.10E-01	1.14E-01	1.00E+01		1.00E+02
Phenol	2.50E-02	6.12E-03	NA		2.00E+01
Acenaphthylene	8.70E-01	1.17E-01			NA
Acenaphthene	1.40E+00	1.04E-01	NA		NA
Fluorene	1.60E+00	1.24E-01	NA		NA
Pentachlorophenol	1.25E-01	2.82E-02	1.00E-03		1.00E+00
Phenanthrene	2.40E+00	1.86E-01	NA		NA
Anthracene	8.30E-01	3.75E-02	NA		NA
Fluoranthene	5.80E-01	4.21E-02	NA		NA
Pyrene	4.90E-01	3.14E-02	NA		NA
Benz(a)anthracene	2.90E-01	2.26E-02	1.00E-06		NA
Chrysene	3.00E-01	2.26E-02	2.00E-06		NA
Bis(2-ethylhexyl)phthalate	2.50E-02	5.12E-03	6.00E-03		NA
Benzo(b)fluoranthene	2.70E-01	2.02E-02	2.00E-06		NA
Benzo(k)fluoranthene	2.70E-01	2.02E-02	2.00E-06		NA
Benzo(a)pyrene	2.90E-01	1.94E-02	2.00E-06		NA
Indeno(1,2,3-cd)pyrene	6.80E-02	8.36E-03	4.00E-06		NA
Dibenz(a,h)anthracene	3.50E-02	6.64E-03	3.00E-06		NA
Benzo(ghi)perylene	8.20E-02	9.08E-03	NA		NA
Naphthalene	7.90E+00	8.89E-01	NA		1.00E+00
2-Methyl Naphthalene	8.80E+00	6.13E-01	NA		NA
Dibutyl phthalate	NA	NA	NA		NA
Butyl benzyl phthalate	NA	NA	1.00E-01		NA
Arsenic	1.08E-01	3.13E-02	5.00E-02		NA
Barium	5.95E-01	1.92E-01	2.00E+00	1.00E+00	NA
Beryllium	5.50E-04	5.50E-04	4.00E-03		2.00E+01
Cadmium	2.15E-03	2.15E-03	5.00E-03	1.00E-01	2.00E-02
Chromium VI	2.50E-03	2.50E-03	1.00E-01	5.00E-02	8.00E-01
Copper	1.55E-03	1.29E-03	1.3 *	1.00E+00	NA
Iron	2.77E+01	6.60E+00	NA	3.00E-01	NA
Lead	8.80E-03	1.77E-03	0.015 *	5.00E-02	NA
Manganese and compounds	1.78E+01	5.39E+00	NA	5.00E-02	NA
Mercury , inorganic	1.00E-04	1.00E-04	2.00E-03		2.00E-03
Nickel	3.50E-02	1.58E-02	1.00E-01		1.70E+00
Selenium	5.00E-03	3.03E-03	5.00E-02	1.00E-02	NA
Silver and compounds	2.15E-03	2.15E-03	NA	5.00E-02	2.00E-01
Sodium	4.08E+01	2.84E+01	NA		NA
Thallium	1.00E-03	1.00E-03	2.00E-03		2.00E-02
Vanadium	3.30E-03	1.51E-03	NA		NA
Zinc	2.14E-01	3.57E-02	NA	5.00E+00	1.00E+01
Cyanide	3.47E-01	1.30E-02	2.00E-01		8.00E-01

Notes:
Exceedances boldfaced
MCL - Maximum Contaminant Level
NA - Not Available
* - Action Levels
† - PA Code §109.202

Summary of Ground Water Analyses
Brodhead Creek Site OU-2

TABLE 2

ORGANICS	BR-1			BR-2			BR-3		
VOCs (µg/l)	6/3/93	12/10/93	5/8/95	6/3/93	12/9/93	5/9/95	6/4/93	12/9/93	5/8/95
Carbon Disulfide	0.2	NA	ND	0.4	NA	ND	0.2	NA	ND
Trichloroethene	0.6	ND	ND	0.3	ND	ND	5.1	ND	ND
m&p xylene	ND	0.1	ND	ND	ND	ND	0.2	ND	ND
1,2,4-trimethylbenzene	0.1	ND	ND	ND	ND	ND	0.1	ND	ND
Chloromethane	ND	ND	ND	ND	ND	ND	ND	0.2	ND
Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	0.1	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	0.5	ND	ND	0.2	ND	ND	ND	ND
SVOCs (µg/l))									
2-Methylnaphthalene	0.09	0.1	ND	ND	ND	ND	0.09	ND	ND
Naphthalene	0.1	0.1	ND	ND	0.08	0.04	0.2	ND	ND
Diethylphthalate	0.3	0.2	0.08	0.2	0.3	0.09	0.3	ND	ND
Butylbenzylphthalate	ND	0.08	ND	ND	0.1	ND	0.1	ND	ND
Bis(2-ethylhexyl)phthalate	21	8.0	0.8	ND	10	0.8	ND	ND	ND
Dimethylphthalate	ND	0.06	ND	ND	0.06	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	0.1	ND	ND	ND	ND
Phenanthrene	ND	0.05	ND	ND	ND	0.02	ND	ND	ND
Di-n-butylphthalate	ND	0.4	ND	ND	0.1	ND	ND	ND	ND
Bis (2-ethylhexyl)adipate	ND	0.3	ND	ND	0.5	ND	ND	ND	ND

TABLE 3

Constituent	Maximum Downgradient Concentration		Background Concentration	USEPA Region III Risk-Based Concentration Table	Ratio of Maximum Detected/ Screening Level
Volatile Compounds					
2-Butanone	7	J	ND	22000	3.18E-04
Benzene	990		ND	0.36	2.75E+03
Toluene	45		ND	750	6.00E-02
Ethylbenzene	490		ND	1300	3.77E-01
Total Xylenes	610	J	ND	12000	5.08E-02
Styrene	27		ND	1600	1.69E-02
Semi-Volatile Compounds					
Naphthalene	7700	J	ND	1500	5.13E+00
2-Methylnaphthalene ††	8800	J	ND	1500	5.87E+00
Acenaphthylene ††	1800	J	ND	1500	1.20E+00
Acenaphthene	440	J	ND	2200	2.00E-01
Dibenzofuran ††	250	J	ND	1500	1.67E-01
Fluorene	1200	J	ND	1500	8.00E-01
Phenanthrene †	2000	J	ND	1100	1.82E+00
Anthracene	310	J	ND	11000	2.82E-02
Fluoranthene	360	J	ND	1500	2.40E-01
Pyrene	180	J	ND	1100	1.64E-01
Benzo(a)anthracene	160	J	ND	0.092	1.74E+03
Chrysene	150	J	ND	9.2	1.63E+01
Bis(2-ethylhexyl)phthalate	10	J	ND	4.8	2.08E+00
Benzo(b or k)fluoranthene*	120	J	ND	0.092	1.30E+03
Benzo(a)pyrene	120	J	ND	0.0092	1.30E+04
Indeno(1,2,3-cd)pyrene	26	J	ND	0.092	2.83E+02
Dibenz(a,h)anthracene	16	J	ND	0.0092	1.74E+03
Benzo(g,h,i)perylene †	30	J	ND	1100	2.73E-02
Phenol	13		ND	22000	5.91E-04
Pentachlorophenol	9	J	ND	0.56	1.61E+01
Benzoic Acid	13	J	ND	150000	8.67E-05
Benzyl Alcohol	2	J	NA	11000	1.82E-04
Dissolved Metals					
Aluminum	4240		27	-	-
Arsenic	108	J	6.9 J	0.038	2.84E+03
Barium	595		105	2600	2.29E-01
Calcium	89200		63800	-	-
Iron	20300		60	-	-
Lead	8.8	J	ND	-	-
Magnesium	9150	J	4920 J	-	-
Manganese	16800		3010	180	9.33E+01
Nickel	35		ND	730	4.79E-02
Sodium	31800		35600	-	-
Vanadium	3.3		ND	260	1.27E-02
Zinc	214		15 B	11000	1.95E-02
Cyanide	158		13	730	2.16E-01

Notes:
† Screening level based on pyrene toxicity data
†† Screening level based on withdrawn naphthalene toxicity data
NA = Not analyzed
ND = Not detected
J = quantitative estimate
B = compound was detected in blank sample at a similar concentration
- = no risk-based screening level is available for this compound
* Screening level based on Benzo(b)fluoranthene toxicity data (most conservative)
All values in µg/L

Justification Table for the Selection of Constituents of Potential Concern in the Shallow Aquifer
Brodhead Creek Site
Stroudsburg, Pennsylvania

TABLE 4

Constituent	Background concentration greater than downgradient concentration?	Exceeds Region III risk-based screening level?	Ratio of maximum detected to screening level greater than 0.1?	Retained for evaluation in risk assessment?	Rationale
Volatile Compounds					
2-Butanone	No	No	No	No	Did not fail screening against risk-based screening level
Benzene	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Toluene	No	No	No	No	Did not fail screening against risk-based screening level
Ethylbenzene	No	No	Yes	Yes	Ratio of maximum concentration to the screening level is greater than 0.1
Total Xylenes	No	No	No	No	Did not fail screening against risk-based screening level
Styrene	No	No	No	No	Did not fail screening against risk-based screening level
Semi-Volatile Compounds					
Naphthalene	No	Yes	Yes	Yes	Failed screening against risk-based screening level
2-Methylnaphthalene	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Acenaphthylene	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Acenaphthene	No	No	Yes	Yes	Ratio of maximum concentration to the screening level is greater than 0.1
Dibenzofuran	No	No	Yes	Yes	Ratio of maximum concentration to the screening level is greater than 0.1
Fluorene	No	No	Yes	Yes	Ratio of maximum concentration to the screening level is greater than 0.1
Phenanthrene	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Anthracene	No	No	No	No	Did not fail screening against risk-based screening level
Fluoranthene	No	No	Yes	Yes	Ratio of maximum concentration to the screening level is greater than 0.1
Pyrene	No	No	Yes	Yes	Ratio of maximum concentration to the screening level is greater than 0.1
Benzo(a)anthracene	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Chrysene	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Bis(2-ethylhexyl)phthalate	No	Yes	Yes	No	Not a constituent of coal tar (see report text)
Benzo(b or k)fluoranthene	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Benzo(a)pyrene	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Indeno(1,2,3-cd)pyrene	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Dibenz(a,h)anthracene	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Benzo(g,h,i)perylene	No	No	No	No	Did not fail screening against risk-based screening level
Phenol	No	No	No	No	Did not fail screening against risk-based screening level
Pentachlorophenol	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Benzoic Acid	No	No	No	No	Did not fail screening against risk-based screening level
Benzyl Alcohol	No	No	No	No	Did not fail screening against risk-based screening level
Dissolved Metals					
Aluminum	No	-	-	No	No quantitative toxicity indices are available for aluminum, not a historical constituent of potential concern at the site
Arsenic	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Barium	No	No	Yes	Yes	Ratio of maximum concentration to the screening level is greater than 0.1
Calcium	No	-	-	No	No quantitative toxicity indices are available, essential human nutrient, not historical constituent of potential concern
Iron	No	-	-	No	No quantitative toxicity indices are available, essential human nutrient, not historical constituent of potential concern
Lead	No	-	-	No	No quantitative toxicity indices are available for lead, below the USEPA drinking water action level of 15 ppb for lead
Magnesium	No	-	-	No	No quantitative toxicity indices are available, essential human nutrient, not historical constituent of potential concern
Manganese	No	Yes	Yes	Yes	Failed screening against risk-based screening level
Nickel	No	No	No	No	Did not fail screening against risk-based screening level
Sodium	No	-	-	No	No quantitative toxicity indices are available, essential human nutrient, not historical constituent of potential concern
Vanadium	No	No	No	No	Did not fail screening against risk-based screening level
Zinc	No	No	No	No	Did not fail screening against risk-based screening level
Cyanide	No	No	Yes	Yes	Ratio of maximum concentration to the screening level is greater than 0.1

Notes
- = no risk-based screening level is available for this compound

TABLE 5

Constituent	Maximum Downgradient Concentration		Background Concentration	USEPA Region III Risk-Based Concentration Table	Ratio of Maximum Detected/ Screening Level
Volatile Compounds					
Benzene	0.1	J	ND	0.36	2.78E-01
Carbon disulfide	0.4	J	0.2	21	1.90E-02
Trichloroethene	0.6		5.1	1.6	N / A
Toluene	0.5		0.3 B	750	6.67E-04
m+p Xylene •	0.1	J	0.2	520	1.92E-04
1,2,4-Trimethylbenzene	0.1	J	0.1	3	3.33E-02
Semi-Volatile Compounds					
Naphthalene	0.1	J	0.2	1500	6.67E-05
2-Methylnaphthalene ††	0.1	J	0.09	1500	6.67E-05
Diethylphthalate	0.3	J	0.3	29000	1.03E-05
Di-n-butylphthalate	0.4	J	0.3 B	3700	1.08E-04
Dimethylphthalate	0.06	J	ND	370000	1.62E-07
Butylbenzylphthalate	0.1	J	0.1	7300	1.37E-05
Bis (2-ethylhexyl)adipate	0.5	J	0.2 B	56	8.93E-03
Bis(2-ethylhexyl)phthalate	21	J	12 B	4.8	4.38E+00
Pentachlorophenol	0.1	J	ND	0.56	1.79E-01
Phenanthrene †	0.05	J	ND	1100	4.55E-05
Total Metals (unfiltered)					
Calcium	58100		40800	-	-
Iron	9600	J	33600	-	-
Magnesium	5080	-	10900	-	-
Manganese	347		354	180	N / A

Notes:
J = quantitative estimate
ND = Not detected
- = no risk-based screening level is available for this compound
†† Screening level based on withdrawn naphthalene toxicity data
† Screening level based on pyrene toxicity data
• Screening level based on p-Xylene
N / A Not applicable; Did not exceed the background concentration
All values in µg/L

Justification Table for the Selection of Constituents of Potential Concern in the Deep Aquifer
Brodhead Creek Site
Stroudsburg, Pennsylvania

TABLE 6

Constituent	Background concentration greater than downgradient concentration?	Exceeds Region III risk-based screening level?	Ratio of maximum detected to screening level greater than 0.1?	Retained for evaluation in risk assessment?	Rationale
Volatile Compounds					
Benzene	No	No	Yes	No	Did not fail screening against risk-based level and presence in ground water is suspect (see report text)
Carbon disulfide	No	No	No	No	Did not fail screening against risk-based level
Trichloroethene	Yes	N/A	N/A	No	Detected in background at higher concentration than on-site
Toluene	No	No	No	No	Did not fail screening against risk-based level
m+p Xylene	Yes	No	No	No	Did not exceed background concentration, did not fail screening against risk-based level
Semi-Volatile Compounds					
Naphthalene	Yes	N/A	N/A	No	Did not exceed background concentration; did not fail screening against risk-based level
2-Methylnaphthalene	No	No	No	No	Did not fail screening against risk-based level
Diethylphthalate	No	No	No	No	Did not fail screening against risk-based level
Di-n-butylphthalate	No	No	No	No	Did not fail screening against risk-based level
Dimethylphthalate	No	No	No	No	Did not fail screening against risk-based level
Butylbenzylphthalate	No	No	No	No	Did not fail screening against risk-based level
Bis (2-ethylhexyl)phthalate	No	Yes	Yes	No	Not a constituent of coal tar (see report text)
Bis (2-ethylhexyl)adipate	No	No	No	No	Did not fail screening against risk-based level
Pentachlorophenol	No	No	Yes	No	Did not fail screening against risk-based level and presence in ground water is suspect (see report text)
Phenanthrene	No	No	No	No	Did not fail screening against risk-based level
1,2,4-Trimethylbenzene	No	No	No	No	Did not fail screening against risk-based level
Total Metals (unfiltered)					
Calcium	No	-	-	No	No quantitative toxicity indices are available, essential human nutrient, not historical constituent of potential concern
Iron	Yes	-	-	No	No quantitative toxicity indices are available, essential human nutrient, not historical constituent of potential concern
Magnesium	Yes	-	-	No	No quantitative toxicity indices are available, essential human nutrient, not historical constituent of potential concern
Manganese	Yes	N/A	N/A	No	Detected in background at higher concentration than on-site

Notes:
- = no risk-based screening level is available for these constituents
N/A = Not applicable; did not exceed background concentration.

Summary of Toxicity Data for Constituents of Potential Concern
Brodhead Creek Site
Stroudsburg, Pennsylvania

TABLE 7

Constituent	Inhalation RfD mg/kg/day		Oral RfD mg/kg/day		Inhalation CPF 1/mg/kg/day		Oral CPF 1/mg/kg/day		USEPA Carcinogenic Classification
Volatile Compounds									
Benzene	1.71E-03	(6)	NA		2.90E-02	(1)	2.90E-02	(1)	A
Ethylbenzene	2.86E-01	(1)	1.00E-01	(1)	NA		NA		D
Semi-Volatile Compounds									
Naphthalene	NA		4.00E-02	(4)	NA		NA		D
2-Methylnaphthalene	NA		4.00E-02	(4)	NA		NA		*
Acenaphthylene	NA		4.00E-02	(4)	NA		NA		D
Acenaphthene	NA		6.00E-02	(1)	NA		NA		*
Dibenzofuran	NA		4.00E-02	(4)	NA		NA		D
Fluorene	NA		4.00E-02	(1)	NA		NA		D
Phenanthrene	NA		3.00E-02	(5)	NA		NA		D
Fluoranthene	NA		4.00E-02	(1)	NA		NA		D
Pyrene	NA		3.00E-02	(1)	NA		NA		D
Benzo(a)anthracene	NA		NA		6.10E-01	(3)	7.30E-01	(3)	B2
Chrysene	NA		NA		6.10E-03	(3)	7.30E-03	(3)	B2
Benzo(b or k)fluoranthene	NA		NA		6.10E-01	(3)	7.30E-01	(3)	B2
Benzo(a)pyrene	NA		NA		6.10E+00	(2)	7.30E+00	(1)	B2
Indeno(1,2,3-cd)pyrene	NA		NA		6.10E-01	(3)	7.30E-01	(3)	B2
Dibenz(a,h)anthracene	NA		NA		6.10E+00	(3)	7.30E+00	(3)	B2
Pentachlorophenol	NA		0.03	(1)	NA		1.20E-01	(1)	B2
Dissolved Metals									
Arsenic	NA		3.00E-04	(1)	1.51E+01	(1)	1.75E+00	(1)	A
Barium	1.43E-04	(2)	7.00E-02	(1)	NA		NA		*
Lead	NA		NA		NA		NA		B2
Manganese	1.43E-05	(1)	5.00E-03	(1)	NA		NA		D
Cyanide	NA		2.00E-02	(1)	NA		NA		D

Notes:
NA = Not available from IRIS or HEAST
1 = IRIS (USEPA, 1994)
2 = HEAST (USEPA, 1994b)
3 = Benzo(a)Pyrene Equivalence (USEPA, 1993)
4 = Based on withdrawn naphthalene value from IRIS/HEAST.
5 = Based on toxicity data for pyrene.
6 = EPA-ECAO, 1994
A = Human carcinogen.
B 2 = Probable human carcinogen; sufficient evidence in animals or no evidence in humans
D = Not classifiable as to human carcinogenicity
* = Not classified

Intake/Risk Calculations for Hypothetical Residential Use of Shallow Ground Water by an Adult
Brodhead Creek Site
Stroudsburg, Pennsylvania

TABLE 8

Carcinogenic Risk

Constituent	Exposure Concentration mg/L	Oral CPF (mg/kg-day)^-1	Intake Factor Ingestion (L/kg-day)	Intake Factor Dermal (L/kg-day)	Inhalation CPF (mg/kg-day)^-1	Intake Factor Inhalation (mg/kg-day)	Risk
Benzene	9.90E-01	2.90E-02	1.17E-02	4.93E-04	2.90E-02	1.57E-02	9.06E-04
Benzo(a)anthracene	5.64E-02	7.30E-01	1.17E-02	1.90E-02	6.10E-01	N/A	1.49E-03
Benzo(a)pyrene	4.60E-02	7.30E+00	1.17E-02	2.82E-02	6.10E+00	N/A	1.34E-02
Benzo(b)fluoranthene	4.60E-02	7.30E-01	1.17E-02	2.82E-02	6.10E-01	N/A	1.34E-03
Chrysene	6.26E-02	7.30E-03	1.17E-02	1.90E-02	6.10E-03	N/A	1.41E-05
Dibenz(a,h)anthracene	9.30E-03	7.30E+00	1.17E-02	6.34E-02	6.10E+00	N/A	5.10E-03
Indeno(1,2,3-cd)pyrene	1.25E-02	7.30E-01	1.17E-02	4.46E-02	6.10E-01	N/A	5.14E-04
Pentachlorophenol	9.00E-03	1.20E-01	1.17E-02	1.53E-02	NA	N/A	2.92E-05
Arsenic	1.08E-01	1.75E+00	1.17E-02	2.35E-08	1.51E+01	N/A	2.22E-03
						Total Risk:	2.49E-02

Non-Carcinogenic Hazard

Constituent	Exposure Concentration mg/L	Oral RfD (mg/kg-day)	Intake Factor Ingestion (L/kg-day)	Intake Factor Dermal (L/kg-day)	Inhalation RfD (mg/kg-day)	Intake Factor Inhalation (mg/kg-day)	Hazard Index
Benzene	9.90E-01	N/A	2.74E-02	1.15E-03	1.71E-03	3.64E-02	2.14E+01
Ethylbenzene	4.90E-01	1.00E-01	2.74E-02	4.05E-03	2.86E-01	1.81E-02	2.17E-01
Acenaphthylene	1.80E+00	4.00E-02	2.74E-02	5.23E-03	NA	N/A	1.47E+00
Acenaphthene	3.63E-01	6.00E-02	2.74E-02	8.30E-03	NA	N/A	2.16E-01
Dibenzofuran	1.65E-01	4.00E-02	2.74E-02	9.01E-03	NA	N/A	1.30E-01
Fluorene	8.49E-01	4.00E-02	2.74E-02	1.96E-02	NA	N/A	9.98E-01
Fluoranthene	2.40E-01	4.00E-02	2.74E-02	1.97E-02	NA	N/A	2.83E-01
Naphthalene	5.73E+00	4.00E-02	2.74E-02	3.78E-03	NA	N/A	4.47E+00
2-Methylnaphthalene	8.80E+00	4.00E-02	2.74E-02	1.18E-02	NA	N/A	5.62E+00
Phenanthrene	2.00E+00	3.00E-02	2.74E-02	1.48E-02	NA	N/A	2.51E+00
Pyrene	9.38E-02	3.00E-02	2.74E-02	1.78E-02	NA	N/A	1.41E-01
Pentachlorophenol	9.00E-03	3.00E-02	2.74E-02	3.56E-02	NA	N/A	1.89E-02
Arsenic	1.08E-01	3.00E-04	2.74E-02	5.48E-08	NA	N/A	9.88E+00
Barium	5.95E-01	7.00E-02	2.74E-02	5.48E-08	1.43E-04	N/A	2.33E-01
Manganese	1.15E+01	5.00E-03	2.74E-02	5.48E-08	1.43E-05	N/A	6.29E+01
Cyanide	1.45E-01	2.00E-02	2.74E-02	5.48E-08	NA	N/A	1.99E-01
						Total Hazard Index:	1.14E+02

Intake/Risk Calculations for Hypothetical Residential Use of Shallow Ground Water by a Child (0-6)
Brodhead Creek Site
Stroudsburg, Pennsylvania

TABLE 9

Carcinogenic Risk

Constituent	Exposure Concentration mg/L	Oral CPF (mg/kg-day)^-1	Intake Factor Ingestion (L/kg-day)	Intake Factor Dermal (L/kg-day)	Inhalation CPF (mg/kg-day)^-1	Intake Factor Inhalation (mg/kg-day)	Risk
Benzene	9.90E-01	2.90E-02	5.48E-03	1.61E-04	2.90E-02	1.46E-02	5.82E-04
Benzo(a)anthracene	5.64E-02	7.30E-01	5.48E-03	6.20E-03	6.10E-01	N/A	5.56E-04
Benzo(a)pyrene	4.60E-02	7.30E+00	5.48E-03	9.18E-03	6.10E+00	N/A	4.92E-03
Benzo(b)fluoranthene	4.60E-02	7.30E-01	5.48E-03	9.18E-03	6.10E-01	N/A	4.92E-04
Chrysene	6.26E-02	7.30E-03	5.48E-03	6.20E-03	6.10E-03	N/A	5.24E-06
Dibenz(a,h)anthracene	9.30E-03	7.30E+00	5.48E-03	2.07E-02	6.10E+00	N/A	1.77E-03
Indeno(1,2,3-cd)pyrene	1.25E-02	7.30E-01	5.48E-03	1.45E-02	6.10E-01	N/A	1.83E-04
Pentachlorophenol	9.00E-03	1.20E-01	5.48E-03	4.97E-03	NA	N/A	1.13E-05
Arsenic	1.08E-01	1.75E+00	5.48E-03	7.65E-06	1.51E+01	N/A	1.04E-03
						Total Risk:	9.57E-03

Non-Carcinogenic Hazard

Constituent	Exposure Concentration mg/L	Oral RfD (mg/kg-day)	Intake Factor Ingestion (L/kg-day)	Intake Factor Dermal (L/kg-day)	Inhalation RfD (mg/kg-day)	Intake Factor Inhalation (mg/kg-day)	Hazard Index
Benzene	9.90E-01	N/A	6.39E-02	1.87E-03	1.71E-03	1.71E-01	9.89E+01
Ethylbenzene	4.90E-01	1.00E-01	6.39E-02	6.60E-03	2.86E-01	8.45E-02	4.90E-01
Acenaphthylene	1.80E+00	4.00E-02	6.39E-02	8.52E-03	NA	N/A	3.26E+00
Acenaphthene	3.63E-01	6.00E-02	6.39E-02	1.35E-02	NA	N/A	4.69E-01
Dibenzofuran	1.65E-01	4.00E-02	6.39E-02	1.47E-02	NA	N/A	3.26E-01
Fluorene	8.49E-01	4.00E-02	6.39E-02	3.20E-02	NA	N/A	2.04E+00
Fluoranthene	2.40E-01	4.00E-02	6.39E-02	3.21E-02	NA	N/A	3.76E-01
Naphthalene	5.73E+00	4.00E-02	6.39E-02	6.16E-03	NA	N/A	1.00E+01
2-Methylnaphthalene	8.80E+00	4.00E-02	6.39E-02	1.92E-02	NA	N/A	1.83E+01
Phenanthrene	2.00E+00	3.00E-02	6.39E-02	2.41E-02	NA	N/A	5.87E+00
Pyrene	9.38E-02	3.00E-02	6.39E-02	2.91E-02	NA	N/A	2.91E-01
Pentachlorophenol	9.00E-03	3.00E-02	6.39E-02	5.80E-02	NA	N/A	3.66E-02
Arsenic	1.08E-01	3.00E-04	6.39E-02	8.92E-08	NA	N/A	2.30E+01
Barium	5.95E-01	7.00E-02	6.39E-02	8.92E-08	1.43E-04	N/A	5.44E-01
Manganese	1.15E+01	5.00E-03	6.39E-02	8.92E-08	1.43E-05	N/A	1.47E+02
Cyanide	1.45E-01	2.00E-02	6.39E-02	8.92E-08	NA	N/A	4.63E-01
						Total Hazard Index:	3.11E+02

APPENDIX C

RESPONSIVENESS SUMMARY
BRODHEAD CREEK SUPERFUND SITE
OPERABLE UNIT TWO

This Responsiveness Summary for Operable Unit Two of the Brodhead Creek Superfund Site ("the Site") in Stroudsburg, Pennsylvania, is divided into the following sections:

Section I	**Overview** - A summary of the public's reaction to EPA's preferred alternative for Operable Unit Two.
Section II	**Background on Community Involvement** A discussion of community interest in the Site and of information provided to the community by EPA and the media.
Section III	**Summary of Public Comments and Agency Responses** - A summary of comments received during the public comment period on the Proposed Remedial Action Plan for Operable Unit Two and EPA's responses

I. OVERVIEW

On March 29, 1991, EPA issued a Record of Decision ("ROD") on Operable Unit One ("OU-1") at the Brodhead Creek Superfund Site. This ROD contained EPA's selected interim remedy for the free coal tar accumulation in the subsurface soils at the Site. The interim remedy consisted of an enhanced recovery program for the free coal tar and attendant ground water monitoring.

On May 25, 1995, EPA issued a Proposed Remedial Action Plan ("Proposed Plan") for Operable Unit Two ("OU-2") at the Site. The Proposed Plan addressed residual coal tar in the subsurface soils and ground water contamination. In the Proposed Plan, EPA identified its preferred alternative for OU-2 as no further action. The Agency determined that the work already being done under OU-1 should be sufficient to protect human health and the environment.

A public comment period on the Proposed Plan was held from May 25 through June 23, 1995. On June 6, 1995, a public meeting was held which provided an opportunity for the public to ask questions and express opinions on the Proposed Plan. Attendance at the meeting was moderate. Based on input received during the public meeting, EPA believes the community members are generally supportive of the no-further-action alternative for OU-2

II. BACKGROUND OF COMMUNITY INVOLVEMENT

The Brodhead Creek Superfund Site is located in the Borough of Stroudsburg, 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 have been few expressions of community interest or inquiries to EPA about the Site.

Besides the meeting on June 6, 1995, EPA held public meetings to update the community on the progress of site activities in February of 1991 and February of 1994. In April of 1995, EPA conducted interviews with community residents and officials to determine the community's awareness of, and concerns about the Site. EPA has also kept community members informed of ongoing work through informational fact sheets and announcements in the Pocono Record. In addition, the community has access to EPA's local information repository at the Stroudsburg Borough Building.

Media coverage of the Site was extensive in the early 1980's when the contamination was first discovered, 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 and the meeting held on June 6, 1995, on the Proposed Remedial Action Plan for Operable Unit Two.

The comments made during the public comment period and EPA's responses to those comments are described in the following summary.

III. SUMMARY OF PUBLIC COMMENTS AND AGENCY RESPONSES

1. A community member asked if the pocket of coal tar accumulation located outside the slurry wall is a result of a defect in the slurry wall.

EPA RESPONSE: No. The slurry wall is working as intended. However, when the slurry wall was originally constructed, a small area of free coal tar was inadvertently trapped outside of the wall. This free coal tar accumulation is effectively contained by the elevation of the silty sand unit in this area because the free coal tar cannot move through the silty sand, and therefore it should not pose a threat to Brodhead Creek. The OU-1 remedy addresses this area (MW-2 area) of free coal tar. In addition, the integrity of the slurry wall will continue to be monitored as part of the OU-1 remedy.

2. A community member commented on the costs of the Alternatives for OU-1 and OU-2 and questioned why EPA did not select a no-further-action alternative for Operable Unit One as well.

EPA RESPONSE: It was determined that the free coal tar present at the Site was a principal threat to ground water. EPA defines a principal threat as a high volume, high toxicity waste. Therefore, EPA determined that the free coal tar in the stratigraphic depression on-site (RCC area) and the MW-2 area of the Site should be removed. This will be accomplished by the OU-1 enhanced recovery program. Once the enhanced recovery program is completed, there should be no principal threat from the former areas of free coal tar accumulation at the Site since they should contain only residual levels of coal tar contamination.

3. A community member asked if the residual coal tar will remain unchanged or if nature will take care of it.

EPA RESPONSE: Over the long-term, natural breakdown of the coal tar contaminants in the soils would be expected to occur. Unfortunately, there is no way to determine accurately how long these natural processes will take. The removal of free coal tar from the subsurface soils may improve conditions for the natural degradation of the contaminants.

4. A community member asked what would prompt EPA to take action at the Site in the future.

EPA RESPONSE: The ground water and Brodhead Creek will continue to be monitored under the OU-1 remedial program. Should these monitoring results reveal that Site conditions have changed, EPA will reevaluate its selected remedies and determine if they are still protective of human health and the environment or if further action is needed. In addition, EPA will conduct a formal review of the Site every five years to ensure that the selected remedies continue to protect human health and the environment. Finally, if EPA determines that Site conditions represent an imminent and substantial endangerment to the public health or welfare, it has authority to take action under Section 106 of the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. § 9601 et seq., and Section 7003 of the Resource Conservation and Recovery Act, 42 U.S.C. § 6901 et seq.

5. A community member questioned what types of deed restrictions would be placed on the Site property and whether the property could be put to beneficial use.

EPA RESPONSE: The property owners will be required to place deed restrictions on the property to prevent the disturbance of material below the surface and to prevent the use of ground water on-site. Possible future uses of the Site will be considered when structuring the deed restriction.

6. A community member asked what the classification of Brodhead Creek was and if the levels of contaminants entering the stream are below the levels necessary to maintain that classification.

EPA RESPONSE: Brodhead Creek is classified by Pennsylvania as a high quality cold water stream. A high quality cold water stream is a stream or watershed which has excellent quality waters and environmental or other features that require special water quality protection and maintains and/or propagates fish species and additional flora and fauna which are indigenous to a cold water habitat. Although dissolved coal tar contaminants are discharging to the Creek via ground water, upon entering the Creek these contaminants are being diluted to a level which cannot be detected. EPA has determined that there are currently no significant risks associated with the recreational use of Brodhead Creek or the ingestion of fish from the Creek.

7. A community member asked if the coal tar contaminants entering Brodhead Creek are being carried downstream and affecting other areas.

EPA RESPONSE: Current information indicates that for the reason discussed in EPA's response to comment 6 above, there is no risk associated with the use of Brodhead Creek either at the Site or downstream of the Site.

8. A community member asked, if severe disturbance to the creek bed were to occur from natural excavations or a flood, would that allow dangerous levels of coal tar contaminants to enter Brodhead Creek?

EPA RESPONSE: The possibility of a flood was considered during the original remedial investigation and feasibility study conducted for the Site. A worst case scenario of a 1,000 year flood event was assumed. Computer modeling revealed that approximately two feet of the creek bed would be eroded. Under that scenario, there would not be a significant release of coal tar contaminants to the Creek.

9. A community member asked if the Stroudsburg sewage treatment plant (on the western boundary of the Site) is impacted by the Site.

EPA RESPONSE: No. The sewage treatment plant is not impacted by the Site.

10. A community member asked if potential development upstream

would be restricted because of the Site.

EPA RESPONSE: EPA does not foresee that any restrictions at the Site will limit other activities upstream; i.e., there is no need for restrictions upstream of the Site.

11. A community member asked who is bearing the cost of the remedy for Operable Unit 1.

EPA RESPONSE: Pennsylvania Power and Light Company and Union Gas Company are paying for the cleanup work.

12. A community member asked when EPA will make a final decision on Operable Unit Two and notify the public.

EPA RESPONSE: EPA is hoping to make a decision on Operable Unit Two as soon as possible. However, EPA wants to ensure that it has considered all available information and evaluate public comments prior to making a final decision. EPA will also consult with the Commonwealth of Pennsylvania prior to finalizing its decision. EPA will publish a public notice in the Pocono Record when it has finalized its decision for Operable Unit Two of the Brodhead Creek Site.