RISK ASSESSMENT FOR A FORMER MANUFACTURED GAS PLANT SITE WATER STREET, PENN YAN, NEW YORK

June 1994

Prepared for:

New York State Electric and Gas Corporation
Corporate Drive, Kirkwood Industrial Park
P.O. Box 5224
Binghamton, New York 13902-5224

Prepared by:

Geraghty & Miller, Inc.
Risk Evaluation Group
2840 Plaza Place - Suite 350
Raleigh, North Carolina 27612
(919) 571-1662

RISK ASSESSMENT FOR A FORMER MANUFACTURED GAS PLANT SITE WATER STREET, PENN YAN, NEW YORK

June 1994

Geraghty & Miller, Inc., is submitting this report to the New York State Electric and Gas Corporation (NYSEG) for work performed at a former manufactured gas plant (MGP) site located on Water Street in Penn Yan, New York. The report was prepared in conformance with Geraghty & Miller's strict quality assurance/quality control procedures to ensure that the report meets industry standards in terms of the methods used and the information presented. If you have any questions or comments concerning this report, please contact one of the individuals listed below.

Respectfully submitted,

GERAGHTY & MILLER, INC.

Theodore M. [signature] for

T. Adam Ayers
Scientist

[signature] for

Shawn L. Sager, Ph.D.
Principal Scientist

CONTENTS

CONTENTS - continued

TABLES

TABLES - continued

TABLES - continued

FIGURES

RISK ASSESSMENT FOR A FORMER MANUFACTURED GAS PLANT SITE WATER STREET, PENN YAN, NEW YORK

1.0 INTRODUCTION

The objective of this risk assessment is to evaluate the potential risk to human health and the environment associated with exposure to constituents detected in surface water and sediment in Keuka Lake Outlet in the vicinity of the New York State Electric and Gas Corporation (NYSEG) former manufactured gas plant (MGP) site on Water Street in Penn Yan, New York. A risk assessment for the site was previously prepared by TRC (1990b). Calculated health risk estimates for both on-site and off-site scenarios showed the site to pose no significant threat to human health.

In order to evaluate the potential risk to human health and the environment associated with exposure to the constituents detected in samples obtained during the supplemental investigation, a risk assessment which focuses on the sediments and surface water quality in Keuka Lake Outlet has been prepared by Geraghty & Miller. The focus of this risk assessment is on potential exposures to site-related constituents that may have migrated into the Keuka Lake Outlet. The specific goals of this current risk assessment are to provide:

(1) an analysis of potential risks and help determine whether remedial actions are needed at Keuka Lake Outlet;

(2) if necessary, based on the results of the risk assessment, provide site-specific remediation goals for surface-water and sediment constituent concentrations which are protective of human health during exposures in Keuka Lake Outlet; and

(3) an analysis of potential adverse effects to the aquatic ecosystem of Keuka Lake Outlet in the vicinity of the site.

The risk assessment was completed following U.S. Environmental Protection Agency (USEPA) guidance for risk assessments (USEPA 1991a; 1989a,b,c) and was based on the use of reasonable maximum exposure (RME) assumptions. The RME method is recommended by the USEPA as a method to calculate conservative (protective of public health) risk levels. The risk assessment is organized with the following basic components, each of which are described below:

- Section 2, Site Characterization, describes the former MGP, provides a summary of the history of the site, land use in the area of the site, and describes the geology and hydrology of the site and surrounding area.

- Section 3, Constituent Characterization, identifies and summarizes the occurrence of constituents in surface water and sediments.

- Section 4, Hazard Characterization, identifies and presents summaries of the inherent toxicological properties of the constituents detected at the site and their toxicity values.

- Section 5, Exposure Characterization, discusses the physical and chemical properties influencing constituent migration, potential exposure routes, and potential receptors exposed to constituents detected in surface water and sediments.

- Section 6, Risk Characterization, summarizes the potential risk to human health from exposure to constituents detected in surface water and sediments.

- Section 7, Ecological Risk Assessment, summarizes, qualitatively evaluates, and identifies environmental receptors that may come in contact with surface water and sediments in Keuka Lake Outlet.

- Section 8, Uncertainties in the Risk Assessment, discusses the inherent uncertainties in the risk assessment process.

- Section 9, Findings and Conclusions, summarizes the results of the risk assessment.

2.0 SITE CHARACTERIZATION

This section provides a brief description of background information for the site, including discussions of the site location, history, and hydrology. A review of previous studies conducted at the site provided general information, such as the site topography, land use, and geology.

2.1 SITE DESCRIPTION AND HISTORY

The NYSEG former MGP is in the Village of Penn Yan, Yates County, New York, on Water Street approximately 10 feet north of Keuka Lake Outlet (Figure 1). The former MGP was constructed between 1899 and 1900 and produced retort coal gas until 1930, when the coal gasification operation ceased. The majority of the site currently is owned and occupied by Lake Country Ford Mercury, Inc., and Lake Country Maxi-Mini Storage. A small (natural gas) regulator house owned and maintained by NYSEG occupies the remainder of the site area.

A summary of the NYSEG site history was conducted by TRC and is provided below (TRC, 1990b). Industrial operations at the site began with the H. Tuttle and Son Malt House and Wool Storage facility, which existed until 1899. In 1899, the property was purchased by the Penn Yan Gas Light Company. The MGP was built on the southeastern portion of property, and gas production began shortly thereafter. New York Central Electric Corporation purchased the Penn Yan Gas Light Company in 1926, and the plant continued to produce gas until early 1930. New York Central Electric Gas Corporation merged with NYSEG in 1937. In 1943, NYSEG sold the property to Penn Yan Wine Cellars, Inc.; however, NYSEG retained a 400-square-foot parcel which contained the gas regulator house. Penn Yan Wine Cellars, Inc., sold the property in 1988 to Lake Country Ford Mercury, Inc., and Lake Country Maxi-Mini Storage. NYSEG subsequently purchased the property in November 1990, and is the current property owner.

2.2 LAND USE

The former MGP is in an area characterized by commercial operations. Liberty Street is the west boundary of the site and Water Street is the north boundary. Across Water Street is a car dealership. There are two residences at the corner of Water and Liberty Streets. Yates-Blodgett Grainery is to the east. Keuka Lake Outlet forms the southern boundary of the site (TRC, 1990a).

TRC (1990a) conducted a land use survey for a 1-mile radius around the site. Residential, commercial, agricultural, industrial, and open land comprise 40, 20, 20, 5, and 15 percent, respectively, of the land use. Five schools and one hospital were found north and northwest of the site.

2.3 GEOLOGY

Geologic data for the site were collected by TRC (1990b). The top unit encountered at the site consisted of unconsolidated sediments divided into three units: (1) fill; (2) layers of brown clay, silt, and sand; and (3) fine to coarse-grained sand with gravel and silt. Up to 11.3 feet of fill comprised of brick, foundation fragments, ash and wood chips, as well as intact railroad ties, were encountered. Beneath the fill to a depth of 35 feet was a fine-grained unit with layers of silt, sand, and clay. The third unit, found to a depth of 55 feet, consisted of fine to coarse-grained sand with gravel and silt.

Bedrock was not encountered by TRC (1990b) during drilling to a depth of 55 feet. Bedrock underneath the site should be part of the Genesee formation, which is comprised of interbedded shales and mudstones.

2.4 HYDROLOGY

Surface-water hydrology at the site is dominated by Keuka Lake Outlet, which is approximately 10 feet south of the site. The former MGP is in a low, flat area on the north bank of the outlet. Hydrological data indicate that shallow groundwater beneath the site flows toward Keuka Lake Outlet (TRC, 1990b).

The primary groundwater aquifer in the Penn Yan area occurs within unconsolidated Quaternary glacial deposits near Keuka Lake Outlet and extend north along Jacobs Brook Valley. The Penn Yan municipal water supply is acquired from Keuka Lake. The intake for this supply is approximately 7,200 feet southwest of the site on West Lake Road.

3.0 CONSTITUENT CHARACTERIZATION

This section describes the occurrence of constituents detected in surface water and sediment in Keuka Lake Outlet in the vicinity of the site. A composite of historical surface-water data presented in the TRC Risk Assessment Report (TRC, 1990a) was used to represent the occurrence of constituents in Keuka Lake Outlet surface water in the vicinity of the site. Data collected by Geraghty & Miller in November 1993 were used to represent the occurrence of constituents in Keuka Lake Outlet sediments in the vicinity of the site.

Data collected from surface water and sediment are summarized in Tables 3-1 and 3-2, respectively. The tables list the frequency of detection (ratio of the number of detects to the total number of samples in that group), the range of sample quantitation limits (SQLs), the range of detected values, the arithmetic mean, and the 95 percent upper confidence limit (UCL) on the mean. Constituents that were not detected in a specific medium were not included in the data summary tables. However, if a constituent was detected in at least one sample, the mean concentration was based on the detected concentration(s) and one-half the reported SQL for the non-detects. Both mean and UCL were calculated using proxy concentrations for non-detects.

3.1 OCCURRENCE OF CONSTITUENTS IN SURFACE WATER

A site investigation was conducted by TRC during 1987 and 1989 to determine the nature and extent of contamination in the soil, groundwater, surface water, and air at the site. Surface-water samples were collected during January, April, and July 1987 and May 1989. Analytical results for these samples were used to complete this risk assessment.

Surface-water samples collected by TRC were analyzed for volatile organic compounds (VOCs), base/neutral and acid extractable compounds (BNAs), metals, and inorganics. One upstream (background) sample was collected during each sampling event. One sample was collected adjacent to the site, and one sample was collected downstream of the site during each sampling event, for a total of eight samples. Table 3-1 provides a summary of these data.

One VOC, acetone, was detected in the eight samples. Concentrations ranged from 0.027 parts per million (ppm) to 0.034 ppm. Acetone was detected in an upgradient sample at a concentration of 0.615 ppm and also in a field blank. As a result, acetone likely is present as a laboratory contaminant rather than due to MGP-related activities. Bis(2-ethylhexyl)phthalate was detected in two samples at concentrations ranging from 0.024 ppm to 0.733 ppm. Bis(2-ethylhexyl)phthalate is not believed to be associated with activities at the site, and detected concentrations were attributed to laboratory contamination or field sampling equipment (gloves) (TRC, 1990a,b). Acenapthene (0.011ppm) and acenaphthylene (0.074 ppm) were detected at an upgradient location during the July 1987 sampling event. These constituents were not detected in any other surface-water sampling locations and were not considered to be site-related. Six inorganic constituents, including cadmium, iron, mercury, organic nitrogen, sulfate, and zinc, were detected in surface-water samples.

Constituents of potential concern (COCs) were selected for the site following USEPA guidance (USEPA, 1989a). As stated above, acetone and bis(2-ethylhexyl)phthalate were attributed to laboratory contamination and/or gloves used by field personnel during sampling activities. Organic nitrogen commonly occurs in water bodies at concentrations similar to those detected during the surface-water investigation. Therefore, organic nitrogen was not retained as a COC. All other constituents detected were considered as COCs. Table 3-3 summarizes the constituents selected as COCs in surface water.

3.2 OCCURRENCE OF CONSTITUENTS IN SEDIMENT

The TRC sampling results are presented below to provide historical perspective. More recent data, collected by Geraghty & Miller, was used to complete the risk assessment. Sediment samples collected by TRC during January 1987 and May 1989 were analyzed for VOCs, BNAs, inorganics, and phenols. Results of these sediment data indicated that PAHs and inorganics were present at elevated concentrations in sediments. Sixteen PAHs (acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, benzo[a]pyrene, chrysene, dibenzo[a,h] anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene, and pyrene) were detected during the sampling events. Total PAH concentrations ranged from not detected to 2,674 ppm during the January 1987 sampling event and from not detected to 27 ppm during the April 1987 sampling event. Seven metals, including arsenic, cadmium, chromium, iron, mercury, lead, and zinc, were detected in sediment samples.

In the most recent sampling event (November 1993), nine sediment samples collected by Geraghty & Miller from eight locations in Keuka Lake Outlet in the vicinity of the site were analyzed for target compound list (TCL) and target analyte list (TAL) constituents following the USEPA Contract Laboratory Program (CLP) Statements of Work (SOWs) for organics and inorganics as specified in the most recent New York State Department of Environmental Conservation (NYSDEC) Analytical Services Protocol, dated December 1991. Two samples were collected at Location 10, one at a depth of 0 to 2 feet, and one at a depth of 3 to 5 feet. Two upgradient samples (SD-1 collected January 1987 and SD-10 collected May 1989) collected during the TRC investigations were used to represent background conditions. Table 3-2 summarizes the occurrence of constituents detected in sediments. The Geraghty & Miller sediment sampling locations are shown on Figure 2.

Seven VOCs (acetone, benzene, ethylbenzene, methylene chloride, toluene, trichloroethene, and xylenes) were detected in the sediment samples. The semi-VOCs, carbazole, and total phenols each were detected in seven of nine samples. Phenols were detected in one background sample. Eighteen PAHs and 13 inorganics were detected in the sediment samples. With the exception of mercury, inorganics were detected in all nine samples. Lead and zinc concentrations detected in background samples exceeded those detected in samples adjacent to and downgradient of the site. Table 3-2 summarizes the constituents detected in sediment during the most recent sampling event.

COCs were selected for the site following USEPA guidance (USEPA, 1989a). Acetone was eliminated from the list of sediment COCs because it is a common laboratory contaminant. Lead and zinc were detected in upgradient samples at concentrations exceeding downgradient samples and samples located adjacent to the site; however, these constituents were detected in historical on-site soil sampling events and potentially are associated with site activities. (Therefore, lead and zinc were considered to be COCs. All other constituents detected in Keuka Lake Outlet sediments were retained as COCs.) Table 3-3 summarizes the constituents selected as COCs in sediment.

4.0 HAZARD CHARACTERIZATION

The risks associated with exposure to constituents detected at the site are a function of the inherent toxicity (hazard) of the constituents and the exposure dose. This section addresses the inherent toxicological properties of the constituents. The exposure doses are estimated in the Exposure Characterization section.

4.1 GENERAL TOXIC EFFECTS

A distinction is made between carcinogenic and non-carcinogenic effects. For potential carcinogens, the current regulatory guidelines (USEPA, 1989a) use a conservative approach in which it is assumed that any level of exposure to a carcinogen could hypothetically cause cancer. This is contrary to the traditional toxicological approach to toxic chemicals, in which finite thresholds are identified, below which toxic effects are not expected to occur. This traditional approach still is applied in evaluating non-carcinogenic effects.

4.2 CARCINOGENIC EFFECTS

Identification of constituents as known, probable, or possible human carcinogens is based on a USEPA weight-of-evidence classification scheme in which chemicals are systematically evaluated for their ability to cause cancer in mammalian species and conclusions are reached about the potential to cause cancer in humans. The USEPA classification scheme (USEPA, 1989a) contains six classes based on the weight of available evidence, as follows:

- A known human carcinogen;
- B1 probable human carcinogen -- limited evidence in humans;
- B2 probable human carcinogen -- sufficient evidence in animals and inadequate data in humans;
- C possible human carcinogen -- limited evidence in animals;
- D inadequate evidence to classify; and
- E evidence of non-carcinogenicity.

Constituents in Classes A, B1, B2, and C are included in this assessment as known or potential human carcinogens. Benzene and arsenic are classified as Class A carcinogens. Cadmium, chromium, and nickel are classified as Class B1, A, and A carcinogens, respectively, via the inhalation route only. Methylene chloride, the PAHs, and lead are classified as B2 carcinogens. Trichloroethene is classified as a Class C-B2 carcinogen. Arsenic, chromium, lead, and nickel occur naturally in the environment.

Currently, the USEPA uses a linearized multistage model for extrapolating from high to low doses. The model provides a 95 percent upperbound estimate of cancer incidence at a given dose. The slope of the extrapolated curve, called the cancer slope factor (CSF), is used to calculate the probability of cancer associated with the exposure dose.

Recent research on the mechanisms of carcinogenesis suggests that use of this model may overestimate the cancer risks associated with exposure to low doses of chemicals. At high doses many chemicals cause large-scale cell death which stimulates replacement by division. Dividing cells are more subject to mutations than quiescent (non-dividing) cells; thus, there is an increased potential for tumor formation. It is possible that administration of these same chemicals at lower doses would not increase cell division and thus would not increase mutations. This would suggest that the current methodology may overestimate cancer risk.

4.3 NON-CARCINOGENIC EFFECTS

For many non-carcinogenic effects, protective mechanisms must be overcome before the effect is manifested. Therefore, a finite dose (threshold), below which adverse effects will not occur, is believed to exist for non-carcinogens. Non-carcinogenic health effects include birth defects, organ damage, behavioral effects, and many other health impacts. A single compound might elicit several adverse effects depending on the dose, the exposure route, and the duration of exposure. For a given chemical, the dose that elicits no effect when evaluating the most sensitive response (the adverse effect which occurs at the lowest dose) in the most sensitive species is used to establish a reference dose (RfD). RfDs that are sanctioned by the USEPA are called verified reference doses for oral exposure (RfD_os) or reference concentrations for inhalation exposure (RfCs). In this risk assessment, RfCs have been converted to reference doses for inhalation exposure (RfD_is) (USEPA, 1993a).

4.4 TOXICITY SUMMARY

A summary of the potential health effects of the COCs considered in this report is provided in Table 4-1. The listed adverse health effects are for informational purposes only. Some of the toxic effects listed in the table are associated with high levels of exposure and may not be representative of adverse effects resulting from the relatively low concentrations detected in the environment.

4.5 TOXICITY VALUES

In general, CSFs, cancer classifications, RfDs, and RfCs are taken from IRIS (1994) or, in the absence of IRIS data, the USEPA Health Effects Assessment Summary Tables (HEAST) (USEPA, 1993a). RfDs for the COCs are presented in Table 4-2. CSFs, cancer type or tumor sites, and carcinogen classifications for the carcinogenic COCs at the site are presented in Table 4-3. Because toxicity values for dermal exposure are rarely available (appropriate toxicity data are scarce), the oral RfD and CSF are adjusted to an absorbed dose, using the constituent-specific oral absorption efficiency, as recommended by the USEPA (1989a), to derive an adjusted RfD and CSF to assess dermal exposure. Constituent-specific absorption efficiencies (both oral and dermal) for COCs are provided in Table 4-4. Adjusted RfDs and CSFs are shown in Table 4-5.

Permeability constants (PCs) for dermal absorption from water were obtained from the USEPA (USEPA, 1992a) or if no published values were available, the PC was estimated using the Brown and Rossi (1989) equation. This equation for the PC is a function of the constituent-specific octanol-water partition coefficient (K_{ow}). The equation used to calculate the PC for a VOC or semi-VOC is:

$$PC = 0.1 \times [K_{ow}^{0.75} / (120 + K_{ow}^{0.75})].$$

The PC of water (0.001 centimeters per hour [cm/hr]) was used as a default value (USEPA, 1992a) to estimate the dermal adsorption for those inorganic constituents not having constituent-specific PCs (e.g., lead and nickel). Using the water PC likely overestimates the dermal adsorption (and therefore toxicity) of the inorganic constituents. The PCs for the COCs are presented in Table 4-6.

There are no USEPA-verified RfDs for lead. The best method currently available for evaluating lead exposure is through the measurement of blood lead levels. Lead was evaluated in this risk assessment based on acceptable blood lead levels for young children using the USEPA (1991b) biokinetic/uptake model (LEAD5).

The CSFs for benzo(a)pyrene were used to calculate cancer risks associated with exposure to all carcinogenic PAHs in the surface water and sediment at the site. In accordance with USEPA guidance (USEPA, 1992b), the oral CSF for benzo(a)pyrene was converted using toxicity equivalency factors (TEFs) for each individual carcinogenic PAH. This approach is based on the relative potency of each compound to the potency of benzo(a)pyrene (USEPA, 1992b). There are a limited number of RfDs available for the PAHs detected at the site. The following PAHs have USEPA-verified RfDs: acenaphthene, anthracene, fluoranthene, fluorene, and pyrene. The RfD for pyrene was used to calculate non-cancer risks associated with exposure to detected non-carcinogenic PAHs not having individual RfDs.

5.0 EXPOSURE CHARACTERIZATION

This section addresses the potential for human exposure to constituents present in surface water and sediment in Keuka Lake Outlet potentially associated with the site. Exposure can occur only when the potential exists for a receptor to directly contact released constituents or there is a mechanism for released constituents to be transported to a receptor. Without exposure there is no risk; therefore, the exposure assessment is one of the key elements of the risk assessment.

5.1 RELEASE/SOURCE ANALYSIS

Keuka Lake Outlet is approximately 10 feet south of the NYSEG former MGP. Wastes generated at the site included those typical of MGPs such as tars, sludges, ash, iron oxide, impregnated wood chips, and liquids from drip boxes. Most of the wastes generated by the coal gas operation were collected and sold; however, oil-water emulsions and ammonia/water mixtures were pumped into a settling tank, and residual tar was drained into a storage vessel adjacent to Keuka Lake Outlet. When the coal tar or water separated from the coal tar reached a specified level in the storage vessel, a drain allowed the discharge of this material into Keuka Lake Outlet. Wastewater from cooling operations also was discharged via floor drains to Keuka Lake Outlet. Constituents commonly found in MGP wastes are VOCs, PAHs, phenols, cyanides, and heavy metals. Heavy metals are COCs in surface water, and VOCs, PAHs, phenolics, and heavy metals are COCs in sediment. A discussion of the release and subsequent transport mechanisms for the constituents detected at the site is provided below.

5.2. PHYSICAL AND CHEMICAL PROPERTIES

The environmental fate and transport of the COCs constituents are dependent on the physical and chemical properties of the constituents, the environmental transformation processes affecting them, and the media through which they are migrating. This section will describe the primary physical and chemical properties affecting fate and transport and the processes expected to control the fate and transport of the organic COCs. The physical and chemical properties and their significance to mobility and persistence of the COCs is discussed in the following sections. Key chemical and physical properties discussed in this section include water solubility, specific gravity, volatility, organic-carbon partition coefficient (K_{oc}), soil distribution coefficient (K_d), octanol-water partition coefficient (K_{ow}), and half-lives. Physical and chemical properties of the organic COCs are summarized in Table 5-1.

The water solubility of a substance is a critical property affecting migration in sediments and surface water. Solubility is expressed in terms of the number of milligrams of a constituent that can dissolve in one liter of water (ppm) under standard conditions of 25 degrees Centigrade (°C) and one atmosphere of pressure (atm). Solubilities range from less than 1 ppm to totally miscible (Lyman et al., 1990). The higher the value of the solubility, the greater the tendency of a constituent to dissolve in water; thus, a highly soluble constituent is generally more mobile in groundwater and more likely to leach in soil than a constituent with a lower solubility. In this report, constituents with solubilities greater than 1,000 ppm, such as benzene, methylene chloride, and trichloroethene, are considered highly soluble; constituents having solubilities less than 10 ppm are considered slightly soluble (Ney, 1990). For inorganic constituents, solubility depends on the form of the constituent.

The specific gravity is the ratio of the density of a chemical in its pure state to the density of water. Non-aqueous phase liquids with a specific gravity greater than one are denser than water and will sink through the water table, whereas constituents with a specific gravity less than one will float on the water table. Constituents that are completely dissolved in water will not form a separate phase regardless of the specific gravity.

Volatilization of a constituent from environmental media will depend on its vapor pressure, water solubility, and diffusion coefficient. Highly water soluble compounds generally have lower volatilization rates from water unless they also have high vapor pressures. Vapor pressure, a relative measure of the volatility of chemicals in their pure state, ranges from about 0.001 to 760 millimeters of mercury (mm Hg) for liquids, with solids ranging down to less than

10^{-10} mm Hg. Of the organic COCs, the VOCs have vapor pressures much greater (at least four orders of magnitude) than heptachlor.

The Henry's Law Constant, combining vapor pressure with solubility and molecular weight, is used for estimating releases from water to air. The Henry's Law Constant is a partition coefficient used to predict the tendency of an organic constituent to volatilize or "partition" from the aqueous or water phase to the vapor phase and may be experimentally determined or calculated from vapor pressure and solubility. Organic compounds with Henry's Law Constants in the range of 10^{-3} atmospheres-cubic meter per mole (atm-m^3/mol) and greater and molecular weights equal to or less than 200 grams pre mole (g/mol) can be expected to readily volatilize from water (i.e., VOCs); those with values ranging from 10^{-3} to 10^{-5} atm-m^3/mol are associated with possibly significant, but not facile, volatilization (e.g., naphthalene), while compounds with values less than 10^{-5} atm-m^3/mol will volatilize only slowly from water to a limited extent.

The K_{ow} often is used to estimate the extent to which a constituent will partition from water into lipophilic parts of organisms, for example, animal fat. Similarly, the K_{oc} reflects the propensity of a compound to adsorb to the organic matter found in the soil or sediments. The bioconcentration factor (BCF) is the ratio of the concentration of the constituent in fish tissue to its concentration in water. As groups of compounds, the PAHs have larger K_{ow}s, and K_{oc}s, indicating a greater tendency to partition in a medium other than water.

The potential for a constituent to sorb to soil particles will affect migration through soil and aquifer materials. When a constituent enters the soil/sediment environment, some of it will bind with particles through the process of sorption and some will dissolve in the water contained in the spaces between soil particles (pore water). The term "sorption" includes adsorption (constituent bound to the outside of soil particles) and absorption (constituent distributed throughout the particle matrix). Sorption to soil reduces volatilization, leaching, and biodegradation. A constituent that is absorbed is not mobile because it is not easily released from the particle. Conversely, a constituent that is adsorbed is released more easily and therefore may be mobile.

Adsorption potential typically is expressed in terms of a partition coefficient, K_{oc} or K_d. A partition coefficient is the ratio of the concentration of adsorbed constituent to the concentration of aqueous phase constituent and is expressed in units of milliliters per gram (mL/g). The K_{oc} may be determined empirically or may be estimated using constituent-specific and soil-specific parameters. The parameters most often used to calculate K_d for organic constituents are the K_{oc}, which measures the selective affinity for soil organic carbon versus water, and the fraction of organic carbon (f_{oc}) in soil. In the absence of site-specific data, the K_d is expressed as the product of the K_{oc} and f_{oc} (USEPA, 1989d). Higher values of K_{oc} (greater than 10,000 mL/g) indicate a greater potential for the constituent to adsorb to organic carbon in soil and aquifer materials. Constituents with low K_{oc} values (less than 1,000 mL/g) do not adsorb strongly to soil and aquifer materials (Ney, 1990). Values of K_{oc} are shown in Table 5-1, and the values typically are based on several different types of studies or element-specific parameters. All of the VOCs are characterized by low K_{oc}s. These constituents do not tend to adsorb readily to soil or aquifer materials, and thus are characterized by high mobility in the environment. The PAHs have large K_{oc} values and are predicted to adsorb readily which will limit its mobility in soil and water.

The ability to volatilize from an environmental medium is an important property affecting the mobility and persistence of organic constituents. Vapor pressure, K_{oc}, and water solubility govern the extent to which a chemical will volatilize into the air under ambient environmental conditions. Solubility and vapor pressure generally decrease with molecular weight, and K_{oc} increases with molecular weight. A constituent with a low vapor pressure, high K_{oc}, and/or high water solubility volatilizes more slowly than a constituent with a higher vapor pressure, lower K_{oc}, and/or lower water solubility (Ney, 1990).

Biodegradation is the biological process by which microorganisms break down organic chemicals. Environmental factors such as moisture, pH, temperature, and available nutrients will affect the rate of biodegradation. Constituents with high water solubility, low K_{oc}, and low K_{ow} values likely will biodegrade (Ney, 1990). Most of the VOCs detected at the Former MGP site have these properties.

Persistence is the "lasting power" of constituents and is commonly expressed in terms of half-lives ($T_{1/2}$) for specific environmental media. The half-life of a constituent is the period of time required for one-half of the mass of a compound to be transformed into other constituents from the time of its introduction to the environment. Half-lives of the detected constituents are presented in Table 5-1 in ranges because the rate of degradation varies according to environmental conditions and concentration. Half-lives may be used to characterize the relative persistence of a constituent in various environmental media.

The inorganic COCs can be found as positively (i.e., cations) or negatively (i.e., anions) charged ions in environmental media at the site. Most of the inorganics present at the site are found as cations and tend to adsorb to sediment materials or form insoluble precipitates, especially under neutral or basic conditions. In the sediment, inorganics tend to adsorb to sediment particles and can be released or desorbed from sediment with changing conditions such as oxidation-reduction potential or pH. The inorganic constituents of potential concern are not volatile.

5.3 MECHANISMS OF MIGRATION

There are several mechanisms by which constituents may migrate through environmental media at the former MGP. If discharge from the site occurs, constituents may migrate directly from the site to Keuka Lake Outlet surface water. When the MGP was operational, constituents were discharged into surface water. Some constituents may have migrated into the sediments and these sediments may be acting as a source for surface water. The mechanisms of migration are discussed in this section from a conceptual standpoint together with a discussion of constituent persistence and transformations that may occur in the source or transport medium.

5.3.1 Migration in Surface Water

The organic COCs detected in surface water may remain in the water column, migrate into air, or migrate into the sediments. Constituents with low water solubilities and high K_{oc}s will tend to partion or migrate into the sediments. This is why there were no PAHs detected in the surface-water samples. The VOCs detected in sediments have higher solubilities and would be expected to migrate, to some extent, from the sediments into the surface water. Once in the surface water, they would be likely to volatilize or migrate into the air, as seen by their relatively high Henry's Law Constants.

The behavior of the inorganic COCs in surface water is affected by water-quality parameters such as pH, temperature, hardness, and dissolved oxygen. Inorganic compounds can occur in aquatic systems as dissolved ions, dissolved complexes with organic and inorganic chemicals, colloids, or particulates. The solubility and mobility of metals is enhanced by their ability to form complexes with humic and fulvic acids, carbonates, hydroxides, and phosphates. In many cases, toxicity to aquatic organisms is reduced by the presence of these complexing agents.

5.3.2 Migration in Sediments

As discussed in the previous section, the sediments may act as a source of constituents to the surface water. Constituents with high water solubilities and low K_{oc}s will tend to migrate from the sediments into the surface water; this behavior would be expected from the VOCs and perhaps some of the smaller PAHs such as naphthalene. The semi-VOCs and PAHs would be expected to remain in the sediments due to their lower solubilities and higher K_{oc}s.

The inorganic COCs will tend to remain in the sediments. Their mobility will depend on the cation and anion exchange capacities (that is, the interaction between positively and negatively charged ions), the fraction of organic matter, pH, and oxidation-reduction potential. In general, inorganic constituents with a positive charge (cations) will be bound by clays exhibiting an overall negative charge, and anions (constituents with a negative charge) such as chromium or arsenic will be more mobile.

5.3.3 Biodegradation and Biotransformation Processes

Biological and chemical processes occurring in sediments can be important in determining the ultimate fate of the constituents in sediments in Keuka Lake Outlet. The extent and rates of these reactions are difficult to predict for each individual site. Microorganisms naturally occurring in soils are able to use several organics (including the COCs) as a food source, degrading the components ultimately to carbon dioxide and water (Kostecki and Calabrese, 1989).

Benzene, ethylbenzene, toluene, and xylenes (BTEX) may be degraded in soils and sediments (Kostecki and Calabrese, 1989). For aerobic degradation, adequate amounts of oxygen, moisture, and nutrients (e.g., nitrogen, phosphorus) need to be available. Aerobic metabolism of constituents under these conditions may result in the total depletion of oxygen. When this happens, the microorganisms may begin utilizing inorganic ions, such as nitrate or sulfate, and continue aerobic respiration, or other types of microorganisms may become active in metabolizing the constituents (USEPA, 1989d). These anaerobic microorganisms are those likely to be present in sediments.

The PAHs found in sediments can biodegrade. Factors which contribute to the degree to which biodegradation occurs include biodegradability rates, production of intermediates, and the effects of mixtures. In general, PAHs with two or three rings (e.g., phenanthrene) were more readily degraded than PAHs with four or more rings (e.g., pyrene) (McKenna and Heath, 1976).

In most cases, an organic contaminant is not broken down completely to carbon dioxide and water by a bacterium, but is metabolized to an intermediate, which in turn is degraded further. The metabolites detected depend primarily on the time at which the reaction is stopped. In general, these intermediates are more water soluble than the parent compound and are therefore more mobile.

5.4 EXPOSURE PATHWAYS

The most likely routes of potential human exposure to constituents detected in Keuka Lake Outlet surface water and sediment are through direct contact (i.e., ingestion and dermal contact) with the surface water and sediment while wading and/or swimming or the ingestion of fish containing COCs.

A small recreational park and picnic area is on the opposite side of Keuka Lake Outlet from the site. This area potentially is used as a recreational area for local children and adults. The banks of Keuka Lake Outlet are unrestricted; therefore, children and adults may contact sediments and/or surface water containing site-related constituents. Exposure may occur via incidental ingestion and dermal contact with surface water and sediment. Older children (aged 6 to 10 years) are more likely to wade or play in surface-water bodies than are adults. Also, children are usually more sensitive receptors than the adults; however, adult and child exposure to surface water was evaluated quantitatively.

Keuka Lake Outlet is classified as a Class C (protection for fishing and fish propagation) surface-water body. Therefore, children and adults could catch and ingest fish potentially affected by site-related constituents.

5.5 EXPOSURE POINT CONCENTRATIONS

Following USEPA methodology (1989a), the medium-specific 95 percent UCL on the arithmetic mean concentrations for the COCs were used as exposure point concentrations (EPCs) to estimate RME. The RME approach is suggested by the USEPA (1989a) to provide an estimate of the maximum exposure (and therefore risk) that might occur. The RME corresponds to a duration and frequency of exposure greater than is expected to occur on an average basis. In those instances where the calculated 95 percent UCL exceeds the maximum detected concentration, the maximum detected concentration was used as a more accurate estimate of the RME concentration (USEPA, 1989a).

The surface-water and sediment data are summarized in Tables 3-1 and 3-2, respectively. The UCL concentrations in these tables were used to represent the EPCs for the potential child and adult swimming and wading scenarios.

COC concentrations in fish tissue were calculated by multiplying the concentration in water by the bioconcentration factor (BCF). BCFs are presented in Table 5-12. Surface water concentrations for PAHs detected in sediments were determined by calculating the interstitial surface water concentrations using the equilibrium partition coefficient method. In this method, the constituent concentration detected in sediment is divided by the constituent-specific partition coefficient (K_d). The K_d is determined by multiplying the constituent-specific octanol-carbon partition coefficient (K_{oc}) by the organic carbon content (f_{oc}). A site-specific f_{oc} value of 0.0769 (7.69 percent organic carbon) was used in this assessment. This value was equal to the total organic carbon content of sediments immediately adjacent to the tar well at the site. Sediments in this area generally contained the highest concentration of site-related constituents. Therefore, it is likely that if fish were exposed to constituents detected in Keuka Lake Outlet sediments, this area would provide a worst-case estimate of constituent uptake.

5.6 EXPOSURE DOSE CALCULATIONS

Average daily exposures were calculated for each receptor and exposure pathway using standard exposure assumptions (USEPA, 1989a,c; 1991a), site-specific data, and professional judgment. Exposure point concentrations were selected as the lower value of the maximum concentration and the UCL for each medium. A basic assumption underlying all exposure calculations was that the EPCs would remain constant throughout the exposure period. Natural attenuation processes in surface water and sediment were not considered. Additionally, metabolization and/or excretion of constituents in fish tissue was not considered. Therefore, using UCL concentrations for the COCs as representative EPCs over the entire exposure period should result in overestimates of exposure.

Current risk assessment guidance requires that the averaging time used to calculate average daily exposure doses depends on the toxic effect (cancer or non-cancer). For carcinogenic effects, the total cumulative dose was averaged over a lifetime (70 years), whereas the total cumulative dose was averaged over the exposure period for non-carcinogenic effects. The approach for carcinogens is based on the assumption that any dose may induce a response (non-threshold) and a given dose has the same probability of inducing a response regardless of the exposure period. In other words, a higher dose received over a short exposure period is equivalent to a lower dose received over a lifetime, as long as the total dose is the same.

Two primary receptors were identified: a current adult visitor and a current child visitor. Residents living in the vicinity of the site or individual visiting the recreational park adjacent to Keuka Lake Outlet could be exposed to surface water and sediment while swimming, wading, or fishing in Keuka Lake Outlet. Specific assumptions and exposure dose calculations are presented in the following sections. Table 5-2 provides a summary of the exposure assumptions used in the risk assessment and described below.

5.6.1 Adult and Child Swimming

Daily exposure doses for dermal contact and ingestion of surface water and sediment were calculated for the hypothetical current scenario. USEPA guidance (1989c; 1991a) and professional judgment were used to develop surface-water and sediment exposure assumptions for dermal contact and ingestion of surface water and sediment by an adult and a child. The assumptions used to assess the average exposure of an adult and child swimming in surface water include:

(1) adult body weight of 70 kg or child body weight of 38 kg (aged 0 to 10 years) (USEPA, 1991a);

(2) incidental ingestion rate for surface water of 0.1 L/hour (USEPA, 1989c);

(3) incidental ingestion rate for sediment of 5 mg/day (USEPA, 1989c);

(4) exposure frequency of 14 days/year (2 days per week for 7 weeks) (based on professional judgment);

(5) exposure duration of 30 years for adult; 10 years for child (based on professional judgment);

(6) exposure time of 2 hours per day (based on professional judgment);

(7) exposed skin surface area of 18,150 cm^2 for the total body surface area of an adult (average of 50th percentile values for adult male and female) or 12,350 cm^2 for the total body surface area of a child (average of 50th percentile values for male and female) (USEPA, 1989c);

(8) sediment adherence rate of 0.1 $mg/cm^2/day$ (one-tenth of the upperbound soil adherence rate) (USEPA, 1992a);

(9) constituent-specific PC (USEPA, 1992a) (Table 4-6); and

(10) averaging period of 70 years for carcinogenic effects and 30 years for non-carcinogenic effects for an adult or 70 years for carcinogenic effects and 10 years for non-carcinogenic effects for a child (USEPA, 1989a).

The assumptions and equations used to calculate the exposure dose for an adult or child swimming in Keuka Lake Outlet are provided in Table 5-3. The results of the calculations are presented in Tables 5-4 and 5-5 for the adult and the child scenarios, respectively.

5.6.2 Adult and Child Wading

The assumptions used to assess the exposure of an adult visitor or child visitor wading in surface water include:

(1) adult body weight of 70 kg or child body weight of 38 kg (USEPA, 1991a);

(2) incidental ingestion rate for surface water of 0.05 L/day (one half the ingestion rate for a swimming scenario) (USEPA, 1989c);

(3) incidental ingestion rate for sediment of 5 mg/day (USEPA, 1989c);

(4) exposure frequency of 24 days/year (4 days per month in June, July, August, and September) (based on professional judgment)

(5) exposure duration of 30 years for an adult and 10 years for a child (based on professional judgment);

(6) exposure time of 2 hours per day (based on professional judgment);

(7) exposed skin surface area of 3,190 cm^2 (hands, feet, lower arms, and lower legs) (average of 50th percentile values for male and female) for an adult and 2,700 cm^2 for a child (hands, feet, lower arms, and lower legs) (average of 50th percentile values for male and female) (USEPA, 1989c);

(8) sediment adherence rate of 0.1 $mg/cm^2/day$ (one-tenth of the upperbound soil adherence rate) (USEPA, 1992a);

(9) constituent-specific PC (USEPA, 1992a) (Table 4-6); and

(10) averaging period of 70 years for carcinogenic effects and 30 years for non-carcinogenic effects for an adult and 70 years for carcinogenic effects and 10 years for non-carcinogenic effects for a child (USEPA, 1989a).

The assumptions and equations used to calculate the exposure dose for an adult or child visitor wading in Keuka Lake Outlet are provided in Table 5-6. The results of the calculations are presented in Tables 5-7 and 5-8 for the adult and child scenarios, respectively.

5.6.3 Fish Ingestion

The assumptions used to assess the average exposure of an adult visitor or child visitor ingesting fish caught from Keuka Lake Outlet include:

(1) adult body weight of 70 kg or child body weight of 38 kg (USEPA, 1991a);

(2) Fishing occurs 28 days per year (1 day per week for 28 weeks) (USEPA, 1989c);

(3) exposure duration of 30 years for an adult or 10 years for a child (professional judgment);

(4) Ingestion rate of 0.054 kg of fish per day (kg/day) (USEPA, 1989c);

(5) Locally caught fish comprise 50 percent of fish diet (source contribution factor) (USEPA, 1989c);

(6) Concentration of constituents in the fish is equal to the surface-water concentration multiplied by the constituent-specific fish BCF (USEPA, 1989c); and

(7) averaging period of 70 years for carcinogenic effects and 30 years for non-carcinogenic effects for adults and 70 years for carcinogenic effects and 10 years for non-carcinogenic effects for a child (USEPA, 1989a).

The assumptions and equations used to calculate the exposure dose for an adult or child visitor ingesting fish from Keuka Lake Outlet are provided in Tables 5-2 and 5-10, respectively. The results of the calculations are presented in Tables 5-11 and 5-12 for the adult visitor scenario and the child visitor scenario, respectively.

5.6.4 Exposure to Lead

The USEPA has not established critical toxicity values, such as RfDs and CSFs, for lead. Instead, blood lead concentration generally has been accepted as the best measure of the external dose of lead (NAS, 1980; USEPA, 1991b). The USEPA has developed an uptake/biokinetic (UBK) model (LEAD5) for predicting mean blood lead levels in a sensitive subpopulation, children of ages 6 months to 7 years old. A corresponding model has not been developed by USEPA for evaluating exposure of adults to lead.

The USEPA UBK model integrates exposure from lead in air, water, soil, dust, diet, and paint with pharmacokinetic modelling to predict blood lead levels in children of ages 6 months to 7 years old. Lead was identified as a COC in sediment. As a conservative scenario, it was assumed that the potential exists for a child resident (aged 6 months to 7 years old) to be exposed to lead in this media. The media concentrations used to evaluate lead exposure are discussed in the section that follows.

With the exception of the site-specific sediment lead concentrations, the UBK model was run using the model's default assumptions. The default assumptions include conservative estimates of the bioavailability of lead from soils, the relationship between soil lead and indoor dust, and the rates at which children are exposed to lead in environmental media and food. The results of the UBK model run using the data for the site are shown in Table 5-13.

6.0 RISK CHARACTERIZATION

This section discusses the estimates of the potential risk to human health associated with Keuka Lake Outlet in the vicinity of the NYSEG former MGP. Risks to environmental receptors are evaluated in Section 7.0. Risks to human health are evaluated for the exposure scenarios identified in Section 5.0. The calculated exposure doses are combined with toxicity values identified in Section 4.0 to identify any potential threat to human health.

6.1 GENERAL CONCEPTS

Risks to human health can be evaluated quantitatively by combining exposure and hazard data. A distinction is made between non-carcinogenic and carcinogenic effects, and two general criteria are used to describe risk: the hazard quotient (HQ) (for non-carcinogenic effects) and excess lifetime cancer risk (ELCR) (for constituents which are thought to be potential human carcinogens).

The ELCR is an estimate of the increased risk of cancer which results from lifetime exposure, at specified average daily dosages, to constituents detected in media at the facility. Estimated doses, or intakes, for each constituent are averaged over the expected lifetime of 70 years. It is assumed that a large dose received over a short period is equal to a smaller dose received over a longer period, as long as the total doses are equivalent. The ELCR, equal to the product of the exposure dose and the CSF, is estimated for each Class A, B, and C carcinogenic COC in each medium. The risk values provided in this report are an indication of the increased risk, above that applying to the general population, which may result from the exposure scenarios described in the Exposure Characterization section (Section 5). The risk estimate is considered to be an upperbound estimate; therefore, it is likely that the true risk is less than that predicted by the model. Current regulatory methodology assumes that excess lifetime cancer risks can be summed across routes of exposure and COCs to derive a "Total Site Risk" (USEPA, 1989a).

Exposure doses are averaged only over the expected exposure period to evaluate non-carcinogenic effects. The hazard quotient (HQ) is the ratio of the estimated exposure dose and the RfD. An HQ greater than 1 indicates that the estimated exposure exceeds the RfD. This ratio does not provide the probability of an adverse effect as does the ELCR. Although an HQ greater than 1 indicates that the estimated exposure dose for that constituent exceeds acceptable levels for protection against non-carcinogenic effects, it does not necessarily imply that adverse health effects will occur. The sum of the HQs is the HI. Current regulatory methodology (USEPA, 1989a) advises summing HIs across exposure routes for all media at the facility to derive a "Total Site Hazard Index." If the HI exceeds 1, COCs may be grouped according to critical toxic effects, and HIs may be calculated separately for each effect.

6.2 EXPOSURE OF ADULT VISITOR/CHILD VISITOR SWIMMING

Risks for a hypothetical adult visitor and hypothetical child visitor exposure to surface-water and sediment constituents in Keuka Lake Outlet while swimming were calculated and are presented in Tables 5-4 and 5-5, respectively. The ELCR and HI for an adult visitor are 1×10^{-6} and 0.1, respectively. The ELCR and HI for a child visitor are 5×10^{-7} and 0.1, respectively.

6.3 EXPOSURE OF ADULT VISITOR/CHILD VISITOR WADING

Risks for a hypothetical adult visitor and hypothetical child visitor exposure to surface-water and sediment constituents in Keuka Lake Outlet while wading were calculated and are presented in Tables 5-7 and 5-8, respectively. The ELCR and HI for an adult visitor are 1×10^{-6} and 0.04, respectively. The ELCR and HI for a child visitor are 7×10^{-7} and 0.06, respectively.

6.4 FISH INGESTION

Risks for a hypothetical adult visitor and hypothetical child visitor exposure to surface water and sediment constituents in Keuka Lake Outlet through fish ingestion were calculated and are presented in Tables 5-11 and 5-12, respectively. The ELCR and HI for an adult visitor are 1×10^{-6} and 0.3, respectively. The ELCR and HI for a child visitor are 9×10^{-7} and 0.6, respectively.

7.0 ECOLOGICAL RISKS

A qualitative ecological risk assessment was completed for Keuka Lake Outlet adjacent to the former MGP to determine if concentrations of metals and organic constituents detected in the sediments may produce adverse biological affects. The assessment included gathering information on the composition of the aquatic community in Keuka Lake Outlet, contacting various agencies to determine the potential presence of threatened or endangered species in the vicinity of the site, and comparing constituent concentrations detected in the sediment to available sediment criteria/guidelines.

7.1 METHODOLOGY

7.1.1 Biological Characterization

An inventory of the aquatic community in Keuka Lake Outlet was not completed as part of this assessment. Instead, the NYSDEC, Bureau of Fisheries - Region 8 was contacted to gather information about the community. They were able to provide information on past electrofishing surveys in Keuka Lake Outlet in the vicinity of the site. Additionally, the NYSDEC and the United States Fish and Wildlife Service (USFWS) were contacted to provide information on the potential existence of endangered or threatened species or sensitive habitats in the vicinity of the site. The USFWS indicated that no federally listed or proposed endangered or threatened species under their jurisdiction are known to exist in the site area.

7.1.2 Sediment Criteria/Guidelines

In order to determine the potential for adverse biological effects associated with metals and organic compounds detected in Keuka Lake Outlet sediments near the site, NYSDEC (1993) criteria and National Oceanic and Atmospheric Administration (Long and Morgan, 1990) guidelines were reviewed.

The NYSDEC (1993) has established sediment criteria for non-polar organic compounds and metals. The criteria for the non-polar organic compounds are derived through equilibrium partitioning (EP), which contends that sediment toxicity is attributable to the concentration of contaminant dissolved in the interstitial pore water. The contaminant concentration dissolved in interstitial pore water is dependent upon the constituent concentration in the sediment, the organic carbon content of the sediment, and the affinity of the contaminant for the organic carbon. A criterion normalized for the sediment organic carbon content is then established based upon the water-quality criterion and the octanol-water coefficient (K_{ow}) for the constituent. Because the sediment organic carbon content was not determined during previous sampling efforts, criteria associated with 1 percent and 3 percent organic carbon content were calculated to provide a conservative range of criteria.

Metals criteria established by the NYSDEC (1993) are based upon observed effects levels. The NYSDEC has established two effect levels: the Lowest Effect Level (LEL) and a Severe Effect Level (SEL). The LEL indicates a level of sediment contamination that can be tolerated by the majority of benthic organisms but still causes toxicity to a few species. The SEL indicates the concentration at which pronounced disturbance of the sediment-dwelling community can be expected.

NOAA (Long and Morgan, 1990) published informal guidelines on sediment contaminant concentrations at which biological effects were observed or predicted to occur. These guidelines are based upon review of contaminant data from numerous sites throughout the country, including freshwater and marine environments. After summarizing the data, they classified the effects concentration associated with the lower 10 percentile as the Effects Range-Low (ER-L) and the effects concentration associated with the 50 percentile as the Effects Range-Medium (ER-M). For purposes of this report, the ER-M concentrations will be used as screening criteria. Because NYSDEC (1993) incorporated NOAA (Long and Morgan, 1990) guidelines when establishing metals criteria, only guidelines for organic compounds from NOAA (1990) are used in this assessment.

Although exceedences of sediment organic and/or metals criteria may not necessarily cause adverse biological effects for a specific site due to various toxicity mitigating factors, it is meant to trigger additional investigations to define potential risks (ambient toxicity testing, benthic [bottom-dwelling] invertebrate studies, etc.).

7.2 RESULTS

7.2.1 Biological Characterization

The NYSDEC completed an electrofishing survey on August 8, 1988, at five locations in Keuka Lake Outlet ranging from approximately one-half mile downstream of the site to approximately 1 mile upstream of Seneca Lake. The most abundant species they captured included northern hogsucker (*Hypentelium nigricans*), white sucker (*Catostomus commersoni*), common shiner (*Notropis cornutus*), longnose dace (*Rhinichthys cataractae*) and smallmouth bass (*Micropterus dolomieui*). They determined this assemblage is fairly typical of western New York warmwater streams. Although the NYSDEC had stocked Keuka Lake Outlet with brown trout (*Salmo trutta*) in the spring from 1966-1988, few were captured during the survey. They concluded the high summer water temperatures were limiting trout survival and recommended that stocking of trout be discontinued.

The NYSDEC-Region 8 responded to the endangered species request and determined there are several significant plants within 1 mile of the site that may impacted by project activities. These plants include an endangered species, the shore-line sedge (*Carex hyalinolepis*); a threatened species, the northern wild comfrey (*Cynoglossum virginianum* var. *boreale*); and two rare species, the handsome sedge (*Carex formosa*) and the false hop sedge (*Carex lupuliformis*). Additionally, the cypress-knee sedge (*Carex decomposita*), prairie wedgegrass (*Sphenopholis obtusata* var. *obtusata*), mead sedge (*Carex meadii*), and blue-hearts (*Buchnera americana*) are listed as unprotected species. Unprotected species are offered no legal protection, but are identified by the NYSDEC due to their relatively low abundance (Woodruff, 1994).

7.2.2 Sediment Criteria

Table 7-1 presents a summary of the inorganics detected in Keuka Lake sediment near the site and the NYSDEC criteria for those inorganics. All the detected inorganics, except for chromium and manganese, exceeded the LEL at least at one sampling location. Copper, lead, and nickel concentrations exceeded the LEL at eight of nine locations. The concentration of lead (locations 5 and 19) also exceeded the SEL. The number of inorganics exceeding the LEL and SEL ranged from three to five at the sampling locations.

A site-specific sediment organic carbon content of 7.69 percent was used to adjust the NYSDEC criteria. Table 7-2 presents available NYSDEC criteria (non-polar organic compounds only) and NOAA guidelines for the organic constituents detected in Keuka Lake Outlet sediments. A site-specific sediment organic carbon content of 7.69 percent was used to adjust the NYSDEC criteria. Sediment organic carbon content in Keuka Lake Outlet adjacent to the tar well at the site was equal to 7.69 percent (TRC, 1990a), and sediments in this area contained the highest concentration of site-related constituents. Therefore, it is likely that if aquatic organisms were exposed to constituents detected in Keuka Lake Outlet, this area may provide a worst case scenario. In general, the majority of detected concentrations of the organic constituents exceeded NYSDEC criteria and NOAA guidelines (both ER-L and ER-M values). Locations 10 (surface only) and 14 (Figure 2) typically had the highest concentrations of the organic compounds, sometimes exceeding sediment criteria/guidelines by several orders of magnitude. Locations 4 and 5 generally had the lowest concentrations, with only two constituents detected at location 4.

7.3 DISCUSSION

7.3.1 Biological Characterization

Based upon correspondence with the NYSDEC-Region 8, it appears Keuka Lake Outlet provides habitat for a warmwater fish community typical of western New York streams and therefore establishes a variety of potential aquatic receptors. It is a Class C body of water, which means it is protected for fishing and fish propagation. The NYSDEC also determined that eight significant plants, four of which are offered legal protection, exist within 1 mile of the site. Because several of these plants are sedges which typically prefer saturated soils for at least a portion of the season, they may occur along the shoreline of Keuka Lake Outlet. A site survey by a qualified botanist would establish if these plants exist on the site.

7.3.2 Sediment Criteria/Guidelines

There are several uncertainties associated with the metals and organic compound sediment criteria, including: 1) the effects criteria for several metals was determined from oligotrophic waters where the toxic level would be expected to be lower than eutrophic waters because fewer ligands exist to complex metal ions; (2) the toxic effect of several metals is not fully understood as the effect could be synergistic, additive, or antagonistic; and (3) NOAA guidelines included effects levels observed in freshwater and marine environments, with no attempt to distinguish bioavailability of the contaminants between the systems. Furthermore uncertainty associated with EP-based sediment criteria for non-polar organics includes sediment composition variability, measurement variation, and K_{ow} and K_{oc} correlations and measurements. Because of these uncertainties, an exceedence of an effects level does not necessarily imply adverse biological effect; however, because of the number and magnitude (mainly Locations 10 and 14) of exceedences, further evaluation of potential risk by completing benthic invertebrate investigations and/or ambient toxicity tests may be required.

8.0 UNCERTAINTIES IN THE RISK ASSESSMENT

The risk estimates presented here are conservative estimates of the risks associated with exposure to constituents detected in media of Keuka Lake Outlet. Uncertainty is inherent in the risk assessment process, and these uncertainties are identified in this section. Each of the three basic building blocks for risk assessment (monitoring data, exposure scenarios, and toxicity values) contribute uncertainties. Environmental sampling itself introduces uncertainty, largely because of the potential for uneven distribution of constituents in the environment.

This risk assessment is based on the assumption that the available monitoring data adequately describe the occurrence of constituents in media at the former MGP. Environmental sampling itself introduces uncertainty. This source of uncertainty can be reduced through a well designed sampling plan, use of appropriate sampling techniques, and implementation of laboratory data validation and quality assurance/quality control (QA/QC). The data used in this report meet QA/QC requirements and are appropriate for risk assessment.

Exposure scenarios and constituent transport models also contribute uncertainty to the risk assessment. Exposure doses for surface water, sediment, and fish ingestion were calculated based on the assumption that the current conditions would remain stable throughout the exposure period. This simplifies reality because natural attenuation processes are expected to reduce constituent concentrations over time. Exposure scenarios were developed based on site-specific information, USEPA exposure guidance documents, and professional judgment. Although uncertainty is inherent in the exposure assessment, the exposure assumptions also were chosen to err on the side of conservatism.

The toxicity values and other toxicologic (health effects) information used in this report are associated with significant uncertainty. Many toxicity values are developed using results of studies in which laboratory animals are exposed to high doses. Although species differences in absorption, distribution, metabolism, excretion, and target organ sensitivity are well documented, available data are not sufficient to allow compensation for these differences. Most laboratory studies strictly control as many factors as possible, yet the human population is genetically diverse and affected by a variety of diets, occupations, pharmaceuticals, and other factors. When human epidemiologic data are available, a different set of uncertainties is present. For instance, exposure dose is seldom well characterized in epidemiologic studies.

Recent research on the mechanisms of carcinogenesis suggest that use of the linearized multistage model may overestimate the cancer risks associated with exposure to low doses of chemicals. At high doses many chemicals cause large-scale cell death which stimulates replacement by division. Dividing cells are more subject to mutations than quiescent (non-dividing) cells; thus, there is an increased potential for tumor formation. It is possible that administration of these same chemicals at lower doses would not increase cell division and thus would not increase mutations. This would suggest that the current methodology may over-estimate cancer risk.

Sufficient toxicological data were not available from the USEPA to develop toxicity values for all of the COCs in media at Keuka Lake Outlet. The lack of RfDs and CSFs for a number of constituents may result in an underestimate of risk associated with exposure to these constituents. For example, toxicological data are not available to develop toxicity values for the semi-volatiles carbazole and phenols. In addition, toxicological data are not available to develop toxicity values for the tentatively identified compounds (TICs).

There is significant uncertainty in the constituent-specific absorption factors. Constituent-specific dermal absorption factors were not available for the inorganics except lead and nickel. When constituent-specific absorption factors were not available, the higher end of a range of absorption efficiencies was used. Qualitative absorption efficiencies are available in the literature. According to the Agency of Toxic Substances and Disease Registry (ATSDR), dermal absorption is not expected to be a significant pathway for manganese; however, the dermal pathway contributes more to the ELCR and HI than ingestion. This may be an over estimate of risk.

There also is uncertainty associated with the toxicity of mixtures. For the most part, data about the toxicity of chemical mixtures are unavailable. Rather, toxicity studies generally are performed using a single chemical. Chemicals present in a mixture may interact to yield a new chemical or one may interfere with the absorption, distribution, metabolism, or excretion of another. Chemicals may also act by the same mechanism at the same target organ or may act completely independently. The risk assessment assumes that toxicity is additive; the ELCRs and HQs were summed across chemicals. This assumes that the mixture of constituents present at the site has neither synergistic nor antagonistic interactions.

The use of upperbound assumptions, no attenuation, and the conservatism built into the RfDs and CSFs are believed to result in an overestimate of human-health risk. Therefore, actual risk may be lower than the estimates presented here but is unlikely to be greater.

The qualitative evaluation of potential ecological risks presented here is believed to be a conservative assessment of the risks associated with potential current and future exposure to media at Keuka Lake Outlet. Sources of uncertainty in any ecological assessment include monitoring data, exposure assessments, and toxicity values. The ecological assessment presents additional uncertainty in that toxicological data relevant to population or ecosystem level impacts are very limited. In addition, methods of predicting nonchemical stresses (e.g., drought), biotic interactions, behavior patterns, biological variability (i.e., differences in physical conditions, nutrient availability, etc.), and resiliency and recovery capacities are often unavailable.

9.0 FINDINGS AND CONCLUSIONS

This risk assessment was prepared to evaluate whether surface water or sediment in the Keuka Lake Outlet adjacent to the former MGP in Penn Yan, New York, could pose a threat to human health or the environment under current conditions. A small recreational park and picnic area is on the opposite side of Keuka Lake Outlet from the site. This area is potentially used as a recreational area for local children and adults. The banks of Keuka Lake Outlet are unrestricted; therefore, children and adults may contact sediments and/or surface water containing site-related constituents. Keuka Lake Outlet is used for fishing, and individuals may be exposed to constituents bioconcentrating in fish. These exposures were evaluated in the risk assessment.

COCs were identified based on available data. Constituents considered to be related to MGP activities on the site were included in the risk assessment. Inorganic constituents were compared with local background concentrations. Those present at background concentrations and not thought to be related to MGP operations were not selected as COCs.

Several exposure scenarios were developed in this risk assessment based on the uses of the Keuka Lake Outlet. The exposure scenarios evaluated were: (1) adult exposure to surface water and sediments while swimming or wading; (2) child exposure to surface water and sediments while swimming or wading; and (3) adult and child exposure to constituents through ingestion of fish caught in the Keuka Lake Outlet.

All risks to potential receptors were within or below acceptable risk ranges; therefore, site-specific remediation goals for surface-water and sediment constituent concentrations were not calculated. The USEPA target risk ranges are an ELCR between 10^{-4} and 10^{-6} and an HI less than 1. The results of the risk assessment can be summarized as follows:

- The ELCR and HI for a hypothetical adult exposed to surface-water and sediment constituents in Keuka Lake Outlet while swimming were calculated to be 1 x 10^{-6}

and 0.1, respectively. For exposure while wading, the ELCR and HI for an adult were calculated to be 1 x 10^{-6} and 0.04, respectively. The ELCRs were at the lower end of the USEPA target risk range, and the HIs were well below the USEPA target value. As a result, exposure to MGP constituents in the Keuka Lake Outlet should not pose a threat to adults wading or swimming in the vicinity of the NYSEG former MGP site.

- The ELCR and HI for a child exposed to COCs in surface water and sediments in Keuka Lake Outlet while swimming were calculated to be 5 x 10^{-7} and 0.1, respectively. The ELCR and HI for a child wading in Keuka Lake Outlet were calculated to be 7 x 10^{-7} and 0.06, respectively. The ELCRs and the HIs were below the USEPA target risk ranges. As a result, exposure to MGP constituents in the Keuka Lake Outlet should not pose a threat to children wading or swimming in the vicinity of the NYSEG former MGP site.

- An individual was assumed to fish in the Keuka Lake Outlet and catch and eat fish exposed to MGP-related constituents. The ELCR and HI for an adult ingesting fish were calculated to be 1 x 10^{-6} and 0.3, respectively. The ELCR and HI for a child ingesting fish were calculated to be 9 x 10^{-7} and 0.6, respectively. The ELCRs and the HIs were at the low end or below the USEPA target risk ranges. As a result, exposure to MGP constituents in the Keuka Lake Outlet should not pose a threat to adults or children ingesting fish exposed to MGP-related constituents detected in the Keuka Lake Outlet in the vicinity of the NYSEG former MGP site.

A qualitative ecological assessment was prepared to evaluate whether the presence of MGP-related constituents detected in surface water and sediments posed a threat to aquatic life in the Keuka Lake Outlet. The assessment included gathering information on the composition of the aquatic community in the Keuka Lake Outlet, contacting various agencies to determine the potential presence of threatened or endangered species in the vicinity of the site, and comparing constituent concentrations detected in the sediment to available sediment criteria/guidelines. The results can be summarized as follows:

- Keuka Lake Outlet provides habitat for a warm water fish community typical of western New York streams and therefore establishes a variety of potential aquatic receptors. It is a Class C body of water, which means it is protected for fishing and fish propagation. The NYSDEC also determined that eight significant plants, four of which are offered legal protection, exist within 1 mile of the site. Because several of these plants are sedges which typically prefer saturated soils for at least a portion of the season, they may occur along the shoreline of Keuka Lake Outlet.

- All the detected inorganics, except for chromium and manganese, exceeded the LEL at least at one sampling location. Copper, lead, and nickel exceeded the LEL at eight of nine locations. Lead (locations 5 and 19) also exceeded the SEL. The number of metals exceeding the LEL and SEL ranged from three to five at each of the sampling locations.

- The majority of detected concentrations of the organic constituents exceeded NYSDEC criteria and NOAA guidelines (both ER-L and ER-M values). Locations 10 (surface only) and 14 typically had the highest concentrations of the organic compounds, sometimes exceeding sediment criteria/guidelines by several orders of magnitude. Locations 4 and 5 generally had the lowest concentrations, with only two constituents detected at location 4.

- There are several uncertainties associated with the inorganic and organic compound sediment criteria, including: (1) the effects criteria for several metals was determined from oligotrophic waters where the toxic level would be expected to be lower than eutrophic waters because fewer ligands exist to complex metal ions; (2) the toxic effect of several metals is not fully understood as the effect could be synergistic, additive or antagonistic and; (3) NOAA guidelines included effects levels observed in freshwater and marine environments, with no attempt to distinguish bioavailibility of the contaminants between the systems. Furthermore, uncertainty associated with EP-based sediment criteria for non-polar organics includes sediment composition variability, measurement variation, and K_{ow} and K_{oc} correlations and measurements. Because of these uncertainties, an exceedence of an effects level does not necessarily imply adverse biological effect; however, because of the number and magnitude (mainly locations 10 and 14) of exceedences, further evaluation of potential risk by completing benthic (bottom-dwelling) invertebrate investigations and/or ambient toxicity tests will likely be required.

10.0 REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR), 1992a. Toxicological Profile for Mercury. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1992b. Toxicological Profile for Zinc. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1991a. Toxicological Profile for Cadmium. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1991b. Toxicological Profile for Chromium. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1991c. Toxicological Profile for Cyanide. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1991d. Toxicological Profile for Lead. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1991e. Toxicological Profile for Nickel. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1990a. Toxicological Profile for Aluminum. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1990b. Draft Toxicological Profile for Barium and Compounds. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1990c. Toxicological Profile for Benzo(a)pyrene. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1990d. Draft Toxicological Profile for Manganese. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1990e. Toxicological Profile for Tetrachloroethylene. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1990f. Toxicological Profile for Vanadium. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1989a. Toxicological Profile for Arsenic. Public Health Services, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1989b. Toxicological Profile for Copper. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1988. Toxicological Profile for Phenol. Public Health Services, U.S. Department of Health and Human Services, Atlanta, GA.

Brown, S.L., and J.E. Rossi, 1989. A Simple Method for Estimating Dermal Absorption of Chemicals in Water. Chemosphere, 19(12):1989-2001.

Genetic Activity Program (GAP), 1991. U.S. Environmental Protection Agency, Health Effects Research Laboratory, Genetic Toxicology Division, Research Triangle Park, NC.Goyer, R.A., 1991. Toxic Effects of Metals in Casarett and Doull's Toxicology. 4th Edition. Pergamon Press, New York, NY.

Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Inc., Chelsea, MI. 725 pp.

Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume II, Solvents. Lewis Publishers, Inc., Chelsea, MI. 546 pp.

Howard, P.H., 1989. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume I, Large Production and Priority Contaminants. Lewis Publishers, Inc., Chelsea, MI. 574 pp.

Integrated Risk Information Service (IRIS), 1994. U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Cincinnati, OH.

Kostecki, P.T., and E.J. Calabrese, 1989. Petroleum Contaminated Soils. Volume I. Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, MI. 357 pp.

Long, E.R., and L.G. Morgan, 1990. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National States and Trends Program. National Oceanic Atmospheric Administration (NOAA) Technical Memorandum No. 5, OMA52, NOAA National Ocean Service, Seattle, Washington.

Lugg, G.A., 1968. Diffusion Coefficients of Some Organic and Other Vapors in Air. Analytical Chemistry, 4(7):1072-1077.

Lyman, W.J., W.F. Rheel, and D.H. Rosenblatt, 1990. Handbook of Chemical Property Estimation Methods. McGraw-Hill, Inc., New York, NY.

MacKay, D, W.Y. Shiu, J. Billington, and G.L. Huang, 1983. Physical Chemical Properties of Polychlorinated Biphenyls. In: Physical Behavior of PCBs in the Great Lakes. Ann Arbor Science, Ann Arbor, MI.

McKenna, E.J., and R.D. Heath, 1976. Biodegradation of Polynuclear Aromatic Hydrocarbon Pollutants by Soil and Water Microorganisms. Water Resources Center, University of Illinois, Research Report No. 113. UILV-WEC-76-0113.

Montgomery, J.H., and L.M. Welkom, 1990. Ground Water Chemicals Desk Reference. Lewis Publishers, Inc., Chelsea, MI. 640 pp.

National Academy of Sciences (NAS), 1980. Lead in the Human Environment. Committee of Lead in the Human Environment. Washington, DC.

National Oceanic and Atmospheric Administration (NOAA), 1974. Climates of the United States. Volume II, Western States. Water Information Center Inc., Port Washington, NY.

National Research Council (NRC), 1988. Drinking Water and Health. National Academy of Sciences, Washington, DC.

New York State Department of Environmental Conservation (NYSDEC), Division of Fish and Wildlife and Division of Marine Resources, 1993. Technical Guidance for Screening Contaminated Sediments.

Ney, R.E. Jr., 1990. Where Did That Chemical Go? Van Nostrand Reinhold Co., New York, NY.

Pucknat, A.W., ed, 1981. Health Impacts of Polynuclear Aromatic Hydrocarbons. Noyes Data Corporation, Park Ridge, NJ.

Sax, N.I., and R.J. Lewis, Sr., 1989. Dangerous Properties of Industrial Materials. Seventh Editor. Van Nostrand Reinhold, New York, NY.

Shen, T.J., 1982. Air Quality Assurance for Land Disposal of Industrial Waste. Environ. Mgmt., 6:297-305.

TRC, 1990a. Final Task 4 Report, New York State Electric and Gas Corporation Risk Assessment for the Former Coal Gasification Site, Penn Yan, New York. Technical Report. October.

TRC, 1990b. Final Task 2 Report, New York State Electric and Gas Corporation Investigation of the Former Coal Gasification Site, Penn Yan, New York. Technical Report. February 21.

U.S. Environmental Protection Agency (USEPA), 1993a. Update to Health Effects Assessment Summary Tables, FY-1992. Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency (USEPA), 1993b. Risk Assessment Issue Paper For: Provisional RfC for Naphthalene (CASRN 91-20-3). Letter from Joan S. Dollarhide, Director, Superfund Health Risk Technical Support Center to James Joyner, Geraghty & Miller, dated November 9.

U.S. Environmental Protection Agency (USEPA), 1993c. Risk Assessment Issue Paper. Memorandum from Daniel Cozza, USEPA Region V, to Al Toma and Richard Bartelt; Regarding Fort Howard Sludge Lagoons Site. September 23.

U.S. Environmental Protection Agency (USEPA), 1992a. Dermal Exposure Assessment: Principles and Applications. Office of Research and Development, Washington, DC. EPA 600/8-91/011B.

U.S. Environmental Protection Agency (USEPA), 1992b. Interim Region IV Guidance on Toxicity Reference Equivalency Factors (TEFs). February 11.

U.S. Environmental Protection Agency (USEPA), 1992c. Carcinogenicity Characterization of Perchloroethylene (PERC) (CASRN 127-18-4) and Trichberylloroethylene (TCE) (CASRN 79-01-6). Memorandum from Joan S. Dollarhide, Associate Director, Superfund Health Risk Technical Assessment Branch to Dan Stralka, RPM. June 9.

U.S. Environmental Protection Agency (USEPA), 1991a. Human Health Evaluation Manual, Supplemental Guidance, "Standard Default Exposure Factors," Interim Final. Office of Emergency and Remedial Response, Washington, DC. March 25.

U.S. Environmental Protection Agency (USEPA), 1991b. Users Guide for Lead: A PC Software Application of the Uptake/Biokinetic Model: Version 0.50. Environmental Criteria and Assessment Office, Cincinnati, OH.

U.S. Environmental Protection Agency (USEPA), 1991c. Toxic Substance Spreadsheet. Water Quality Standards Unit, Region IV. February 25.

U.S. Environmental Protection Agency (USEPA), 1989a. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency (USEPA), 1989b. Risk Assessment Guidance for Superfund. Volume II. Environmental Evaluation Manual, Interim Final. Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency (USEPA), 1989c. Exposure Factors Handbook. Exposure Assessment Group, Office of Health and Environmental Assessment, Washington, DC.

U.S. Environmental Protection Agency (USEPA), 1989d. Transport and Fate of Contaminants in the Subsurface. Seminar Publication, Center for Environmental Research Information, Cincinnati, OH.

U.S. Environmental Protection Agency (USEPA), 1985. Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites. Office of Waste Programs Enforcement, Washington, DC.

Veith, G.D., and P. Kosian, 1982. Estimating Bioconcentration Potential from Octanol-Water Partition Coefficients. In: Physical Behavior of PCBs in the Great Lakes. Ann Arbor Science, Ann Arbor, MI.

Verschueren, K., 1983. Handbook of Environmental Data on Organic Chemicals, Second Ed. Van Nostrand Reinhold Co., New York, NY.

Woodruff, 1994. Personal communication between Mr. David Woodruff, Senior Wildlife Biologist, NYSDEC, Region 8, and Mr. Jim Ihrig, Geraghty & Miller. February.

Table 3-1. Occurrence Summary for Constituents Detected in Keuka Lake Outlet Surface-Water Samples, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Frequency Detects / Total	Range of SQLs Min - Max	Range of Detects Min - Max	Mean	UCL	Background Range [a] Min - Max
VOCs						
Acetone	2 / 8	0.01 - 0.01	0.027 - 0.034	0.01	0.019	<0.01 - 0.615
Semi-VOCs						
Bis(2-ethylhexyl)phthalate	2 / 8	0.01 - 0.01	0.024 - 0.733	0.10	0.27	<0.01 - 0.167
Inorganics						
Cadmium	2 / 8	0.001 - 0.001	0.001 - 0.17	0.02	0.062	<0.001 - 0.001
Iron	4 / 8	0.05 - 0.05	0.09 - 0.28	0.09	0.15	<0.05 - 0.33
Mercury	1 / 8	0.0002 - 0.0002	0.0003	0.00013	0.00017	<0.0002
Organic nitrogen	2 / 8	0.04 - 0.04	0.4 - 0.46	0.12	0.25	<0.04 - 0.42
Sulfate	8 / 8	NA	20.6 - 30.3	25	27	21.4 - 28.5
Zinc	1 / 8	0.01 - 0.01	0.01	0.0056	0.0068	<0.01

Concentrations are reported in milligrams per liter (mg/L).

Data presented represents analytical results for surface water samples collected by TRC on January 1987, April 1987, July 1987, and May 1989 (TRC 1990b).

[a] Background surface-water samples include four rounds of data collected at SW-1 (sampled January 1987, April 1987, July 1987, and May 1989).
Mean Arithmetic average of the total number of samples, using proxy concentrations for non-detects.
NA Not available.
Semi-VOCs Semi-volatile organic compounds.
UCL 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.
VOCs Volatile organic compounds.

Table 3-2. Occurrence Summary for Constituents Detected in Keuka Lake Outlet Sediment Samples, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Frequency	Range of SQLs	Range of Detects	Mean	UCL	Background Range [a]
	Detects / Total	Min - Max	Min - Max			Min - Max
VOCs						
Acetone	7 / 9	0.01 - 0.01	0.016 - 0.14	0.039	0.07	<0.01
Benzene	4 / 9	0.005 - 0.005	0.002 - 2.0	0.26	0.67	<0.005
Ethylbenzene	4 / 9	0.005 - 0.005	0.008 - 3.9	0.81	1.8	<0.005
Methylene chloride	4 / 9	0.005 - 0.005	0.010 - 0.01	0.007	0.0097	<0.005
Toluene	4 / 9	0.005 - 0.005	0.004 - 0.79	0.12	0.28	<0.005
Trichloroethene	1 / 9	0.004 - 0.004	0.002	0.002	0.002	<0.004
Xylenes	4 / 9	0.005 - 0.005	0.022 - 10	2.0	4.4	<0.005
Semi-VOCs						
Carbazole	7 / 9	0.01 - 0.01	0.140 - 70	14	29	<0.01
Total Phenols	7 / 9	1.60 - 1.8	1.8 - 86	14	31	<1.8 - 1.5
PAHs						
Acenaphthene	8 / 9	0.01 - 0.01	0.1 - 270	54	110	<0.01
Acenaphthylene	6 / 9	0.01 - 0.01	0.12 - 25	4.3	9.4	<0.01
Anthracene	8 / 9	0.01 - 0.01	0.4 - 290	50	110	<0.01
Benzo(a)anthracene	8 / 9	0.01 - 0.01	1.4 - 160	35	69	<0.01
Benzo(b)fluoranthene	8 / 9	0.01 - 0.01	1.3 - 83	21	39	<0.01
Benzo(k)fluoranthene	8 / 9	0.01 - 0.01	1.1 - 97	20	40	<0.01
Benzo(g,h,i)perylene	4 / 9	0.01 - 0.01	0.47 - 32	4.4	11	<0.01
Benzo(a)pyrene	8 / 9	0.01 - 0.01	1.2 - 110	25	48	<0.01
Chrysene	8 / 9	0.01 - 0.01	1.5 - 140	30	59	<0.01
Dibenzo(a,h)anthracene	4 / 9	0.01 - 0.01	0.7 - 5.6	1.2	2.4	<0.01
Dibenzofuran	7 / 9	0.01 - 0.01	2.8 - 180	34	73	<0.01

Footnotes appear on Page 3.

Table 3-2. Occurrence Summary for Constituents Detected in Keuka Lake Outlet Sediment Samples, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Frequency Detects / Total	Range of SQLs Min - Max	Range of Detects Min - Max	Mean	UCL	Background Range [a] Min - Max
PAHs (cont.)						
Fluoranthene	8 / 9	0.01 - 0.01	2.6 - 380	82	160	<0.01
Fluorene	7 / 9	0.01 - 0.01	4.1 - 210	41	87	<0.01
Indeno(1,2,3-c,d)pyrene	8 / 9	0.01 - 0.01	0.9 - 57	13	26	<0.01
2-Methylnaphthalene	6 / 9	0.01 - 0.01	5.9 - 370	67	150	<0.01
Naphthalene	7 / 9	0.01 - 0.01	0.1 - 820	150	320	<0.01
Phenanthrene	8 / 9	0.01 - 0.01	1.9 - 620	120	260	<0.01
Pyrene	8 / 9	0.01 - 0.01	2.9 - 300	65	130	<0.01
Inorganics						
Aluminum	9 / 9	NA	4,180 - 16,100	10,000	12,000	NA
Arsenic	9 / 9	NA	2.1 - 7.8	3.4	4.6	3.95**
Barium	9 / 9	NA	52.1 - 122	78	90	NA
Chromium	9 / 9	NA	10.7 - 23.5	18	20	18.6**
Copper	9 / 9	NA	13.3 - 55.7	28	35	NA
Iron	9 / 9	NA	10,200 - 24,200	18,000	20,000	15,400 - 16,300
Lead	9 / 9	NA	21.8 - 340	99	160	450**
Manganese	9 / 9	NA	136 - 344	230	280	NA
Mercury	6 / 9	0.07 - 0.08	0.13 - 0.38	0.180	0.26	<0.07
Nickel	9 / 9	NA	13 - 27.4	23	26	NA
Sulfide	9 / 9	NA	32.4 - 846	200	360	NA
Vanadium	9 / 9	NA	11 - 24.9	17	19	NA
Zinc	9 / 9	NA	63.5 - 172	110	130	130 - 196

Footnotes appear on page 3.

Table 3-2. Occurrence Summary for Constituents Detected in Keuka Lake Outlet Sediment Samples, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Concentrations are reported in milligrams per kilogram (mg/kg).

Data presented represents analytical results for sediment samples collected by Geraghty & Miller, November 1993. Background data presented represents analytical results for sediment samples collected by TRC, January 1987 and May 1989 (TRC 1990b).

[a]	Background sediment samples include SD-1 (sampled January 1987) and SD-10 (sampled May 1989).
**	Constituent was analyzed and detected in only one background sample.
Mean	Arithmetic mean of all the samples using proxy concentrations for non-detects.
NA	Not available.
PAHs	Polycyclic aromatic hydrocarbons.
Semi-VOCs	Semi-volatile organic compounds.
SQLs	Sample quantitation limits for the non-detects. If there were no non-detects, the SQLs were not available (NA).
UCL	95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.
VOCs	Volatile organic compounds.

Table 3-3. Constituents of Concern in Keuka Lake Outlet Surface Water and Sediment, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Surface Water	Sediment
<u>VOCs</u>		
Benzene		•
Ethylbenzene		•
Methylene chloride		•
Toluene		•
Trichloroethene		•
Xylenes		•
<u>Semi-VOCs</u>		
Carbazole		•
Phenol		•
<u>PAHs</u>		
Acenaphthene		•
Acenaphthylene		•
Anthracene		•
Benzo(a)anthracene		•
Benzo(b)fluoranthene		•
Benzo(k)fluoranthene		•
Benzo(g,h,i)perylene		•
Benzo(a)pyrene		•
Chrysene		•
Dibenzo(a,h)anthracene		•
Dibenzofuran		•
Fluoranthene		•
Fluorene		•
Indeno(1,2,3-c,d)pyrene		•
2-Methylnaphthalene		•
Naphthalene		•
Phenanthrene		•
Pyrene		•
<u>Inorganics</u>		
Aluminum		•
Arsenic		•

Footnotes appear on page 2.

Table 3-3. Constituents of Concern in Keuka Lake Outlet Surface Water and Sediment, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Surface Water	Sediment
Inorganics (cont.)		
Barium		*
Cadmium	*	
Chromium		*
Copper		*
Cyanide		*
Iron	*	*
Lead		*
Manganese		*
Mercury	*	*
Nickel		*
Sulfide/Sulfate	*	*
Vanadium		*
Zinc	*	*

* Indicates constituent of concern.

PAHs Polycyclic aromatic hydrocarbons.
Semi-VOCs Semi-volatile organic compounds.
VOCs Volatile organic compounds.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
<u>VOCs</u>				
Benzene	**Critical Effects:** Drowsiness, dizziness, headache, vertigo; moderately toxic by ingestion.	**Critical Effects:** Pancytopenia, hearing impairment, polyneuritis. **Data Summary:** Not available.	Class A; human carcinogen. The cancer slope factor was derived from human data in which leukemia rates increased.	**Developmental:** No evidence suggesting any adverse effects even when the mother exhibits toxicity. **Reproductive:** Ovarian hypofunction. **Mutagenicity:** Chromosomal aberrations in human lymphocytes.
Ethylbenzene	**Critical Effects:** Throat irritation, chest constriction, eye irritation, dizziness, vertigo.	**Critical Effects:** Increases in kidney to body weight ratios were seen in rats. **Data Summary:** The oral RfD is based on a NOEL of 97 mg/kg/day in rats. The inhalation RfD is based on a NOEL of 100 ppm in rats.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** Increases in the incidence of fetal anomalies were seen in rats, mice, and rabbits. **Reproductive:** No data available. **Mutagenicity:** Negative results were seen in various *Salmonella typhirium* assays.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Methylene chloride	**Critical Effects:** Fatigue, nausea, eye and skin irritation, cardiac arrhythmias; slightly toxic.	**Critical Effects:** Fatty liver and hepatocellular changes. **Data Summary:** The oral RfD was based on a NOAEL of 5.85 mg/kg/day in rats. The RfC is based on a NOAEL of 694.8 mg/m^3 in rats.	Class B2; probable human carcinogen. This is based on a drinking-water study in rats.	**Developmental:** Skeletal defects were detected in rats. **Reproductive:** No data available. **Mutagenicity:** Positive results were seen in various bacteria and mammalian tests.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Toluene	**Critical Effects:** Narcosis, CNS dysfunction, eye and skin irritation. **Comments:** Toluene is abused for its narcotic effects. This usually occurs with sniffing toluene-based glue.	**Critical Effects:** Decreased blood leukocytes, renal tubular acidosis, ataxia, tremors, impaired speech, hearing, and vision. **Data Summary:** The oral RfD was derived from a 13-week rat gavage study. A NOAEL of 223 mg/kg/day was developed. Changes in liver and kidney weights were seen at a LOAEL of 446 mg/kg/day. The inhalation RfD is based on human data in which a NOAEL of 88 ppm resulted in CNS toxicity.	Class D; no evidence of carcinogenicity.	**Developmental:** CNS anomalies, growth retardation. **Reproductive:** No data available. **Mutagenicity:** Results were negative or inconclusive for various tests.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Trichloroethene	**Critical Effects:** Irritation of eyes and skin, CNS depression, nausea, possible liver toxicity, cardiac arrhythmias at high exposure levels. **Comments:** Mildly toxic to humans by ingestion or inhalation. Concentrations as high as 200 ppm may be tolerated for several hours without adverse effects.	**Critical Effects:** May cause CNS disturbances. Liver and kidney toxicity reported in animal studies at high concentrations. **Data Summary:** No data available. **Comments:** Ingestion of alcohol can potentiate liver and kidney toxicity.	Class C-B2; probable human carcinogen.	**Developmental:** Inhalation and oral exposure in rats have resulted in fetotoxicity and developmental effects at 750 mg/kg (diet). No birth defects reported. **Reproductive:** Sperm abnormalities in mice (2,000 ppm via inhalation). Impaired sexual behavior in rats at oral doses of 1,000 mg/kg/day. **Mutagenicity:** Human data are inconclusive. Some evidence from *in vitro* and *in vivo* studies suggest that trichloroethene may be a weak, indirect mutagen.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Xylenes	**Critical Effects:** Dyspnea, nose, skin, and throat irritation, nausea, vomiting, CNS depression; moderately toxic.	**Critical Effects:** Increased hepatic weights in rats, renal toxicity, tremors, and labored breathing. **Data Summary:** The oral RfD was based on a chronic rat gavage study in which a NOAEL of 250 mg/kg/day was reported. At higher doses, hyperactivity occurred.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** Fetal hemorrhages and decreased fetal weights in rats. **Reproductive:** No data available. **Mutagenicity:** Negative results were seen in various tests.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Semi-VOCs				
Bis (2-ethylhexyl)phthalate	**Critical Effects:** Eye and skin irritant, polyneuropathies.	**Critical Effects:** Hepatotoxicity, hepatitis. **Data Summary:** The RfD is based on a LOAEL of 19 mg/kg/day in which the liver weight of guinea pigs increased.	Class B2; probable human carcinogen. In a 103-week study in mice, liver tumors developed.	**Developmental:** In mice, bis(2-ethylhexyl)phthalate caused a decrease in fetal body weight. **Reproductive:** It causes testicular effects in both rats and mice. **Mutatagenicity:** Chromosomal aberrations and sister chromatid exchange were found in hamster cells exposed to bis(2-ethylhexyl)phthalate.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Carbazole	**Critical Effects:** No data available.	**Critical Effects:** No data available.	Class B2; probable human carcinogen. It causes liver tumors in mice.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** No data available.
Phenol	**Critical Effects:** Diarrhea, mouth sores.	**Critical Effects:** Cardiac arrhythmias, dermal necrosis. **Data Summary:** The oral RfD is based on a NOAEL of 60 mg/kg/day in a rat study.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** Various skeletal anomalies were seen in mice pups. **Reproductive:** No data available. **Mutagenicity:** Chromosomal aberrations were seen in the spermatozoa of mice.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
PAHs				
Acenaphthene	**Critical Effects:** No data available.	**Critical Effects:** Dose-dependent increases in liver weights were observed in mice. **Data Summary:** The oral RfD is based on a subchronic mouse study in which a LOAEL of 350 mg/kg/day caused hepatotoxicity.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** No data available.
Anthracene	**Critical Effects:** No data available.	**Critical Effects:** Humans consuming anthracene-containing laxatives developed melanosis of the colon and rectum. **Data Summary:** The oral RfD is based on a subchronic study in mice in which a NOAEL of 1,000 mg/kg/day was established.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** Negative results were seen in various prokaryote assays.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Benzo(a)anthracene	**Critical Effects:** Enzyme alterations have been observed in animal studies.	**Critical Effects:** No data available.	Class B2; probable human carcinogen.	**Developmental:** No data available. **Reproductive:** No data available. **Genotoxicity:** Negative results were seen in *Drosophila melanogaster* studies.
Benzo(b)fluoranthene	**Critical Effects:** No data available.	**Critical Effects:** No data available.	Class B2; probable human carcinogen.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** Positive results were seen in *Salmonella* studies. It is also a weak inducer of sister chromatid exchange.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Benzo(k)fluoranthene	**Critical Effects:** No data available.	**Critical Effects:** No data available.	Class B2; probable human carcinogen.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** It has been reported to bind to DNA in CD-1 mouse skin following dermal exposure.
Benzo(a)pyrene	**Critical Effects:** No data available. **Comments:** Used as a surrogate for carcinogenic PAHs.	**Critical Effects:** Aplastic anemia. **Data Summary:** No data available.	Class B2; probable human carcinogen. The oral cancer slope is based on mice developing stomach tumors. Respiratory tract tumors resulted in hamsters upon inhalation.	**Developmental:** No data available. **Reproductive:** Decreased fertility in both male and female mice. **Mutagenicity:** Tested positive in both animal and bacterial assays.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Chrysene	**Critical Effects:** No data available.	**Critical Effects:** No data available. **Data Summary:** No data available.	Class B2; probable human carcinogen.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** Positive results were seen in both reverse and forward bacterial mutation studies.
Dibenzo(a,h)anthracene	**Critical Effects:** No data available.	**Critical Effects:** In mice, subaceous glands were suppressed after dermal application. **Data Summary:** No data available.	Class B2; probable human carcinogen.	**Developmental:** Increases in fetal resorptions were seen in rats. **Reproductive:** No data available. **Mutagenicity:** Positive results were seen in various gene mutation studies.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Fluoranthene	**Critical Effects:** No data available; mildly toxic.	**Critical Effects:** No data available. **Data Summary:** The oral RfD is based on a study in mice in which a NOAEL of 125 mg/kg/day was determined. Kidney and liver toxicity resulted at a LOAEL of 250 mg/kg/day. **Comments:** There is limited bioaccumulation due to rapid metabolism and excretion.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** Negative results were detected in bacteria tests.
Fluorene	**Critical Effects:** No data available.	**Critical Effects:** Decreased erythrocytes. **Data Summary:** The oral RfD is based on a NOAEL of 1.25 mg/kg/day in mice.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** Negative results in various prokaryote assays.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
2-Methylnaphthalene	**Critical Effects:** No data available. See Naphthalene.	**Critical Effects:** No data available. See Naphthalene.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** No data available. See Naphthalene.
Naphthalene	**Critical Effects:** Eye and skin irritation, nausea, headache, vomiting; mildly toxic.	**Critical Effects:** Hemolytic anemia. **Data Summary:** The RfD is based on a rat study in which the NOAEL was 50 mg/kg/day.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** Crosses the placenta barrier causing hemolytic anemia in the fetus. **Reproductive:** No data available. **Mutagenicity:** Negative results were seen *in vitro*.
Phenanthrene	**Critical Effects:** Increased liver enzyme activity; slightly toxic.	**Critical Effects:** No data available. **Data Summary:** No data available.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** Positive results in bacteria tests.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Pyrene	**Critical Effects:** No data are available; slightly toxic. **Comments:** Pyrene is used as a surrogate for non-carcinogenic PAHs.	**Critical Effects:** Fatty and enlarged liver. **Data Summary:** The RfD is based on a mouse study in which a NOAEL of 75 mg/kg/day was developed.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** Negative results were seen in bacteria tests.
Inorganics				
Aluminum	**Critical Effects:** Respiratory tract irritation.	**Critical Effects:** Lung fibrosa, osteomalacia. **Data Summary:** No data available.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** Progressive encephalopathy. **Reproductive:** No effects seen. **Mutagenicity:** Positive results in sister chromatid exchange.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Arsenic	**Critical Effects:** Gastrointestinal disturbances (nausea, diarrhea, abdominal pain), cardiac arrhythmias, vomiting, and vertigo; moderately toxic. **Comments:** When arsenic is heated or comes in contact with acids, it emits highly toxic fumes. Toxicity varies depending on the form.	**Critical Effects:** Polyneuropathies (both motor and sensory in the extremities), anorexia, hyperpigmentation, hepatitis, anemia. **Data Summary:** The oral RfD is based on a human epidemiological study in which a NOAEL of 9 μg/kg/day was determined. **Comments:** Arsenic accumulates in hair and nails. This can be a useful indicator of chronic toxicity.	Class A; human carcinogen via inhalation. This is based on human epidemiological data from smelter workers. It is also a known carcinogen by the oral route.	**Developmental:** Increases in spontaneous abortions were seen in women living near smelter plants. **Reproductive:** No evidence suggesting toxicity. **Mutagenicity:** Chromosomal aberrations in humans and laboratory animals.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Barium	**Critical Effects:** Gastroenteritis, muscular paralysis, ventricular fibrillation, and irritation to mucous membranes and skin; moderately toxic. **Comments:** Different types of toxicity occur, depending on whether it is a soluble salt or an alkaline. Alkaline compounds cause irritation, and soluble salts cause the more severe toxicity. Barium sulfate is sometimes used orally in making x-rays of the stomach and intestine. This compound is not harmful to humans.	**Critical Effects:** Chronic inhalation results in baritosis. **Data Summary:** The oral RfD was based on epidemiological in which a NOAEL of 0.21 mg/kg/day was determined. The RfD was based on a NOAEL of 0.14 mg/kg/day in rats.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** In one study conducted on rats, barium exposure caused an increase in mortality. **Reproductive:** Upon inhalation of barium, a decrease in spermatogenesis occurred in rats. **Mutagenicity:** Positive results were seen in some bacteria tests.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Cadmium	**Critical Effects:** Gastrointestinal distress, lung irritation; moderately toxic. **Comments:** Toxicity depends on the chemical and physical form. Soluble forms (cadmium chloride, cadmium oxide) tend to be more toxic than insoluble forms (cadmium sulfide).	**Critical Effects:** Lung, kidney, liver, bone, testes, immune system, cardiovascular system. **Data Summary:** Cadmium has two oral RfDs. Studies involving humans resulted in proteinuria. The water RfD is a result of a NOAEL of 0.005 mg/kg/day. The food NOAEL of 0.01 mg/kg/day is a result of toxicokinetic modeling using 2.5 percent absorption from food. **Comments:** The lung and kidney most likely are affected from inhalation exposure. Long-term exposure to concentrations below 0.02 mg/m^3 is not likely to affect the lung or kidney.	Class B1; probable carcinogen, inhalation exposure only. Limited evidence of lung cancer observed in smelter workers. Lung tumors and mammary tumors have been reported in laboratory studies.	**Developmental:** Not shown to cause developmental effects in humans. Some evidence from animal studies but most oral and inhalation studies have not shown developmental or fetotoxic effects. **Reproductive:** None reported in humans. Some decreased reproductive success reported in a few animal studies. **Mutatagenicity:** Conflicting results from human data. Studies in bacteria and yeast are inconclusive. Positive responses in mutation assays with hamster cells and mouse lymphoma cells.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Chromium	**Critical Effects:** Dermatitis, respiratory irritation, renal tubular necrosis. **Comments:** Toxicity depends on valence form, with Chromium VI exerting more toxicity.	**Critical Effects:** Ulceration of the nasal cavity, eczema. **Data Summary:** The RfD was based on a 1-year study in rats. This was based on a NOAEL of 2.4 mg/kg/day.	Class A; human carcinogen for inhalation exposure. The cancer slope factor is a result of human epidemiological data showing an increase in lung cancer.	**Developmental:** None observed. **Reproductive:** None observed. **Mutagenicity:** Positive results in human red blood cells, Chinese hamster cells, and bacteria tests for Chromium VI.
Copper	**Critical Effects:** Metal fume fever, gastritis, discoloration of skin and hair.	**Critical Effects:** Anemia. **Data Summary:** The current drinking-water standard of 1.3 mg/L is used as a surrogate for the oral RfD as stated in IRIS.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** Increases in fetal mortality were seen in both mice and minks. **Reproductive:** In a rat study, increases in rat weights were seen. Sexual impotence was seen in factory workers. **Mutagenicity:** No data available.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Cyanide	**Critical Effects:** Parasthesis, abdominal pain, tachycardia, cyanosis; highly toxic. **Comments:** Toxicity depends on the form of cyanide, whether it be with hydrogen, potassium, or sodium.	**Critical Effects:** Optic atrophy, pernicious anemia. **Data Summary:** The RfD was based on a NOAEL of 10.8 mg/kg/day in rats.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** Decreases in fetal growth and body weight were detected in rats. **Reproductive:** No data available. **Mutagenicity:** Negative results were seen *in vitro*.
Iron	**Critical Effects:** Vomiting, ulceration of gastrointestinal tract. **Comments:** Iron is an essential element and is involved in hemoglobin formation.	**Critical Effects:** Liver damage, coagulation defects, renal failure. **Data Summary:** No data available.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** No data available. **Reproductive:** Decrease in spermatogenesis. **Mutagenicity:** No data available.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Lead	**Critical Effects:** Reversible kidney damage. **Comments:** Toxicity is dependent on its accumulation in the blood.	**Critical Effects:** Brain encephalopathy, peripheral neuropathies, kidney damage, learning disabilities, anemia. **Data Summary:** There is no RfD for lead. A blood lead model is used to determine toxicity. **Comments:** Children have a greater risk of toxicity due to greater absorption and less developed blood brain barrier.	Class B2; probable carcinogen. No slope factor exists.	**Developmental:** A relationship in the decreased gestation period and fetal weights to maternal blood lead levels was seen. **Reproductive:** Increases in spontaneous abortions were detected in women living near smeltering plants. In men, decreases in sperm count were detected. **Mutagenicity:** Positive results in sister chromatid exchange and chromosomal aberrations.
Manganese	**Critical Effects:** Cough, bronchitis.	**Critical Effects:** Lung edema, emphysema, manganism, anorexia, muscle pain, impotence, tremors. **Data Summary:** The inhalation RfD is based on occupational exposure and a LOAEL of 0.097 mg/kg/day.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** Animal studies suggest that manganese may cause neurological effects in the fetus. **Reproductive:** Impotence and loss of libido have been seen in men occupationally exposed. **Mutagenicity:** Negative

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
				results have been seen in various *in vitro* tests.
Mercury	**Critical Effects:** Bronchitis, chest pain, dyspnea, gingivitis, gastrointestinal disturbances.	**Critical Effects:** CNS toxicity, kidney damage. **Data Summary:** The oral RfD is based on several rat studies. The RfC is based on human occupational studies in which a NOAEL of 0.009 mg/m^3 was developed. **Comments:** CNS toxicity results from exposure to organic mercury and kidney toxicity from inorganic mercury.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** Inhalation of inorganic mercury results in spontaneous abortions. Ingestion of organic mercury causes infant brain damage. **Reproductive:** Rats orally receiving organic mercury had lower litter sizes. **Mutagenicity:** Increases in chromosomal anomalies in lymphocytes of workers.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Nickel	**Critical Effects:** Nausea, vomiting, diarrhea, allergic contact dermatitis, asthma, conjunctivitis.	**Critical Effects:** Dermatitis. **Data Summary:** The oral RfD is based on a chronic rat feeding study in which a NOAEL of 5 mg/kg/day was determined.	Class A; human carcinogen by inhalation. It results in respiratory tract carcinomas.	**Developmental:** Mice exposed to nickel in their drinking water had an increase in spontaneous abortions. **Reproductive:** Testicular degeneration was noted in mice upon inhalation of nickel. **Mutagenicity:** Positive results were seen in human lymphocytes for chromosomal aberrations and sister chromatid exchange.
Sulfate	**Critical Effects:** No acute adverse responses have been reported for concentrations of 750 to 1,000 mg/L.	**Critical Effects:** No chronic adverse responses have been reported for concentrations of 750 to 1,000 mg/L. **Data Summary:** No data available.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** No data available.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Vanadium	**Critical Effects:** Eye and respiratory tract irritation; variable toxicity.	**Critical Effects:** Rhinitis and bronchitis. **Data Summary:** The RfD is based on a NOAEL of 0.7 mg/kg/day in rats.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** No data available. **Reproductive:** No data available. **Mutagenicity:** No data available.
Zinc	**Critical Effects:** Dyspnea, cough, vomiting.	**Critical Effects:** Copper deficiency in blood. **Data Summary:** The RfD was based on human epidemiological data involving therapeutic doses (2.14 mg/kg/day) causing anemia. **Comments:** Zinc is an essential element in the daily diet.	Class D; inadequate evidence of carcinogenicity.	**Developmental:** Reduced fetal weights and copper deficiency in rats. **Reproductive:** Decreased level of maternal copper and iron. **Mutagenicity:** Chromosomal aberrations in rats exposed to 650 mg/kg/day in their diet.

Footnotes appear on page 24.

Table 4-1. Toxicity Summaries for Constituents of Concern, NYSEG Former Coal Gasification Site, Penn Yan, New York.

References: ATSDR documents; GAP, 1991; IRIS, 1994; NTP, 1989; Sax and Lewis, 1989; USEPA, 1993.

Limited information was available on the PAHs. Benzo(a)pyrene and pyrene were used as surrogates for PAHs lacking individual toxicity information. This includes benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, dibenzofuran, and indeno(1,2,3-c,d)pyrene.

CNS	Central nervous system.
EEG	Electroencephalogram.
LOAEL	Lowest observed adverse effect level.
mg/kg	Milligrams per kilogram.
mg/kg/day	Milligrams per kilogram per day.
mg/L	Milligrams per liter.
mg/m^3	Milligrams per cubic meter.
NOAEL	No observed adverse effect level.
NOEL	No observed effect level.
PAHs	Polycyclic aromatic hydrocarbons.
ppm	Parts per million
RfC	Reference concentration.
RfD	Reference dose.

able 4-2. Reference Doses, Target Sites, and Confidence Levels for Constituents of Concern in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

onstituent	RfDo (mg/kg/day)		RfDi (mg/kg/day)		Target Sites		Confidence Level/
	Subchronic	Chronic	Subchronic	Chronic	Oral	Inhalation	Uncertainty Factor
OCs							
enzene	NA	NA	NA	1.4E-04	NA	NA	NA
thylbenzene	1.0E-01	1.0E-01	2.9E-01	2.9E-01	liver, kidney	developmental	low/1000
lethylene chloride	6.0E-02	6.0E-02	8.6E-01	8.6E-01	liver	liver	medium/100
oluene	2.0E+00	2.0E-01	5.7E-01	1.1E-01	liver, kidney	CNS	medium/1000
richloroethene	6.0E-03	6.0E-03	NA	NA	liver	NA	low/3000
ylenes	4.0E+00	2.0E+00	NA	NA	hyperactivity	NA	medium/100
emi-VOCs							
arbazole	NA	NA	NA	NA	NA	NA	NA
henol	6.0E-01	6.0E-01	NA	NA	fetotoxicity	NA	low/100
AHs							
cenaphthene	6.0E-01	6.0E-02	NA	NA	liver	NA	low/3000
cenanphthylene	NA	NA	NA	NA	NA	NA	NA
nthracene	3.0E+00	3.0E-01	NA	NA	none	NA	low/3000
enzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA
enzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA
enzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA
enzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA
enzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA
hrysene	NA	NA	NA	NA	NA	NA	NA
ibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA
ibenzofuran	NA	NA	NA	NA	NA	NA	NA
luoranthene	4.0E-01	4.0E-02	NA	NA	liver, kidney	NA	low/3000
luorene	4.0E-01	4.0E-02	NA	NA	anemia	NA	low/3000
ndeno(1,2,3-c,d)pyrene	NA	NA	NA	NA	NA	NA	NA
-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA
aphthalene	4.0E-02	4.0E-02	NA	3.7E-04	GI system, anemia	NA	low/1000
henanthrene	NA	NA	NA	NA	NA	NA	NA
yrene	3.0E-01	3.0E-02	NA	NA	kidney	NA	low/3000

ootnotes appear on Page 2.

able 4-2. Reference Doses, Target Sites, and Confidence Levels for Constituents of Concern in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

onstituent	RfDo (mg/kg/day)		RfDi (mg/kg/day)		Target Sites		Confidence Level/
	Subchronic	Chronic	Subchronic	Chronic	Oral	Inhalation	Uncertainty Factor
norganics							
luminum	NA	NA	NA	NA	NA	NA	NA
rsenic	3.0E-04	3.0E-04	NA	NA	skin	NA	medium/3
arium	7.0E-02	7.0E-02	1.4E-03	1.4E-04	increased blood pressure	fetotoxicity	medium/3
admium (food)	NA	1.0E-03	NA	NA	kidney	NA	high/10
admium (water)	NA	5.0E-04	NA	NA	kidney	NA	high/10
hromium VI	2.0E-02	5.0E-03	NA	NA	NA	NA	low/500
opper*	3.7E-02	3.7E-02	NA	NA	gastrointestinal tract	NA	NA
yanide	2.0E-02	2.0E-02	NA	NA	thyroid	NA	medium/100
ron	NA	NA	NA	NA	NA	NA	NA
ead	NA	NA	NA	NA	CNS	CNS	NA
anganese (food)	1.4E-01	1.4E-01	1.4E-05	1.4E-05	CNS	CNS, respiratory	medium/1
anganese (water)	5.0E-03	5.0E-03	1.4E-05	1.4E-05	CNS	CNS, respiratory	medium/1
ercury	3.0E-04	3.0E-04	8.6E-05	8.6E-05	kidney	CNS	NA
ickel	2.0E-02	2.0E-02	NA	NA	decreased body weight	NA	medium/300
ulfide/Sulfate	NA	NA	NA	NA	NA	NA	NA
anadium	7.0E-03	7.0E-03	NA	NA	none	NA	NA
inc	3.0E-01	3.0E-01	NA	NA	anemia	NA	medium/3

eferences: IRIS, 1994; USEPA, 1993a; USEPA, 1993b, USEPA 1993c.
* Based on current drinking-water standard.
CNS Central nervous system.
ng/kg/day Milligrams per kilogram per day.
NA Not available.
PAHs Polycyclic aromatic hydrocarbons.
RfDi Inhalation reference dose.
RfDo Oral reference dose.
Semi-VOCs Semi-volatile organic compounds.
VOCs Volatile organic compounds.

Doc. 1742\4-02LAN.XLS\J:1-Feb-94

Table 4-3. Cancer Slope Factors, Tumor Sites, and USEPA Cancer Classifications for Constituents of Concern in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	CSF (kg-day/mg)		Tumor site		USEPA Classification
	Oral	Inhalation	Oral	Inhalation	
VOCs					
Benzene	2.9E-02	2.9E-02	leukemia	leukemia	A
Methylene chloride	7.5E-03	1.6E-03	liver	lung, liver	B2
Trichloroethene	1.1E-02	6.0E-03	NA	NA	C-B2
PAHs					
Benzo(a)anthracene	NA	NA	NA	NA	B2
Benzo(b)fluoranthene	NA	NA	NA	NA	B2
Benzo(k)fluoranthene	NA	NA	NA	NA	B2
Benzo(a)pyrene	7.3E+00	6.1E+00	stomach	respiratory tract	B2
Chrysene	NA	NA	NA	NA	B2
Dibenzo(a,h)anthracene	NA	NA	NA	NA	B2
Indeno(1,2,3-c,d)pyrene	NA	NA	NA	NA	B2
Inorganics					
Arsenic	1.75E+00	5.0E+01	skin	respiratory tract	A
Cadmium	NAP	6.3E+00	NA	respiratory tract	B1
Chromium VI	NAP	4.1E+01	NA	lung	A
Lead	NA	NA	NA	NA	B2
Nickel	NAP	8.4E-01	NA	respiratory tract	A

References: ATSDR , 1991; IRIS, 1994; USEPA,1993a, USEPA, 1992c

CSF Cancer slope factor.
kg-day/mg Kilograms-day per milligram.
NA Not available.
NAP Not applicable, since it is carcinogenic by inhalation.
PAHs Polycyclic aromatic hydrocarbons.
VOCs Volatile organic compounds.

Table 4-4. Dermal and Oral Absorption Efficiencies for Constituents Detected in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituents	Absorption Efficiency			
	Dermal		Oral	
VOCs	0.25	a	1.00	b
Semi-VOCs				
Carbazole	NA		NA	
Phenol	0.80	c	0.90	c
PAHS	0.03	c	0.85	c
Inorganics				
Aluminum	0.01	a	0.27	c
Arsenic	0.01	a	0.95	c
Barium	0.01	a	0.07	c
Cadmium	0.01	a	0.06	c
Chromium	0.01	a	0.02	c
Copper	0.01	a	0.60	c
Cyanide	1.00	b	0.47	c
Iron	0.01	a	0.15	c
Lead	0.0006	c	0.05	c
Manganese	0.01	a	0.05	c
Mercury	0.026	c	0.001	c
Nickel	0.0023	c	0.043	c
Sulfide	0.01	a	1.00	d
Vanadium	0.01	a	0.01	c
Zinc	0.01	a	0.30	c

a Ryan et al. (1987).
b Assumed.
c ATSDR documents.
d National Research Council (1988).
NA Not available.

Table 4-5. Adjusted Toxicity Values Used to Assess Dermal Exposure for Constituents of Concern Detected in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	RfDo (mg/kg/day)		CSFo (kg-day/mg)	Oral Absorption Efficiency	RfDa (mg/kg/day)		CSFa (kg-day/mg)
	Subchronic	Chronic			Subchronic	Chronic	
VOCs							
Benzene	NA	NA	2.9E-02	1.00	NA	NA	2.9E-02
Ethylbenzene	1.0E-01	1.0E-01	NC	1.00	1.0E-01	1.0E-01	NC
Methylene chloride	6.0E-02	6.0E-02	7.5E-03	1.00	6.0E-02	6.0E-02	7.5E-03
Toluene	2.0E+00	2.0E-01	NC	1.00	2.0E+00	2.0E-01	NC
Trichloroethene	6.0E-03	6.0E-03	1.1E-02	1.00	6.0E-03	6.0E-03	1.1E-02
Xylenes	4.0E+00	2.0E+00	NC	1.00	4.0E+00	2.0E+00	NC
Semi-VOCs							
Carbazole	NA	NA	NA	NA	NA	NA	NA
Phenol	6.0E-01	6.0E-01	NC	0.90	5.4E-01	5.4E-01	NC
PAHs							
Acenaphthene	6.0E-01	6.0E-02	NC	0.85	5.1E-01	5.1E-02	NC
Acenaphthylene [a]	3.0E-01	3.0E-02	NC	0.85	2.6E-01	2.6E-02	NC
Anthracene	3.0E+00	3.0E-01	NC	0.85	2.6E+00	2.6E-01	NC
Benzo(a)anthracene [a]	3.0E-01	3.0E-02	7.3E+00	0.85	2.6E-01	2.6E-02	NAP
Benzo(b)fluoranthene [a]	3.0E-01	3.0E-02	7.3E+00	0.85	2.6E-01	2.6E-02	NAP
Benzo(k)fluoranthene [a]	3.0E-01	3.0E-02	7.3E+00	0.85	2.6E-01	2.6E-02	NAP
Benzo(g,h,i)perylene [a]	3.0E-01	3.0E-02	NC	0.85	2.6E-01	2.6E-02	NC
Benzo(a)pyrene [a]	3.0E-01	3.0E-02	7.3E+00	0.85	2.6E-01	2.6E-02	NAP
Chrysene [a]	3.0E-01	3.0E-02	7.3E+00	0.85	2.6E-01	2.6E-02	NAP
Dibenzo(a,h)anthracene [a]	3.0E-01	3.0E-02	7.3E+00	0.85	2.6E-01	2.6E-02	NAP
Dibenzofuran [a]	3.0E-01	3.0E-02	NC	0.85	2.6E-01	2.6E-02	NC

Footnotes appear on page 3.

Table 4-5. Adjusted Toxicity Values Used to Assess Dermal Exposure for Constituents of Concern Detected in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	RfDo (mg/kg/day)		CSFo	Oral Absorption	RfDa (mg/kg/day)		CSFa
	Subchronic	Chronic	(kg-day/mg)	Efficiency	Subchronic	Chronic	(kg-day/mg)
PAHs (cont.)							
Fluoranthene	4.0E-01	4.0E-02	NC	0.85	3.4E-01	3.4E-02	NC
Fluorene	4.0E-01	4.0E-02	NC	0.85	3.4E-01	3.4E-02	NC
Indeno(1,2,3-c,d)pyrene [a]	3.0E-01	3.0E-02	7.3E+00	0.85	2.6E-01	2.6E-02	NAP
2-Methylnaphthalene [b]	4.0E-02	4.0E-02	NC	0.85	3.4E-02	3.4E-02	NC
Naphthalene	4.0E-02	4.0E-02	NC	0.85	3.4E-02	3.4E-02	NC
Phenanthrene [a]	3.0E-01	3.0E-02	NC	0.85	2.6E-01	2.6E-02	NC
Pyrene	3.0E-01	3.0E-02	NC	0.85	2.6E-01	2.6E-02	NC
Inorganics							
Aluminum	NA	NA	NC	0.27	NA	NA	NC
Arsenic	3.0E-04	3.0E-04	1.75E+00	0.95	2.9E-04	2.9E-04	1.8E+00
Barium	7.0E-02	7.0E-02	NC	0.07	4.9E-03	4.9E-03	NC
Cadmium (food)	NA	1.0E-03	NAP	0.06	NA	6.0E-05	NA
Cadmium (water)	NA	5.0E-04	NAP	0.06	NA	3.0E-05	NA
Chromium VI	2.0E-02	5.0E-03	NAP	0.02	4.0E-04	1.0E-04	NAP
Copper	3.7E-02	3.7E-02	NC	0.60	2.2E-02	2.2E-02	NC
Cyanide	2.0E-02	2.0E-02	NC	0.47	9.4E-03	9.4E-03	NC
Iron	NA	NA	NC	0.15	NA	NA	NC
Lead	NA	NA	NA	0.05	NA	NA	NA
Manganese (food)	1.4E-01	1.4E-01	NC	0.05	7.0E-03	7.0E-03	NC
Manganese (water)	5.0E-03	5.0E-03	NC	0.05	2.5E-04	2.5E-04	NC
Mercury	3.0E-04	3.0E-04	NC	0.001	3.0E-07	3.0E-07	NC
Nickel	2.0E-02	2.0E-02	NAP	0.04	8.6E-04	8.6E-04	NAP

Footnotes appear on page 3.

Table 4-5. Adjusted Toxicity Values Used to Assess Dermal Exposure for Constituents of Concern Detected in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	RfDo (mg/kg/day)		CSFo (kg-day/mg)	Oral Absorption Efficiency	RfDa (mg/kg/day)		CSFa (kg-day/mg)
	Subchronic	Chronic			Subchronic	Chronic	
Inorganics (cont.)							
Sulfide	NA	NA	NC	NA	NA	NA	NC
Vanadium	7.0E-03	7.0E-03	NC	0.01	7.0E-05	7.0E-05	NC
Zinc	3.0E-01	3.0E-01	NC	0.30	9.0E-02	9.0E-02	NC

[a] Pyrene is used as a surrogate for non-carcinogens; benzo(a)pyrene used as a surrogate for carcinogens..
[b] Naphthalene used as a surrogate.
CSFa Adjusted cancer slope factor.
CSFo Oral cancer slope factor.
kg-day/mg Kilograms-day per milligram.
mg/kg/day Milligrams per kilogram per day.
NA Not available.
NAP Not applicable.
NC Not evaluated as a carcinogen.
PAHs Polycyclic aromatic hydrocarbons.
RfDa Adjusted reference dose.
RfDo Oral reference dose.
Semi-VOCs Semi-volatile organic compounds.
VOCs Volatile organic compounds.

Table 4-6. Permeability Constants Used to Assess Dermal Exposures for Constituents Detected in Keuka Lake Outlet, NYSEG Former Goal Gasification Site, Penn Yan, New York.

Constituent	log Kow	Kow	PC (cm/hr)	Reference
VOCs				
Benzene	--	--	1.0E-01	b
Ethylbenzene	--	--	1.0E+00	b
Methylene chloride	1.275	1.9E+01	4.5E-03	c
Toluene	3.3	2.0E+03	1.0E+00	b
Trichloroethene	2.795	6.2E+02	2.0E-01	b
Xylenes			8.0E-02	c
Semi-VOCs				
Carbazole	3.29	1.9E+03	7.1E-02	a
Phenol	--	--	5.5E-03	c
PAHs				
Acenaphthene	4.125	1.3E+04	9.1E-02	a
Acenaphthylene	4.1	1.3E+04	9.1E-02	a
Anthracene	4.44	2.8E+04	9.5E-02	a
Benzo(a)anthracene	5.76	5.8E+05	9.9E-02	a
Benzo(b)fluoranthene	6.57	3.7E+06	1.0E-01	a
Benzo(k)fluoranthene	6.85	7.1E+06	1.0E-01	a
Benzo(g,h,i)perylene	7.1	1.3E+07	1.0E-01	a
Benzo(a)pyrene	6.155	1.4E+06	1.0E-01	a
Chrysene	5.755	5.7E+05	9.9E-02	a
Dibenzo(a,h)anthracene	6.235	1.7E+06	1.0E-01	a
Dibenzofuran	4.215	1.6E+04	9.2E-02	a
Fluoranthene	5.22	1.7E+05	9.9E-02	a
Fluorene	4.25	1.8E+04	9.3E-02	a
Indeno(1,2,3-cd)pyrene	6.805	6.4E+06	1.0E-01	a
2-Methylnaphthalene	3.985	9.7E+03	8.9E-02	a
Naphthalene	3.95	8.9E+03	8.8E-02	a
Phenanthrene	4.40	2.5E+04	9.4E-02	a
Pyrene	5.1	1.3E+05	9.8E-02	a
Inorganics				
Aluminum	--	--	1.0E-03	d
Arsenic	--	--	1.0E-03	d

Footnotes appear on page 2.

Table 4-6. Permeability Constants Used to Assess Dermal Exposures for Constituents Detected in Keuka Lake Outlet, NYSEG Former Goal Gasification Site, Penn Yan, New York.

Constituent	log Kow	Kow	PC (cm/hr)	Reference
Inorganics (cont.)				
Barium	--	--	1.0E-03	d
Cadmium	--	--	1.0E-03	d
Chromium	--	--	1.0E-03	d
Copper	--	--	1.0E-03	d
Cyanide	--	--	1.0E-03	d
Iron	--	--	1.0E-03	d
Lead	--	--	4.0E-06	b
Manganese	--	--	1.0E-03	d
Mercury	--	--	1.0E-03	d
Nickel	--	--	1.0E-04	b
Sulfide	--	--	1.0E-03	d
Vanadium	--	--	1.0E-03	d
Zinc	--	--	1.0E-03	d

-- Value not used to determine permeability constant.

a Permeability constant estimated using method of Brown and Rossi (1989):
(PC = 0.1 x [(Kow^0.75)/(120 + Kow^0.75)]).

b Experimentally measured permeability constant (USEPA, 1992a).

c Predicted permeability constant (USEPA, 1992a).

d Experimentally measured permeability constant for water (USEPA, 1992a).

cm/hr Centimeters per hour.

PAHs Polycyclic aromatic hydrocarbons.

PC Permeability constant.

Semi-VOCs Semi-volatile organic compounds.

VOCs Volatile organic compounds.

Table 5-1. Physical and Chemical Properties of Organic Constituents of Concern Detected in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Molecular Weight (g/mol)	Water Solubility (mg/L 25 °C)	Specific Gravity	Vapor Pressure (mm Hg 25 °C)	Henry's Law Constant (atm-m³/mol) (25 °C)	Diffusivity (cm²/sec)	Koc (mL/g)	Log Kow	Fish BCF (L/kg)	Ground Water T ½ Low (days)	Ground Water T ½ High (days)	Soil T ½ Low (days)	Soil T ½ High (days)
VOCs													
Benzene	78	1,780	0.88	9.5E+01	5.48E-03	0.09320	49 - 100	1.56 - 2.15	5.2	10 -	720	5 -	16
Ethylbenzene	106	152 - 208	0.87	9.5E+00	8.68E-03	0.06667	95 - 260	3.05 - 3.15	37.5	6 -	228	3 -	10
Methylene chloride	85	13,000 - 16,700	1.32	4.4E+02 - 4.6E+02	2.69E-03	0.08500	8.7	1.25 - 1.30	0.9	14 -	56	7 -	28
Toluene	92	490 - 627	0.87	2.8E+01	6.74E-03	0.07828	115 - 150	2.11 - 2.80	10.7	7 -	28	4 -	22
Trichloroethene	131	1,100 - 1,500	1.46	7.3E+01	9.90E-03	0.08116	65 -126	2.29 - 3.30	10.6	321 -	1,643	90 -	365
Xylenes (total)	106	162 - 200	0.87	6.6E+00 - 8.8E+00	6.30E-03	0.07164	128 - 1,580	2.77 - 3.20	132	14 -	360	7 -	28
Semi-VOCs													
Carbazole	167	ND	1.1	ND	ND	0.07542	ND	3.29	ND	ND		ND	
Phenol	94	67,000 - 93,000	1.06	3.4E-01	3.97E-07	0.08924	17 - 27	1.46 - 1.48	1.4	0.5 -	7	1 -	10
PAHs													
Acenaphthene	154	3.47 - 3.93	ND	1.6E-03	7.92E-05	0.05951	4,600	3.92 - 4.33	242	24.6 -	204	12.3 -	102
Acenaphthylene	152	3.93	0.898	2.9E-02 (20 °C)	1.14E-04	0.06703	4,790	4.1	30	85 -	120	42.5 -	60
Anthracene	178	0.030 - 0.1125	1.24	1.7E-05 - 1.95E-04	6.51E-05	0.05904	16,000 - 26,000	4.34 - 4.54	30	100 -	919.8	50 -	459.9
Benzo(a)anthracene	228	0.0094 - 0.014	1.274	1.1E-07	8.00E-06	0.04564	1,400,000	5.61 - 5.91	30	204 -	1,361	102 -	678.9
Benzo(b)fluoranthene	252	0.0012	ND	5.0E-07	1.20E-05	0.04392	550,000	6.57	30	719.1 -	1,219	360 -	609.6
Benzo(k)fluoranthene	252	0.00055	ND	9.6E-11	1.04E-03	0.04392	4,400,000	6.85	30	1,821 -	4,271	909 -	2,139
Benzo(g,h,i)perylene	276	0.00026	ND	1.0E-10	1.40E-07	0.04197	7,800,000	7.1	30	1,168 -	1,314	590 -	650
Benzo(a)pyrene	252	0.0038 - 0.004	1.35	5.5E-09	2.40E-06	0.04653	398,000 - 1,900,000	5.81 - 6.50	30	114 -	1,059	57 -	529.3
Chrysene	228	0.0018 - 0.006	1.27	6.3E-09	3.15E-07	0.04531	240,000	5.60 - 5.91	30	744.6 -	2,000	372 -	992.8
Dibenzo(a,h)anthracene	278	0.00249 - 0.005	1.28	10E-10 (20 °C)	7.33E-09	0.05707	1,700,000	5.97 - 6.50	30	722.7 -	1,880	361 -	941.7
Dibenzofuran	168	10	ND	3.4E-05	7.45E-07	0.05780	8,100 - 13,000	4.12 - 4.31	ND	8.5 -	35	7 -	28
Fluoranthene	202	0.206 - 0.373	1.25	5.0E-06	1.69E-02	0.04941	42,000	5.22	1,150	280 -	879.7	140 -	440
Fluorene	166	1.66 - 1.98	1.2	1.0E-03 - 1.0E-02	2.10E-04	0.05710	5,000	4.12 - 4.38	30	64 -	120	32 -	60
Indeno(1,2,3-c,d)pyrene	276	0.062	ND	1.0E-09	2.96E-20	0.05728	31,000,000	5.91 - 7.70	30	1,201 -	1,460	599 -	730
2-Methylnaphthalene	142	25	1.001	4.5E-02	3.36E-04	0.06196	7,400 - 8,500	3.86 - 4.11	190	ND		ND	
Naphthalene	128	301- 34	1.16	2.3E-01 - 8.7E-01	4.60E-04	0.08205	550 - 3,160	3.2 - 4.7	10.5	1 -	258	16.6 -	48
Phenanthrene	178	0.71 - 1.29	1.18	6.8E-04	2.56E-05	0.05430	5,250 - 38,900	4.2 - 4.6	30	32 -	401.5	16 -	200
Pyrene	202	0.013 - 0.171	1.27	6.85E-07 - 2.5E-06	1.10E-05	0.05039	46,000 - 135,000	4.88 - 5.32	30	419.8 -	3,796	210 -	1,898

References: Howard et al., 1991; Howard, 1990 and 1989; Lugg, 1968; Lyman et al., 1990; Mackay et al., 1983; Montgomery and Welkom, 1990; Shen, 1982; USEPA, 1991(tox sub sprdsht); Veith and Kosian, 1982; and Verschueren, 1983.

atm-m³/mol	Atmospheres-cubic meters per mole.	L/kg	Liters per kilogram.
BCF	Bioconcentration factor.	mg/L	Milligrams per liter.
°C	Degrees Celsius.	mL/g	Milliliters per gram.
cm²/sec	Square centimeters per second.	mm Hg	Millimeters of mercury.
g/mol	Grams per mole.	ND	No data.
Koc	Organic carbon partition coefficient.	T ½	Half-life.
Kow	Octanol-water partition coefficient.		

Table 5-2. Exposure Parameters Used to Assess Risk to Receptors at Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Parameters	Swimming		Wading		Fish Ingestion	
	Adult	Child	Adult	Child	Adult	Child
APcar (days)	25,550	25,550	25,550	25,550	25,550	25,550
APnon (days)	10,950	3,650	10,950	3,650	10,950	3,650
BW (kg)	70	38	70	38	70	38
ED (years)	30	10	30	10	30	10
EF (days/year)	14	14	24	24	28	28
ET (hours/day)	2	2	2	2	NA	NA
IRfish (kg/day)	NA	NA	NA	NA	0.054	0.054
IRsed (mg/day)	5	5	5	5	NA	NA
IRsw (L/hour)	0.1	0.1	0.05	0.05	NA	NA
SAR (mg/cm²-day)	0.1	0.1	0.1	0.1	NA	NA
SC	NA	NA	NA	NA	0.5	0.5
SSAw (cm²)	18,150	12,350	3,190	2,700	NA	NA

References: USEPA 1991a; USEPA 1989a,c.

APcar	Averaging period for carcinogenic effects.
APnon	Averaging period for non-carcinogenic effects.
BW	Body weight.
cm²	Square centimeters.
ED	Exposure duration.
EF	Exposure frequency.
ET	Exposure time.
IRfish	Ingestion rate for fish.
IRsed	Sediment ingestion rate.
IRsw	Surface-water ingestion rate.
kg	Kilograms.
L	Liter.
mg	Milligrams.
NA	Not applicable.
SAR	Soil adherence rate.
SC	Source contribution.
SSAw	Skin surface area in contact with water.
yr	Year.

Table 5-3. Equations and Sample Calculations for Swimming Exposure in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Equation definitions:

$$SWExD_o = \frac{C_{sw} \times IR_{sw} \times EF \times ET \times ED}{BW \times AP} + \frac{C_{sed} \times IR_{sed} \times EF \times ED}{BW \times AP \times UC2}$$

$$SWExD_d = \frac{C_{sw} \times SSA \times PC \times UC1 \times ET \times EF \times ED}{BW \times AP} + \frac{C_{sed} \times SSA \times SAR \times ABS \times EF \times ED}{BW \times AP \times UC2}$$

$$ELCR = (SWExD_o \times CSF_o) + (SWExD_d \times CSF_a)$$

$$HQ = (SWExD_o/RfD_o) + (SWExD_d/RfD_a)$$

where:

ABS	Dermal absorption efficiency (constituent-specific) (unitless).
AP	Averaging period (days/lifetime).
BW	Body weight (kg).
C_{sed}	Constituent concentration in the sediment (mg/kg) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration). For carcinogenic PAHs, the constituent concentration was multiplied by the constituent-specific Toxicity Equivalency Factor (TEF).
C_{sw}	Constituent concentration in the surface water (mg/L) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration). For carcinogenic PAHs, the constituent concentration was multiplied by the constituent-specific Toxicity Equivalency Factor (TEF).
CSF_a	Adjusted cancer slope factor for dermal exposure (kg-day/mg).
CSF_o	Cancer slope factor for oral exposure (kg-day/mg).
ED	Exposure duration (years).
EF	Exposure frequency (days/year).
ELCR	Excess lifetime cancer risk (unitless).
ET	Exposure time (hours/day).
HQ	Hazard quotient (unitless).
IR_{sed}	Incidental ingestion rate of sediment while wading or swimming (mg/day).
IR_{sw}	Incidental ingestion rate of surface water while wading or swimming (L/hr).
PC	Permeability constant (cm/hour).
RfD_a	Adjusted reference dose for dermal exposure (mg/kg-day).

Footnotes appear on page 3.

Table 5-3. Equations and Sample Calculations for Swimming Exposure in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

RfD_o Reference dose for oral exposure (mg/kg-day).
SAR Sediment adherence rate (0.1 mg/cm^2-day [because of the rinsing action of the water, adherence of sediment is thought to be much lower than dust adherence]).
$SWExD_d$ Exposure dose from dermal contact with surface water and sediment during swimming activity (mg/kg-day).
$SWExD_o$ Exposure dose from oral contact with surface water and sediment during swimming activity (mg/kg-day).
SSA Exposed skin surface area (cm^2).
TEF Toxicity equivalency factor.
UC1 Unit conversion 1 (10^{-3} L/cm^3).
UC2 Unit conversion 2 (10^6 mg/kg).

<u>Sample calculation - benzo(a)anthracene, cancer effects, adult visitor:</u>

$$SWExD_o = \frac{(69\ mg/kg \times 0.1) \times (5\ mg/day) \times (14\ days/year) \times (30\ years)}{(70\ kg) \times (25{,}550\ days) \times (10^6\ mg/kg)}$$

$$= 8.1 \times 10^{-9}\ mg/kg\text{-}day$$

$$SWExDd = \frac{(69\ mg/kg \times 0.1) \times (18{,}150\ cm^2) \times (0.1\ mg/cm^2\text{-}day) \times (0.03) \times (14\ days/year) \times (30\ years)}{(70\ kg) \times (25{,}550\ days) \times (10^6\ mg/kg)}$$

$$= 8.8 \times 10^{-8}\ mg/kg\text{-}day$$

$$ELCR = [(8.1 \times 10^{-9}\ mg/kg\text{-}day) \times (7.3 kg\text{-}day/mg)] + [(8.8 \times 10^{-8}\ mg/kg\text{-}day) \times (NAP)]$$

$$= 5.9 \times 10^{-8}$$

<u>Sample calculation - cadmium, non-cancer effects, adult visitor:</u>

$$SWExD_o = \frac{(0.062\ mg/L) \times (0.1\ L/hr) \times (14\ days/yr) \times (2\ hr/day) \times (30\ years)}{(70\ kg) \times (10{,}950\ days)}$$

$$= 6.8 \times 10^{-6}\ mg/kg\text{-}day$$

Footnotes appear on page 3.

Table 5-3. Equations and Sample Calculations for Swimming Exposure in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

$$SWExD_d = \frac{(0.062\ mg/L) \times (18{,}150\ cm^2) \times (0.001) \times (10^{-3}\ L/cm^3) \times (2\ hours/day) \times (14\ days/year) \times (30\ years)}{(70\ kg) \times (10{,}950\ days)}$$

$$= 1.2 \times 10^{-6}\ mg/kg\text{-}day$$

$$HQ* = \frac{6.8 \times 10^{-6}\ mg/kg\text{-}day}{5.0 \times 10^{-4}\ mg/kg\text{-}day} + \frac{1.2 \times 10^{-6}\ mg/kg\text{-}day}{3.0 \times 10^{-5}\ mg/kg\text{-}day}$$

$$= 0.055$$

---

* RfD for water used to assess water ingestion.

Table 5-4. Swimming in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Adult Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	SWExDo (mg/kg-day)	SWExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
CANCER EFFECTS								
						CSFo	CSFa	ELCR
VOCs								
Benzene	ND	0.67	NAP	7.9E-10	7.1E-08	2.9E-02	2.9E-02	2.1E-09
Methylene chloride	ND	0.0097	NAP	1.1E-11	1.0E-09	7.5E-03	7.5E-03	7.8E-12
Trichloroethene	ND	0.002	NAP	2.3E-12	2.1E-10	1.1E-02	1.1E-02	2.4E-12
PAHs								
Benzo(a)anthracene	ND	69	0.1	8.1E-09	8.8E-08	7.3E+00	NAP	5.9E-08
Benzo(b)fluoranthene	ND	39	0.1	4.6E-09	5.0E-08	7.3E+00	NAP	3.3E-08
Benzo(k)fluoranthene	ND	40	0.1	4.7E-09	5.1E-08	7.3E+00	NAP	3.4E-08
Benzo(a)pyrene	ND	48	1	5.6E-08	6.1E-07	7.3E+00	NAP	4.1E-07
Chrysene	ND	59	0.01	6.9E-10	7.5E-09	7.3E+00	NAP	5.1E-09
Dibenzo(a,h)anthracene	ND	2.4	1	2.8E-09	3.1E-08	7.3E+00	NAP	2.1E-08
Indeno(1,2,3-c,d)pyrene	ND	26	0.1	3.1E-09	3.3E-08	7.3E+00	NAP	2.2E-08
Inorganics								
Arsenic	ND	4.6	NAP	5.4E-09	2.0E-08	1.8E+00	1.8E+01	3.6E-07
Lead	ND	160	NAP	1.9E-07	4.1E-08	NAP	NA	NA
							ELCR	1E-06

Footnotes appear on page 4.

Table 5-4. Swimming in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Adult Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	SWExDo (mg/kg-day)	SWExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
NON-CANCER EFFECTS								
						RfDo	RfDa	HQ
VOCs								
Benzene	ND	0.67	NAP	1.8E-09	1.7E-07	NA	NA	NA
Ethylbenzene	ND	1.8	NAP	4.9E-09	4.5E-07	1.0E-01	1.0E-01	4.5E-06
Methylene chloride	ND	0.0097	NAP	2.7E-11	2.4E-09	6.0E-02	6.0E-02	4.1E-08
Toluene	ND	0.28	NAP	7.7E-10	7.0E-08	2.0E-01	2.0E-01	3.5E-07
Trichloroethene	ND	0.002	NAP	5.5E-12	5.0E-10	6.0E-03	6.0E-03	8.4E-08
Xylenes	ND	4.4	NAP	1.2E-08	1.1E-06	2.0E+00	2.0E+00	5.5E-07
Semi-VOCs								
Carbazole	ND	29	NAP	7.9E-08	NA	NA	NA	NA
Phenol	ND	31	NAP	8.5E-08	2.5E-05	6.0E-01	5.4E-01	4.6E-05
PAHs								
Acenaphthene	ND	110	NAP	3.0E-07	3.3E-06	6.0E-02	5.1E-02	6.9E-05
Acenaphthylene	ND	9.4	NAP	2.6E-08	2.8E-07	3.0E-02	2.6E-02	1.2E-05
Anthracene	ND	110	NAP	3.0E-07	3.3E-06	3.0E-01	2.6E-01	1.4E-05
Benzo(a)anthracene	ND	69	NAP	1.9E-07	2.1E-06	3.0E-02	2.6E-02	8.5E-05
Benzo(b)fluoranthene	ND	39	NAP	1.1E-07	1.2E-06	3.0E-02	2.6E-02	4.8E-05
Benzo(k)fluoranthene	ND	40	NAP	1.1E-07	1.2E-06	3.0E-02	2.6E-02	5.0E-05
Benzo(g,h,i)perylene	ND	11	NAP	3.0E-08	3.3E-07	3.0E-02	2.6E-02	1.4E-05
Benzo(a)pyrene	ND	48	NAP	1.3E-07	1.4E-06	3.0E-02	2.6E-02	5.9E-05
Chrysene	ND	59	NAP	1.6E-07	1.8E-06	3.0E-02	2.6E-02	7.3E-05

Footnotes appear on page 4.

Table 5-4. Swimming in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Adult Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	SWExDo (mg/kg-day)	SWExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
						RfDo	RfDa	HQ
PAHs (cont.)								
Dibenzo(a,h)anthracene	ND	2.4	NAP	6.6E-09	7.2E-08	3.0E-02	2.6E-02	3.0E-06
Dibenzofuran	ND	73	NAP	2.0E-07	2.2E-06	3.0E-02	2.6E-02	9.0E-05
Fluoranthene	ND	160	NAP	4.4E-07	4.8E-06	4.0E-02	3.4E-02	1.5E-04
Fluorene	ND	87	NAP	2.4E-07	2.6E-06	4.0E-02	3.4E-02	8.2E-05
Indeno(1,2,3-c,d)pyrene	ND	26	NAP	7.1E-08	7.8E-07	3.0E-02	2.6E-02	3.2E-05
2-Methylnaphthalene	ND	150	NAP	4.1E-07	4.5E-06	4.0E-02	3.4E-02	1.4E-04
Naphthalene	ND	320	NAP	8.8E-07	9.5E-06	4.0E-02	3.4E-02	3.0E-04
Phenanthrene	ND	260	NAP	7.1E-07	7.8E-06	3.0E-02	2.6E-02	3.2E-04
Pyrene	ND	130	NAP	3.6E-07	3.9E-06	3.0E-02	2.6E-02	1.6E-04
Inorganics								
Aluminum	ND	12,000	NAP	3.3E-05	1.2E-04	NA	NA	NA
Arsenic	ND	4.6	NAP	1.3E-08	4.6E-08	3.0E-04	2.9E-04	2.0E-04
Barium	ND	90	NAP	2.5E-07	9.0E-07	7.0E-02	4.9E-03	1.9E-04
Cadmium*	0.062	ND	NAP	6.8E-06	1.2E-06	5.0E-04	3.0E-05	5.5E-02
Chromium	ND	20	NAP	5.5E-08	2.0E-07	5.0E-03	1.0E-04	2.0E-03
Copper	ND	35	NAP	9.6E-08	3.5E-07	3.7E-02	2.2E-02	1.8E-05
Cyanide	ND	6.9	NAP	1.9E-08	6.9E-06	2.0E-02	9.4E-03	7.3E-04
Iron	0.15	20,000	NAP	7.1E-05	2.0E-04	NA	NA	NA
Lead	ND	160	NAP	4.4E-07	9.5E-08	NA	NA	NA
Manganese**	ND	280	NAP	7.7E-07	2.8E-06	1.4E-01	7.0E-03	4.0E-04
Mercury	0.00017	0.26	NAP	1.9E-08	1.0E-08	3.0E-04	3.0E-07	3.4E-02
Nickel	ND	26	NAP	7.1E-08	5.9E-08	2.0E-02	8.6E-04	7.3E-05

Footnotes appear on page 4.

Table 5-4. Swimming in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Adult Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	SWExDo (mg/kg-day)	SWExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
						RfDo	RfDa	HQ
Inorganics (cont.)								
Sulfide/Sulfate	27	360	NAP	3.0E-03	5.4E-04	NA	NA	NA
Vanadium	ND	19	NAP	5.2E-08	1.9E-07	7.0E-03	7.0E-05	2.7E-03
Zinc	0.0068	130	NAP	1.1E-06	1.4E-06	3.0E-01	9.0E-02	2.0E-05
							HI	0.1

* RfD for water used to assess exposure to water.
** RfD for food used to assess exposure to sediment.

Csed — Constituent concentration in sediment (mg/kg) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration).
Csw — Constituent concentration in surface water (mg/L) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration).
ELCR — Excess lifetime cancer risk.
HI — Hazard index (sum of the HQs).
HQ — Hazard quotient.
NA — Not available.
NAP — Not applicable.
ND — Not detected.
PAHs — Polycyclic aromatic hydrocarbons.
Semi-VOCs — Semi-volatile organic compounds.
SWExDd — Swimming exposure dose for dermal contact (mg/kg-day).
SWExDo — Swimming exposure dose for incidental ingestion (mg/kg-day).
TEF — Toxicity equivalency factor.
VOCs — Volatile organic compounds.

Table 5-5. Swimming in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Child Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	SWExDo (mg/kg-day)	SWExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
CANCER EFFECTS						CSFo	CSFa	ELCR
VOCs								
Benzene	ND	0.67	NAP	4.8E-10	3.0E-08	2.9E-02	2.9E-02	8.8E-10
Methylene chloride	ND	0.0097	NAP	7.0E-12	4.3E-10	7.5E-03	7.5E-03	3.3E-12
Trichloroethene	ND	0.002	NAP	1.4E-12	8.9E-11	1.1E-02	1.1E-02	1.0E-12
PAHs								
Benzo(a)anthracene	ND	69	0.1	5.0E-09	3.7E-08	7.3E+00	NAP	3.6E-08
Benzo(b)fluoranthene	ND	39	0.1	2.8E-09	2.1E-08	7.3E+00	NAP	2.1E-08
Benzo(k)fluoranthene	ND	40	0.1	2.9E-09	2.1E-08	7.3E+00	NAP	2.1E-08
Benzo(a)pyrene	ND	48	1	3.5E-08	2.6E-07	7.3E+00	NAP	2.5E-07
Chrysene	ND	59	0.01	4.3E-10	3.2E-09	7.3E+00	NAP	3.1E-09
Dibenzo(a,h)anthracene	ND	2.4	1	1.7E-09	1.3E-08	7.3E+00	NAP	1.3E-08
Indeno(1,2,3-c,d)pyrene	ND	26	0.1	1.9E-09	1.4E-08	7.3E+00	NAP	1.4E-08
Inorganics								
Arsenic	ND	4.6	NAP	3.3E-09	8.2E-09	1.8E+00	1.8E+01	1.5E-07
Lead	ND	160	NAP	1.2E-07	1.7E-08	NAP	NA	NA
							ELCR	5E-07

Footnotes appear on page 4.

Table 5-5. Swimming in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Child Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	SWExDo (mg/kg-day)	SWExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
NON-CANCER EFFECTS								
						RfDo	RfDa	HQ
VOCs								
Benzene	ND	0.67	NAP	3.4E-09	2.1E-07	NA	NA	NA
Ethylbenzene	ND	1.8	NAP	9.1E-09	5.6E-07	1.0E-01	1.0E-01	5.7E-06
Methylene chloride	ND	0.0097	NAP	4.9E-11	3.0E-09	6.0E-02	6.0E-02	5.1E-08
Toluene	ND	0.28	NAP	1.4E-09	8.7E-08	2.0E-01	2.0E-01	4.4E-07
Trichloroethene	ND	0.002	NAP	1.0E-11	6.2E-10	6.0E-03	6.0E-03	1.1E-07
Xylenes	ND	4.4	NAP	2.2E-08	1.4E-06	2.0E+00	2.0E+00	7.0E-07
Semi-VOCs								
Carbazole	ND	29	NAP	1.5E-07	NA	NA	NA	NA
Phenol	ND	31	NAP	1.6E-07	3.1E-05	6.0E-01	5.4E-01	5.8E-05
PAHs								
Acenaphthene	ND	110	NAP	5.6E-07	4.1E-06	6.0E-02	5.1E-02	9.0E-05
Acenaphthylene	ND	9.4	NAP	4.7E-08	3.5E-07	3.0E-02	2.6E-02	1.5E-05
Anthracene	ND	110	NAP	5.6E-07	4.1E-06	3.0E-01	2.6E-01	1.8E-05
Benzo(a)anthracene	ND	69	NAP	3.5E-07	2.6E-06	3.0E-02	2.6E-02	1.1E-04
Benzo(b)fluoranthene	ND	39	NAP	2.0E-07	1.5E-06	3.0E-02	2.6E-02	6.3E-05
Benzo(k)fluoranthene	ND	40	NAP	2.0E-07	1.5E-06	3.0E-02	2.6E-02	6.4E-05
Benzo(g,h,i)perylene	ND	11	NAP	5.6E-08	4.1E-07	3.0E-02	2.6E-02	1.8E-05
Benzo(a)pyrene	ND	48	NAP	2.4E-07	1.8E-06	3.0E-02	2.6E-02	7.7E-05
Chrysene	ND	59	NAP	3.0E-07	2.2E-06	3.0E-02	2.6E-02	9.5E-05

Footnotes appear on page 4.

Table 5-5. Swimming in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Child Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	SWExDo (mg/kg-day)	SWExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
						RfDo	RfDa	HQ
PAHs (cont.)								
Dibenzo(a,h)anthracene	ND	2.4	NAP	1.2E-08	9.0E-08	3.0E-02	2.6E-02	3.9E-06
Dibenzofuran	ND	73	NAP	3.7E-07	2.7E-06	3.0E-02	2.6E-02	1.2E-04
Fluoranthene	ND	160	NAP	8.1E-07	6.0E-06	4.0E-02	3.4E-02	2.0E-04
Fluorene	ND	87	NAP	4.4E-07	3.3E-06	4.0E-02	3.4E-02	1.1E-04
Indeno(1,2,3-c,d)pyrene	ND	26	NAP	1.3E-07	9.7E-07	3.0E-02	2.6E-02	4.2E-05
2-Methylnaphthalene	ND	150	NAP	7.6E-07	5.6E-06	4.0E-02	3.4E-02	1.8E-04
Naphthalene	ND	320	NAP	1.6E-06	1.2E-05	4.0E-02	3.4E-02	3.9E-04
Phenanthrene	ND	260	NAP	1.3E-06	9.7E-06	3.0E-02	2.6E-02	4.2E-04
Pyrene	ND	130	NAP	6.6E-07	4.9E-06	3.0E-02	2.6E-02	2.1E-04
Inorganics								
Aluminum	ND	12,000	NAP	6.1E-05	1.5E-04	NA	NA	NA
Arsenic	ND	4.6	NAP	2.3E-08	5.7E-08	3.0E-04	2.9E-04	2.8E-04
Barium	ND	90	NAP	4.5E-07	1.1E-06	7.0E-02	4.9E-03	2.4E-04
Cadmium*	0.062	ND	NAP	1.3E-05	1.5E-06	5.0E-04	3.0E-05	7.7E-02
Chromium	ND	20	NAP	1.0E-07	2.5E-07	5.0E-03	1.0E-04	2.5E-03
Copper	ND	35	NAP	1.8E-07	4.4E-07	3.7E-02	2.2E-02	2.5E-05
Cyanide	ND	6.9	NAP	3.5E-08	8.6E-06	2.0E-02	9.4E-03	9.2E-04
Iron	0.15	20,000	NAP	1.3E-04	2.5E-04	NA	NA	NA
Lead	ND	160	NAP	8.1E-07	1.2E-07	NA	NA	NA
Manganese**	ND	280	NAP	1.4E-06	3.5E-06	1.4E-01	7.0E-03	5.1E-04
Mercury	0.00017	0.26	NAP	3.6E-08	1.3E-08	3.0E-04	3.0E-07	4.2E-02
Nickel	ND	26	NAP	1.3E-07	7.5E-08	2.0E-02	8.6E-04	9.3E-05

Footnotes appear on page 4.

Table 5-5. Swimming in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Child Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	SWExDo (mg/kg-day)	SWExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
						RfDo	RfDa	HQ
Inorganics (cont.)								
Sulfide/Sulfate	27	360	NAP	5.5E-03	6.8E-04	NA	NA	NA
Vanadium	ND	19	NAP	9.6E-08	2.4E-07	7.0E-03	7.0E-05	3.4E-03
Zinc	0.0068	130	NAP	2.0E-06	1.8E-06	3.0E-01	9.0E-02	2.7E-05
							HI	0.1

*	RfD for water used to assess exposure to water.
**	RfD for food used to assess exposure to sediment.
Csed	Constituent concentration in sediment (mg/kg) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration).
Csw	Constituent concentration in surface water (mg/L) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration).
ELCR	Excess lifetime cancer risk.
HI	Hazard index (sum of the HQs).
HQ	Hazard quotient.
NA	Not available.
NAP	Not applicable.
ND	Not detected.
PAHs	Polycyclic aromatic hydrocarbons.
Semi-VOCs	Semi-volatile organic compounds.
SWExDd	Swimming exposure dose for dermal contact (mg/kg-day).
SWExDo	Swimming exposure dose for incidental ingestion (mg/kg-day).
TEF	Toxicity equivalency factor.
VOCs	Volatile organic compounds.

Table 5-6. Equations and Sample Calculations for Wading Exposure in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Equation definitions:

$$WExD_o = \frac{C_{sw} \times IR_{sw} \times EF \times ET \times ED}{BW \times AP} + \frac{C_{sed} \times IR_{sed} \times EF \times ED}{BW \times AP \times UC2}$$

$$WExD_d = \frac{C_{sw} \times SSA \times PC \times UC1 \times ET \times EF \times ED}{BW \times AP} + \frac{C_{sed} \times SSA \times SAR \times ABS \times EF \times ED}{BW \times AP \times UC2}$$

$$ELCR = (WExD_o \times CSF_o) + (WExD_d \times CSF_a)$$

$$HQ = (WExD_o/RfD_o) + (WExD_d/RfD_a)$$

where:

ABS	Dermal absorption efficiency (constituent-specific) (unitless).
AP	Averaging period (days/lifetime).
BW	Body weight (kg).
C_{sed}	Constituent concentration in the sediment (mg/kg) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration). For carcinogenic PAHs, the constituent concentration was multiplied by the constituent-specific toxicity equivalency factor (TEF).
C_{sw}	Constituent concentration in the surface water (mg/L) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration). For carcinogenic PAHs, the constituent concentration was multiplied by the constituent-specific TEF.
CSF_a	Adjusted cancer slope factor for dermal exposure (kg-day/mg).
CSF_o	Cancer slope factor for oral exposure (kg-day/mg).
ED	Exposure duration (years).
EF	Exposure frequency (days/year).
ELCR	Excess lifetime cancer risk (unitless).
ET	Exposure time (hours/day).
HQ	Hazard quotient (unitless).
IR_{sed}	Incidental ingestion rate of sediment while wading or swimming (mg/day).
IR_{sw}	Incidental ingestion rate of surface water while wading or swimming (L/hr).
PC	Permeability constant (cm/hour).
RfD_a	Adjusted reference dose for dermal exposure (mg/kg-day).
RfD_o	Reference dose for oral exposure (mg/kg-day).

Table 5-6. Equations and Sample Calculations for Wading Exposure in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

SAR	Sediment adherence rate (0.1 mg/cm^2-day [because of the rinsing action of the water, adherence of sediment is thought to be much lower than dust adherence]).
SSA	Exposed skin surface area (cm^2).
TEF	Toxicity equivalency factor.
UC1	Unit conversion 1 (10^{-3} L/cm^3).
UC2	Unit conversion 2 (10^6 mg/kg).
$WExD_d$	Exposure dose from dermal contact with surface water and sediment during wading activity (mg/kg-day).
$WExD_o$	Exposure dose from oral contact with surface water and sediment during wading activity (mg/kg-day).

Sample calculation - benzo(a)anthracene, cancer effects, child visitor:

$$WExD_o = \frac{(69 \text{ mg/kg} \times 0.1) \times (5 \text{ mg/day}) \times (24 \text{ days/year}) \times (10 \text{ years})}{(38 \text{ kg}) \times (25{,}550 \text{ days}) \times (10^6 \text{ mg/kg})}$$

$$= 8.5 \times 10^{-9} \text{ mg/kg-day}$$

$$WExDd = \frac{(69 \text{ mg/kg} \times 0.1) \times (2{,}700 \text{ cm}^2) \times (0.1 \text{ mg/cm}^2\text{-day}) \times (0.03) \times (24 \text{ days/year}) \times (10 \text{ years})}{(38 \text{ kg}) \times (25{,}550 \text{ days}) \times (10^6 \text{ mg/kg})}$$

$$= 1.4 \times 10^{-8} \text{ mg/kg-day}$$

$$ELCR = [(8.5 \times 10^{-9} \text{ mg/kg-day}) \times (7.3 \text{ kg-day/mg})] + [(1.4 \times 10^{-8} \text{ mg/kg-day}) \times (\text{NAP})]$$

$$= 6.2 \times 10^{-8}$$

Sample calculation - cadmium, non-cancer effects, child visitor:

$$WExD_o = \frac{(0.062 \text{ mg/L}) \times (0.05 \text{ L/hr}) \times (24 \text{ days/yr}) \times (2 \text{ hr/day}) \times (10 \text{ years})}{(38 \text{ kg}) \times (3{,}650 \text{ days})}$$

$$= 1.1 \times 10^{-5} \text{ mg/kg-day}$$

Table 5-6. Equations and Sample Calculations for Wading Exposure in Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

$$WExD_d = \frac{(0.062\ mg/L) \times (2{,}700\ cm^2) \times (0.001) \times (10^{-3}\ L/cm^3) \times (2\ hours/day) \times (24\ days/year) \times (10\ years)}{(38\ kg) \times (3{,}650\ days)}$$

$$= 5.8 \times 10^{-7}\ mg/kg\text{-}day$$

$$HQ* = \frac{1.1 \times 10^{-5}\ mg/kg\text{-}day}{5.0 \times 10^{-4}\ mg/kg\text{-}day} + \frac{5.8 \times 10^{-7}\ mg/kg\text{-}day}{3.0 \times 10^{-5}\ mg/kg\text{-}day}$$

$$=0.041$$

* RfD for water used to assess water ingestion.

Table 5-7. Wading in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Adult Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	WExDo (mg/kg-day)	WExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
CANCER EFFECTS								
						CSFo	CSFa	ELCR
VOCs								
Benzene	ND	0.67	NAP	1.3E-09	2.2E-08	2.9E-02	2.9E-02	6.6E-10
Methylene chloride	ND	0.0097	NAP	2.0E-11	3.1E-10	7.5E-03	7.5E-03	2.5E-12
Trichloroethene	ND	0.002	NAP	4.0E-12	6.4E-11	1.1E-02	1.1E-02	7.5E-13
PAHs								
Benzo(a)anthracene	ND	69	0.1	1.4E-08	2.7E-08	7.3E+00	NAP	1.0E-07
Benzo(b)fluoranthene	ND	39	0.1	7.9E-09	1.5E-08	7.3E+00	NAP	5.7E-08
Benzo(k)fluoranthene	ND	40	0.1	8.1E-09	1.5E-08	7.3E+00	NAP	5.9E-08
Benzo(a)pyrene	ND	48	1	9.7E-08	1.8E-07	7.3E+00	NAP	7.1E-07
Chrysene	ND	59	0.01	1.2E-09	2.3E-09	7.3E+00	NAP	8.7E-09
Dibenzo(a,h)anthracene	ND	2.4	1	4.8E-09	9.2E-09	7.3E+00	NAP	3.5E-08
Indeno(1,2,3-c,d)pyrene	ND	26	0.1	5.2E-09	1.0E-08	7.3E+00	NAP	3.8E-08
Inorganics								
Arsenic	ND	4.6	NAP	9.3E-09	5.9E-09	1.8E+00	1.8E+01	1.2E-07
Lead	ND	160	NAP	3.2E-07	1.2E-08	NAP	NA	NA
							ELCR	1E-06

Footnotes appear on page 4.

Table 5-7. Wading in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Adult Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	WExDo (mg/kg-day)	WExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
NON-CANCER EFFECTS								
						RfDo	RfDa	HQ
VOCs								
Benzene	ND	0.67	NAP	3.1E-09	5.0E-08	NA	NA	NA
Ethylbenzene	ND	1.8	NAP	8.5E-09	1.3E-07	1.0E-01	1.0E-01	1.4E-06
Methylene chloride	ND	0.0097	NAP	4.6E-11	7.3E-10	6.0E-02	6.0E-02	1.3E-08
Toluene	ND	0.28	NAP	1.3E-09	2.1E-08	2.0E-01	2.0E-01	1.1E-07
Trichloroethene	ND	0.002	NAP	9.4E-12	1.5E-10	6.0E-03	6.0E-03	2.7E-08
Xylenes	ND	4.4	NAP	2.1E-08	3.3E-07	2.0E+00	2.0E+00	1.8E-07
Semi-VOCs								
Carbazole	ND	29	NAP	1.4E-07	NA	NA	NA	NA
Phenol	ND	31	NAP	1.5E-07	7.4E-06	6.0E-01	5.4E-01	1.4E-05
PAHs								
Acenaphthene	ND	110	NAP	5.2E-07	9.9E-07	6.0E-02	5.1E-02	2.8E-05
Acenaphthylene	ND	9.4	NAP	4.4E-08	8.5E-08	3.0E-02	2.6E-02	4.7E-06
Anthracene	ND	110	NAP	5.2E-07	9.9E-07	3.0E-01	2.6E-01	5.5E-06
Benzo(a)anthracene	ND	69	NAP	3.2E-07	6.2E-07	3.0E-02	2.6E-02	3.5E-05
Benzo(b)fluoranthene	ND	39	NAP	1.8E-07	3.5E-07	3.0E-02	2.6E-02	2.0E-05
Benzo(k)fluoranthene	ND	40	NAP	1.9E-07	3.6E-07	3.0E-02	2.6E-02	2.0E-05
Benzo(g,h,i)perylene	ND	11	NAP	5.2E-08	9.9E-08	3.0E-02	2.6E-02	5.5E-06
Benzo(a)pyrene	ND	48	NAP	2.3E-07	4.3E-07	3.0E-02	2.6E-02	2.4E-05
Chrysene	ND	59	NAP	2.8E-07	5.3E-07	3.0E-02	2.6E-02	3.0E-05

Footnotes appear on page 4.

Table 5-7. Wading in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Adult Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	WExDo (mg/kg-day)	WExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
						RfDo	RfDa	HQ
PAHs (cont.)								
Dibenzo(a,h)anthracene	ND	2.4	NAP	1.1E-08	2.2E-08	3.0E-02	2.6E-02	1.2E-06
Dibenzofuran	ND	73	NAP	3.4E-07	6.6E-07	3.0E-02	2.6E-02	3.7E-05
Fluoranthene	ND	160	NAP	7.5E-07	1.4E-06	4.0E-02	3.4E-02	6.1E-05
Fluorene	ND	87	NAP	4.1E-07	7.8E-07	4.0E-02	3.4E-02	3.3E-05
Indeno(1,2,3-c,d)pyrene	ND	26	NAP	1.2E-07	2.3E-07	3.0E-02	2.6E-02	1.3E-05
2-Methylnaphthalene	ND	150	NAP	7.0E-07	1.3E-06	4.0E-02	3.4E-02	5.7E-05
Naphthalene	ND	320	NAP	1.5E-06	2.9E-06	4.0E-02	3.4E-02	1.2E-04
Phenanthrene	ND	260	NAP	1.2E-06	2.3E-06	3.0E-02	2.6E-02	1.3E-04
Pyrene	ND	130	NAP	6.1E-07	1.2E-06	3.0E-02	2.6E-02	6.5E-05
Inorganics								
Aluminum	ND	12,000	NAP	5.6E-05	3.6E-05	NA	NA	NA
Arsenic	ND	4.6	NAP	2.2E-08	1.4E-08	3.0E-04	2.9E-04	1.2E-04
Barium	ND	90	NAP	4.2E-07	2.7E-07	7.0E-02	4.9E-03	6.1E-05
Cadmium*	0.062	ND	NAP	5.8E-06	3.7E-07	5.0E-04	3.0E-05	2.4E-02
Chromium	ND	20	NAP	9.4E-08	6.0E-08	5.0E-03	1.0E-04	6.2E-04
Copper	ND	35	NAP	1.6E-07	1.0E-07	3.7E-02	2.2E-02	9.2E-06
Cyanide	ND	6.9	NAP	3.2E-08	2.1E-06	2.0E-02	9.4E-03	2.2E-04
Iron	0.15	20,000	NAP	1.1E-04	6.1E-05	NA	NA	NA
Lead	ND	160	NAP	7.5E-07	2.9E-08	NA	NA	NA
Manganese**	ND	280	NAP	1.3E-06	8.4E-07	1.4E-01	7.0E-03	1.3E-04
Mercury	0.00017	0.26	NAP	1.7E-08	3.0E-09	3.0E-04	3.0E-07	1.0E-02
Nickel	ND	26	NAP	1.2E-07	1.8E-08	2.0E-02	8.6E-04	2.7E-05

Footnotes appear on page 4.

Table 5-7. Wading in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Adult Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	WExDo (mg/kg-day)	WExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
						RfDo	RfDa	HQ
Inorganics (cont.)								
Sulfide/Sulfate	27	360	NAP	2.5E-03	1.6E-04	NA	NA	NA
Vanadium	ND	19	NAP	8.9E-08	5.7E-08	7.0E-03	7.0E-05	8.3E-04
Zinc	0.0068	130	NAP	1.2E-06	4.3E-07	3.0E-01	9.0E-02	8.9E-06
							HI	0.04

*	RfD for water used to assess exposure to water.
**	RfD for food used to assess exposure to sediment.
Csed	Constituent concentration in sediment (mg/kg) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration).
Csw	Constituent concentration in surface water (mg/L) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration).
ELCR	Excess lifetime cancer risk.
HI	Hazard index (sum of the HQs).
HQ	Hazard quotient.
NA	Not available.
NAP	Not applicable.
ND	Not detected.
PAHs	Polycyclic aromatic hydrocarbons.
Semi-VOCs	Semi-volatile organic compounds.
TEF	Toxicity equivalency factor.
VOCs	Volatile organic compounds.
WExDd	Wading exposure dose for dermal contact (mg/kg-day).
WExDo	Wadingexposure dose for incidental ingestion (mg/kg-day).

Table 5-8. Wading in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Child Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	WExDo (mg/kg-day)	WExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
CANCER EFFECTS								
						CSFo	CSFa	ELCR
VOCs								
Benzene	ND	0.67	NAP	8.3E-10	1.1E-08	2.9E-02	2.9E-02	3.5E-10
Methylene chloride	ND	0.0097	NAP	1.2E-11	1.6E-10	7.5E-03	7.5E-03	1.3E-12
Trichloroethene	ND	0.002	NAP	2.5E-12	3.3E-11	1.1E-02	1.1E-02	3.9E-13
PAHs								
Benzo(a)anthracene	ND	69	0.1	8.5E-09	1.4E-08	7.3E+00	NAP	6.2E-08
Benzo(b)fluoranthene	ND	39	0.1	4.8E-09	7.8E-09	7.3E+00	NAP	3.5E-08
Benzo(k)fluoranthene	ND	40	0.1	4.9E-09	8.0E-09	7.3E+00	NAP	3.6E-08
Benzo(a)pyrene	ND	48	1	5.9E-08	9.6E-08	7.3E+00	NAP	4.3E-07
Chrysene	ND	59	0.01	7.3E-10	1.2E-09	7.3E+00	NAP	5.3E-09
Dibenzo(a,h)anthracene	ND	2.4	1	3.0E-09	4.8E-09	7.3E+00	NAP	2.2E-08
Indeno(1,2,3-c,d)pyrene	ND	26	0.1	3.2E-09	5.2E-09	7.3E+00	NAP	2.3E-08
Inorganics								
Arsenic	ND	4.6	NAP	5.7E-09	3.1E-09	1.8E+00	1.8E+01	6.5E-08
Lead	ND	160	NAP	2.0E-07	6.4E-09	NAP	NA	NA
							ELCR	7E-07

Footnotes appear on page 4.

Table 5-8. Wading in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Child Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	WExDo (mg/kg-day)	WExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
NON-CANCER EFFECTS								
						RfDo	RfDa	HQ
VOCs								
Benzene	ND	0.67	NAP	5.8E-09	7.8E-08	NA	NA	NA
Ethylbenzene	ND	1.8	NAP	1.6E-08	2.1E-07	1.0E-01	1.0E-01	2.3E-06
Methylene chloride	ND	0.0097	NAP	8.4E-11	1.1E-09	6.0E-02	6.0E-02	2.0E-08
Toluene	ND	0.28	NAP	2.4E-09	3.3E-08	2.0E-01	2.0E-01	1.8E-07
Trichloroethene	ND	0.002	NAP	1.7E-11	2.3E-10	6.0E-03	6.0E-03	4.2E-08
Xylenes	ND	4.4	NAP	3.8E-08	5.1E-07	2.0E+00	2.0E+00	2.8E-07
Semi-VOCs								
Carbazole	ND	29	NAP	2.5E-07	NA	NA	NA	NA
Phenol	ND	31	NAP	2.7E-07	1.2E-05	6.0E-01	5.4E-01	2.2E-05
PAHs								
Acenaphthene	ND	110	NAP	9.5E-07	1.5E-06	6.0E-02	5.1E-02	4.6E-05
Acenaphthylene	ND	9.4	NAP	8.1E-08	1.3E-07	3.0E-02	2.6E-02	7.8E-06
Anthracene	ND	110	NAP	9.5E-07	1.5E-06	3.0E-01	2.6E-01	9.1E-06
Benzo(a)anthracene	ND	69	NAP	6.0E-07	9.7E-07	3.0E-02	2.6E-02	5.7E-05
Benzo(b)fluoranthene	ND	39	NAP	3.4E-07	5.5E-07	3.0E-02	2.6E-02	3.2E-05
Benzo(k)fluoranthene	ND	40	NAP	3.5E-07	5.6E-07	3.0E-02	2.6E-02	3.3E-05
Benzo(g,h,i)perylene	ND	11	NAP	9.5E-08	1.5E-07	3.0E-02	2.6E-02	9.1E-06
Benzo(a)pyrene	ND	48	NAP	4.2E-07	6.7E-07	3.0E-02	2.6E-02	4.0E-05
Chrysene	ND	59	NAP	5.1E-07	8.3E-07	3.0E-02	2.6E-02	4.9E-05

Footnotes appear on page 4.

Table 5-8. Wading in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Child Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	WExDo (mg/kg-day)	WExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
						RfDo	RfDa	HQ
PAHs (cont.)								
Dibenzo(a,h)anthracene	ND	2.4	NAP	2.1E-08	3.4E-08	3.0E-02	2.6E-02	2.0E-06
Dibenzofuran	ND	73	NAP	6.3E-07	1.0E-06	3.0E-02	2.6E-02	6.0E-05
Fluoranthene	ND	160	NAP	1.4E-06	2.2E-06	4.0E-02	3.4E-02	1.0E-04
Fluorene	ND	87	NAP	7.5E-07	1.2E-06	4.0E-02	3.4E-02	5.5E-05
Indeno(1,2,3-c,d)pyrene	ND	26	NAP	2.2E-07	3.6E-07	3.0E-02	2.6E-02	2.2E-05
2-Methylnaphthalene	ND	150	NAP	1.3E-06	2.1E-06	4.0E-02	3.4E-02	9.4E-05
Naphthalene	ND	320	NAP	2.8E-06	4.5E-06	4.0E-02	3.4E-02	2.0E-04
Phenanthrene	ND	260	NAP	2.2E-06	3.6E-06	3.0E-02	2.6E-02	2.2E-04
Pyrene	ND	130	NAP	1.1E-06	1.8E-06	3.0E-02	2.6E-02	1.1E-04
Inorganics								
Aluminum	ND	12,000	NAP	1.0E-04	5.6E-05	NA	NA	NA
Arsenic	ND	4.6	NAP	4.0E-08	2.1E-08	3.0E-04	2.9E-04	2.1E-04
Barium	ND	90	NAP	7.8E-07	4.2E-07	7.0E-02	4.9E-03	9.7E-05
Cadmium*	0.062	ND	NAP	1.1E-05	5.8E-07	5.0E-04	3.0E-05	4.1E-02
Chromium	ND	20	NAP	1.7E-07	9.3E-08	5.0E-03	1.0E-04	9.7E-04
Copper	ND	35	NAP	3.0E-07	1.6E-07	3.7E-02	2.2E-02	1.6E-05
Cyanide	ND	6.9	NAP	6.0E-08	3.2E-06	2.0E-02	9.4E-03	3.5E-04
Iron	0.15	20,000	NAP	2.0E-04	9.5E-05	NA	NA	NA
Lead	ND	160	NAP	1.4E-06	4.5E-08	NA	NA	NA
Manganese**	ND	280	NAP	2.4E-06	1.3E-06	1.4E-01	7.0E-03	2.0E-04
Mercury	0.00017	0.26	NAP	3.2E-08	4.7E-09	3.0E-04	3.0E-07	1.6E-02
Nickel	ND	26	NAP	2.2E-07	2.8E-08	2.0E-02	8.6E-04	4.4E-05

Footnotes appear on page 4.

Table 5-8. Wading in Keuka Lake Outlet Exposure Doses and Risk Calculations for a Hypothetical Child Visitor, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	Csed (mg/kg)	TEF	WExDo (mg/kg-day)	WExDd (mg/kg-day)	Toxicity Values Oral	Toxicity Values Dermal	Calculated Risk
						RfDo	RfDa	HQ
Inorganics (cont.)								
Sulfide/Sulfate	27	360	NAP	4.7E-03	2.5E-04	NA	NA	NA
Vanadium	ND	19	NAP	1.6E-07	8.9E-08	7.0E-03	7.0E-05	1.3E-03
Zinc	0.0068	130	NAP	2.3E-06	6.7E-07	3.0E-01	9.0E-02	1.5E-05
							HI	0.06

*	RfD for water used to assess exposure to water.
**	RfD for food used to assess exposure to sediment.
Csed	Constituent concentration in sediment (mg/kg) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration).
Csw	Constituent concentration in surface water (mg/L) (lesser of 95 percent upper confidence limit on the arithmetic average and maximum concentration).
ELCR	Excess lifetime cancer risk.
HI	Hazard index (sum of the HQs).
HQ	Hazard quotient.
NA	Not available.
NAP	Not applicable.
ND	Not detected.
PAHs	Polycyclic aromatic hydrocarbons.
Semi-VOCs	Semi-volatile organic compounds.
TEF	Toxicity equivalency factor.
VOCs	Volatile organic compounds.
WExDd	Wading exposure dose for dermal contact (mg/kg-day).
WExDo	Wading exposure dose for incidental ingestion (mg/kg-day).

Table 5-9. Calculated Interstitial Surface-Water Concentrations for Polycyclic Aromatic Hydrocarbons Detected in Keuka Lake Outlet Sediments, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csed (mg/kg)	Koc (L/kg)	Kd (L/kg)	Csw (mg/L)
Acenaphthene	110	4,600	354	0.311
Acenaphthylene	9.4	4,790	368	0.026
Anthracene	110	26,000	1,999	0.055
Benzo(a)anthracene	69	1,400,000	107,660	0.00064
Benzo(b)fluoranthene	39	550,000	42,295	0.00092
Benzo(k)fluoranthene	40	4,400,000	338,360	0.00012
Benzo(g,h,i)perylene	11	7,800,000	599820	0.000018
Benzo(a)pyrene	48	1,900,000	146,110	0.00033
Chrysene	59	240,000	18,456	0.0032
Dibenzo(a,h)anthracene	2.4	1,700,000	130,730	0.000018
Dibenzofuran	73	13,000	1000	0.073
Fluoranthene	160	42,000	3230	0.050
Fluorene	87	5,000	385	0.226
Indeno(1,2,3-cd)pyrene	26	31,000,000	2,383,900	0.00001
2-Mehtylnaphthalene	150	8,500	654	0.229
Naphthalene	320	3,160	243	1.317
Phenanthrene	260	38,900	2,991	0.087
Pyrene	130	135,000	10,382	0.013

L/kg Liters per kilogram.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Equation definition:

$$\text{Csw (mg/L)} = \frac{\text{Csed (mg/kg)}}{\text{Kd (L/kg)}}$$

where: Koc (L/kg) x foc (unitless)

and

foc = 0.0769

<u>Sample Calculation - acenaphthylene</u>

$$\text{Csw} = \frac{110\ \text{(mg/kg)}}{(4{,}600\ \text{L/kg}) \times (0.0769)}$$

$$= 0.311\ \text{mg/L}$$

Doc.1742\5-09POR.XLS\TAA:6/22/94

Table 5-10. Exposure Dose and Risk Equations and Sample Calculations for Fish Ingestion, Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Equation definition:

$$FExD_s = \frac{C_{sw} \times BCF \times IR_f \times SC \times EF \times ED}{BW \times AP}$$

Where:

AP	Averaging period (days/lifetime).
BCF	Bioconcentration factor (L/kg) (constituent-specific).
BW	Body weight (kg).
C_{sw}	Surface water concentration (mg/L).
ED	Exposure duration (years).
EF	Exposure frequency (days/year).
FExDs	Fish ingestion exposure dose (mg/kg/day).
IR_f	Fish ingestion rate.
SC	Source contribution (0.50).

Sample calculation - acenaphthene, non-cancer effects, adult:

$$FExD = \frac{(0.311 \text{ mg/L}) \times (242 \text{ L/kg}) \times (0.054 \text{ kg/day}) \times (0.50) \times (30 \text{ years}) \times (28 \text{ days/year})}{(70 \text{ kg}) \times (10{,}950 \text{ days/lifetime})}$$

$$= 2.2 \times 10^{-3} \text{ mg/kg-day}$$

$$HQ = \frac{2.2 \times 10^{-3} \text{ mg/kg-day}}{6 \times 10^{-2} \text{ mg/kg-day}}$$

$$= 0.037$$

Table 5-11. Exposure Doses and Risk Calculations for a Hypothetical Adult Visitor Ingesting Fish from Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	TEF	BCF (L/kg)	FExDo (mg/kg-day)	Toxicity Values	Calculated Risk
CANCER EFFECTS						
					CSFo	ELCR
PAHS						
Benzo(a)anthracene	0.00064	0.1	30	2.4E-08	7.3E+00	1.8E-07
Benzo(b)fluoranthene	0.00092	0.1	30	3.5E-08	7.3E+00	2.6E-07
Benzo(k)fluoranthene	0.00012	0.1	30	4.5E-09	7.3E+00	3.3E-08
Benzo(a)pyrene	0.00033	1	30	1.2E-08	7.3E+00	9.1E-08
Chrysene	0.0032	0.01	30	1.2E-07	7.3E+00	8.9E-07
Dibenzo(a,h)anthracene	0.000018	1	30	7.0E-10	7.3E+00	5.1E-09
Indeno(1,2,3-c,d)pyrene	0.000011	0.1	30	4.1E-10	7.3E+00	3.0E-09
					ELCR	1E-06
NON-CANCER EFFECTS						
					RfDo	HQ
PAHs						
Acenaphthene	0.311	NAP	242	2.2E-03	6.0E-02	3.7E-02
Acenaphthylene	0.026	NAP	30	2.3E-05	3.0E-02	7.7E-04
Anthracene	0.055	NAP	30	4.9E-05	3.0E-01	1.6E-04
Benzo(a)anthracene	0.00064	NAP	30	5.7E-07	3.0E-02	1.9E-05
Benzo(b)fluoranthene	0.00092	NAP	30	8.2E-07	3.0E-02	2.7E-05
Benzo(k)fluoranthene	0.00012	NAP	30	1.1E-07	3.0E-02	3.6E-06
Benzo(g,h,i)perylene	0.000018	NAP	30	1.6E-08	3.0E-02	5.3E-07
Benzo(a)pyrene	0.00033	NAP	30	2.9E-07	3.0E-02	9.8E-06
Chrysene	0.0032	NAP	30	2.8E-06	3.0E-02	9.5E-05
Dibenzo(a,h)anthracene	0.000018	NAP	30	1.6E-08	3.0E-02	5.3E-07
Dibenzofuran	0.073	NAP	NA	2.2E-06	3.0E-02	7.2E-05
Fluoranthene	0.05	NAP	1,150	1.7E-03	4.0E-02	4.3E-02

Footnotes appear on page 2.

Table 5-11. Exposure Doses and Risk Calculations for a Hypothetical Adult Visitor Ingesting Fish from Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	TEF	BCF (L/kg)	FExDo (mg/kg-day)	Toxicity Values	Calculated Risk
PAHs (cont.)					RfDo	HQ
Fluorene	0.226	NAP	30	2.0E-04	4.0E-02	5.0E-03
Indeno(1,2,3-c,d)pyrene	0.00001	NAP	30	8.9E-10	3.0E-02	3.0E-08
2-Methylnaphthalene	0.229	NAP	190	1.3E-03	4.0E-02	3.2E-02
Naphthalene	1.317	NAP	10.5	4.1E-04	4.0E-02	1.0E-02
Phenanthrene	0.087	NAP	30	7.7E-05	3.0E-02	2.6E-03
Pyrene	0.013	NAP	30	1.2E-05	3.0E-02	3.8E-04
Inorganics						
Cadmium**	0.062	NAP	64	1.2E-04	1.0E-03	1.2E-01
Iron	0.15	NAP	NA	4.4E-06	NA	NA
Mercury	0.00017	NAP	5,500	2.8E-05	3.0E-04	9.2E-02
Sulfide/Sulfate	27	NAP	NA	8.0E-04	NA	NA
Zinc	0.0068	NAP	47	9.5E-06	3.0E-01	3.2E-05
					HI	0.3

**	RfD for food used to assess fish ingestion.
BCF	Bioconcentration factor (L/kg).
CSFo	Cancer slope factor for oral exposure (kg-day/mg).
Csw	Surface-water concentration (mg/L).
ELCR	Excess lifetime cancer risk.
HI	Hazard index (sum of the HQs).
HQ	Hazard quotient.
FExDo	Fish ingestion exposure dose (mg/kg-day).
NA	Not available.
NAP	Not applicable.
PAHs	Polycyclic aromatic hydrocarbons.
RfDo	Reference dose for oral exposure (mg-kg/day).
Semi-VOCs	Semi-volatile organic compounds.
TEF	Toxicity equivalency factor.
VOCs	Volatile organic compounds.

Table 5-12. Exposure Doses and Risk Calculations for a Hypothetical Child Visitor Ingesting Fish from Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	TEF	BCF (L/kg)	FExDo (mg/kg-day)	Toxicity Values	Calculated Risk
CANCER EFFECTS						
					CSFo	ELCR
PAHS						
Benzo(a)anthracene	0.00064	0.1	30	1.5E-08	7.3E+00	1.1E-07
Benzo(b)fluoranthene	0.00092	0.1	30	2.2E-08	7.3E+00	1.6E-07
Benzo(k)fluoranthene	0.00012	0.1	30	2.8E-09	7.3E+00	2.0E-08
Benzo(a)pyrene	0.00033	1	30	7.7E-09	7.3E+00	5.6E-08
Chrysene	0.0032	0.01	30	7.5E-08	7.3E+00	5.5E-07
Dibenzo(a,h)anthracene	0.000018	1	30	4.3E-10	7.3E+00	3.1E-09
Indeno(1,2,3-c,d)pyrene	0.000011	0.1	30	2.5E-10	7.3E+00	1.9E-09
					ELCR	9E-07
NON-CANCER EFFECTS						
					RfDo	HQ
PAHs						
Acenaphthene	0.311	NAP	242	4.1E-03	6.0E-02	6.8E-02
Acenaphthylene	0.026	NAP	30	4.3E-05	3.0E-02	1.4E-03
Anthracene	0.055	NAP	30	9.0E-05	3.0E-01	3.0E-04
Benzo(a)anthracene	0.00064	NAP	30	1.0E-06	3.0E-02	3.5E-05
Benzo(b)fluoranthene	0.00092	NAP	30	1.5E-06	3.0E-02	5.0E-05
Benzo(k)fluoranthene	0.00012	NAP	30	2.0E-07	3.0E-02	6.5E-06
Benzo(g,h,i)perylene	0.000018	NAP	30	2.9E-08	3.0E-02	9.8E-07
Benzo(a)pyrene	0.00033	NAP	30	5.4E-07	3.0E-02	1.8E-05
Chrysene	0.0032	NAP	30	5.2E-06	3.0E-02	1.7E-04
Dibenzo(a,h)anthracene	0.000018	NAP	30	2.9E-08	3.0E-02	9.8E-07
Dibenzofuran	0.073	NAP	NA	4.0E-06	3.0E-02	1.3E-04
Fluoranthene	0.05	NAP	1,150	3.1E-03	4.0E-02	7.8E-02

Footnotes appear on page 2.

Table 5-12. Exposure Doses and Risk Calculations for a Hypothetical Child Visitor Ingesting Fish from Keuka Lake Outlet, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Csw (mg/L)	TEF	BCF (L/kg)	FExDo (mg/kg-day)	Toxicity Values	Calculated Risk
PAHs (cont.)					RfDo	HQ
Fluorene	0.226	NAP	30	3.7E-04	4.0E-02	9.2E-03
Indeno(1,2,3-c,d)pyrene	0.00001	NAP	30	1.6E-09	3.0E-02	5.5E-08
2-Methylnaphthalene	0.229	NAP	190	2.4E-03	4.0E-02	5.9E-02
Naphthalene	1.317	NAP	10.5	7.5E-04	4.0E-02	1.9E-02
Phenanthrene	0.087	NAP	30	1.4E-04	3.0E-02	4.7E-03
Pyrene	0.013	NAP	30	2.1E-05	3.0E-02	7.1E-04
Inorganics						
Cadmium**	0.062	NAP	64	2.2E-04	1.0E-03	2.2E-01
Iron	0.15	NAP	NA	8.2E-06	NA	NA
Mercury	0.00017	NAP	5,500	5.1E-05	3.0E-04	1.7E-01
Sulfide/Sulfate	27	NAP	NA	1.5E-03	NA	NA
Zinc	0.0068	NAP	47	1.7E-05	3.0E-01	5.8E-05
					HI	0.6

**	RfD for food used to assess fish ingestion.
BCF	Bioconcentration factor (L/kg).
CSFo	Cancer slope factor for oral exposure (kg-day/mg).
Csw	Surface-water concentration (mg/L).
ELCR	Excess lifetime cancer risk.
HI	Hazard index (sum of the HQs).
HQ	Hazard quotient.
FExDo	Fish ingestion exposure dose (mg/kg-day).
NA	Not available.
NAP	Not applicable.
PAHs	Polycyclic aromatic hydrocarbons.
RfDo	Reference dose for oral exposure (mg-kg/day).
Semi-VOCs	Semi-volatile organic compounds.
TEF	Toxicity equivalency factor.
VOCs	Volatile organic compounds.

Table 5-13. Blood Lead Levels in Children (Age 0 to 6), NYSEG Former Coal Gasification Site, Penn Yan, New York.

Medium	Concentration[a]	Blood Lead Levels[a] Geometric Mean µg/dL	Blood Lead Levels[a] Percent Below 10 µg/dL
Sediment Water Air	160 mg/kg 4.0 µg/L 0.20 µg/m³	2.5	100
Soil/Dust Water Air	340 mg/kg 4.0 µg/L 0.20 µg/m³	3.4	99.91

a Calculated using the USEPA model "LEAD5."
b 95 percent UCL on the mean of the lognormal distribution in sediment.
c Maximum detected concentration in sediments.
mg/kg Milligrams per kilogram.
ug/L Micrograms per liter.
ug/m³ Micrograms per cubic meter.

Table 7-1. Comparison of Inorganic Constituent Concentrations Detected in Keuka Lake Outlet Sediments t Sediment Screening Criteria, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Frequency (Detect/Total)	Range of Detects	NYSDEC Criteria LEL	NYSDEC Criteria SEL
Inorganics				
Aluminum	9/9	4,180-16,100	--	--
Arsenic	9/9	2.1-7.8	6.0	33
Barium	9/9	52.1-122	--	--
Chromium	9/9	10.7-23.5	26	110
Copper	9/9	13.3-55.7	16	110
Iron	9/9	10,200-24,200	20,000	40,000
Lead	9/9	21.8-340	31	110
Manganese	9/9	136-344	460	1,100
Mercury	5/9	ND-0.38	0.15	1.3
Nickel	9/9	13.0-27.4	16	50
Vanadium	9/9	11.0-24.9	--	--
Zinc	9/9	63.5-172	120	270

All concentrations in mg/kg.

Criteria were obtained from the NYSDEC - Division of Fish and Wildlife and Division of Marine Resources. guidance document entitled "Technical Guidance for Screening Contaminated Sediments - November 1993."

*	Sample quantitation limits for the non-detects equaled or exceeded the LEL for that constituent.
--	Criteria not given.
LEL	Lowest effect level.
ND	Analyte analyzed for, but not detected.
SEL	Severe effect level.

Table 7-2. Comparison of Organic Constituent Concentrations Detected in Keuka Lake Outlet Sediments to Sediment Screening Criteria, NYSEG Former Coal Gasification Site, Penn Yan, New York.

Constituent	Frequency (Detects/Total)	Range of Detects (mg/kg)	NYSDEC Benthic Aquatic Life Chronic Toxicity Criteria Norm. (µg/gOC)	NYSDEC Benthic Aquatic Life Chronic Toxicity Criteria 7.69% TOC (mg/kg)	NOAA Guidelines ER-L (mg/kg)	NOAA Guidelines ER-M (mg/kg)
VOCs						
Benzene	4/9	0.002-2.0	---	---	---	---
Ethyl benzene	4/9	0.008-3.9	---	---	---	---
Methylene chloride	4/9	0.01-0.01	---	---	---	---
Toluene	4/9	0.004-0.79	---	---	---	---
Trichloroethene	1/9	0.002	---	---	---	---
Xylene (total)	4/9	0.022-10.0	---	---	---	---
Semi-VOCs						
Carbazole	7/9	0.14-70	---	---	---	---
Phenols, total chlorinated*	7/9	1.8-86	0.6	0.046	---	---
PAHs						
Acenaphthene	8/9	0.1-270	140	10.8	0.15	0.65
Acenaphthylene	6/9	0.12-25	---	---	---	---
Anthracene	8/9	0.4-290	---	---	0.085	0.96
Benzo(a)anthracene	8/9	1.4-160	---	---	0.23	1.60
Benzo(b)fluoranthene	8/9	1.3-83	---	---	---	---
Benzo(k)fluoranthene	8/9	1.1-97	---	---	---	---
Benzo(g,h,i)perylene	4/9	0.47-32	---	---	---	---
Benzo(a)pyrene	8/9	1.2-110	---	---	0.40	2.50
Chrysene	8/9	1.5-140	---	---	0.40	2.80
Dibenzo(a,h)anthracene	4/9	0.7-5.6	---	---	0.06	0.26
Dibenzofuran	7/9	2.8-180	---	---	---	---
Fluoranthene	8/9	32.6-380	1020	78.4	0.60	3.60
Fluorene	7/9	4.1-210	---	---	0.035	0.64
Indeno(1,2,3-cd)pyrene	8/9	0.9-57	---	---	---	---
2-Methylnaphthalene	6/9	5.9-370	---	---	0.065	0.67
Naphthalene	7/9	0.1-820	---	---	0.34	2.10
Phenanthrene	8/9	1.9-620	120	9.2	0.225	1.38
Pyrene	8/9	2.9-300	---	---	0.35	2.20

Footnotes appear on page 2

NYSDEC Criteria Sample Calculation - Acenaphthene, assuming 1% TOC in sediment:

10.8 mg/kg = 140 μg/gOC x 76.9 gOC/kg x 1 mg/1,000 μg

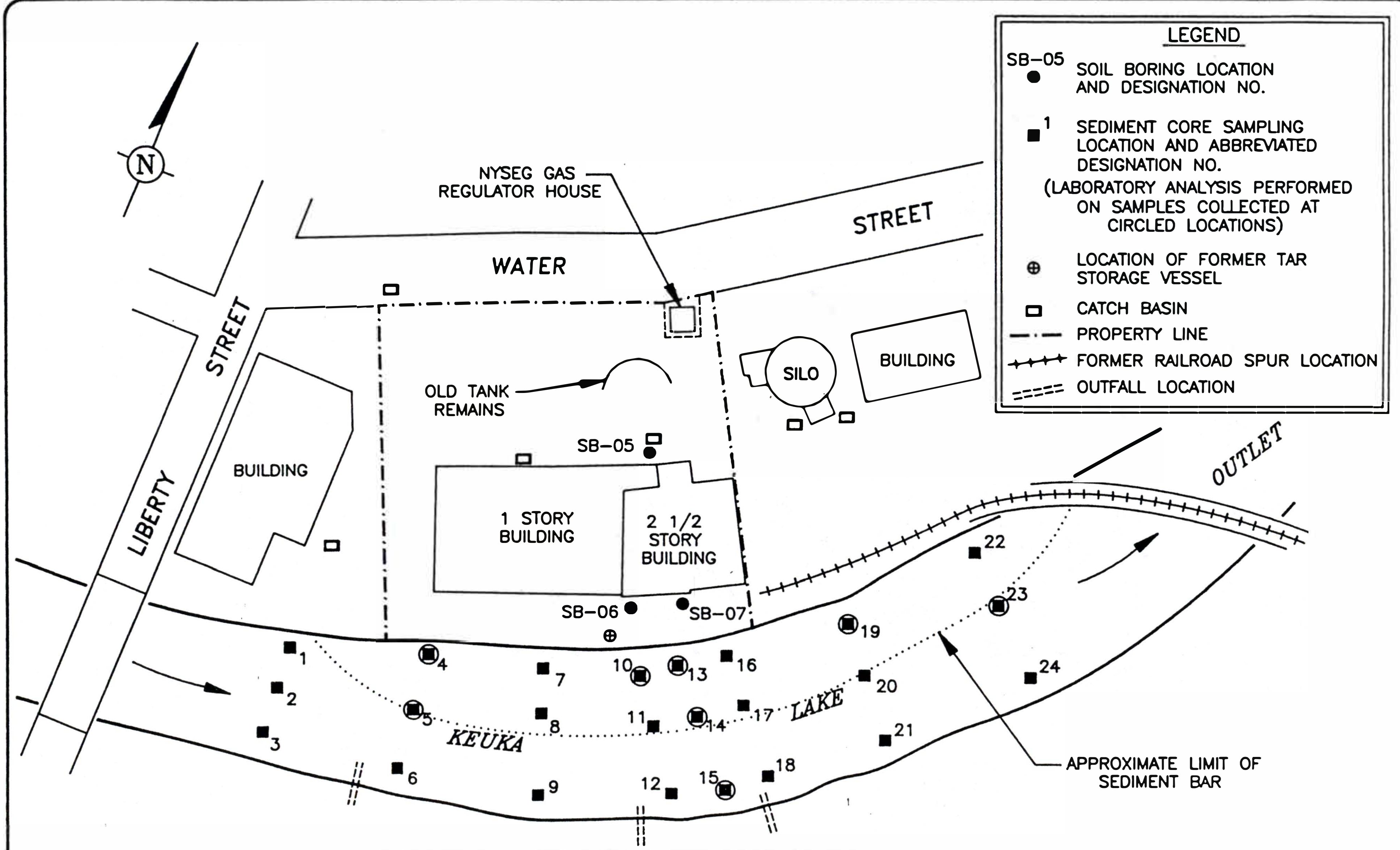
NYSDEC criteria were obtained from the Divison of Fish and Wildlife and Division of Marine Resources guidance document entitled "Technical Guidance for Screening Contaminated Sediments - November 1993".

Phenols were included in this analysis as they behave similarly to non-polar organic compounds in the sediment.

NOAA Guidelines were obtained from NOAA Technical Memorandum NOS OMA 52 entitled "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program" (Long and Morgan, 1990).

*	Sample quantitation limits for the two non-detects exceeded criteria at both TOC levels.
---	Criteria not available.
ER-L	Effects Range-Low, refers to the lower 10 percentile concentration observed or predicted to be associated with biological effects for a particular constituent.
ER-M	Effects Range-Medium, refers to the median concentration observed or predicted to be associated with biological effects for a particular constituent.
μg/gOC	Micrograms per gram of organic carbon.
mg/kg	Milligrams per kilogram.
NOAA	National Oceanic and Atmospheric Administration.
Norm.	Refers to constituent-specific sediment criteria normalized for sediment TOC.
PAH	Polycyclic aromatic hydrocarbon.
Semi-VOC	Semi-volatile organic compound.
TOC	Total organic carbon.
7.69% TO	Refers to sediment criteria with 7.69 percent total organic carbon.
VOC	Volatile organic compound.

DATE: DEC. 1993	PRJCT. NO.: AY0153002	FILE NO.:	CAD FILE: G183	COMPILER: P. HOLLOWAY	MGR.: P. HOLLOWAY	DRAFTER: TAD/FJF

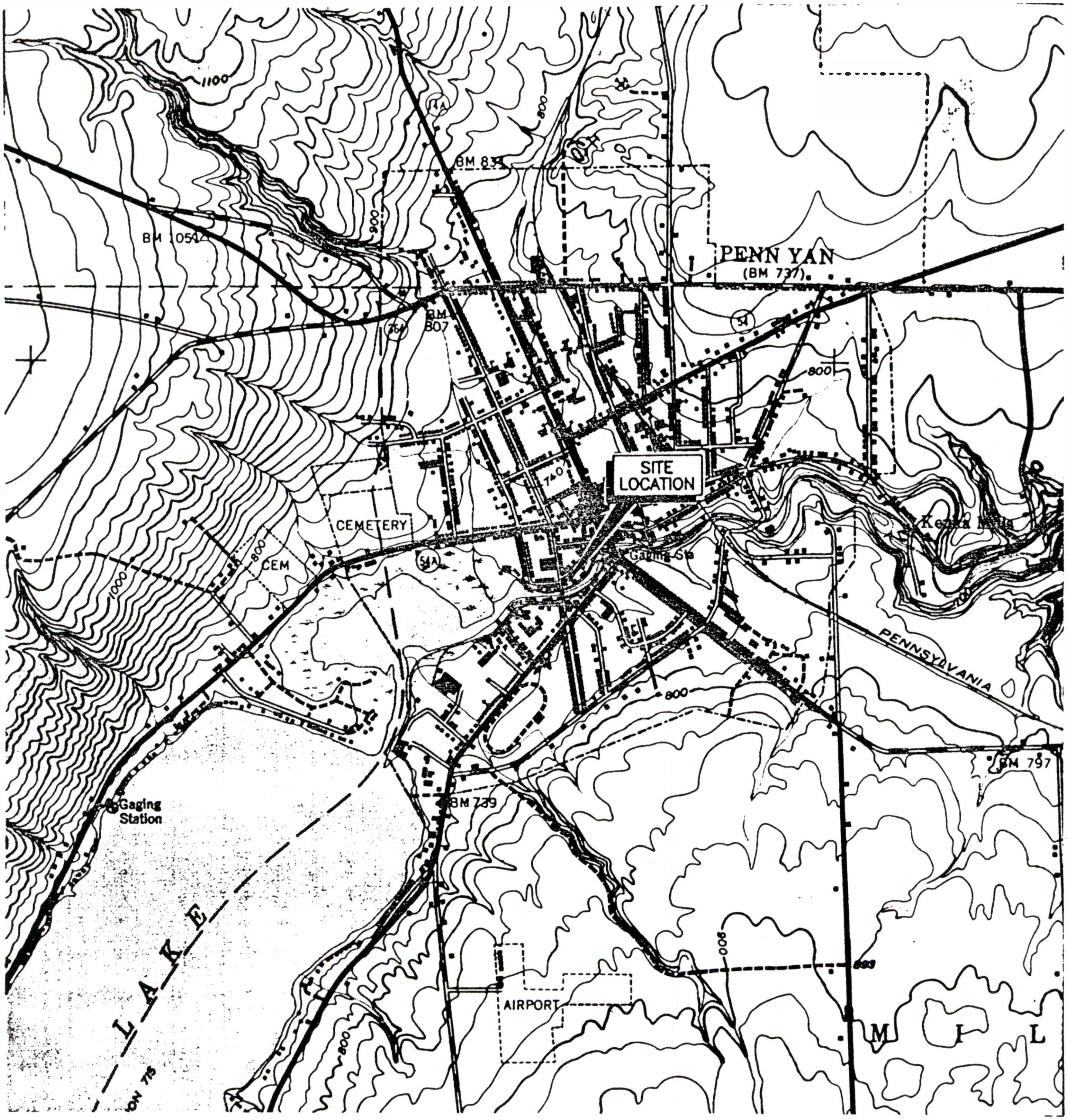


0 80
SCALE IN FEET

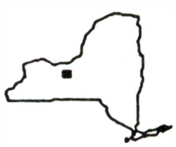
GERAGHTY & MILLER, INC.
Environmental Services

SOIL AND SEDIMENT BORING LOCATIONS
NYSEG SUPPLEMENTAL INVESTIGATION OF A FORMER MGP SITE
WATER STREET, PENN YAN, NEW YORK

FIGURE 2



QUADRANGLE LOCATION



SCALE

0 0.25 0.50

MILES

N

(SOURCE: PENN YAN, NEW YORK 7.5 MINUTE U.S.G.S. TOPOGRAPHIC QUADRANGLE, 1942 (1978))

GERAGHTY & MILLER, INC.
Environmental Services

SITE LOCATION

NYSEG
MGP SITE PENN YAN, NEW YORK

FIGURE
1

DWG DATE: 28MAR93 | PRJCT NO.: 50118AY | FILE NO.: 1=1' | DRAWING: NYSEG-03