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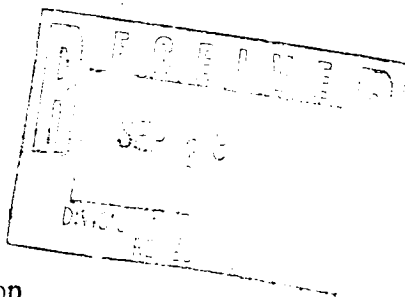
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

SEP 22 1998

EXPRESS MAIL

Mr. Edward R. Belmore, P.E.
Director
Bureau of Western Remedial Action
Division of Hazardous Waste Remediation
New York State Department of Environmental
Conservation (NYSDEC)
50 Wolf Road
Albany, NY 12233



RECEIVED

JUL 16 2002

NYSDEC - REG. 9
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REL UNREL

Re: Record of Decision (ROD), DuPont Necco Park Site

Dear Mr. Belmore:

Enclosed please find two copies of the signed ROD for the DuPont Necco Park Site, Niagara Falls, New York. Thank you for your efforts and those of your staff in helping us meet our 1998 Fiscal Year ROD commitment.

Sincerely yours,

John E. La Padula, P.E., Chief
New York Remediation Branch

Enclosure

cc: Dave Foster, NYSDEC
G. Anders Carlson, NYSDOH (1 copy)

RECORD OF DECISION

DuPont Necco Park Site

City of Niagara Falls and Town of Niagara,
Niagara County, New York

United States Environmental Protection Agency
Region II

September 1998

DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION--

DuPont Necco Park Site

City of Niagara Falls and Town of Niagara

Niagara County, New York

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the DuPont Necco Park Site, which was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision document explains the factual and legal basis for selecting the remedy for the Source Area (as defined herein).

The New York State Department of Environmental Conservation (NYSDEC) concurs with the selected remedy. A letter of concurrence from the NYSDEC is attached to this document (Appendix IV).

The information supporting this remedial action decision is contained in the administrative record for this Site. The index for the administrative record is attached to this document (Appendix III).

ASSESSMENT OF THE SITE

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

DESCRIPTION OF THE SELECTED REMEDY

The remedy described in this document for the DuPont Necco Park Site will address contaminants in the landfill soils and dense non-aqueous phase liquid (DNAPL) in the soils and bedrock which represent continuing sources of contamination to the groundwater. This action will require long-term management to maintain the groundwater pump and treat systems and groundwater monitoring to determine the effectiveness of the containment measures in reducing contaminant concentrations in the far-field aquifer.

The major components of the selected remedy include the following:

1. Containment of the Source Area by:

- upgrading the existing cap to meet New York State Part 360, or equivalent standards;
- using hydraulic measures in the overburden (A zone) to maintain an inward gradient within the Source Area or installing a physical barrier (e.g., slurry wall, sheet pile) on the southern, and portions of the eastern and western Necco Park property boundaries; and
- using hydraulic measures in the bedrock (B-F zones) to maintain an inward gradient within the Source Area and prevent the movement of contaminated groundwater beyond the Source Area boundary.

The control of the contaminated groundwater will be achieved through the installation, operation, and maintenance of the groundwater extraction wells (and, optionally, a physical barrier in the overburden). The exact number, size, depth, and pumping rates of these wells will be determined in the remedial design of the selected remedy.

2. Treatment of the extracted groundwater from the Source Area, either on-site or off-site, to achieve the appropriate discharge requirements. Currently, groundwater extracted from the Site is treated at the adjacent CECOS wastewater treatment plant. Expansion of the CECOS facility would likely be required to accommodate the increased volume of water to be treated under this remedy. The need to either expand the CECOS facility, build an on-site facility, or utilize another off-site facility for groundwater treatment will be determined during the design.

3. Collection of DNAPL in the Source Area by:

- utilizing the existing monitoring wells network;
- utilizing any groundwater recovery wells placed in the Source Area; and
- the installation of additional dedicated DNAPL recovery well(s).

Collected DNAPL would be disposed of off-site at an appropriate facility.

4. Operation and maintenance (O&M) of the existing systems and the systems constructed under this selected remedy.

5. Comprehensive monitoring to verify hydraulic control, identify DNAPL occurrence, demonstrate the effectiveness of the remedial measures, and assess the impact of such measures on far-field groundwater quality. Existing monitoring wells on the Necco Park property will be used to monitor the performance of the groundwater extraction system and establish that sufficient control occurs. Additional monitoring wells may be required. The need for such additional wells will be determined during the design and implementation of the groundwater extraction system.

6. Additional characterization of the Site to assess whether natural attenuation will be effective in addressing far-field contamination.

7. Development and implementation of institutional controls to restrict Site access, the use of groundwater at the Site, and control land use such that it is consistent with Site conditions.

DECLARATION OF STATUTORY DETERMINATIONS

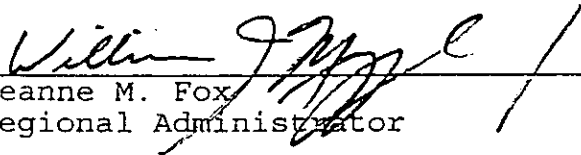
The selected remedy meets the requirements for remedial actions set forth in CERCLA §121, 42 U.S.C. §9621, is protective of human health and the environment, and is cost-effective. The remedy utilizes permanent solutions and treatment technologies to the maximum extent practicable, given the scope of the action, and will permanently reduce the toxicity, mobility, or volume of contaminants at the Site. In addition, the actions to address contamination at the Necco Park Site comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action.

Remediation of the DNAPL contaminated soils, bedrock and groundwater in the Source Area of the Necco Park Site is considered to be technically impracticable from an engineering perspective. Therefore, this ROD waives the federal and State drinking water standards and State groundwater quality standards for the groundwater in the Source Area. The waiver is issued pursuant to Section 121(d)(4)(C) of CERCLA, 42, U.S.C. § 9621(d)(4)(C), and §300.430(f)(1)(ii)(C)(3) of the NCP. There are technical limitations which make it impracticable to recover all of the DNAPL from the Necco Park Source Area. Removal of all the DNAPL would require the excavation of more than 1,000,000 cubic yards of landfill materials (soils and fill) from the Necco Park and adjacent BFI landfills. In addition, DNAPL has migrated into the fractured bedrock beneath the Necco Park landfill, adjacent CECOS secure hazardous waste cells, and the adjacent BFI landfill. No current technology exists to completely remove the DNAPLs from the fractured bedrock medium. Since it is technically impracticable to excavate this area, and current technologies for the removal of all of the DNAPLs from the fractured bedrock are unavailable, DNAPL impacted soil, bedrock and groundwater will remain at the Site.

Because DNAPLs contribute to dissolved phase contamination, restoration of groundwater in the Source Area of the Necco Park Site has been determined to be technically impracticable.

EPA believes that the selected remedy for the Source Area at the Necco Park Site is protective of human health and the environment. Recognizing that groundwater restoration in the Source Area is technically impracticable, the goal of this remedial action is to establish hydraulic control of the contaminated groundwater within the Source Area, and to prevent groundwater and DNAPLs from migrating beyond the Source Area by utilizing hydraulic barriers (and, optionally, a physical barrier in the overburden [A zone]). This action complies with federal and State requirements that are applicable or relevant and appropriate to this remedial action (other than those requirements which are being waived as described in the preceding paragraph) and is cost-effective. The selected remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable, and it satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

Because this remedy will result in hazardous substances remaining on the Site above health-based levels, a review of this remedial action, pursuant to CERCLA §121(c), 42 U.S.C. §9621(c), will be conducted within five years after commencement of remedial action, and every five years thereafter, to ensure that the remedy continues to provide adequate protection of human health and the environment.



Jeanne M. Fox
Regional Administrator

9/18/94

Date

ROD FACT SHEET

SITE

Site name: DuPont Necco Park Site

Site location: City of Niagara Falls and Town of Niagara, Niagara County, New York

ROD

Selected remedy: Source containment through upgrading and expanding the existing cap, optional installation of an overburden physical barrier, groundwater pump and treat, additional DNAPL collection and additional Site characterization.

Capital cost: \$7,837,136.

O&M cost: \$4,614,775.

30-year present-worth cost: \$57,264,743.

Total Cost: \$65,102,000.

LEAD

United States Environmental Protection Agency

Primary Contact: Michael Negrelli, (212) 637-4278

Secondary Contact: Kevin M. Lynch (212) 637-4287

Main PRPs: DuPont Chemical Corporation

WASTE

Waste type: Various industrial and hazardous wastes including volatile, semi-volatile, inorganics and tentatively identified compounds (TICs).

Waste origin: Chemical manufacturing and processing.

Estimated waste quantity: Groundwater: Estimated volume to be pumped and treated annually is 73,584,000 gal. Contaminated Landfill Soils: approximately 1,000,000 cubic yds.

Contaminated medium: Groundwater, soils, and bedrock.

RECORD OF DECISION
DECISION SUMMARY

DuPont Necco Park Site

City of Niagara Falls and Town of Niagara, Niagara County, New York

United States Environmental Protection Agency
Region II
New York, New York

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SITE NAME, LOCATION AND DESCRIPTION

The 24-acre Necco Park landfill is an inactive hazardous and industrial waste landfill located approximately 1.5 miles north of the Niagara River in the City of Niagara Falls and the Town of Niagara, Niagara County, New York (Figures 1 and 2). The landfill, located off of Pine Avenue near 56th Street in Niagara Falls, was originally used as a recreational park by the Niagara Electrochemical Company, from which "Necco" is derived. The property was sold to DuPont in 1930.

Necco Park is located in a heavily industrialized section of Niagara Falls and is bounded on three sides by commercial disposal facilities. Immediately adjacent to the north and east lies the Newco solid waste landfill, an active nonhazardous waste facility owned by Browning-Ferris Industries (BFI) ("BFI facility"). Immediately adjacent to the south are three inactive secure hazardous waste landfill cells and a wastewater treatment facility owned by CECOS International, Inc. ("CECOS facility"). An access road and a Conrail (Niagara Junction Railway Company) right-of-way bound the landfill to the west. The nearest residential neighborhoods are located approximately 2,000 feet to the south and 2,500 feet to the west, respectively.

Wastes from the Necco Park landfill have migrated in the overburden and bedrock underneath the landfill and now extend underneath the CECOS facility and a portion of the BFI facility. The Necco Park Site ("Necco Park Site" or "Site") consists of the 24-acre landfill and the areas surrounding the landfill where hazardous substances in the soil, bedrock and the groundwater from the landfill have come to be located.

Regional Physiography

Regional Soil

Unconsolidated overburden material in the Niagara Falls area consists of glacially derived sand, silt, and clay and miscellaneous fill. Natural unconsolidated overburden deposits, in ascending order from top of bedrock to top of grade, can be divided into the following three units (Figure 3): glacial till; glaciolacustrine sediment; and recent alluvium.

Regional Bedrock Geology

The western New York region is underlain by a thick succession of Paleozoic sedimentary rocks that form the northern flank of the Allegheny Basin. The Niagara Falls area is underlain by strata representing Ordovician and Silurian systems. The upper Ordovician, represented by the Queenston Formation, consists of a thick, laterally extensive, soft red-brown mudstone with minor sandstone beds. The Silurian system is represented, from oldest to youngest, by the Medina, Clinton, and Lockport Groups.

Topographically, the western New York region is relatively flat. The three most prominent topographic features in the area include the Niagara Gorge, Niagara Escarpment, and Onondaga Escarpment. The Niagara and Onondaga Escarpments coincide with exposures of two relatively resistant bedrock units, the Lockport Dolomite and Onondaga Limestone.

Vertical fractures related to regional stress patterns are present in the Lockport Formation, particularly in the upper 20 or 30 feet of the Lockport Dolomite, where a high degree of weathering has occurred. Where joints have been further opened through dissolution, they act as vertical and horizontal conduits of groundwater between bedding-plane fracture zones. Near the bedrock surface, joints tend to be open and well developed. However, they become relatively tight and poorly developed at depth. The frequency of vertical fractures may vary with depth between areas.

Horizontal fracture zones coincident with various bedding planes are distributed throughout the Lockport Formation. In the Niagara Falls area, bedding-plane fracture zones tend to be horizontally continuous and can be traced for several miles. Numerous investigations have illustrated that these horizontal bedding-plane fracture zones are primary pathways for groundwater movement through the Lockport Formation.

Regional Hydrogeology

Groundwater in the Lockport Formation flows generally toward the Niagara Gorge and the lower Niagara River. The Niagara River downstream of Niagara Falls receives discharge from the bedrock groundwater flow system. The Niagara River upstream of Niagara Falls acts as a groundwater recharge area. However, studies demonstrate that the New York Power Authority (NYPA) conduits and several sewers/tunnels act as regional groundwater sinks. Groundwater entering the conduit drainage system near the Necco Park Site may flow either to the south where a portion infiltrates the Falls Street tunnel where these structures intersect, or to the north where the water may eventually discharge to the Forebay Canal through bedrock fractures. The dry weather flow of the Falls Street tunnel discharges to the Niagara Falls Publically Owned Treatment Works (POTW), where the effluent is treated (discussed in greater detail, below).

Groundwater flows horizontally and, to a lesser extent, vertically in the Lockport Formation. Horizontal flow occurs predominantly through bedding-plane fracture zones. These water-bearing bedding-plane fracture zones are primary conduits for groundwater flow through the Lockport Formation. The bedding-plane fracture zones have been found to be areally extensive and affect groundwater flow for distances of several miles.

The groundwater aquifer in the Niagara area is classified by New York State as class GA fresh groundwaters. As defined in New York State Codes, Rules and Regulations (NYCRR), Title 6, Part 701.15, the best usage of class GA fresh groundwaters is as a source of potable water supply. Upper zones of the Lockport Formation were historically used as potable water supplies. However, groundwater sources are not generally used for domestic purposes in the Niagara region because of the close proximity to the large fresh water supply of the Niagara River. No known domestic wells are present in the areas downgradient of the Site at this time. Groundwater withdrawal from the Lockport Formation in the Niagara Falls area is generally limited to industrial cooling water use or for groundwater remediation purposes.

The regional groundwater quality of the Lockport Formation has been heavily affected by industrial sources of contamination. In addition to the Necco Park Site, other sites have been identified as contributors to groundwater contamination in the region.

Man-made Passageway Capture Zones

Groundwater flow in the bedrock regime is greatly influenced by a number of man-made features. These include water transport and storage structures related to the NYPA Robert Moses Power Project, several sewers and tunnels excavated into bedrock and the overburden, bedrock grouting, and groundwater extraction. Each of these features has varying effects on regional and near-Site groundwater flow.

Completed in the early 1960s, the NYPA Robert Moses Power Project water diversion and storage structures have a great influence on regional groundwater flow. Components having the greatest effect are: the NYPA conduits, which transport water north to the Robert Moses Power Generating Stations; the Forebay Canal, an L-shaped excavation linking the conduits to the generating stations; and the storage reservoir, a 2.97-square mile surface impoundment east of the Forebay Canal (Figure 4).

The NYPA conduits consist of twin buried tunnels of poured concrete constructed in parallel trenches 52 feet wide. The depth of the NYPA conduits varies between 100 feet (at the intake structures) and 160 feet (near the Forebay Canal) below ground surface, well into bedrock. Each conduit is jacketed by a drain system that is in direct contact with the bedrock and is designed to balance hydrostatic pressure on the conduit walls. The drain system jacket is hydraulically connected to the conduit structures at two locations. Each location uses weirs to balance hydraulic head in the NYPA conduits and surrounding jacket.

Studies of regional groundwater flow in the Niagara Falls area by the United States Geological Survey (USGS) indicate that the conduit drain system acts as a line discharge for groundwater in

the upper Lockport Formation along its entire length. Groundwater in the upper Lockport Formation both east and west of the conduit flows toward the conduits and into the conduit drain system.

The Forebay Canal is an unlined excavation into bedrock approximately 4,000 feet long, 500 feet wide, and 110 feet deep. Water enters the Forebay Canal through conduits, where it is either diverted to the Robert Moses Generating Station or to the reservoir, depending on the power generation schedule. Daily water levels in the Forebay Canal fluctuate as much as 25 feet during low flow conditions in the Niagara River, which occur during summer and fall. The Forebay Canal is in hydraulic communication with the conduit drain system through bedding-plane fracture zones exposed in the walls of the Forebay Canal.

The Falls Street tunnel also has a great influence on bedrock groundwater flow in the Niagara Falls area. A gravity-fed sewer constructed in the early 1900s, it extends 16,000 feet from 56th Street and John Street to the lower Niagara River near the Rainbow Bridge. For most of its length, it is an unlined rock tunnel. Used as a combined sewer for decades, in 1985 it was converted to a storm sewer. Where the Falls Street tunnel crosses the NYPA conduits, it is a 500-foot section of 84-inch diameter concrete pipe, 300 feet of which is encased in a concrete vault. A study conducted in 1987 by the city of Niagara Falls identified the 500-foot section of the Falls Street tunnel where it crosses the conduits as the major groundwater discharge location for an 11-square-mile area, the north/south axis of which coincides with the NYPA conduits. Current estimates are that 4 to 5 million gallons per day (mgd) of infiltration enter the Falls Street tunnel in the vicinity of Falls Street tunnel/NYPA conduits intersection.

At a minimum, an undetermined amount of groundwater flowing south from the Necco Park Site in the upper bedrock zones (B and C zones, discussed below) has the potential to, or does, enter the Falls Street tunnel. Currently, 100% of dry weather flow in the tunnel goes to the Niagara Falls POTW. However, during wet-weather flow (i.e., storm event), a portion of the flow in the Falls Street tunnel bypasses the POTW and discharges directly to the Niagara River. Also, groundwater flowing west from Necco Park in the middle and lower bedrock zones (D through G zones) has the potential to, or does, enter the NYPA conduit drain system. Water in the drain system may flow north, towards the Forebay Canal, or south, towards the Falls Street tunnel.

As discussed above, there is a degree of hydraulic connection between the NYPA conduit drain system and the Falls Street tunnel where the two structures cross. It is believed that water from the conduit drain system enters the Falls Street tunnel at this intersection which is located southwest of the Site. There is currently insufficient information to determine the direction of flow in the NYPA conduit drains on a continual basis. It is

believed that fluctuations in water volume used by the NYPA creates changes in flow direction in the NYPA conduit drainage system. Therefore, any groundwater contamination from the Necco Park Site that may enter the conduit drainage system has the potential to flow either to the north where it may discharge to the Forebay Canal through bedrock fractures, or to the south where at least a portion of the water enters the Falls Street tunnel.

Loadings to the Niagara River and Lake Ontario

As stated previously, a portion of the contaminated groundwater from the Site enters the Niagara River which flows into Lake Ontario. During the 1970s, it became apparent that pollution caused by persistent toxic substances was harming Great Lakes species and posing risks to human and wildlife consumers of fish. Accordingly, the Great Lakes Water Quality Agreement of 1978 was signed between the United States and Canada which commits the two countries to "virtually eliminate" persistent toxic substances in the Great Lakes ecosystem.

To address this contamination and chemical loadings to the Niagara River, a Four-Party Agreement was signed in 1987. The four parties [Environment Canada, EPA, Ontario Ministry of the Environment, and New York State Department of Environmental Conservation (NYSDEC)] committed to reducing, by 50 percent by 1996, toxic loadings entering the Niagara River. As a result, most of the dry weather flow in the Falls Street tunnel was diverted to the Niagara Falls POTW in 1989. Since 1993, all dry-weather flow and an undetermined amount of wet-weather flow is directed to the POTW, where it is treated prior to discharging to the Niagara River.

It is estimated that the 50 percent reduction goal in loadings of certain toxic chemicals to the Niagara River (set forth in the Four-Party Agreement of 1987) has been accomplished through remedial actions taken to date at several hazardous waste sites, including Necco Park, and by the 1993 diversion of all dry-weather flow in the Falls Street tunnel to the Niagara Falls POTW. However, during wet-weather flow, at least some of the flow in the Falls Street tunnel bypasses the POTW and discharges directly to the Niagara River. In addition, contaminated groundwater has the potential to move untreated into the Forebay Canal, and subsequently the Niagara River. Therefore, further actions to reduce the loadings, which is in keeping with the "virtual elimination" goal, need to be conducted at the Site.

To accomplish the objective of "virtual elimination", the International Joint Commission in 1990 urged the United States and Canada to develop "a comprehensive, binational program to lessen the uses of, and exposure to persistent toxic chemicals found in the Great Lakes environment." Since that time, both countries have undertaken their own virtual elimination efforts. In addition, in February 1995, Prime Minister Chretien and President Clinton

confirmed the commitment by the U.S. and Canada to work together to develop a binational strategy to reduce and eventually eliminate the input of the most persistent toxic substances in the Great Lakes environment. The binational strategy was approved for implementation by Environment Canada and EPA in 1997.

Site Physiography

Site Geology

Three geologic units exist beneath the Necco Park Site. These units include unconsolidated overburden, the Lockport Formation, and the Rochester Shale Formation. The Lockport Formation underlies unconsolidated overburden deposits. In general, the top of bedrock is relatively unweathered. The Lockport Formation within the study area ranged in thickness from 142 to 151 feet. The Rochester Shale is a non-permeable formation which underlies the Lockport Formation.

Site Hydrogeology

A series of horizontal bedding-plane fracture zones in the Lockport Formation similar to those described for the region have been delineated at the Necco Park Site. Groundwater beneath the Site flows in the overburden under unconfined conditions and in the separate, fairly continuous bedding-plane fracture zones in dolomite bedrock of the Lockport Formation under confined conditions.

These fracture zones behave as separate and hydraulically distinct water-producing units. Letter designations were assigned to these principal water-bearing zones as follows: the A zone refers to saturated overburden and the B, C, CD, D, E, F, and G zones refer to identified Lockport Formation bedding-plane fracture zones (Figure 5). The interface between the basal member of the Lockport Formation and Rochester Shale is defined as the J zone. Based on hydraulic conductivity testing, the J zone was determined not to be a significant water-producing zone.

Overburden is defined as the A zone. As a consequence of the low hydraulic conductivity (1×10^{-7} cm/sec) estimated for those areas of the A zone where most liquid disposal occurred, groundwater in the overburden tends to flow vertically downward to the more transmissive bedrock units.

The upper Lockport, which includes water-producing fracture zones in approximately the upper 30 feet of the Lockport Dolomite, corresponds to the B and C zones at the Necco Park Site. Groundwater in the B and C zones generally flows to the south in areas beyond the radius of influence of the operational recovery well system. Although the Falls Street tunnel is located southwest

of the Site and flow in the study area is to the south, the hydraulic influence of the Falls Street tunnel may extend some distance east of the Falls Street tunnel/John Street sewer intersection. Therefore, although insufficient information is available to determine the exact flow path, a portion of B and C zone groundwater ultimately discharges to the Falls Street tunnel.

Groundwater in the D, E, and F zones generally flows in a westerly direction toward the NYPA power conduits. This groundwater is intercepted by the conduit drain system.

The piezometric map for the G zone generally indicates that hydraulic gradients are low. The primary flow direction appears to be west/northwest toward the groundwater discharge boundary at the NYPA conduits. However, some easterly components have been observed, usually during water-level fluctuations in the Forebay Canal.

Construction of a grout curtain in the bedrock zones was completed at the Site in 1989. It was designed to reduce the rate of bedrock groundwater flow beneath the Site from upgradient areas and enhance efficiency of on-Site groundwater recovery operations. As a result of the grout curtain installation, it appears that cones of depression associated with recovery wells RW-1 and RW-2 have been enlarged under the same pumping rates.

Recovery well RW-3 was installed after the grout curtain completion. Results of a well RW-3 pumping study indicate that consistent operation of recovery well RW-3 at its optimal pumping rate of 4 gpm causes drawdown in the D, E, and F zones in the eastern portion of the Necco Park Site.

SITE HISTORY AND ENFORCEMENT ACTIVITIES

The Necco Park landfill was used for the disposal of industrial and process wastes generated at the DuPont Niagara Plant from the mid-1930's until 1977. Specific knowledge of activities at the Site prior to 1964 is limited. Available evidence indicates that approximately 186 million pounds of liquid and solid industrial wastes were disposed of at the Site. The following wastes were disposed of in the largest quantities:

- Fly ash
- Building demolition and miscellaneous plant debris
- Sodium sludge waste salts, cell bath, and floor sweepings (i.e., barium, calcium, and sodium chloride)
- Sodium cell rubble (i.e., thermal brick, corroded steel)
- Polyvinyl acetate solids and stilling bottoms (i.e., vinyl acetate with high-boiling tars)
- Chlorinolysis wastes (i.e., high-boiling residues such as hexachlorobenzene, hexachlorobutadiene, and hexachloroethane)

- Liming residues (i.e., sludge saturated with tri- and tetrachloroethene (TCE and PCE))
- Scrap organic mixtures, off-grade product
- Glycol polymer (Terathane) scrap (i.e., filter press cloth, filter press sludge)
- Refined adiponitrile wastes (high-boiling residues)

These wastes were reported to contain hazardous substances such as carbon tetrachloride, chloroform, hexachlorobenzene, hexachlorobutadiene, hexachloroethane, methylene chloride, PCE, and TCE. Liquid wastes were generally disposed of in shallow earthen lagoons on the southeastern portion of the landfill, while the remainder of the landfill functioned primarily as a solid waste landfill.

Wastes from the Necco Park landfill have migrated in the overburden and bedrock underneath the landfill and now extend underneath the CECOS facility and a portion of the BFI facility. The "Site" consists of the 24-acre landfill and the areas surrounding the landfill where hazardous substances from the landfill have come to be located.

As a result of this disposal, soils at the landfill and groundwater beneath and downgradient from the landfill have been contaminated. Contamination at the Site is found as aqueous phase liquids (APL, i.e., dissolved in water) and as non-aqueous phase liquids (NAPL, i.e., occurs as a separate phase and does not readily dissolve in water; in this case, dense NAPL or DNAPL, i.e., heavier than water). Areas of soil contamination exist above levels that would be considered protective of groundwater quality. Groundwater contamination is above New York State (NYS) groundwater standards.

In 1977, the Site was identified as a potential source of groundwater contamination and the landfill was closed. In February 1977, the State requested that DuPont take action to correct groundwater contamination at the Site. Groundwater investigations were initiated in September 1977. Since that time, several investigations and remedial studies have been conducted. Preliminary investigations by DuPont's contractors (Calspan, 1978; Recra Research, 1979; Roy F. Weston, 1978, 1979, 1981, 1982; and Woodward-Clyde, 1984) focused on assessing conditions in the immediate vicinity of Necco Park and establishing a groundwater recovery operation.

Previous Response Actions

Several response actions were implemented to mitigate the impact and spread of contamination. These remedial actions are identified in Figure 6 and are described as follows:

During 1978 and 1979, a clay cap was constructed over the 24-acre site. The final compacted cover consisted of a minimum of 18 inches of clay. Data collected from soil borings at the Site indicate that the average cap thickness is approximately 24 inches. The cap is overlain by a 6-inch cover of topsoil and grass.

In 1982, two existing monitor wells (D-12 and 52) were converted to recovery wells (RW-1 and RW-2) to control off-Site migration of contaminated groundwater in the upper bedrock fracture zones (B and C zones). Extracted groundwater is pumped to a CECOS commercial wastewater treatment facility located adjacent to Necco Park where it is treated and discharged to the Niagara Falls POTW. Wells RW-1 and RW-2 have been used as recovery wells from 1982 to the present.

Under optimal conditions, wells RW-1 and RW-2 are pumped at an average rate of 10 to 15 gallons per minute (gpm) and 5 to 10 gpm, respectively. However, mechanical difficulties have curtailed continuous operation of well RW-2, particularly from early 1992 through 1993. Efforts to improve the system's operational efficiency, including pump and line replacement and construction of an automated acid addition system for well RW-2, were undertaken. Initial evaluations of the recovery well network's effectiveness indicated that under continuous operation, the wells created a hydraulic barrier across the entire southern perimeter of the Necco Park property in the first two bedrock water-bearing zones (B and C zones). However, after additional monitoring wells were installed during subsequent investigations, a reevaluation of the recovery well system's effectiveness revealed that some off-site flow from these two zones was occurring, particularly along the eastern property boundary in the C zone. The primary influence of well RW-2 was observed in the B zone, and the primary influence of well RW-1 was observed in the C zone.

To enhance the groundwater pumping system's effectiveness, a grout curtain, termed Subsurface Formation Repair (SFR), was constructed from July 1988 through September 1989 (Figures 6 and 7). The SFR extends along the entire western and northern perimeter of the Necco Park property and to just over one-half of the eastern perimeter. The southern perimeter and southern portion of the eastern perimeter were left ungrouted due to the possible presence of DNAPL and to allow for recovery of contamination that had migrated beyond the Necco Park property boundary. To reduce the potential for an upgradient increase in the water-table elevation in the overburden, the upper 10 feet of bedrock were not grouted on the northern perimeter.

Post remedial investigation data indicates that wells RW-1 and RW-2 and the SFR have reduced off-Site migration of contamination in the B and C zones. In 1992, a third recovery well, RW-3, was installed and began operation at the Necco Park Site. Well RW-3 penetrates the D, E, and F zones, is located at the center of the southern Necco Park property line, and is pumped at an average rate of 3.5

to 4 gpm. When well RW-3 is pumped continuously, a shallow cone of depression extending throughout the central portions of the Necco Park property is observed in the D, E, and F zones.

Annual groundwater sampling and analytical testing is conducted at 38 monitoring wells on or near the Necco Park property. Groundwater monitoring systems are currently in place at the CECOS and BFI facilities, in accordance with State and federal regulations, to assure protection of human health and the environment as a result of operation of those facilities.

Investigations

A number of supplemental investigation and remedial studies needed to design and implement a remedial program were conducted from 1984 to 1988. DuPont and EPA agreed to a Consent Decree (as a settlement of a civil action filed by DuPont in federal district court seeking judicial review of an Administrative Order issued by EPA under Section 3013 of the Resource Conservation and Recovery Act (RCRA)) that specified additional investigations pertaining to the Necco Park Site. The Consent Decree was entered by the court in January 1988. DuPont had commenced most of the work required by the Consent Decree before it was entered into judgment, and the work specified in the Consent Decree was completed by February 1989. This work included: an evaluation of existing monitoring wells; monitoring well seal verification; installation of new monitoring wells; development of a geologic report; characterization of vertical fracturing (lineament study); development and refinement of a Site-specific indicator parameter list for groundwater and NAPLs; groundwater and NAPL sampling; a man-made passageway investigation; an historic drainageway investigation; and development of a health and safety plan. The results of these investigations are presented in the Necco Park Interpretive Report (Woodward-Clyde (WCC) 1991). EPA approved the Interpretive Report in July 1992.

In October 1989, an Administrative Order on Consent pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) was signed by EPA and DuPont. This Order required DuPont to conduct additional investigations beyond those performed pursuant to the 1988 Consent Decree, and to analyze remedial alternatives to address the contamination at the Site. These investigations included: additional groundwater monitoring; sampling for 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD); further investigation of vertical fracturing (lineament investigation); assessment of the current remedial actions; sampling of underground man-made passageways; and further assessment for the presence of NAPLs. This work began in May 1991 and was completed in September 1992. The results of these investigations are presented in the Necco Park Investigation Report (IR, WCC 1993). EPA approved the Investigation Report in May 1994.

Based on the information collected during the investigation and from previous investigations, EPA performed a Risk Assessment which examined the potential human health and environmental risks attributable to the contaminants present at the Site. EPA considered both present risks and potential future risks from the Site. A summary of the Risk Assessment is presented below.

An analysis of alternatives was then conducted to identify, develop, screen, and evaluate response action alternatives to address the contamination and potential health risks identified by the Necco Park Investigation and EPA's Risk Assessment and Addendum to the Risk Assessment. This analysis of remedial alternatives is presented in the Analysis of Alternatives (AOA) Report. The AOA Report was approved by the EPA in June 1996.

HIGHLIGHTS OF COMMUNITY PARTICIPATION

The IR, AOA Report, and the Proposed Plan for the Site were released to the public for comment on July 22, 1996. These documents were made available to the public in the administrative record file at the EPA Docket Room in Region II, New York and the information repository at EPA's Public Information Office, 345 Third Street, Suite 530, Niagara Falls, New York. The notice of availability for the above-referenced documents was published in the "Niagara Gazette" on July 22 and July 24, 1996. The public comment period was held from July 22, 1996 to August 20, 1996. In response to a request, the comment period was extended 30 days to September 19, 1996. A notice was published in the Niagara Gazette on August 23, 1996 announcing the extension of the public comment period.

On August 13, 1996, EPA and NYSDEC conducted a public meeting at the Best Western Inn on the River, 7001 Buffalo Avenue, Niagara Falls, New York to inform local officials and interested citizens about the Superfund process, to review current and planned remedial activities at the Site, and to respond to any questions from area residents and other attendees. Responses to the comments received at the public meeting and in writing during the 1996 public comment period are included in the Responsiveness Summary, Part I (see Appendix V).

The nature of the comments received during the 1996 public comment period were unsupportive both from the general public, who felt the preferred alternative was not comprehensive enough, and from DuPont, which felt that additional remedial actions were not necessary. As a result, EPA reconsidered the preferred alternative. Following discussions with DuPont, and keeping the comments of the general public in mind, EPA developed a modified preferred alternative that is fully protective of human health and the environment and is supported by DuPont in its commitment to implement the modified remedy.

The modified preferred alternative was detailed in a Revised Proposed Plan. This document was released to the public for comment on February 28, 1998, along with the Responsiveness Summary, Part I, from the 1996 comment period. These documents were made available for review in the administrative record file at the information repositories at EPA's Region II office and at EPA's Niagara Falls Public Information Office. The notice of availability for the Revised Proposed Plan was published in the "Niagara Gazette" on February 28, 1998. The public comment period was held from February 28, 1998 to March 29, 1998. In response to a request, the comment period was extended 60 days to May 28, 1998. A notice was published in the Niagara Gazette on March 30, 1998 announcing the extension of the public comment period.

On March 12, 1998, EPA conducted a second public meeting at the Best Western Inn on the River to inform local officials and interested citizens about the modified preferred alternative and to respond to any questions from area residents and other attendees. Responses to the comments received at the public meeting and in writing during the 1998 public comment period are included in the Responsiveness Summary, Part II (see Appendix V), which is part of this ROD. This decision document represents the selected remedial action for source control for the DuPont Necco Park Site in Niagara County, New York, chosen in accordance with CERCLA, as amended, and to the extent practicable, the NCP. The decision for this Site is based on the administrative record.

SCOPE AND ROLE OF OPERABLE UNIT

In order to evaluate various alternatives and deal with the most contaminated areas at the Site first, the Site was subdivided into two areas of concern:

- The Source Area: An area associated with Necco Park acting as a continuing source of constituent migration to the downgradient aqueous environment was identified. The primary criterion for defining the source area was the areal extent of free-phase or residual DNAPL. To be conservative, in addition to areas where DNAPLs were observed to be present, areas where aqueous constituent levels might theoretically indicate the presence of DNAPLs were included using various solubility criteria. The source area, therefore, includes: the 24-acre Necco Park landfill itself, areas where DNAPLs have been observed to be present, and areas where the concentration of aqueous phase contaminants in the groundwater indicate that DNAPL may be present (Figure 8).
- Far-field Area: The far-field is the large area outside the source area (Figures 9-15) where chemical constituents attributable to the Necco Park Site have been found to have contaminated the groundwater. The far-field aqueous plume is

defined as the plume of dissolved contaminants downgradient of the source area. Transport modeling of dissolved constituents was conducted to supplement available monitoring well data to estimate horizontal spreading in the far-field.

This ROD addresses the source area. The EPA is proposing this action to eliminate or reduce the contribution of DNAPLs, contaminated soil and bedrock, and contaminated groundwater in the source area to the degradation of the groundwater quality in the far-field. The IR identified groundwater at the Necco Park Site above NYS groundwater quality standards, NYS drinking water standards and federal maximum contaminant levels (MCLs). The IR has also identified soils on the property that need to be addressed to protect the groundwater quality. Therefore, the selected remedy will implement hydraulic control/containment of the groundwater and DNAPLs in the source area (with the option of including physical control/containment for the A zone), and the physical containment of soil in the source area. Further characterization of the groundwater in the far-field area will be performed to determine the effectiveness of the source control remedy in eliminating further contribution to the far-field area and determine the ability of natural attenuation to achieve the groundwater standards in the far-field.

The EPA and NYSDEC are currently coordinating activities concerning the groundwater contamination that is present at other sites in the Niagara Falls area and adjacent to Necco Park. These sites are being managed by using source control measures (e.g., groundwater pump and treat, capping, etc.) as well.

SUMMARY OF SITE CHARACTERISTICS

The IR, combined with previous studies, resulted in the characterization of the environmental conditions at the Necco Park Site. Sampling of all media including air, soil, surface water, sediment and groundwater has identified areas of potential environmental concern. The following briefly summarizes the results of the sampling conducted during the Investigation:

Soil Vapor: The potential for volatile organic contaminant (VOC) vapors to infiltrate basement structures in the downgradient communities was examined in an attachment to the Risk Assessment. Based on actual contaminant levels in groundwater, modeling was performed to estimate the concentrations of vapors that could potentially infiltrate basements. The results of the contaminant vapor analysis did not indicate any current potential for VOC vapors in the soil or groundwater to pose a human health risk via basement infiltration.

Drainage Swale Sediments: The sediments from the drainage swales contained very low levels (low parts per billion (ppb) range) of

chemicals associated with surface water runoff before the landfill was capped. These sediments contained contaminants at levels below concentrations considered protective of groundwater. On at least one occasion, the sediments have been excavated, tested, and disposed of properly.

Surface Water: The surface water existing in the drainage swales in between the Necco Park landfill and the CECOS/BFI landfills contained very low levels (low ppb range) of chemical constituents due to surface water runoff from the landfill areas.

Soils and DNAPLs: The soils at the Necco Park landfill are known to contain a variety of contaminants associated with past disposal of industrial and hazardous wastes. Soil borings were performed at more than 90 locations across the Necco Park property for the installation of monitoring wells and recovery wells, DNAPL investigations, and soil characterization. The investigation identified occurrences of chemicals in the surface soil throughout the Necco Park property. Soils in specific areas of the former landfill on the Necco Park property contained DNAPLs. The soil borings performed to date indicate the presence of DNAPLs in the southeastern and western portions of the Necco Park property. The presence of contaminants and DNAPLs in the soils constitutes a threat to groundwater (i.e., contamination levels are sufficiently high such that potentially contaminants can continue to go into solution and enter the groundwater system). The soils and DNAPLs in the source area represent "hot spots" or concentrated areas of contamination which act as continuing sources of groundwater contamination.

Groundwater: A total of approximately 150 monitoring wells have been installed at the Site. Some of these wells were installed prior to, and some were installed as part of, the Investigation. Based on the sampling conducted prior to, and during the Investigation, the evidence indicates that groundwater beneath the Necco Park property contains chemical constituents above NYS drinking water standards, NYS groundwater quality standards and EPA MCLs. Groundwater containing Site indicator parameters (Table 1) is moving downgradient from the Necco Park property. In the upper bedrock zones (B and C zones), groundwater flows to the south-southwest, and in the lower bedrock zones (D through G zones), groundwater flows to the west (Figures 9 - 15). Concentrations of Site indicator parameters in the groundwater are very high (high parts per million (ppm) range) directly beneath, and immediately adjacent to, the Necco Park property. Chemical concentrations diminish as the groundwater flows south and west away from the property. Available information from the IR and other previous studies indicates there are regional occurrences of chloroethylenes and that additional sources of these contaminants are present outside the extent of the Necco Park property.

Man-made Passageways: Several man-made passageways (i.e. sewers, sumps, etc.) were sampled including: the 61st Street sewer, dewatering sumps at Great Lakes Carbon, John Street tunnel, Falls Street tunnel, New Road tunnel and the New York Power Authority (NYPA) conduit drain system. The 61st Street sewer samples contained only chloroform at very low (<10 ppb) levels. VOCs were detected up to a maximum of 160 ppb in four of five of the Great Lakes Carbon sumps that penetrated the upper bedrock (B zone). No VOCs were detected in the sumps that penetrated only the overburden. The John Street Tunnel had no Site indicator parameter detections; however, other organic compounds including 2-butanone, acetone, and bis(2-ethylhexyl)phthalate were detected. A variety of organic compounds were detected in both the Falls Street Tunnel and the New Road Tunnel up to a maximum of 140 ppb, including several Site indicator parameters. Several Site indicator parameters were also detected in all three of the NYPA drain system monitoring wells sampled. Concentrations of organic compounds detected ranged from 0.13 to 1,100 ppb.

Hydrogeology: The geologic units beneath the Necco Park Site (in descending order from the ground surface) are: unconsolidated overburden, the Lockport Formation, and the Rochester Shale Formation. A series of horizontal bedding-plane fracture zones in the Lockport Formation similar to those described for the region has been delineated at the Site. These fracture zones behave as separate and hydraulically distinct water-producing units. Letter designations were assigned to these principal water-bearing zones as follows: the A zone refers to saturated overburden and the B, C, CD, D, E, F, and G zones refer to identified Lockport Formation bedding-plane fracture zones (Figure 5). The interface between the basal member of the Lockport Formation and Rochester Shale is defined as the J zone. Based on hydraulic conductivity testing, the J zone was determined not to be a significant water-producing zone.

Groundwater in the A zone generally flows vertically downward, feeding the bedrock aquifers.

Groundwater in the B and C zones generally flows to the south in areas beyond the radius of influence of the operational recovery well system.

Groundwater in the D, E, F, and G zones generally flows in a westerly direction toward the NYPA power conduit drainage system.

The piezometric map for the G zone generally indicates that hydraulic gradients are very low. The primary flow direction appears to be west/northwest toward the groundwater discharge boundary at the NYPA conduit drainage system.

The groundwater aquifer in the Niagara area is classified by the State as class GA fresh groundwaters. As defined in NYCRR, Title

6, Part 701.15, the best usage of Class GA fresh groundwaters is as a source of potable water supply. However, groundwater sources currently are not used for domestic purposes in the Niagara region because of the proximity to the large fresh water supply of the Niagara River.

The regional groundwater quality of the Lockport Formation has been heavily affected by industrial sources of contamination. In addition to the Necco Park Site, numerous other major sites have been identified as contributing to groundwater contamination in the region.

Man-made Passageway Capture Zones: Groundwater flow in the bedrock regime is greatly influenced by a number of man-made features. These include water transport and storage structures related to the NYPA Robert Moses Power Project, several sewers and tunnels excavated into bedrock and the overburden, bedrock grouting, and groundwater extraction. Each of these features has varying effects on regional and near-Site groundwater flow.

Components having the greatest effect are the NYPA conduits and conduit drain system, which transport water north to the Robert Moses Power Generating Station; the Forebay Canal, an L-shaped excavation linking the conduits to the generating station; the storage reservoir, a 2.97-square-mile surface impoundment east of the Forebay Canal (Figure 4); and the Falls Street tunnel, an unlined sewer in the upper bedrock of the Lockport formation.

Based on all available data, B and C zone groundwater leaving Necco Park flows south towards the Falls Street tunnel and D through G zone groundwater flows west towards the NYPA conduit drain system. A portion of the groundwater that collects in the drain system west of Necco Park discharges to the Falls Street tunnel through bedrock fractures and is conveyed through the tunnel for treatment at the Niagara Falls POTW.

At a minimum, an undetermined amount of groundwater flowing south from the Necco Park Site in the B and C zones has the potential to, or does, enter the Falls Street tunnel. Currently, 100% of dry weather flow in the tunnel goes to the POTW. However, a portion of the wet-weather flow in the Falls Street tunnel bypasses the POTW and discharges directly to the Niagara River.

Groundwater flowing west from Necco Park in the D through G zones has the potential to, or does, enter the NYPA conduit drain system. There was a direct hydraulic connection between the NYPA conduit drain system and the Falls Street tunnel where the two structures cross. This connection was grouted by the City of Niagara Falls in 1989. Notwithstanding this grouting project, it is believed that water from the drainage system continues to enter the Falls Street tunnel at, and in the vicinity of, this intersection which is located southwest of Necco Park. However, there is currently

insufficient information to determine whether the direction of flow in the NYPA conduit drain system is towards the Falls Street tunnel on a continual basis. It is believed that fluctuations in water used by the NYPA create changes in flow direction in the NYPA conduit drainage system. Therefore, any groundwater contamination from the Site that may enter the conduit drainage system has the potential to flow either to the north where it may discharge to the Forebay Canal through bedrock fractures, or to the south where at least a portion of the water enters the Falls Street tunnel.

Loadings to the Niagara River and Lake Ontario: As stated previously, an unquantified portion of the contaminated groundwater from the Site enters the Niagara River which flows into Lake Ontario. During the 1970s, it became apparent that pollution caused by persistent toxic substances was harming Great Lakes species and posing risks to human and wildlife consumers of fish. Accordingly, the United States and Canada entered into the Great Lakes Water Quality Agreement of 1978 which committed the two countries to the "virtual elimination" of persistent toxic substances in the Great Lakes ecosystem.

In 1987, the four environmental agencies representing the federal, state, and provincial governments in the United States and Canada entered into the Four-Party Agreement which committed the governments to the overall reduction of toxic chemical loadings to the Niagara River. In particular, the parties committed to an interim goal for the reduction by 50 percent of the total point and non-point source loadings of persistent toxic chemicals of concern entering the Niagara River by 1996.

In 1987, portions of the groundwater from at least seven hazardous waste sites, including the Necco Park Site, had infiltrated the Falls Street tunnel and was discharged from the tunnel directly to the Niagara River without treatment. The Falls Street tunnel was reconnected to the Niagara Falls POTW in 1989 with a diversion of part of the flows in the tunnel to the POTW. Since 1993, all dry-weather flow and an unquantified amount of flow from storm events in the Falls Street tunnel is directed to the POTW, where it is treated prior to discharge to the Niagara River. The redirection of Falls Street tunnel flows to the POTW constituted one of the most significant reductions in loadings to the Niagara River towards attainment of the interim goal of 50 percent reduction of persistent toxic chemicals of concern to the Niagara River.

To accomplish the final objective of "virtual elimination", the International Joint Commission in 1990 urged the United States and Canada to develop "a comprehensive, binational program to lessen the uses of, and exposure to persistent toxic chemicals found in the Great Lakes environment." Since that time, both countries have undertaken their own virtual elimination efforts. In addition, in February 1995, Prime Minister Chretien and President Clinton confirmed the commitment by the U.S. and Canada to work together to

develop a binational strategy to reduce and eventually eliminate the input of the most persistent toxic substances in the Great Lakes environment. The binational strategy was approved for implementation by Environment Canada and EPA in 1997.

Groundwater and DNAPLs: Two different groundwater areas have been defined for purposes of evaluating remedial options in the Necco Park AOA: a DNAPL zone (source area) and a dissolved contamination zone (far-field area).

Source Area Definition:

The source area has been defined as the area associated with Necco Park acting as a continuing source of constituent migration to the downgradient aqueous environment. The primary criterion for defining the source area was the areal extent of free-phase or residual DNAPL. To be conservative, areas where aqueous constituent levels might theoretically indicate the presence of DNAPL were included using various solubility criteria.

The Necco Park source area is presented in Figure 8. This defined area is considered the source of the far-field aqueous plume for purposes of defining the far-field area.

Far-Field Area Definition:

The far-field area is defined as the aqueous plume of dissolved VOCs downgradient of the source area. Figures 9 through 15 show the estimated extent of dissolved contamination for the A through G zones, respectively. To evaluate remedial alternatives for the far-field, the extent of dissolved constituents was derived using transport modeling to supplement available monitoring well data to estimate horizontal spreading in the far-field.

Nature and Extent of Contamination: As part of the 1988 Consent Decree, a list of indicator parameters for the Necco Park Site was identified (Table 1). Overburden, bedrock, and groundwater at the Site have been impacted by past waste disposal activities. Most groundwater contamination at the Site is the result of the dissolution of disposed chlorinated organic liquids. DNAPLs have been observed and recovered from wells in and near the Necco Park property. Inorganic constituents disposed of at the Site are also present in groundwater.

Groundwater in and near the Necco Park Site has been impacted by organic compounds, primarily chlorinated VOCs and semivolatile organic compounds (SVOCs).

No other media associated with the Site (air, sediment, or surface water) have been shown to be significantly contaminated.

In summation, the results of the Investigation conducted at the DuPont Necco Park Site indicate the past disposal activities has contaminated the soils, bedrock and groundwater at the Site. Sampling indicates the presence of volatile organic, semi-volatile organic and inorganic contaminants in the form of DNAPLs and APLs in the landfill and adjacent soils as well as in the bedrock above levels considered protective of groundwater quality. These constituents have contaminated a large area of groundwater beneath and downgradient of the Necco Park landfill.

SUMMARY OF SITE RISKS

The following Tables are included in Appendix II for the risk assessment discussion below:

Table 2a:

Contaminants of concern are included in Table 2a.

Table 2b:

Exposure pathways considered, pathways quantitatively evaluated clearly distinguishing between current and future land-uses, populations evaluated (i.e., children, adults) and the rationale for selection or exclusion of a pathway.

Table 2c:

Noncarcinogenic toxicity values-oral and inhalation and subchronic, if applicable and sources of toxicity information.

Table 2d:

Noncarcinogenic risk estimates for each exposure pathway and receptor assessed. Total Site risk.

Table 2e:

Carcinogenic toxicity values - oral and inhalation, if applicable and sources of toxicity information.

Table 2f:

Carcinogenic risk estimates for each exposure pathway and receptor assessed.

Table 2g:

Contaminants of concern used in the environmental evaluation (assessment of risk to non-human receptors).

Table 2h:

List of exposure assumptions.

Table 2i:

List of species in ecologically significant habitats.

Table 2j:

Estimated concentration of groundwater contaminants discharged to the Niagara River through the Falls Street tunnel (before Niagara River dilution).

Table 2k:

Estimated concentration of groundwater contaminants discharged to the Forebay Canal through the NYPA conduit drain system.

Table 2l:

Estimated concentration of groundwater contaminants discharged to the Niagara River through the Falls Street tunnel and the Forebay Canal.

Table 2m:

Surface water ecological risk summary.

Based upon the results of the IR and previous reports, a baseline risk assessment was conducted to estimate the risks associated with current and future Site conditions. The baseline risk assessment estimates the human health and ecological risk which could result from the contamination at the Site if no remedial action were taken. Some of the groundwater contamination from the Site has the potential to enter the Niagara River and ultimately Lake Ontario. Contamination of the fish and ecosystem in the Lake Ontario basin has been an ongoing concern to both the United States and Canada and has resulted in a strategy to "virtually eliminate" persistent toxic substances that affect or have the potential to affect the Great Lakes ecosystem. It is important to note that the risk assessment evaluated the risks from the Necco Park Site contaminants only. Total ecological risks or synergistic effects posed from other contaminants present in the Niagara River and Lake Ontario basin were not evaluated.

EPA conducted a baseline risk assessment to evaluate the potential risks to human health and the environment associated with the DuPont Necco Park Site in its current and future states. The Risk Assessment focused on contaminants in the groundwater which are likely to pose significant risks to human health and the environment. Air, surface water, sediments, soils and biota (fish)

were also evaluated. The summary of the contaminants of concern (COC) in sampled matrices are listed in Table 2a for human health receptors and Table 2g for environmental receptors.

Human Health

EPA's baseline risk assessment addressed the potential risks to human health by identifying several potential exposure pathways by which the public may be exposed to contaminant releases at the Site under current and future land-use conditions. Air, soil, sediment, surface water, and groundwater exposures were assessed either qualitatively or quantitatively for both present and future land-use scenarios. As discussed above, groundwater can be found in several different bedrock zones (B-G zones, Figure 5). Since some of these zones are hydraulically similar, the risk assessment grouped several of these bedrock zones together for the purposes of the risk characterization. The groundwater pathway was divided into three groups: the A-C zones (overburden and upper bedrock), the D-F zones (middle bedrock) and the G zone (lower bedrock). The contaminants of concern for human health receptors are listed in Table 2a.

The current land-use scenario quantitatively evaluated the potential for volatilization of groundwater contaminants into the basements of residents. The current land-use scenario qualitatively evaluated ingestion of, and dermal contact with, Necco Park drainage ditch sediments by Site workers and trespassers. The current land-use scenario also qualitatively evaluated ingestion of, and dermal contact with, Niagara River surface water. Finally, the current land-use scenario considered the ingestion of fish from the Niagara River by residents. The exposure pathways considered under current and future uses are listed in Table 2b. The reasonable maximum exposure was evaluated.

The future land-use scenarios quantitatively evaluated the groundwater ingestion, inhalation and dermal contact pathways for adult residents. A list of exposure assumptions for these scenarios are listed in Table 2h. Inhalation of volatile vapors from groundwater infiltrating basements was qualitatively evaluated. Necco Park drainage ditch sediment ingestion and dermal contact as well as dermal contact with the drainage ditch surface waters by Site workers and trespassers were evaluated qualitatively under the future land-use scenario. Ingestion and dermal contact of Niagara River surface water were also qualitatively evaluated under the future land-use scenario. Finally, the future land-use scenario considered the ingestion of fish from the Niagara River by residents.

Under current EPA guidelines, the likelihood of carcinogenic (cancer-causing) and noncarcinogenic effects due to exposure to Site chemicals are considered separately. It was assumed that the toxic effects of the Site-related chemicals would be additive.

Thus, carcinogenic and noncarcinogenic risks associated with exposures to individual compounds of concern were summed to indicate the potential risks associated with mixtures of potential carcinogens and noncarcinogens, respectively.

Noncarcinogenic risks were assessed using a hazard index (HI) approach, based on a comparison of expected contaminant intakes and safe levels of intake (Reference Doses). Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects. RfDs, which are expressed in units of mg/kg-day, are estimates of daily exposure levels for humans which are thought to be safe over a lifetime (including sensitive individuals). The reference doses for the compounds of concern at the Site are presented in Table 2c. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) are compared to the RfD to derive the Hazard Quotient for the contaminant in the particular medium (The Hazard Quotient acquires a numerical value by dividing the chronic daily intake (CDI) by the RfD.) The HI is obtained by adding the hazard quotients for all compounds across all media that impact a particular receptor population.

An HI greater than 1.0 indicates that the potential exists for noncarcinogenic health effects to occur as a result of Site-related exposures. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media. A summary of the noncarcinogenic risks associated with these chemicals across various exposure pathways is found in Table 2d.

It can be seen from Table 2d that the HIs for noncarcinogenic effects from groundwater ingestion under the reasonable maximum exposure for adults in the three different groundwater pathways are 1×10^4 (10,000) for the A-C zones (upper bedrock), 3×10^3 (3,000) for the D-F zones (middle bedrock) and 1×10^2 (100) for the G zone (lower bedrock). Therefore, noncarcinogenic effects may occur from the exposure routes evaluated in the Risk Assessment. The noncarcinogenic risk was attributable to several compounds including carbon tetrachloride, chloroform, trichloroethane, cis-1,2-dichloroethene, barium and 1,1,2-trichloroethane. HIs were also generated for dermal contact with the groundwater from the various bedrock zones. The noncarcinogenic effects from dermal contact for the upper, middle and lower bedrock zones were calculated to be 3×10^3 (3000), 9×10^2 (900) and 3×10^1 (30), respectively. Noncarcinogenic risk associated with inhalation of volatilized groundwater contaminants could not be determined because there are no EPA-approved inhalation toxicity values (RfDs) for the contaminants detected.

Potential carcinogenic risks were evaluated using the cancer slope factors developed by EPA for the contaminants of concern. Cancer slope factors (SFs) have been developed by EPA's Carcinogenic Risk

Assessment Verification Endeavor for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. SFs, which are expressed in units of $(\text{mg/kg-day})^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day , to generate an upper-bound estimate of the excess lifetime cancer risk associated with exposure to the compound at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes the underestimation of the risk highly unlikely. The SF for the compounds of concern are presented in Table 2e.

For known or suspected carcinogens, EPA considers excess upper-bound individual lifetime cancer risks of between 10^{-4} to 10^{-6} to be acceptable. This level indicates that an individual has not greater than approximately one in ten thousand to one in a million chance of developing cancer as a result of Site-related exposure to a carcinogen over a 70-year (i.e., lifetime) period under specific exposure conditions at the Site.

Under the future land-use scenario, the excess lifetime cancer risks for adult residents exposed to the highest levels of contaminants by ingesting the contaminated groundwater exceeded 1 in 100 for the A-C zones, the D-F zones and the G zone. Carcinogenic risks attributable to inhalation of volatilized contaminants (such as would occur during a shower) also exceeded 1 in 100 for the upper, middle and lower bedrock zones. Carcinogenic risk from dermal contact with the contaminated groundwater was also evaluated. Contact with groundwater from the upper, middle and lower bedrock zones yielded excess cancer risks of greater than 1 in 100 (upper and middle bedrock) and 6×10^{-3} (6 in 1000, lower bedrock), respectively. All of these calculated carcinogenic risk numbers are considered above EPA's acceptable excess cancer risk. The carcinogenic risk estimates are summarized in Table 2f.

The results of the baseline risk assessment indicated that the current use of groundwater was not a risk since no one is believed to use the groundwater for domestic purposes. However, future potential carcinogenic and noncarcinogenic risks from using the groundwater were determined to be significant. On the Necco Park property, current and future worker/trespasser exposures from soil ingestion, inhalation and dermal contact scenarios were not considered because the Site is capped, access is restricted, disturbance is expected to be minimal and historical data indicate that the Site does not contribute significantly to airborne contaminant levels. Current and future worker/trespasser exposure to Site drainage ditch sediments via ingestion and dermal contact, and exposure to drainage ditch surface waters via dermal contact were also not considered significant for the same reasons. Ingestion and dermal contact risks for Niagara River surface waters were determined to be minimal due to the dilution of Necco Park contaminants in the river and the infrequent exposure of

individuals that would likely occur. Exposure to contaminated biota (i.e., ingestion of fish) is possible, however, the dilution of Necco Park constituents combined with low exposure frequency minimize human health risks from this Site alone.

Ecological

Potential risks to the environmental receptors associated with the DuPont Necco Park Site were identified in the ecological risk assessment. The ecological risk assessment identified no species, sensitive environments/resources as potential receptors at the facility threatened by the Site contaminants under current Site conditions. The reasonable maximum environmental exposure is evaluated. A four-step process is utilized for assessing Site-related ecological risks for a reasonable maximum exposure scenario: *Problem Formulation*--a qualitative evaluation of contaminant release, migration, and fate; identification of contaminants of concern, receptors, exposure pathways, and known ecological effects of the contaminants; and selection of endpoints for further study. *Exposure Assessment*--a quantitative evaluation of contaminant release, migration, and fate; characterization of exposure pathways and receptors; and measurement or estimation of exposure point concentrations. *Ecological Effects Assessment*--literature reviews, field studies, and toxicity tests, linking contaminant concentrations to effects on ecological receptors. *Risk Characterization*--measurement or estimation of both current and future adverse effects.

The ecological risk assessment began with habitat and species characterization. The Necco Park property is not considered a unique or significant habitat. The 24-acre Site is capped with an overlying grass cover that is regularly maintained through mowing. However, regionally significant habitats that may be impacted by Necco Park contaminants are present within 1.5 miles of the Site. Areas of ecological significance include the Niagara River, Niagara Gorge and Lake Ontario. A variety of species that inhabit these areas were then identified (Table 2i).

The primary medium of concern for the characterization of ecological risk at the Necco Park Site is downgradient surface water that may be impacted by Site contaminants transported by groundwater and man-made structures. Possible exposure pathways for ecological receptors include: ingestion of contaminated biota in the food chain and, contact with and/or ingestion of surface water contaminants. Surface soils at the Site are not expected to represent a significant exposure medium as the former landfill has been covered by a clay cap. The cap likely precludes exposure of the identified receptor species.

The contaminants of concern identified in Table 2g were assumed to travel through the groundwater and ultimately two different

discharge locations to surface water habitats. Groundwater in the A-C zones would flow south and into the Falls Street tunnel while the groundwater in the D-G zones would flow west to the NYPA conduit drain system. Water in the Falls Street tunnel was assumed to discharge directly to the Niagara River (*This risk assessment was performed before any diversion of the Falls Street tunnel flow to the Niagara Falls POTW was occurring, and is therefore, conservative). Water in the conduit drain system was assumed to flow north and discharge to the Forebay Canal through bedrock fractures. The concentrations of contaminants reaching the Falls Street tunnel, Forebay Canal and the Niagara River are presented in Tables 2j, 2k and 2l.

Risks to ecological receptors were assessed quantitatively by modeling Necco Park groundwater contaminant concentrations reaching the area of the Niagara River at two locations: the Forebay Canal adjacent to the Robert Moses Powerplant, and the Falls Street tunnel outlet to the river.

Potential risks to ecological receptors from estimated surface water concentrations of contaminants were assessed by comparing exposure point concentrations with criteria/guidelines. This comparison (expressed as a risk index) was calculated for each contaminant of concern. If the calculated Risk Index is greater than one, it indicates that biota may be at risk of an adverse effect from that contaminant within that exposure medium. A total risk index was also calculated for each exposure medium by summing chemical-specific risk indices. If the total risk index is greater than one, this indicates that exposure to all contaminants of concern within one medium may pose a risk to organisms. The Risk Indices are presented in Table 2m.

Potential hazards to aquatic organisms present within the surface waters of the Falls Street tunnel discharge, Forebay Canal and Niagara River were assessed by comparing mean and maximum exposure point concentrations of contaminants with Ambient Water Quality Criteria (AWQC) or toxicity effect levels (when AWQC were not available).

Estimated mean and maximum contaminant concentrations within the Forebay Canal and Niagara River are several orders of magnitude below acute and chronic ambient water quality criteria. Mean concentrations of contaminants within the Falls Street tunnel discharge to the Niagara River are also below acute ambient water quality criteria. Maximum concentrations of hexachlorobutadiene, pentachlorophenol, and cyanide within the Falls Street tunnel discharge are slightly above acute criteria, and average maximum concentrations somewhat exceed (Federal and State of New York) chronic criteria. However, adverse impacts to aquatic biota are not expected within the Niagara River as a result of additional contaminant dilution with the Niagara River water volume. Pentachlorophenol, hexachlorobenzene, and hexachlorobutadiene

represent Necco Park contaminants that are known to bioaccumulate within aquatic receptor species. However, estimated fish tissue concentrations calculated from the concentrations of these two contaminants within the Forebay Canal and Niagara River were determined to be several orders of magnitude below fish flesh criteria designed to protect piscivorous wildlife. The concentration of hexachlorobenzene within the Falls Street tunnel discharge yielded a mean fish tissue calculation above fish flesh criteria. It is unknown whether this discharge location represents a foraging area for wildlife receptor species.

The ecological risk assessment considered all potential exposure media for ecological receptors. Exposure of potential receptor species to surface soils and airborne contaminants was assumed to be insignificant due to the presence of the existing clay cap. Surface water and sediment contaminant risks associated with the Necco Park drainage ditch were not assessed because of the low levels of contaminants in those areas.

The risk assessment determined that the contaminated soils, groundwater, and surface water attributable to the Necco Park Site alone currently do not pose an unacceptable ecological risk. As discussed above, impacts to Lake Ontario or cumulative risks from this Site plus other sites in Niagara Falls were not assessed. Future ecological impacts to the Niagara River may occur however, if remedial actions are not implemented.

Uncertainties

The procedures and inputs used to assess risks in this evaluation, as in all such assessments, are subject to a wide variety of uncertainties. In general, the main sources of uncertainty include:

- environmental chemistry sampling and analysis
- environmental parameter measurement
- fate and transport modeling
- exposure parameter estimation
- toxicological data.

Uncertainty in environmental sampling arises in part from the potentially uneven distribution of chemicals in the media sampled. Consequently, there is significant uncertainty as to the actual levels present. Environmental chemistry-analysis error can stem from several sources including the errors inherent in the analytical methods and characteristics of the matrix being sampled.

Uncertainties in the exposure assessment are related to estimates of how often an individual would actually come in contact with the chemicals of concern, the period of time over which such exposure would occur, and in the models used to estimate the concentrations of the chemicals of concern at the point of exposure.

Uncertainties in toxicological data occur in extrapolating both from animals to humans and from high to low doses of exposure, as well as from the difficulties in assessing the toxicity of a mixture of chemicals. These uncertainties are addressed by making conservative assumptions concerning risk and exposure parameters throughout the assessment. As a result, the Risk Assessment provides upper-bound estimates of the risks to populations near the Site, and is highly unlikely to underestimate actual risks related to the Site.

More specific information concerning public health risks, including a quantitative evaluation of the degree of risk associated with various exposure pathways, is presented in the Risk Assessment Report.

Actual or threatened releases of hazardous substances from this Site, if not addressed by the selected alternative or one of the other remedial measures considered, may present an imminent and substantial endangerment to the public health, welfare, and the environment.

RESPONSE ACTION OBJECTIVES

Response action objectives (RAOs) are specific goals to protect human health and the environment. These objectives are based on available information and standards such as applicable, or relevant and appropriate requirements (ARARs) and risk-based levels established in the risk assessment.

The following RAOs were established for the Site:

Groundwater

The Risk Assessment has identified a number of COCs in the groundwater. These contaminants are listed in the Risk Assessment Summary section. The contaminants in the groundwater pose a future carcinogenic and noncarcinogenic health risk to residents who may reside downgradient (south and west) of the Necco Park Site. These contaminants in groundwater are subject to a number of regulations for cleanup and discharge. These regulations include the New York State Water Quality Regulations, specifically, 6 NYCRR and 10 NYCRR as well as federal Maximum Contaminant Levels (MCLs). A complete list of the ARARs is included in Table 3. The specific ARARs identifying the groundwater cleanup are presented in Table 4. The treatment of groundwater will also address compounds which are not COCs, but exceed the ARARs.

Therefore, the specific RAOs for groundwater are the reduction of risks to human health associated with potential exposure to Site-related compounds by: reducing the quantity of source materials (i.e., DNAPLs) to the extent practicable; controlling the migration

of groundwater downgradient from the Necco Park property and the source area; and attaining the groundwater cleanup criteria.

The RAO of attaining the groundwater cleanup criteria is only being applied to areas outside the source area (i.e., the far-field area). Due to the concentration of DNAPLs and contaminants in the soils and bedrock in the source area, and the complexities associated with remediation of DNAPLs in fractured bedrock, EPA does not anticipate that the RAOs can be achieved within the source area. Since waste materials are being left in place, and it is technically impracticable to achieve the RAOs for groundwater in areas where DNAPL has migrated, the groundwater ARARs are not expected to be met in the source area. Therefore, EPA is issuing a technical impracticability waiver of groundwater ARARs in the source area.

EPA's memorandum, Guidance for Evaluating the Technical Impracticability of Groundwater Remediation (OSWER Directive 9234.2-25, October 1993) recognizes that there are circumstances under which groundwater restoration may be technically impracticable. Presently, there are technical limitations in recovering DNAPL from soil and fractured bedrock. Even if all the soil containing DNAPLs at the Site were excavated, DNAPLs would still be present in the fractured bedrock. No present-day technology has been developed to completely remove DNAPLs from fractured bedrock. Because these residual DNAPLs would continue to contribute to aqueous phase groundwater contamination, restoration of the groundwater in the source area to ARARs is determined to be technically impracticable.

Landfill Soils

No human health risks associated with direct exposure to the contaminants remaining in Site soils are anticipated with the maintenance of the cap. However, contaminant concentrations in the landfill soils are above levels that would be protective of the groundwater quality. This means that, unless remediated or contained, the soil could continue to act as a source of contamination to the groundwater. The NYSDEC has developed soil cleanup criteria that it considers to be protective of groundwater quality. This criteria, established in NYSDEC's Technical and Administrative Guidance Memorandum (TAGM), will be used as a to-be-considered (TBC) goal in cleaning up soils at the Site (Table 5). The TBC values are not promulgated regulations and, therefore, are not considered ARARs. As TBCs, they are not enforceable standards but may be used as one of the criteria in determining whether the RAOs have been met.

Therefore, the RAOs for soils at the Site are the protection of the groundwater quality, and ultimately human health, through reduction

of the source materials (i.e., DNAPLs) to the extent practicable, as well as limiting exposure to surficial soil contaminants.

DESCRIPTION OF REMEDIAL ALTERNATIVES

CERCLA §121(b)(1), 42 U.S.C. §9621(b)(1), requires that each selected Site remedy be protective of human health and the environment, be cost-effective, comply with other statutory laws, and utilize permanent solutions, alternative treatment technologies and resource recovery alternatives to the maximum extent practicable. In addition, the statute includes a preference for the use of treatment as a principal element for the reduction of toxicity, mobility, or volume of the hazardous substances. CERCLA §121(d), 42 U.S.C. §9621(d), further specifies that a remedial action must attain a level or standard of control of the hazardous substances, pollutants, and contaminants, which at least attains ARARs under federal and state laws, unless a waiver can be justified.

This Record of Decision evaluates in detail, fourteen alternatives for addressing the contamination associated with the Necco Park Site. Construction time refers to the time required to physically construct the remedial alternative. This does not include the time required to negotiate with the responsible parties for the remedial design and remedial action, or design the remedy.

The alternatives to address the contamination at the Site are as follows:

Alternative 1: No Action

Capital Cost: \$ 0

O&M Cost: \$ 0/year

O&M Present Worth Cost: \$ 0

Total Cost: \$ 0

Construction Time: No construction is required for the no action alternative.

The Superfund program requires that the "no-action" alternative be considered as a baseline for comparison of other alternatives. This alternative has been included in order to provide a datum from which to evaluate the other alternatives. The no action alternative assumes that all present remedial activities at the Site will cease and that no additional actions will be taken at the Site to address groundwater contamination. Contaminated groundwater beneath the Necco Park property would continue to move uncontrolled, downgradient and potentially impact the Niagara River. Contaminated soils at the Site would not be addressed by this alternative either. This would allow contaminants to contribute to the degradation of the groundwater quality by leaching from the soils. No institutional controls would be

implemented which would provide no control for groundwater use in the area or well restrictions. This alternative would not treat any quantity of the contaminated groundwater, requires no engineering components, treatment components, and has no costs associated with its implementation. The no action alternative is easily implemented as no effort would be required. The groundwater ARARs would not be met for this alternative.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 2: Existing Systems

Capital Cost: \$ 271,785
O&M Cost: \$ 1,658,325/year
O&M Present Worth Cost (30 years): \$-20,578,155
Total Cost: \$ 20,850,000
Construction Time: This alternative would require less than one year to implement.

Alternative 2 consists of continuation of present response activities at the Necco Park Site. Groundwater recovery from the existing wells RW-1, RW-2, and RW-3 would continue at a rate of approximately 20 gpm. Extracted groundwater would be treated at the CECOS waste-water treatment plant (WWTP) and discharged to the POTW. Groundwater monitoring and the current DNAPL extraction program would continue. The grout curtain and cap would remain in place. The cap would continue to be maintained through mowing and repair of subsidence. Access controls (fencing and security personnel) would continue to be maintained. Utility drains would continue to intercept a portion of the far-field groundwater. Estimated percent reduction in loadings from the source area to the far-field, as compared to Alternative 1, would be 40%. Total groundwater to be pumped would be approximately 20 gallons per minute (gpm).

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternatives 3 through 13 all contain, as part of their remedy, the existing systems described in Alternative 2. The description for these alternatives includes components in addition to the existing systems that would be provided by these alternatives.

Alternative 3

Capital Cost: \$ 2,780,899
O&M Cost: \$ 1,669,025/year
O&M Present Worth Cost (30 years): \$ 20,710,931

Total Cost: \$ 23,492,000

Construction Time: It is estimated that the time required to upgrade the cap and install additional DNAPL extraction wells would be less than one year.

Alternative 3 would include an upgrade of the existing clay cap to comply with the New York State regulations (6NYCRR, Part 360) for a landfill cap [hereinafter, "Part 360 (or equivalent) cap"] and additional DNAPL extraction through a dedicated recovery well. Also included under this alternative is the continued O&M of existing systems described in Alternative 2, above. Estimated percent reduction of loadings to the far-field is 40%. Total groundwater to be pumped is approximately 20 gpm.

Because this alternative may result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 4

Capital Cost: \$ 5,094,136

O&M Cost: \$ 1,933,650/year

O&M Present Worth Cost (30 years): \$ 23,944,663

Total Cost: \$ 29,089,000

Construction Time: The estimated time to construct this alternative would be less than one year.

Alternative 4 includes installation of a slurry wall in the overburden along the southern boundary and southern sections of the eastern and western boundaries of the 24-acre Necco Park facility. Overburden collection wells would be installed in the landfill near the slurry wall to maintain an inward hydraulic gradient across the slurry wall, prevent mounding within Necco Park overburden, contain overburden groundwater, and function as collection points for DNAPL removal. This alternative would also include an upgrade of the existing clay cap, as necessary, to comply with requirements of a Part 360 (or equivalent) cap. Also included under this alternative is the continued O&M of existing systems described in Alternative 2, above. Estimated percent reduction in loading to the far-field is 40%. Total groundwater to be pumped is approximately 25 gpm.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 5

Capital Cost: \$.6,530,587

O&M Cost: \$ 1,810,450/yr + \$ 768,750 for Dual Phase Extraction (DPE) for 5 years

O&M Present Worth Cost: The 30-year present worth cost is

\$ 22,465,874 + 5-year present worth cost
of \$ 3,152,029 for DPE
Total Cost: \$ 32,148,000
Construction Time: This alternative would require approximately one
to two years to complete construction.

Alternative 5 consists of construction and operation of a dual phase extraction (DPE) system on the 24-acre Necco Park landfill. The DPE system consists of extraction wells, pumps, piping, and vapor- and liquid-phase treatment to remove and destroy organic constituents. The DPE system would also provide a level of hydraulic control through removal of groundwater from the A zone and upper bedrock zones. A pilot test would be required to determine the most effective design for a DPE system. This alternative assumes that the DPE system would be in operation for approximately five years and that the system would be shut down during November through March (DPE does not operate efficiently in extremely cold conditions). Also included under this alternative is groundwater recovery from wells RW-1, RW-2, and RW-3, groundwater treatment at CECOS, and groundwater monitoring. During operation of the DPE system, groundwater recovery rates from wells RW-1 and RW-2 may be reduced or halted because the DPE system would recover groundwater from upper bedrock zones. Once DPE operation is complete, total recovery rate from wells RW-1, RW-2 and RW-3 would be approximately 20 gpm. The cap would be upgraded upon completion of the DPE system. The current DNAPL extraction program would continue. The existing grout curtain would remain in place. The cap would be maintained to ensure integrity. Access controls (fencing and security personnel) would continue to be maintained by CECOS. The utility drains would continue to intercept a portion of the far-field groundwater. Natural attenuation of far-field groundwater would continue to occur. Estimated percent reduction of loadings to the far-field is 40%. Total groundwater pumped would vary with the operation of the DPE system between 20-30 gpm.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 6

Capital Cost: \$ 3,760,774
O&M Cost: \$ 2,897,775/yr
O&M Present Worth Cost (30 year): \$ 35,958,490
Total Cost: \$ 39,719,000
Construction Time: This alternative would require less than one
year to construct.

The goal of Alternative 6 is to reduce constituent loading to the far field by 80% compared to Alternative 1. Alternative 6 includes installation of additional recovery wells to increase the

groundwater recovery rate to achieve an 80% reduction in constituent loadings to the far field compared to the no action alternative. The estimated total recovery rate to achieve the 80% reduction is approximately 70 gpm. Recovered groundwater would be treated at the CECOS WWTP and discharged to the POTW. In addition, a new, dedicated DNAPL extraction well would be installed. The cap would be upgraded in this alternative to meet Part 360 or equivalent standards through permeability testing and placement of additional low-permeability material as necessary. Also included under this alternative is the continued O&M of existing systems described in Alternative 2, above.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 7

Capital Cost:	\$ 6,074,011
O&M Cost:	\$ 3,162,400/yr
O&M Present Worth Cost (30 year):	\$ 39,242,222
Total Cost:	\$ 45,316,000

Construction Time: It is estimated that the time to construct this alternative would be approximately one year.

Under Alternative 7, a slurry wall would be installed in the overburden along the southern boundary and southern sections of the eastern and western boundaries of the 24-acre Necco Park facility. Overburden collection wells would be installed in the landfill near the slurry wall to maintain an inward hydraulic gradient across the slurry wall, prevent mounding within Necco Park overburden, contain overburden groundwater, and function as collection points for DNAPL removal. Alternative 7 includes an increase in groundwater recovery rates to achieve an approximately 80% reduction in constituent loadings to the far field compared to Alternative 1. To increase groundwater recovery, additional recovery wells would be installed. Recovered groundwater would be treated at the CECOS WWTP and discharged to the POTW. The cap would be upgraded in this alternative to meet Part 360 or equivalent standards through permeability testing and the placement of additional low-permeability material, as necessary. Also included under this alternative is the continued O&M of existing systems described in Alternative 2, above. Estimated percent reduction in loadings to the far-field is 80%. Total groundwater pumped is approximately 70-75 gpm.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 8

Capital Cost: \$ 7,510,462
O&M Cost: \$ 2,887,075/yr + \$ 850,875 for DPE for 5 years
O&M Present Worth Cost: The estimated 30-year present worth cost is \$ 35,825,714 + \$ 3,448,758 5-year present worth cost for DPE
Total Cost: \$ 46,825,000
Construction Time: It is estimated that the time to construct this alternative would be approximately one to two years.

Alternative 8 consists of construction and operation of a DPE system on the 24-acre Necco Park landfill. The DPE system consists of extraction wells, piping, and vapor- and liquid-phase treatment. The DPE system would remove groundwater from the A zone and upper bedrock zones. This alternative also includes an increase in groundwater recovery rates to achieve an approximate 80% reduction in constituent loading to the far-field compared to the no action alternative. To increase groundwater recovery, additional recovery wells would be installed. The estimated recovery rates to achieve an 80% reduction in constituent loading to the far-field compared to the no action alternative is 70 gpm. Recovered groundwater would be treated at the CECOS WWTP and discharged to the POTW. A pilot test would be required to determine the most effective design for a DPE system. This alternative assumes that the DPE system would be in operation for approximately five years and that the system would be shut down during November through March. The cap would be upgraded upon completion of the DPE system, as necessary. Also included under this alternative is the continued O&M of existing systems described in Alternative 2, above. Estimated percent reduction in loadings to the far-field is 80%. Total groundwater pumped would vary with the operation of the DPE system between 25-70 gpm.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 9

Capital Cost: \$ 15,564,011
O&M Cost: \$ 3,080,275/yr
O&M Present Worth Cost (30 year): \$ 38,223,132
Total Cost: \$ 53,787,000
Construction Time: It is estimated that one to five years would be required to construct this alternative.

Alternative 9 consists of installing a grout curtain in the bedrock (on the southern, southeastern, and southwestern boundaries of the source area) that would be tied into the existing grout curtain

(also called the subsurface formation repair or SFR which was installed on the northern, northeastern and northwestern boundaries of the source area), around the source area, extending from the B through F zones (approximately 80 feet deep). Groundwater would be recovered in the B through F zones to maintain an inward hydraulic gradient across the curtain. Estimated flow rate to achieve an inward hydraulic gradient in the B through F zones in the source area is approximately 65 gpm.

Extracted groundwater would be treated at the CECOS WWTP and discharged to the POTW. Under this alternative, a slurry wall would be installed in the overburden along the southern boundary and southern sections of the eastern and western boundaries of the 24-acre Necco Park landfill. Overburden collection wells would be installed in the landfill near the slurry wall to maintain an inward hydraulic gradient across the slurry wall, prevent mounding within the Necco Park property overburden, contain overburden groundwater, and function as collection points for DNAPL removal. Groundwater extraction from inside the grout curtain and slurry wall would result in total hydraulic control of source area groundwater in the A through F zones. The cap would be upgraded in this alternative to meet Part 360 or equivalent standards as necessary. Also included under this alternative is the continued O&M of existing systems described in Alternative 2, above. Estimated percent reduction in loadings to the far-field is 90%. Total groundwater pumped is approximately 65-75 gpm.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 10

Capital Cost:	\$ 7,837,136
O&M Cost:	\$ 4,614,775/yr
O&M Present Worth Cost (30 year):	\$ 57,264,743
Total Cost:	\$ 65,102,000

Construction Time: It is estimated that the time to construct this alternative would be approximately one year.

As with Alternatives 2 through 13, Alternative 10 consists of groundwater extraction from the existing wells RW-1, RW-2, and RW-3 as well as additional extraction to achieve total hydraulic control of the A through F zones in the source area. The approximate pumping rate required to create a complete hydraulic barrier in the A through F zones in the source area is 155 gpm. Treatment of the extracted groundwater from the source area, either on-site or off-site, would be required to achieve the appropriate discharge requirements. Currently, groundwater extracted from the Site is treated at the adjacent CECOS wastewater treatment plant. Expansion of the CECOS facility would likely be required to

accommodate the increased volume of water to be treated under this alternative. The need to either expand the CECOS facility, build an on-site facility, or utilize another off-site facility for groundwater treatment would be determined during the design. For costing purposes, it is assumed that recovered groundwater would be treated at the CECOS facility, expanded for the increased capacity, and discharged to the POTW. The CECOS WWTP has an available capacity of 110 gpm and would require expansion to treat the additional 50 gpm, at an estimated cost of \$1,050,000 (this is included in the total cost). Under this alternative, a slurry wall would be installed along the southern boundary and southern sections of the eastern and western boundaries of the 24-acre Necco Park landfill. Overburden collection wells would be installed in the landfill near the slurry wall to maintain an inward hydraulic gradient across the slurry wall, prevent mounding within Necco Park overburden, contain overburden groundwater, and function as collection points for DNAPL removal. Groundwater extraction from the B through F zones and overburden groundwater recovery would result in total hydraulic control of source area groundwater in the A through F zones. The cap would be upgraded under this alternative to meet Part 360 or equivalent standards as necessary. Also included under this alternative is the continued O&M of existing systems described in Alternative 2, above. Estimated percent reduction in loadings to the far-field is 95%. Total groundwater pumped is approximately 155-160 gpm.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 10A

For ease of reference, the modified preferred alternative described in the "Highlights of Community Participation" section of this ROD, is designated Alternative 10A. This alternative is essentially identical to Alternative 10, except that A zone containment may be achieved either hydraulically or by physical barrier (e.g., slurry wall, sheet pile) implementation. The capital cost figure cited below includes the construction cost of a slurry wall, estimated to be \$1,335,000. If the slurry wall is not constructed, the capital cost would be reduced to \$6,502,136, but the O&M Present Worth Cost would increase since more leachate would be generated in the overburden that would require collection and treatment. The increased O&M costs anticipated without a slurry wall were not estimated at this time. These anticipated costs will be calculated during the design phase of the remedy. The relative cost-effectiveness of hydraulic and physical containment will be assessed at that time. Either alternative that is implemented will have to meet the performance standards for containment of groundwater in the A zone.

Capital Cost: \$ 7,837,136
 O&M Cost: \$ 4,614,775/yr
 O&M Present Worth Cost (30 year): \$ 57,264,743
 Total Cost: \$ 65,102,000
 Construction Time: It is estimated that the time to construct this alternative would be approximately one year.

As with Alternatives 2 through 13, Alternative 10A consists of groundwater extraction from the existing wells RW-1, RW-2, and RW-3 as well as additional extraction to achieve total hydraulic control of the A through F zones in the source area. The approximate pumping rate required to create a complete hydraulic barrier in the A through F zones in the source area is 155 gpm (and possibly slightly higher if hydraulic containment is employed in the A zone). As described under Alternative 10, the treatment facility for the extracted groundwater would be determined in the design. For costing purposes, it is assumed that recovered groundwater would be treated at the CECOS facility, expanded for the increased capacity, and discharged to the POTW. The CECOS WWTP has an available capacity of 110 gpm and would require expansion, at an estimated cost of \$1,050,000 (this is included in the total cost), to treat the additional 50+ gpm. Under this alternative, either groundwater extraction and treatment to achieve hydraulic containment in the overburden would be implemented or a physical barrier would be installed along the southern boundary and southern sections of the eastern and western boundaries of the 24-acre Necco Park landfill. Overburden collection wells would be installed in the landfill near the physical barrier to maintain an inward hydraulic gradient across the barrier, prevent mounding within Necco Park overburden, contain overburden groundwater, and function as collection points for DNAPL removal. Groundwater extraction from the B through F zones and overburden groundwater recovery (either exclusively through hydraulic means or through slurry wall implementation) would result in hydraulic control of source area groundwater in the A through F zones. The cap would be upgraded in this alternative to meet Part 360 or equivalent standards. Also included under this alternative is the continued O&M of existing systems described in Alternative 2, above. Estimated percent reduction in loadings to the far-field is 95%. Total groundwater pumped under this alternative is approximately 155-160 gpm.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 11

Capital Cost: \$ 9,354,723
 O&M Cost: \$ 4,421,575/year + \$ 768,750 for DPE for 5 years

O&M Present Worth Cost: The estimated 30-year present worth cost is
\$ 54,867,324 + the 5-year present worth
cost of \$ 3,152,029 for DPE.

Total Cost: \$ 67,374,000

Construction Time: It is estimated that the time to construct this alternative would be approximately one year.

Alternative 11 consists of construction and operation of a DPE system on the 24-acre Necco Park landfill. The DPE system consists of extraction wells, pumps, controls, piping, and vapor- and liquid-phase treatment. The DPE system would remove groundwater from the A zone and upper bedrock zones. This alternative includes an increase in groundwater recovery rates to achieve total control of source area groundwater in the A through F zones. The estimated recovery rate to achieve total hydraulic control in the source area is 160 gpm. As described under Alternative 10, the treatment facility for the extracted groundwater would be determined in the design. For costing purposes, it is assumed that recovered groundwater would be treated at the CECOS facility, expanded for the increased capacity, and discharged to the POTW. The CECOS WWTP has an available capacity of 110 gpm and would require expansion, at an estimated cost of \$ 1,050,000 (this is included in the total cost), to treat the additional 50 gpm. A pilot test would be required to determine the most effective design for a DPE system. This alternative assumes that the DPE system would be in operation for approximately five years and that the system would be shut down during November through March. The cap would be upgraded upon completion of the DPE system, as necessary. Also included under this alternative is the continued O&M of existing systems described in Alternative 2, above. Estimated reduction in loadings to the far-field is 95%. Total groundwater pumped would vary with the operation of the DPE system between 140-160 gpm.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 12

Capital Cost: \$ 39,051,761
O&M Cost: \$ 3,218,650/year
O&M Present Worth Cost (30 year): \$ 39,940,228
Total Cost: \$ 78,992,000

Construction Time: It is estimated that the time to construct this alternative would be approximately one to five years.

Alternative 12 consists of installing a grout curtain in the bedrock that would be tied into the existing grout curtain (also called the subsurface formation repair or SFR), around the source area, extending from the B through G zones (approximately 120 - 140 feet deep). A total pumping rate of approximately 70 gpm would be

necessary to maintain an inward hydraulic gradient in the B through G zones within the source area. Extracted groundwater would be treated at the CECOS WWTP and discharged to the POTW. Under this alternative, a slurry wall would be installed in the overburden along the southern boundary and southern sections of the eastern and western boundaries of the 24-acre Necco Park facility. Overburden collection wells would be installed in the landfill near the slurry wall to maintain an inward hydraulic gradient across the slurry wall, prevent mounding within Necco Park overburden, contain overburden groundwater, and function as collection points for DNAPL removal. Groundwater extraction from inside the grout curtain and slurry wall would result in total hydraulic control of source area groundwater in the A through G zones. The cap would be upgraded in this alternative to meet Part 360 or equivalent standards as necessary. Also included under this alternative is the continued O&M of existing systems described in Alternative 2, above. Estimated percent reduction in loadings to the far-field is 96%. Total groundwater pumped is approximately 70-75 gpm.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

Alternative 13

Capital Cost:	\$ 19,343,761
O&M Cost:	\$ 6,214,525/year
O&M Present Worth Cost (30 year):	\$ 77,116,041
Total Cost:	\$ 96,460,000

Construction Time: It is estimated that the time to construct this alternative would be one to five years.

Alternative 13 consists of installing a grout curtain in the bedrock that would be tied into the existing grout curtain (also called the subsurface formation repair or SFR), around the source area, extending from the B through F zones (approximately 80 feet deep). The grout curtain would be tied into the existing grout curtain. Groundwater would be recovered in the B through F zones to maintain an inward hydraulic gradient. The estimated flow rate needed to achieve an inward hydraulic gradient is 65 gpm. Extracted groundwater would be treated at the CECOS WWTP and discharged to the POTW. Under this alternative, a slurry wall would also be installed in the overburden along the southern boundary and southern sections of the eastern and western boundaries of the 24-acre Necco Park facility. Overburden collection wells would be installed in the landfill near the slurry wall to maintain an inward hydraulic gradient across the slurry wall, prevent mounding within Necco Park overburden, contain overburden groundwater, and function as collection points for DNAPL removal. The goal of groundwater extraction from inside the grout curtain and slurry wall would be total hydraulic control of source

area groundwater in the A through F zones. Groundwater would also be pumped from the far field in an effort to intercept and remove virtually all of the groundwater constituents from the Necco Park area prior to entering the NYPA conduit system. Approximately 400 gpm would be extracted in the far-field to attempt to intercept virtually all of the far-field groundwater. This water would be treated at the POTW. The cap would be upgraded in this alternative to meet Part 360 or equivalent standards as necessary. Also included under this alternative is the continued O&M of existing systems described in Alternative 2, above. Estimated percent reduction in loadings to the far-field is 96.5%. Total groundwater pumped is approximately 465-475 gpm.

Because this alternative would result in contaminants remaining on the Site above health-based levels, CERCLA requires that the Site be reviewed every five years.

SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

During the detailed evaluation of remedial alternatives, each alternative was assessed utilizing nine evaluation criteria as set forth in CERCLA §121, 42 U.S.C. §9621, the NCP, 40 CFR §300.430(e)(9) and OSWER Directive 9355.3-01. These criteria were developed to address the requirements of Section §121 of CERCLA to ensure all important considerations are factored into remedy selection decisions.

The following "threshold" criteria are the most important, and must be satisfied by any alternative in order to be eligible for selection:

1. *Overall protection of human health and the environment* addresses whether or not a remedy provides adequate protection and describes how risks posed through each exposure pathway (based on a reasonable maximum exposure scenario) are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.
2. *Compliance with ARARs* addresses whether or not a remedy would meet all of the applicable, or relevant and appropriate requirements of federal and state environmental statutes and requirements or provide grounds for invoking a waiver.

The following "primary balancing" criteria are used to make comparisons and to identify the major trade-offs between alternatives:

3. *Long-term effectiveness and permanence* refers to the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met. It also addresses the magnitude and effectiveness of the

measures that may be required to manage the risk posed by treatment residuals and/or untreated wastes.

4. *Reduction of toxicity, mobility, or volume through treatment* is the anticipated performance of a remedial technology, with respect to these parameters, that a remedy may employ.
5. *Short-term effectiveness* addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation periods until cleanup goals are achieved.
6. *Implementability* is the technical and administrative feasibility of a remedy, including the availability of materials and services needed.
7. *Cost* includes estimated capital and operation and maintenance costs, and the present-worth costs.

The following "modifying" criteria are considered fully after the formal public comment period on the Proposed Plan is complete:

8. *State acceptance* indicates whether, based on its review of the RI/FS and the Proposed Plan, the State supports, opposes, and/or has identified any reservations with the preferred alternative.
9. *Community acceptance* refers to the public's general response to the alternatives described in the Proposed Plan and the IR/AOA reports. Factors of community acceptance to be discussed include support, reservation, and opposition by the community.

A comparative analysis of the remedial alternatives, based upon the evaluation criteria noted above, follows.

o Overall Protection of Human Health and the Environment

The no action alternative (Alternative 1) would not provide protection of human health because the contaminants in the landfill would continue to leach into the groundwater and therefore degrade the groundwater quality. The potential for exposure through the groundwater migration pathway would then present a future potential human health risk. In addition, the existing cap would not be maintained under Alternative 1. The degradation of the existing cap would create the potential for individuals to come into direct contact with contaminants in the landfill.

Currently, the groundwater aquifer is not being used for public water supply, therefore no current unacceptable risk to human

health exists for Alternatives 2 through 13. However, since the aquifer has been used as a source in the past, and is classified by the State as class GA fresh groundwater, a future potential risk does exist if someone were to use the aquifer for domestic purposes. Under the future residential-use scenario, all identified alternatives except for no action will reduce risk to varying degrees by reducing constituent loadings to the far-field and therefore the Niagara River. The risk reduction is the result of a reduction of constituent loading to the far-field through various techniques.

Alternatives 2 through 5 reduce the loadings to the far-field the least. Alternatives 6 through 8 provide a greater reduction in loadings while Alternatives 9 through 12 accomplish the largest reduction in loadings. Alternative 13 reduces loadings to the far-field and captures all the contaminants in the far-field groundwater that are not contained in the source area. The loadings from the source area to the far-field for each alternative are quantified in Table 6 (It should be noted that the loadings for the remedial alternatives are estimates based on groundwater modeling performed for the AOA Report. These estimates are subject to errors inherent in the assumptions made in applying the models to a complex fractured bedrock system).

Contaminant levels in the source area will be similar for most of the alternatives as each, except for no action, employ DNAPL recovery through monitoring and extraction wells. However, because DNAPL in fractured bedrock and in overburden cannot be fully removed, residual DNAPLs will remain in the soil and bedrock for all alternatives.

Alternatives that include DPE (Alternatives 5, 8 and 11) will result in greater source removal, but the resultant effect on source area groundwater cannot be quantified. It is important to note that there is considerable uncertainty whether any of the alternatives will achieve the groundwater ARARs, and therefore protectiveness, in the far-field.

In addition to reducing contaminant loading to the far-field, Alternatives 9, 12 and 13 also provide a physical barrier to DNAPL migration through the installation of a grout curtain in the bedrock to surround the source area. Alternatives 9 and 13 would grout the B-F bedrock zones while Alternative 12 would grout the B-G bedrock zones. This would prevent DNAPL migration in the bedrock and prevent the source area from expanding.

In addition to active remedial measures, all alternatives include interception of a portion of far-field groundwater by the existing utility drains where a portion of collected groundwater is then treated at the Niagara Falls POTW.

The cap will be maintained or upgraded in all alternatives except for no action. This cap would protect human health by preventing contact with contaminated soil. The cap also acts to minimize precipitation percolation through contaminated soil and thus minimize constituent migration.

o Compliance with ARARs

There are currently no promulgated standards for contaminant levels in soils. The EPA is instead using the procedure for determining soil cleanup values developed by NYSDEC that are considered protective of groundwater quality, as a TBC criteria for organic chemicals in soil. The TBC values, as discussed above, are found in NYSDEC's TAGM.

Alternative 1, no action, would not meet the TBC soil criteria. Contaminants in the soil would not be treated or contained in any manner, resulting in continued leaching into the groundwater system. Alternatives 2 through 13, which involve upgrading the existing cap, would not meet the TBC criteria either. However, the mobility of the contaminants would be reduced by eliminating the exposure to infiltrating precipitation. In addition, Alternatives 2 through 13 would comply with NYS Part 360 standards by upgrading the cap.

In the source area, none of the identified alternatives would achieve the groundwater chemical-specific limits identified in the following ARARs: New York Safe Drinking-Water Act Standards, New York Surface-Water and Groundwater-Quality Standards and Effluent Standards, Federal Safe Drinking-Water Act, National Primary Drinking-Water Standards and Amendments, National Secondary Drinking-Water Standards, Niagara County Drinking-Water Standards, and the Coastal Zone Management Act.

The presence of the surficial waste materials (landfill) and DNAPL in fractured bedrock in the source area makes attainment of the groundwater ARARs technically impracticable. Therefore, this ROD waives the federal and state drinking water standards and state groundwater quality standards for the groundwater in the source area. The waiver is issued pursuant to Section 121(d)(4)(C) of CERCLA, 42, U.S.C. § 9621(d)(4)(C), and §300.430(f)(1)(ii)(C)(3) of the National Contingency Plan (NCP) which authorizes EPA to waive applicable or relevant and appropriate requirements for groundwater cleanup in the source area of the Necco Park Site based on technical impracticability, from an engineering perspective. There are technical limitations which make it impracticable to recover all the DNAPL from the Necco Park source area. In order to remove all the DNAPL, in excess of 1,000,000 cubic yards of landfill materials (soils and fill) from the Necco Park and adjacent BFI landfills would require excavation. In addition, DNAPL has migrated into the fractured bedrock beneath the Necco Park landfill, adjacent CECOS secure hazardous waste cells, and adjacent

BFI landfill. No current technology exists to completely remove DNAPLs from the fractured bedrock medium. Since it is technically impracticable to excavate this area and current technologies for the removal of all of the DNAPL from the fractured bedrock are insufficient, DNAPL impacted soil, bedrock and groundwater will remain at the Site. Because DNAPLs contribute to dissolved phase contamination, restoration of groundwater in the source area of the Necco Park Site has been determined to be technically impracticable.

No alternative completely complies with the Coastal Zone Management Act. Specifically, the Coastal Zone Management Policy 38 states that "the quality and quantity of surface-water and groundwater supplies will be conserved and protected..." Alternatives 2 through 13 would provide increasing incremental compliance with the CZMA through increasing groundwater remedial action and therefore, increasing incremental benefits to the groundwater resource. Any alternative chosen will require a full Coastal Zone Consistency Evaluation to be completed. This evaluation would occur during the early design stage of the selected remedy. A Final Coastal Zone Consistency Determination would be made by EPA.

As discussed above, Alternatives 2 through 13 reduce far-field constituent loading from the source area to varying degrees. It is expected that contaminants in the far-field groundwater would naturally attenuate over time to eventually reach the groundwater standards. However, based on limited existing information and the complexities of modeling groundwater in a fractured bedrock medium, a degree of uncertainty exists whether the groundwater will or will not eventually achieve the MCLs in the far-field. Additional information will be required to fully evaluate the potential for ARARs to be achieved in the far-field.

The second RAO is control of source material (DNAPL and contaminated soil) to minimize direct exposure and impact on groundwater quality. Alternatives 2 through 13 reduce far-field contaminant loading through groundwater extraction, thereby improving groundwater quality. Alternatives 9 through 11 and 13 include total hydraulic control of the A through F zones in the source area. Alternative 12 includes hydraulic control of the A through G zones in the source area. In addition to active remedial measures, all alternatives include interception of a portion of far-field groundwater by the existing utility drains where a portion of collected groundwater is then treated at the Niagara Falls POTW.

EPA has identified the Great Lakes Water Quality Agreement of 1978, not as an ARAR but as a "to be considered" (TBC) criterion. This Agreement establishes as its primary purpose that "[the] discharge of toxic substances in toxic amounts be prohibited and the discharge of any or all persistent toxic substances be virtually eliminated...and [that] best management practices be developed and

implemented...to ensure adequate control of all sources of pollutants." Based on the remedial activities that have been taken at Necco Park to date, and the treatment of the portion of groundwater from Necco Park that infiltrates into the Falls Street tunnel and is treated at the POTW, the Analysis of Alternatives Report estimated that discharges from the Site have been reduced by at least the 50 percent which corresponds to the interim percentage reduction commitment for 1996 established in the Four-Party Agreement (discussed in the Site Description section, above). However, the interim commitment and the final goal of "virtual elimination," established in the Great Lakes Water Quality Agreement, are applicable to the total loadings from all point sources as well as non-point sources, which include surface runoff, atmospheric deposition, and unaccounted for loadings. All non-point sources must be addressed to reduce loadings to the Niagara River to the maximum extent practicable to address the goal of "virtual elimination." Alternatives 1 through 13 incrementally decrease loadings to the far-field and ultimately to the Niagara River. Alternative 13 therefore would best address the goal of "virtual elimination."

o Long-Term Effectiveness and Permanence

Alternative 1 would not be effective or permanent in providing protection to public health over the long-term. Contaminated groundwater would continue to migrate from the Site posing a risk to potential receptors. The cap would degrade, mobilizing more contamination, and create a potential direct exposure pathway to contaminated soil and landfill materials.

All of the alternatives, except no action, permanently reduce the volume of DNAPL at the Site through DNAPL recovery in monitoring and extraction wells and subsequent destruction. However, Alternatives 5, 8 and 11 would probably recover the most DNAPL through the use of DPE.

Alternatives 5, 8 and 11, that include DPE, would provide long-term effectiveness for some of the contaminants by permanently removing them from the soil. However, other contaminants at the Site are not effectively removed by DPE due to their low volatility. These remaining contaminants may be sufficiently soluble to be transported into the groundwater. DPE would be required to be shut down during the winter months which limits its effectiveness in contaminant removal. Following the application of the DPE, capping of the soils would be expected to reduce or eliminate the mobility of the remaining contaminants. O&M would be required to operate the DPE system and maintain the cap. Periodic monitoring would be required to evaluate the performance of the DPE.

Permanence of protection would be achieved by removal of the contaminants from the soils and groundwater through treatment. Alternatives 2 through 13 provide increasing capture and subsequent

treatment of contaminated groundwater. Alternative 2 captures and treats the least amount of contaminated groundwater while Alternative 13 captures and treats all of the contaminant plume. The constituent loadings for each alternative are included in Table 6.

All alternatives, except for no action, rely on pump-and-treat technology and a grout curtain (either existing or additional) for hydraulic control. Pump-and-treat systems require periodic maintenance to maintain effectiveness of the hydraulic control system. Operation and maintenance of the extraction and treatment system would be required including the servicing of pumps and motors, periodic well development, and treatment operation. The extraction and treatment system would require monitoring to measure its performance.

Alternatives 9, 12 and 13 include a downgradient grout curtain. Attempts to control DNAPL hydraulically (i.e., pump-and-treat) remain unproven since DNAPL may move independently from the groundwater flow. The grout curtain would provide a more permanent and reliable barrier to DNAPL migration. However, these alternatives do not contain DNAPL that may have migrated under the BFI landfill.

Alternatives with a downgradient slurry wall or DPE (Alternatives 4, 5, 7 through 13, and optionally for 10A) limit DNAPL migration in the A zone. Alternatives with a complete source area grout curtain (Alternatives 9 and 13) limit horizontal DNAPL migration in the B through F zones through the use of a vertical barrier. Alternative 12 includes a source area grout curtain to limit horizontal DNAPL migration in the B through G zones. Because of the unpredictable nature of DNAPL movement and the potential that DNAPL exists under the BFI landfill, no proposed alternative can completely contain DNAPL.

A low-permeability cap, which is included in Alternatives 2 through 13, is effective in reducing potential contact with constituents and minimizing precipitation percolation into the landfill. With maintenance, the cap is a reliable containment technology.

o Reduction in Toxicity, Mobility, or Volume

Alternative 1 does not reduce the toxicity, mobility or volume of contaminants present in the groundwater. The movement of contaminated groundwater would be unrestricted allowing downgradient migration and the existence of a potential exposure pathway. Such an exposure pathway would create an unacceptable risk to human health. If no action were taken at the Site, contaminants in the landfill would continue to leach into the groundwater resulting in greater mobility. While the contaminant concentrations would decrease in the soil and bedrock, the resultant volume of contaminated material would also increase as

contaminants spread through the groundwater. Residual contaminant compounds would remain in the soils and act as potential sources to groundwater contamination. The existing clay cap would not be maintained and would degrade creating a possible direct contact exposure risk.

All alternatives, except for no action, include technologies to reduce constituent toxicity once it is removed from the environment. Alternatives that include groundwater extraction (Alternatives 2 through 13) reduce aqueous constituent toxicity through treatment at the CECOS WWTP and further treatment at the Niagara Falls POTW. The CECOS WWTP treats aqueous-phase constituents by metal precipitation, air stripping, vapor-phase carbon adsorption, and liquid-phase carbon adsorption. The POTW treats aqueous-phase constituents through physical-chemical treatment. Liquid-phase toxicity is reduced in Alternatives 2 through 13 through the use of an off-Site incinerator that destroys DNAPL. Vapor-phase toxicity is reduced in DPE alternatives (Alternatives 5, 8, and 11) by treatment.

Alternatives 2 through 13 include maintaining a cap that limits precipitation and percolation, thus limiting mobility of overburden constituents. Groundwater pumping and treatment also reduces constituent mobility. The extent of aqueous constituent mobility reduction can be estimated by the constituent loadings for each alternative (Table 6).

Alternatives with slurry walls (Alternatives 4, 7, 9, 10, 12, 13, and optionally for 10A) reduce mobility of aqueous and DNAPL constituents in the A zone. Grout curtain alternatives (Alternatives 9, 12, and 13) reduce mobility of DNAPLs in the B through F zones (9 and 13), and the B through G zones (12), through the use of a vertical barrier.

Alternatives 2 through 13 include extraction of DNAPLs, which reduces DNAPL volume. Alternatives that include DPE (Alternatives 5, 8, and 11) may result in greater DNAPL volume reduction through the use of vacuum extraction in overburden and upper bedrock zones. Treatability studies are required to determine the extent of reduction and effect on groundwater quality.

o Short-Term Effectiveness

For Alternatives 2 through 13, no short-term risks to the public are expected to be created by constructing the groundwater extraction and treatment systems. The operation of the extraction and treatment systems is expected to be a long-term activity which is not anticipated to present a risk to the public.

Alternative 1, no action, would not present any risk due to the fact that the contaminants are present at depth which leaves no opportunity for short-term exposure. Alternative 2 is not expected

to present any short-term risks through the construction and implementation of the remedy. Alternatives 3 through 13 may involve a slight increase in truck traffic in the area to transport in materials to construct the cap. This impact is expected to be minimal as the area is industrial and truck traffic is a routine occurrence. Alternatives 5, 8 and 11 would not present any risks during construction; however, the operation of the DPE system may generate volatile organic vapors by extracting them from the soil. These vapors, depending on their concentration, may require treatment either by carbon adsorption or incineration in a burn unit. The DPE system is not expected to present a risk when properly monitored and operated. However, a malfunction of the vapor recovery system could create a potential hazard to workers at the Site.

Once completed, all alternatives will require a similar amount of time to attain full effectiveness (steady-state constituent concentrations in the far-field). However, it should be noted that the effectiveness of the various alternatives in reducing concentrations in the far-field vary considerably. Alternative 2 is least effective in reducing contaminants concentrations in the far-field while Alternative 13 would be most effective by capturing the entire plume. Alternative 13 may reach a steady-state condition in a slightly shorter time period due to far-field pumping.

Alternatives that physically disturb overburden material may create short-term risks due to organic constituent volatilization. A significant amount of overburden material is disturbed in alternatives that include a slurry wall (Alternatives 4, 7, 9, 10, 13, and optionally for 10A).

Alternatives that include a grout curtain (Alternatives 9, 12, and 13) or that require expansion of the CECOS WWTP (Alternatives 10, 10A, and 11) will require the longest time to implement (up to five years) because of the need for extensive construction activities. DPE alternatives (Alternatives 5, 8, and 11) require one to three years to construct because of the need for a pilot study.

o Implementability

Alternatives 1 and 2 require no further construction and, therefore, are the easiest to implement. The no action alternative, Alternative 1, would not involve construction or the use of technologies of any kind. No modifications to the Site would be required to be made. Therefore, this alternative would be easily implemented. However, DNAPLs would not be contained, downgradient migration of contaminants in the groundwater would continue to occur, and the cap would eventually degrade, creating a potential risk to receptors. All components of Alternative 2 (existing systems) are in place, therefore, no new additional

construction would be required. However, modifications to the existing systems would be required to make them more reliable.

Alternatives 2 through 13 involve the extraction and treatment of groundwater. This type of technology has been applied at a variety of sites. From a geologic and hydrologic viewpoint, the groundwater aquifers under the Necco Park Site which are characterized by fractured bedrock would make it slightly more difficult to operate a pump and treat system successfully when compared to unfractured strata. However, adequate control of groundwater beneath the Necco Park property could be established through the use of a system of extraction and monitoring wells. The treatment systems required in these alternatives would all be the same. Many standard water treatment technologies exist that have been employed at other sites. It would be expected that these same technologies would be able to treat the groundwater at this Site.

While Alternative 2 would not require the installation of any new groundwater extraction wells, Alternatives 3 through 13 would. The installation of groundwater extraction wells has been conducted at many sites and is easily implementable in most cases. At sites where DNAPLs are present, extra precautions must be taken to minimize and/or prevent further mobilization of DNAPL during well installation. Alternatives that rely solely on hydraulic control of the bedrock (Alternatives 3, 4, 5, 6, 7, 8, 10, 10A, and 11) involve installation of groundwater extraction wells. Alternative 3 would require the least number of wells while Alternative 13 would require the greatest number of wells. Since Alternative 13 includes installation of a grout curtain and construction of an extensive far-field pump-and-treat system downgradient of the Necco Park property, this alternative may be the most difficult to implement. The far-field pump-and-treat system requires permission from commercial or residential property owners to install extraction wells. Right-of-ways are also necessary for connection to the sanitary sewer system.

Alternatives 4, 7, 9, 10, 12, 13, and optionally for 10A, include a slurry wall. A slurry wall may be difficult to implement because of the need to excavate through contaminated overburden, but the technology has been widely used at landfill sites.

DPE alternatives (Alternatives 5, 8, and 11) require treatability studies to determine the effectiveness of the system on Necco Park contaminants and to complete the detailed design. DPE alternatives also include an extensive well, piping, and vapor-phase treatment system.

Alternatives 10, 10A, and 11 require expansion of the CECOS WWTP. This will require an agreement to expand by CECOS, followed by design and construction. Negotiations between CECOS and DuPont would be required to determine if this alternative is

implementable. If not, construction of an on-Site treatment system or implementation of an alternate off-Site treatment system would be required. This would be implementable but would extend the required construction time.

Grout curtain alternatives require a long time (up to five years) to implement. The grout curtain may be difficult to implement due to physical limitations in repairing fractured bedrock and the need for intrusive rights-of-way or easements to other properties near the landfill. A partial grout curtain has already been installed at the Site, however, so these limitations are not impossible to overcome.

o Cost

The costs for all of the alternatives are presented in the description of the Summary of Alternatives section above. For comparison purposes, the costs of the various alternatives are presented as follows:

Of the various groundwater alternatives, Alternative 1, no action, presents the lowest costs at \$ 0 for capital, present-worth and O&M. This alternative provides a baseline to compare the costs of other alternatives. Alternative 13, is the most expensive alternative to implement with a total cost of \$ 96,460,000. The costs of all other alternatives fall in between these two.

The alternatives' costs are included in Table 7. Alternative 1 has the lowest total cost followed by Alternatives 2, 3, 4, 5, 6, 7, 8, 9, 10, 10A, 11, 12, and 13.

o State Acceptance

After review of all available information, NYSDEC has indicated that it concurs with the selected remedy. NYSDEC's letter of concurrence is presented in Appendix IV of this document.

o Community Acceptance

Community acceptance of the preferred alternative has been assessed in the Responsiveness Summary portion of this ROD following review of the public comments received on the IR, AOA Report, the Proposed Plan, and the Revised Proposed Plan. All comments submitted during the two public comment periods were evaluated and are addressed in the attached Responsiveness Summary, Parts I and II (Appendices V and VI).

SELECTED REMEDY

The EPA has determined, upon consideration of the requirements of CERCLA, the detailed analysis of the various alternatives, and

public comments, that Alternative 10A is the appropriate remedy for the Site.

This remedy (the subject of this Record of Decision) for the DuPont Necco Park Site will address the contaminants in the landfill soils, and DNAPL in the soils and bedrock which present the greatest threats to the groundwater as continuing sources of contamination. This action will require long-term management to maintain the groundwater extraction systems and upgraded closure cap.

The major components of the selected remedy include the following:

1. Containment of the Source Area by:

- upgrading the existing cap to meet New York State Part 360, or equivalent standards;
- using hydraulic measures in the overburden (A zone) to maintain an inward gradient within the Source Area or installing a physical barrier (e.g., slurry wall, sheet pile) on the southern, and portions of the eastern and western Necco Park property boundaries; and
- using hydraulic measures in the bedrock (B-F zones) to maintain an inward gradient within the Source Area and prevent the movement of contaminated groundwater beyond the Source Area boundary.

The control of the contaminated groundwater will be achieved through the installation, operation, and maintenance of the groundwater extraction wells (and, optionally, a physical barrier in the overburden). The exact number, size, depth, and pumping rates of these wells will be determined in the remedial design of the selected remedy.

2. Treatment of the extracted groundwater from the Source Area, either on-site or off-site, to achieve the appropriate discharge requirements. Currently, groundwater extracted from the Site is treated at the adjacent CECOS wastewater treatment plant. Expansion of the CECOS facility would likely be required to accommodate the increased volume of water to be treated under this remedy. The need to either expand the CECOS facility, build an on-site facility, or utilize another off-site facility for groundwater treatment will be determined during the design.

3. Collection of DNAPL in the Source Area by:

- utilizing the existing monitoring wells network;
- utilizing any groundwater recovery wells placed in the Source Area; and

- the installation of additional dedicated DNAPL recovery well(s).

Collected DNAPL would be disposed of off-site at an appropriate facility.

4. Operation and maintenance (O&M) of the existing systems and the systems constructed under this selected remedy.

5. Comprehensive monitoring to verify hydraulic control, identify DNAPL occurrence, demonstrate the effectiveness of the remedial measures, and assess the impact of such measures on far-field groundwater quality. Existing monitoring wells on the Necco Park property will be used to monitor the performance of the groundwater extraction system and establish that sufficient control occurs. Additional monitoring wells may be required. The need for such additional wells will be determined during the design and implementation of the groundwater extraction system.

6. Additional characterization of the Site to assess whether natural attenuation will be effective in addressing far-field contamination.

7. Development and implementation of institutional controls to restrict Site access, the use of groundwater at the Site, and control land use such that it is consistent with Site conditions.

The use of groundwater will be restricted until such time as the groundwater beneath the Site has been determined to be fully remediated.

The goal of the remedial action is to contain the source area to minimize further impact to the far-field groundwater, and to attain groundwater cleanup criteria. Based on information obtained during the Investigation, and the analysis of all remedial alternatives, EPA and NYSDEC believe that the selected remedy will be able to achieve this goal.

However, sporadic low-level regional groundwater contamination may be especially persistent in the far-field. Therefore, the ability to achieve cleanup goals in the groundwater downgradient of the source area cannot be determined until the containment, extraction and treatment systems have been implemented, modified as necessary, and plume response monitored over time.

The estimated costs for the selected remedy are as follows:

Capital Cost:	\$ 7,837,136
Annual O&M Costs:	\$ 4,614,775
30-year Present Worth Cost:	\$ 57,264,743
Total Cost:	\$ 65,102,000

STATUTORY DETERMINATIONS

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete the selected remedial action for this Site must comply with applicable, or relevant and appropriate environmental standards established under federal and state environmental laws unless a statutory waiver is justified. The selected remedy also must be cost-effective and utilize permanent solutions and alternative treatment technologies or resource-recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

The selected remedy is protective of human health and the environment. Contaminated groundwater will be prevented from migrating from the source area and further degrading the quality of the aquifer. Potential exposure to contaminated groundwater will be controlled through the extraction and treatment of the groundwater. Contaminants in the groundwater will be removed through treatment. The landfill soils and the source area representing potential sources of contamination to the groundwater will be contained through the installation of the cap, groundwater extraction wells, and, optionally, a physical barrier.

Recognizing that groundwater restoration in the source area is technically impracticable, the goal of this remedial action is to establish hydraulic control of the source area contaminated groundwater, and to prevent groundwater and DNAPL from migrating beyond the source area by utilizing hydraulic barriers (optionally, a physical barrier in the overburden). The selected remedy also combines the groundwater remediation with the soils remediation to address the principal threat posed by the soils, which is: the further contribution to groundwater degradation from contaminants in the soil. By addressing the contaminated soils in the source area, the preferred alternative also reduces the potential contribution to groundwater contamination.

Containment of the source area through the implementation of a cap and groundwater extraction and treatment system (and, optionally, a physical barrier) would provide long-term effectiveness in the protection of human health and the environment. In addition, human health will be protected further through institutional controls to restrict access to the Site and the use of groundwater at the Site.

It is not anticipated that any significant short-term impacts on human health or the environment would occur during the construction and implementation of the preferred alternative.

Compliance with ARARs

The groundwater extraction and treatment portion of the selected remedy is expected to meet the ARARs for pretreatment of discharges to POTWs.

The presence of DNAPLs in the contaminated soils, bedrock, and groundwater in the source area of the Necco Park Site, renders the attainment of groundwater requirements within the source area technically impracticable. Therefore, this ROD waives the federal and State drinking water standards and State groundwater quality standards for the groundwater in the source area. The waiver is issued pursuant to Section 121(d)(4)(C) of CERCLA, 42, U.S.C. § 9621(d)(4)(C), and §300.430(f)(1)(ii)(C)(3) of the National Contingency Plan (NCP) which authorizes EPA to waive applicable or relevant and appropriate requirements based on technical impracticability, from an engineering perspective. EPA's memorandum, Guidance for Evaluating the Technical Impracticability of Groundwater Remediation (OSWER Directive 9234.2-25, October 1993), recognizes that there are circumstances under which groundwater restoration may be technically impracticable. There are technical limitations which make it impracticable to recover all the DNAPL from the Necco Park source area. In order to remove all the DNAPL, in excess of 1,000,000 cubic yards of landfill materials (soils and fill) from the Necco Park and adjacent BFI landfills would require excavation. In addition, DNAPL has migrated into the fractured bedrock beneath the Necco Park landfill, adjacent CECOS secure hazardous waste cells, and adjacent BFI landfill. No current technology exists to completely remove DNAPLs from the fractured bedrock medium. Since it is technically impracticable to excavate this area, and current technologies for the removal of all of the DNAPL from the fractured bedrock are insufficient, DNAPL impacted soil, bedrock and groundwater will remain at the Site. Because DNAPLs contribute to dissolved phase contamination, restoration of groundwater in the source area of the Necco Park Site has been determined to be technically impracticable.

Additionally, the upgrading of the cap to meet NYS Part 360 standards and the prevention of groundwater from migrating beyond the source area by utilizing a hydraulic barrier, is consistent with the TBC Great Lakes Water Quality Agreement of 1978 that best management practices be implemented to ensure adequate control of all sources of pollution.

EPA believes that the selected remedy will achieve the Response Action Objectives (RAOs) for groundwater of reduction of risk to human health through prevention of migration of groundwater

downgradient from the source area and through collection and treatment of DNAPLs to the extent practicable. Due to the concentration of DNAPLs and contaminants in the soils and bedrock in the source area, and the complexities associated with remediation of DNAPLs in fractured bedrock, EPA does not anticipate that the RAOs can be achieved within the source area. It is uncertain whether or not the implementation of this source containment remedy will enable the aquifer outside the source area to be restored to a usable quality. The potential diffusion of contaminants from the Site in the bedrock, as well as the presence of groundwater contaminants from other sources in the region, may exacerbate or prevent the attainment of groundwater ARARs in the far-field. Therefore, groundwater in the far-field will be monitored to determine the effectiveness of the source containment efforts and additional Site characterization will be performed to collect further data to evaluate the future potential for natural processes to achieve ARARs in the far-field.

In addition to the ARARs and TBCs, the selected remedy will also be consistent with the NCP and EPA policy concerning remedial actions at sites with contaminated groundwater and DNAPL. Expectations for contaminated groundwater are stated in the NCP as follows: "EPA expects to return usable groundwaters to their beneficial uses wherever practicable, within a reasonable time frame that is reasonable given the particular circumstances of the site. When restoration of the groundwater to beneficial uses is not practicable [e.g., source area groundwater], EPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction." Also, EPA guidance indicates that source control is a critical component of both active and passive restoration remedies. Where the objective of preventing further contamination of groundwater can not be attained by removal and/or treatment of contaminated soils and subsurface NAPLs, containment of the subsurface NAPLs and soils would be the preferred approach, to the extent practicable. EPA guidance, "Considerations in Groundwater Remediation at Superfund Sites and RCRA Facilities - Update," OSWER Directive 9283.1-06, May 27, 1992; and "Guidance for Evaluating Technical Impracticability of Groundwater Restoration," OSWER Directive 9234.2-25, EPA/540-R-93-080, September 1993, recommend the following for DNAPL sites:

A) Short-term actions should: 1) Prevent further spread of the aqueous plume (plume containment), 2) Control further migration of contaminants from subsurface DNAPLs (source containment) where practicable, and 3) Reduce the quantity of source material (free-phase DNAPL) present in the subsurface, to the extent practicable (source removal/treatment).

B) Long-term remedies should: 1) Minimize further release of contaminants from soils and DNAPLs to the surrounding groundwater (source containment), 2) Reduce the quantity of

source material (free-phase NAPL) present in the subsurface, to the extent practicable (source removal/treatment), and 3) Restore the maximum areal extent of the aquifer to those cleanup levels appropriate for its beneficial use.

Cost-Effectiveness

The selected remedy is cost-effective because it has been demonstrated to provide the best overall effectiveness proportional to its cost.

Due to the presence of waste materials and DNAPLs in the source area, and the lack of present-day technology to remove those materials from the fractured bedrock medium, none of the alternatives are capable of achieving the ARARs in a cost-effective manner in the source area. Therefore, it is imperative that those materials be contained to prevent further spread of the source area and to prevent the source area from further degrading groundwater quality downgradient.

The various methods employed to achieve containment of the source area have strong bearing on the cost-effectiveness of the various alternatives. Alternatives 9, 12, and 13 provide both physical and hydraulic containment of the source area through the use of a grout curtain and pumping wells in the bedrock, and a slurry wall in the overburden. Alternatives 4, 7, and 10 (and 10A, as an option) utilize a slurry wall or other physical barrier for containment in the overburden and hydraulic containment for the bedrock source area. Each of these alternatives utilize a physical barrier for some level of source area containment. Although a physical barrier provides effective containment of groundwater and DNAPLs, it is capital cost intensive to implement. Alternatives 2, 3, 6, and 10A (without the optional physical barrier) employ solely hydraulic controls for source area containment. Hydraulic controls are less capital cost intensive but more costly in terms of operation and maintenance expenditures. Since a hydraulic remedy can be implemented in phases, the potential exists to achieve hydraulic containment at lower pumping rates than originally estimated. Physical barriers do not allow for this degree of flexibility and the capital costs disbursed in the initial installation of the physical barrier cannot be recouped once the barrier is in place. Furthermore, the barrier, once placed, cannot contain materials that may subsequently be discovered outside the barrier without occasioning a costly extension of the barrier. For these reasons, a hydraulic containment remedy is considered more cost-effective compared to the alternatives with physical barrier components.

None of the alternatives achieves ARARs within the source area, however, the selected alternative (Alternative 10A) achieves the maximum amount of containment in the source area, at less capital cost than other alternatives. Therefore, the selected remedy will

provide the best balance of trade-offs among alternatives with respect to the evaluating criteria.

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

By employing treatment for the groundwater and destruction of DNAPLs collected, the selected remedy utilizes permanent solutions and treatment technologies to the maximum extent practicable.

It is anticipated that the groundwater extraction and treatment portion of the preferred alternative in conjunction with the installation of the cap (and, optionally, a physical A zone barrier) will effectively reduce the mobility and volume of the contaminated groundwater. Uncertainty does exist concerning the ability of the containment system to achieve the appropriate groundwater standards in the far-field. The ability to achieve the standards through containment and natural attenuation will be determined by additional Site characterization. The toxicity of the contaminants may also be permanently reduced through destruction. The contaminants in the groundwater within the source area will be captured and treated in the groundwater treatment system, permanently reducing their volume, mobility, and potentially their toxicity. Containment of the source area soils will reduce their mobility.

Preference for Treatment as a Principal Element

This remedy also satisfies the statutory preference for treatment as a principal element to reduce the toxicity, mobility and volume of contaminants at the Site.

Groundwater extraction and treatment will provide long-term effectiveness in the protection of human health and the environment. The extraction and treatment of groundwater in the source area and the collection and destruction of DNAPLs in the source area will also be permanent solutions through the removal of contaminants in the affected media. The application of groundwater pump and treat combined with the DNAPL collection will utilize treatment technologies to address the contaminants present at the Site.

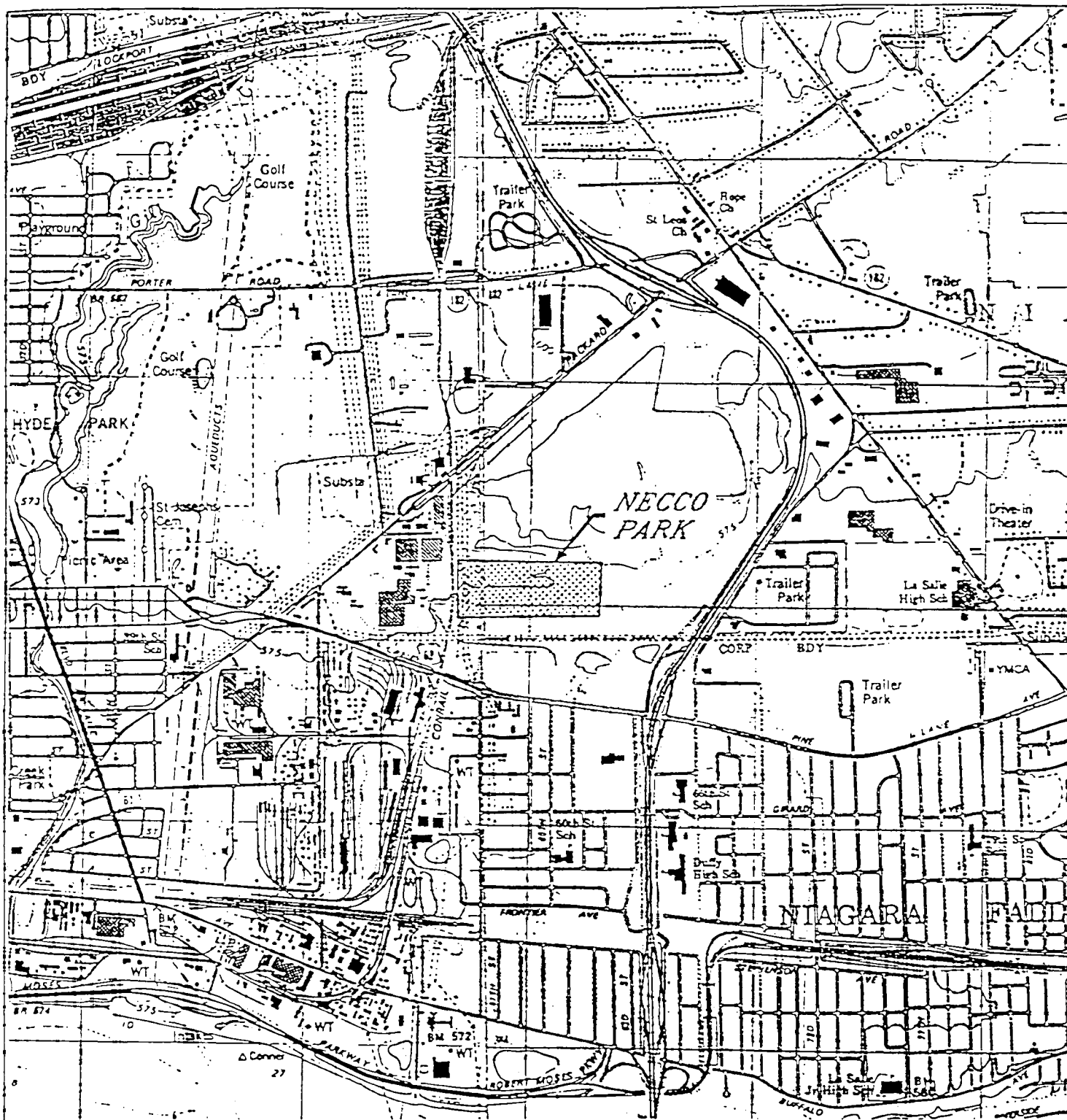
DOCUMENTATION OF SIGNIFICANT CHANGES

There are no significant changes from the preferred alternative presented in the Revised Proposed Plan.

APPENDIX I

FIGURES

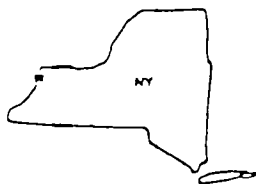
- Figure 1 - Site Location
- Figure 2 - Site Sketch (Site Plan)
- Figure 3 - Overburden Stratigraphic Cross Section (Regional Surface Geology)
- Figure 4 - Man-Made Structures Affecting Regional Hydrology
- Figure 5 - Geology/Hydrogeology
- Figure 6 - Existing Remedial Systems
- Figure 7 - Subsurface Formation Repair
- Figure 8 - Source Area
- Figure 9 - A-zone Contaminant Plume
- Figure 10 - B-zone Contaminant Plume
- Figure 11 - C-zone Contaminant Plume
- Figure 12 - D-zone Contaminant Plume
- Figure 13 - E-zone Contaminant Plume
- Figure 14 - F-zone Contaminant Plume
- Figure 15 - G-zone Contaminant Plume



SCALE 1:24,000

0 2000 4000 FEET

0 1 MILE



SOURCE: NIAGARA FALLS, NY-ONT. & TONAWANDA WEST, NY QUADRANGLES, 7.5' SERIES

FIGURE 1

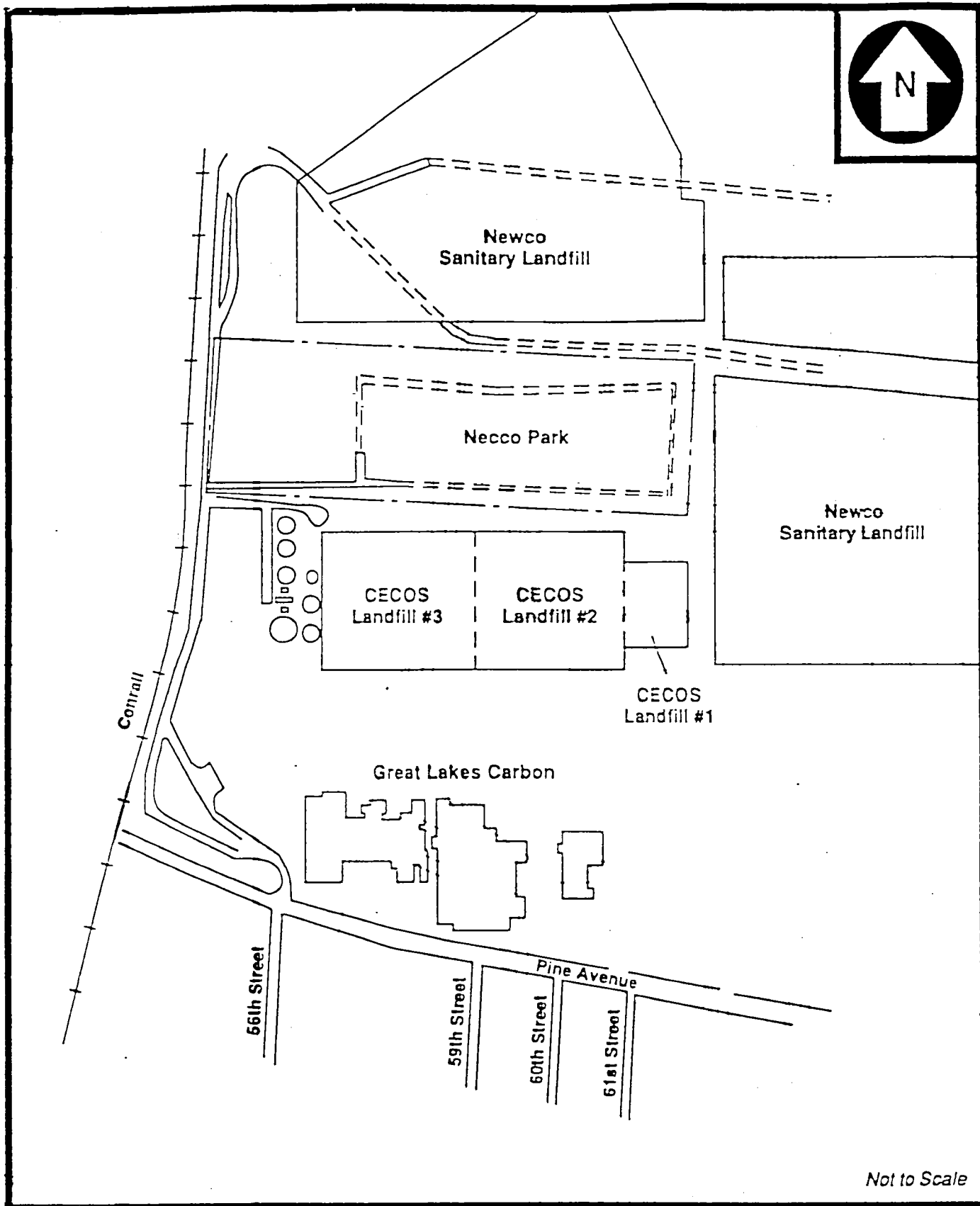
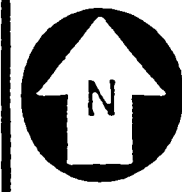


SITE LOCATION MAP

SCALE 1" = 2000'	DESIGNED BY DATE 4/21/95	DRAWN BY SMM CHECKED PFM APPROVED JMM	CAD DRAWING NO. PROJECT NO 1281
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DU PONT NECCO PARK
NIAGARA FALLS, NY

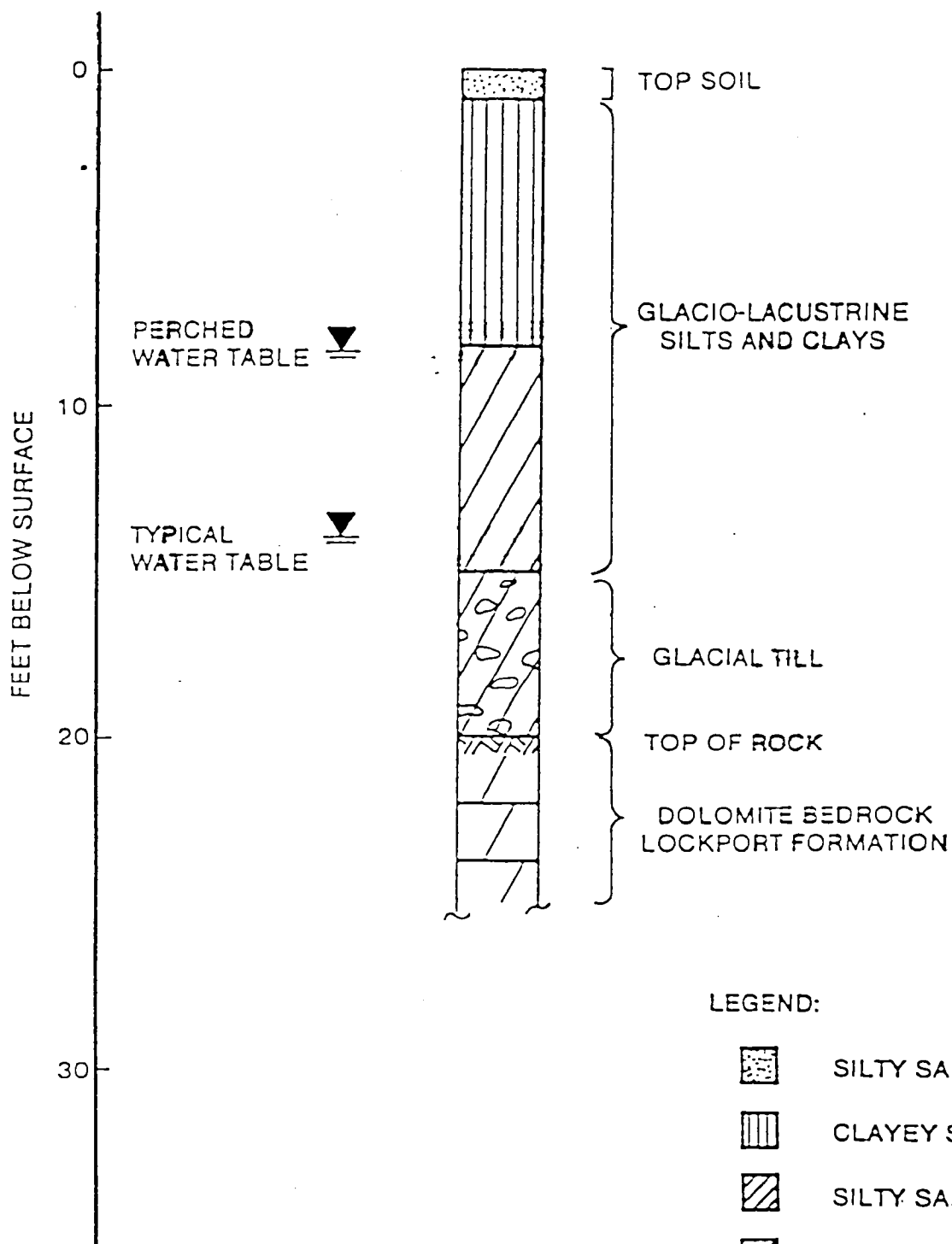
Du Pont Environmental Remediation Services



Not to Scale

--- Necco Park Property Line	SITE SKETCH NECCO PARK NIAGARA FALLS, NEW YORK	TRC Figure 2.
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MS642M

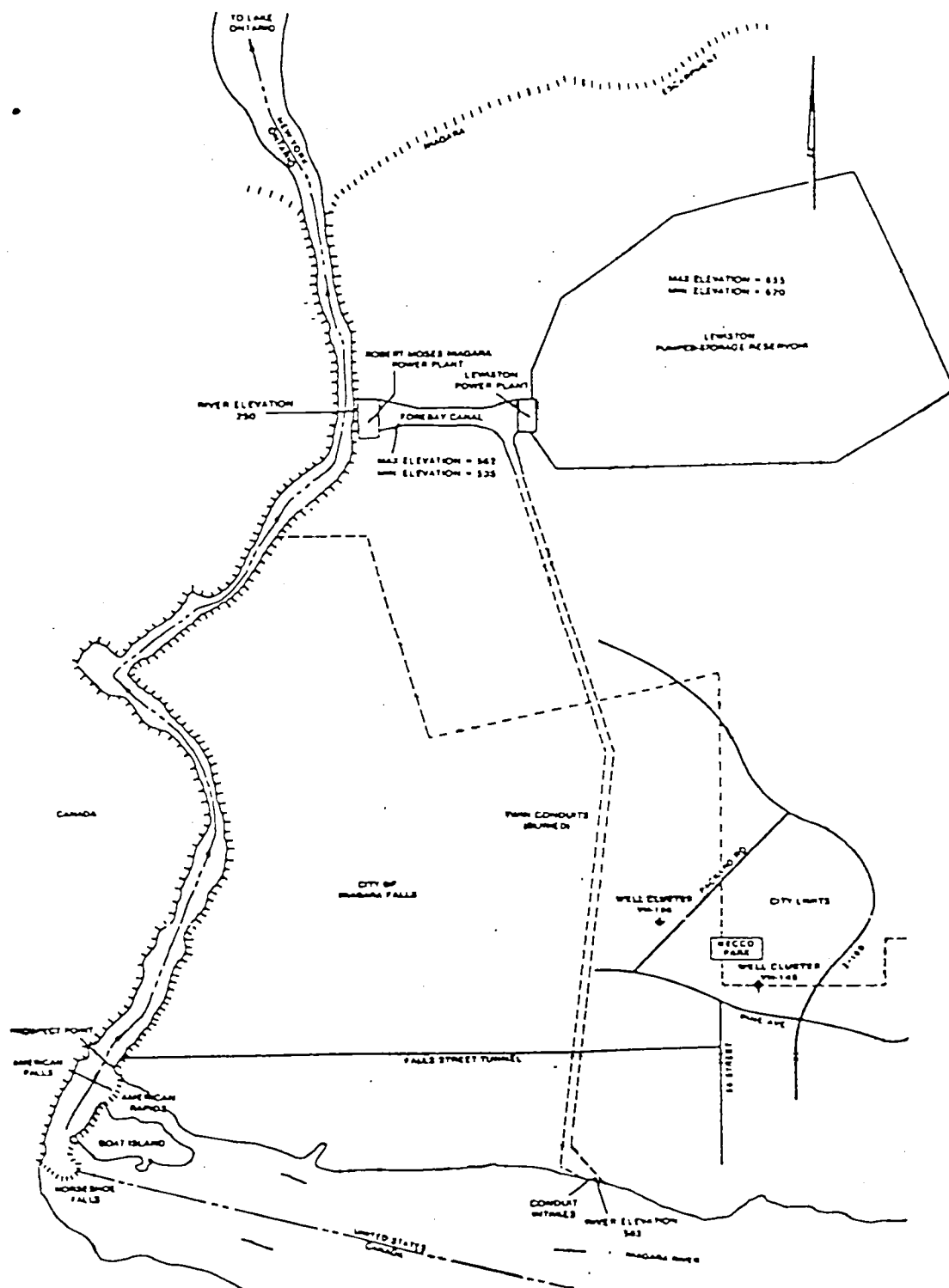


LEGEND:

-  SILTY SANDY LOAM
-  CLAYEY SANDY SILT
-  SILTY SANDY CLAY
-  SANDY, GRAVELLY CLAY (GLACIAL TILL)

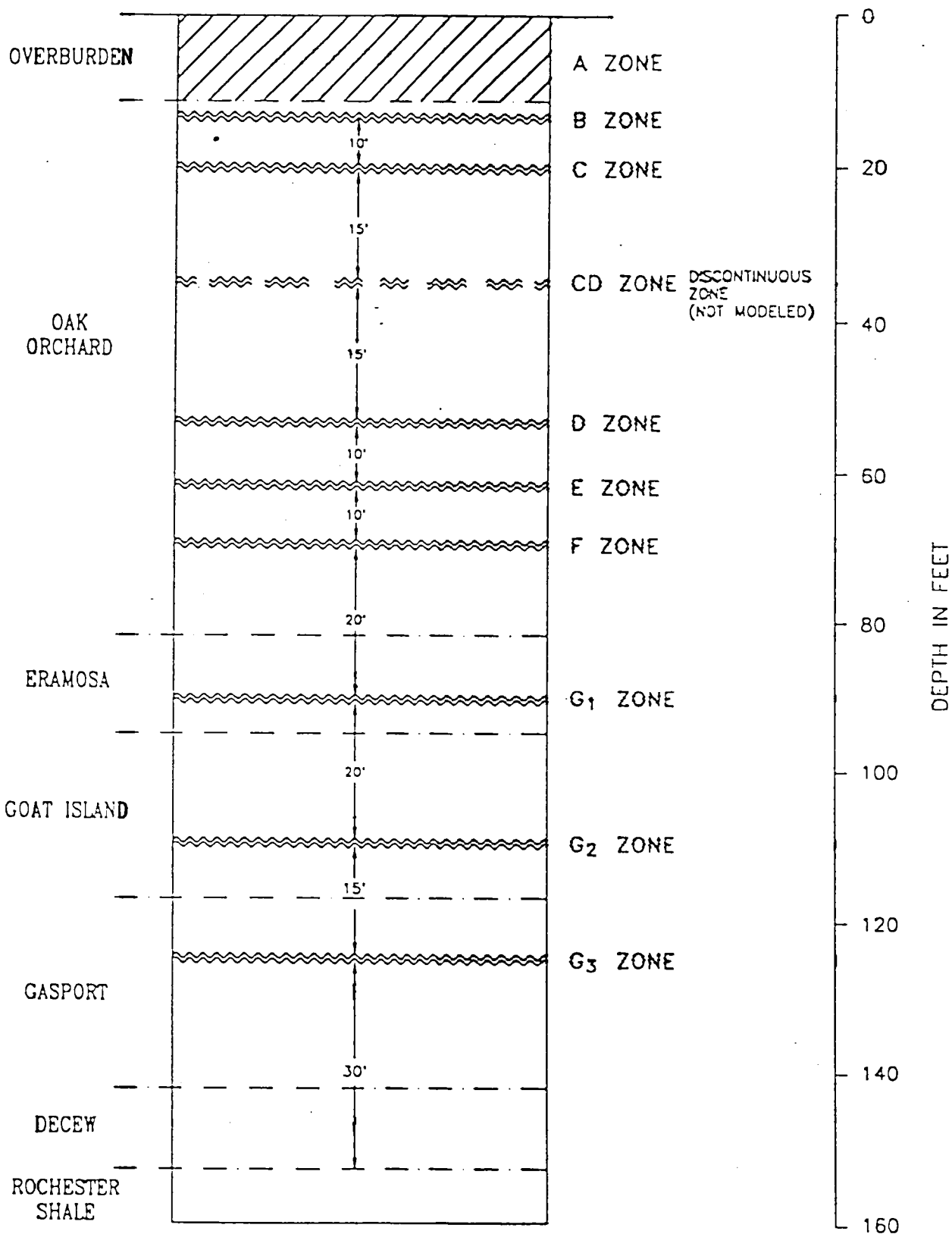
TAKEN FROM W.C.C.
GEOLOGIC REPORT
NECCO PARK, VOL. I
8/88

FIGURE 3		OVERBURDEN STRATIGRAPHIC CROSS SECTION			
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	DATE 4/21/95	CHECKED PFM	APPROVED CLB	PROJECT NO. 1281	
DUPONT NECCO PARK NIAGARA FALLS, NY					



TAKEN FROM PLATE 1B
WATER RESOURCES INVESTIGATIONS REPORT
86-4138

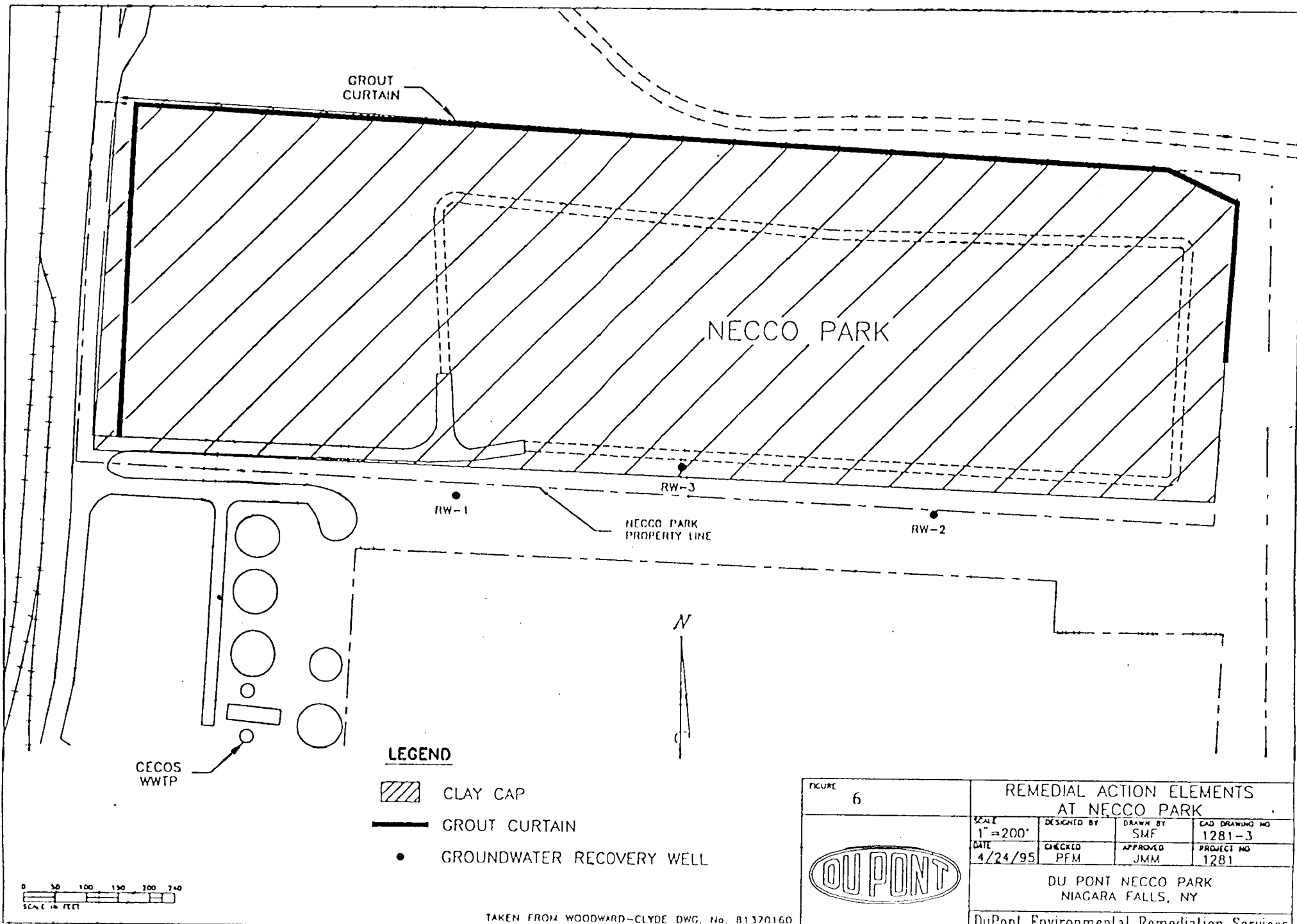
FIGURE		COMPONENTS OF THE NYPA ROBERT MOSES POWER PROJECT			
4		SCALE AS SHOWN	DESIGNED BY	DRAWN BY	EAD DRAWING NO.
		DATE 4/21/95	CHECKED PFM	APPROVED JMM	PROJECT NO. 1281
		DUPONT NECCO PARK NIAGARA FALLS, NY			



LEGEND

- — STRATIGRAPHIC CONTACT
- ~~~~~ BEDDING PLANE FRACTURE ZONE

FIGURE 5		GEOLOGIC CROSS SECTION			
	SCALE AS SHOWN	DESIGNED BY PFM	DRAWN BY SMF	EAD DRAWING NO. 3293-3	
	DATE 4/24/95	CHECKED CLB	APPROVED RGB	PROJECT NO. 3293	
	DuPont Necco Park Niagara Falls, New York				



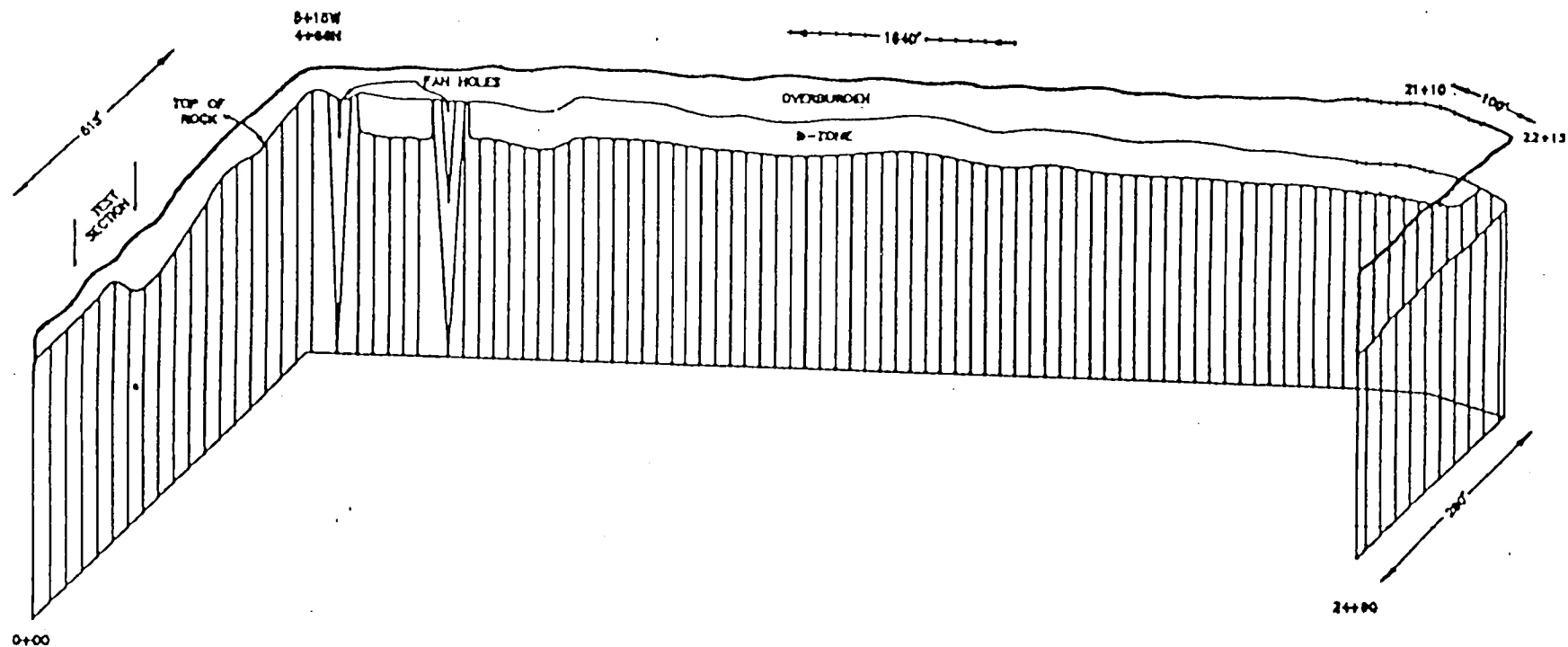
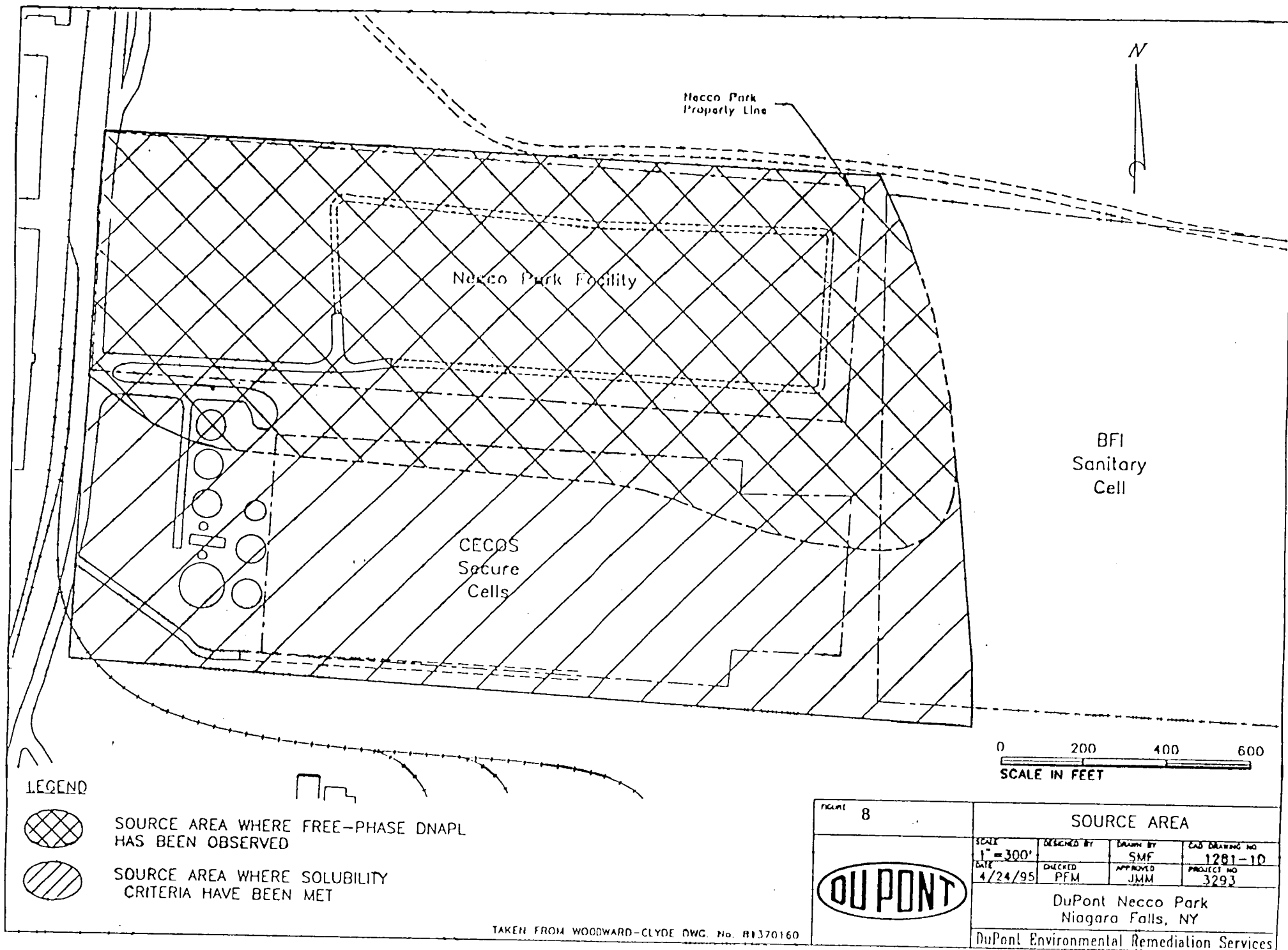
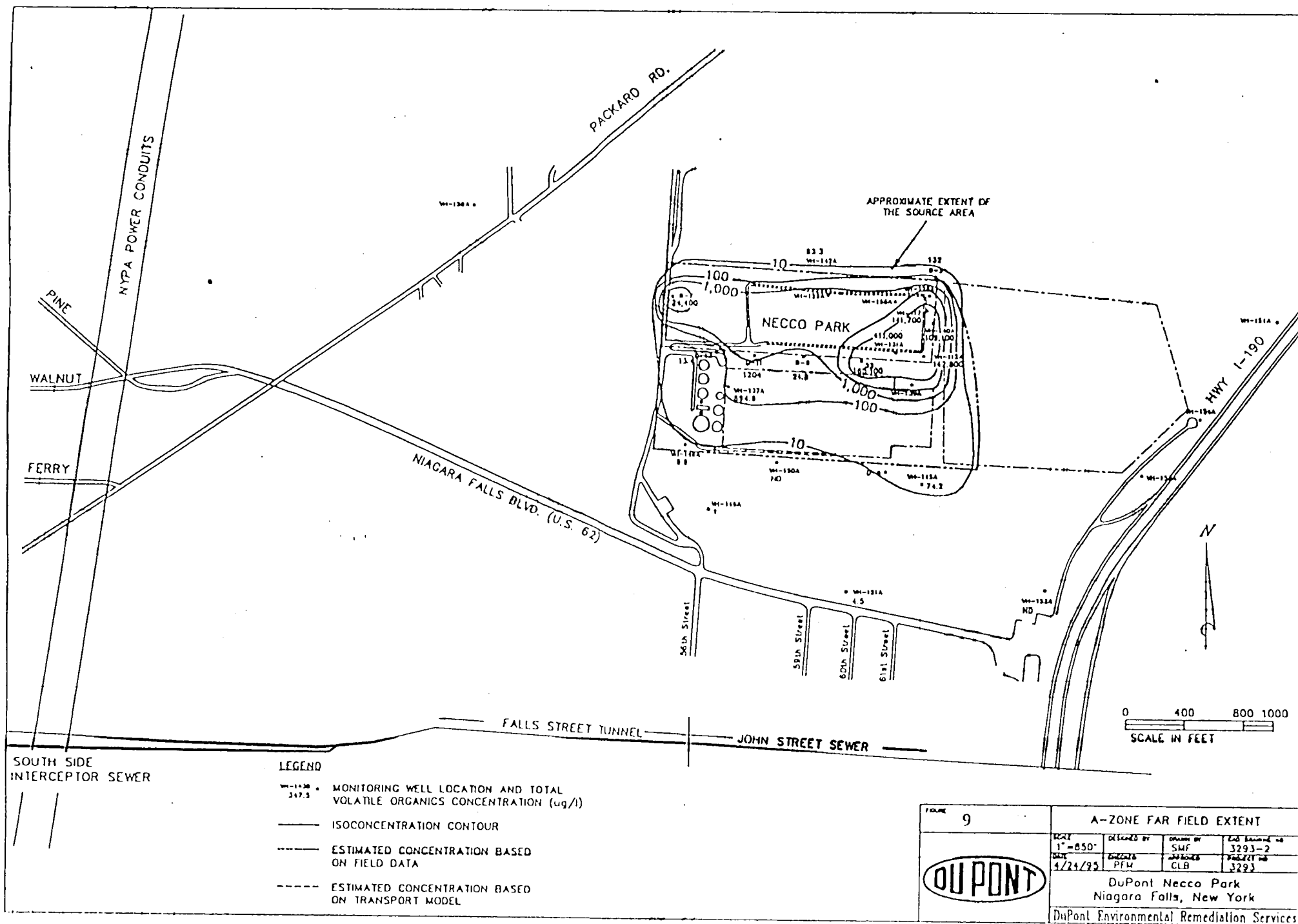
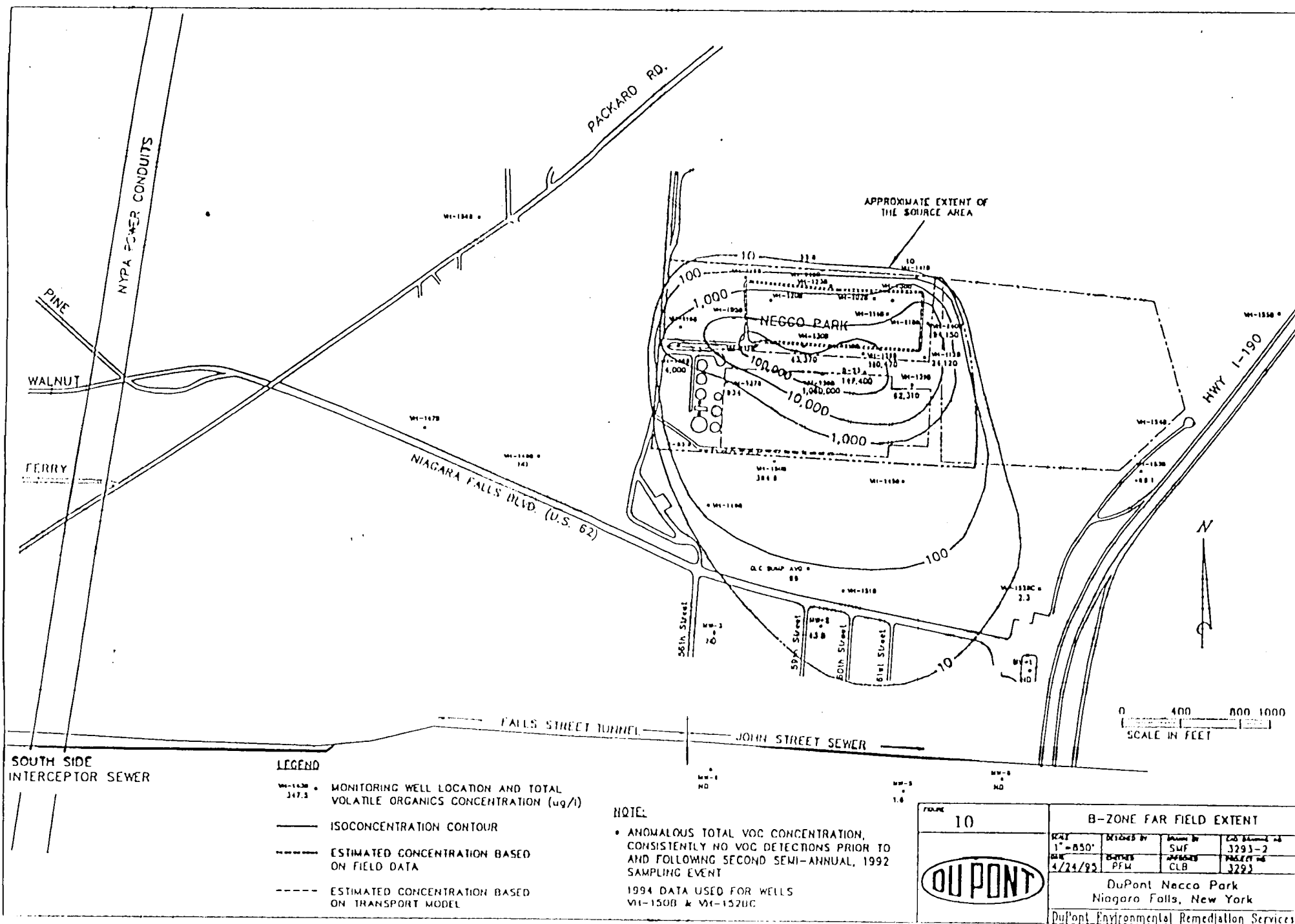
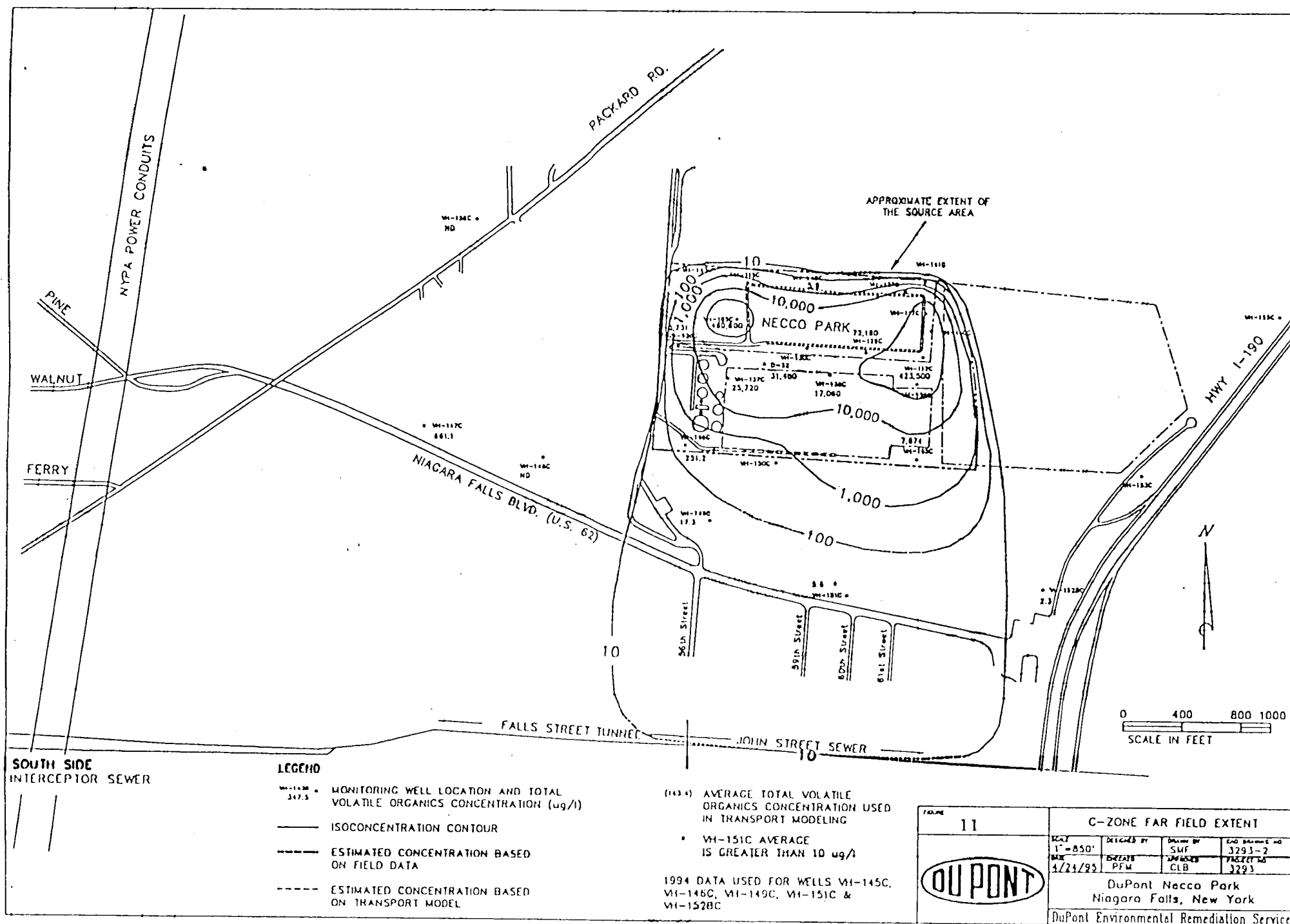


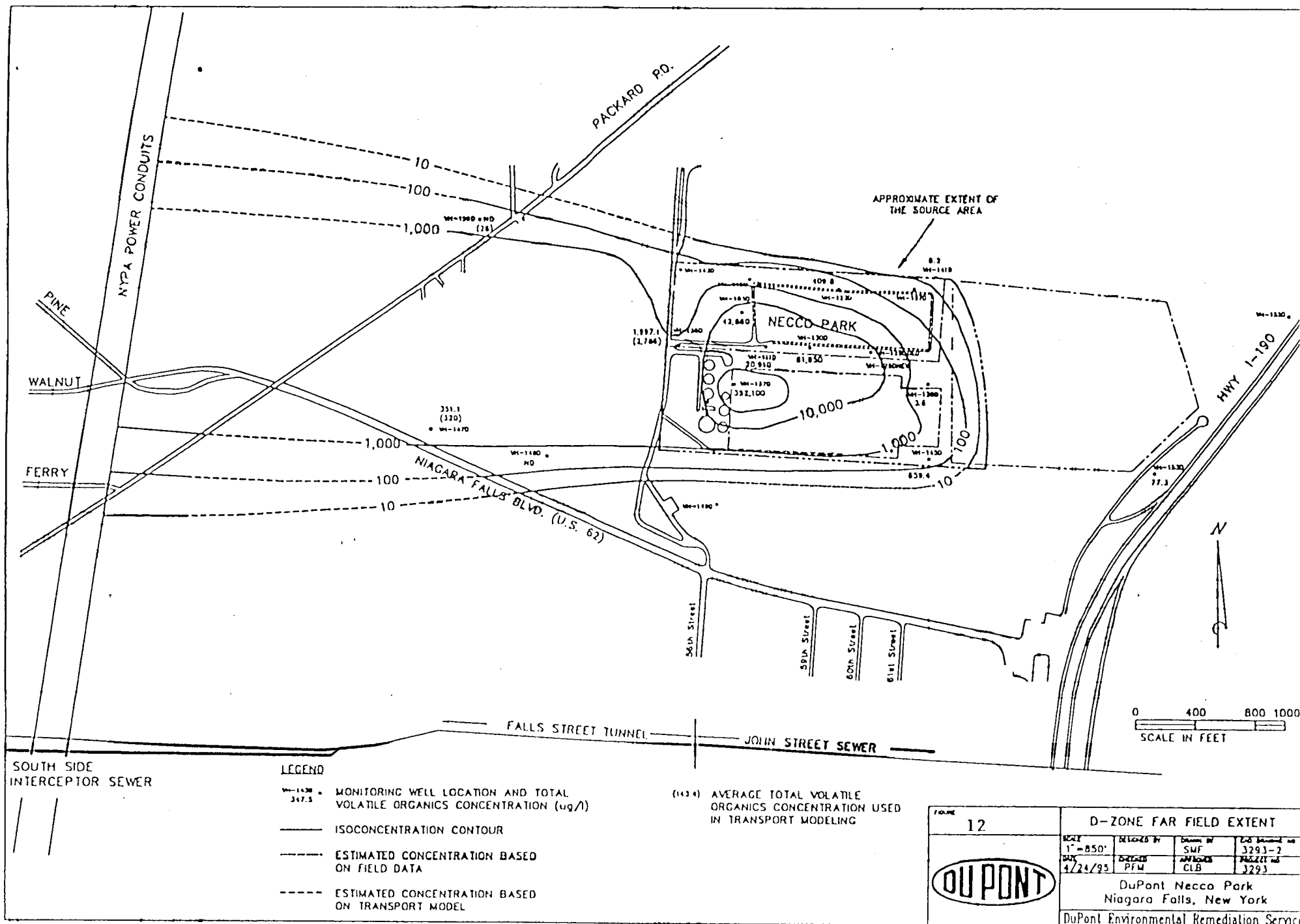
FIGURE 7		GROUT CURTAIN PROFILE		
	SCALE AS SHOWN	DESIGNED BY	DRAWN BY	CAD DRAWING NO.
	DATE 4/21/95	CHECKED PFM	APPROVED JMM	PROJECT NO 1281
DUPONT NECCO PARK NIAGARA FALLS, NY				
DuPont Environmental Remediation Service				

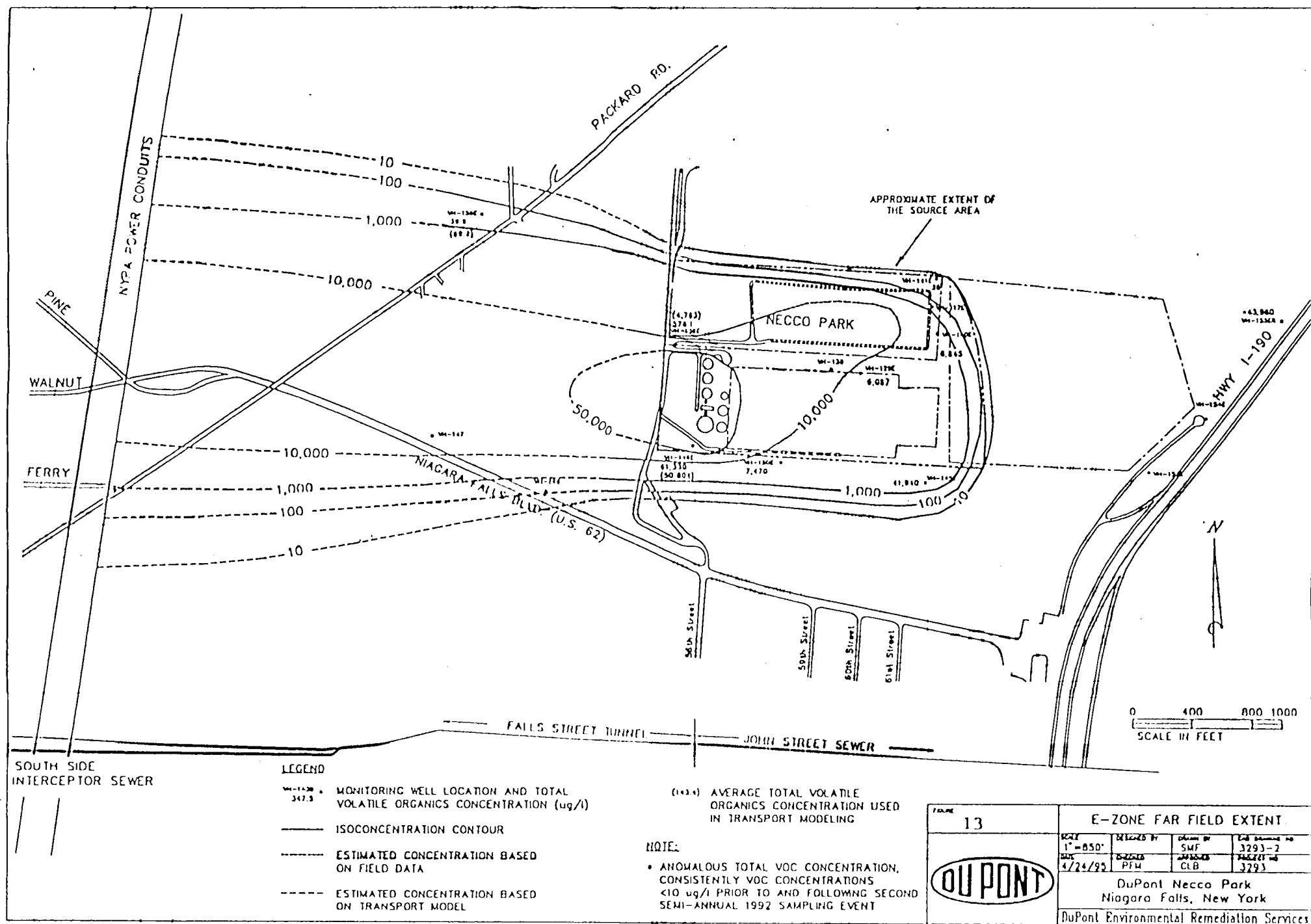


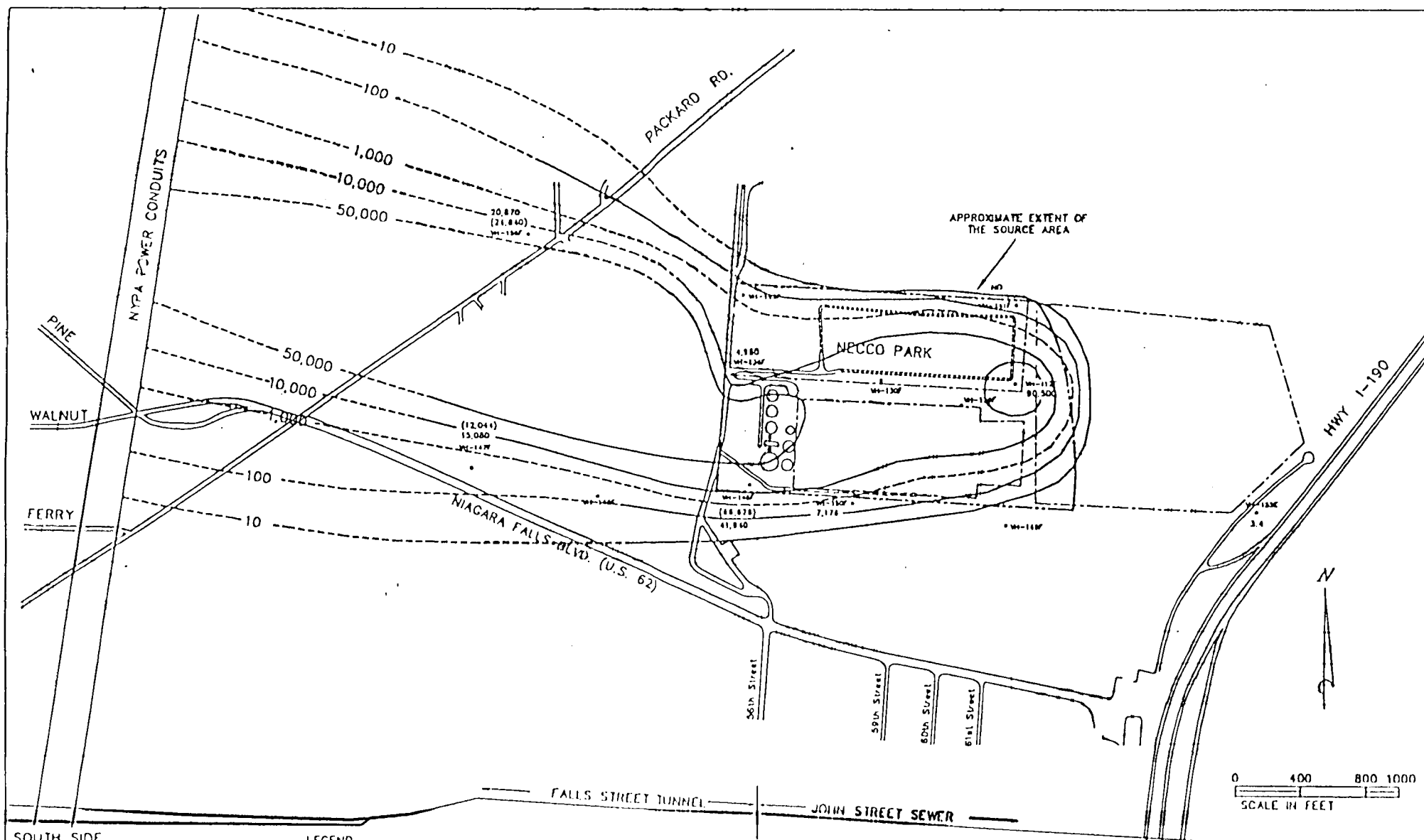












SOUTH SIDE
INTERCEPTOR SEWER

LEGEND

WM-100 • MONITORING WELL LOCATION AND TOTAL
VOLATILE ORGANICS CONCENTRATION (ug/l)

— ISOCONCENTRATION CONTOUR

--- ESTIMATED CONCENTRATION BASED
ON FIELD DATA

--- ESTIMATED CONCENTRATION BASED
ON TRANSPORT MODEL

(1434) AVERAGE TOTAL VOLATILE
ORGANICS CONCENTRATION USED
IN TRANSPORT MODELING

FIGURE
14

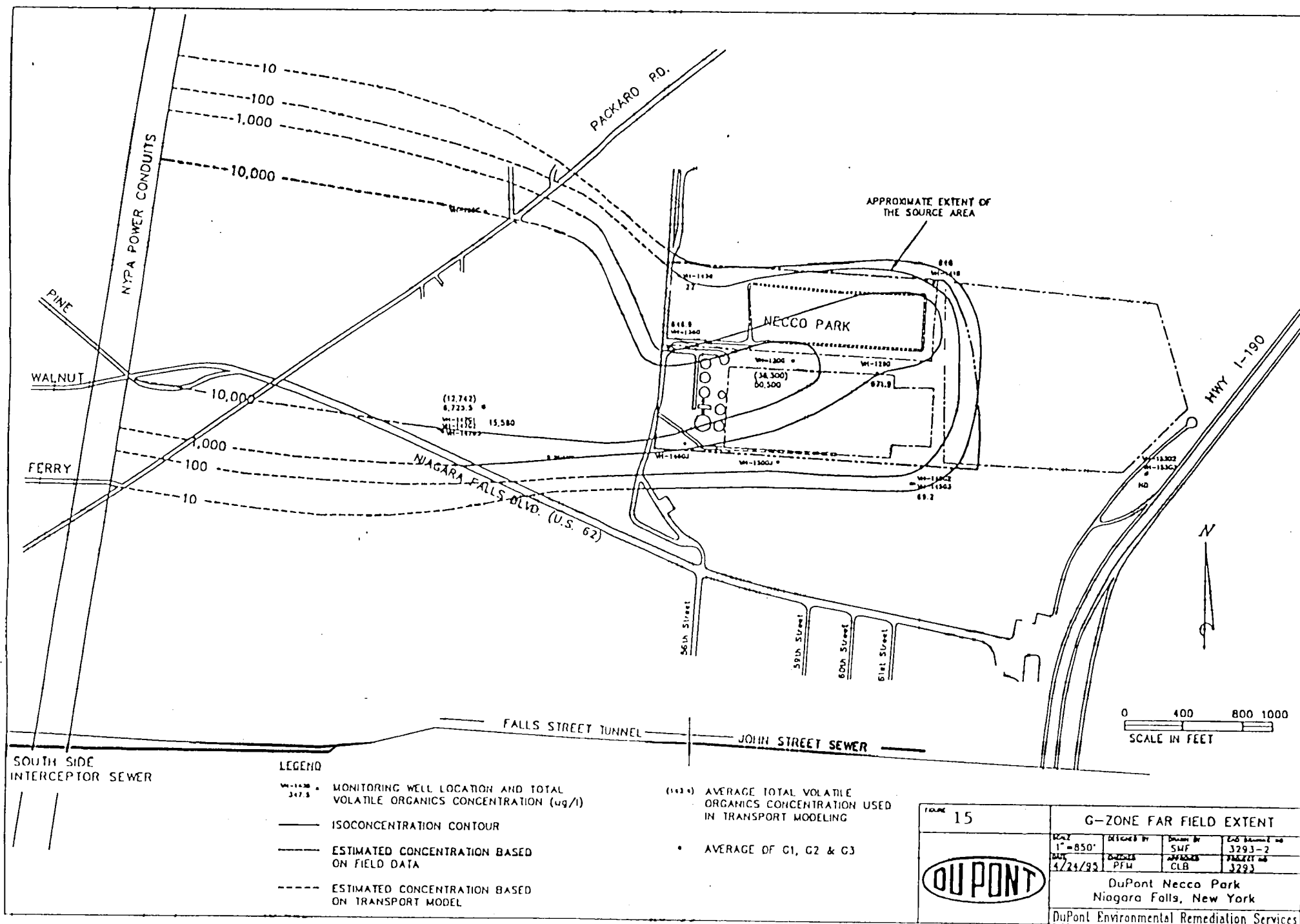
F-ZONE FAR FIELD EXTENT

DATE 1-8-90	DATE BY SUF	DATE BY SUF	DATE BY SUF
BY 4/24/92	DATE BY PFM	DATE BY CLB	DATE BY CLB



DuPont Necco Park
Niagara Falls, New York

DuPont Environmental Remediation Service



APPENDIX II

TABLES

Table 1 - Necco Park Indicator Parameters

Table 2 - Risk Assessment Tables

Table 2a - Risk Assessment: Contaminants of Concern, Human Health Receptors

Table 2b - Risk Assessment: Summary of Exposure Pathways

Table 2c - Risk Assessment: Noncarcinogenic Toxicity Values

Table 2d - Risk Assessment: Noncarcinogenic Risk Estimates

Table 2e - Risk Assessment: Carcinogenic Toxicity Values

Table 2f - Risk Assessment: Carcinogenic Risk Estimates

Table 2g - Risk Assessment: Contaminants of Concern, Environmental Receptors

Table 2h - Risk Assessment: List of Exposure Assumptions

Table 2i - Risk Assessment: List of Potentially Impacted Species

Table 2j - Risk Assessment: Estimated Concentration of Groundwater Contaminants Discharged to the Niagara River Through the Falls Street Tunnel

Table 2k - Risk Assessment: Estimated Concentration of Groundwater Contaminants Discharged to the Forebay Canal Through the NYPA Conduit Drain System

Table 2l - Risk Assessment: Estimated Concentrations of Groundwater Contaminants Discharged to the Niagara River

Table 2m - Risk Assessment: Surface Water Ecological Risk Summary

Table 3 - List of ARARs, Potential ARARs, and TBCs

Table 4 - Chemical-Specific Groundwater Quality Criteria

Table 5 - New York State TAGM: Determination of Soil Cleanup Objectives and Cleanup Levels

Table 6 - Contaminant Loadings from the Source Area

Table 7 - Cost of Alternatives

Table 1

NECCO PARK AQUEOUS INDICATOR PARAMETER LIST

Inorganic and General Water-Quality Parameter	Volatile Organic Compounds	Semivolatile Organic Compounds
pH	Vinyl chloride	Hexachloroethane
Specific conductivity	1,1-dichloroethene	Hexachlorobutadiene
Temperature	Trans-1,2-dichloroethene	Phenol
Chloride	Cis-1,2-dichloroethene	4-methylphenol
Ammonia nitrogen	Chloroform	2,4,6-trichlorophenol
Soluble barium	Carbon tetrachloride	2,4,5-trichlorophenol
Cyanide	1,2-dichloroethane	Pentachlorophenol
Total organic halogens	Trichloroethene	Hexachlorobenzene
Total organic carbons	1,1,2-trichloroethane	TIC-1
Total dissolved solids	Tetrachloroethene	
Total suspended solids	1,1,2,2-tetrachloroethane	
Rhodamine		

TABLE 2

RISK ASSESSMENT TABLES

TABLE 2a INDICATOR CHEMICALS DETECTED IN 1992 GROUND WATER
SAMPLES (HUMAN HEALTH RECEPTORS)

VOCs

Carbon Tetrachloride
Chloroform
1,2-Dichloroethane
1,1-Dichloroethene
Cis-1,2-Dichloroethene
Trans-1,2-Dichloroethene
Hexachlorobenzene
Hexachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethene
1,1,2-Trichloroethane
Trichloroethene
Vinyl Chloride

BNAs

Hexachlorobutadiene
4-Methylphenol
Pentachlorophenol
Phenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Inorganics

Barium
Cyanide

TABLE 2b DUPONT NECCO PARK SITE: SUMMARY OF EXPOSURE PATHWAYS

Pathway	Receptor	TIME-FRAME EVALUATED		DEGREE OF ASSESSMENT		Rationale for Selection or Exclusion	Data Grouping
		Present	Future	Quant.	Qual.		
Ground Water							
Ingestion of Ground Water	Resident	No	Yes	X		Although no private drinking water wells or public water supplies are currently located downgradient of the site, it is possible that downgradient private wells may be installed and used as a drinking water source in the future. Furthermore, New York State has classified ground water in the vicinity of the site as a potable drinking water source (Class GA).	On-site sampling data from several aquifers used as input to contaminant transport model.
Inhalation of Ground Water Contaminants during Showers	Resident	No	Yes	X		Same rationale as above.	On-site sampling data from several aquifers used as input to contaminant transport model.
Dermal Contact with Ground Water	Resident	No	Yes	X		Same rationale as above.	On-site sampling data from several aquifers used as input to contaminant transport model.
Inhalation of Contaminants that Volatilize from Ground Water and Seep into Basements	Resident	Yes	Yes		X	Infiltration of volatiles in ground water to local basements is possible.	
Soils							
Incidental Ingestion of Onsite Soils	Worker/Trespasser	No	No			The site has been capped with approximately 2 to 4 feet of clean fill. Disturbance is expected to be minimal.	
		No	No				
Dermal Contact with Onsite Soils	Worker/Trespasser	No	No			Same as above.	
Inhalation of VOC Emissions and Particulates from Soils	Worker/Trespasser	No	No			Same as above.	

TABLE 2b (CONTINUED)

Pathway	Receptor	TIME-FRAME EVALUATED		DEGREE OF ASSESSMENT		Rationale for Selection or Exclusion	Data Grouping
		Present	Future	Quant.	Qual.		
Sediments (Drainage Ditches)							
Incidental Ingestion of Sediments	Worker/Trespasser	Yes	Yes		X	Drainage ditches exist along the perimeter of the site which accumulate standing water and sediments. A major source of these sediments and runoff water is considered to be upgradient sites (landfills). The contribution of Dupont Necco Park is difficult to determine.	
Dermal Contact with Sediments	Worker/Trespasser	Yes	Yes		X	Same as above.	
Surface Water (Drainage Ditches)							
Incidental Ingestion of Surface Water	Worker/Trespasser	No	No			Water level in ditches is shallow. Anticipated activity involves negligible exposure via the oral route.	
Dermal Contact with Surface Water	Worker/Trespasser	Yes	Yes		X	Drainage ditches exist along the perimeter of the site which accumulate standing water and sediments. A major source of these sediments and runoff water is considered to be upgradient sites (landfills). The contribution of Dupont Necco Park is difficult to determine.	
Surface Water (Niagara River and Reservoir near Forebay Canal)							
Incidental Ingestion of Surface Water	Resident	Yes	Yes		X	The Niagara River downstream of Niagara Gorge and the reservoir near the Forebay Canal may be used for recreation. Exposure potential is minimal as a result of dilution and infrequent exposure.	
Dermal Contact with Surface Water	Resident	Yes	Yes		X	Same rationale as above.	
Biota (Niagara River and Reservoir near Forebay Canal)							
Ingestion of Fish	Resident	Yes	Yes		X	Exposure is possible. Dilution, low exposure frequency, and generally low bioconcentration potential will reduce risks.	

TABLE 2c TOXICITY VALUES FOR CONTAMINANTS OF CONCERN AT
THE DUPONT NECCO PARK SITE

Chemical	CARCINOGENIC			NON-CARCINOGENIC	
	Weight of Evidence	Oral Slope Factor	Inhal. Slope Factor	Chronic Oral RfD	Chronic Inhal. RfD
	Classification	(mg/kg/day) ⁻¹	(mg/kg/day) ⁻¹	(mg/kg/day)	(mg/kg/day)
VOCs					
Carbon tetrachloride	B2 a	1.30E-01 a	5.30E-02 b	7.00E-04 a	
Chloroform	B2 a	6.10E-03 a	8.10E-02 b	1.00E-02 a	
1,2-Dichloroethane	B2 a	9.10E-02 a	9.10E-02 a	3.00E-01 c	
1,1-Dichloroethene	C a	6.00E-01 a	1.20E+00 a	9.00E-03 a	
cis-1,2-Dichloroethene	D a			1.00E-02 b	
trans-1,2-Dichloroethene	-- a			2.00E-02 a	
Hexachlorobenzene	B2 a	1.60E+00 a	1.60E+00 b	8.00E-04 a	
Hexachloroethane	C a	1.40E-02 a	1.40E-02 b	1.00E-03 a	
1,1,2,2-Tetrachloroethane	C a	2.00E-01 a	2.00E-01 a		
Tetrachloroethene	B2-C c	5.20E-02 c	2.00E-03 c	1.00E-02 a	
1,1,2-Trichloroethane	C a	5.70E-02 a	5.70E-02 b	4.00E-03 a	
Trichloroethene	B2-C c	1.10E-02 c	6.00E-03 c	6.00E-03 c	
Vinyl chloride (chloroethene)	A b	1.90E+00 b	3.00E-01 b		
BNAs					
Hexachlorobutadiene	C a	7.80E-02 a	7.80E-02 b	2.00E-03 a	
4-Methylphenol (p-cresol)	C a			5.00E-03 b	
Pentachlorophenol	B2 a	1.20E-01 a		3.00E-02 a	
Phenol	D a			6.00E-01 a	
2,4,5-Trichlorophenol	--			1.00E-01 a	
2,4,6-Trichlorophenol	B2 a	1.10E-02 a	1.00E-02 b		
Inorganics					
Barium	-- a			7.00E-02 a	1.00E-04 b
Cyanide	D a			2.00E-02 a	

a. From IRIS

b. From HEAST

c. Interim value from ECAO (see risk assessment text for specific references)

TABLE 2d SUMMARY OF NONCARCINOGENIC HAZARD INDICES (HI)
ESTIMATED FOR THE DUPONT NECCO PARK SITE

Scenario	Receptor	Present/Future	Chronic HI
Ground Water - Aquifer Layers A-C			
Ingestion	Resident	F	$1 \times 10^4^*$
Inhalation During Showering	Resident	F	--
Dermal Contact During Showering	Resident	F	$3 \times 10^3^*$
Ground Water - Aquifer Layers D-F			
Ingestion	Resident	F	$3 \times 10^3^*$
Inhalation During Showering	Resident	F	--
Dermal Contact During Showering	Resident	F	$9 \times 10^2^*$
Ground Water - Aquifer Layer G			
Ingestion	Resident	F	$1 \times 10^2^*$
Inhalation During Showering	Resident	F	--
Dermal Contact During Showering	Resident	F	$3 \times 10^1^*$

* - HI exceeds one (1)

-- Not evaluated quantitatively due to lack of toxicity values

TABLE 2e TOXICITY VALUES FOR CONTAMINANTS OF CONCERN AT
THE DUPONT NECCO PARK SITE

Chemical	CARCINOGENIC			NON-CARCINOGENIC	
	Weight of Evidence Classification	Oral Slope Factor (mg/kg/day) ⁻¹	Inhal. Slope Factor (mg/kg/day) ⁻¹	Chronic Oral RfD (mg/kg/day)	Chronic Inhal. RfD (mg/kg/day)
VOCs					
Carbon tetrachloride	B2 a	1.30E-01 a	5.30E-02 b	7.00E-04 a	
Chloroform	B2 a	6.10E-03 a	8.10E-02 b	1.00E-02 a	
1,2-Dichloroethane	B2 a	9.10E-02 a	9.10E-02 a	3.00E-01 c	
1,1-Dichloroethene	C a	6.00E-01 a	1.20E+00 a	9.00E-03 a	
cis-1,2-Dichloroethene	D a			1.00E-02 b	
trans-1,2-Dichloroethene	-- a			2.00E-02 a	
Hexachlorobenzene	B2 a	1.60E+00 a	1.60E+00 b	8.00E-04 a	
Hexachloroethane	C a	1.40E-02 a	1.40E-02 b	1.00E-03 a	
1,1,2,2-Tetrachloroethane	C a	2.00E-01 a	2.00E-01 a		
Tetrachloroethene	B2-C c	5.20E-02 c	2.00E-03 c	1.00E-02 a	
1,1,2-Trichloroethane	C a	5.70E-02 a	5.70E-02 b	4.00E-03 a	
Trichloroethene	B2-C c	1.10E-02 c	6.00E-03 c	6.00E-03 c	
Vinyl chloride (chloroethene)	A b	1.90E+00 b	3.00E-01 b		
BNAs					
Hexachlorobutadiene	C a	7.80E-02 a	7.80E-02 b	2.00E-03 a	
4-Methylphenol (p-cresol)	C a			5.00E-03 b	
Pentachlorophenol	B2 a	1.20E-01 a		3.00E-02 a	
Phenol	D a			6.00E-01 a	
2,4,5-Trichlorophenol	--			1.00E-01 a	
2,4,6-Trichlorophenol	B2 a	1.10E-02 a	1.00E-02 b		
Inorganics					
Barium	-- a			7.00E-02 a	1.00E-04 b
Cyanide	D a			2.00E-02 a	

a. From IRIS

b. From HEAST

c. Interim value from ECAO (see risk assessment text for specific references)

TABLE 2f SUMMARY OF CARCINOGENIC RISKS ESTIMATED FOR THE DUPONT
NECCO PARK SITE

Scenario	Receptor	Present/Future	Total Risk
Ground Water - Aquifer Layers A-C			
Ingestion	Resident	F	$1 \times 10^{0**}$
Inhalation During Showering	Resident	F	$5 \times 10^{-1**}$
Dermal Contact During Showering	Resident	F	$2 \times 10^{-1**}$
Ground Water - Aquifer Layers D-F			
Ingestion	Resident	F	$5 \times 10^{-1**}$
Inhalation During Showering	Resident	F	$2 \times 10^{-1**}$
Dermal Contact During Showering	Resident	F	$1 \times 10^{-1**}$
Ground Water - Aquifer Layer G			
Ingestion	Resident	F	$6 \times 10^{-2**}$
Inhalation During Showering	Resident	F	$3 \times 10^{-2**}$
Dermal Contact During Showering	Resident	F	$6 \times 10^{-3**}$

**Exceeds 10^{-4} risk

TABLE 2g INDICATOR CHEMICALS DETECTED IN 1992 GROUND WATER
SAMPLES (ENVIRONMENTAL RECEPTORS)

VOCs

Carbon Tetrachloride
Chloroform
1,2-Dichloroethane
1,1-Dichloroethene
Cis-1,2-Dichloroethene
Trans-1,2-Dichloroethene
Hexachlorobenzene
Hexachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethene
1,1,2-Trichloroethane
Trichloroethene
Vinyl Chloride

BNAs

Hexachlorobutadiene
4-Methylphenol
Pentachlorophenol
Phenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Inorganics

Barium
Cyanide

TABLE 2b EXPOSURE PATHWAY: INGESTION OF GROUND WATER BY
RESIDENT FOR FUTURE SCENARIO

VARIABLE	RANGE	MIDPOINT	VALUE USED	RATIONALE	REFERENCE
<i>Receptor Population</i>				Resident	
<i>Body Weight (kg)</i>					
Adult Resident	--	--	70	Per EPA Guidance	RAGS Suppl.
<i>Duration of Exposure (years)</i>					
Adult Resident	1 - 70	35	30	90th percentile for time at a single residence	RAGS Suppl.
<i>Exposure Frequency (days/year)</i>					
Adult Resident	1 - 365	182.5	350	Per EPA Guidance	RAGS Suppl.
<i>Ingestion Rate (l/day)</i>					
Adult Resident	--	--	2	Per EPA Guidance	RAGS Suppl.
<i>Averaging Time (days)</i>					
noncarcinogens	--	--	10950	Values used are based on exposure duration for noncarcinogens and lifetime exposure for carcinogens	RAGS
carcinogens	--	--	25550		

RAGS Suppl.: U.S. EPA, *Risk Assessment Guidance for Superfund, Vol. I. Supplemental Guidance: Standard Default Exposure Factors*, Interim Final. Office of Emergency and Remedial Response. March 1991.

RAGS: U.S. EPA, *Risk Assessment Guidance for Superfund, Volume I*, EPA 540/1-89/002. Office of Emergency and Remedial Response. December 1989.

TABLE 2h EXPOSURE PATHWAY: INHALATION OF CONTAMINANTS VOLATILIZED FROM GROUND WATER WHEN RESIDENTS SHOWER FOR FUTURE SCENARIO
(continued)

VARIABLE	RANGE	MIDPOINT	VALUE USED	RATIONALE	REFERENCE
<i>Receptor Population</i>				Residents	
<i>Contaminant Concentration (mg/cu. m)</i> Modeled value based on contaminant concentrations associated with on-site wells			See Appendix E		
<i>Body Weight (kg)</i> Adult	--	--	70	Per EPA Guidance	RAGS Suppl.
<i>Exposure Time (hours/day)</i> Adult	0.116 - 0.2	0.158	0.2	90th percentile value for showering	RAGS
<i>Duration of Exposure (years)</i> Adult	1 - 70	35	30	90th percentile for time at a single residence	RAGS Suppl.
<i>Exposure Frequency (days/year)</i>	1 - 365	182.5	350	Equivalent to ingestion frequency	RAGS Suppl.
<i>Inhalation Rate (cu. m/hour)</i> Adult	--	--	0.6	Value used is an hourly rate that is specific to showering activities	RAGS
<i>Averaging Time (days)</i> Adult noncarcinogens carcinogens	-- --	-- --	10950 25550	Values used are based on exposure duration for noncarcinogens and lifetime exposure for carcinogens	RAGS

RAGS: U.S. EPA, *Risk Assessment Guidance for Superfund Volume I*, EPA 540/1-89/002. Office of Emergency and Remedial Response. December 1989.

RAGS Suppl.: U.S. EPA, *Risk Assessment Guidance for Superfund, Vol. I. Supplemental Guidance: Standard Default Exposure Factors*, Interim Final. Office of Emergency and Remedial Response. March 1991.

TABLE 2b EXPOSURE PATHWAY: DERMAL CONTACT WITH GROUND WATER WHEN
(continued) RESIDENTS SHOWER FOR FUTURE SCENARIO

VARIABLE	RANGE	MIDPOINT	VALUE USED	RATIONALE	REFERENCE
<i>Receptor Population</i>				Residents	
<i>Body Weight (kg)</i> Adult			70	Per EPA Guidance	RAGS Suppl.
<i>Exposure Time (hours/day)</i> Adult	0.116 - 0.2	0.158	0.2	90th percentile value for showering.	RAGS
<i>Duration of Exposure (years)</i> Adult	1 - 70	35	30	90th percentile for time of a single residence.	RAGS Suppl.
<i>Exposure Frequency (days/year)</i>	1 - 365	182.5	350	Equivalent to ingestion frequency.	RAGS Suppl.
<i>Skin Surface Area Contacted (sq. cm)</i> Total	17,000- 23,000	20,000	20,000	50th percentile value averaged over entire group.	DEA
<i>Permeability Coefficient (cm/hr)</i> Chemical-specific	--	--	see Table 4-5	Chemical-specific values	DEA
<i>Averaging Time (days)</i> noncarcinogenic carcinogenic	-- --	--	10950 25550	Values used are based on exposure duration for noncarcinogens and lifetime for carcinogens	RAGS

RAGS: U.S. EPA. *Risk Assessment Guidance for Superfund, Volume I*, EPA 540/1-89/002. Office of Emergency and Remedial Response. December 1989.

RAGS, Suppl.: U.S. EPA. *Risk Assessment Guidance for Superfund, Vol. I. Supplemental Guidance: Standard Default Exposure Factors*, Interim Final, Office of Emergency and Remedial Response. March 1991.

DEA: *Dermal Exposure Assessment: Principles and Applications*, Interim Report. EPA/600/8-91/011B. Office of Research and Development. January 1992.

TABLE 21 WILDLIFE SPECIES POTENTIALLY INHABITING THE NECCO PARK SITE, NIAGARA FALLS, NY

Family	Common Name	Latin Name	Guild ¹	Forage Method	Breeding Substrate
Amphibians					
Bufo	Eastern American Toad	<i>Bufo a. americanus</i>	I	Ground Ambusher	Water
Birds					
Accipitridae	Northern Harrier	<i>Circus cyaneus</i>	C	Ground Pouncer	Not applicable ²
	Red-tailed Hawk	<i>Buteo jamaicensis</i>	C	Ground Pouncer	Tree-Branch
	*Rough-legged Hawk	<i>Buteo lagopus</i>	C	Ground Pouncer	Not applicable
Alaudidae	Horned Lark	<i>Eremophila alpestris</i>	O	Ground Gleaner	Ground-Herb
Apodidae	Chimney Swift	<i>Chaetura pelagica</i>	I	Air Screener	Buildings
Caprimulgidae	Common Nighthawk	<i>Chordeiles minor</i>	I	Air Screener	Buildings
Charadriidae	*Killdeer	<i>Charadrius vociferus</i>	I	Ground Gleaner	Ground-Herb
Columbidae	Mourning Dove	<i>Zenaida macroura</i>	G	Ground Gleaner	Tree-Branch
	*Rock Dove	<i>Columba livia</i>	O	Ground Gleaner	Buildings
Corvidae	American Crow	<i>Corvus brachyrhynchos</i>	O	Ground Gleaner	Tree-Branch
Falconidae	*American Kestrel	<i>Falco sparverius</i>	C	Ground Pouncer	Tree Cavity-Crevise
Fringillidae	American Tree Sparrow	<i>Spizella arborea</i>	O	Ground Gleaner	Not applicable
	Common Redpoll	<i>Carduelis flammea</i>	G	Ground Gleaner	Not applicable
	Dark-eyed Junco	<i>Junco hyemalis</i>	G	Ground Gleaner	Not applicable
	Grasshopper Sparrow	<i>Ammodramus savannarum</i>	O	Ground Gleaner	Ground-Herb
	Hoary Redpoll	<i>Carduelis hornemanni</i>	G	Ground Gleaner	Not applicable
	Lapland Longspur	<i>Calcarius lapponicus</i>	G	Ground Gleaner	Not applicable
	Savannah Sparrow	<i>Passerculus sandwichensis</i>	O	Ground Gleaner	Ground-Herb
	Snow Bunting	<i>Plectrophenax nivalis</i>	G	Ground Gleaner	Not applicable
	*Song Sparrow	<i>Melospiza melodia</i>	O	Ground Gleaner	Ground-Herb
	Vesper Sparrow	<i>Pooecetes gramineus</i>	O	Ground Gleaner	Ground-Herb
	White-throated Sparrow	<i>Zonotrichia albicollis</i>	G	Ground Gleaner	Not applicable
	Barn Swallow	<i>Hirundo rustica</i>	I	Air Screener	Buildings
	Cliff Swallow	<i>Hirundo pyrrhonota</i>	I	Air Screener	Buildings
Icteridae	Bobolink	<i>Dolichonyx oryzivorus</i>	O	Ground Gleaner	Ground-Herb
	Brown-headed Cowbird	<i>Molothrus ater</i>	O	Ground Gleaner	Nest Parasite
	Common Grackle	<i>Quiscalus quiscula</i>	O	Ground Gleaner	Tree-Branch
	Eastern Meadowlark	<i>Sturnella magna</i>	I	Ground Gleaner	Ground-Herb

TABLE 21 WILDLIFE SPECIES POTENTIALLY INHABITING THE NECCO PARK SITE, NIAGARA FALLS, NY (cont.)

Family	Common Name	Latin Name	Guild ¹	Forage Method	Breeding Substrate
Icteridae	Red-winged Blackbird	<i>Agelaius phoeniceus</i>	O	Ground Gleaner	Shrub
Laniidae	Northern Shrike	<i>Lanius excubitor</i>	C	Ground Pouncer	Not applicable
Phasianidae	*Ring-necked Pheasant	<i>Phasianus colchicus</i>	O	Ground Gleaner	Ground-Herb
Picidae	Northern Flicker	<i>Colaptes auratus</i>	I	Ground Gleaner	Tree Cavity-Crevise
Ploceidae	House Sparrow	<i>Passer domesticus</i>	G	Ground Gleaner	Buildings
Scolopacidae	Upland Sandpiper	<i>Bartramia longicauda</i>	I	Ground Gleaner	Ground-Herb
Strigidae	Short-eared Owl	<i>Asio flammeus</i>	C	Ground Pouncer	Not applicable
	Snowy Owl	<i>Nyctea scandiaca</i>	C	Ground Pouncer	Not applicable
Sturnidae	European Starling	<i>Sturnus vulgaris</i>	O	Ground Gleaner	Buildings
Turdidae	American Robin	<i>Turdus migratorius</i>	O	Ground Gleaner	Tree-Branch
Tytonidae	Common Barn-Owl	<i>Tyto alba</i>	C	Ground Pouncer	Buildings
Mammals					
Canidae	Coyote	<i>Canis latrans</i>	O	Ground Forager	Terrestrial Subsurface
	Red Fox	<i>Vulpes vulpes</i>	O	Ground Forager	Terrestrial Subsurface
Cervidae	White-tailed Deer	<i>Odocoileus virginianus</i>	H	Ground Grazer	Ground-Herb
Cricetidae	*Meadow Vole	<i>Microtus pennsylvanicus</i>	H	Ground Grazer	Terrestrial Subsurface
	White-footed Mouse	<i>Peromyscus leucopus</i>	O	Ground Forager	Terrestrial Subsurface
Didelphidae	Virginia Opossum	<i>Didelphis virginiana</i>	O	Ground Forager	Tree Cavity-Crevise
Leporidae	Eastern Cottontail	<i>Sylvilagus floridanus</i>	H	Ground Grazer	Ground-Herb
Muridae	House Mouse	<i>Mus musculus</i>	O	Ground Forager	Buildings
	Norway Rat	<i>Rattus norvegicus</i>	O	Ground Forager	Terrestrial Subsurface
Mustelidae	*Striped Skunk	<i>Mephitis mephitis</i>	O	Ground Forager	Terrestrial Subsurface
Procyonidae	Raccoon	<i>Procyon lotor</i>	O	Ground Forager	Tree Cavity-Crevise
Sciuridae	Woodchuck	<i>Marmota monax</i>	H	Ground Grazer	Terrestrial Subsurface
Soricidae	N. Short-tailed Shrew	<i>Blarina brevicauda</i>	I	Ground Gleaner	Terrestrial Subsurface
Talpidae	Hairy-tailed Mole	<i>Parascalops breweri</i>	I	Ground Gleaner	Terrestrial Subsurface
Vespertilionidae	Big Brown Bat	<i>Eptesicus fuscus</i>	I	Air Hawker	Buildings
	Little Brown Bat	<i>Myotis lucifugus</i>	I	Air Hawker	Buildings
	N. Long-eared Bat	<i>Myotis septentrionalis</i>	I	Air Hawker	Tree Cavity-Crevise
	Small-footed Myotis	<i>Myotis leibii</i>	I	Air Hawker	Buildings
Zapodidae	Meadow Jumping Mouse	<i>Zapus hudsonius</i>	O	Ground Forager	Ground-Herb

TABLE 21 WILDLIFE SPECIES POTENTIALLY INHABITING THE NECCO PARK SITE, NIAGARA FALLS, NY (cont.)

Family	Common Name	Latin Name	Guild ¹	Forage Method	Breeding Substrate
Reptiles					
Colubridae	E. Smooth Green Snake	<i>Opheodrys v. vernalis</i>	I	Ground Ambusher	Terrestrial Subsurface
	Eastern Garter Snake	<i>Thamnophis s. sirtalis</i>	C	Ground Ambusher	Terrestrial Subsurface
	Eastern Milk Snake	<i>Lampropeltis t. triangulum</i>	C	Ground Ambusher	Terrestrial Subsurface
	Northern Brown Snake	<i>Storeria d. dekayi</i>	I	Ground Ambusher	Terrestrial Subsurface

* Species (or sign) observed on the site.

¹ Guild Includes: C: Carnivore
G: Granivore (Seed-eater)
H: Herbivore
I: Insectivore
O: Omnivore

² Not applicable since not anticipated to breed in vicinity of site.

TABLE 21. WILDLIFE SPECIES POTENTIALLY INHABITING THE NIAGARA RIVER, NIAGARA FALLS, NY (cont.)

Family	Common Name	Latin Name	Guild ¹	Forage Method	Breeding Substrate
Mammals					
Mustelidae	Mink	<i>Mustela vison</i>	P	Water Diver	Riparian Subsurface
Vespertilionidae	Big Brown Bat	<i>Eptesicus fuscus</i>	I	Air Hawker	Buildings
	Eastern Pipistrelle	<i>Pipistrellus subflavus</i>	I	Air Hawker	Cave-Crevise
	Little Brown Bat	<i>Myotis lucifugus</i>	I	Air Hawker	Buildings
	N. Long-eared Bat	<i>Myotis septentrionalis</i>	I	Air Hawker	Tree Cavity-Crevise
	Small-footed Myotis	<i>Myotis leibii</i>	I	Air Hawker	Buildings
Reptiles					
Chelydridae	Snapping Turtle	<i>Chelydra serpentina</i>	O	Bottom Forager	Riparian Subsurface
Colubridae	Northern Water Snake	<i>Nerodia s. sipedon</i>	C	Water Ambusher	Riparian Subsurface
Emydidae	Midland Painted Turtle	<i>Chrysemys p. marginata</i>	O	Bottom Forager	Terrestrial Subsurface
	Map Turtle	<i>Graptemys geographica</i>	O	Bottom Forager	Terrestrial Subsurface
Kinosternidae	Stinkpot	<i>Sternotherus odoratus</i>	C	Bottom Forager	Riparian Subsurface

* Species observed in the area.

¹ Guild includes:

- C: Carnivore
- G: Granivore
- H: Herbivore
- I: Insectivore
- O: Omnivore
- P: Piscivore

² Not applicable since species not anticipated to breed in vicinity.

TABLE 21. WILDLIFE SPECIES POTENTIALLY INHABITING THE NIAGARA RIVER, NIAGARA FALLS, NY (cont.)

Family	Common Name	Latin Name	Guild ¹	Forage Method	Breeding Substrate
Amphibians					
Plethodontidae	N. Two-lined Salamander	<i>Eurycea b. bislineata</i>	I	Water Gleaner	Water
Ranidae	Bullfrog	<i>Rana catesbeiana</i>	C	Water Ambusher	Water
	Green Frog	<i>Rana clamitans melanota</i>	C	Riparian Ambusher	Water
Birds					
Accipitridae	Bald Eagle	<i>Haliaeetus leucocephalus</i>	C	Ground Scavenger	Not applicable ²
	Osprey	<i>Pandion haliaetus</i>	P	Water-Foot Plunger	Tree Branch
Alcedinidae	Belted Kingfisher	<i>Ceryle alcyon</i>	P	Water Plunger	Riparian Subsurface
Anatidae	American Black Duck	<i>Anas rubripes</i>	O	Water Forager	Riparian Ground
	Bufflehead	<i>Bucephala albeola</i>	O	Bottom Forager	Not applicable
	Canada Goose	<i>Branta canadensis</i>	H	Ground Grazer	Riparian Ground
	Common Goldeneye	<i>Bucephala clangula</i>	O	Bottom Forager	Not applicable
	Common Merganser	<i>Mergus merganser</i>	P	Water Diver	Riparian Tree Cavity
	Greater Scaup	<i>Aythya marila</i>	O	Bottom Forager	Not applicable
	Mallard	<i>Anas platyrhynchos</i>	G	Water Forager	Riparian Ground
	Oldsquaw	<i>Clangula hyemalis</i>	O	Bottom Forager	Not applicable
	Red-breasted Merganser	<i>Mergus serrator</i>	P	Water Diver	Riparian Ground
	Great Blue Heron	<i>Ardea herodias</i>	C	Water Ambusher	Riparian Twig-Branch
	Green-backed Heron	<i>Butorides striatus</i>	C	Water Ambusher	Riparian Shrub
	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	C	Water Ambusher	Riparian Twig-Branch
Gaviidae	Common Loon	<i>Gavia immer</i>	P	Water Diver	Not applicable
Hirundinidae	Bank Swallow	<i>Riparia riparia</i>	I	Air Screener	Terrestrial Subsurface
	N. Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	I	Air Screener	Terrestrial Subsurface
	Tree Swallow	<i>Tachycineta bicolor</i>	I	Air Screener	Tree Cavity-Crevise
Laridae	Common Tern	<i>Sterna hirundo</i>	P	Water Plunger	Beach-Rock-Dune
	*Herring Gull	<i>Larus argentatus</i>	C	Coastal Scavenger	Beach-Rock-Dune
	*Ring-billed Gull	<i>Larus delawarensis</i>	O	Coastal Scavenger	Beach-Rock-Dune
Phalacrocoracidae	*Double-crested Cormorant	<i>Phalacrocorax auritus</i>	P	Ocean Diver	Riparian Ground
Scolopacidae	Spotted Sandpiper	<i>Actitis macularia</i>	O	Riparian Gleaner	Ground-Herb

TABLE 21 FISHES PRESENT IN NIAGARA RIVER, NEW YORK (cont.)		
Family	Common Name	Scientific Name
Lepisosteidae	Longnose Gar	<i>Lepisosteus osseus</i>
Clupeidae	Alewife Gizzard Shad	<i>Alosa pseudoharengus</i> <i>Dorosoma cepedianum</i>
Ictaluridae	Brown Bullhead Tadpole Madtom	<i>Ictalurus nebulosus</i> <i>Noturus gyrinus</i>
Catostomidae	White sucker Norther Hogsucker Silver Redhorse Golden Redhorse Shorthead Redhorse Greater Redhorse	<i>Catostomus commersoni</i> <i>Hypentelium nigricans</i> <i>Moxostoma anisurum</i> <i>Moxostoma erythrum</i> <i>Moxostoma macrolepidotum</i> <i>Moxostoma valenciennesi</i>
Cyprinidae	Goldfish Common Carp Golden Shiner Hornhead chub River Chub Longnose Dace Emerald Shiner Striped Shiner Common Shiner Spottail Shiner Sand Shiner Bluntnose Minnow Blacknose Shiner	<i>Carassius auratus</i> <i>Cyprinus carpio</i> <i>Notemigonus crysoleucus</i> <i>Nocomis biguttatus</i> <i>Nocomis micropogon</i> <i>Rhinichthys cataractae</i> <i>Notropis atherinoides</i> <i>Notropis chrysocephalus</i> <i>Notropis cornutus</i> <i>Notropis hudsonius</i> <i>Notropis stramineus</i> <i>Pimephales notatus</i> <i>Notropis heterolepis</i>
Osmeridae	Rainbow Smelt	<i>Osmerus mordax</i>
Esocidae	Northern Pike Muskellunge	<i>Esox lucius</i> <i>Esox masquinongy</i>
Cyprinodontidae	Banded Killifish	<i>Fundulus diapharus</i>
Centrarchidae	Rock Bass Pumpkinseed Bluegill Smallmouth Bass Largemouth Bass Black Crappie White Crappie	<i>Ambloplites rupestris</i> <i>Lepomis gibbosus</i> <i>Lepomis macrochirus</i> <i>Micropterus dolemiei</i> <i>Micropterus salmoides</i> <i>Pomoxis nigromaculatus</i> <i>Pomoxis annularis</i>

TABLE 21 (CONTINUED)		
Family	Common Name	Scientific Name
Percidae	Rainbow Darter	<i>Etheostoma caeruleum</i>
	Johnny Darter	<i>Etheostoma nigrum</i>
	Yellow Perch	<i>Perca flavescens</i>
	Walleye	<i>Stizostedion vitreum</i>
Sciaenidae	Freshwater Drum	<i>Aplodinotus grunniens</i>
Cottidae	Mottled Sculpin	<i>Cottus bairdi</i>
Umbridae	Central Mudminnow	<i>Umbra limi</i>
Moronidae	White Bass	<i>Morone chrysops</i>
Salmonidae	Chinook Salmon	<i>Oncorhynchus tshawytscha</i>
	Coho Salmon	<i>Oncorhynchus kisutch</i>
	Rainbow Trout	<i>Salmo gairdneri</i>

From Smith, 1985

TABLE 2j. CONCENTRATIONS OF NECCO PARK GROUND WATER CONTAMINANTS (A - C) DISCHARGED TO NIAGARA RIVER THROUGH THE FALLS STREET TUNNEL (PRIOR TO DILUTION TO NIAGARA RIVER).

Contaminant	Necco Park Concentration (ug/l)		Dilution Factor ¹	Exposure Concentration (ug/l)	
	Mean	Maximum		Mean	Maximum
VOLATILES					
Carbon Tetrachloride	8751.8	210000	8.60E-04	7.53E+00	1.81E+02
Chloroform	26242.8	200000	8.60E-04	2.26E+01	1.72E+02
1,2-Dichloroethane	1232.3	13000	8.60E-04	1.06E+00	1.12E+01
1,1-Dichloroethene	958.3	22000	8.60E-04	8.24E-01	1.89E+01
(cis)1,2-Dichloroethene	6728.8	66000	8.60E-04	5.79E+00	5.68E+01
(trans)1,2-Dichloroethene	1400.4	19000	8.60E-04	1.20E+00	1.63E+01
Hexachlorobenzene	158.9	1500	8.60E-04	1.37E-01	1.29E+00
Hexachloroethane	342.0	3000	8.60E-04	2.94E-01	2.58E+00
1,1,2,2-Tetrachloroethane	18689.4	170000	8.60E-04	1.61E+01	1.46E+02
Tetrachloroethene	6440.8	69000	8.60E-04	5.54E+00	5.93E+01
1,1,2-Trichloroethane	8849.8	180000	8.60E-04	7.61E+00	1.55E+02
Trichloroethene	29407.6	270000	8.60E-04	2.53E+01	2.32E+02
Vinyl Chloride	1314.0	19000	8.60E-04	1.13E+00	1.63E+01
BASE-NEUTRAL ACID EXTRACTABLES					
Hexachlorobutadiene	4553.1	120000	8.60E-04	3.92E+00	1.03E+02
4-Methylphenol	141.8	900	8.60E-04	1.22E-01	7.74E-01
Pentachlorophenol	1497.2	28000	8.60E-04	1.29E+00	2.41E+01
Phenol	306.6	1900	8.60E-04	2.64E-01	1.63E+00
2,4,5-Trichlorophenol	308.4	6600	8.60E-04	2.65E-01	5.68E+00
2,4,6-Trichlorophenol	203.8	2800	8.60E-04	1.75E-01	2.41E+00
INORGANICS					
Barium	567590.0	14800000	8.60E-04	4.88E+02	1.27E+04
Cyanide	2360.0	70000	8.60E-04	2.03E+00	6.02E+01

¹ Dilution factor calculated by dividing ground water layer (A - C) flux rate (1040 cfd) derived in Appendix D-2 by the average Fall Street Tunnel flow rate (1,203,208 cfd).

**TABLE 2k CONCENTRATIONS OF NECCO PARK GROUND WATER
CONTAMINANTS (D - G) DISCHARGED TO THE FOREBAY CANAL
VIA PASNY CONDUITS.**

Contaminant	Necco Park		Dilution Factor ¹	Exposure	
	Concentration (ug/l)			Concentration (ug/l)	
	Mean	Maximum		Mean	Maximum
Ground Water Layers D, E, F:					
VOLATILES					
Carbon Tetrachloride	4017.0	70000	1.00E-06	4.02E-03	7.00E-02
Chloroform	7748.7	110000	1.00E-06	7.75E-03	1.10E-01
1,2-Dichloroethane	348.3	3700	1.00E-06	3.48E-04	3.70E-03
1,1-Dichloroethene	718.0	11000	1.00E-06	7.18E-04	1.10E-02
(cis)1,2-Dichloroethene	2206.9	10000	1.00E-06	2.21E-03	1.00E-02
(trans)1,2-Dichloroethene	654.3	4900	1.00E-06	6.54E-04	4.90E-03
Hexachlorobenzene	71.9	280	1.00E-06	7.19E-05	2.80E-04
Hexachloroethane	237.6	3600	1.00E-06	2.38E-04	3.60E-03
1,1,2,2-Tetrachloroethane	4188.7	58000	1.00E-06	4.19E-03	5.80E-02
Tetrachloroethene	4246.1	46000	1.00E-06	4.25E-03	4.60E-02
1,1,2-Trichloroethane	2228.4	21000	1.00E-06	2.23E-03	2.10E-02
Trichloroethene	13699.9	170000	1.00E-06	1.37E-02	1.70E-01
Vinyl Chloride	775.7	5700	1.00E-06	7.76E-04	5.70E-03
BASE-NEUTRAL ACID EXTRACTABLES					
Hexachlorobutadiene	1673.3	17000	1.00E-06	1.67E-03	1.70E-02
4-Methylphenol	32.0	130	1.00E-06	3.20E-05	1.30E-04
Pentachlorophenol	439.3	4250	1.00E-06	4.39E-04	4.25E-03
Phenol	71.5	740	1.00E-06	7.15E-05	7.40E-04
2,4,5-Trichlorophenol	275.8	2950	1.00E-06	2.76E-04	2.95E-03
2,4,6-Trichlorophenol	201.3	1900	1.00E-06	2.01E-04	1.90E-03
INORGANICS					
Barium	130.0	1300	1.00E-06	1.30E-04	1.30E-03
Cyanide	10.0	170	1.00E-06	1.00E-05	1.70E-04

Ground Water Layer G:

VOLATILES					
Carbon Tetrachloride	25.6	34	5.00E-07	1.28E-05	1.70E-05
Chloroform	2250.6	12000	5.00E-07	1.13E-03	6.00E-03
1,2-Dichloroethane	30.0	150	5.00E-07	1.50E-05	7.50E-05
1,1-Dichloroethene	279.4	1800	5.00E-07	1.40E-04	9.00E-04
(cis)1,2-Dichloroethene	1977.8	11000	5.00E-07	9.89E-04	5.50E-03
(trans)1,2-Dichloroethene	604.4	3500	5.00E-07	3.02E-04	1.75E-03
1,1,2,2-Tetrachloroethane	379.6	1700	5.00E-07	1.90E-04	8.50E-04
Tetrachloroethene	297.0	1400	5.00E-07	1.49E-04	7.00E-04
1,1,2-Trichloroethane	1349.8	6700	5.00E-07	6.75E-04	3.35E-03

**TABLE 2k CONCENTRATIONS OF NECCO PARK GROUND WATER
CONTAMINANTS (D - G) DISCHARGED TO THE FOREBAY CANAL
VIA PASNY CONDUITS (CONTINUED).**

Contaminant	Necco Park Concentration (ug/l)		Dilution Factor ¹	Exposure Concentration (ug/l)	
	Mean	Maximum		Mean	Maximum
Trichloroethene	3870.2	17000	5.00E-07	1.94E-03	8.50E-03
Vinyl Chloride	229.9	1500	5.00E-07	1.15E-04	7.50E-04
BASE-NEUTRAL ACID EXTRACTABLES					
Hexachlorobutadiene	213.0	1600	5.00E-07	1.07E-04	8.00E-04
Phenol	58.0	200	5.00E-07	2.90E-05	1.00E-04
INORGANICS					
Barium	80.0	540	5.00E-07	4.00E-05	2.70E-04

¹ Dilution factor calculated by dividing groundwater layer flux rate (D - F: 4754 cfd and G: 2246 cfd) by low PASNY conduit flow rate (50,000 cfs or 4,320,000,000 cfd).

TABLE 21 CONCENTRATIONS OF NECCO PARK GROUND WATER CONTAMINANTS DISCHARGED TO NIAGARA RIVER (THROUGH THE FALLS STREET TUNNEL AND FOREBAY CANAL).

Contaminant	Falls Street Tunnel			Forebay Canal			Niagara River	
	Concentration (ug/l)		Dilution Factor ¹	Concentration (ug/l)		Dilution Factor ²	Concentration (ug/l) ³	
	Mean	Maximum		Mean	Maximum		Mean	Maximum
VOLATILES								
Carbon Tetrachloride	7.53E+00	1.81E+02	1.54E-04	4.03E-03	7.00E-02	5.56E-01	3.40E-03	6.69E-02
Chloroform	2.26E+01	1.72E+02	1.54E-04	8.88E-03	1.16E-01	5.56E-01	8.42E-03	9.10E-02
1,2-Dichloroethane	1.06E+00	1.12E+01	1.54E-04	3.63E-04	3.78E-03	5.56E-01	3.65E-04	3.83E-03
1,1-Dichloroethene	8.24E-01	1.89E+01	1.54E-04	8.58E-04	1.19E-02	5.56E-01	6.04E-04	9.53E-03
(cis)1,2-Dichloroethene	5.79E+00	5.68E+01	1.54E-04	3.20E-03	1.55E-02	5.56E-01	2.67E-03	1.74E-02
(trans)1,2-Dichloroethene	1.20E+00	1.63E+01	1.54E-04	9.56E-04	6.65E-03	5.56E-01	7.16E-04	6.21E-03
Hexachlorobenzene	1.37E-01	1.29E+00	1.54E-04	7.19E-05	2.80E-04	5.56E-01	6.11E-05	3.55E-04
Hexachloroethane	2.94E-01	2.58E+00	1.54E-04	2.38E-04	3.60E-03	5.56E-01	1.78E-04	2.40E-03
1,1,2,2-Tetrachloroethane	1.61E+01	1.46E+02	1.54E-04	4.38E-03	5.88E-02	5.56E-01	4.92E-03	5.52E-02
Tetrachloroethene	5.54E+00	5.93E+01	1.54E-04	4.39E-03	4.67E-02	5.56E-01	3.29E-03	3.51E-02
1,1,2-Trichloroethane	7.61E+00	1.55E+02	1.54E-04	2.91E-03	2.44E-02	5.56E-01	2.79E-03	3.75E-02
Trichloroethene	2.53E+01	2.32E+02	1.54E-04	1.56E-02	1.78E-01	5.56E-01	1.26E-02	1.35E-01
Vinyl Chloride	1.13E+00	1.63E+01	1.54E-04	8.91E-04	6.45E-03	5.56E-01	6.70E-04	6.10E-03
BASE-NEUTRAL ACID EXTRACTABLES								
Hexachlorobutadiene	3.92E+00	1.03E+02	1.54E-04	1.78E-03	1.78E-02	5.56E-01	1.59E-03	2.58E-02
4-Methylphenol	1.22E-01	7.74E-01	1.54E-04	3.20E-05	1.30E-04	5.56E-01	3.66E-05	1.92E-04
Pentachlorophenol	1.29E+00	2.41E+01	1.54E-04	4.39E-04	4.25E-03	5.56E-01	4.43E-04	6.08E-03
Phenol	2.64E-01	1.63E+00	1.54E-04	1.01E-04	8.40E-04	5.56E-01	9.66E-05	7.18E-04
2,4,5-Trichlorophenol	2.65E-01	5.68E+00	1.54E-04	2.76E-04	2.95E-03	5.56E-01	1.94E-04	2.52E-03
2,4,6-Trichlorophenol	1.75E-01	2.41E+00	1.54E-04	2.01E-04	1.90E-03	5.56E-01	1.39E-04	1.43E-03
INORGANICS								
Barium	4.88E+02	1.27E+04	1.54E-04	1.70E-04	1.57E-03	5.56E-01	7.55E-02	1.96E+00
Cyanide	2.03E+00	6.02E+01	1.54E-04	3.14E-04	9.30E-03	5.56E-01	4.88E-04	1.45E-02

¹ Dilution factor calculated by dividing Falls Street Tunnel discharge rate (13.9 cfs) by the Niagara River low flow rate (90,000 cfs).

² Dilution factor calculated by dividing Forebay Canal discharge rate (50,000 cfs) by the Niagara River low flow rate (90,000 cfs).

³ Niagara River concentration equals the sum of the FST and Forebay Canal concentrations multiplied by their respective dilution factor.

TABLE 2m SURFACE WATER ECOLOGICAL RISK SUMMARY.

CONTAMINANT OF CONCERN	EXPOSURE CONCENTRATION ¹ (ug/l)		WATER QUALITY VALUE ² (ug/l)		RISK INDICES ³ FOR ACUTE CRITERIA		RISK INDICES ³ FOR CHRONIC CRITERIA	
	MEAN	MAXIMUM	ACUTE	CHRONIC	MEAN	MAXIMUM	MEAN	MAXIMUM
Falls Street Tunnel (at discharge to Niagara River)								
Carbon Tetrachloride	7.53E+00	1.81E+02	3.52E+04	-	2E-04	5E-03	-	-
Chloroform	2.26E+01	1.72E+02	2.89E+04	1.24E+03	8E-04	6E-03	2E-02	1E-01
1,2-Dichloroethane	1.06E+00	1.12E+01	1.18E+05	2.00E+04	9E-06	9E-05	5E-05	6E-04
1,1-Dichloroethene	8.20E-01	1.89E+01	1.16E+04	-	7E-05	2E-03	-	-
(cis)1,2-Dichloroethene	5.79E+00	5.68E+01	1.16E+04	-	5E-04	5E-03	-	-
(trans)1,2-Dichloroethene	1.20E+00	1.63E+01	1.16E+04	-	1E-04	1E-03	-	-
Hexachlorobenzene	1.40E-01	1.29E+00	6.00E+00	3.68E+00	2E-02	2E-01	4E-02	4E-01
Hexachloroethane	2.90E-01	2.58E+00	9.80E+02	5.40E+02	3E-04	3E-03	5E-04	5E-03
1,1,2,2-Tetrachloroethane	1.61E+01	1.46E+02	-	2.40E+03	-	-	7E-03	6E-02
Tetrachloroethene	5.54E+00	5.93E+01	5.28E+03	8.40E+02	1E-03	1E-02	7E-03	7E-02
1,1,2-Trichloroethane	7.61E+00	1.55E+02	-	9.40E+03	-	-	8E-04	2E-02
Trichloroethene	2.53E+01	2.32E+02	4.50E+04	2.19E+04	6E-04	5E-03	1E-03	1E-02
Vinyl Chloride	1.13E+00	1.63E+01	3.88E+05	1.16E+03	3E-06	4E-05	1E-03	1E-02
Hexachlorobutadiene	3.92E+00	1.03E+02	9.00E+01	1.00E+00	4E-02	1E+00	4E+00	1.0E+02
4-Methylphenol	1.20E-01	7.70E-01	1.40E+03	4.20E+01	9E-05	6E-04	3E-03	2E-02
Pentachlorophenol	1.29E+00	2.41E+01	2.00E+01	4.00E-01	6E-02	1E+00	3E+00	6.0E+01
Phenol	2.60E-01	1.63E+00	1.02E+04	5.00E+00	3E-05	2E-04	5E-02	3E-01
2,4,5-Trichlorophenol	2.70E-01	5.68E+00	1.00E+02	6.30E+01	3E-03	6E-02	4E-03	9E-02
2,4,6-Trichlorophenol	1.80E-01	2.41E+00	-	9.70E+02	-	-	2E-04	2E-03
Barium	4.88E+02	1.27E+04	1.45E+04	5.80E+03	3E-02	9E-01	8E-02	2E+00
Cyanide	2.03E+00	6.02E+01	2.20E+01	5.20E+00	9E-02	3E+00	4E-01	1.2E+01
TOTAL RISK INDEX					3E-01	6E+00	8E+00	1.8E+02

TABLE 2m SURFACE WATER ECOLOGICAL RISK SUMMARY (CONTINUED).

CONTAMINANT OF CONCERN	EXPOSURE CONCENTRATION ¹		WATER QUALITY VALUE ²		RISK INDICES ³ FOR ACUTE CRITERIA		RISK INDICES ³ FOR CHRONIC CRITERIA	
	(ug/l)		(ug/l)					
	MEAN	MAXIMUM	ACUTE	CHRONIC	MEAN	MAXIMUM	MEAN	MAXIMUM
Forebay Canal								
Carbon Tetrachloride	4.00E-03	7.00E-02	3.52E+04	-	1E-07	2E-06	-	-
Chloroform	9.00E-03	1.16E-01	2.89E+04	1.24E+03	3E-07	4E-06	7E-06	9E-05
1,2-Dichloroethane	3.60E-04	4.00E-03	1.18E+05	2.00E+04	3E-09	3E-08	2E-08	2E-07
1,1-Dichloroethene	1.00E-03	1.20E-02	1.16E+04	-	9E-08	1E-06	-	-
(cis) 1,2-Dichloroethene	3.00E-03	1.60E-02	1.16E+04	-	3E-07	1E-06	-	-
(trans) 1,2-Dichloroethene	1.00E-03	7.00E-03	1.16E+04	-	9E-08	6E-07	-	-
Hexachlorobenzene	7.20E-05	2.80E-04	6.00E+00	3.68E+00	1E-05	5E-05	2E-05	8E-05
Hexachloroethane	2.40E-04	4.00E-03	9.80E+02	5.40E+02	2E-07	4E-06	4E-07	7E-06
1,1,2,2-Tetrachloroethane	4.00E-03	5.90E-02	-	2.40E+03	-	-	2E-06	2E-05
Tetrachloroethene	4.00E-03	4.70E-02	5.28E+03	8.40E+02	8E-07	9E-06	5E-06	6E-05
1,1,2-Trichloroethane	3.00E-03	2.40E-02	-	9.40E+03	-	-	3E-07	3E-06
Trichloroethene	1.60E-02	1.79E-01	4.50E+04	2.19E+04	4E-07	4E-06	7E-07	8E-06
Vinyl Chloride	1.00E-03	7.00E-03	3.88E+05	1.16E+03	3E-09	2E-08	9E-07	6E-06
Hexachlorobutadiene	2.00E-03	1.80E-02	9.00E+01	1.00E+00	2E-05	2E-04	2E-03	2E-02
4-Methylphenol	3.20E-05	1.30E-04	1.40E+03	4.20E+01	2E-08	9E-08	8E-07	3E-06
Pentachlorophenol	4.40E-04	4.00E-03	2.00E+01	4.00E-01	2E-05	2E-04	1E-03	1E-02
Phenol	1.00E-04	1.00E-03	1.02E+04	5.00E+00	1E-08	1E-07	2E-05	2E-04
2,4,5-Trichlorophenol	2.80E-04	3.00E-03	1.00E+02	6.30E+01	3E-06	3E-05	4E-06	5E-05
2,4,6-Trichlorophenol	2.00E-04	2.00E-03	-	9.70E+02	-	-	2E-07	2E-06
Barium	1.80E-04	1.57E-03	1.45E+04	5.80E+03	1E-08	1E-07	3E-08	3E-07
Cyanide	1.00E-05	1.70E-04	2.20E+01	5.20E+00	5E-07	8E-06	2E-06	3E-05
TOTAL RISK INDEX					6E-05	5E-04	3E-03	3E-02

TABLE 2m SURFACE WATER ECOLOGICAL RISK SUMMARY (CONTINUED).

CONTAMINANT OF CONCERN	EXPOSURE CONCENTRATION ¹		WATER QUALITY VALUE ²		RISK INDICES ³ FOR ACUTE CRITERIA		RISK INDICES ³ FOR CHRONIC CRITERIA	
	(ug/l)		(ug/l)		MEAN	MAXIMUM	MEAN	MAXIMUM
	MEAN	MAXIMUM	ACUTE	CHRONIC				
Niagara River								
Carbon Tetrachloride	3.40E-03	6.69E-02	3.52E+04	-	1E-07	2E-06	-	-
Chloroform	8.42E-03	9.10E-02	2.89E+04	1.24E+03	3E-07	3E-06	7E-06	7E-05
1,2-Dichloroethane	3.65E-04	3.83E-03	1.18E+05	2.00E+04	3E-09	3E-08	2E-08	2E-07
1,1-Dichloroethene	6.04E-04	9.53E-03	1.16E+04	-	5E-08	8E-07	-	-
(cis)1,2-Dichloroethene	2.67E-03	1.74E-02	1.16E+04	-	2E-07	1E-06	-	-
(trans)1,2-Dichloroethene	7.16E-04	6.21E-03	1.16E+04	-	6E-08	5E-07	-	-
Hexachlorobenzene	6.11E-05	3.55E-04	6.00E+00	3.68E+00	1E-05	6E-05	2E-05	1E-04
Hexachloroethane	1.78E-04	2.40E-03	9.80E+02	5.40E+02	2E-07	2E-06	3E-07	4E-06
1,1,2,2-Tetrachloroethane	4.92E-03	5.52E-02	-	2.40E+03	-	-	2E-06	2E-05
Tetrachloroethene	3.29E-03	3.51E-02	5.28E+03	8.40E+02	6E-07	7E-06	4E-06	4E-05
1,1,2-Trichloroethane	2.79E-03	3.75E-02	-	9.40E+03	-	-	3E-07	4E-06
Trichloroethene	1.26E-02	1.35E-01	4.50E+04	2.19E+04	3E-07	3E-06	6E-07	6E-06
Vinyl Chloride	6.70E-04	6.10E-03	3.88E+05	1.16E+03	2E-09	2E-08	6E-07	5E-06
Hexachlorobutadiene	1.59E-03	2.58E-02	9.00E+01	1.00E+00	2E-05	3E-04	2E-03	3E-02
4-Methylphenol	3.66E-05	1.92E-04	1.40E+03	4.20E+01	3E-08	1E-07	9E-07	5E-06
Pentachlorophenol	4.43E-04	6.08E-03	2.00E+01	4.00E-01	2E-05	3E-04	1E-03	2E-02
Phenol	9.66E-05	7.18E-04	1.02E+04	5.00E+00	9E-09	7E-08	2E-05	1E-04
2,4,5-Trichlorophenol	1.94E-04	2.52E-03	1.00E+02	6.30E+01	2E-06	3E-05	3E-06	4E-05
2,4,6-Trichlorophenol	1.39E-04	1.43E-03	-	9.70E+02	-	-	1E-07	1E-06
Barium	7.55E-02	1.96E+00	1.45E+04	5.80E+03	5E-06	1E-04	1E-05	3E-04
Cyanide	4.88E-04	1.45E-02	2.20E+01	5.20E+00	2E-05	7E-04	9E-05	3E-03
TOTAL RISK INDEX					8E-05	1E-03	3E-03	4E-02

¹ Surface water exposure concentrations from Tables 5-5 (Layers A - C), 5-6 (Layers D - F and G totaled), and 5-7 (all layers diluted into Niagara River).

² Water Quality Criteria/Effects Concentrations from Table 5-8.

³ Risk Index = COC concentration (average or maximum) divided by water quality value (acute or chronic)

Table 3

CHEMICAL-SPECIFIC ARARs

Standards, Requirements, Criteria, or Limits	Citation or Reference	Description
New York Safe Drinking-Water Act Standards	10 NYCRR Chapter I, Part 5-1	State maximum contaminant level (MCL) standards for public water systems based on public health and feasible technology
New York Surface-Water and Groundwater Quality Standards and Effluent Standards	6 NYCRR Parts 700-705	State surface-water and groundwater quality and receiving water discharge standards
New York State Pollutant Discharge Elimination System	6 NYCRR Chapter X, Parts 750-758	Permitting procedures and discharge limitations for discharges of effluent to surface water
Federal Safe Drinking-Water Act	42 USC §300f	The act that provides the EPA with the authority to develop and implement drinking-water standards
National Primary Drinking-Water Standards	40 CFR 141	Standards (MCLs and MCLGs) for public water systems based on public health and feasible technology
National Secondary Drinking-Water Standards	40 CFR 143	Numerical criteria-based (secondary MCLs—SMCLs) aesthetics
Niagara County Drinking-Water Standards	Niagara County Sanitary Code Chapter IV	Niagara County drinking-water standards (MCLs) for public water systems based on public health and feasible technology
Standards for Owners and Operators of Hazardous Waste TSDs	40 CFR 264.94	Groundwater protection standards for toxic metals and pesticides
Federal Water-Quality Criteria	33 USC SS 1251-1376 40 CFR 131	Criteria for water quality based on toxicity to aquatic organisms and public health
New York Water Pollution Control Regulations	6 NYCRR Parts 608, 610-614	Permit requirements for protected stream disturbance, petroleum cleanup, and petroleum storage
New York Rules for Inactive Hazardous Waste Disposal Sites	6 NYCRR Part 375	Regulation for inactive hazardous waste sites
Toxic Substances Control Act	40 CFR 761	Regulation of PCBs, dioxins, and commercial chemicals

Table 3 (continued)

POTENTIAL LOCATION-SPECIFIC ARARs

Standards, Requirements, Criteria, or Limits	Citation or Reference	Description
Coastal Zone Management Act	16 USC 1451 15 CFR 923/930	Preserves, protects, develops, restores, and enhances the resources of the coastal zone
Endangered Species Act	16 USC 153	Protects endangered species threatened to become extinct
New York Wetlands Regulations	6 NYCRR Part-661	Protects wetlands in the state of New York from adverse environmental impact caused by development activities
Executive Order on Floodplain Management	E.O. No. 11988	Requires federal agencies to evaluate the potential effects of actions in a floodplain to avoid, to the maximum extent possible, the adverse impact associated with direct and indirect development of a floodplain

Table 3 (continued)

ACTION-SPECIFIC ARARs AND TBCs

Standards, Requirements, Criteria, or Limits	Citation or Reference	Description
New York Safe Drinking-Water Act Standards	10 NYCRR Chapter I, Part 5-1	State standards (MCLs) for public water systems based on public health and feasible technology
New York Surface-Water and Groundwater Quality Standards and Effluent Standards	6 NYCRR Parts 700-705	State surface-water and groundwater quality and receiving-waters discharge standards
New York State Pollutant Discharge Elimination System	6 NYCRR Chapter X, Parts 750-758	Requirements for discharges of effluent to surface water
Federal Safe Drinking-Water Act	42 USC §300f	The act that provides the EPA with the authority to develop and implement drinking-water standards
National Primary Drinking-Water Standards	40 CFR 141	Standards (MCLs and MCLGs) for public water systems based on public health and feasible technology
National Secondary Drinking-Water Standards	40 CFR 143	Numerical criteria-based (SMCLs) aesthetics
Standards for Owners and Operators of Hazardous Waste TSDs	40 CFR 264.94	Groundwater protection standards for toxic metals and pesticides
Toxic Substances Control Act	40 CFR 761	Regulation of the management of PCBs and dioxins and commercial chemicals
Clean Water Act Section 404	40 CFR 300	Prohibits discharge of dredged or fill material into wetlands without a permit; preserves and enhances wetlands
New York Hazardous Waste Regulations	6 NYCRR Parts 370-375	Establishes regulations for hazardous waste treatment, storage, transportation, and disposal in the state of New York
Water Allocation Permit	Article 15, Environmental Conservation Law, Title 16	Laws implementing requirements of the Great Lakes compact; applicable to facilities with a minimum well pumping rate of 100,000 gallons per day and other facilities that divert water from the Great Lakes drainage basin
New York State Solid and Hazardous Waste Regulations	6 NYCRR Part 364	Waste Transporter Permit
New York State Solid and Hazardous Waste Regulations	6 NYCRR Part 376	LDRs
New York State Solid and Hazardous Waste Regulations	6 NYCRR Part 257	Air Quality Standards
New York Solid Waste Regulations	6 NYCRR 360	Establishes regulations for nonhazardous waste disposal
New York Air Emissions Limits Regulations	6 NYCRR Parts 200-254	Sets limits for air emissions for specific processes and permit requirements
Well Permitting Procedures	10 NYCRR Chapter I, Part 5	Establishes procedures for permitting installation of a well
City of Niagara Falls Sewer Discharge Permit	City of Niagara Falls Sewer Use Ordinance Chapter 250	Limits contaminant concentration and discharges to POTWs

Table 3 (continued)

ACTION-SPECIFIC ARARs AND TBCs

Standards, Requirements, Criteria, or Limits	Citation or Reference	Description
Niagara County Drinking Water Standards	Niagara County Sanitary Code Chapter IV	Niagara County drinking-water standards (MCLs) for public water systems based on public health and feasible technology
Resource Conservation and Recovery Act	40 CFR 260 - 270 42 USC 6901 et seq.	Regulates the generation, transport, treatment, storage, and disposal of hazardous wastes
New York Occupational Safety and Health	6 NYCRR 662-666	Worker health and safety
Federal Occupational Safety and Health	29 CFR	Worker health and safety
Federal Air Emissions Regulations	40 CFR Part 50-80	Regulation of the construction, operation, and emissions from stationary and mobile sources of air pollutants identified by the EPA
Hazardous Materials Transportation Act	49 USC 55 1801-1813 49 CFR 100-180	Regulation of the packaging, marking, labeling, manifesting, and mode of transportation of materials identified as hazardous materials by the Department of Transportation
NYSDEC Technical and Administrative Guidance Memorandum	N/A	Determination of soil cleanup objectives and cleanup levels
New York State Air Guide 1	N/A	Toxic Ambient Air Contaminants Guidelines
Four-Party Agreement	N/A	

Table 4

CHEMICAL-SPECIFIC ARARs AND ACCEPTABLE RISK-BASED CONCENTRATIONS FOR GROUNDWATER

Contaminant	New York Public Water Supply Regulations (µg/l)	New York Groundwater Quality Standards (µg/l)	Maximum Contaminant Level (µg/l)	Maximum Contaminant Level Goal (µg/l)	Noncarcinogenic Risk Based Concentration ⁷ (µg/l)	Carcinogenic Risk Based Concentration ¹ (µg/l)	Practical Quantitation Limit (µg/l)
1,1,2,2-tetrachloroethane	5 ^{4,6}	5 ⁴				0.3	10
Carbon tetrachloride	5 ^{4,6}	5	5	0	15	0.46	10
Vinyl chloride	2	2	2	0		0.04	10
1,1,2-trichloroethane	5 ^{4,6}	5 ⁴	5	3	98	1.0	10
1,1-dichloroethene	5 ^{4,6}	5 ⁴	7	7	200	0.07	10
Hexachlorobutadiene	5 ^{4,6}	5 ⁴			18	0.3	10
1,2-dichloroethane	5 ^{4,6}	5 ⁴	5	0	7,387	0.63	10
Chloroform	100 ²	7	100 ²		238	1.9	10
Tetrachloroethene	5 ^{4,6}	5 ⁴	5	0	183	1.0	10
Trichloroethene	5 ^{4,6}	5 ⁴	5	0	136	5.5	10
2,4,6-trichlorophenol	50 ⁵	1 ³				4.5	10
Hexachlorobenzene	5 ^{4,6}	0.35	1	0	4	0.008	10
Hexachloroethane	5 ^{4,6}	5 ⁴			17	2.8	10
Pentachlorophenol	1	1 ³	1	0	67	0.04	50
Barium, soluble	2,000	1,000	2,000	2,000	2,555		
Cyanide, total		100	200		730		
Phenol	50 ^{5,6}	1 ³			21,054		10
4-methylphenol	50 ^{5,6}	1 ³			169		10
2,4,5-trichlorophenol	50 ^{5,6}	1 ³			1,839		50
cis-1,2-dichloroethene	5 ^{4,6}	5 ⁴	70	70	229		10
trans-1,2-dichloroethene	5 ^{4,6}	5 ⁴	100	100	459		10

¹Concentrations were calculated for a cancer risk level of 10^{-6} assuming residential exposures via ingestion, inhalation, and dermal adsorption while showering.

²Based on total trihalomethanes.

³Total phenolics.

⁴Based on classification as a principal organic contaminant (POC).

⁵Based on classification as an unspecified organic contaminant (UOC).

⁶Total combined POC and UOC has a maximum limit of 100 µg/l.

⁷Concentrations were calculated for a hazard index of 1 assuming residential exposures via ingestion, inhalation, and dermal adsorption while showering.

µg/l = micrograms per liter

TABLE 5

TECHNICAL AND ADMINISTRATIVE GUIDANCE MEMORANDUM:
DETERMINATION OF SOIL CLEANUP OBJECTIVES AND CLEANUP LEVELS



New York State Department of Environmental Conservation

MEMORANDUM

TO: Regional Haz. Waste Remediation Engineers, Bureau Dirs. & Section Chiefs
FROM: Michael J. O'Toole, Jr., Director, Div. of Hazardous Waste Remediation
SUBJECT: DIVISION TECHNICAL AND ADMINISTRATIVE GUIDANCE MEMORANDUM:
DATE: DETERMINATION OF SOIL CLEANUP OBJECTIVES AND CLEANUP LEVELS

JAN 24 1994

The cleanup goal of the Department is to restore inactive hazardous waste sites to predisposal conditions, to the extent feasible and authorized by law. However, it is recognized that restoration to predisposal conditions will not always be feasible.

1. INTRODUCTION:

This TAGM provides a basis and procedure to determine soil cleanup levels at individual Federal Superfund, State Superfund, 1986 EQBA Title 3 and Responsible Party (RP) sites, when the Director of the DHWR determines that cleanup of a site to predisposal conditions is not possible or feasible.

The process starts with development of soil cleanup objectives by the Technology Section for the contaminants identified by the Project Managers. The Technology Section uses the procedure described in this TAGM to develop soil cleanup objectives. Attainment of these generic soil cleanup objectives will, at a minimum, eliminate all significant threats to human health and/or the environment posed by the inactive hazardous waste site. Project Managers should use these cleanup objectives in selecting alternatives in the Feasibility Study (FS). Based on the proposed selected remedial technology (outcome of FS), final site specific soil cleanup levels are established in the Record of Decision (ROD) for these sites.

It should be noted that even after soil cleanup levels are established in the ROD, these levels may prove to be unattainable when remedial construction begins. In that event, alternative remedial actions or institutional controls may be necessary to protect the environment.

2. BASIS FOR SOIL CLEANUP OBJECTIVES:

The following alternative bases are used to determine soil cleanup objectives:

- (a) Human health based levels that correspond to excess lifetime

TABLE 5 (continued)

cancer risks of one in a million for Class A¹ and B² carcinogens, or one in 100,000 for Class C³ carcinogens. These levels are contained in USEPA's Health Effects Assessment Summary Tables (HEASTs) which are compiled and updated quarterly by the NYSDEC's Division of Hazardous Substances Regulation;

- (b) Human health based levels for systemic toxicants, calculated from Reference Doses (RfDs). RfDs are an estimate of the daily exposure an individual (including sensitive individuals) can experience without appreciable risk of health effects during a lifetime. An average scenario of exposure in which children ages one to six (who exhibit the greatest tendency to ingest soil) is assumed. An intake rate of 0.2 gram/day for a five-year exposure period for a 16-kg child is assumed. These levels are contained in USEPA's Health Effects Assessment Summary Tables (HEASTs) which are compiled and updated quarterly by the NYSDEC's Division of Hazardous Substances Regulation;
- (c) Environmental concentrations which are protective of groundwater/drinking water quality; based on promulgated or proposed New York State Standards;
- (d) Background values for contaminants; and
- (e) Detection limits.

A recommendation on the appropriate cleanup objective is based on the criterion that produces the most stringent cleanup level using criteria a, b, and c for organic chemicals, and criteria a, b, and d for heavy metals. If criteria a and/or b are below criterion d for a contaminant, its background value should be used as the cleanup objective. However, cleanup objectives developed using this approach must be, at a minimum, above the method detection limit (MDL) and it is preferable to have the soil cleanup objectives above the Contract Required Quantitation Limit (CRQL) as defined by NYSDEC. If the cleanup objective of a compound is "non-detectable", it should mean that it is not detected at the MDL. Efforts should be made to obtain the best MDL detection possible when selecting a laboratory and analytical protocol.

The water/soil partitioning theory is used to determine soil cleanup objectives which would be protective of groundwater/drinking water quality for its best use. This theory is conservative in nature and assumes that contaminated soil and groundwater are in direct contact. This theory is based upon the ability of organic matter in soil to adsorb organic chemicals. The approach predicts the maximum amount of contamination that may remain in soil so that leachate from the contaminated soil will not violate groundwater and/or drinking water

TABLE 5 (continued)

standards.

- (1) Class A are proved human carcinogens
- (2) Class B are probable human carcinogens
- (3) Class C are possible human carcinogens

This approach is not used for heavy metals, which do not partition appreciably into soil organic matter. For heavy metals, eastern USA or New York State soil background values may be used as soil cleanup objectives. A list of values that have been tabulated is attached. Soil background data near the site, if available, is preferable and should be used as the cleanup objective for such metals. Background samples should be free from the influences of this site and any other source of contaminants. Ideal background samples may be obtained from uncontaminated upgradient and upwind locations.

3. DETERMINATION OF SOIL CLEANUP GOALS FOR ORGANICS IN SOIL FOR PROTECTION OF WATER QUALITY

Protection of water quality from contaminated soil is a two-part problem. The first is predicting the amount of contamination that will leave the contaminated media as leachate. The second part of the problem is to determine how much of that contamination will actually contribute to a violation of groundwater standards upon reaching and dispersing into groundwater. Some of the contamination which initially leaches out of soil will be absorbed by other soil before it reaches groundwater. Some portion will be reduced through natural attenuation or other mechanism.

PART A: PARTITION THEORY MODEL

There are many test and theoretical models which are used to predict leachate quality given a known value of soil contamination. The Water-Soil Equilibrium Partition Theory is used as a basis to determine soil standard or contamination limit for protection of water quality by most of the models currently in use. It is based on the ability of organic carbon in soil to adsorb contamination. Using a water quality value which may not be exceeded in leachate and the partition coefficient method, the equilibrium concentration (C_s) will be expressed in the same units as the water standards. The following expression is used:

$$\text{Allowable Soil Concentration } C_s = f \times K_{oc} \times C_w \dots (1)$$

Where: f = fraction of organic carbon of the natural soil medium.

TABLE 5 (continued)

Koc = partition coefficient between water and soil media. Koc can be estimated by the following equation:

$$\log Koc = 3.64 - 0.55 \log S$$

S = water solubility in ppm

Cw = appropriate water quality value from TOGS 1.1.1

Most Koc and S values are listed in the Exhibit A-1 of the USEPA Superfund Public Health Evaluation Manual (EPA/540/1-86/060). The Koc values listed in this manual should be used for the purpose. If the Koc value for a contaminant is not listed, it should be estimated using the above mentioned equation.

PART B: PROCEDURE FOR DETERMINATION OF SOIL CLEANUP OBJECTIVES

When the contaminated soil is in the unsaturated zone above the water table, many mechanisms are at work that prevent all of the contamination that would leave the contaminated soil from impacting groundwater. These mechanisms occur during transport and may work simultaneously. They include the following: (1) volatility, (2) sorption and desorption, (3) leaching and diffusion, (4) transformation and degradation, and (5) change in concentration of contaminants after reaching and/or mixing with the groundwater surface. To account for these mechanisms, a correction factor of 100 is used to establish soil cleanup objectives. This value of 100 for the correction is consistent with the logic used by EPA in its Dilution Attenuation Factor (DAF) approach for EP Toxicity and TCLP. (Federal Register/Vol. 55, No. 61, March 29, 1990/Pages 11826-27). Soil cleanup objectives are calculated by multiplying the allowable soil concentration by the correction factor. If the contaminated soil is very close (<3' - 5') to the groundwater table or in the groundwater, extreme caution should be exercised when using the correction factor of 100 (one hundred) as this may not give conservative cleanup objectives. For such situations the Technology Section should be consulted for site-specific cleanup objectives.

Soil cleanup objectives are limited to the following maximum values. These values are consistent with the approach promulgated by the States of Washington and Michigan.

- 1) Total VOCs $\leq$ 10 ppm.
- 2) Total Semi VOCs $\leq$ 500 ppm.
- 3) Individual Semi VOCs $\leq$ 50 ppm.
- 4) Total Pesticides $\leq$ 10 ppm.

One concern regarding the semi-volatile compounds is that some of these compounds are so insoluble that their Cs values are fairly large. Experience (Draft TOGS on Petroleum

Contaminated Soil Guidance) has shown that soil containing some of these insoluble substances at high concentrations can exhibit a distinct odor even though the substance will not leach from the soil. Hence any time a soil exhibits a discernible odor nuisance, it shall not be considered clean even if it has met the numerical criteria.

4. DETERMINATION OF FINAL CLEANUP LEVELS:

Recommended soil cleanup objectives should be utilized in the development of final cleanup levels through the Feasibility Study (FS) process. During the FS, various alternative remedial actions developed during the Remedial Investigation (RI) are initially screened and narrowed down to the list of potential alternative remedial actions that will be evaluated in detail. These alternative remedial actions are evaluated using the criteria discussed in TAGM 4030, Selection of Remedial Actions at Inactive Hazardous Waste Sites, revised May 15, 1990, and the preferred remedial action will be selected. After the detailed evaluation of the preferred remedial action, the final cleanup levels which can be actually achieved using the preferred remedial action must be established. Remedy selection, which will include final cleanup levels, is the subject of TAGM 4030.

Recommended soil cleanup objectives that have been calculated by the Technology Section are presented in Appendix A. These objectives are based on a soil organic carbon content of 1% (0.01) and should be adjusted for the actual organic carbon content if it is known. For determining soil organic carbon content, use attached USEPA method (Appendix B). Please contact the Technology Section, Bureau of Program Management for soil cleanup objectives not included in Appendix A.

Attachments

cc: T. Jorling

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Regional Directors

Regional Engineers

Regional Solid and Haz. Waste Engrs.

Regional Citizen Participation Spec.

TABLE 5 (continued)

APPENDIX A
TABLE 1
Recommended soil cleanup objectives (mg/kg or ppm)
Volatile Organic Contaminants

Contaminant	Partition coefficient K _{oc}	Groundwater Standards/ Criteria C _w ug/l or ppb.	a	b	** USEPA Health Based (ppm)		CRDL (ppb)	*** Rec. soil Cleanup Object (ppm)
			Allowable Soil conc. ppm. Cs	Soil Cleanup objectives to Protect GW Quality (ppm)	Carcinogens	Systemic Toxicants		
Acetone	2.2	50	0.0011	0.11	N/A	8,000	10	0.2
Benzene	83	0.7	0.0006	0.06	24	N/A	5	0.06
Benzoic Acid	54*	50	0.027	2.7	N/A	300,000	5	2.7
2-Butanone	4.5*	50	0.003	0.3	N/A	4,000	10	0.3
Carbon Disulfide	54*	50	0.027	2.7	N/A	8,000	5	2.7
Carbon Tetrachloride	110*	5	0.006	0.6	5.6	60	5	0.6
Chlorobenzene	330	5	0.017	1.7	N/A	2,000	5	1.7
Chloroethane	37*	50	0.019	1.9	N/A	N/A	10	1.9
Chloroform	31	7	0.003	0.30	114	800	5	0.3
Dibromochloromethane	N/A	50	N/A	N/A	N/A	N/A	5	N/A
1,2-Dichlorobenzene	1,700	4.7	0.079	7.9	N/A	N/A	330	7.9
1,3-Dichlorobenzene	310 *	5	0.0155	1.55	N/A	N/A	330	1.6
1,4-Dichlorobenzene	1,700	5	0.025	8.5	N/A	N/A	330	8.5
1,1-Dichloroethane	30	5	0.002	0.2	N/A	N/A	5	0.2
1,2-Dichloroethane	14	5	0.001	0.1	7.7	N/A	5	0.1
1,1-Dichloroethene	65	5	0.004	0.4	12	700	5	0.4
1,2-Dichloroethene(trans)	59	5	0.003	0.3	N/A	2,000	5	0.3
1,3-dichloropropane	51	5	0.003	0.3	N/A	N/A	5	0.3
Ethylbenzene	1,100	5	0.055	5.5	N/A	8,000	5	5.5
113 Freon(1,1,2 Trichloro- 1,2,2 Trifluoroethane)	1,230*	5	0.060	6.0	N/A	200,000	5	6.0
Methylene chloride	21	5	0.001	0.1	93	5,000	5	0.1
4-Methyl-2-Pentanone	19*	50	0.01	1.0	N/A	N/A	10	1.0
Tetrachloroethene	277	5	0.014	1.4	14	800	5	1.4
1,1,1-Trichloroethane	152	5	0.0076	0.76	N/A	7,000	5	0.8
1,1,2,2-Tetrachloroethane	118	5	0.006	0.6	35	N/A	5	0.6
1,2,3-trichloropropane	68	5	0.0034	0.34	N/A	80	5	0.4
1,2,4-Trichlorobenzene	670 *	5	0.034	3.4	N/A	N/A	330	3.4
Toluene	300	5	0.015	1.5	N/A	20,000	5	1.5
Trichloroethene	126	5	0.007	0.70	64	N/A	5	0.7
Vinyl chloride	57	2	0.0012	0.12	N/A	N/A	10	0.2
Xylenes	240	5	0.012	1.2	N/A	200,000	—	1.2

a. Allowable Soil Concentration $C_s = f \times C_w \times K_{oc}$

b. Soil cleanup objective = $C_s \times$ Correction Factor (CF)

N/A is not available

- * Partition coefficient is calculated by using the following equation:
 $\log K_{oc} = -0.55 \log S + 3.64$, where S is solubility in water in ppm.
All other K_{oc} values are experimental values.

** Correction Factor (CF) of 100 is used as per TACM 84046

*** As per TACM 84046, Total VOCs < 10 ppm.

Note: Soil cleanup objectives are developed for soil organic carbon content (f) of 1%, and should be adjusted for the actual soil organic carbon content if it is known.

TABLE 5 (continued)

APPENDIX A (cont.)

TABLE 2

Recommended Soil Cleanup Objectives (mg/kg or ppm)
Semi-Volatile Organic Contaminants

Contaminant	Partition coefficient K _{oc}	Groundwater Standards/ Criteria CW ug/l or ppb.	a Allowable Soil conc. ppm Cs	b Soil Cleanup objectives to Protect GW Quality (ppm)	USEPA Health Based (ppm)		ERGL (ppb)	Rec. soil Cleanup Object. (ppm)
					Carcinogens	Systemic Toxicants		
Acenaphthene	4,600	20	0.9	90.0	N/A	5,000	330	50.0***
Acenaphthylene	2,056*	20	0.41	41.0	N/A	N/A	330	41.0
Aniline	13.8	5	0.001	0.1	123	N/A	330	0.1
Anthracene	14,000	50	7.00	700.0	N/A	20,000	330	50.0***
Benzo(a)anthracene	1,380,000	0.002	0.03	3.0	0.024	N/A	330	0.024 or MOI
Benzo(a)pyrene	5,500,000	0.002 (MO)	0.110	11.0	0.0609	N/A	330	0.061 or MO
Benzo(b)fluoranthene	550,000	0.002	0.011	1.1	N/A	N/A	330	1.1
Benzo(g,h,i)perylene	1,600,000	5	2.3	800	N/A	N/A	330	50.0***
Benzo(k)fluoranthene	550,000	0.002	0.011	1.1	N/A	N/A	330	1.1
bis(2-ethylhexyl)phthalate	8,706*	50	4.35	435.0	50	2,000	330	50.0***
Butylbenzylphthalate	2,433	50	1.215	122.0	N/A	20,000	330	50.0***
Chrysene	200,000	0.002	0.004	0.4	N/A	N/A	330	0.4
4-Chloroaniline	43 ****	5	0.0022	0.22	200	300	330	0.220 or KC
4-Chloro-3-methylphenol	47	5	0.0024	0.24	N/A	N/A	330	0.240 or KC
2-Chlorophenol	15*	50	0.008	0.8	N/A	400	330	0.8
Bibenzofuran	1,230*	3	0.062	6.2	N/A	N/A	330	6.2
Bibenz(a,h)anthracene	33,000,000	50	1,650	165,000	0.0143	N/A	330	0.014 or KC
3,3'-Dichlorodenzidine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2,4-Dichlorophenol	380	1	0.004	0.4	N/A	200	330	0.4
2,4-Dinitrophenol	38	5	0.002	0.2	N/A	200	330	0.2
2,6 Dinitrotoluene	198*	5	0.01	1.0	1.03	N/A	1,600	0.200 or M
Diethylphthalate	142	50	0.071	7.1	N/A	60,000	330	7.1
Dimethylphthalate	40	50	0.020	2.0	N/A	80,000	330	2.0
Di-n-butyl phthalate	162*	50	0.081	8.1	N/A	8,000	330	8.1
Di-n-octyl phthalate	2,346*	50	1.2	120.0	N/A	2,000	330	50.0**
Fluoranthene	38,000	50	19	1900.0	N/A	3,000	330	50.0**
Fluorene	7,300	50	3.5	350.0	N/A	3,000	330	50.0***
Hexachlorobenzene	3,900	0.35	0.014	1.4	0.41	60	330	0.41
Indeno(1,2,3-cd)pyrene	1,600,000	0.002	0.032	3.2	N/A	N/A	330	3.2
Isophorone	88.31*	50	0.044	4.40	1,707	20,000	330	4.40
2-methylnaphthalene	727*	50	0.364	36.4	N/A	N/A	330	36.4
2-Methylphenol	15	5	0.001	0.1	N/A	N/A	330	0.100 or M
4-Methylphenol	17	50	0.009	0.9	N/A	4,000	330	0.9
Naphthalene	1,300	10	0.130	13.0	N/A	300	330	13.0
Nitrobenzene	36	5	0.002	0.2	N/A	40	330	0.200 or
2-Nitroaniline	86	5	0.0043	0.43	N/A	N/A	1,600	0.430 or
2-Nitrophenol	65	5	0.0033	0.33	N/A	N/A	330	0.330 or
4-Nitrophenol	21	5	0.001	0.1	N/A	N/A	1,600	0.100 or
3-Nitroaniline	93	5	0.005	0.5	N/A	N/A	1,600	0.500 or
Pentachlorophenol	1,022	1	0.01	1.0	N/A	2,000	1,600	1.0 or KC
Phenanthrene	4,363*	50	2.20	220.0	N/A	N/A	330	50.0*
Phenol	27	1	0.0003	0.03	N/A	50,000	330	0.03 or M
Pyrene	13,295*	50	6.65	665.0	N/A	2,000	330	50.0*
2,4,5-Trichlorophenol	87*	1	0.001	0.1	N/A	8,000	330	0.1

TABLE 5 (continued)

- a. Allowable Soil Concentration $C_s = f \times C_w \times K_{oc}$
- b. Soil cleanup objective = $C_s \times \text{Correction Factor (CF)}$

N/A is not available

MDL is Method Detection Limit

- Partition coefficient is calculated by using the following equation:
 $\log K_{oc} = -0.55 \log S + 3.64$, where S is solubility in water in ppm. Other K_{oc} values are experimental values.
- Correction Factor (CF) of 100 is used as per TAGM #4046
- As per TAGM #4046, Total VOCs < 10 ppm., Total Semi-VOCs < 500 ppm. and Individual Semi-VOCs < 50 ppm.
- K_{oc} is derived from the correlation $K_{oc} = 0.63 K_{ow}$ (Determining Soil Response Action Levels..... EPA/540/2-89/057). K_{ow} is obtained from the USEPA computer database 'MAIN'.

Note: Soil cleanup objectives are developed for soil organic carbon content (f) of 1%, and should be adjusted for the actual soil organic carbon content if it is known.

TABLE 5 (continued)

APPENDIX A (cont.)
TABLE 3
Recommended soil cleanup objectives (mg/kg or ppm)
Organic Pesticides / Herbicides and PCBs

Contaminant	Partition coefficient Koc	Groundwater Standards/ Criteria Cw ug/l or ppb.	a Allowable Soil conc. ppm. Cs	b Soil Cleanup objectives to Protect GW Quality (ppm)	** USEPA health Based (ppm)		EROL (ppb)	*** Rec. soil Cleanup Object (ppm)
					Carcinogens	Systemic Toxicants		
Aldrin	96,000	MD(<0.01)	0.005	0.5	0.041	2	8	0.041
alpha - BHC	3,800	MD(<0.05)	0.002	0.2	0.111	N/A	8	0.11
beta - BHC	3,800	MD(<0.05)	0.002	0.2	3.89	N/A	8	0.2
delta - BHC	6,600	MD(<0.05)	0.003	0.3	N/A	N/A	8	0.3
Chlordane	21,305*	0.1	0.02	2.0	0.54	50	80	0.54
2,4-D	104*	4.4	0.005	0.5	N/A	800	800	0.5
4,4'-DDD	770,000*	MD(<0.01)	0.077	7.7	2.9	N/A	16	2.9
4,4'-DDE	440,000*	MD(<0.01)	0.0440	4.4	2.1	N/A	16	2.1
4,4'-DDT	243,000*	MD(<0.01)	0.025	2.5	2.1	40	16	2.1
Dibenzo-P-dioxins(PCDD)								
2,3,7,8 TCDD	1709800	0.000035	0.0006	0.06	N/A	N/A	N/A	N/A
Dieldrin	10,700*	MD(<0.01)	0.0010	0.1	0.044	4	16	0.044
Endosulfan I	8,168*	0.1	0.009	0.9	N/A	N/A	16	0.9
Endosulfan II	8,031*	0.1	0.009	0.9	N/A	N/A	16	0.9
Endosulfan Sulfate	10,038*	0.1	0.01	1.0	N/A	N/A	16	1.0
Endrin	9,157*	MD(<0.01)	0.001	0.1	N/A	20	8	0.10
Endrin ketone	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
gamma - BHC (Lindane)	1,080	MD(<0.05)	0.0006	0.06	5.4	20	8	0.06
gamma - chlordane	140,000	0.1	0.14	14.0	0.54	5	80	0.54
Heptachlor	12,000	MD(<0.01)	0.0010	0.1	0.16	40	8	0.10
Heptachlor epoxide	220	MD(<0.01)	0.0002	0.02	0.077	0.8	8	0.02
Methoxychlor	25,637	35.0	9.0	900	N/A	400	80	***
Mitotane	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Parathion	760	1.5	0.012	1.2	N/A	500	8	1.2
PCBs	17,510*	0.1	0.1	10.0	1.0	N/A	160	1.0(Surfa 10(sub-s)
Polychlorinated dibenzo- furans(PCDF)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Silvex	2,600	0.26	0.007	0.7	N/A	600	330	0.7
2,4,5-T	53	35	0.019	1.9	N/A	200	330	1.9

a. Allowable Soil Concentration $C_s = f \times C_w \times K_{oc}$

b. Soil cleanup objective = $C_s \times$ Correction Factor (CF)

N/A is not available

* Partition coefficient is calculated by using the following equation:
 $\log K_{oc} = -0.55 \log S + 3.64$, where S is solubility in water in ppm.

All other Koc values are experimental values.

** Correction Factor (CF) of 100 is used as per TACM #4046

*** As per TACM #4046, Total Pesticides < 10 ppm.

Note: Soil cleanup objectives are developed for soil organic carbon content (f) of 1% (5% for PCBs as per PCB guidance document), and should be adjusted for the actual soil organic Carbon content if it is known.

TABLE 5 (continued)

APPENDIX A

Rev. 12/93

TABLE 4

Recommended Soil Cleanup Objectives (mg/kg or ppm) for Heavy Metals

Contaminants	Protect Water Quality ppm	Eastern USA Background ppm	CRDL mg/kg or ppm	Rec. soil Cleanup Object. (ppm)
Aluminum	N/A	33,000	2.0	SB
Antimony	N/A	N/A	0.6	SB
Arsenic	N/A	3-12 **	0.1	7.5 or SB
Barium	N/A	15-600	2.0	300 or SB
Beryllium	N/A	0-1.75	0.05	0.16 (HEAST) or SB
Cadmium	N/A	0.1-1	0.05	1 or SB
Calcium	N/A	130 - 35,000 **	50.0	SB
Chromium	N/A	1.5-40 **	0.1	10 or SB
Cobalt	N/A	2.5-60 **	0.5	30 or SB
Copper	N/A	1-50	0.25	25 or SB
Cyanide	N/A	N/A	0.1	***
Iron	N/A	2,000 - 550,000	1.0	2,000 or SB
Lead	N/A	****	0.03	SB****
Magnesium	N/A	100 - 5,000	50.0	SB
Manganese	N/A	50 - 5,000	0.15	SB
Mercury	N/A	0.001-0.2	0.002	0.1
Nickel	N/A	0.5-25	0.4	13 or SB
Potassium	N/A	8,500 - 43,000 **	50.0	SB
Selenium	N/A	0.1-3.9	0.05	2 or SB
Silver	N/A	N/A	0.1	SB
Sodium	N/A	6,000 - 8,000	50.0	SB
Thallium	N/A	N/A	0.1	SB
Vanadium	N/A	1-300	0.5	150 or SB
Zinc	N/A	9-50	0.2	20 or SB

Note: Some forms of metal salts such as Aluminum Phosphide, Calcium Cyanide, Potassium Cyanide, Copper cyanide, Silver cyanide, Sodium cyanide, Zinc phosphide, Thallium salts, Vanadium pentoxide, and Chromium (VI) compounds are more toxic in nature. Please refer to the USEPA HEASTs database to find cleanup objectives if such metal salts are present in soil.

SB is site background

N/A is not available

* CRDL is contract required detection limit which is approx. 10 times the CRDL for water.

** New York State background

*** Some forms of Cyanide are complex and very stable while other forms are pH dependent and hence are very unstable. Site-specific form(s) of Cyanide should be taken into consideration when establishing soil cleanup objective.

**** Background levels for lead vary widely. Average levels in undeveloped, rural areas may range from 4-61 ppm. Average background levels in metropolitan or suburban areas or near highways are much higher and typically range from 200-500 ppm.

***** Recommended soil cleanup objectives are average background concentrations as reported in a 1984 survey of reference material by E. Carol McGovern, NYSDEC.

Conventional Sediment Variables
Total Organic Carbon (TOC)
March 1986

TOTAL ORGANIC CARBON (TOC)

USE AND LIMITATIONS

Total organic carbon is a measure of the total amount of nonvolatile, volatile, partially volatile, and particulate organic compounds in a sample. Total organic carbon is independent of the oxidation state of the organic compounds and is not a measure of the organically bound and inorganic elements that can contribute to the biochemical and chemical oxygen demand tests.

Because inorganic carbon (e.g., carbonates, bicarbonates, free CO₂) will interfere with total organic carbon determinations, samples should be treated to remove inorganic carbon before being analyzed.

FIELD PROCEDURES

Collection

Samples can be collected in glass or plastic containers. A minimum sample size of 25 g is recommended. If unrepresentative material is to be removed from the sample, it should be removed in the field under the supervision of the chief scientist and noted on the field log sheet.

Processing

Samples should be stored frozen and can be held for up to 6 mo under that condition. Excessive temperatures should not be used to thaw samples.

LABORATORY PROCEDURES

Analytical Procedures

• Equipment

- Induction furnace
e.g., Leco VR-12, Dohrmann DC-50, Coleman CH analyzer,
Perkin Elmer 240 elemental analyzer, Carlo-Erba 1106
- Analytical balance
0.1 mg accuracy
- Desiccator
- Combustion boats
- 10 percent hydrochloric acid (HCl)
- Cupric oxide fines (or equivalent material)
- Benzoic acid or other carbon source as a standard.

TABLE 5 (continued)

Conventional Sediment Variables
Total Organic Carbon (TOC)
March 1986

- Equipment preparation
 - Clean combustion boats by placing them in the induction furnace at 950° C. After being cleaned, combustion boats should not be touched with bare hands.
 - Cool boats to room temperature in a desiccator.
 - Weigh each boat to the nearest 0.1 mg.
- Sample preparation
 - Allow frozen samples to warm to room temperature.
 - Homogenize each sample mechanically, incorporating any overlying water.
 - Transfer a representative aliquot (5-10 g) to a clean container.
- Analytical procedures
 - Dry samples to constant weight at 70 ± 20 ° C. The drying temperature is relatively low to minimize loss of volatile organic compounds.
 - Cool dried samples to room temperature in a desiccator.
 - Grind sample using a mortar and pestle to break up aggregates.
 - Transfer a representative aliquot (0.2-0.5 g) to a clean, preweighed combustion boat.
 - Determine sample weight to the nearest 0.1 mg.
 - Add several drops of HCl to the dried sample to remove carbonates. Wait until the effervescing is completed and add more acid. Continue this process until the incremental addition of acid causes no further effervescence. Do not add too much acid at one time as this may cause loss of sample due to frothing. Exposure of small samples (i.e., 1-10 mg) having less than 50 percent carbonate to an HCl atmosphere for 24-48 h has been shown to be an effective means of removing carbonates (Hedges and Stern 1984). If this method is used for sample sizes greater than 10 mg, its effectiveness should be demonstrated by the user.
 - Dry the HCl-treated sample to constant weight at 70 ± 20 ° C.
 - Cool to room temperature in a desiccator.
 - Add previously ashed cupric oxide fines or equivalent material (e.g., alumina oxide) to the sample in the combustion boat.
 - Combust the sample in an induction furnace at a minimum temperature of 950 ± 100 ° C.
- Calculations
 - If an ascarite-filled tube is used to capture CO₂, the carbon content of the sample can be calculated as follows:

$$\text{Percent carbon} = \frac{A(0.2729)(100)}{8}$$

TABLE 5 (continued)

Conventional Sediment Variables
Total Organic Carbon (TOC)
March 1986

Where:

- A = the weight (g) of CO₂ determined by weighing the ascarite tube before and after combustion
- B = dry weight (g) of the unacidified sample in the combustion boat
- 0.2729 = the ratio of the molecular weight of carbon to the molecular weight of carbon dioxide

A silica gel trap should be placed before the ascarite tube to catch any moisture driven off during sample combustion. Additional silica gel should be placed at the exit end of the ascarite tube to trap any water that might be formed by reaction of the trapped CO₂ with the NaOH in the ascarite.

- If an elemental analyzer is used, the amount of CO₂ will be measured by a thermal conductivity detector. The instrument should be calibrated daily using an empty boat blank as the zero point and at least two standards. Standards should bracket the expected range of carbon concentrations in the samples.

QA/QC Procedures

It is critical that each sample be thoroughly homogenized in the laboratory before a subsample is taken for analysis. Laboratory homogenization should be conducted even if samples were homogenized in the field.

Dried samples should be cooled in a desiccator and held there until they are weighed. If a desiccator is not used, the sediment will accumulate ambient moisture and the sample weight will be overestimated. A color-indicating desiccant is recommended so that spent desiccant can be detected easily. Also, the seal on the desiccator should be checked periodically and, if necessary, the ground glass rims should be greased or the "O" rings should be replaced.

It is recommended that triplicate analyses be conducted on one of every 20 samples, or on one sample per batch if less than 20 samples are analyzed. A method blank should be analyzed at the same frequency as the triplicate analyses. The analytical balance should be inspected daily and calibrated at least once per week. The carbon analyzer should be calibrated daily with freshly prepared standards. A standard reference material should be analyzed at least once for each major survey.

DATA REPORTING REQUIREMENTS

Total organic carbon should be reported as a percentage of the dry weight of the unacidified sample to the nearest 0.1 unit. The laboratory should report the results of all samples (including QA replicates, method

TABLE 5 (continued)

Conventional Sediment Variables
Total Organic Carbon (TOC)
March 1986

blanks, and standard reference measurements) and should note any problems that may have influenced sample quality. The laboratory should also provide a summary of the calibration procedure and results (e.g., range covered, regression equation, coefficient of determination).

Table 6

ZONE SPECIFIC FAR-FIELD LOADINGS

Alternative	LOADING TO FAR-FIELD (lb/day)						TOTAL
	B zone	C zone	D zone	E zone	F zone	G zone	
1	4.97	3.86	0.55	4.82	7.43	0.99	22.6
2	0.01	<0.01	0.53	4.61	7.14	0.98	13.3
3	0.01	<0.01	0.53	4.61	7.14	0.98	13.3
4	0.01	<0.01	0.53	4.61	7.14	0.98	13.3
5	0.01	<0.01	0.53	4.61	7.14	0.98	13.3
6	0.01	<0.01	0.13	1.11	1.61	0.97	3.8
7	0.01	<0.01	0.13	1.11	1.61	0.90	3.8
8	0.01	<0.01	0.13	1.11	1.61	0.97	3.8
9	0.09	0.10	0.03	0.25	0.38	0.89	1.7
10 & 10A	<0.01	<0.01	0.00	0.01	0.01	0.96	1.0
11	<0.01	<0.01	0.00	0.01	0.01	0.96	1.0
12	0.05	0.08	0.03	0.24	0.36	<0.01	0.8
13	0.01	0.06	0.03	0.24	0.37	0.82	1.5

TABLE 7

ALTERNATIVE	CAPITAL COST	ANNUAL O&M COST	30-YEAR PRESENT WORTH COST	TOTAL COST
Alternative 1	\$0	\$0	\$0	\$0
Alternative 2	\$271,785	\$1,658,325	\$20,578,155	\$20,850,000
Alternative 3	\$2,780,899	\$1,669,025	\$20,710,931	\$23,492,000
Alternative 4	\$5,094,136	\$1,933,650	\$23,944,663	\$29,089,000
Alternative 5	\$6,530,587	\$1,810,450 + \$768,750 for 5 years for DPE	\$22,465,874 + \$3,152,029 for 5 years for DPE	\$32,148,000
Alternative 6	\$3,760,774	\$2,897,775	\$35,958,490	\$39,719,000
Alternative 7	\$6,074,011	\$3,162,400	\$39,242,222	\$45,316,000
Alternative 8	\$7,510,462	\$2,887,075 + \$350,875 for 5 years for DPE	\$35,825,714 + \$3,488,758 for 5 years for DPE	\$46,825,000
Alternative 9	\$15,564,011	\$3,080,275	\$38,223,132	\$53,787,000
Alternative 10 / 10A	\$7,837,136	\$4,614,775	\$57,264,743	\$65,102,000
Alternative 11	\$9,354,723	\$4,421,575 + \$768,750 for 5 years for DPE	\$4,867,324 + \$3,152,029 for 5 years for DPE	\$67,374,000
Alternative 12	\$39,051,761	\$3,218,650	\$39,940,228	\$78,992,000
Alternative 13	\$19,343,761	\$6,214,525	\$77,116,041	\$96,460,000

APPENDIX III

ADMINISTRATIVE RECORD INDEX

DUPONT/NECCO PARK
ADMINISTRATIVE RECORD FILE
INDEX OF DOCUMENTS

3.0 REMEDIAL INVESTIGATION

3.1 Sampling and Analysis Plans

- P. 300001- Report: Field Sampling Plan, Necco Park,
300058 prepared by Woodward-Clyde Consultants, prepared
for E.I. du Pont de Nemours & Company, Inc.,
November 1991.

3.2 Sampling and Analysis Data/Chain of Custody Forms

- P. 300059- Letter to Mr. Dale Carpenter, Chief, Site
300086 Compliance Branch, Emergency and Remedial Response
Division, US EPA, Region II, from Ms. Marjorie
D. Ripsom, Area Engineer, Engineering and
Environmental Affairs, Du Pont Chemicals, re:
attached lab report from Enseco-CAL laboratory's
analysis for 2,3,7,8-TCDD Study, April 10, 1992.
Attached Report: Data Quality Assessment and
Validation, Du Pont Necco Park, 2,3,7,8-TCDD
Analytical Program, prepared by Woodward-Clyde
Consultants, prepared for E.I. du Pont de Nemours
& Company, Inc., March 1992.
- P. 300087- Letter to Ms. Margie D. Ripsom, Area Engineer,
300113 Engineering and Environmental Affairs, Du Pont
Chemicals, from Ms. Shelly Eyraud, Manager of
Low Resolution Dioxin Services, Enseco, re:
enclosed amended report for the fourteen aqueous
and four solid samples for the DuPont Necco Park
Project, received at Enseco-Cal Lab on October 18,
1991, January 8, 1992.
- P. 300114- Letter to Ms. Ann Masse, Du Pont Chemicals, from
300134 Ms. Shelly Eyraud, Manager of Low Resolution
Dioxin Services, Enseco, re: enclosed report
for the one aqueous, four solid and seven waste
samples for the DuPont Necco Park Project,
received at Enseco-Cal Lab on October 23, 1991,
November 25, 1991.

- P. 300135- Report: Geologic Report, Necco Park, Niagara
300266 Falls, New York, July 1988 - Volume I, prepared
by Woodward-Clyde Consultants, prepared for E.I.
du Pont de Nemours and Company, July 1988.
- P. 300267- Report: Geologic Report Necco Park, Niagara
300758 Falls, New York, July 1988 - Volume II, prepared
by Woodward-Clyde Consultants, prepared for E.I.
du Pont de Nemours and Company, July 1988.
- P. 300759- Report: Results of NAPL Sampling and Analytical
300892 Program (May, 1987), Necco Park, Niagara Falls,
New York, December 7, 1987, prepared by Woodward-
Clyde Consultants, December 7, 1987.
- P. 300893- Report: Ambient Air Sampling Report for the Necco
300956 Park Landfill Summer 1986 Sampling, prepared by
Woodward-Clyde Consultants, prepared for E.I. du
Pont de Nemours & Company, August 21, 1987.
- P. 300957- Report: Refinement of Aqueous Indicator
301152 Parameter List for Necco Park, prepared by
Woodward-Clyde Consultants, prepared for E.I. du
Pont de Nemours and Company, December 31, 1986.
- P. 301153- Report: NAPL Investigation, Necco Park, Niagara
301242 Falls, New York, prepared by Woodward-Clyde
Consultants, prepared for E.I. du Pont de Nemours
and Company, December 22, 1986.
- P. 301243- Report: Ambient Air Sampling Report for the Necco
301296 Park Landfill, Fall 1985 Sampling, prepared by
Woodward-Clyde Consultants, prepared for E.I. du
Pont de Nemours and Company, July 23, 1986.
- P. 301297- Map: Sample Location Map, Niagara Falls
301442 Groundwater Monitoring Program, Niagara Falls,
N.Y., prepared by NUS Corporation, (undated).
Attached are: Well Construction Details, Borehole
Logs, Well Descriptions, Appendix D - Monitoring
Well Installation, Construction and Development,
and Appendix F - Borehole Logs.

3.3 Work Plans

- P. 301443- Report: Quality Assurance/Quality Control Audit
301639 Manual, Version 3.1, Necco Park, prepared by
Woodward-Clyde Consultants, prepared for E.I. du
Pont de Nemours & Company, Inc., November 1991.
- P. 301640- Report: Investigation Work Plan, Necco Park,
301775 prepared by Woodward-Clyde Consultants, prepared
for E.I. du Pont de Nemours & Company, Inc., March
1991.

3.4 Remedial Investigation Reports

- P. 301776- Report: Investigation Report, Necco Park, Volume
302024 I - Text, Tables, Figures, prepared by Woodward-
Clyde Consultants, prepared for E.I. du Pont de
Nemours and Company, Inc., October 1993.
- P. 302025- Report: Investigation Report, Necco Park,
302492 Volume II, Appendix A-C, prepared by Woodward-
Clyde Consultants, prepared for E.I. du Pont de
Nemours and Company, Inc., October 1993.
- P. 302493- Report: Investigation Report, Necco Park, Volume
302947 III Appendix D-I, prepared by Woodward-
Clyde Consultants, prepared for E.I. du Pont de
Nemours and Company, Inc., October 1993.
- P. 302948- Report: Final Risk Assessment, Dupont Necco Park
303374 Site, Niagara Falls, New York - Risk Assessment,
Work Assignment: C02124 (Ref. No. 1-635-353),
prepared for United States Environmental
Protection Agency, prepared by TRC Environmental
Corporation, July 29, 1993.
- P. 303375- Report: Niagara Falls Regional Groundwater
303540 Assessment, Volume I - Text, prepared by Woodward-
Clyde Consultants and Conestoga-Rovers &
Associates for Du Pont Chemicals, Occidental
Chemical Corporation, and Olin Chemicals, June
1992.
- P. 303541- Report: Niagara Falls Regional Groundwater
304128 Assessment, Volume II - Appendix A-Site Summary
Attachments, prepared by Woodward-Clyde Consultants
and Conestoga-Rovers & Associates for Du Pont
Chemicals, Occidental Chemical Corporation, and
Olin Chemicals, June 1992.

- P. 304129- Drawings: Niagara Falls Regional Groundwater
304160 Assessment - Volume III Plans, prepared by
Woodward-Clyde Consultants and Conestoga-Rovers
Associates, prepared for Du Pont Chemicals,
Occidental Chemical Corporation, and Olin
Chemicals, June 1992.
- P. 304161- Report: Interpretive Report for Necco Park, E.I.
304611 du Pont de Nemours & Company, Niagara Falls, New
York, Volume II, Appendices C, D, E and F,
prepared by Woodward-Clyde Consultants, prepared
for E.I. du Pont de Nemours and Company, Inc.,
January 16, 1991.
- P. 304612- Report: Addendum to Appendix D, Interpretive
304673 Report, Tabulated Qualified Data, Necco Park,
Niagara Falls, New York, prepared by Woodward-
Clyde Consultants, prepared for E.I. du Pont de
Nemours and Company, Inc., October 30, 1989.
- P. 304674- Report: Appendix D, Interpretive Report
304754 Tabulated Qualified Data, Necco Park, Niagara
Falls, New York, prepared by Woodward-Clyde
Consultants, prepared for E.I. du Pont de Nemours
and Company, Inc., June 14, 1989.
- P. 304755- Report: Interpretive Report for Necco Park, E.I.
304947 du Pont de Nemours & Company, Niagara Falls, New
York, Volume I, prepared by Woodward-Clyde
Consultants, prepared for E.I. du Pont de Nemours
and Company, Inc., May 4, 1989.
- P. 304948- Report: Interpretive Report for Necco Park, E.I.
305303 du Pont de Nemours & Company, Niagara Falls, New
York, Volume II - Appendices, prepared by
Woodward-Clyde Consultants, prepared for E.I. du
Pont de Nemours and Company, Inc., May 4, 1989.
- P. 305304- Report: Contaminant Transport Estimates for Du
305443 Pont Necco Park, Supporting Calculations and Maps,
prepared by Woodward-Clyde Consultants, prepared
for E.I. du Pont de Nemours & Company, Inc.,
(undated).
- P. 305444- Report: Attachment 1 - Vapor Infiltration
305449 Modeling Summary, prepared by TRC Environmental
Corporation, (undated).

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4.0 FEASIBILITY STUDY

4.3 Feasibility Study Reports

- P. 400001- Report: Volume I, Analysis of Alternatives,
400533 DuPont Necco Park Site, Niagara Falls, New York,
prepared for DuPont Niagara Plant, prepared by
DuPont Environmental Remediation Services, revised
October 11, 1995.
- P. 400534- Report: Volume II, Analysis of Alternatives,
401110 DuPont Necco Park Site, Niagara Falls, New York,
prepared for DuPont Niagara Plant, prepared by
DuPont Environmental Remediation Services, revised
October 11, 1995.
- P. 401111- Report: Addendum to the Analysis of Alternatives
401113 (AOA) Report, Du Pont, Necco Park Site, Niagara
Falls, New York (October 1995), undated.

7.0 ENFORCEMENT

7.3 Administrative Orders

- P. 700001- US EPA Administrative Order on Consent, In the
700025 Matter of, E.I. du Pont de Nemours and Company,
Respondent, Index No. II CERCLA-90221, September
28, 1989. Attached Report: Outline for Scope of
Work: Necco Park, prepared by Woodward-Clyde
Consultants, (undated).

9.0 NATURAL RESOURCE TRUSTEES

9.3 Reports

- P. 900001- Report: Effect of Niagara Power Project on
900039 Ground-Water Flow in the Upper Part of the
Lockport Dolomite, Niagara Falls Area, New York,
prepared by U. S. Geological Survey, Water
Resources Investigations, in cooperation with US
EPA and the New York State Department of
Environmental Conservation, 1987.

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10.0 PUBLIC PARTICIPATION

10.7 Responsiveness Summary

- P. 10.00001- Responsiveness Summary, Dupont Necco Park
10.00171 Site, Town of Niagara and City of Niagara
Falls, Niagara County, New York, prepared by U.S.
EPA, Region II, February 28, 1998.

10.9 Proposed Plan

- P. 10.00172- Plan: Revised Proposed Plan, Modification to
10.00181 Proposed Remedy, Dupont Necco Park Superfund Site,
City of Niagara Falls, Niagara County, New York,
prepared by U.S. EPA, Region II, February 1998.

APPENDIX IV

STATE LETTER OF CONCURRENCE

New York State Department of Environmental Conservation

Division of Environmental Remediation, Room 260B

50 Wolf Road, Albany, New York 12233-7010

Phone: (518) 457-5861 FAX: (518) 457-3972



John P. Cahill
Commissioner

AUG 25 1998

Mr. Richard L. Caspe, P.E.
Director
Emergency & Remedial Response Division
United States Environmental Protection Agency
Region II
290 Broadway - 19th Floor
New York, NY 10007-1866

Dear Mr. Caspe:

RE: DuPont Necco Park Site (Number 9-32-047) Record of Decision

The New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYSDOH) have reviewed the Record of Decision which your staff has prepared. The NYSDEC supports the conceptual approach of employing site containment technology while continuing to monitor the far field for site impacts. Alternative 10A achieves this generalized goal and we concur with the United States Environmental Protection Agency (EPA) Region II's recommendation of Alternative 10A for remedy selection.

We wish to reiterate two points. First, we believe that significant environmental and cost benefits may accrue from enhanced DNAPL recovery efforts set forth in the Remedial Design Statement of Work. Second, there should be a clearly defined set of criteria and objectives which must be met prior to termination of active recovery efforts. We strongly recommend that such criteria and objectives be incorporated into the enforcement vehicle, but in any case must be developed prior to completion of remedial design.

We appreciate the opportunity to continue our participation in future discussions relating to the enforcement vehicle and design of the final remedy. If you have any questions or require further clarification, please contact myself or David Foster of my staff at (518) 457-0315.

bcc: M. O'Toole (2)
E. Belmore
A. Carlson
D. King
W. Wertz
A. English
D. Foster

Sincerely,

Michael J. O'Toole, Jr.
Director
Division of Environmental Remediation

cc: John E. La Padula