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Occidental Chemical Corporation

Olin
CHEMICALS GROUP

REMEDIAL INVESTIGATION FINAL REPORT

VOLUME 1 - TEXT

102nd Street Landfill Site
Niagara Falls, New York

PRINTED ON

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VOLUME 1 - TEXT

102nd Street Landfill Site
Niagara Falls, New York

JULY 1990
REF. NO. 1431(47)

CONESTOGA-ROVERS & ASSOCIATES
WOODWARD-CLYDE CONSULTANTS

SUMMARY

I) INTRODUCTION

The 102nd Street Landfill Site (Site), presently owned by Occidental Chemical Corporation (OCC) and Olin Corporation (Olin), is located at the eastern edge of the City of Niagara Falls adjacent to the Niagara River. The Site was operated as a disposal site for industrial wastes by both companies and their predecessors.

A comprehensive Remedial Investigation (RI) program for the Site was developed by the United States Environmental Protection Agency (EPA), New York State (State) and OCC/Olin. The Work Plan for the RI was approved by the United States District Court for the Western District of New York in 1984. Between July 1984 and October 1985, protocols for the RI were developed. OCC and Olin commenced field work at the Site in October 1985 and completed this activity in April 1988. The information collected during the RI is presented in summary form in this report, the Draft Final RI Report.

II) OBJECTIVES

In addition to refining the previous understanding of Site conditions, the objectives of the RI are:

- The characterization of the nature and extent of the presence of chemicals originating from the Site.
- The collection of sufficient data on the hydrogeologic conditions and other physical characteristics of the Site and affected off-site areas necessary for the engineering conceptualization and assessment of remedial courses of action which will be evaluated in the currently ongoing Feasibility Study.

III) CONCLUSIONS

The RI was prepared and completed in accordance with the Work Plan which consisted of sixteen (16) individual tasks. This extensive study involved the installation of ninety-five (95) boreholes and monitoring wells and the collection of thousands of surface soil, subsurface soil, sediment and groundwater samples.

Data collected during the RI was periodically submitted to and approved by the EPA/State in the form of Milestone Reports and other supplemental data submissions.

Based upon the information collected and interpretation thereof, it is concluded that the database is now sufficient to accurately characterize Site conditions and the extent of chemical migration from the Site. The following additional observations and conclusions are also premised on the results of the RI:

1) The RI is complete and has met the requirements of the Work Plan.

2) The data are sufficient to complete a Feasibility Study (FS) which will include:

   a) conceptualization and assessment of remedial courses of action;

   b) performance of a health and environmental assessment of the chemicals found at and near the Site following completion of the assessment chemical monitoring program;

   c) development of appropriate criteria for cleanup standards; and

   d) development of an effective plan of remediation for the Site.

3) Based upon the QA reviews performed, the analytical data reported are, in general, technically acceptable and adequately characterize the Site conditions.

4) The extent of 102nd Street Indicator chemicals in the Niagara River sediments is essentially limited to an area within 46 to 304 feet of the River's edge. The major sources include the former spit constructed from fill, historic surface soil erosion, groundwater, and storm sewer effluent.

5) Non-Aqueous Phase Liquids (NAPL) were identified on Site in limited areas in the fill and alluvium strata. NAPL was not found to be present in the clay, till, bedrock, river sediment or in any off-site samples. The volume of NAPL present on site is limited. The potential for off-site NAPL migration is restricted by geologic conditions. It has been agreed with EPA/State that the extent of NAPL presence, if any, south of the bulkhead will be determined through additional boreholes installed in preparation for the design of the Site Containment System.

6) Site-related chemicals were detected in off-site surface soils typically in areas adjacent to the Site boundary and were generally consistent with expected migration patterns.

7) The Site is only one of the potential sources for mercury detected in off-site surface soils.

8) Dioxin (2,3,7,8 tetrachlorodibenzo-p-dioxin) was detected in samples collected from boreholes installed on site by the EPA. Lower concentrations of dioxin were also detected in three surface soil samples collected off-site immediately adjacent to the northern Site property boundary and interim corrective measures were implemented in this area.

9) Groundwater flows through the Fill and Alluvium are the principal pathways of chemicals migrating from the Site. The estimated quantity of organic chemicals migrating from the Site to the Niagara River via the groundwater is on the order of 26 pounds per day. The Site Specific Indicator Parameters account for approximately 2.6 pounds per day of the organic quantity. The estimated quantities of phosphorus and mercury migrating from the Site are 33 and 0.0003 pounds per day, respectively. While it is not possible to reliably estimate the rate of southerly NAPL migration, if any, off-site through the Fill, Alluvium or storm sewer, any remedial alternative would address such NAPL, if found.

10) The sewer crossing the property is a minor pathway of dissolved chemical migration from the Site to the environment. The sewer bedding does not appear to be a preferential pathway of chemical migration.

11) The Clay/Till stratum acts as an effective barrier against vertical groundwater and chemical migration from the Fill/Alluvium to the Bedrock.

12) No SSI were detected in bedrock groundwater samples. General Parameters detected were not believed to be site-related.

13) The data collected during this RI improves and confirms the understanding of Site conditions developed by previous studies undertaken by OCC/Olin and provides new information about the quality of bedrock groundwater, hydrogeologic conditions, and off-site soils.

IV FUTURE STUDIES

Based upon the results of the RI, the FS will consider the need for potential remediation to address the following conditions if a public health risk or adverse environmental impact is identified:

- discharge of groundwater from the Fill and Alluvium strata to the Niagara River.
- potential for off-site migration of NAPL.
- potential for exposure to on-site waste materials via surface soil erosion, airborne releases and direct contact with waste materials.
- potential for exposure to chemicals which have migrated from the Site to surrounding surface soils.

- potential for exposure to Site related chemicals identified in the sediment of the Niagara River within 46 to 304 feet of the River's edge.

- release of Site chemicals via infiltration to the storm sewer traversing the Site.

- potential for exposure due to Site related chemicals along underground utilities.

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NOMENCLATURE

- ALL RESULTS IN REPORT LISTED AS ug/L OR ug/kg (ppb) UNLESS OTHERWISE NOTED
- ALLUVIAL RIVER DEPOSITS - ALLUVIUM
- AQUEOUS PHASE LIQUID - APL
- BASE/NEUTRAL ACID EXTRACTABLES - B/NA
- BUFFALO DISTRICT CORPS OF ENGINEERS - COE
- COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT - CERCLA
- CHLOROBENZENE - CB
- CHLOROPHENOLS - CP
- CONFINING CLAY/TILL UNIT - CONFINING UNIT
- CUBIC FEET PER SECOND - CFS
- DELTA HEXACHLOROCYCLOHEXANE - d-HCCH
- DEPARTMENT OF ENVIRONMENTAL CONSERVATION - DEC
- DICHLOROBENZENES - DCB
- FEASIBILITY STUDY - FS
- FILL MATERIAL - FILL

NOMENCLATURE

- FOURIER TRANSFORM INFRARED SPECTROSCOPY - FTIR
- GALLONS PER MINUTE - GPM
- GAMMA HEXACHLOROCYCLOHEXANE - g-HCCH
- GAS CHROMATOGRAPHY/MASS SPECTROMETRY - GC/MS
- GENERAL PARAMETERS - GP
- GLACIAL TILL - TILL
- GLACIOLACUSTRINE CLAY - CLAY
- HEAVIER THAN WATER NON-AQUEOUS PHASE LIQUID - HNAPL
- HEXACHLOROBENZENE - HCB
- HIGH PERFORMANCE LIQUID CHROMATOGRAPHY - HPLC
- INDUCTIVELY COUPLED PLASMA - ICP
- INFRA-RED - IR
- INTERAGENCY TASK FORCE - ITF
- LIGHTER THAN WATER NON-AQUEOUS PHASE LIQUID - LNAPL
- MASS SPECTROMETRY - MS
- MEAN SEA LEVEL - MSL

NOMENCLATURE

- MERCURY - Hg
- METHYL-T-BUTYLETHER - MTBE
- MILESTONE REPORT NO. 9, APPENDIX C QUALITY ASSURANCE PLAN FOR THE SITE-SPECIFIC INDICATORS - QAP
- MONOCHLOROTOLUENES - MCT
- NATIONAL PRIORITY LIST - NPL
- NATIVE OR NATURAL SOILS - NATIVE SOIL
- NEW YORK STATE DEPARTMENT OF HEALTH - NYSDOH
- NEW YORK STATE WATER QUALITY STANDARDS - NYS WQS
- NIAGARA RIVER - RIVER
- NON-AQUEOUS PHASE LIQUID - NAPL
- NON-CARCINOGEN TOXICITY CONSTANT - NCTC
- NON-DETECT OR NOT DETECTABLE - ND
- NUCLEAR MAGNETIC RESONANCE - NMR
- OCCIDENTAL CHEMICAL CORPORATION - OCC
- OCTANOL /ORGANIC CARBON PARTITION COEFFICIENT - K_{OC}

NOMENCLATURE

- OLIN CORPORATION - OLIN
- ORIGINAL TOPSOIL LAYER, PEAT, ETC. - ORGANIC RICH LAYER
- PENTACHLOROBENZENE - P5CB
- POLYCHLORODIBENZODIOXINS - PCDD
- POLYCHLORODIBENZOFURANS - PCDF
- POLYCHLORINATED BIPHENYL - PCB
- POLYVINYL CHLORIDE - PVC
- POTENTIAL CARCINOGEN TOXICITY CONSTANT - PCTC
- POWER AUTHORITY OF THE STATE OF NEW YORK - PASNY
- QUALITY ASSURANCE/QUALITY CONTROL - QA/QC
- REMEDIAL INVESTIGATION - RI
- SITE OPERATIONS PLAN - SOP
- SITE-SPECIFIC INDICATORS - SSI
- SITE-SPECIFIC QUALITY ASSURANCE REQUIREMENTS - SSQAR
- SITE WATER BALANCE - SWB

NOMENCLATURE

- SOIL AND SEDIMENT INVESTIGATION AREAS - STUDY AREAS
- SPECIFIC CONDUCTANCE - SC
- SPECIFIC GRAVITY - SP. GR.
- STATE POLLUTION DISCHARGE ELIMINATION SYSTEM - SPDES
- TARGET COMPOUND LIST - TCL
- TETRACHLOROBENZENES - TECB
- TETRACHLOROETHANE - TECA
- TETRACHLOROETHENE - TECE
- TOTAL DISSOLVED PHOSPHORUS - P
- TOTAL HALOGENATED ORGANIC SCAN - THO
- TOTAL HEXACHLOROCYCLOHEXANES - HCCH (a-, b-, d- and g-HCCH)
- TOTAL KJELDAHL NITROGEN - TKN
- TOTAL ORGANIC CARBON - TOC
- TOTAL ORGANIC HALOGEN - TOX
- TRICHLOROBENZENES - TCB
- UNITED STATES GEODETIC SURVEY - USGS

NOMENCLATURE

- UNITED STATES ENVIRONMENTAL PROTECTION AGENCY/ NEW YORK STATE - EPA/STATE
- USEPA CONTRACT LABORATORY PROTOCOL - CLP
- USEPA WATER QUALITY CRITERIA - USEPA WQC
- VINYL CHLORIDE MONOMER - VCM
- VOLATILE ORGANICS ANALYSIS - VOA
- VOLUME 1 - TEXT
- VOLUME 2 - APPENDICES AND PLANS
- WELL-SPECIFIC CORRECTION FACTOR - WSCF
- WORK PLAN FOR THE REMEDIAL INVESTIGATION - WORK PLAN
- 102ND STREET LANDFILL SITE - SITE
- 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN - DIOXIN

1.0 INTRODUCTION

The 102nd Street Landfill Site (Site), presently owned by Occidental Chemical Corporation (OCC) and Olin Corporation (Olin), is located at the eastern edge of the City of Niagara Falls adjacent to the Niagara River. The Site was operated as a disposal site for industrial wastes by both companies and their predecessors.

OCC, formerly Hooker Chemical and Plastics Company, operated its 15.6-acre portion of the Site as a landfill from approximately 1943 to 1970. Olin operated its 6.5-acre portion of the Site from 1948 to 1970. In December 1970, the Buffalo District Corps of Engineers (COE) notified OCC and Olin that construction, filling and dumping at the Site must cease until a dike or bulkhead was installed along the River shore, under a permit from the COE. The bulkhead was completed in 1972/1973, and no subsequent landfilling occurred.

A comprehensive Remedial Investigation (RI) program for the Site was developed by the United States Environmental Protection Agency (EPA), New York State (State) and OCC/Olin. The Work Plan for the RI was approved by the United States District Court for the Western District of New York in 1984. Between July 1984 and October 1985, protocols for the RI were developed. OCC and Olin commenced field work at the Site in October 1985 and completed this activity in April 1988. The information collected during the RI is presented in summary form in this report, the Draft Final RI Report.

1.1 OBJECTIVES OF THE REMEDIAL INVESTIGATION

In addition to refining the previous understanding of Site conditions, the objectives of the RI are:

- The characterization of the nature and extent of the presence of chemicals originating from the Site.
- The collection of sufficient data on the hydrogeologic conditions and other physical characteristics of the Site and affected off-site areas necessary for the engineering

conceptualization and assessment of remedial courses of action which will be evaluated in the currently ongoing Feasibility Study.

This report presents the information which has been gathered from the RI program and correlates this data with historical information and other studies which contribute to the fulfillment of these objectives. The sources of historical information used in the preparation of this report are presented in the Section entitled "References". Referral to references in this report will be made by the integer value preceding the citation in the "Reference" section.

1.1.1 CHARACTERIZATION OF THE SITE

Although estimates have previously been made of the quantities and locations of various types of waste materials deposited at the Site, it was an objective of this investigation to determine the areal and vertical extent of migration of chemicals originating from these materials.

Potential routes of off-site migration of chemicals were identified as follows:

- surface water runoff to the Niagara River,
- surface water runoff to off-site soils,
- groundwater discharge to the Niagara River,
- airborne transport of soil/waste particulates to off-site locations,
- transport of soil/waste off site via vehicles and equipment, and
- NAPL migration.

Groundwater, surface soils and Niagara River sediment are the principal potential receptors for this chemical migration and field activities were therefore implemented to evaluate the presence and potential impact of such migration.

1.1.2 DATA COLLECTION

The field investigation programs were designed and implemented to provide additional information regarding both physical and chemical characteristics of the Site. The activities conducted under the field programs delineated in the Work Plan are summarized as follows:

TASK 1: HEALTH, SAFETY AND GENERAL SITE RECONNAISSANCE

A site reconnaissance meeting was held on Site on June 11, 1984 in order to assess the health and safety requirements for the RI and to verify existing conditions. Results of this reconnaissance meeting were presented (20).

TASK 2: SITE-SPECIFIC HEALTH AND SAFETY REQUIREMENTS

A site-specific Environmental Health and Safety Plan (21) was prepared for the RI and approved by the EPA/State before initiation of field studies. This Plan's stated purpose was to protect the health and safety of Project Personnel, Survey Site Personnel and Authorized Personnel and the surrounding community during the RI. Throughout the RI, air monitoring of the work space and surrounding area was undertaken as required. Air monitoring measurements taken during the waste well installation program were compiled and forwarded to the EPA/State in January 1986 (39, Appendix B).

TASK 3: SPECIFIC QUALITY ASSURANCE REQUIREMENTS

Site-specific quality assurance requirements for sampling programs associated with the RI were developed and defined (22, 9-Appendix C). These requirements address field procedures, analytical methods and data evaluation.

TASK 4: DEVELOPMENT OF SITE OPERATIONS PLAN

A Site Operations Plan (SOP) (18) was developed to outline protocols and procedures to be used in carrying out the various activities described in the Work Plan. The SOP was supplemented by two addenda dated May 28, 1985 and June 13, 1985, respectively.

TASK 5: COMMUNITY RELATIONS FUNCTION

The EPA/State was responsible for keeping the public informed as to the progress of the RI and this effort was supported by OCC/Olin as necessary.

TASK 6: PERMITS, RIGHTS OF ENTRY AND OTHER AUTHORIZATIONS

Appropriate access, authorizations and permits were obtained by OCC/Olin or their representatives prior to performing RI activities. Property ownership information was updated periodically during the course of the RI to assure that current owners were aware of proposed work on their property.

TASK 7: TOPOGRAPHIC MAPS

A topographic base map of the Site and surrounding area was prepared by a licensed land surveyor (McIntosh & McIntosh) from available aerial photographs. The scale of this map is 1-inch=50 feet with a contour interval of 1-foot. Subsequent 1-inch=200 feet scale maps with a contour interval of 2 feet were generated from this base. A copy of each base map (Maps 1 and 2) is enclosed in this report - Volume 2 -Appendices and Plans.

TASK 8: GROUND SURVEY

All monitoring wells, boreholes, soil sample locations and sediment sample locations were marked in the field at the time of installation or sampling and later located horizontally by a licensed land surveyor with respect to a pre-established grid coordinate system. The elevations of all sample points were also surveyed with reference to mean sea level (MSL) using a United States Geodetic Survey (USGS) benchmark as a common fixed datum. These points were added to the topographic base map as they were sampled.

All work completed used the USGS datum and all elevations presented in this report are USGS unless otherwise noted.

TASK 9: DOCUMENTATION OF UTILITIES

An investigation was made of utilities in the vicinity of the Site. The results of this investigation were reported (1). In addition to the utility investigation, whenever subsurface work was to be performed near utilities, the public utility companies were notified and conducted field location markings of their services.

During the RI, two separate studies were undertaken to further investigate the utilities. The first involved a review of the condition of a water meter pit located along the north property line on OCC property. A letter report on this topic was submitted to the EPA/State on November 18, 1987 (47). The second study was an electromagnetic survey of the area along Buffalo Avenue with the intent of identifying any subsurface conduits. The results of the study were presented (40).

TASK 10: STORM SEWER REVIEW

An in-depth investigation of the existing storm sewer which crosses the Site was performed. Included in this investigation was an examination of the physical condition of the sewer line by video camera and installation and sampling of monitoring wells in the sewer bedding material. Results of this investigation were reported (2).

TASK 11: NIAGARA RIVER SEDIMENT SURVEY

As one of the potential receptors of site-related chemical migration through storm sewer discharge, site runoff, or groundwater discharge, the sediments of the Niagara River were sampled and analyzed to define the extent of chemicals associated with the Site. Results of the Sediment Survey Program are discussed (3). A report (26) was prepared to provide historical data and information regarding Niagara River sediments.

TASK 12: OFF-SITE INVESTIGATION

Surface soils to the west, east and north of the Site were sampled and analyzed to evaluate the extent and degree of site-related chemicals in surface soil. The initial physical boundaries of the Soil Survey area were defined in the Work Plan. Results of this investigation are discussed (4).

TASK 13: HYDROGEOLOGIC INVESTIGATION

The hydrogeologic investigation of the Site included several field programs. The objective of this investigation was to acquire the additional data necessary to evaluate the nature and extent of groundwater contamination at and migrating from the Site. With that purpose in mind, several well drilling and hydraulic head monitoring programs were conducted. The following reports present the results of these programs:

- Information Report No. 2, August 1987
- Milestone Report No. 6, Hydraulic Head Monitoring, June 9, 1986
- Milestone Report No. 7, Initial 5-Day Hydraulic Head Monitoring Program, Data Presentation, Proposals for Future Monitoring Programs, April 17, 1987
- Milestone Report No. 8, Hydraulic Head Monitoring Program, September 17, 1987
- Milestone Report No. 16, Bulkhead Investigation and Sampling, Revision No. 1, April 1, 1988.

The information presented in these reports supplements the data presented in the historic hydrogeologic reports (24, 25).

TASK 14: GROUNDWATER AND CHEMICAL SURVEYS

Three groundwater sampling programs have been conducted as part of the RI. The purpose of these programs was to identify and quantify the major chemical constituents leaving the Site. The results of these programs are discussed in the following reports:

- Milestone Report No. 9, Site-Specific Indicator Chemicals, Survey Levels and Analytical Procedure Selections, September 16, 1986
- Milestone Report No. 10, letter from OCC/Olin to EPA/State, November 13, 1985 regarding Comprehensive Waste Analysis Program
- Milestone Report No. 11, Design Survey Well Selection, April 21, 1986

- Milestone Report No. 12, Four Month Extended Survey Well Selections, November 25, 1986
- Milestone Report No. 13, Revision 1, Extended Groundwater Sampling Program, April 4, 1988
- Milestone Report No. 14, Revision 3, NAPL Study, October 21, 1987
- Milestone Report No. 16, Bulkhead Investigation and Sampling, Revision No. 1, April 1, 1988
- Supplemental NAPL Investigation, Revision 1, May 1988.

TASK 15: DATA REDUCTION AND EVALUATION

Data produced in the field investigations were evaluated throughout the course of the RI and were used to help guide the investigation in an iterative manner. Periodic Milestone Reports have been issued to accomplish this goal. These reports are listed below:

- Milestone Report No. 5, Revision 3, Additional Well Assessment, October 1988
- Milestone Report No. 12, Four-Month Extended Survey Well Selections, November 25, 1986
- Milestone Report No. 15, Modeling Evaluation, November 12, 1987.

TASK 16: REMEDIAL INVESTIGATION REPORT

The purpose of this report is to assemble all pertinent field and laboratory data and results of the RI and historical investigation programs. The report consolidates the information previously provided in the series of Milestone Reports which detailed the various aspects of the studies undertaken at the Site.

Table 1.1 presents a chronological summary of activities completed during the RI. Each of these sampling programs is discussed later in this report.

1.1.3 SUMMARY OF REMEDIAL INVESTIGATION OBJECTIVES

The objectives of the RI are to determine the nature and extent of the problem, and to gather sufficient information to determine the necessity for and proposed extent of remedial action. To that end, each of the tasks described previously was completed in furtherance of the objectives of the Work Plan and OCC/Olin believe that the data are sufficient to develop appropriate remedial alternatives to address the environmental concerns identified.

1.2 102ND STREET LANDFILL SITE HISTORY

1.2.1 HISTORICAL BACKGROUND

The present OCC portion of the Site was created by the combination of properties resulting from the merger of two firms (Niagara Alkali in 1955 and Oldbury Electrochemical in 1956) with the Hooker Electrochemical Company (Hooker). Site ownership has been continuous by Hooker since that time, although the company name changed to Hooker Chemical Corporation (1958), Hooker Chemicals & Plastics (1974) and OCC (1982). The historic ownership of the OCC property including the dates of acquisition of various parcels is as follows:

	Company	Date of Acquisition
°	Oldbury Electrochemical Company	1924
		1927
°	Hooker Electrochemical Company	1947 (access acquired - 1942)
°	Niagara Alkali	1945

Figure 1.2 shows the historical progression of Site ownership.

The Olin portion of the Site was acquired by its predecessor company, Mathieson Chemical Corporation, in 1948. Site ownership has been continuous although the company name changed to Olin Mathieson Chemical Corporation in 1954 and Olin Corporation in 1969.

Estimates of wastes disposed at the Site are presented in Tables 1.2 and 1.3 for Olin and OCC, respectively. The quantities reported on these tables represent all waste materials known or believed to have been deposited at the Site based on company records and residue factors. These tabulations are based on a very limited amount of documented information and, consequently, the quantifications are essentially best estimates.

No formal records exist as to the use of the OCC property for disposal by others. Newspaper accounts indicate that the City of Niagara Falls, with permission, used the Site for the burial of refuse for several weeks in 1955.

The Griffon Park area to the west of the OCC property was acquired by the City of Niagara Falls in 1939. This property was used for the dumping of refuse between 1949 and 1953, with intermittent use thereafter. The records also indicate dumping and burning of branches as early as 1943 and that some unauthorized dumping by unknown haulers may have occurred.

Figure 1.3 shows the outline of the existing filled area on the Olin portion of the Site as of August 1943 prior to the purchase of the property by Olin. The character and source of the fill material existing at that time is unknown.

Goodyear Tire and Rubber Company reported to the Interagency Task Force (ITF) (48) that its wastes had been disposed of at the Olin site. The ITF draft report indicates that 15,050 tons of waste were disposed of at the Olin site with 1,300 tons of waste disposed east of the Olin property at the Belden Site. Based on conversations with Goodyear and their hauling contractor, the report was found to be in error and has been corrected with the ITF. These wastes, mainly from polyvinyl chloride (PVC) production using emulsion technology for the conversion of vinyl chloride monomer (VCM), were disposed to the east of the Site at the Belden site. The New York State Registry (49) reports the disposal of unknown quantities of chemical wastes at the Belden site.

The general practice for the disposal of wastes on the Site involved the deposition of material on top of the existing land surface working from the north side of the Site near Buffalo Avenue toward the south (Niagara River). Excavation into the Site was not a normal practice except for disposal of material containing phosphorus. In that case, the wastes were deliberately buried below the water table as a safety precaution. A map detailing the locations of phosphorus burial was kept current at the time of disposal and is provided on Figure 1.4. The phosphorus disposal areas were situated on the property originally owned by Oldbury Electrochemical.

From historical aerial photographs, it appears that occasional excavation related to disposal of waste materials may also have occurred in some areas on the Olin property in already placed fill.

1.2.2 PRIOR REMEDIAL WORK

Prior remedial work has been performed to date at the Site as described in the following:

1.2.2.1 BULKHEAD CONSTRUCTION

On December 8, 1970, the Buffalo District Corps of Engineers (COE) notified OCC and Olin that all construction, filling and dumping at the Site must cease until a dike or bulkhead was installed along the River shore, under a permit from the COE. The purpose of the bulkhead construction was to stabilize the River bank and prevent erosion of the Site. Bulkhead designs were subsequently developed by OCC and Olin and submitted to the COE as part of Permit Requests.

Permit Applications were also filed by both OCC and Olin with the State. The State requested two design modifications which were incorporated into the bulkhead. These were:

i. The bulkhead should follow the shoreline around the lowland area.

ii. Surface water drains, 2-feet in diameter by 6-feet deep, installed on 100-foot centers should be installed to drain surface water from behind the OCC bulkhead back into the Site and prevent formation of mosquito breeding pockets (see Figure 1.5). Similar drains on 50-foot centers were to be installed in the Olin bulkhead.

The COE also requested a design change from OCC to extend the clay portion of the bulkhead 50 feet north from the River along the west site boundary at Griffon Park. This design change was incorporated in a modified Permit Application.

Construction of the bulkhead was completed in 1972/1973.

Figures 1.6 and 1.7 illustrate the construction of the bulkheads.

Historical documents related to bulkhead construction indicate that the Site received materials from the excavation and removal of a once existing spit which was constructed of fill material as an extension of the landfill. The spit was constructed during the late 1950's and removed during the bulkhead construction project. Remnants of the spit may still exist. The construction of the spit occurred after production of Olin's organic division ceased operation.

Over the years, some damage occurred to the Olin portion of the bulkhead and a repair or revetment project was undertaken in 1982. An improved bulkhead design was developed by Olin engineers in conjunction with Wendel Engineers, P.C. A joint DEC/COE permit was issued on November 5, 1982 to undertake the repairs. Construction work commenced on November 8, 1983 and was completed on January 17, 1984. A typical existing Olin bulkhead section is shown on Figure 1.7. The Olin dike revetment was integrated with the OCC bulkhead at the property line.

1.2.2.2 COVER CONSTRUCTION

The Site was covered with topsoil which currently supports a vegetative cover essentially across the entire Site. In fact, in the northwest and north central areas of the Site, a fairly dense growth of trees has taken root. With the exception of the treed areas, the grassed area is cut two to three times per year.

1.2.2.3 FENCES

The majority of the Site has been enclosed with a 6-foot chain link fence since commencement of landfilling. In 1984, a section of fence was added along the eastern property line preventing site access by land and completing site enclosure.

1.2.2.4 ACCESS ROADS

A system of access roads has been constructed across the Site during the period from 1984 to 1987. Use of the access roads has essentially eliminated the potential for rutting of the surface cover material and potential exposure of covered wastes.

1.2.3 HISTORICAL INVESTIGATION PROGRAMS

A series of investigations of the subsurface conditions at the Site, in addition to the RI, have been ongoing since 1973. The following subsections briefly discuss these programs.

1.2.3.1 SUBSURFACE EXPLORATION

In 1973, three exploratory borings were drilled on the Olin property. These borings extend along the alignment of the bulkhead, with Boring No. 1 to the west, Boring No. 2 lying at an intermediate position and Boring No. 3 to the east, though the precise locations are unknown.

In 1977, nine groundwater monitoring wells were installed at the Site. Wells BL1-77 through BL6-77 were located on the OCC property and three wells (A,B,C) were installed on the Olin property. All nine wells were subsequently closed by grouting to land surface with a cement/bentonite grout.

More detailed studies of the hydrogeologic conditions of the Site were begun in 1978. A series of 75 groundwater monitoring wells were installed by OCC/Olin during the period 1978 through 1980. These wells were used where appropriate in the RI.

Table 1.4 summarizes the historic subsurface exploration programs. Stratigraphic logs for all of the historic drilling programs have been presented (17).

Historical information pertaining to the hydrogeologic conditions of the Site is also available from earlier studies which were originally presented in the following reports prepared individually for OCC and Olin:

- "Hydrogeologic Investigation - Olin 102nd Street Landfill - Niagara Falls, Niagara County, New York" - 1979 - prepared by Recra Research Inc. and Wehran Engineering P.C.

- "Hydrogeologic Investigation - Final Report - Olin 102nd Street Landfill, Niagara Falls, New York" - 1981 - prepared by Recra Research Inc. and Wehran Engineering P.C.

- "Historical Review - Hydrogeologic Conditions - 102nd Street Landfill" - September 1983 - prepared by Conestoga-Rovers & Associates (CRA).

In addition to these on-site programs, several drilling programs conducted by government consultants as part of the Love Canal Investigation have provided information regarding conditions in the general vicinity of the Site. Stratigraphic logs for wells and boreholes which provide relevant background information for the RI have been presented (17).

1.2.3.2 OFF-SHORE SEDIMENTS INVESTIGATION

Since 1976, several sampling programs have been initiated in order to determine the extent of the migration of chemicals from the Site into the Niagara River sediment. The following is a list of known Niagara River sediment sampling programs that have been undertaken prior to initiation of the RI:

Hooker Chemicals & Plastics Corp.	November 1976
Recra Phase I (Olin)	November 1978
Arthur D. Little, Inc. (Hooker)	Apr.-June 1979
Hydroscience (Hooker)	April 1979
Hooker Chemicals & Plastics Corp.	June 1979
Hites/EPA	June-Nov. 1979
Recra Phase II (Olin)	October 1979
NYSDOH/NYSDEC	November 1979
Arthur D. Little, Inc. (Hooker)	August 1981
Jaffe/EPA	September 1981
EPA	May 1982
Malcolm Pirnie, Inc. (NYSDEC)	January 1983
U.S. Army Corps of Engineers	September 1983

In addition to these programs which were designed specifically to gather information regarding the Site and Love Canal, other more general sampling programs have been conducted in the Niagara River between Lake Erie and Lake Ontario.

In 1981, the Niagara River Toxics Committee was established to oversee and coordinate a study of toxic substances pollution in the Niagara River. The committee consisted of representatives of:

- Environment Canada,
- United States Environmental Protection Agency,
- Ontario Ministry of the Environment, and
- New York State Department of Environmental Conservation.

The Niagara River Toxics Committee consolidated a series of existing sub-projects that had been individually designed to fulfill certain agency objectives. The results of this study were published in October 1984 (41).

A separate report (26), prepared in conjunction with the RI, presents the data from these sampling programs. This report was submitted to the EPA/State in October 1988.

1.2.3.3 EPA DIOXIN SAMPLING PROGRAM

In April 1985, the EPA, as part of the National Dioxin Strategy, conducted a subsurface drilling and sampling program at the Site to determine whether 2,3,7,8-tetrachlorodibenzo-p-dioxin (Dioxin) was present.

A total of 10 boreholes were drilled on the Site (4-OCC; 6-Olin) and sampled for analysis of Dioxin. The locations of these boreholes are shown on Figure 1.8.

Following collection, samples were homogenized and split between EPA and OCC at the OCC Grand Island Research Facility. Samples were subsequently analyzed by OCC (at Grand Island) and by the EPA contract laboratory. Table 1.5 summarizes the results of this sampling program.

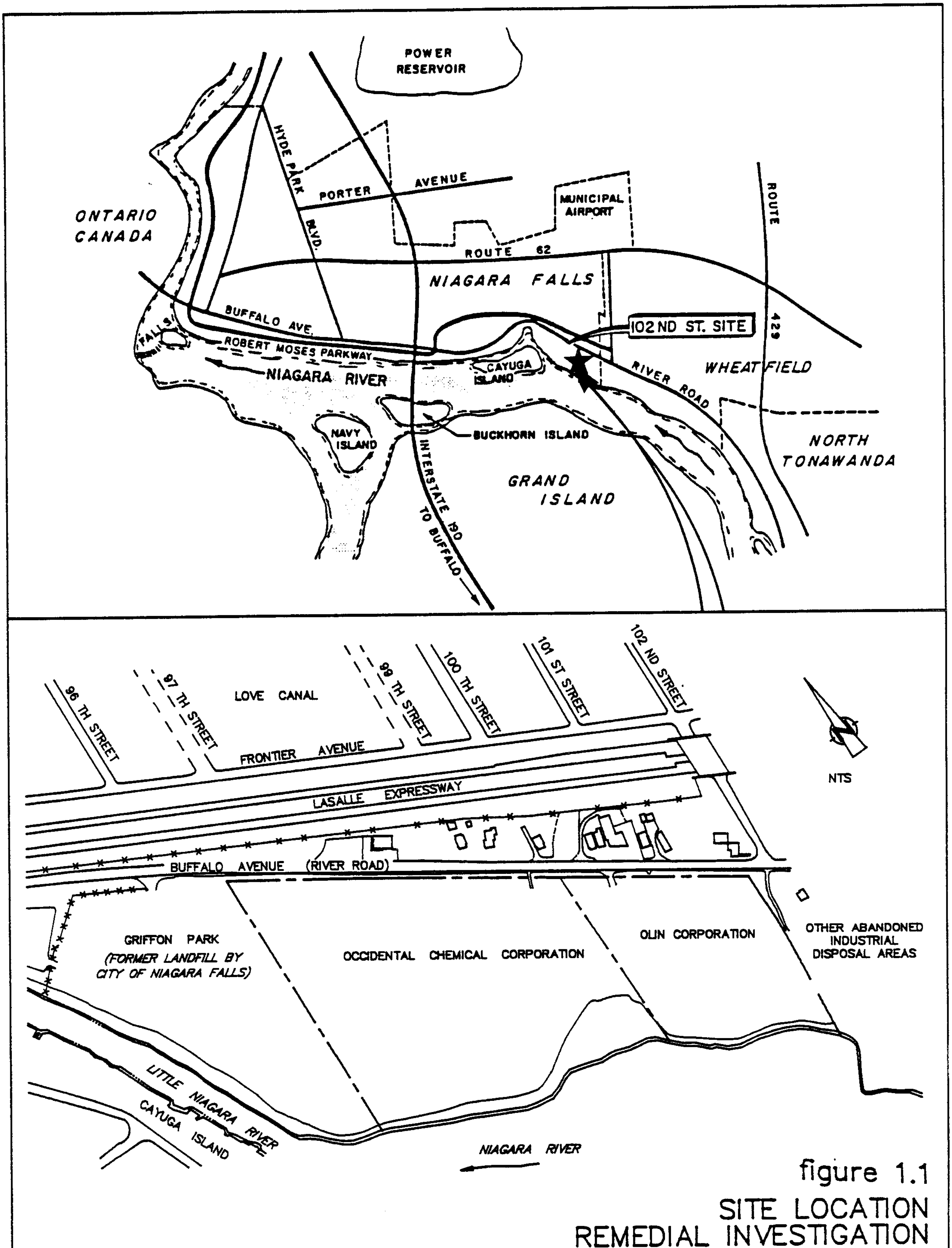


figure 1.1

SITE LOCATION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P-89)

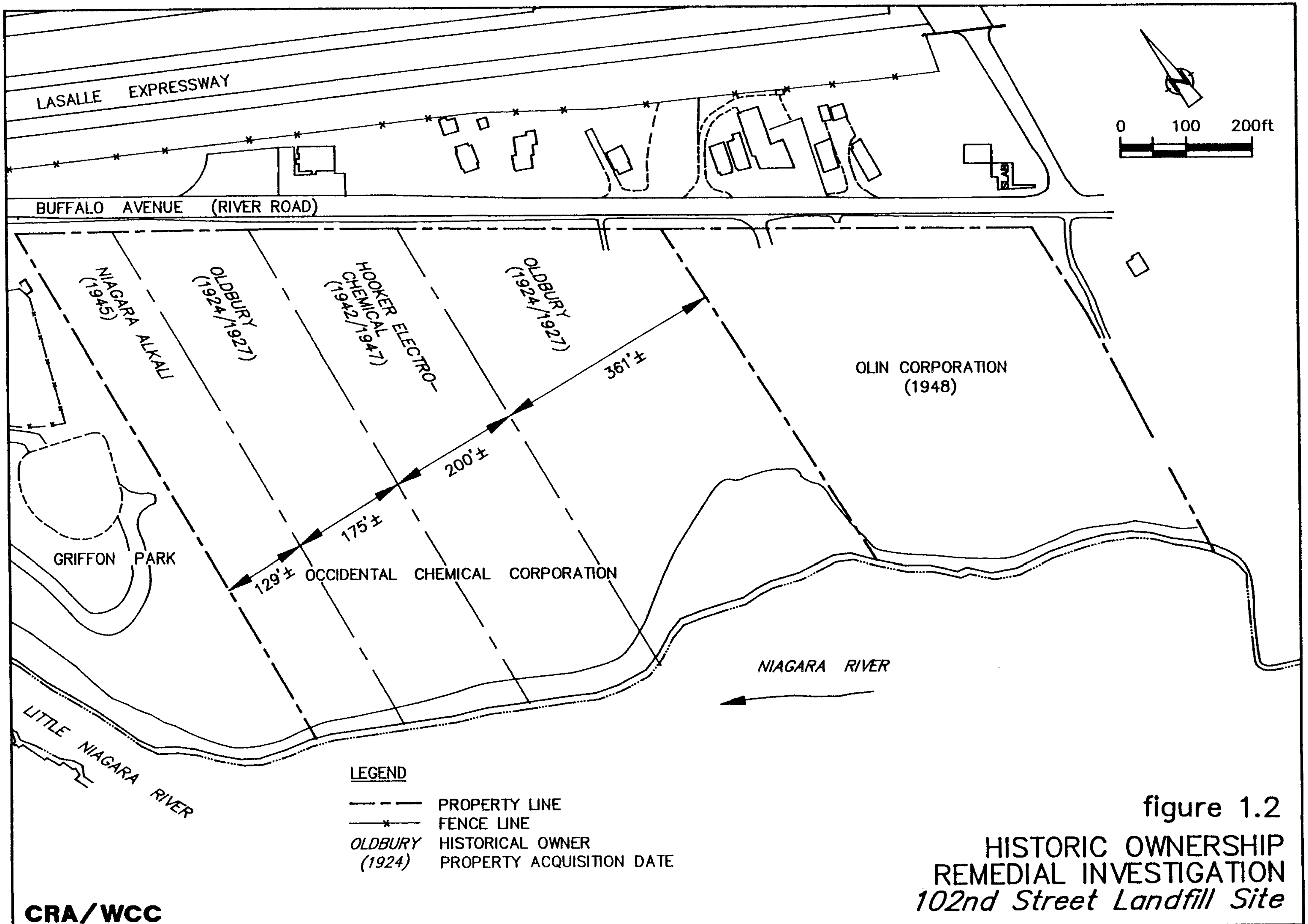
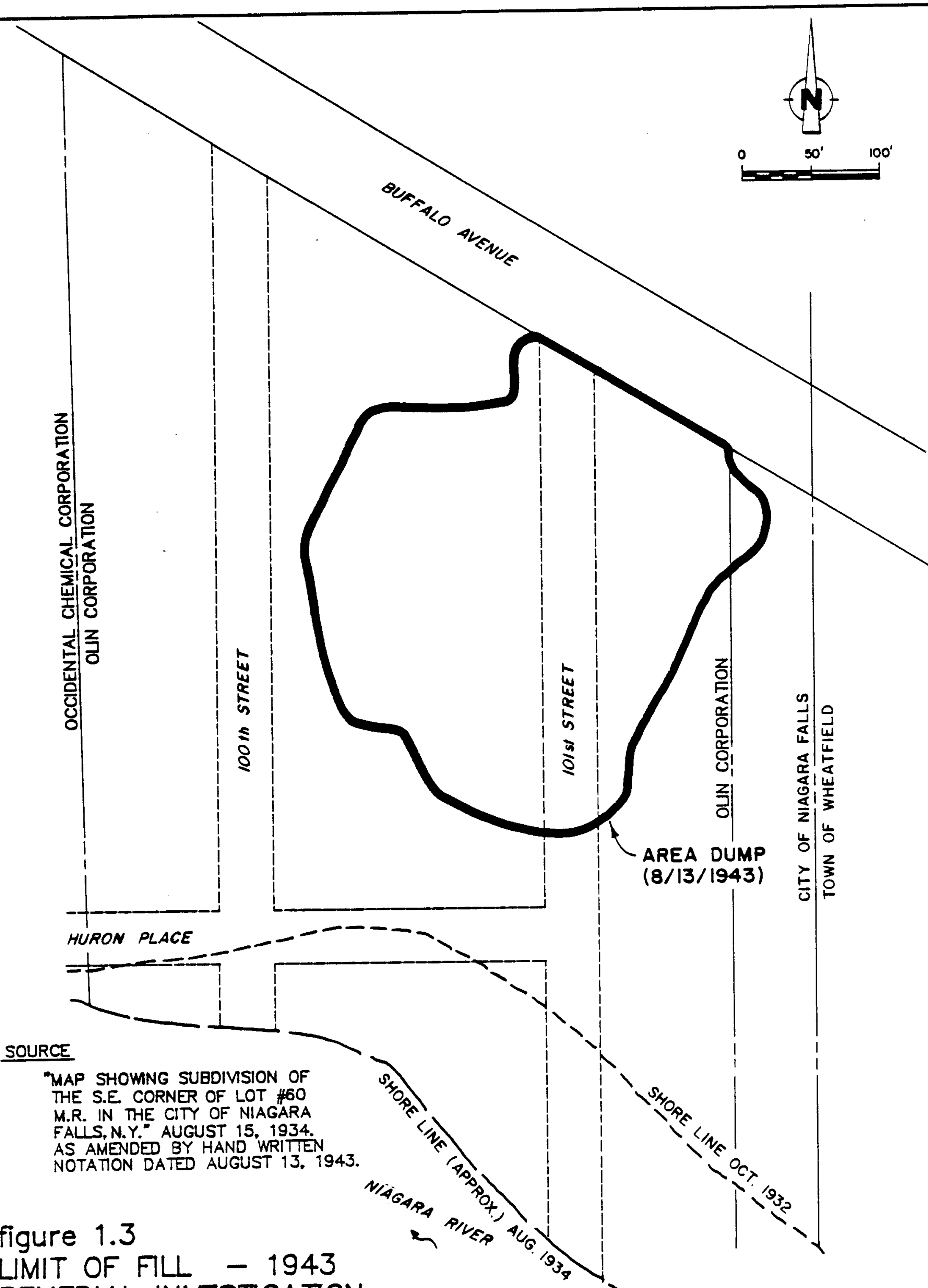


figure 1.2

HISTORIC OWNERSHIP
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (P-85)



SOURCE

"MAP SHOWING SUBDIVISION OF THE S.E. CORNER OF LOT #60 M.R. IN THE CITY OF NIAGARA FALLS, N.Y." AUGUST 15, 1934. AS AMENDED BY HAND WRITTEN NOTATION DATED AUGUST 13, 1943.

figure 1.3
LIMIT OF FILL – 1943
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1

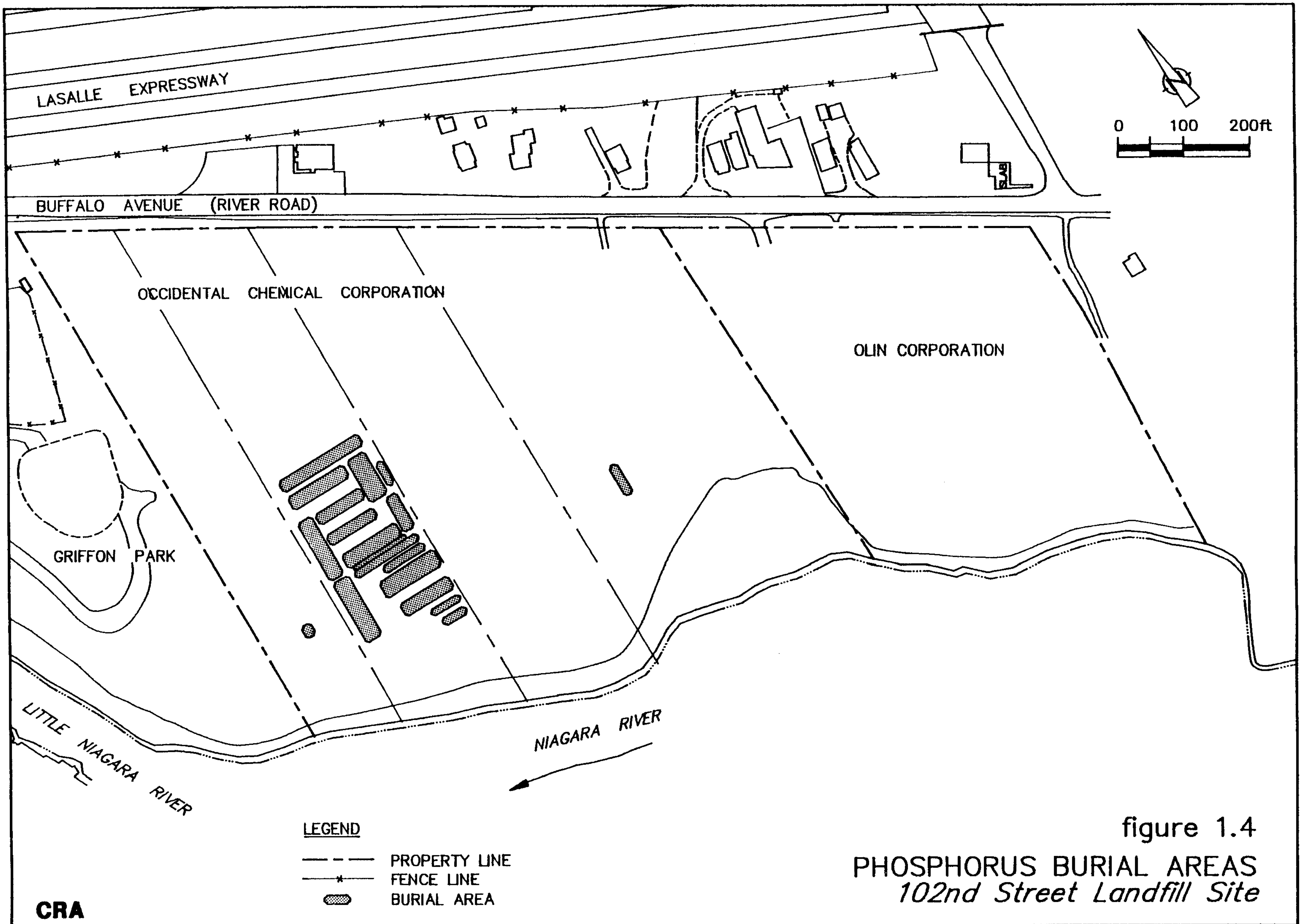


figure 1.4

PHOSPHORUS BURIAL AREAS
102nd Street Landfill Site

1431-13/07/88-47-D-2 (P-88)

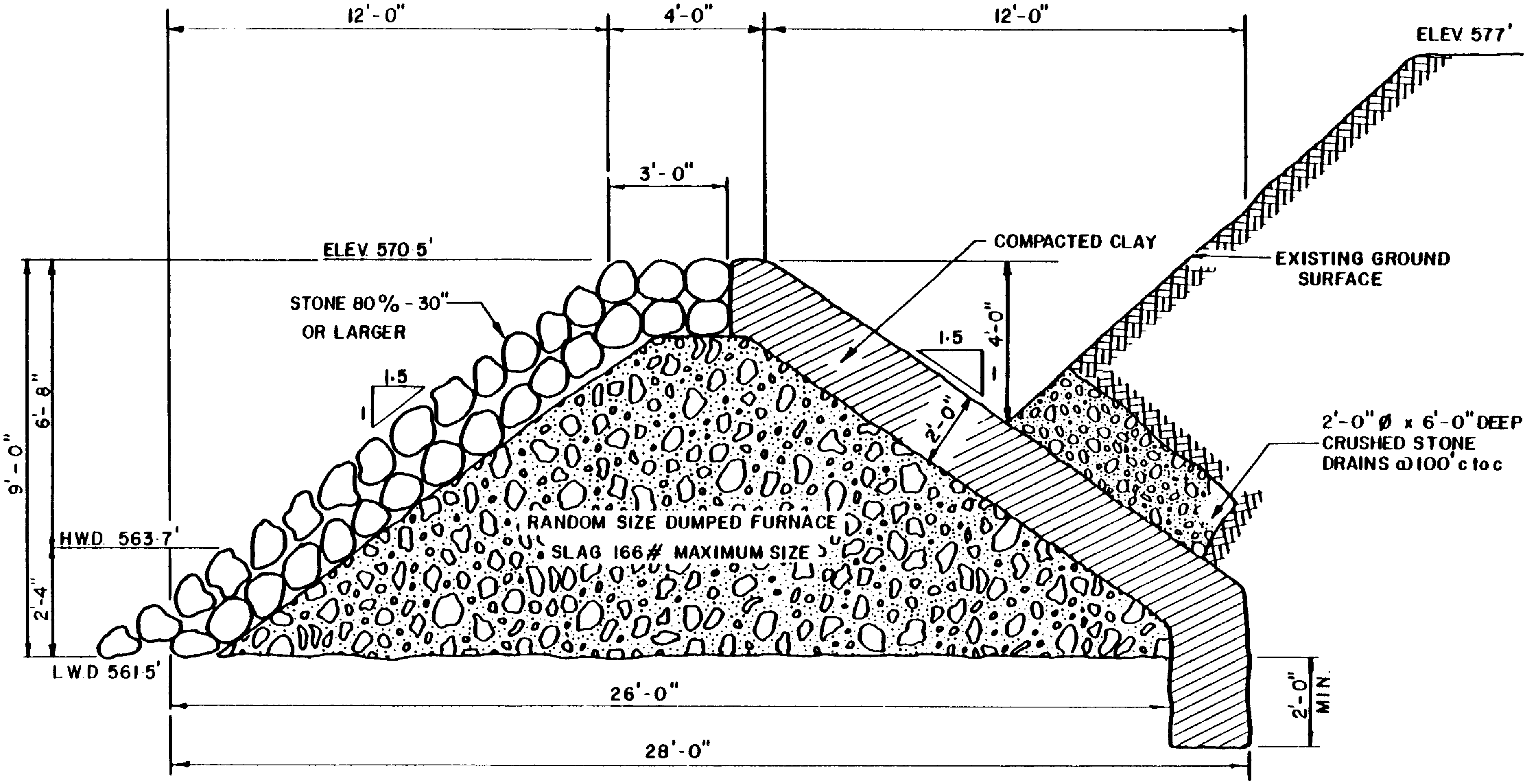


figure 1.5

DESIGN OF BULKHEAD SECTION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

REFERENCE : FROM DWG. Nº A11-500-900
LAST REV. 9-14-72

CRA/WCC

1431-13/07/88-47-D-1

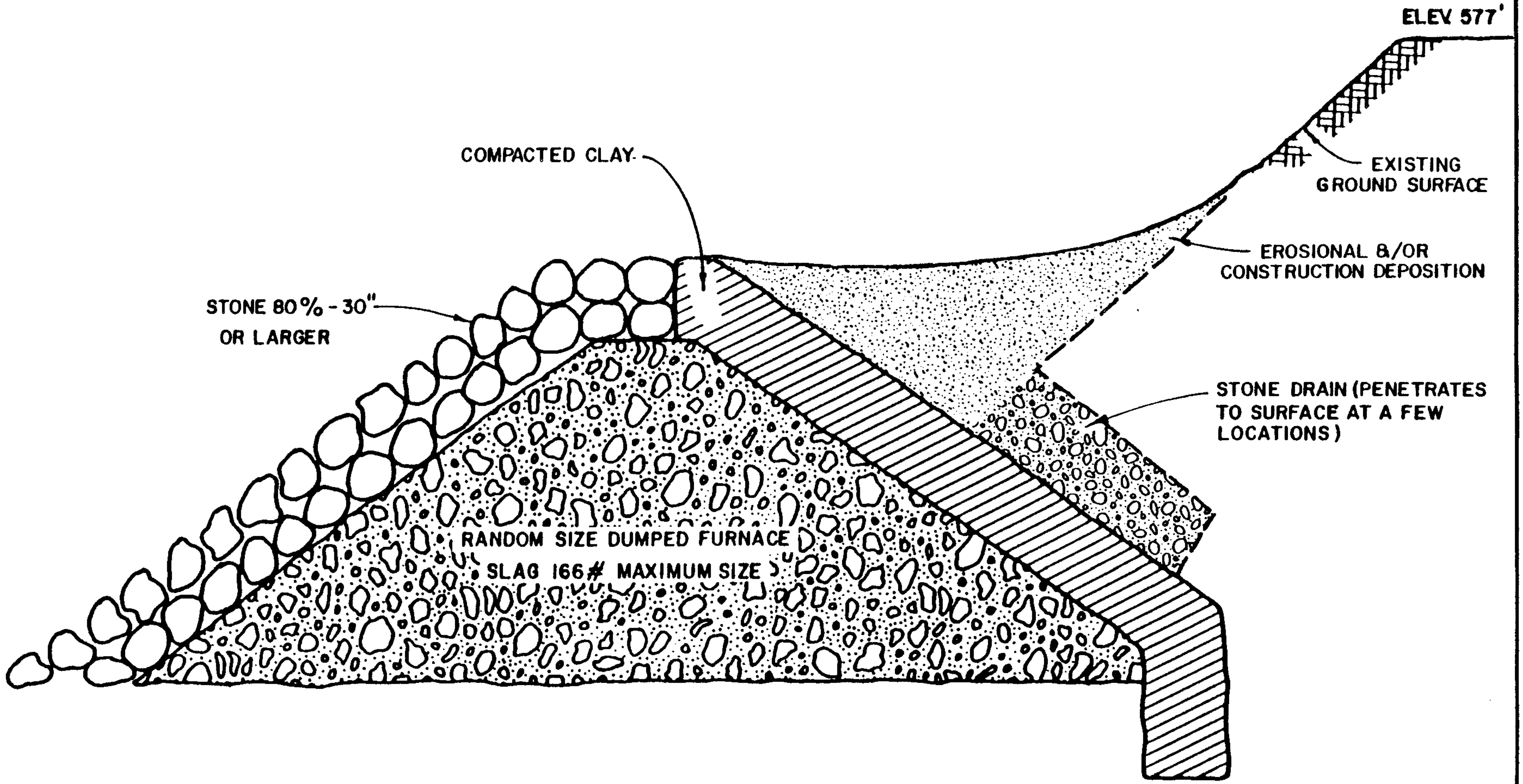
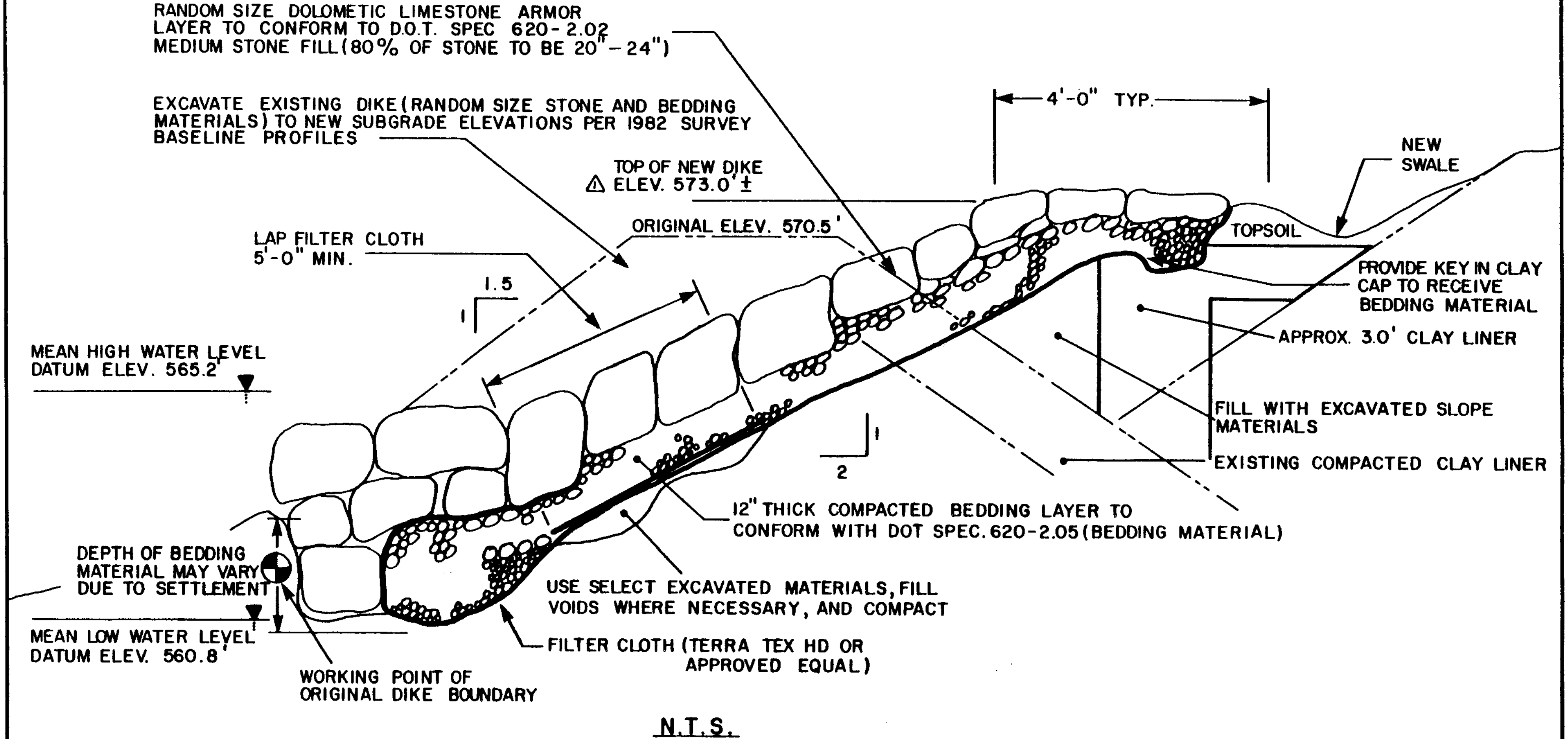


figure 1.6

EXISTING CONDITIONS – OCC BULKHEAD SECTION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1



SOURCE: WENDEL ENGINEERING

figure 1.7

EXISTING CONDITIONS – OLIN BULKHEAD SECTION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1

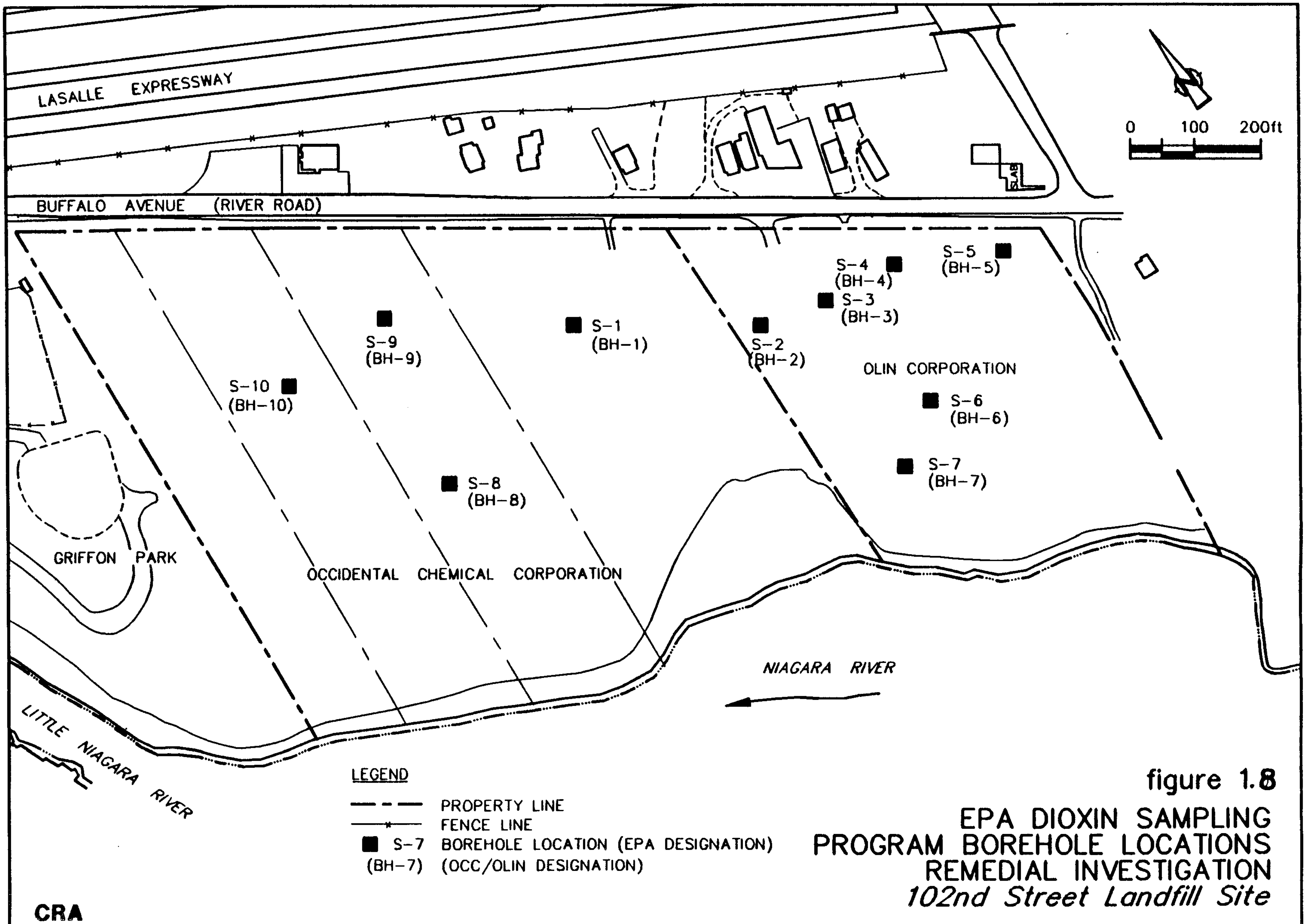


figure 1.8

EPA DIOXIN SAMPLING PROGRAM BOREHOLE LOCATIONS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-0 (P-86)

TABLE 1.1

CHRONOLOGICAL SUMMARY OF FIELD ACTIVITIES
102ND STREET LANDFILL
REMEDIAL INVESTIGATION

TIME	ACTIVITY
June 1984	Finalization of Work Plan
June 1984	Site Reconnaissance
June 1984 to October 1985	Preparation and Approval of Plans and Protocols
June 1984 to July 1985	Utilities Investigation Conducted
October 1985 to December 1985	Fill Well Installation Program
January 1986 to April 1986	Comprehensive On-Site Waste Wells Sampling Program
March 1986	Off-Site Fill Well Sampling Program
December 1985 to January 1987	Installation of Overburden/ Bedrock Monitoring Wells
April 1986	Video Inspection of Storm Sewer
May 1986	Design Survey Sampling
May 1986	Bathymetric Survey
July 1986	5-Day Hydraulic Monitoring Program
October 1986 to December 1987	Off-Site Soil Survey Sampling Program
November 1986 to December 1987	Niagara River Sediment Sampling Program Sewer Bedding Borehole Installation
January 1987 to December 1987	Extended Hydraulic Head Monitoring Program
January 1987 to December 1987	Extended Survey Sampling Program (6 rounds)
February 1987 to July 1987	Dioxin Soil Sampling
March 1987 to April 1987	Continuous Head Monitoring Program
April 1987	NAPL Sampling Program
April 1987	Electromagnetic Survey

TABLE 1.1

CHRONOLOGICAL SUMMARY OF FIELD ACTIVITIES
102ND STREET LANDFILL
REMEDIAL INVESTIGATION

TIME	ACTIVITY
May 1987	Bulkhead Investigation & Sampling
August 1987 to September 1987	NAPL Borehole Drilling Program
December 1987	Closure of OCC Deep Bedrock Wells
December 1987	Installation of Additional Wells (MW-23 and MW-24)
February 1988 to April 1988	Sampling of Additional Wells MW-23 and MW-24

TABLE 1.2

OLIN CORPORATION CHEMICAL INVENTORY
102ND STREET LANDFILL SITE **

The following inventory of chemicals was developed from all available records, the Interagency Task Force (ITF) Report on Hazardous Waste (1978) and additional information.

<u>INORGANICS</u>[1]

"Black Cake"[2]	19,760 cubic yards
Graphite	742 tons
Concrete	6,625 tons
Flyash	5,472 truckloads
Lime Sludge	22,695 cubic yards
Brine Sludge	15,899 cubic yards

<u>ORGANICS</u>[3]

Benzene Hexachloride (BHC) Trichlorophenol (TCP) Trichlorobenzene (TCB) and Benzene	295 truckloads
V-Tetrachlorobenzene	310,550 gallons

(1) Disposal quantities of inorganic were generally based on production factors rather than actual recorded amounts. Inorganics can roughly be translated to tonnages through the use of the conversion factors. Estimated tonnages are as follows:

"Black Cake"	18,673 tons
Graphite	742 tons
Concrete	6,625 tons
Lime Sludge	22,978 tons
Brine Sludge	<u>67,186</u> tons
	116,204 tons (excluding flyash)

(2) "Black Cake" resulted from the production of sodium chlorite and had a dry basis composition approximately as follows:

Approximately 2% soluble material (sodium chloride, sodium chlorite, sodium chlorate)

18% carbon

80% calcium carbonate/calcium hydroxide

TABLE 1.2

OLIN CORPORATION CHEMICAL INVENTORY
102ND STREET LANDFILL SITE

(3) Available records indicate truckload shipments of these materials to the landfill. There is no way to determine the specific quantities of the different chemicals, however, there is also no reason to believe they constitute a mixture. Rather, it is believed they were simply loads of some bulk and some drummed material on the same truck. Tetrachlorobenzene is a separate known quantity. Trichloroanisole was a probable impurity in one of the production processes. It was not disposed of as a separate item.

All the organic materials are solids at STP except benzene and 1,2,4-trichlorobenzene. The quantity of benzene and 1,2,4-trichlorobenzene (if the 1,2,4-isomer was disposed of at the site) are unknown.

The organic disposal can roughly be translated to tonnages through use of the conversion factors of eight cubic yards per truckload and a density of 0.85 grams per cubic centimer (g/cc). Tetrachlorobenzene has a density of 1.8 g/cc.

BHC, TCP, TCB and Benzene	2,000 tons
Tetrachlorobenzene	2,327 tons
	4,327 tons

** Previously submitted with the Work Plan approved by the United States District Court for the Western District of New York in 1984.

TABLE 1.3

OCCIDENTAL CHEMICAL CORPORATION CHEMICAL INVENTORY 102ND STREET LANDFILL SITE **

Type of Waste	Physical State	Estimated Quantity (tons)	Container
Organic phosphites	L,S	<100	D
Sodium hypophosphite mud	S	20,000	B
Phosphorus and inorganic phosphorus derivatives (excluding sodium hypophosphite)	L,S	1,300	D
BHC cake (including Lindane)	S	300	D
Chlorobenzenes */	S	(?)	(?)
Misc. 10% including cell parts used in chlorate production	S	2,200	D,B
SUB-TOTAL		23,800	
Brine, sludge & gypsum		53,200	
TOTAL WASTE REPORTED		77,000	

*/ Quantity Unknown, but believed to be small.

Notes:

L = liquid
S = solid
D = drummed
B = bulk

From Occidental Chemical Corporation's November 17, 1978 and May 23, 1979 responses to the New York State Interagency Task Force.

** Previously submitted with the Work Plan approved by the United States District Court for the Western District of New York in 1984.

TABLE 1.4

HISTORIC SUBSURFACE EXPLORATION PROGRAMS

1973	Olin	Pittsburg Testing Laboratory, three borings for proposed bulkhead construction
1977	Olin	Wendt wells installed (3) - subsequently abandoned
1977	OCC	URS/overburden wells, removed in 1979
1978	Olin	RECRA/Wehran, shallow bedrock wells (4)
1978	Olin	RECRA/Wehran, overburden piezometers (17)
1979	Olin	RECRA/Wehran, overburden piezometers (1) RECRA/Wehran, overburden couplet wells (5)
1979	OCC	CRA overburden wells (18)
1979	OCC	CRA bedrock wells (5)
1980	Olin	RECRA/Wehran, overburden couplet wells (2)
1980	Olin	RECRA/Wehran, overburden exploration borings (5)
1980	Olin	RECRA/Wehran, overburden monitoring wells (12)
1980	OCC	CRA overburden wells (6)

TABLE 1.5

SUMMARY OF DIOXIN RESULTS - SOIL SAMPLES
102ND STREET LANDFILL

BOREHOLE NO.	SAMPLE DATE	SAMPLE DEPTH (ft BGS)	Dioxin (ng/g) OCC/EPA
S-1	4/23-24/85	Surface	ND/ND
		2' - 4'	ND/ND
		4' - 6'	ND/NA
		6' - 8'	ND/ND
S-2	4/24/85	Surface	0.26/ND
		0' - 4'	680/>200
		4' - 8'	3.5/R
		6' - 8'	9.5/R
		8' - 10'	4.9/8.0
		8' - 10'	6.4/9.5
		10' - 12'	11.6/R
S-3	4/25/85	Surface	ND/ND
		2' - 4'	0.87/R
		4' - 6'	1.3/ND
		8' - 10'	0.5/R
S-4	4/25/85	Surface	0.77/0.59
		2' - 8'	ND/NA
		4' - 6'	0.44/R
		6' - 8'	ND/ND
S-5	4/25/85	Surface	0.58*/0.71*/ND
		2' - 4'	ND/ND
		4' - 6'	ND/NA
		6' - 8'	ND/ND
S-6	4/25/85	Surface	ND/ND
		0' - 2'	1.1/R
		2' - 4'	140/173
		4' - 6'	0.54/R
		8' - 12'	ND/R
		12' - 14'	ND/NA
S-7	4/26/85	Surface	ND/ND
		6' - 8'	0.45/R
		10' - 12'	ND*/ND*/R
		12' - 14'	ND/ND

TABLE 1.5

SUMMARY OF DIOXIN RESULTS - SOIL SAMPLES
102ND STREET LANDFILL

BOREHOLE NO.	SAMPLE DATE	SAMPLE DEPTH (ft BGS)	Dioxin (ng/g) OCC/EPA
S-8	4/26/85	Surface	ND/ND
		4' - 6'	ND/ND
		4' - 12'	ND/NA
		14' - 16'	ND/NA
S-9	4/29/85	Surface	ND/ND
		2' - 4'	0.75/ND
		4' - 6'	1.1/NA
		6' - 14'	3.4/NA
		8' - 10'	10/R
		10' - 12'	2.2/R
S-10	4/30/85	Surface	ND/ND
		0' - 2'	ND/ND
		2' - 4'	ND*/ND*/ND
		6' - 12'	ND/NA
		8' - 10'	ND/R
		10' - 12'	ND/ND

ND = None detected
NA = Not analyzed
R = EPA results did not pass QA/QC review
* = Results of OCC duplicate analysis

2.0 AREA DESCRIPTION

2.1 LOCATION

The Site is approximately 22.1 acres in size (15.6 acres-OCC; 6.5 acres-Olin) and is located in the southeast corner of the City of Niagara Falls at the western boundary of the Town of Wheatfield as previously shown in Figure 1.1.

This area of the City is commonly referred to as the LaSalle area. It is primarily a residential area although some commercial businesses are scattered throughout the area.

2.1.1 DEMOGRAPHY

According to the 1980 census, the population of the City of Niagara Falls is approximately 71,000 and the population of the Town of Wheatfield is approximately 9,600. The City of Niagara Falls population has dropped considerably from the peak census figures of 1960 when the population was 102,400. Wheatfield's population has remained essentially steady since 1970 (9,700) but increased between 1960 and 1970 (8,000 to 9,700).

Within the immediate vicinity of the Site, there has been a substantial reduction in the number of residents permanently residing in the area. This occurred as a result of the relocation of residents from the Love Canal area in the late 1970's and 1980's. Consequently, the area around the Site is relatively isolated with the exception of a few residences along Buffalo Avenue and those on Cayuga Island.

2.1.2 EXISTING LAND USE IN THE SURVEY AREA

The physical boundaries of the Survey Area were defined in the Work Plan as follows: the asphalt area on the boat dock to the west, the southern side of LaSalle Expressway to the north, and an area along a line approximately 25 feet east of the centerline of the ditch located to the east of the Site. The current use of properties in this area is discussed below.

Zoning maps obtained from the City of Niagara Falls and Town of Wheatfield for the properties in the vicinity of the Site have been compiled. Figure 2.1 shows the zoning classifications adjacent to the Survey Area.

Properties to the north of the Site and south of the LaSalle Expressway are zoned C-1 (retail business). There are three properties within this zone currently used for commercial purposes: a restaurant, an automotive repair shop and a welding shop. Four properties have residential dwellings on them although three are presently unoccupied. Ten residential and former residential properties along the north side of Buffalo Avenue have been purchased by the Love Canal Area Revitalization Agency. Current property ownership around the Site is shown on Figure 2.2.

The Survey Area extends approximately 100 feet to the east of the Olin property boundary. This property is zoned R-2 (one- and two-family residential) as are the properties beyond the Survey Area to the east. There are no residences or businesses located within the Survey Area to the east of the Site. There are, however, residences located immediately outside the Survey Area in this direction as well as a privately owned former disposal site commonly referred to as the Belden Site.

The Belden Site is a New York State registered site currently classified as a Code 3 site i.e. does not present a significant threat to the public health or environment. Historically, a restaurant had occupied this property but was destroyed in a fire in the 1950's. According to a NYSDEC report, from 1955 to 1967 Goodyear used this site to dispose of waste materials such as industrial fill, rubble and thiazole polymer blends. In addition, the Belden Site has been used for disposal of demolition debris, household refuse and other unknown materials as can be seen by examination of the debris evident at the surface.

To the west of the Site is Griffon Park, a 12.8 acre former municipal waste disposal area owned by the City of Niagara Falls. This property was formerly a part of the Angevine Tract. The Angevine property was acquired by the City of Niagara Falls in 1939. Although records indicate that the property was used as early as 1943 for dumping and burning of branches. Dumping of refuse apparently did not begin until 1949. By mid-1950, Griffon Park was used by the City on a full-time basis for dumping of refuse. The area was abandoned as a dumping facility in July 1953. However, it was used intermittently for many years thereafter for the burning of trees.

Griffon Park was developed as a recreation facility in approximately 1963 and continued to be used as such until 1986. At the present time, only the boat launch facilities on the west side of the park are open to the public. The Griffon Park area is zoned R-3 (multi-family residential), although it has never been used for this purpose.

The Niagara River bounds the Site to the south. The River in this area is used principally by boaters and fishermen. There is no privately owned property due south of the Site. However, there is a residential neighborhood located on Cayuga Island which is located to the southwest of the Site. Cayuga Island is immediately across the Little Niagara River from Griffon Park. Cayuga Island is zoned R-1 (one-family residential).

2.1.3 UTILITIES

A utilities investigation was performed at the Site and in the immediate area of the off-site surveys. A detailed report of this investigation was submitted (1).

This investigation revealed the presence of the following underground utilities in the area of the Site:

- Watermain: A municipal watermain runs parallel to Buffalo Avenue between the edge of pavement and the Site's north property boundary. The eastern terminus of this line is near the intersection of Buffalo Avenue and 102nd Street, although it could not be precisely located. According to municipal water authorities, the watermain crosses to the north side of Buffalo Avenue at 102nd Street. Field evidence indicates that a residential service extends east on the south side of Buffalo Avenue from the crossing point. However, municipal water authorities have no knowledge of any authorized residential service in that area. The western end of the watermain is connected to the City of Niagara Falls water distribution system. The OCC portion of the Site is serviced with water. This service terminates in the meter pit located on the north property line 800 feet east of OCC's western property boundary. This meter pit is approximately 4'x4'x4.5' and is of concrete construction. Although surface water accumulates in the pit, there is no evidence of influx of groundwater into the pit.

- Sanitary Sewers: No public sanitary sewers are located along Buffalo Avenue adjacent to the Site. Businesses and residences in the vicinity of the Site are currently equipped with private septic systems.

- Gas Main: A gas main runs parallel to Buffalo Avenue along the entire northern boundary of the Site. The eastern portion of the gas main is located on the north side of Buffalo Avenue. This main crosses Buffalo Avenue to the south side approximately 25 feet west of OCC's western property boundary. From the point where the gas main turns to cross under Buffalo Avenue, the construction material changes from steel to plastic pipe and is thus not locatable using metal detection equipment from that point westward.

- Storm Sewer: A section of storm sewer, approximately 900 feet in length, runs along the north side of Buffalo Avenue across from the Site. The sewer discharges into the main trunk sewer (a 42" diameter pipe) which flows from north to south along the alignment of 100th Street. At 100th Street, the trunk sewer crosses to the south side of Buffalo Avenue. The sewer then jogs east approximately 135 feet before turning southward through the Site. The sewer discharges to the Niagara River via the trunk sewer which crosses the Olin portion of the Site in a north-south direction. This sewer services the southern half of the Love Canal Area and the area bordering Frontier Avenue. The westernmost section of the storm sewer system north of Buffalo Avenue was installed solely to service a restaurant (9802 Buffalo Avenue, Property No. 2, Figure 2.2).

  A second storm sewer system, located along the LaSalle Expressway, handles surface water flow from this arterial roadway. The outfall for this system is the Little Niagara River near 93rd Street. This system does not enter into the RI Survey Area.

- Telephone: A New York Telephone cable is buried parallel to and just north of the northern fence line along the Site.

- Other Utilities: All other utilities are located above grade and are supported on the wooden power line poles located along the north edge of pavement of Buffalo Avenue.

The electromagnetic survey conducted in 1987 identified several areas where the instrument readings were higher than background, including two areas north of Buffalo Avenue. While a few of the known underground utilities (water, sewer, telephone cables) could be field located with the equipment, no other specific underground utilities were positively identified. The complete results of the survey are presented (40).

2.2 REGIONAL SETTING

2.2.1 PHYSIOGRAPHY AND CLIMATE

Niagara Falls lies within the Niagara Escarpment Physiographic Region. The dominant landform in the area is the exposed crest of the escarpment. At Niagara Falls, the escarpment is characterized by steep sided cliff faces with typical relief on the order of 300 to 350 feet. The Niagara River flows over the Niagara Escarpment and through the Niagara Gorge to discharge into Lake Ontario. The surface topography within the City of Niagara Falls slopes gently toward the Niagara River. This topography is typical of glacial ground moraines.

The climate of the Niagara Falls area is classified as humid continental, consisting of cool, wet winters and hot, wet summers. The mean monthly temperature and precipitation data for the Buffalo meteorological station, which is located at the Buffalo International Airport, are presented in Table 2.1. The mean annual temperature is 47°F with the coldest average monthly temperature occurring in January (23.7°F) and the warmest in July (70.1°F).

The mean annual precipitation is 36 inches, which is relatively evenly distributed throughout the year.

2.2.2 SURFACE WATER CHARACTERISTICS

Since the general slope of the land surface in the region is toward the Niagara River, the general direction of surface water flow throughout the area is toward the Niagara River. Near the Site, the flow is directed to both the Niagara River and the Little Niagara River.

The influence of the River on the site drainage is discussed in the following subsections:

2.2.2.1 NIAGARA RIVER REGULATION

The flow in the Niagara River is determined by the elevation of Lake Erie at the head (inlet) of the Niagara River. When the elevation of the eastern end of the Lake rises due to wind or to a general rise in lake level, the discharge to the river increases. The discharge of river water over Niagara Falls, however, is regulated by joint Canadian-American power authorities who divert water from the river to hydroelectric stations located in Canada and the United States. During the tourist season (April 1 through October 31), a minimum flow over the Falls of not less than 100,000 CFS is maintained during the daylight hours. In the evening and throughout the winter, the flow of water over the Falls can be decreased to a minimum of 50,000 CFS. In addition to maintaining a minimum flow over the Falls, regulations also control the maximum rate of change in River stage that can be induced by flow regulation over a 24-hour period. Control is based on River elevations as measured at the sluice gate structure in the Chippawa-Grass Island Pool which is located approximately 5 miles downstream from the Site (see Table 2.2).

Figure 2.3 depicts the major surface water hydrologic features in the vicinity of the Site. The sluice gate structure controls the flow of water over the Falls. When the gates are closed, water backs up in the channel and the River level behind the gates rises. When the water rises, the volume of water diverted to the Ontario Hydro and Power Authority of the State of New York (PASNY) water intakes increases and the flow over the Falls decreases. Conversely, when the gates are opened, flow over the Falls increases and flow to the intakes decreases.

The opening and closing of the sluice gates affects the stage of the Niagara River. These changes in River stage occur daily during the tourist season. In the winter, flow is maintained over the Falls at a more or less constant rate (50,000 CFS), thus the River elevation remains relatively constant.

Changes in the Niagara River water level due to these regulatory practices are observable at the Site. However, these fluctuations are considerably less than the fluctuations observed at the sluice gates due to the distance between the control structure and the Site.

2.2.2.2 METEOROLOGICAL INFLUENCES

As stated previously, the rate of flow of the Niagara River past the Site is primarily controlled by the elevation of Lake Erie at the inlet of the Niagara River. Wind direction and velocity, while not directly affecting River level, can influence the level of Lake Erie along its eastern shore. This in turn dictates flow volumes entering the Niagara River. Strong winds out of the west increase the Lake's discharge to the River. Conversely, strong winds out of the east decrease discharge.

Short term precipitation events do not significantly affect discharge to the River from Lake Erie due to the large assimilative capacity of the Lake.

2.2.2.3 FLOODING POTENTIAL

Areas near to the Site have historically experienced flooding in low-lying areas adjacent to the Niagara River. Both Cayuga Island located west of the Site and a residential area along River Road in the Town of Wheatfield east of the Site have been flooded numerous times in the past 40 years with major flood events occurring in 1942, 1943, 1954, 1955, 1962, 1972, 1975, 1979 and 1985. Both of the affected areas are located within a one mile radius of the Site. However, as expected due to the elevated height of the Site, no flood events are known to have occurred for portions of the Site which are located between the bulkhead and Buffalo Avenue.

The COE conducted a study on the Cayuga Island flooding problem and released a report (50) in 1963, and updated in 1980, which outlined recommendations to mitigate flooding problems on the Island. In this report it was determined that local flooding is caused by the following: backwater effect on the Niagara River caused by ice jams in the River above the Falls;

long duration storms over Lake Erie with strong predominantly southwesterly winds which produce abnormally high River flow and stages; or a combination of these causes.

As illustrated in Figure 2.4, the Site contains lands classified as being primarily Zone C status under the National Flood Insurance Program (51). This status designates areas of minimal flooding which are located above the 500-year flood boundary. The small lowland area at the edge of the southern property line on the Niagara River, however, is designated as being a Zone B area, or one which is subject to 100-year flooding with average depths of less than one foot. Figure 2.4 has been adjusted to include the ditch area east of the Site which is expected to be included in the 100-year flood plain.

Ice jamming is prevalent in the riverfront areas around the Site, and as mentioned previously, is one of the primary causes of flooding in the Cayuga Island and Wheatfield areas. The occurrence of massive ice jams has decreased significantly since the annual installation of the ice boom in the mouth of the upper Niagara River began in 1963. A report (44) by the Army Corp. of Engineers on ice problems was printed in 1985.

River stage data obtained at the LaSalle Yacht Club monitoring station in Niagara Falls, NY (downstream of the Site) show the maximum and minimum stages for the Niagara River at this location giving monthly and daily means, and the maximum and minimum instantaneous readings that have been recorded. This data can be used in conjunction with the water level data at the nearest upstream recording station (Tonawanda Station) to interpolate the estimated River elevation at the Site. Based upon measured distances between the recording stations and the Site, it has been determined that a conversion factor of 0.73 feet must be added to the LaSalle Station elevations to approximate Site River elevations. The corrected River stage data are presented in Table 2.3.

Although the historic River stage data in Table 2.3 includes only data from 1965 to 1988, this 23-year span includes major flooding events in 1972, 1975, 1979 and 1985. During these floods the highest recorded instantaneous River elevation was 571.31 feet which is approximately 2 feet lower than the elevation of the top of the lowermost portion of the existing bulkhead. The highest recorded water level prior to construction of the bulkhead occurred in January 1972 (568.08 feet). This water level would not have reached the top of the Site.

2.2.2.4 AREA DRAINAGES

Figure 2.5 shows the existing ground contours of the Site. As can be seen by this figure, the surface of the Site is relatively flat. The maximum change in elevation across the Site is approximately 3 feet. This flat topography, except for the embankment at the River's edge, limits runoff. There are also some slight depressions on the OCC portion of the Site in which surface water collects.

The slightly mounded effect of the surface topography essentially results in surface water flow off site in four directions, although all surface water flow eventually discharges into the Niagara River. The majority of the Site drains directly to the Niagara River to the south. However, there are some surface areas where surface water runoff flows to the east, west and north. The easterly component flows to the ditch that parallels the eastern property boundary. This ditch discharges to the south into the Niagara River. The flow off the western edge of the Site eventually flows into the Niagara River or Little Niagara River. Flow off site to the north follows along the southern edge of pavement of Buffalo Avenue either in an east or west direction until it is past the limits of the Site and then turns south and flows to the River.

Due to the presence of the ditch along the east side of the Site and the crown on the pavement on Buffalo Avenue, surface water flowing off the Site in a northerly or easterly direction is physically limited from migrating extensively. In order to determine whether the discharge of surface water resulted in off-site chemical migration from the Site, a survey of the off-site soils adjacent to the Site was conducted as part of the RI. The results of this survey are presented in Chapter 7 of this report.

2.2.2.5 SEDIMENTATION

As described in Section 2.2.2.4 topographical relief at the Site is minimal. Combined with the fact that the ground surface is covered by a thick growth of vegetation, the present potential for off-site transport of soil in surface water flow is minimal. Historically, while the Site was still operating, erosion of material from the Site and subsequent sedimentation in the Niagara River probably did occur. However, the bulk of the sediment deposition would be expected to have occurred in the area immediately adjacent to the shoreline. This condition was substantiated by the RI sediment survey which identified the major portion of the chemical presence in the sediment to be limited to the shoreline vicinity. As the Site continued to expand further south, many of the sediments historically deposited are now under the current Landfill.

In order to minimize the erosion of material from the Site, certain preventive measures have already been taken along the shoreline. The most significant was the construction of the bulkhead. The placement of the bulkhead material created a buffer between the River and waste materials. Furthermore, the riprap placed on the River face of the bulkhead reduced erosion. In addition, the Olin section of the bulkhead was constructed with a filter fabric membrane behind the riprap and a surface swale along the top which aid further in the prevention of erosion by the River and erosion by surface water flow off the Site.

One of the goals of the RI sediment sampling program was to determine the impact of soil erosion on the Niagara River sediment. This program is described in detail in Chapter 8 of this report.

2.2.3 REGIONAL SURFICIAL GEOLOGY

The surficial geology of the Niagara Falls area has been described (46). The surficial materials can be classified into three units based upon depositional environments (Figure 2.6). These units are Recent Alluvium, Lacustrine Sediments and Glacial Deposits. The major soil classifications in each unit are typically:

Recent Alluvium	-	sand, silt and gravel deposited along modern rivers and streams
Lacustrine Sediments	-	laminated silt, sand and clay
Glacial Deposits	-	silty clay to sandy till

2.2.4 REGIONAL BEDROCK GEOLOGY

The Niagara Falls area is underlain by a thick succession of stratified Paleozoic sedimentary rocks which form the northern flank of the Alleghany basin. The Paleozoic strata dip toward the southeast at a slope of approximately 40 feet per mile. Bedrock exposure is controlled by glacial erosion as expressed by broad west trending bands subparallel to the south shore of Lake Ontario, as shown on Figure 2.7. This pattern is interrupted by the Niagara Escarpment where the entire succession is exposed.

The stratigraphic succession at Niagara Falls consists of rock ranging in age from Middle Silurian to Upper Ordovician. A schematic stratigraphic section illustrating the characteristics of these rock units and their stratigraphic relationships is presented on Figure 2.8. Stratigraphic nomenclature has been based upon the recommendations in Rickard (37).

The principal bedrock units belong to the Salina, Lockport, Clinton and Medina Groups as well as the Queenston Formation.

The bedrock units investigated during the RI include the Salina, if present (the northern limit of the Salina extends approximately to the Site and therefore may or may not have been present in the top few feet of bedrock encountered), all of the Lockport Group and the Decew and Rochester Formations of the Clinton Group.

2.2.5 REGIONAL HYDROGEOLOGY

As will be discussed in the following section, groundwater is not extensively utilized in the Niagara Falls area due to the low waterbearing characteristics and generally poor water quality.

The overburden materials, due to their high clay content, are relatively impermeable. On a regional scale, the overburden would be considered an aquitard, and the limited groundwater flow within this unit will generally be in a downward direction. However, near the Niagara River, a thin layer of more permeable silty sand and areas of fill overlie the aquitard and provide a pathway for lateral migration.

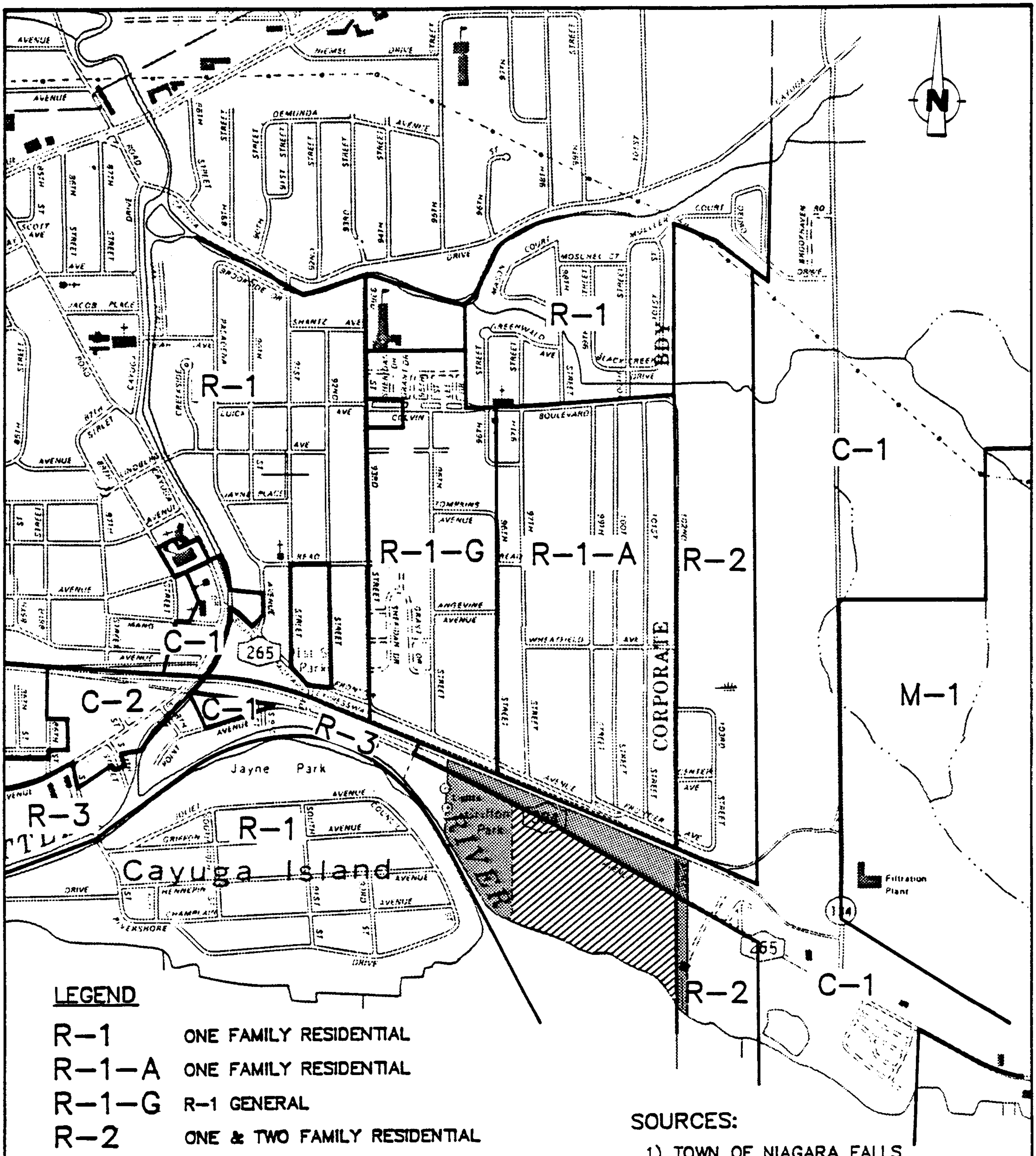
The major aquifer in the Niagara Falls area is the Lockport Group (31). Groundwater occurs in the Lockport Group in three types of openings:

i) bedding plane joints and fractures,
ii) vertical joints, and
iii) small cavities due to gypsum dissolution.

Of these, bedding plane joints are the most important and transmit the largest volume of water moving through the formation.

The joints within the Lockport Group that transmit most of the water are fractures along prominent bedding planes which have been widened by mineral dissolution. In the Niagara Falls area, these planar openings have been found to be areally extensive over several miles (31). A waterbearing unit in the Lockport Group may consist of a single open bedding joint, or an interval of rock up to one-foot thick, containing several open bedding joints.

In general, open vertical joints are less important waterbearing zones in the Lockport Group, except in the upper few feet of the unit. The cavities formed by mineral dissolution are also most prevalent in the upper 15 feet of the Lockport Group.



LEGEND

R-1	ONE FAMILY RESIDENTIAL
R-1-A	ONE FAMILY RESIDENTIAL
R-1-G	R-1 GENERAL
R-2	ONE & TWO FAMILY RESIDENTIAL
R-3	MULTI-FAMILY RESIDENTIAL
C-1	RETAIL BUSINESS
C-2	GENERAL COMMERCIAL
M-1	LIGHT INDUSTRIAL
(dark shading)	OFF-SITE AREA INCLUDED IN STUDY
(hatching)	102ND STREET LANDFILL SITE

SOURCES:

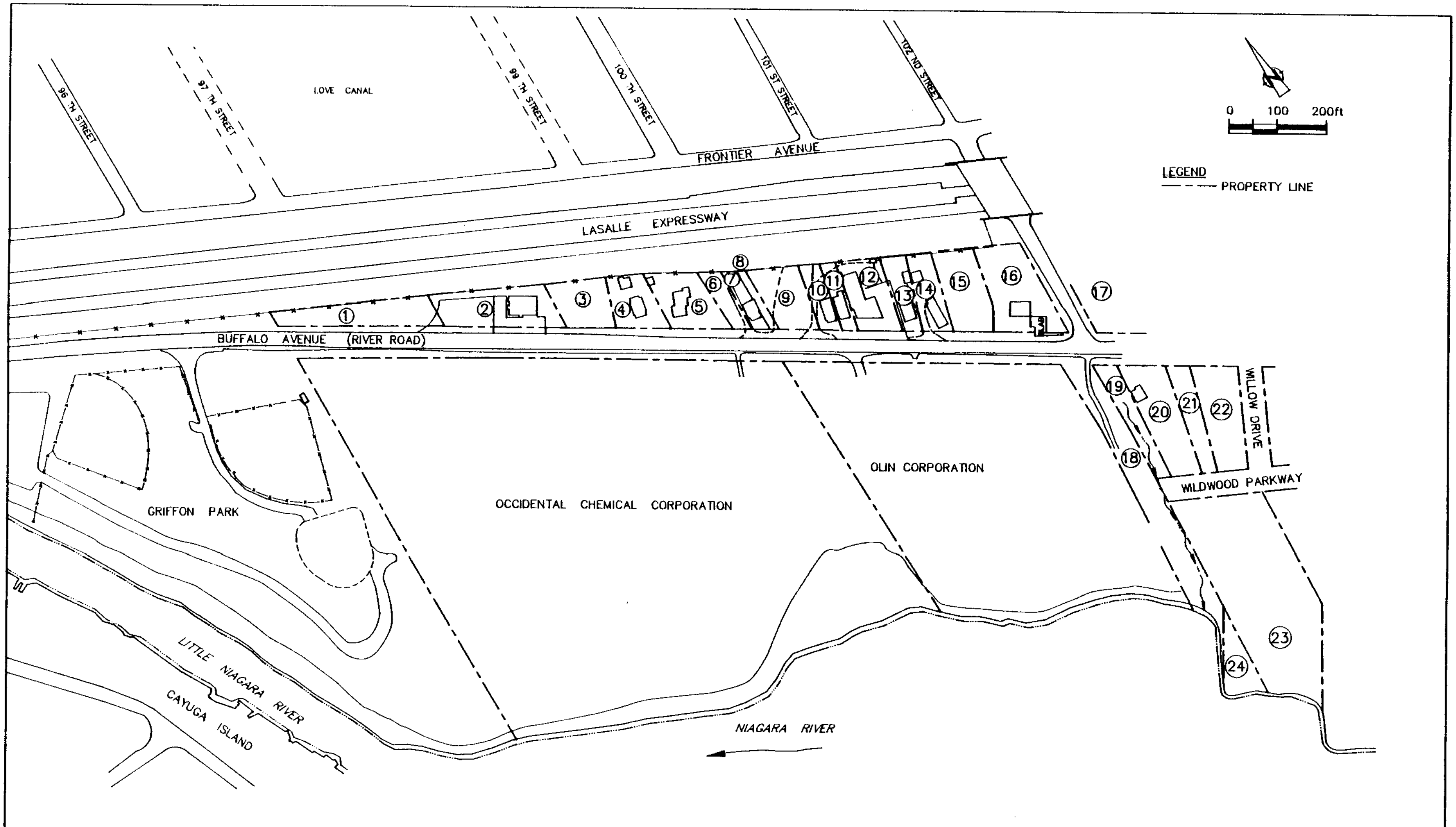
1) TOWN OF NIAGARA FALLS ZONING MAP, DEPT. OF PLANNING AND DEVELOPMENT (FEB. 2 , 1970)
2) TOWN OF WHEATFIELD ZONING MAP

figure 2.1

LAND USE MAP
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431 - 13/07/88 - 47 - D - 1



PROPERTY OWNERSHIP

1) GERARDO BRINDISI
2 & 3) JOSEPH H. SLATTERY
4) HARRY & HAZEL VAN WAGNER
5,6 & 7) LOVE CANAL AREA REVITALIZATION AGENCY
8) CITY OF NIAGARA FALLS
9,10,11,12,13,14 & 15) LOVE CANAL AREA REVITALIZATION AGENCY
16) ANGELO & ANITA FAMA
17,18 & 19) PAUL & ROBERT GORNBEIN
20 & 21) MILDRED BEHRENS
22) DARRELL CLAUS
23) COUNTY OF NIAGARA
24) CITY OF NIAGARA FALLS

CRA/WCC

figure 2.2
PROPERTY OWNERSHIP
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1(P-83)

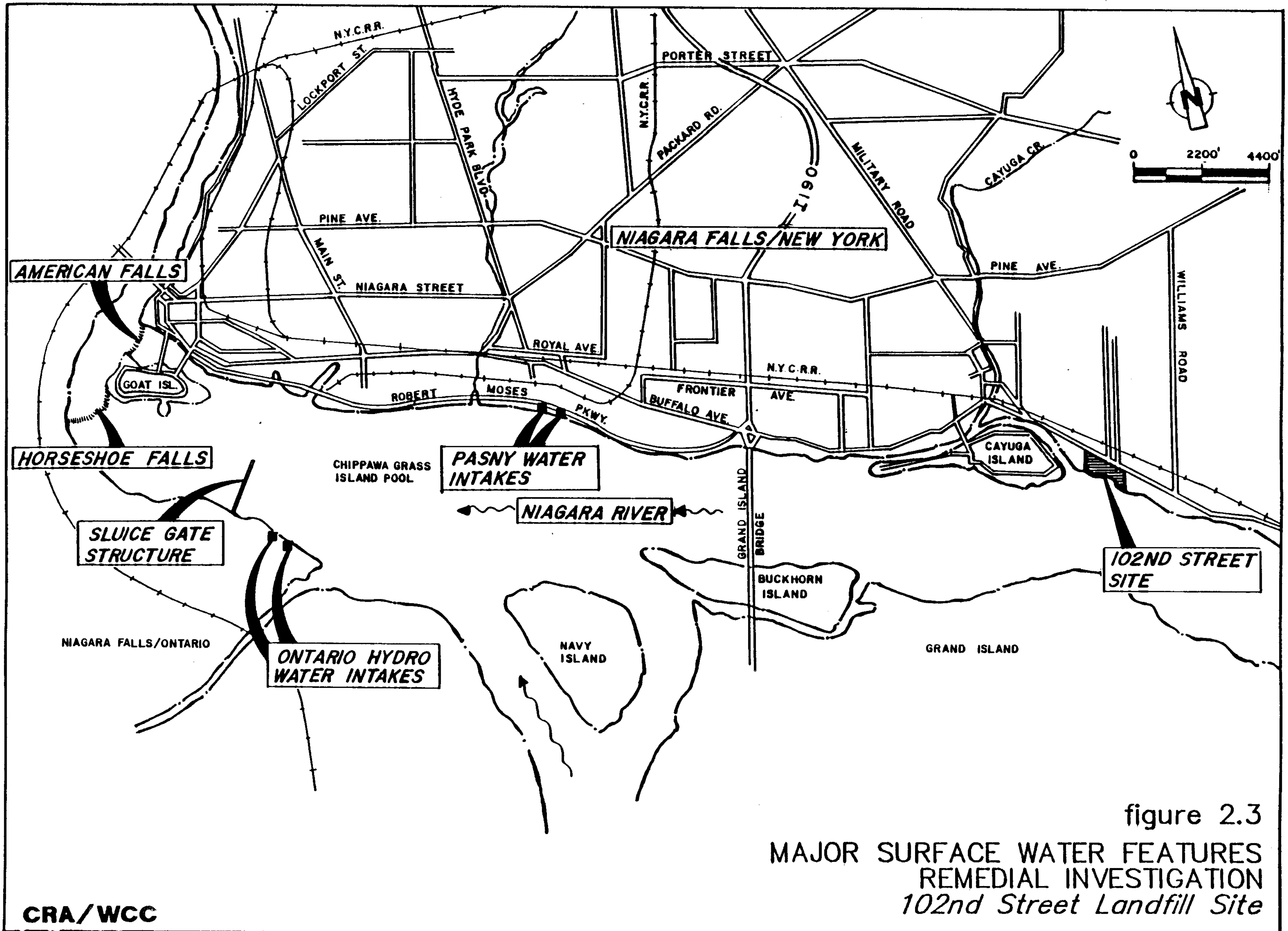
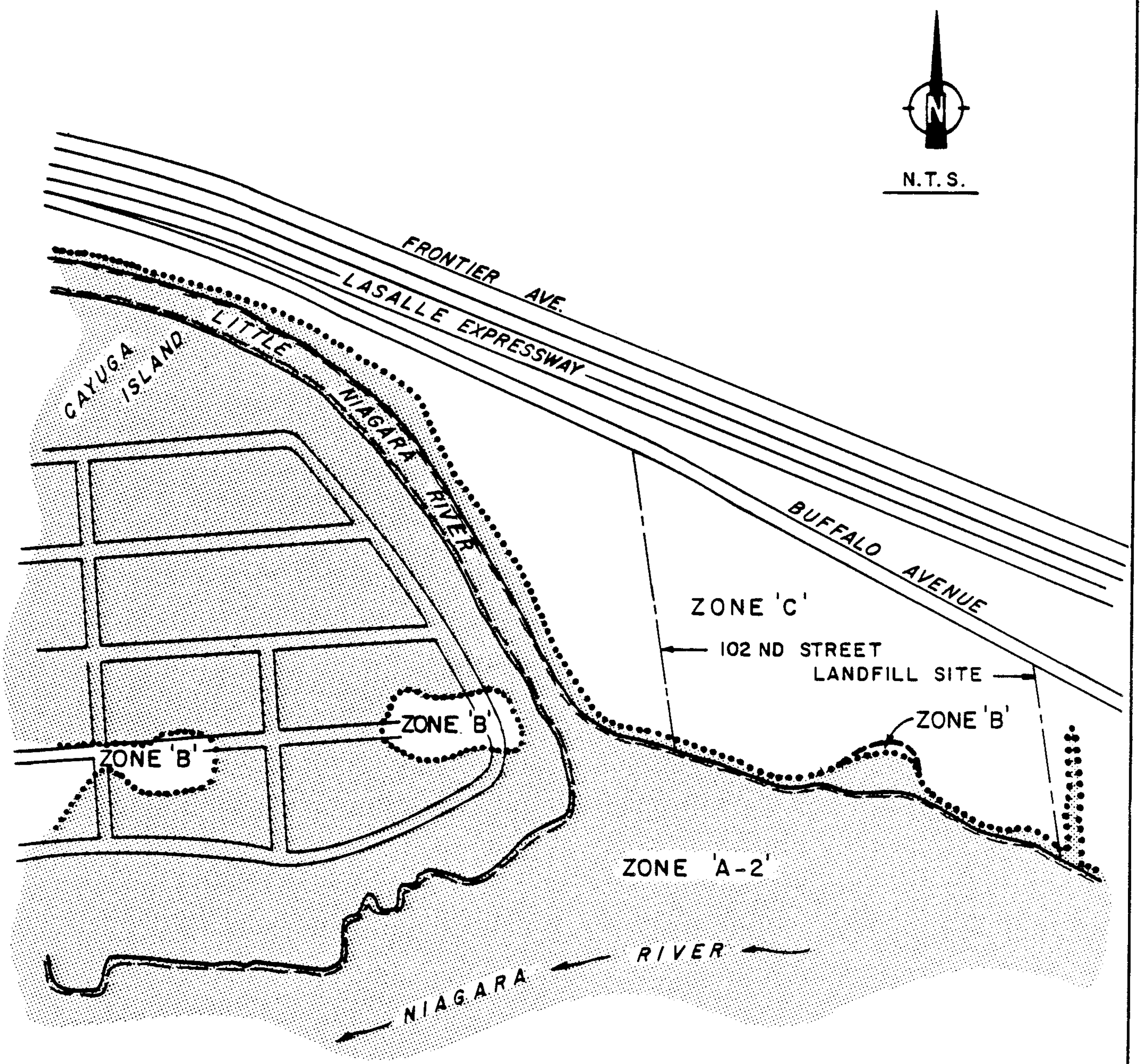


figure 2.3

MAJOR SURFACE WATER FEATURES
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1



LEGEND

••••••••••••	LIMITS OF 100 YEAR FLOOD
ZONE 'A-2'	AREA OF 100 YEAR FLOOD
ZONE 'B'	AREA BETWEEN LIMITS OF 100 YEAR FLOOD AND 500 YEAR FLOOD
ZONE 'C'	AREA OF MINIMAL FLOODING

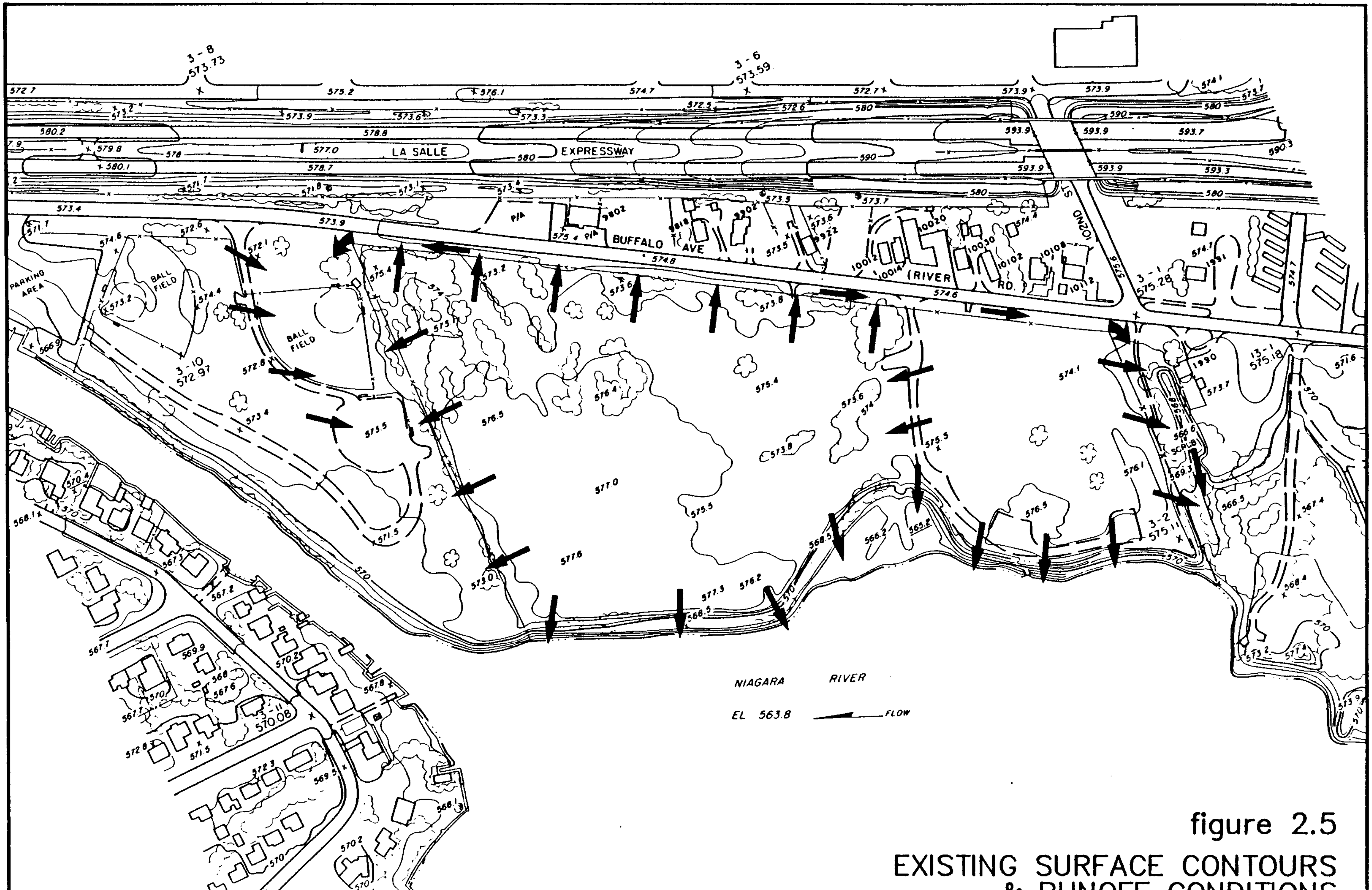
SOURCE: FEMA FLOOD INSURANCE RATE MAP
CITY OF NIAGARA FALLS, NEW YORK, NIAGARA COUNTY.
DATED MARCH 16, 1983
(MODIFIED TO INCLUDE EAST DITCH)

figure 2.4

FLOOD PLAIN MAP
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431–13/07/88–47–D– 1



LEGEND

SURFACE WATER FLOW

figure 2.5

EXISTING SURFACE CONTOURS
& RUNOFF CONDITIONS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1

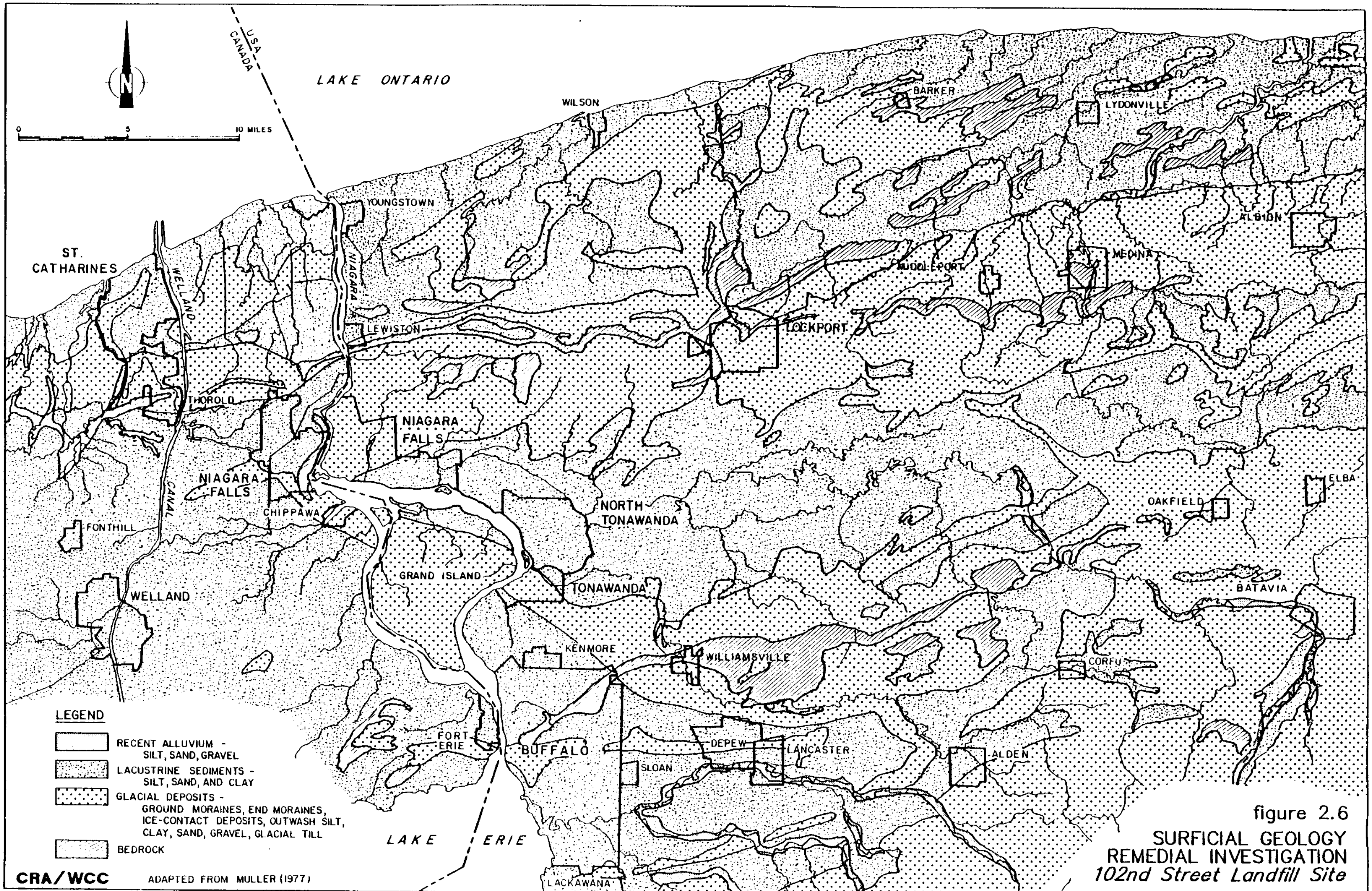


figure 2.6
SURFICIAL GEOLOGY
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1

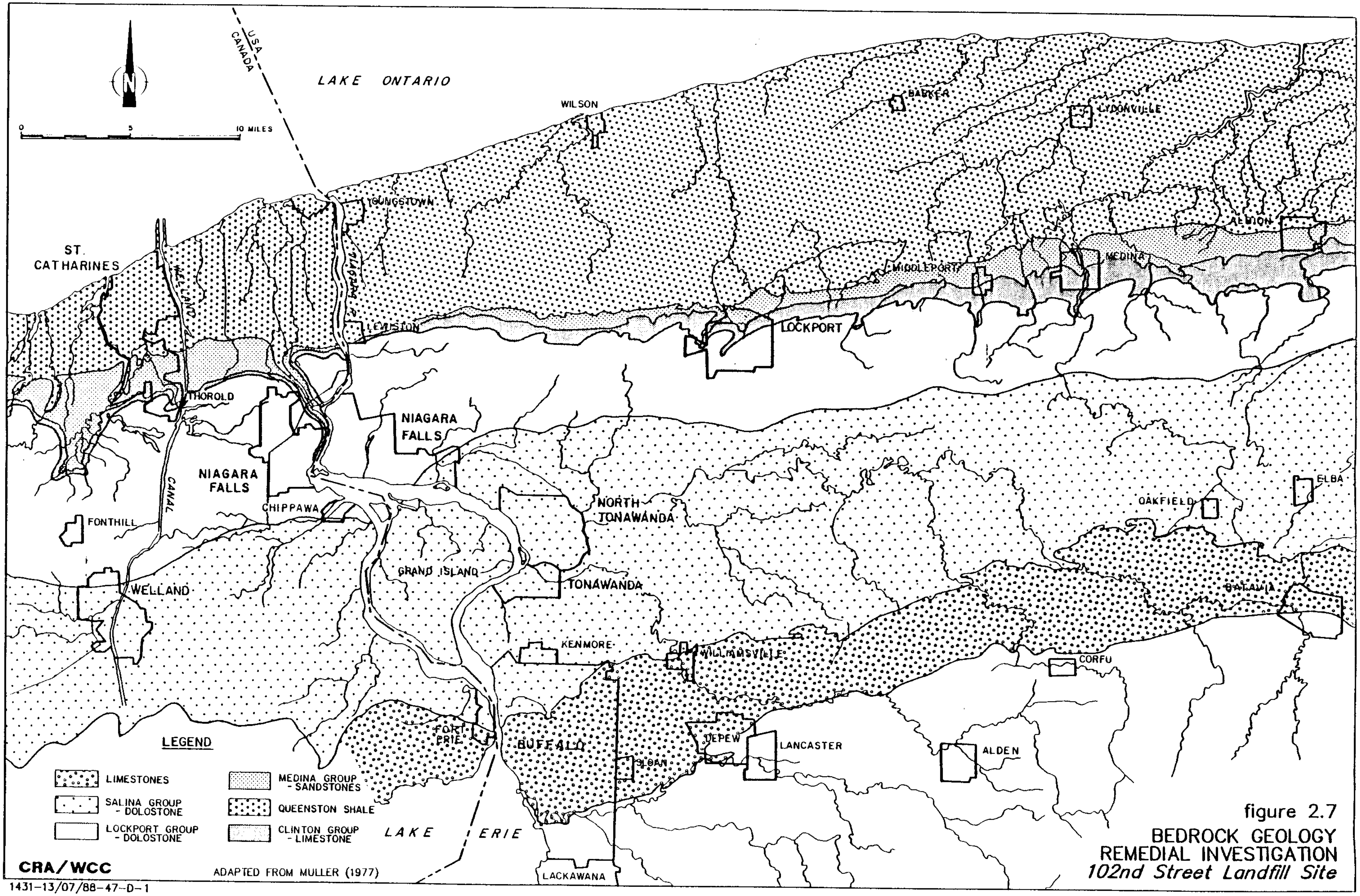


figure 2.7
BEDROCK GEOLOGY
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1

SYSTEM		GROUP	FORMATION	MEMBER	THICKNESS (feet)	DOMINANT LITHOLOGY	DESCRIPTION
SILURIAN	*UPPER*	SALINA	Bertle		45*	Dolostone	massive to laminated, finegrained, dark to light gray, fossiliferous
			Camillus		80 - 100*	Shale	green unfossiliferous, occ. dolomite, anhydrite, siltstone
			Syracuse		100*	Shale & Dolostone	gray, fossiliferous, occ. dolomite, anhydrite, halite
			Vernon		200*	Shale	massive, poorly stratified, green, occ. dolomite, halite
	MIDDLE	LOCKPORT	Oak Orchard/ Guelph		120 - 140	Dolostone	med. to thick-bedded, med. grained, brownish to dark gray, bituminous, occ. cherty, stromatolitic
			Eramosa		7 - 34	Dolostone	v. fine grained, crystalline, gray to brownish gray, occ. chert nodules, shale partings
			Goat Island		16 - 52	Dolostone	massive, fine grained, crystalline, light to dark gray, chert beds, shale bed at upper contact
			Gasport		15 - 45	Limestone & Dolostone	fine to med. grained, semicrystalline, crinoidal, light to med. gray, vuggy
		CLINTON	Decew		5 - 13	Dolostone	fine grained, crystalline, argillaceous, med. to dark gray, shaly partings
			Rochester		55 - 60	Shale & Limestone	thin-bedded, dark gray, calcareous shale, numerous gray limestone interbeds
			Irondequoit		6 - 12	Limestone	med. bedded, fine to med. grained, light to med. gray, crystalline, fossiliferous
			Reynales	Rockway	10	Dolostone	weakly laminated, finegrained, buff to gray, lithographic, occ. shale partings
				Meritton	0 - 3	Limestone	medium grained, crystalline, buff to gray, may be absent
				Hickory Corners	0 - 5	Limestone	thin-bedded, coarse to med. grained, crystalline, dark gray, bioclastic, argillaceous
			Neahga		5	Shale	platy to fissile, soft, dark greenish gray, minor gray limestone
			Thorold		2 - 9	Sandstone	fine to v. fine grained, hard, quartz rich, light gray, silica cement
	LOWER	MEDINA	Grimsby		42 - 55	Sandstone & Shale	fine grained, red (hematitic) sandstone with shale interbeds grading downwards to dominant shale with sandstone interbeds
			Power Glen		34 - 48	Shale & Siltstone	laminated, fissile, sandy calcareous shale, with fine grained sandstone interbeds
			Whirlpool		15 - 28	Sandstone	fine to med. grained, hard, cross bedded, gray to white, thin shaly partings, silica cement
ORDOVICIAN	*UPPER*		Queenston		700 - 1200	Mudstone & Shale	med. bedded, low fissility, random partings, hematitic, uniform, laterally extensive, reddish brown, locally grayish green (reduced by groundwater), extensively fractured and jointed.

SOURCES: Fisher (1970)
Fisher (1977)
Johnson (1964)
Kilgour (1966)
Liberty (1971)
Rickard (1964, 1975)
Zenger (1965)

~~~~~~ Represents erosional unconformity

NOTE: Thickness represents measured thicknessess in Niagara Area.
* Thickness is entire unit stratigraphic thickness since not exposed at Niagara Falls

figure 2.8
GENERALIZED STRATIGRAPHIC SECTION
NIAGARA FALLS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1
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TABLE 2.1
MONTHLY TEMPERATURE AND PRECIPITATION
BUFFALO, NEW YORK

Month	Mean Daily Temperature (°F)	Mean Monthly Precipitation (inches)
January	23.7	2.90
February	24.4	2.55
March	32.1	2.85
April	44.9	3.15
May	55.1	2.97
June	65.7	2.23
July	70.1	2.93
August	68.4	3.53
September	61.6	3.25
October	51.5	3.01
November	39.8	3.74
December	27.9	3.00
Annual	47.0	36.1

Climatological data obtained from the Buffalo Weather Station for the data years 1939 to 1978.

TABLE 2.2

CHIPPAWA-GRASS ISLAND POOL
WATER ELEVATION RESTRICTIONS

	International Great Lakes Datum	United States Geodetic Survey Datum
Minimum Pool Elevation	559.5	557.7
Maximum Pool Elevation	562.5	560.7
Maximum Pool Elevation - *Special Conditions	563.0	561.2
Minimum Pool Elevation - **Special Conditions	559.0	557.2

* Water levels in the range of 562.5 to 563.0 (IGLD) are allowable only after four consecutive hours of flow off Lake Erie in excess of 270,000 cfs. Water must be restored to a level below 562.5 within twelve hours.

** Water levels in the range of 559.0 to 559.5 (IGLD) are allowable only after four consecutive hours of flow off Lake Erie less than 150,000 cfs.

TABLE 2.3

HISTORIC RIVER STAGE DATA
102nd STREET LANDFILL
NIAGARA FALLS, NEW YORK

MAXIMUM STAGES (ft. USGS)

Year	Monthly Mean	Daily Mean	Instantaneous
1965	June - 563.36	Nov. 28 - 564.00	Nov. 27 - 565.17
1966	June - 563.91	Aug. 11 - 564.36	Nov. 4 - 565.12
1967	July - 563.93	Feb. 16 - 565.47	Oct. 27 - 566.57
1968	Aug. - 564.12	Dec. 5 - 565.59	Dec. 5 - 567.21
1969	Aug. - 564.78	Jan. 1 - 565.69	Jan. 1 - 566.45
1970	July - 564.30	Jan. 9 - 565.80	Jan. 9 - 566.56
1971	July - 564.32	Jan. 27 - 565.01	Jan. 27 - 566.37
1972	Dec. - 564.82	Jan. 25 - 566.21	Jan. 25 - 568.08
1973	Jan. - 565.00	Jan. 17 - 565.86	Jan. 5 - 566.47
1974	Apr. - 564.32	Feb. 23 - 565.94	Feb. 23 - 566.53
1975	Mar. - 564.37	Feb. 27 - 566.90	Feb. 26 - 567.98
1976	Mar. - 564.51	Jan. 15 - 566.10	Jan. 15 - 566.91
1977	Sept.- 564.00	Jan. 29 - 565.42	Dec. 9 - 566.18
1978	Jan. - 564.82		Jan. 27 - 566.42
1979	July - 563.90		Jan. 9 - 565.57
1980	Aug. - 563.97		Jan. 12 - 566.32
1981	Aug. - 563.98		Oct. 18 - 565.91
1982	Jan. - 563.79		
1983	Dec. - 563.93		Dec. 28 - 566.23
1984	June - 563.62	Mar. 23 - 564.78	Mar. 23 - 565.24
1985	Feb. - 564.19		Dec. 2 - 571.31
1986	Jan. - 564.16	Jan. 6 - 566.00	Jan. 6 - 566.61
1987	Jan. - 563.52	Jan. 24 - 564.73	Jan. 24 - 565.04
1988	Apr. - 563.28	Apr. 15 - 564.36	Apr. 15 - 565.48

Notes:

- Data obtained from U.S. Army Corps of Engineers, Buffalo, New York (Lasalle Station).
- Elevations are based on USGS datum.

3.0 GEOLOGIC INVESTIGATION

Several field programs were conducted during the RI which were designed to supplement existing geologic data. Details of each of these programs have been presented in Project Milestone Reports previously submitted to the EPA/State. The following sections of this report present a brief summary of these field activities and their results.

3.1 PURPOSE

During the RI, additional wells and boreholes were installed and additional field programs were undertaken which were designed to supplement existing data in order to:

- more accurately characterize the geologic conditions at the Site, and
- more accurately assess the nature and extent of chemical presence in the bedrock, subsurface soils and groundwater at and near the Site.

3.2 RI WELL INSTALLATION AND BORING PROGRAM

The majority of the geologic information compiled during the RI was collected in conjunction with the Monitoring Well Installation Program although there were also several overburden exploration boreholes installed during the investigation.

A total of 95 boreholes were completed during the RI. This included 31 boreholes installed for stratigraphic information, 27 fill monitoring wells, 25 native overburden wells, 8 bedrock wells and 4 sewer bedding wells .

The following subsections of this report discuss the well and borehole installations associated with the RI program.

Boreholes were advanced through the overburden to the required depth by means of hollow stem augers. When wells penetrated into the Bedrock, diamond bit rotary drilling methods were employed. Procedures followed for completion of overburden and bedrock well installations are outlined in the following sub-sections of this chapter.

All equipment and materials used in borehole advancement and well construction were cleaned in accordance with procedures outlined in the SOP (18). All work performed at the Site was done in accordance with specified protocols (21).

The locations of all of the wells and boreholes installed during the RI are indicated on Figure 3.1. Stratigraphic and Instrumentation Logs for these boreholes and monitoring wells were presented (17). Monitoring well installation details for wells installed prior to the RI are summarized (17) and are shown on Figure 3.2. A summary of overburden stratigraphy is presented in Table 3.1.

3.2.1 OVERBURDEN WELL INSTALLATIONS

The first phase of the Well Installation Program consisted of the drilling of 12 on-site fill wells. This work commenced October 15, 1985 and was completed on December 18, 1985.

The nine fill wells on OCC property were designated OW31-85 through OW39-85. The Olin fill wells were designated as MW1, MW2 and MW4. Wells MW2 and MW4 replaced historic wells P4 and P7, respectively. Well P7 has not been removed and was included in the Hydraulic Monitoring Program. The locations of the fill wells were predetermined to supplement existing stratigraphic and hydrogeologic information.

Installation of the additional overburden monitoring wells and boreholes commenced immediately following the completion of the fill well installation program.

The protocols followed to complete each well and borehole installed were those specified (18, Addendum No. 2).

A typical well installation is shown on Figure 3.3.

3.2.2 OVERBURDEN EXPLORATION BORINGS

In addition to the well installation program, a total of 31 boreholes were drilled to gather additional stratigraphic information. Seven of these boreholes were installed during the well installation program, ten during the Supplemental NAPL Investigation, ten during the Niagara River Borehole Drilling Program and four during the Sewer Bedding Investigation.

Stratigraphic logs for these boreholes are presented (17) and a stratigraphic summary is shown on Table 3.1.

3.2.2.1 SOIL EXPLORATION BOREHOLES

Seven soil exploration boreholes were installed during the Well Installation Program. Three boreholes (BH1-86, BH2-86 and BH3-86) were installed to confirm the location of the top of the Alluvium in areas where previous drilling had not adequately defined this interface.

Boreholes BH42-86 and BH43-86 were drilled in conjunction with the installation of monitoring wells OW42-86 and OW43-86. These boreholes were drilled and sampled at the location of each well grouping prior to well installation in an attempt to expedite the monitoring well installation program.

Boreholes BH47B-86 and BH47C-86 were installed to define the presence of NAPL encountered during the installation of well OW47-86.

3.2.2.2 SUPPLEMENTAL NAPL INVESTIGATION BOREHOLES

All of the information collected at the Site during both the RI and historic drilling programs was reviewed to determine the lateral and vertical extent of NAPL presence. All of this information was compiled and presented (14) and resulted in the conclusion that additional information was required to determine the extent of NAPL presence at the Site. As a result, 10 additional boreholes (BH1N-87 through BH10N-87) were installed on the Site. Details of this borehole installation program have been presented (23).

3.2.2.3 NIAGARA RIVER BOREHOLE DRILLING PROGRAM

Due to the identified need for geologic stratigraphy information south of the Site, ten boreholes were installed in the Niagara River between the east and west boundaries of the Site.

The primary purpose of this drilling program was to gather additional information regarding the elevation of the top of the Clay/Till off-shore and adjacent to the Site.

These boreholes were laid out along the primary vector lines which had been established for the Niagara River Sediment Sampling Program. The locations of these boreholes are shown on Figure 3.4.

Details of this drilling program have been presented (27).

3.2.2.4 SEWER BEDDING INVESTIGATION

Due to the uncertainty concerning the type of engineered bedding material, if any, used to support the 42-inch diameter storm sewer that traverses the Site, a program was developed to identify the bedding material and its potential as a preferential pathway for chemical migration. The program consisted of the installation of four sewer bedding wells and four boreholes. Two wells and two boreholes are located near the northern property boundary (MW-10, MW-11, DH-10 and DH-11) and two wells and two boreholes are located near the top of the bulkhead (MW-5, MW-6, DH-5 and DH-6).

Further discussion on the results of soils encountered and subsequent sampling events are presented in Chapter 6.

3.2.3 BEDROCK WELL INSTALLATIONS

A total of eight boreholes were cored into the Bedrock at the Site to provide information pertaining to the hydrogeologic setting and migration of chemicals within the bedrock strata. These installations included five shallow holes drilled to a depth of 15 feet below the top of the bedrock surface and three deep bedrock wells which penetrated to the top of the Rochester Formation.

A stratigraphic summary is presented on Table 3.2. Stratigraphic logs for the bedrock wells are presented (17).

All drilling procedures were completed in accordance with the specified protocols (18) with the exception of the approved modifications (42) made during the installation of the deep bedrock monitoring wells.

Drilling procedures were modified slightly from the SOP for the deep bedrock well installations to allow hydraulic testing of the bedrock formations in conjunction with the well completion. At locations OW42-86, OW44-86 and MW-8, the Bedrock was cored in 15-foot increments to the top of the Rochester Formation. Packer/pump tests were completed at the end of each 15-foot increment. The initial work proposal specified that an NX size corehole would be used for the deep bedrock wells. This was subsequently increased to a 5 3/4-inch diameter corehole to permit use of larger diameter submersible pumps. The greater capacity of these pumps permitted a more accurate determination of the waterbearing characteristics of the bedrock. Details of the packer/pump test methods are discussed in Section 4.2.3.

In order to better accommodate a monitoring well installation in the deeper formations should it be required, a 4-inch ID steel casing was grouted in place after the top of the Gasport Formation was encountered. After the grout was allowed to set, drilling operations continued using an NX coring bit until the Rochester Formation was encountered. Packer/pump tests continued in the Gasport and Decew intervals, however, the narrow diameter of the coreholes prevented placement of the submersible pump into the NX interval. Consequently, the 15-foot increments below the top of Gasport Formation were tested as progressive units of increasing length as they were penetrated (i.e. 0-15 feet, 0-30 feet and 0-45 feet below the top of the Gasport Formation, etc.). Standing water in the casing above the Gasport Formation was removed prior to commencing each of the packer/pump tests.

Initially, it was stated (18) that the deepest identified waterbearing interval (defined as a 15-foot interval of bedrock capable of providing > 0.6 gpm from a 6-inch diameter borehole or the equivalent thereof) within the Lockport Group was to be completed as a monitoring well. The lower formations of the drilled intervals (Gasport and Decew Formations) were found during packer/pump testing to be non-waterbearing. Consequently, the deep bedrock boreholes were not converted to monitor specific waterbearing intervals.

3.3 SITE GEOLOGY

The current and historic investigations at the Site have provided an extensive data base of geologic information. In general, the Site is underlain by five stratigraphic units. These are: Fill Material (Fill), Alluvial River Deposits (Alluvium), Glaciolacustrine Clay (Clay), Glacial Till (Till) and Bedrock. The uppermost bedrock unit is dolomite of the Oak Orchard Formation of the Lockport Group. The characteristics of the geologic units are summarized in the following sections and are consistent with the Regional Geologic conditions. Detailed descriptions of the stratigraphy are presented on the stratigraphic logs (17). In order to be able to better comprehend the geologic stratigraphy at the Site, six geologic cross-sections have been prepared along the alignments shown on Figure 3.5. Figures 3.6 through 3.11 present Cross-Sections A-A' through F-F', respectively.

3.3.1 OVERBURDEN

Stratigraphic information for the overburden is summarized on Table 3.1 and described in detail in the following sections.

3.3.1.1 FILL

The uppermost stratigraphic unit consists of Fill deposited in conjunction with the landfilling activities described in Section 1.2.1. The thickness of the Fill varies across the Site from 0 to 18 feet (see Figure 3.12). The Fill typically consists of mixtures of silt, clay, sand and gravel, as well as demolition debris, flyash, chemical wastes and brine sludges which were typically placed directly on top of existing undisturbed soils. The Fill is highly variable across the Site.

An area of the OCC portion of the Site was used for phosphorus disposal and has been intentionally avoided during subsurface investigations.

3.3.1.2 ALLUVIUM

The Fill is generally underlain by Alluvium deposited by the Niagara River. Topographic contours of the top of this unit are presented in Figure 3.13. The Alluvium ranges in thickness up to 32 feet. The thickest deposit exists along the south central portion of the Site. These deposits thin toward the northern site boundary, as shown on Figure 3.14. The north-south cross-sections (Figures 3.6 through 3.9) demonstrate the depositional environment of this unit. These sediments were deposited following erosion of the underlying Clay. The presence of an erosional terrace is evident on the cross-sections. The Alluvium normally consist of gray silty sand with a trace of clay, however, textural variations to gravelly sand or sandy silt have been observed. Two of these subunits are readily identifiable. The first is a dark gray silt horizon with vegetation (hereinafter referred to as "organic rich layer"), commonly present at the upper contact. It is postulated that this horizon was the original topsoil layer prior to landfilling activities. This horizon is not continuous over the Site. The second subunit is lower, generally thicker and a more permeable gray, sandy member. The basal portion (1 to 2 feet) of the lower gray sandy member tends to coarsen with increasing proximity to the River. On the OCC property, this coarsening occurs only in the southwest and southeast corners. Borehole log descriptions of the basal portions closest to the River indicate that it grades into about 1 foot of nearly clean sands to fine gravels. Hereinafter, this lower layer will be referred to as the Lower Alluvium while the overlying Alluvium will be referred to as the Upper Alluvium.

3.3.1.3 CLAY

The Alluvium is underlain by Clay. This unit typically consists of varved, gray, brown, or red-brown silty clay. Occasional thin silt lenses are observed at some locations.

As discussed above, the upper contact of this unit was formed by erosion. The upper surface of the Clay is observed generally to slope toward the Niagara River. An erosional escarpment is prominently displayed on Figure 3.15 and through the north-south cross-sections (Figures 3.6 through 3.9). As a consequence of this erosion, the thickness of the Clay is observed to vary dramatically across the Site in the north-south direction. This variation is demonstrated in the isopach map of clay thickness presented in Figure 3.16. This unit is approximately 28 feet thick along the northern portion of the Site and is absent along portions of the southern boundary.

In areas where the Alluvium is absent, the Fill has been deposited directly on top of the Clay. The morphology of the Clay along the south portion of the Site is a discrete lens within a depression in the underlying Till. In areas where the Clay is shown to be absent, the Alluvium occurs directly above the Till.

3.3.1.4 TILL

A unit of Till overlies the bedrock surface beneath the entire Site. The upper surface of the Till is irregular as shown by the structural contours on Figure 3.17. The total thickness of the unit ranges from less than four feet to greater than twenty feet as illustrated on Figure 3.18.

The Till generally consists of a red-brown sandy silt matrix with some gravel and traces of clay. The till matrix does vary in grain-size distribution in both a horizontal and vertical direction. At some locations, particularly BH43-86, OW41-85 and OW46-85, a thin layer of silt, sand and gravel sized particles is present above the bedrock surface. This unit likely represents a reworked or washed Till. The hydraulic conductivity of this section of the Till unit is likely greater due to the partial removal of fines.

3.3.2 BEDROCK

The stratigraphy of the Bedrock at the Site has been determined by completion of the three deep boreholes described in Section 3.2.3. The stratigraphic sequence encountered in order of descending depth is the Oak Orchard, Eramosa, Goat Island and Gasport Formations of the Lockport Group and the Decew and Rochester Formations of the Clinton Group. Stratigraphic information for these units is summarized on Table 3.2 and the top of bedrock contours are shown on Figure 3.19. Figures 3.20 and 3.21 locate and present a cross-section drawn along the alignment of the three deep boreholes.

The various formations encountered during the drilling of the three deep boreholes are discussed in greater detail in the following sub-sections. According to the regional geologic mapping currently available (Figures 2.7 and 2.8), the uppermost layer of Bedrock expected to be encountered at the Site is the Vernon Formation Shale of the Salina Group. The uppermost layer of rock typically encountered at the Site was a dolostone material indicative of the Oak Orchard Formation of the Lockport Group. Thus, the Salina Group may not be present beneath the Site although exact determination of the contact between the two Groups is subject to individual geologic interpretation. In any event, if present, the Salina Group thickness beneath the Site is minimal and is not hydrogeologically significant.

3.3.2.1 OAK ORCHARD FORMATION

The Oak Orchard Formation is the uppermost bedrock stratigraphic unit. The Oak Orchard is the thickest formation of the Lockport Group. Observed thicknesses at the Site vary between 90 and 100 feet. This formation consists of thin to medium bedded, fine to medium grained, gray dolomite with fossils, stromatolites, shaly laminations and partings. Secondary mineral replacement of porosity features were occasionally recognized. Fractures and weathered fractures were common in the upper 25 feet but their prominence decreased significantly below this level. Horizontal fractures were common but some may represent secondary fracturing along bedding planes caused by coring operations.

3.3.2.2 ERAMOSA FORMATION

The Eramosa Formation consists of very thin to medium bedded, fine to medium grained, light to olive gray, cherty dolomite. Carbonaceous partings, weathered fractures and cherty nodules were occasionally identified within this unit. The thickness of this unit varied between 12 and 22 feet.

3.3.2.3 GOAT ISLAND FORMATION

The Goat Island Formation is characterized as thick-bedded, fine to medium grained, light to medium gray cherty dolomite. Other characteristic features include stylolitic textures, gypsum, limonite or carbonate coated vugs and frequent shaly partings. The thickness of the Goat Island Formation was observed to vary between 9 and 16 feet. The lower contact of this unit with the underlying Gasport Formation is conformable and was observed to be both sharp and gradational.

3.3.2.4 GASPORT FORMATION

The Gasport Formation was observed to demonstrate some textural variability between the three boreholes. The dominant lithology consists of thin to thick-bedded, fine to medium grained, gray to white, bituminous dolomite. This unit is fossiliferous and displays some porosity features, numerous shale partings and a few fractures. Traces of weathering are evident on some fracture faces. A subunit of black dolomitic shale was observed to be greater than 16 feet thick in OW42-86. In OW44-86 a 6.5 foot thick bed of medium gray, aphanitic limestone occupied a similar stratigraphic position. The total thickness of the Gasport Formation varies between 38 and 44 feet. The lower contact of the Gasport Formation with the underlying Clinton Group was observed to be conformable and either sharp or gradational.

3.3.2.5 DECEW FORMATION

The Decew Formation is considered to be the youngest stratigraphic unit of the Clinton Group. This unit is thick to massive bedded, fine to medium grained, gray to dark gray, argillaceous dolomite. The texture of the Decew Formation is relatively uniform. Carbonaceous partings and occasional clay seams and vugs are common in this formation. The thickness of the Decew Formation was observed to vary between 12 and 14 feet. At OW42-86 the lower contact with the Rochester Formation is marked by a clay seam, while at OW44-86, the contact was observed to be gradational.

3.3.2.6 ROCHESTER FORMATION

The Rochester Formation was designated as the lower limit required for borehole penetration in this investigation. This Formation consists of uniform, massive bedded, fine grained, black, dolomitic shale. Approximately six to nine feet of Rochester Formation was cored before the boreholes were terminated. Several fractured and weathered zones were identified in this interval.

3.4 SOILS PHYSICAL TESTING

During the course of the various investigations at the Site, selected soil samples have been submitted to laboratories for physical testing. Properties tested have included hydraulic conductivity, grain size distribution, moisture content, liquid and plastic limits, and laboratory permeability.

The hydraulic conductivity of a soil material can be estimated from the grain size distribution. This estimation was developed by Hazen (38) and although it is more representative in granular soils, approximations in fine grained soils are possible. The estimation is based upon d_{10}, where d_{10} represents the diameter (in mm) at which 10 percent by weight of the soil is finer and 90 percent of the soil is coarser.

A total of 12 soil samples were submitted for grain size distribution analysis during earlier site investigations in 1979-1980. Grain size distribution curves are presented (17), while the data are summarized on Table 3.3. The estimated hydraulic conductivity values are grouped in terms of the site geologic units. Laboratory determination of hydraulic conductivity were conducted on five of these samples. These results are presented in Table 3.4. Results of laboratory determination for other site soil samples are also presented on Table 3.4.

In addition to this original testing, four Shelby tube samples were collected during the Niagara River Borehole Drilling Program for laboratory permeability, Atterburg limits and grain size distribution determination. The results of these determinations are included on Table 3.4.

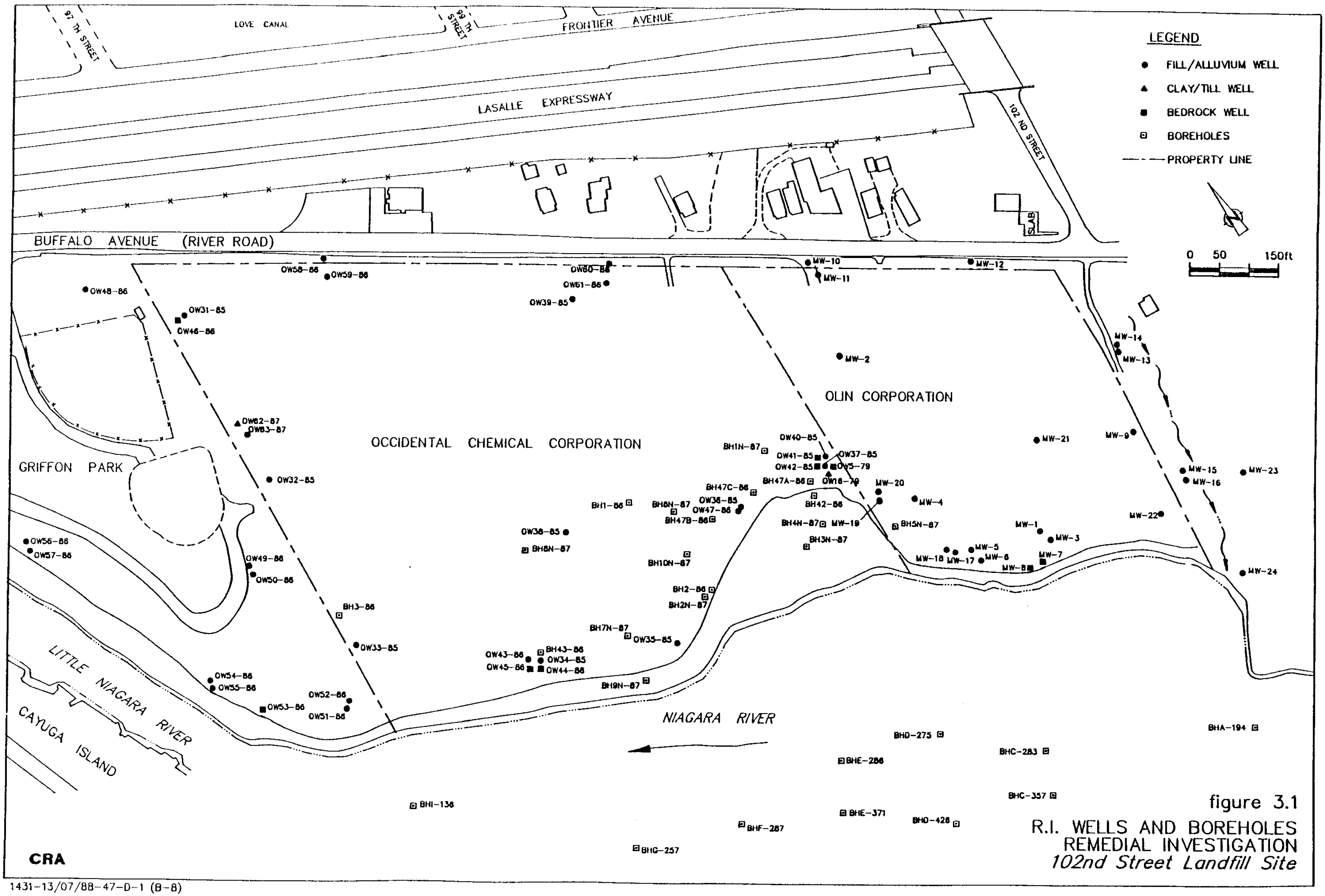


figure 3.1

R.I. WELLS AND BOREHOLES
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (B-8)

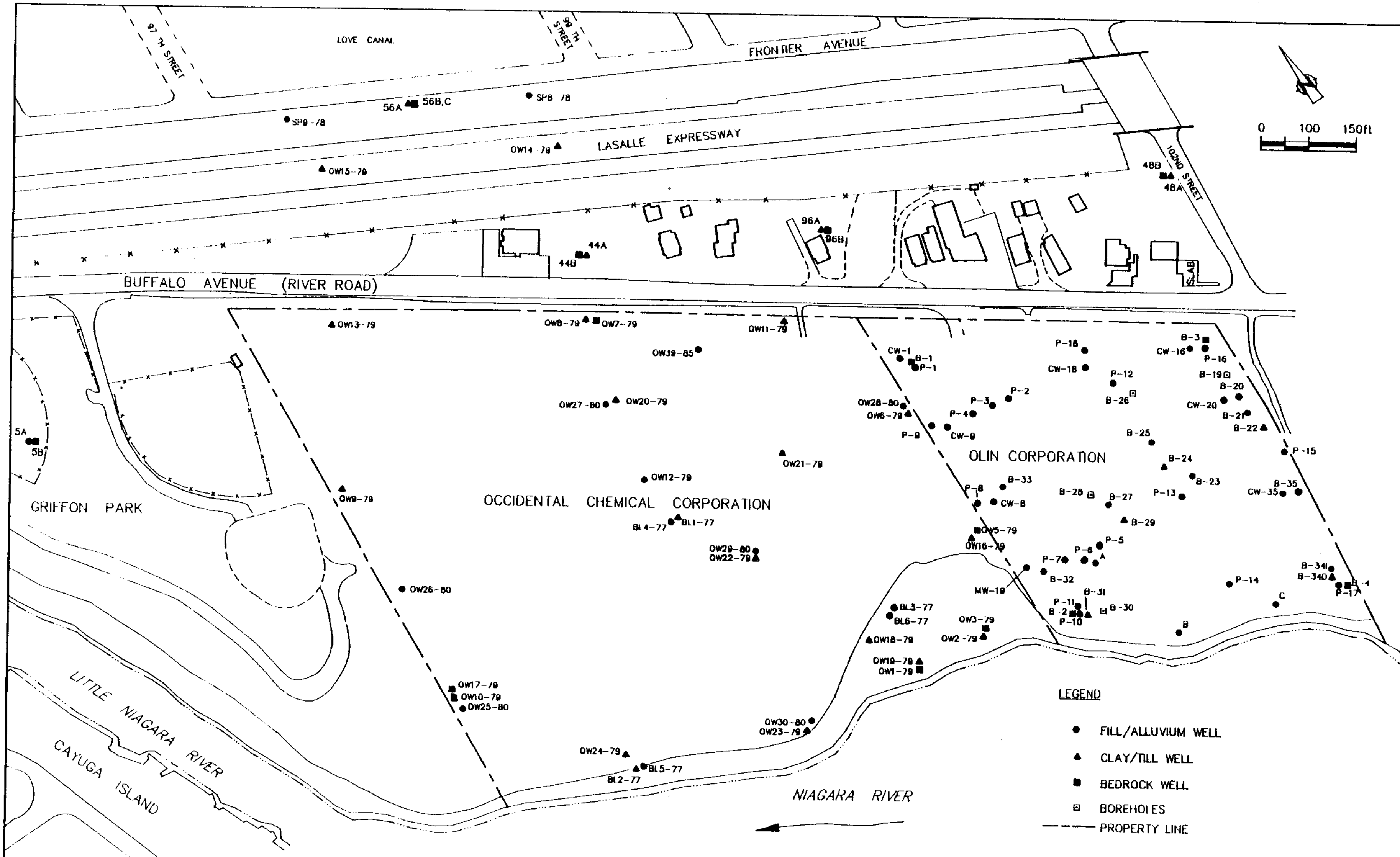


figure 3.2

HISTORICAL WELL/BOREHOLE LOCATIONS
102nd Street Landfill Site

CRA / WCC

1431-9/08/88-47-0-0

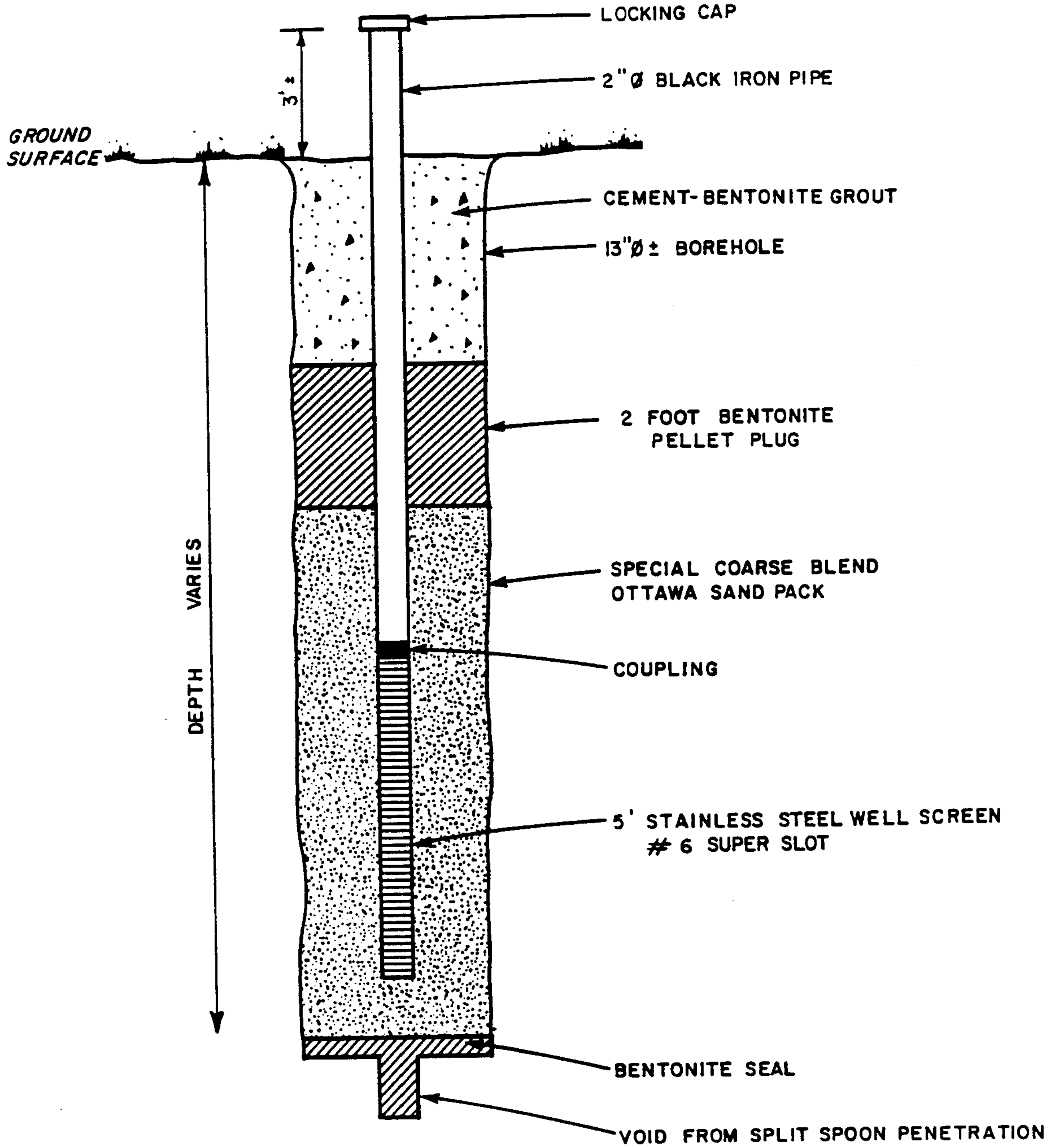


figure 3.3

TYPICAL OVERBURDEN WELL INSTALLATION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1

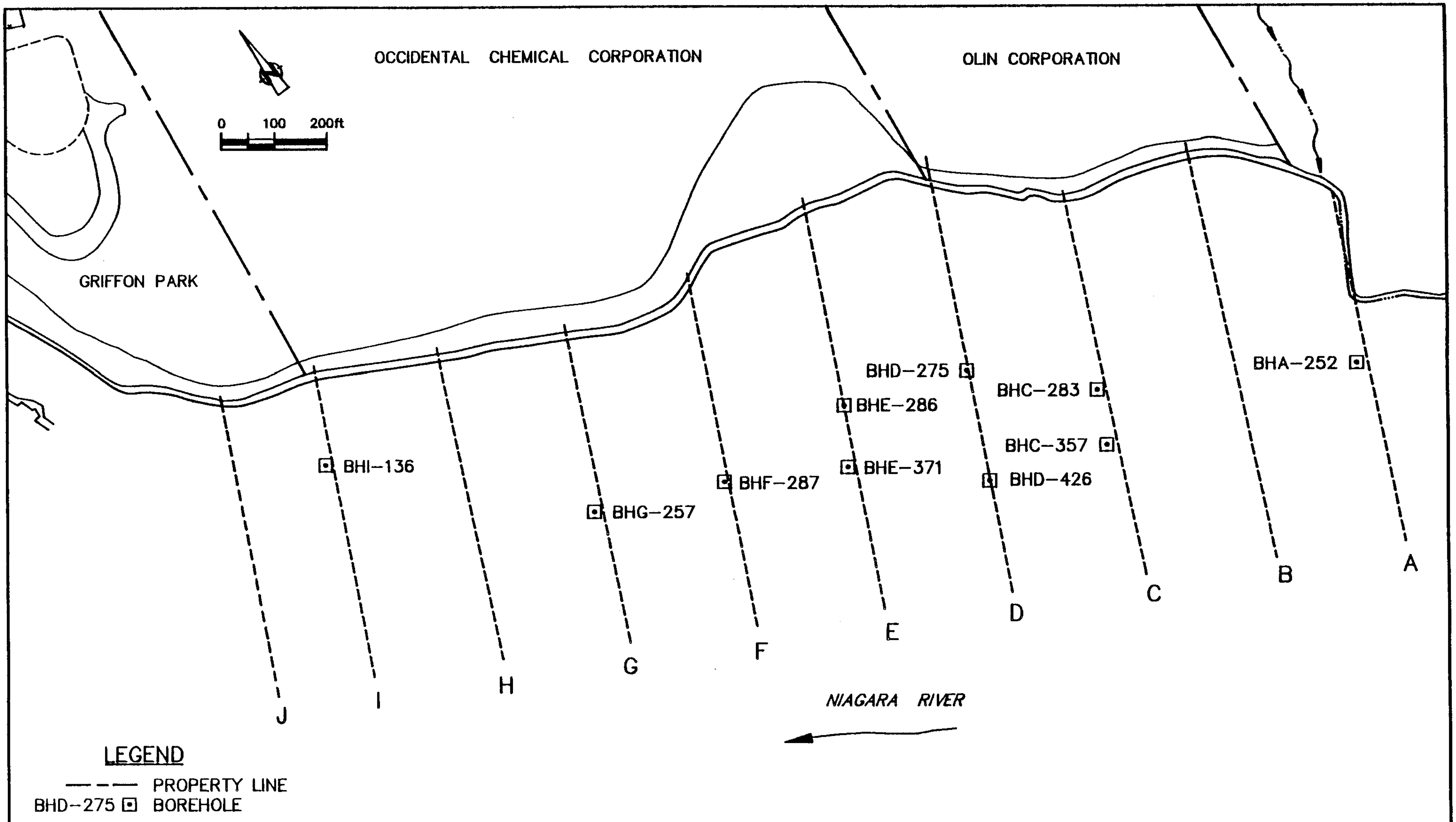


figure 3.4

OFFSHORE BOREHOLE LOCATIONS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P-84)

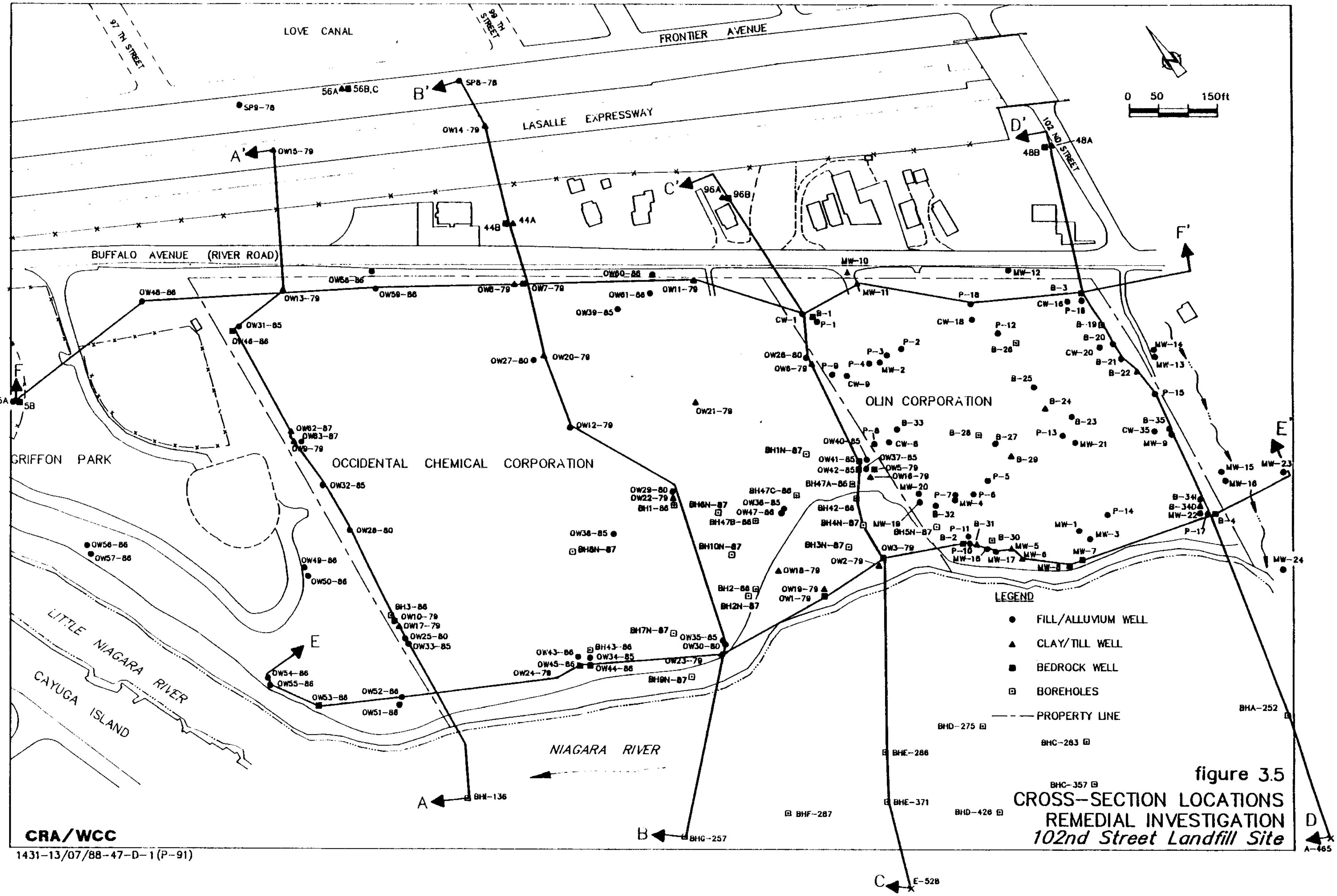


figure 3.5
CROSS-SECTION LOCATIONS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1(P-91)

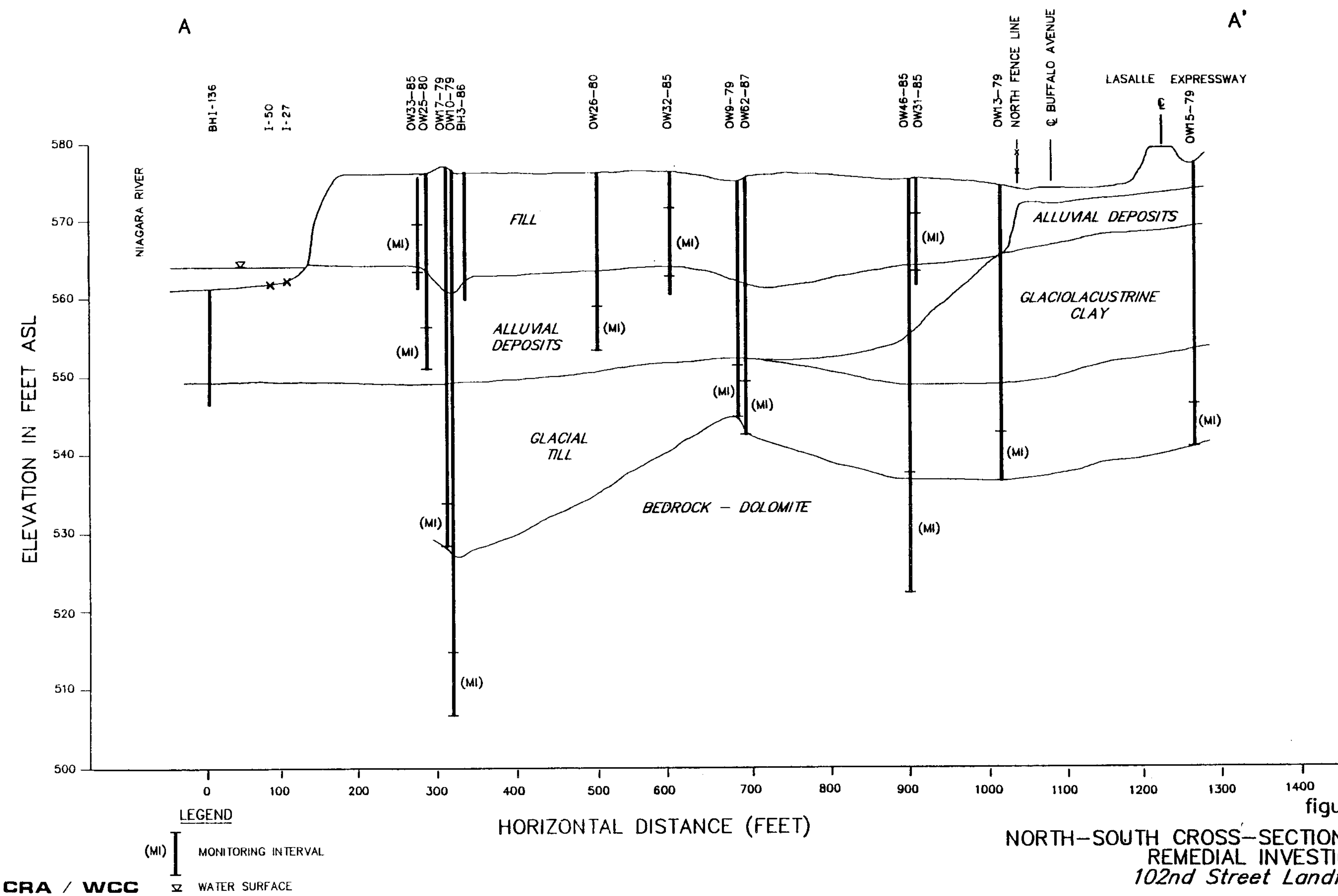


figure 3.6

NORTH–SOUTH CROSS–SECTION A–A'
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA / WCC

1431-13/07/88-47-D-1 (X-31)

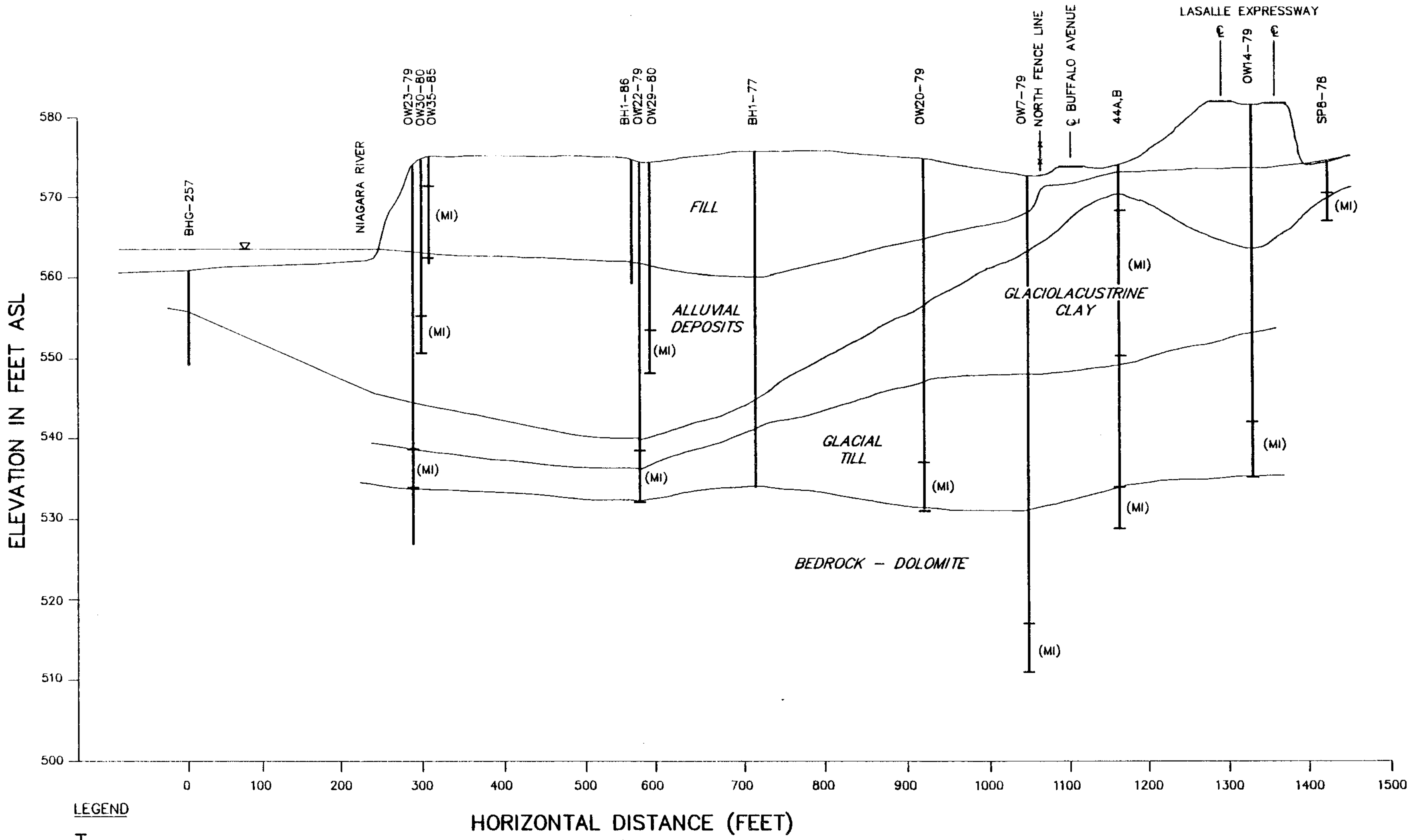


figure 3.7

NORTH-SOUTH CROSS-SECTION B-B'
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-2 (X-28)

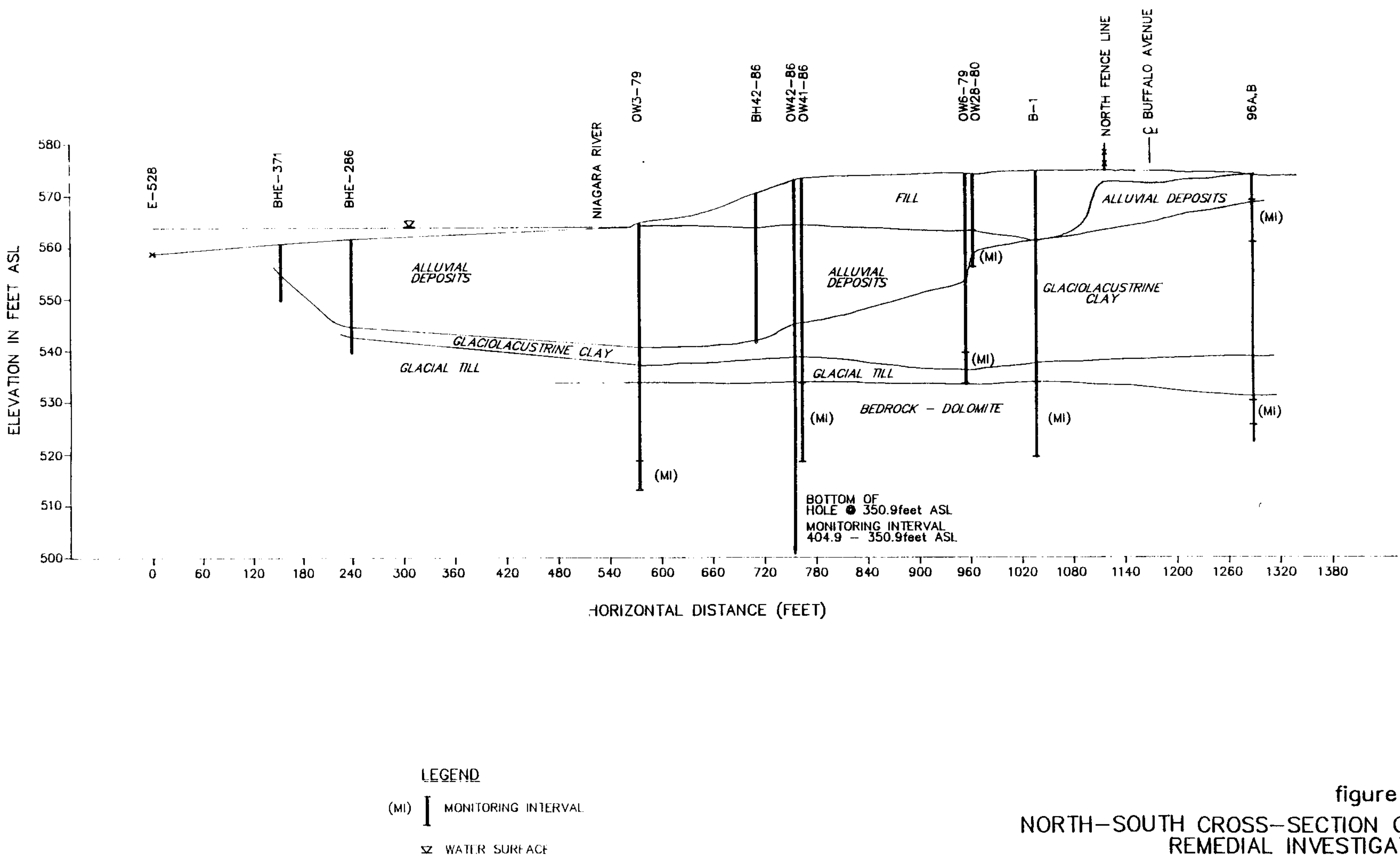


figure 3.8

NORTH–SOUTH CROSS–SECTION C–C'
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88 47 D 1 (P 92)

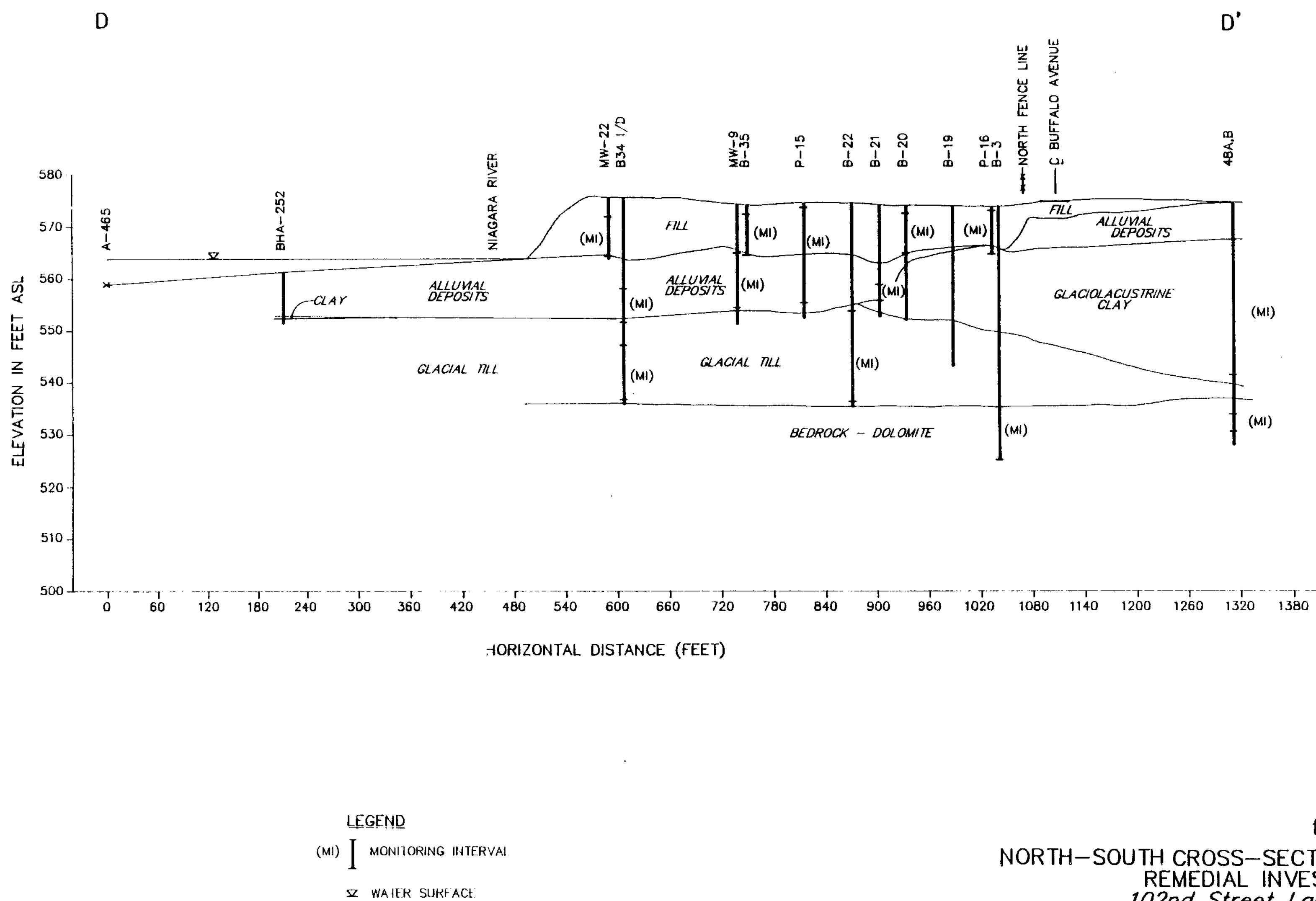
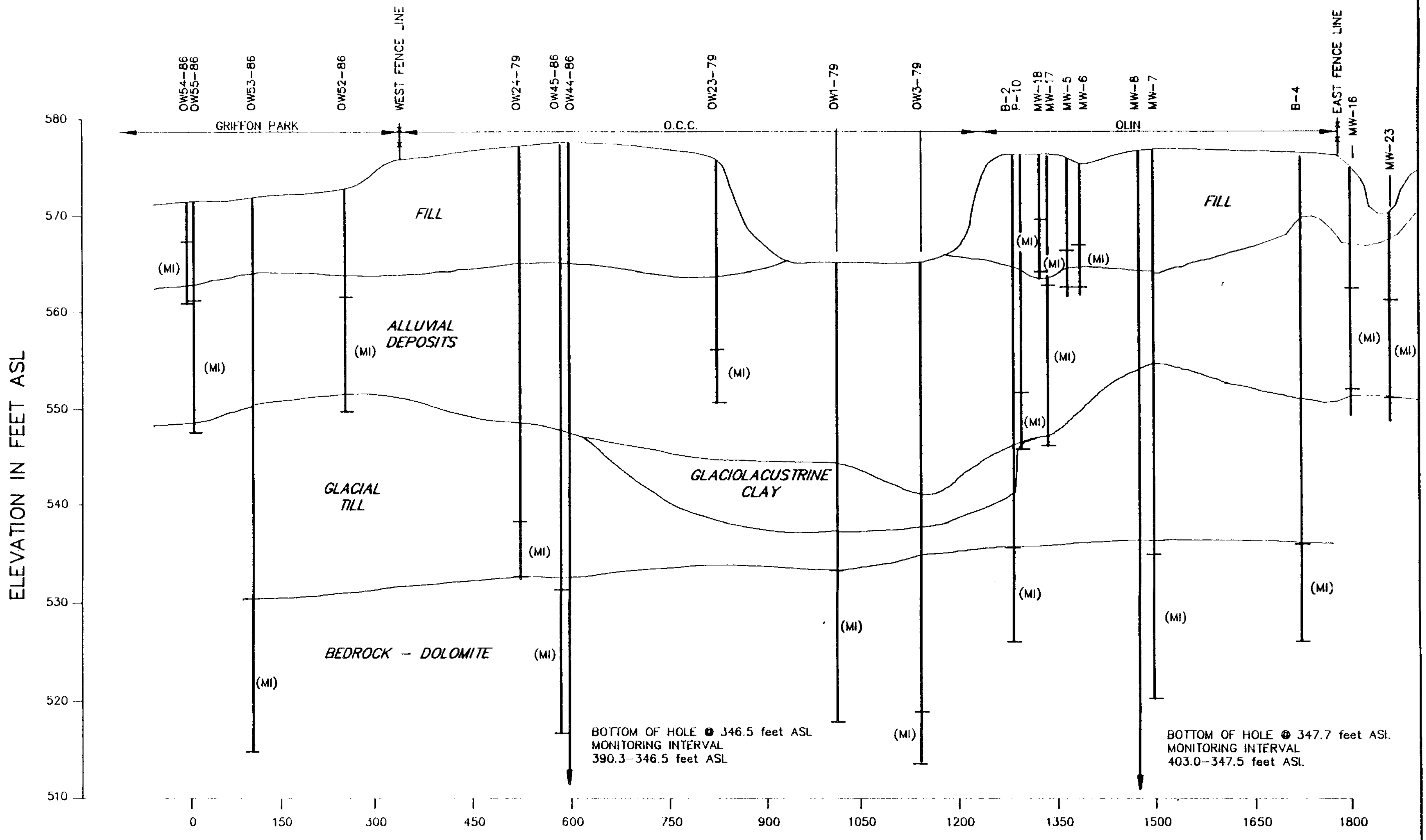


figure 3.9

NORTH–SOUTH CROSS–SECTION D–D'
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P-93)



CRA/WCC

1431--13/07/88--47--D-1 (X-30)

figure 3.10

EAST-WEST CROSS-SECTION E-E'
REMEDIAL INVESTIGATION
102nd Street Landfill Site

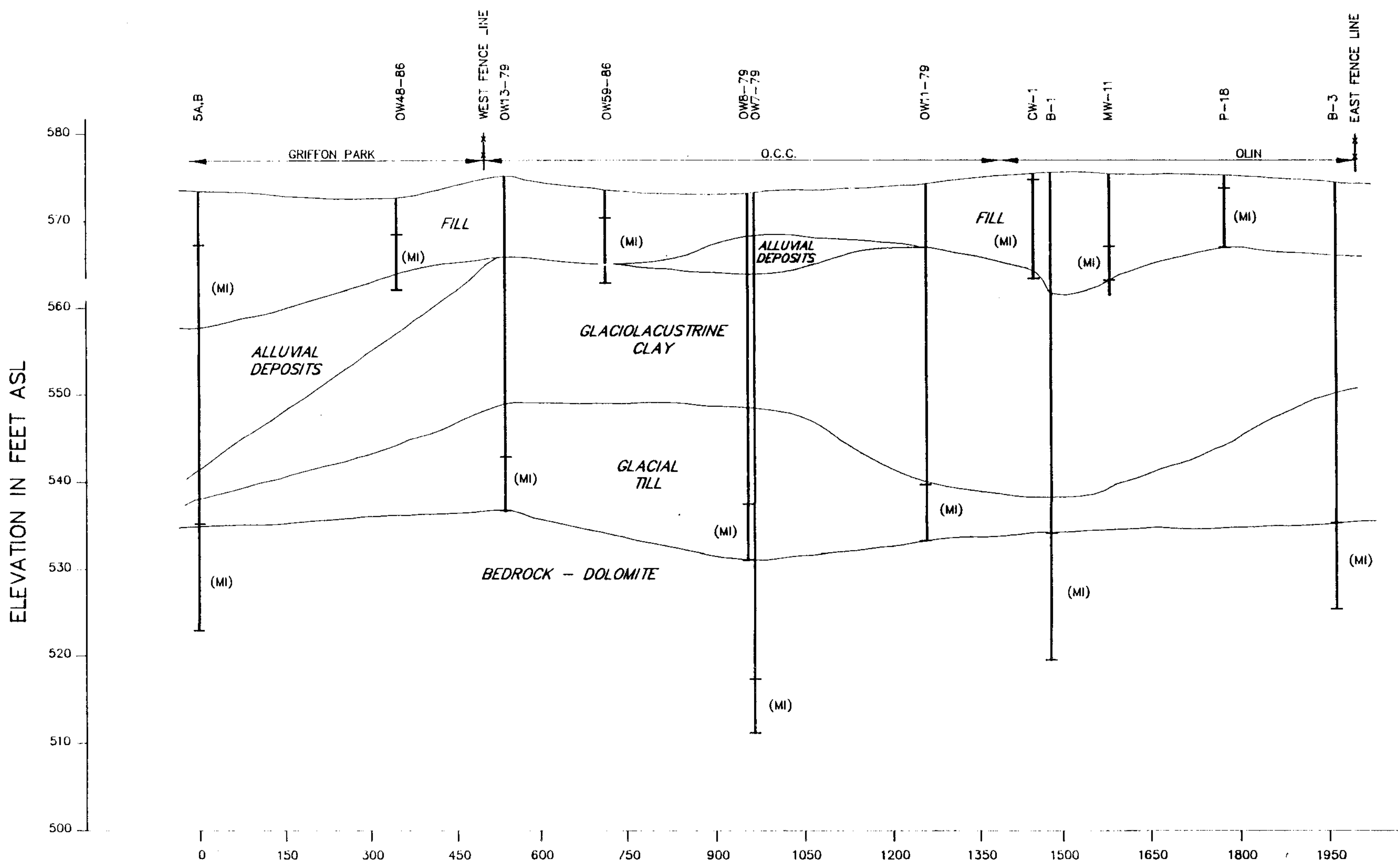


figure 3.11
EAST-WEST CROSS-SECTION F-F'
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC
1431-13/07/88-D-1 (X-29)

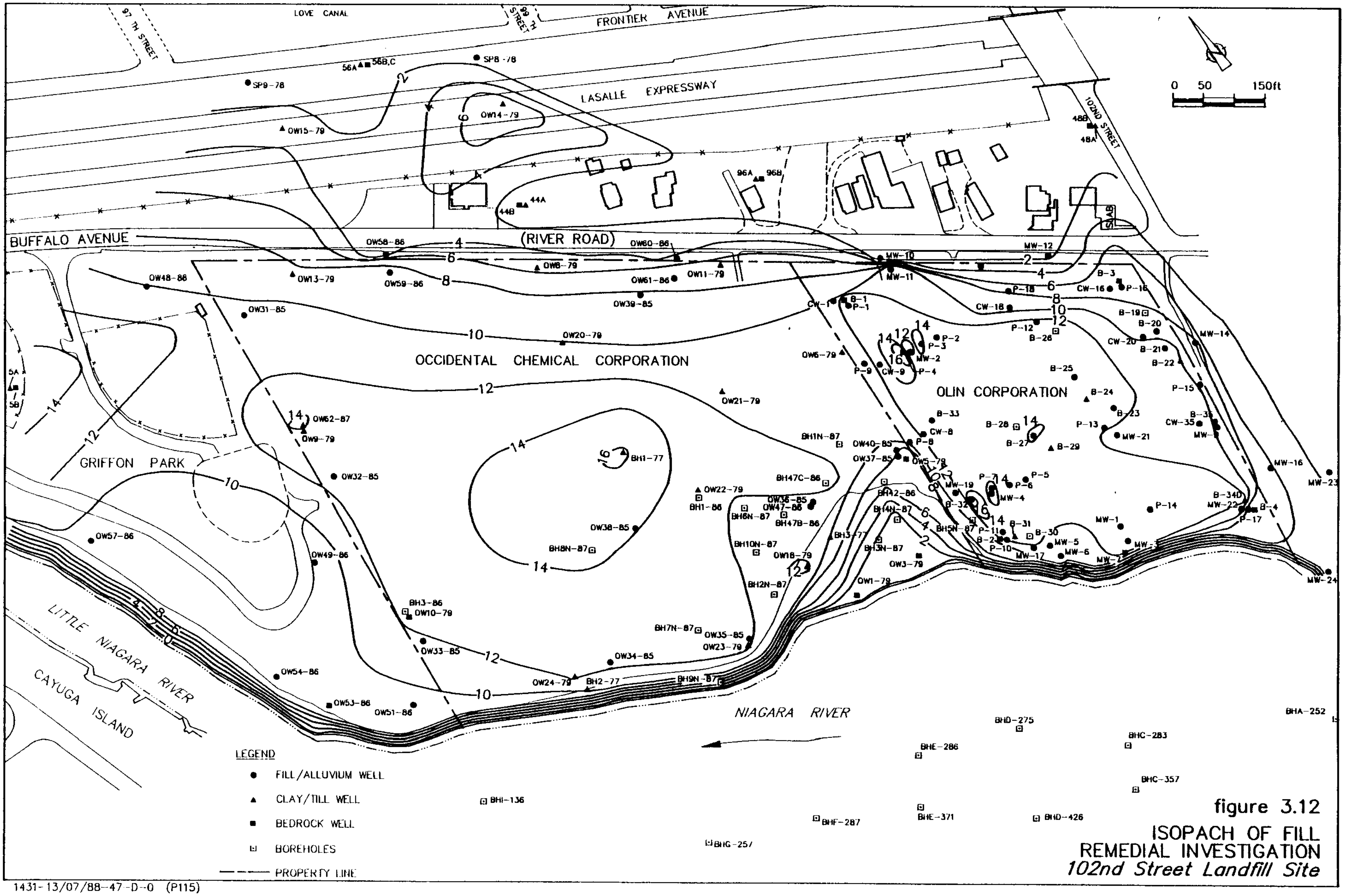


figure 3.12
ISOPACH OF FILL
REMEDIAL INVESTIGATION
102nd Street Landfill Site

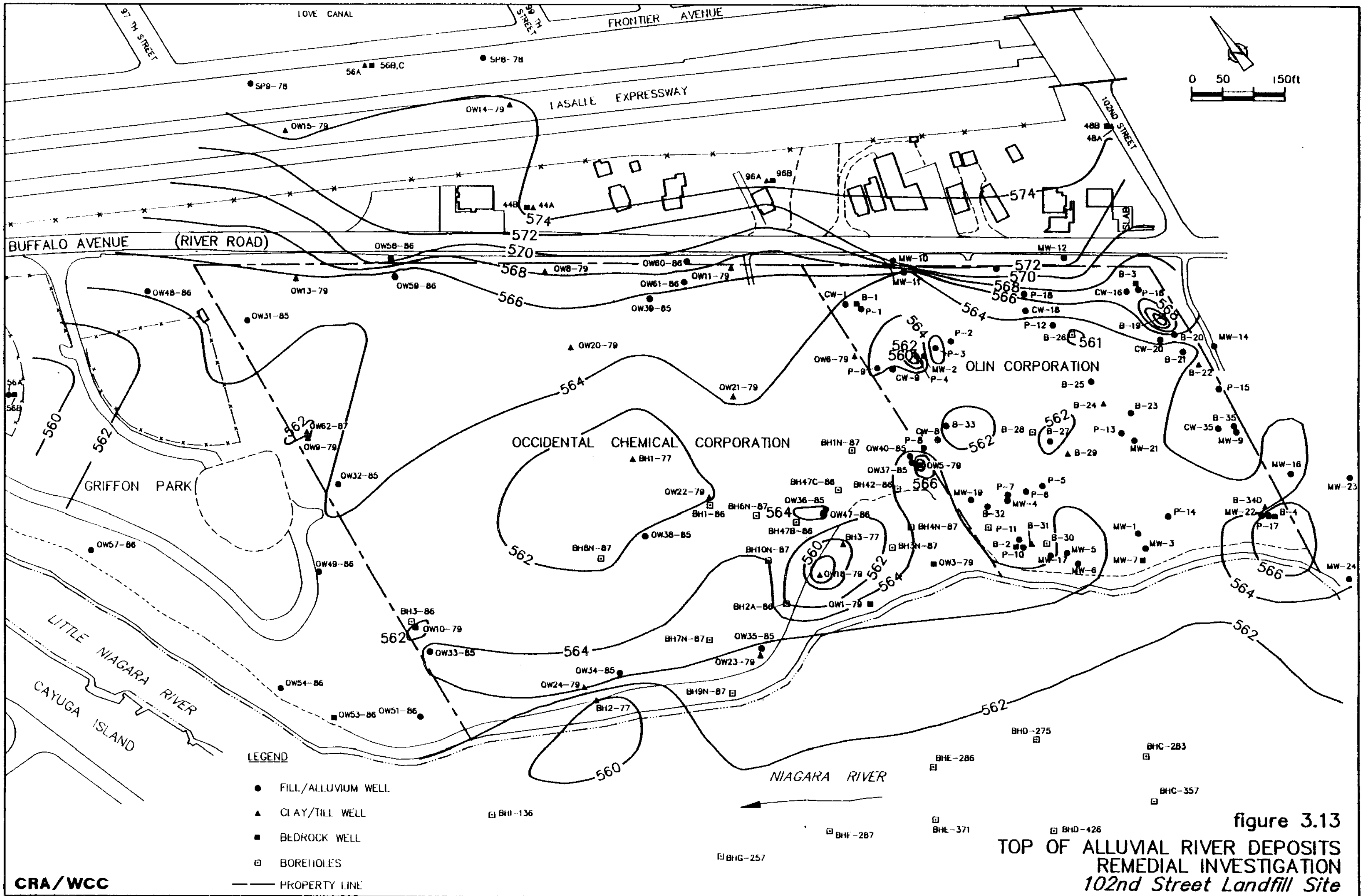


figure 3.13
TOP OF ALLUVIAL RIVER DEPOSITS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (P-114)

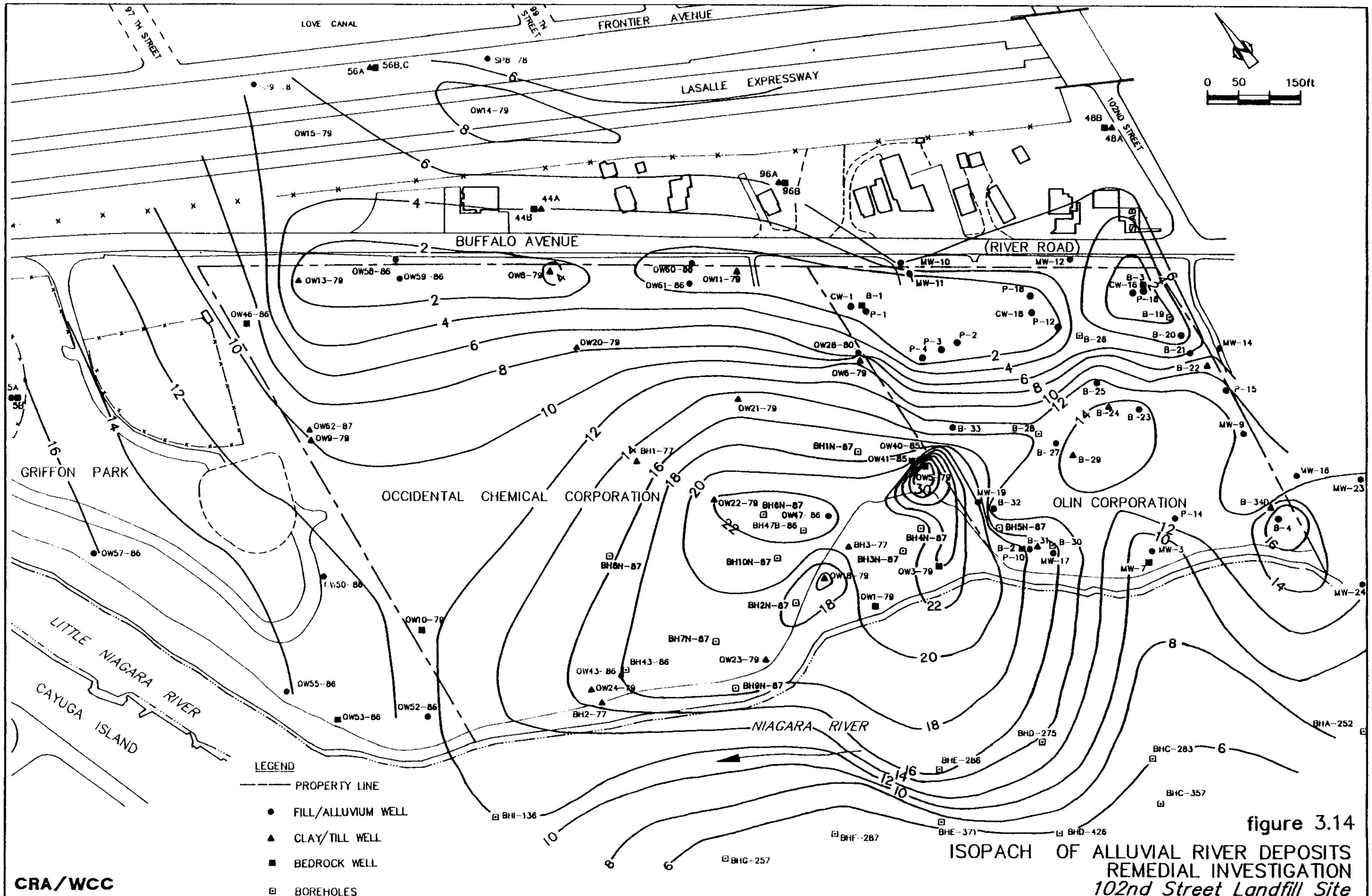


figure 3.14

ISOPACH OF ALLUVIAL RIVER DEPOSITS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1

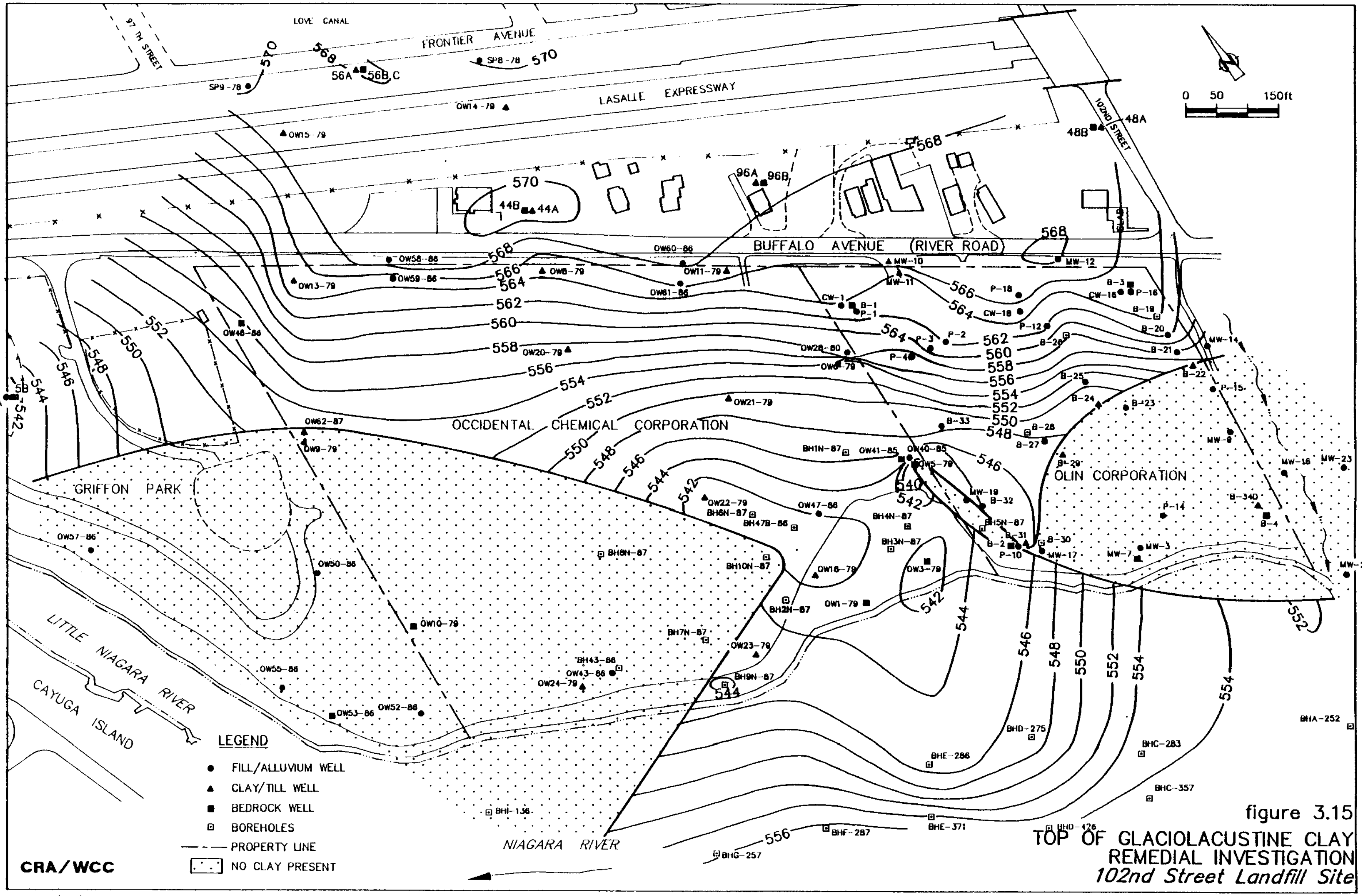


figure 3.15
TOP OF GLACIOLACUSTINE CLAY
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D- 2

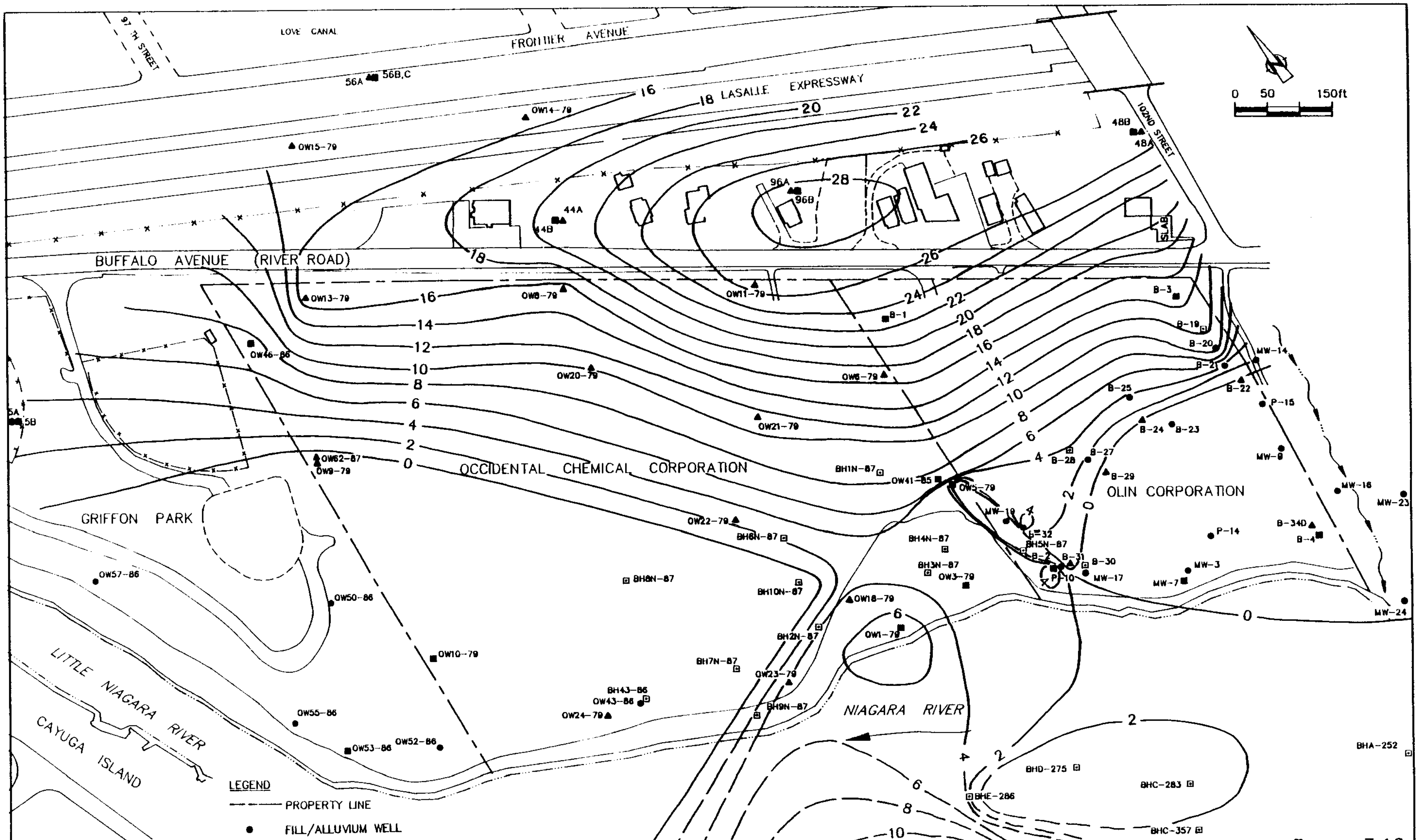


figure 3.16

ISOPACH OF GLACIOLACUSTRINE CLAY
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (P122)

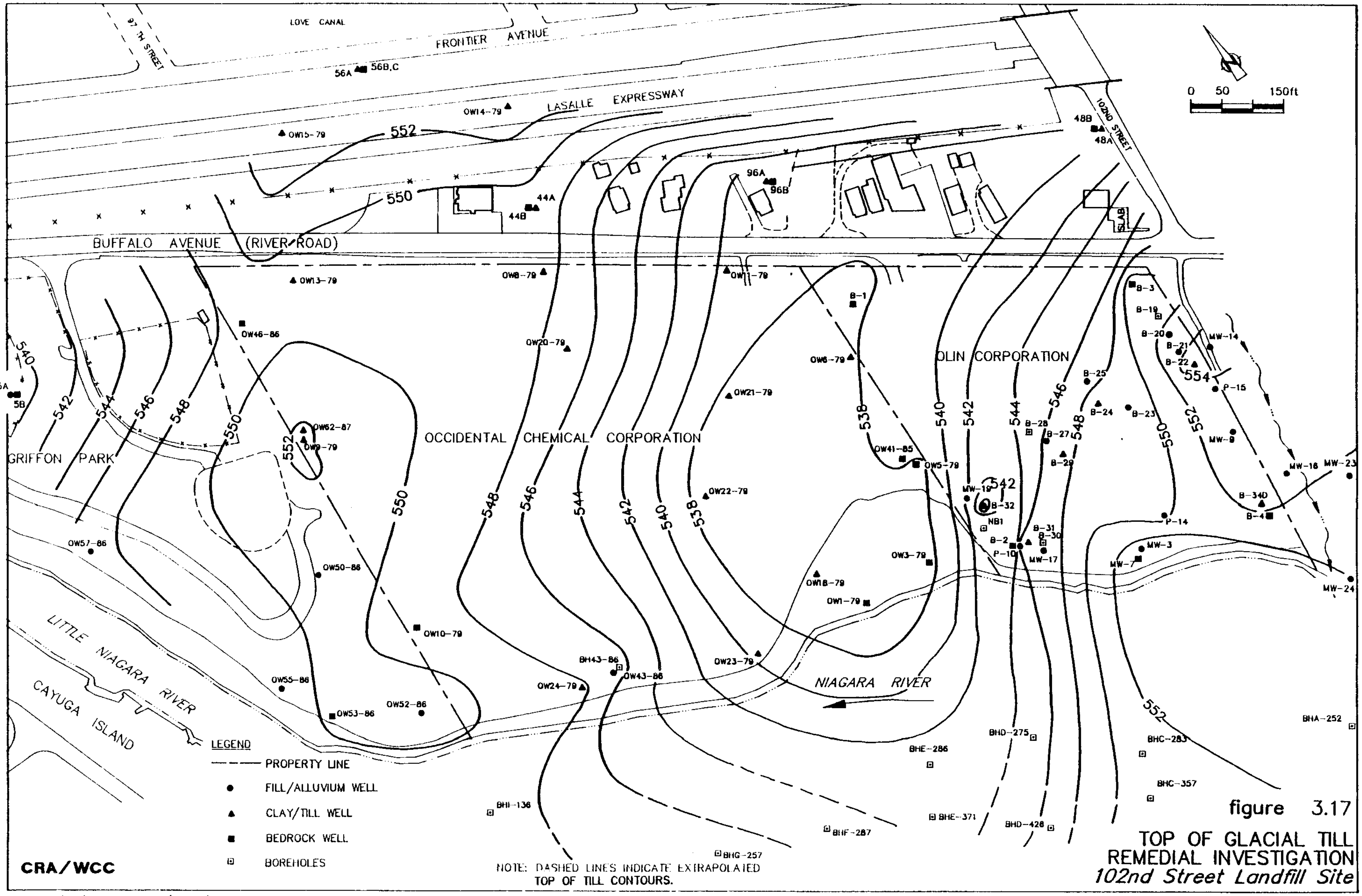


figure 3.17

TOP OF GLACIAL TILL
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (P-121)

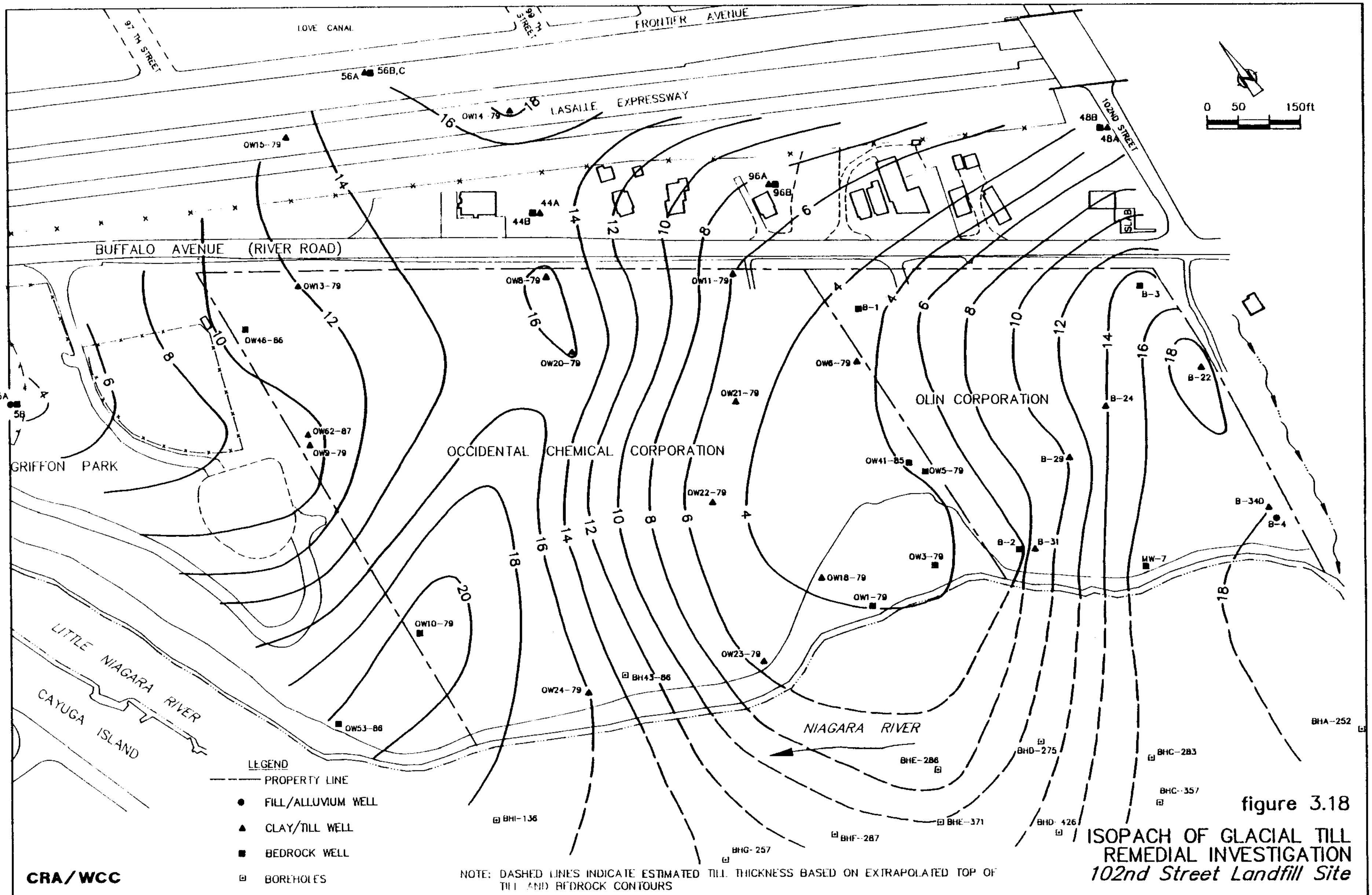


figure 3.18

ISOPACH OF GLACIAL TILL
REMEDIAL INVESTIGATION
102nd Street Landfill Site

NOTE: DASHED LINES INDICATE ESTIMATED TILL THICKNESS BASED ON EXTRAPOLATED TOP OF TILL AND BEDROCK CONTOURS

1431-13/07/88-47-D-1 (P-120)

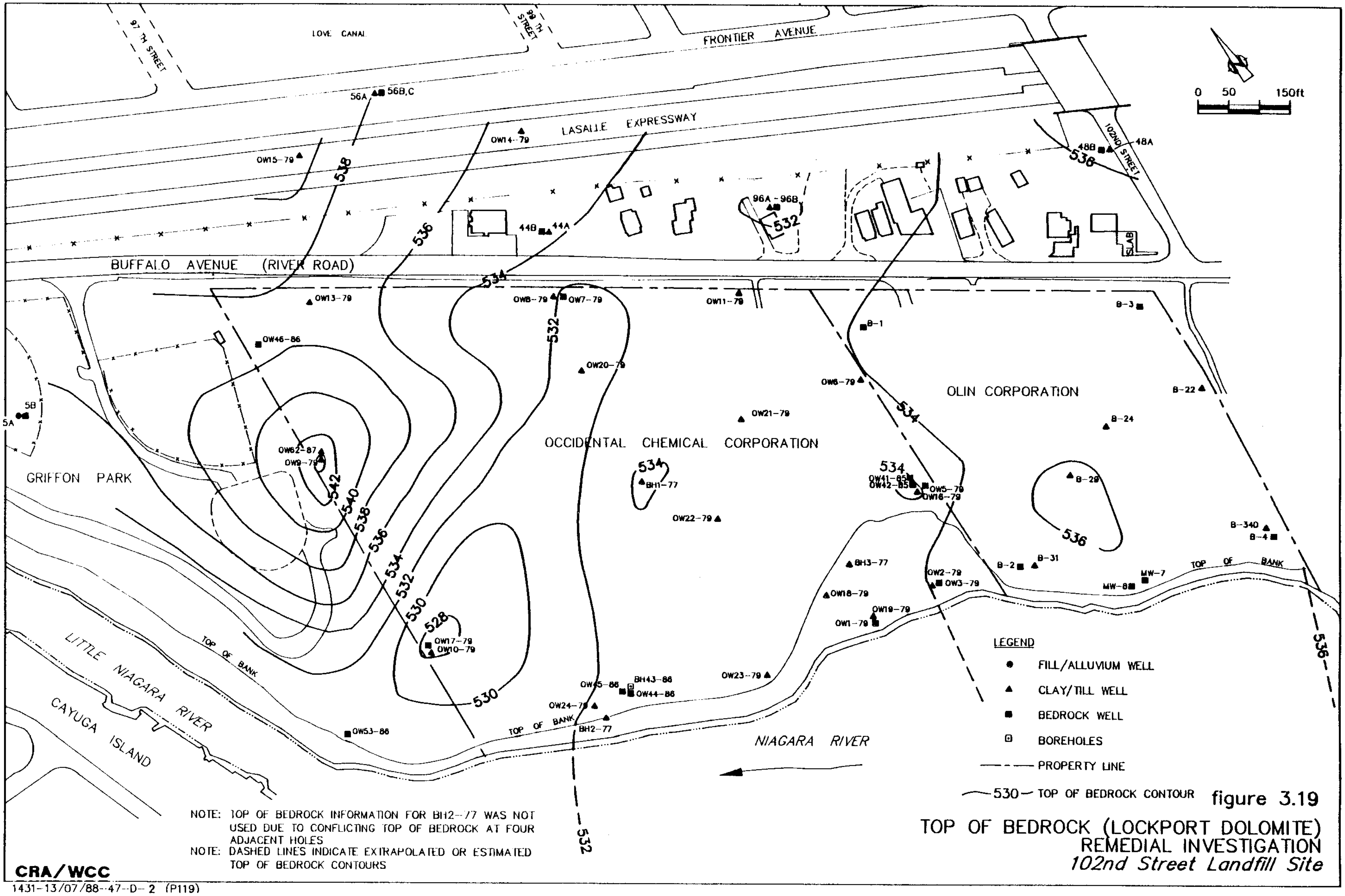


figure 3.19

TOP OF BEDROCK (LOCKPORT DOLOMITE)
REMEDIAL INVESTIGATION
102nd Street Landfill Site

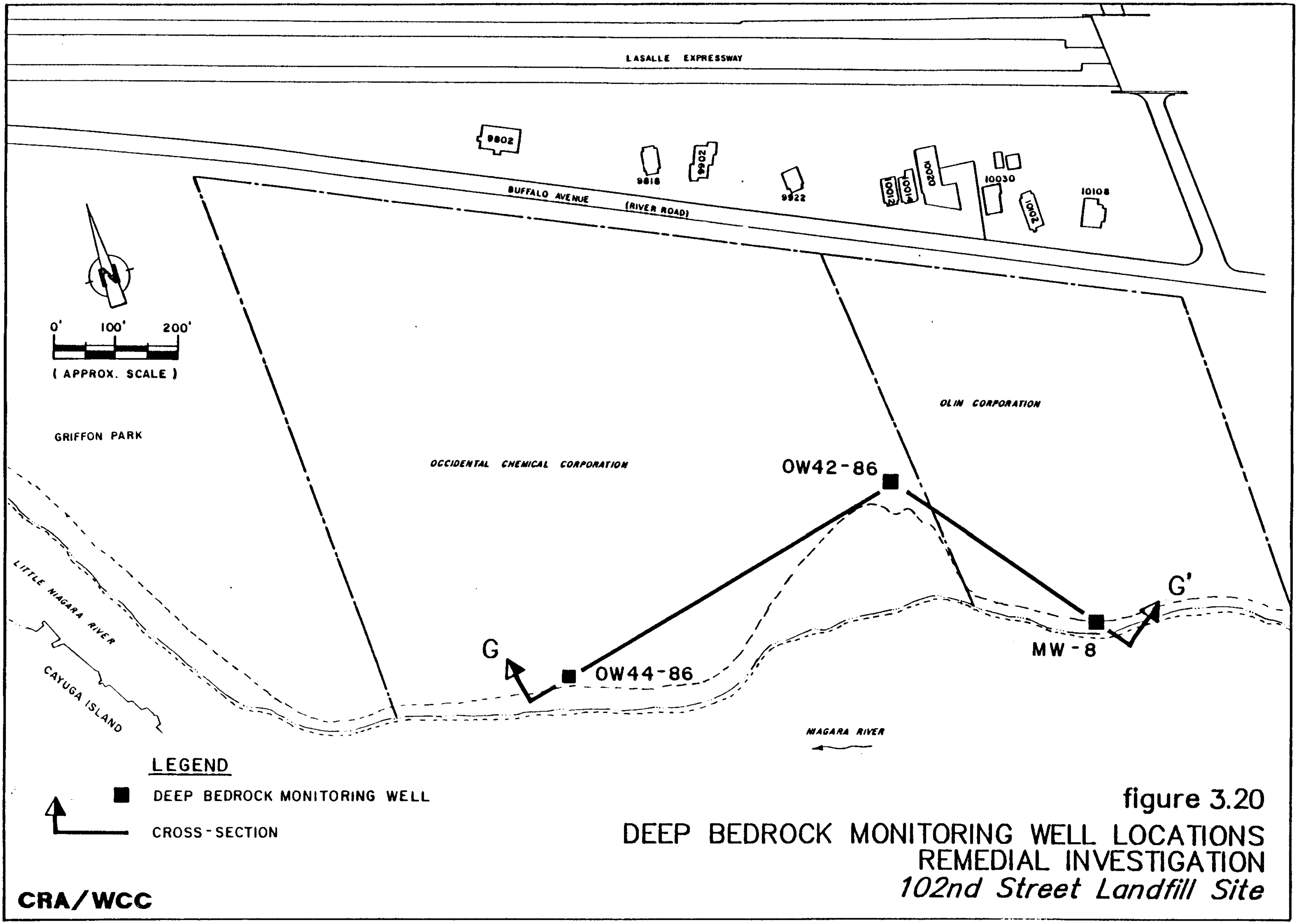


figure 3.20
DEEP BEDROCK MONITORING WELL LOCATIONS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1

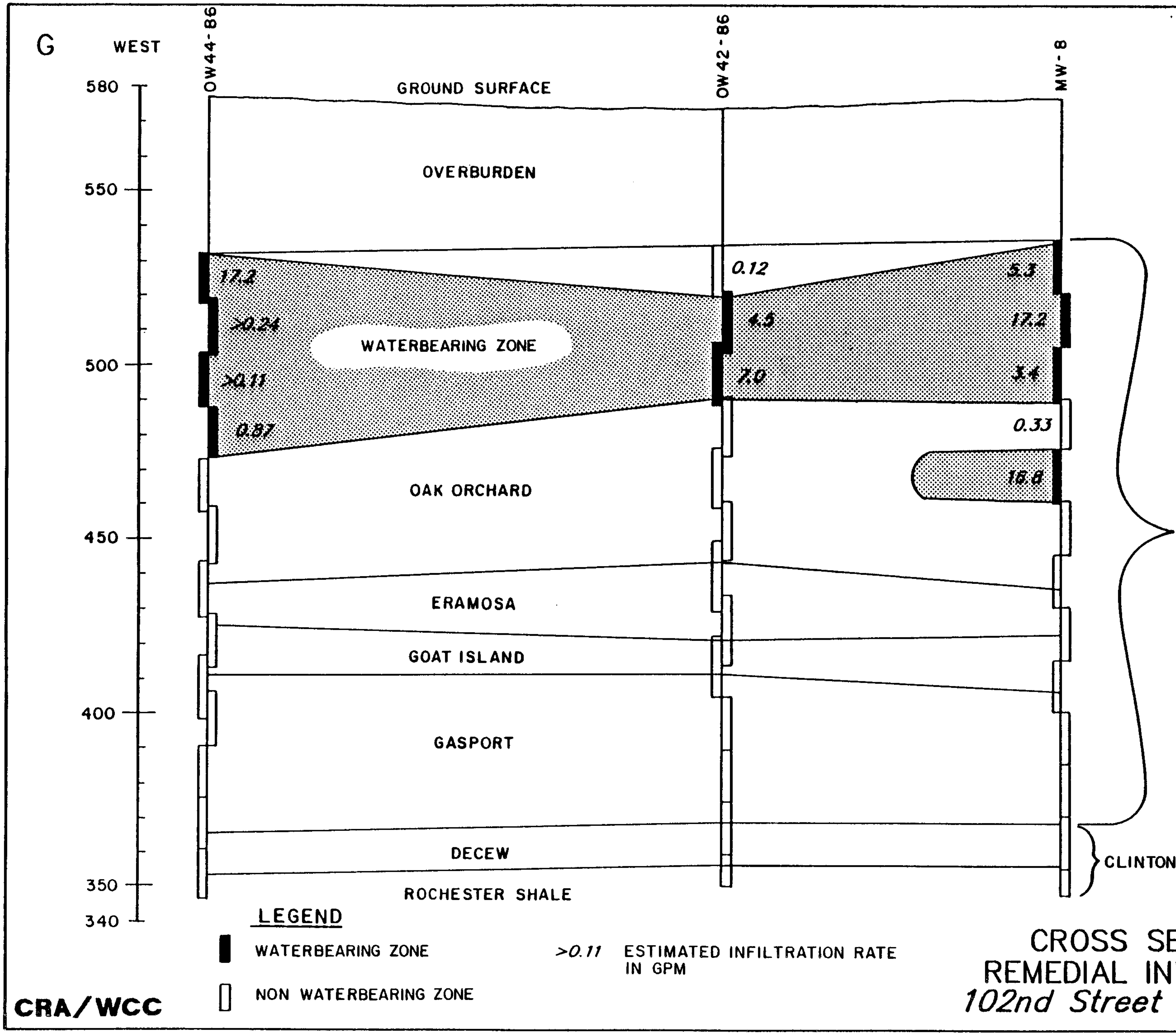


figure 3.21

CROSS SECTION G–G'
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1

TABLE 3.1
STRATIGRAPHIC SUMMARY - OVERBURDEN
102ND STREET LANDFILL

			Fill			Alluvium			Clay			Till			Bedrock	
Well Number	Sampled Depth (ft.BG)	Monitored Regime	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)
OCC																
BL1-77	42.0	Till	0	576.4	16.3	16.3	560.1	14.7	31.0	545.4	4.2	35.2	541.2	6.8	42.0	534.4
BL2-77	32.0	Till	0	569.6	10.0	10.0	559.6	16.2	-	-	0	26.2	543.4	5.8	32.0	537.6
BL3-77	36.0	Till	0	568.7	10.0	10.0	558.7	21.0	31.0	537.7	3.5	34.5	534.2	1.5	36.0	532.7
BL4-77*	16.5	Fill	0	576.4	16.3	16.3	560.1	>0.2								
BL5-77*	17.0	Fill	0	569.6	10.0	10.0	559.6	>7.0								
BL6-77*	16.0	Fill	0	568.7	10.0	10.0	558.7	>6.0								
OW 1-79	47.0	Bedrock			0	0	564.8	21.0	21.0	543.8	7.0	28.0	536.8	4.0	32.0	532.8
OW 2-79*	30.5	Till			0	0	564.7	24.0	24.0	540.7	3.0	27.0	537.7	3.5	30.5	534.2
OW 3-79	51.5	Bedrock			0	0	564.6	24.0	24.0	540.6	3.0	27.0	537.7	3.5	30.5	534.1
OW 5-79	60.0	Bedrock	0	573.6	3.5	3.5	570.1	32.5			0	36.0	537.6	4.0	40.0	533.6
OW 6-79	40.5	Till	0	574.4	11.0	11.0	563.4	10.0	21.0	553.4	17.0	38.0	536.4	2.5	40.5	533.9
OW 7-79*	62.0	Bedrock	0	573.1	5.0	5.0	568.1	4.5	9.5	563.6	15.5	25.0	548.1	17.0	42.0	531.1
OW 8-79	41.5	Till	0	573.5	5.0	5.0	568.5	4.5	9.5	564.0	15.5	25.0	548.5	16.5	41.5	532.0
OW 9-79	30.5	Till	0	575.6	13.0	13.0	562.6	10.0			0	23.0	552.6	7.5	30.5	545.1
OW10-79	68.5	Bedrock	0	575.5	15.0	15.0	560.5	11.5			0	26.5	549.0	22.0	48.5	527.0
OW11-79	40.0	Till	0	573.6	7.0			0	7.0	566.6	27.0	34.0	539.6	6.0	40.0	533.6
OW12-79	0.0	Alluvium	No Stratigraphic Information - No Split Spoon Sampling													
OW13-79	38.0	Till	0	574.8	9.0			0	9.0	565.8	17.0	26.0	548.8	12.0	38.0	536.8
OW14-79	46.2	Till	0	581.7	8.0	8.0	573.7	10.0	18.0	563.7	10.0	28.0	553.7	18.2	46.0	535.5
OW15-79	36.5	Till	0	577.4	3.2	3.2	574.2	5.3	8.5	568.9	15.0	23.5	553.9	13.0	36.0	540.9

*Partial or full stratigraphy taken from neighboring well/borehole

continued....

TABLE 3.1
STRATIGRAPHIC SUMMARY - OVERBURDEN
102ND STREET LANDFILL

			Fill			Alluvium			Clay			Till			Bedrock	
Well Number	Sampled Depth (ft.BG)	Monitored Regime	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)
OCC																
OW16-79*	39.5	Till	0	573.5	3.5	3.5	570.0	32.5			0	36.0	537.5	3.5	39.0	534.0
OW17-79	48.0	Till	0	576.4	15.0	15.0	561.4	11.5			0	26.5	549.9	21.5	48.0	528.4
OW18-79	35.3	Till	0	568.7	13.0	3.0	555.7	15.0	28.0	540.7	4.5	32.5	536.2	2.8	35.3	533.4
OW19-79	32.0	Till			0	0	564.7	21.0	21.0	543.7	7.0	28.0	536.7	4.0	32.0	532.7
OW20-79	44.2	Till	0	575.5	10.0	10.0	565.5	8.0	18.0	557.5	10.0	28.0	547.5	16.2	44.2	531.3
0W21-79	42.0	Till	0	575.3	11.0	11.0	564.3	15.0	26.0	549.3	11.5	37.5	537.8	4.5	42.0	533.3
OW22-79	42.7	Till	0	574.9	13.0	13.0	561.9	22.0	35.0	539.9	3.0	38.0	536.9	4.7	42.7	532.2
OW23-79	41.6	Till	0	575.5	12.0	12.0	563.5	19.0	31.0	544.5	5.5	36.5	539.0	5.1	41.6	533.9
OW24-79	44.5	Till	0	576.8	12.0	12.0	564.8	16.5			0	28.5	548.3	16.0	44.5	532.3
OW25-80*	25.0	Alluvium	0	575.6	15.0	15.0	560.6	>10.0								
OW26-80	23.0	Alluvium	No Stratigraphic Information - Only 1 Split Spoon Sample Taken													
OW27-80*	21.0	Alluvium	0	575.8	10.0	10.0	565.8	>11.0								
OW28-80*	18.0	Alluvium	0	574.6	11.0	11.0	563.6	4.5	15.5	559.2	>2.5					
OW29-80*	27.0	Alluvium	0	575.1	13.0	13.0	562.1	>14.0								
OW30-80*	25.0	Alluvium	0	575.8	12.0	12.0	563.8	>13.0								
OW31-85	14.0	Fill	0	575.8	11.0	11.0	564.8	>3.0								
OW32-85	16.0	Fill	0	576.6	12.1	12.1	564.5	>3.9								
OW33-85	14.0	Fill	0	575.4	11.0	11.0	564.4	>3.0								
OW34-85	15.0	Fill	0	577.4	12.5	12.5	564.9	>2.5								
OW35-85	14.0	Fill	0	575.9	12.5	12.5	563.4	>1.5								

*Partial or full stratigraphy taken from neighboring well/borehole

continued....

TABLE 3.1
STRATIGRAPHIC SUMMARY - OVERBURDEN
102ND STREET LANDFILL

			Fill			Alluvium			Clay			Till			Bedrock	
Well Number	Sampled Depth (ft.BG)	Monitored Regime	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)
OCC																
OW36-85	12.0	Fill	0	575.4	11.0	11.0	564.4	>1.0								
OW37-85	12.0	Fill	0	573.7	10.0	10.0	563.7	>2.0								
OW38-85	20.0	Fill	0	576.2	14.0	14.0	562.2	>6.0								
OW39-85	10.5	Fill	0	574.1	8.5	8.5	565.6	>2.0								
OW40-85*	29.0	Alluvium	0	573.7	9.0	9.0	564.7	19.5	28.5	545.2	>0.5					
OW41-85*	55.3	Bedrock	0	573.7	9.0	9.0	564.7	19.0	28.0	545.7	7.0	35.0	538.7	4.5	39.7	534.0
OW42-86*	223.3	Deep Bedrock	0	573.6	9.0	9.0	564.6	19.0	28.0	545.6	7.0	35.0	538.6	4.3	39.3	534.3
OW43-85*	32.0	Alluvium	0	577.2	12.5	12.5	564.7	18.0			0	30.5	546.7	>1.5		
OW44-86*	230.7	Deep Bedrock	0	577.2	12.5	12.5	564.7	18.0			0	30.5	546.7	14.0	44.4	532.8
OW45-86*	60.9	Bedrock	0	577.2	12.5	12.5	564.7	18.0			0	30.5	546.7	14.5	45.7	531.5
OW46-85*	53.2	Bedrock	0	575.6	11.0	11.0	564.6	9.0	20.0	555.6	7.0	27.0	548.6	11.6	38.0	537.6
OW47-86	35.5	Alluvium	0	575.4	10.5	10.5	564.9	22.5	33.0	542.4	>2.5					
OW48-86	10.0	Fill	0	572.6	8.6	8.6	564.0	>1.4								
OW49-86	12.0	Fill	0	572.4	8.5	8.5	563.9	>3.5								
OW50-86*	22.0	Alluvium	0	572.4	8.5	8.5	563.9	13.0			0	21.5	550.9	>0.5		
OW51-86	10.0	Fill	0	572.2	9.0	9.0	563.2	>1.0								
OW52-86	22.0	Alluvium	0	572.2	9.0	9.0	563.2	11.5			0	20.5	551.7	>1.5		
OW53-86	57.3	Bedrock	0	571.6	8.0	8.0	563.6	13.0			0	21.0	550.6	20.3	41.3	530.3
OW54-86	10.0	Fill	0	571.0	8.3	8.3	562.7	>1.7								
OW55-86*	24.0	Alluvium	0	571.1	8.3	8.3	562.8	14.2			0	22.5	548.6	>1.5		

*Partial or full stratigraphy taken from neighboring well/borehole.

continued....

TABLE 3.1
STRATIGRAPHIC SUMMARY - OVERBURDEN
102ND STREET LANDFILL

			Fill			Alluvium			Clay			Till			Bedrock	
Well Number	Sampled Depth (ft.BG)	Monitored Regime	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)
OCC																
OW56-86*	10.0	Fill	0	573.0	9.5	9.5	563.5	>0.5								
OW57-86	29.0	Alluvium	0	573.1	9.5	9.5	563.6	16.0			0	25.5	547.6	>3.5		
OW58-86	10.0	Alluvium	0	573.7	2.3	2.3	571.4	1.8	4.1	569.6	>5.9					
OW59-86	10.0	Alluvium	0	573.1	8.5	--	--	0	8.5	564.6	>1.5					
OW60-86	10.0	Alluvium	0	573.4	4.0	4.0	569.4	1.0	5.0	568.4	>5.0					
OW61-86	10.0	Alluvium	0	573.6	7.0	--	--	0	7.0	566.6	>3.0					
OW62-87	33.3	Till	0	576.2	14.5	14.5	561.7	9.5			0	24.0	552.2	9.3	33.3	542.9
OW63-87*	14.5	Alluvium	0	575.9	14.5	14.5	561.4									
SP8-78**	8.0	Alluvium			0	0	575.2	5.0	5.0	570.2	>3.0					
SP9-78**	8.0	Alluvium			0	0	575.7	5.5	5.5	570.2	>2.5					
BH1-86	16.0	--------	0	575.3	13.0	13.0	562.3	>3.0								
BH2-86	14.0	--------	0	575.0	13.3	13.3	561.7	>0.7								
BH3-86	16.0	--------	0	575.9	12.8	12.8	563.1	>3.2								
BH42-86	29.0	--------	0	570.4	6.3	6.3	564.1	>22.7								
BH43-86*	44.3	--------	0	577.2	12.5	12.5	564.7	18.0			0	30.5	546.7	13.8	44.3	532.9
BH47B-86	35.0	--------	0	574.7	11.0	11.0	563.7	22.8	33.8	540.9	>1.2					
BH47C-86	15.0	--------	0	575.1	13.0	13.0	562.1	>2.0								
OLIN																
MW-1	14.0	Fill	0	576.2	12.5	12.5	563.7	>1.5								
MW-2	12.0	Fill	0	575.8	10.4	10.4	565.4	>1.6								
MW-3	26.0	Alluvium	0	576.1	12.6	12.6	563.5	8.3			0	20.9	555.2	>5.1		
MW-4	14.0	Fill	0	575.2	11.0	11.0	564.2	>3.0								
MW-5	14.0	Sewer Bedding	0	575.9	11.0	11.0	564.9	>3.0								

* Partial or full stratigraphy taken from neighboring well/borehole.
**Stratigraphic information is approximate.

continued.....

TABLE 3.1
STRATIGRAPHIC SUMMARY - OVERBURDEN
102ND STREET LANDFILL

			Fill			Alluvium			Clay			Till			Bedrock	
Well Number	Sampled Depth (ft.BG)	Monitored Regime	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)
OLIN																
MW-6	12.0	Sewer Bedding	0	574.9	10.5	10.5	564.4	>1.5								
MW-7	56.1	Bedrock	0	576.3	13.0	13.0	563.3	9.5			0	22.5	553.8	18.0	40.5	535.8
MW-8*	229.0	Deep Bedrock	0	576.5	13.0	13.0	563.5	9.5			0	22.5	554.0	18.0	40.5	536.0
MW-9	23.0	Alluvium	0	574.3	8.6	8.6	565.7	11.9			0	20.5	553.8	>2.5		
MW-10	8.0	Sewer Bedding	0	575.0	1.5	1.5	573.5	6.0	7.5	567.5	>0.5					
MW-10A	16.5	-------	0	575.0	11.5			0	11.5	563.5	>0.5					
MW-11	13.0	Sewer Bedding	0	574.7	11.0			0	11.0	563.7	>2.0					
MW-12	8.0	Alluvium	0	574.2	1.0	1.0	573.2	5.0	6.0	568.2	>2.0					
MW-13*	8.5	Fill	0	572.5	8.0	8.0	564.5	>0.5								
MW-14	18.0	Alluvium	0	572.5	8.0	8.0	564.5	7.2	15.2	557.3	2.0	17.2	555.3	>0.8		
MW-15*	7.0	Fill	0	569.9	6.5	6.5	563.4	>0.5								
MW-16	18.0	Alluvium	0	569.9	6.5	6.5	563.4	10.5			0	17.0	552.9	>1.0		
MW-17	30.0	Alluvium	0	575.8	12.5	12.5	563.3	16.5			0	29.0	546.8	>1.0		
MW-18*	12.5	Fill	0	575.8	12.5	12.5	563.3									
MW-19	34.0	Alluvium	0	575.0	11.5	11.5	563.5	20.0			0	31.5	543.5	>2.5		
MW-20*	12.0	Fill	0	575.0	11.5	11.5	563.5	>0.5								
MW-21	13.0	Fill	0	575.4	11.8	11.8	563.6	>1.2								
MW-22	12.0	Fill	0	575.9	11.0	11.0	564.9	>1.0								
MW-23	17.0	Alluvium	0	567.2	2.5	2.5	564.7	13.2			0	15.7	551.5	>1.3		
MW-24	17.5	Alluvium	0	569.0	5.0	5.0	564.0	12.0			0	17.0	552.0	>0.5		

*Partial or full stratigraphy taken from neighboring well/borehole.

continued....

TABLE 3.1
STRATIGRAPHIC SUMMARY - OVERBURDEN
102ND STREET LANDFILL

Well Number	Sampled Depth (ft.BG)	Monitored Regime	Fill Depth (ft. BG)	Fill Elev. (ft. AMSL)	Fill Thickness (ft.)	Alluvium Depth (ft. BG)	Alluvium Elev. (ft. AMSL)	Alluvium Thickness (ft.)	Clay Depth (ft. BG)	Clay Elev. (ft. AMSL)	Clay Thickness (ft.)	Till Depth (ft. BG)	Till Elev. (ft. AMSL)	Till Thickness (ft.)	Bedrock Depth (ft. BG)	Bedrock Elev. (ft. AMSL)
OLIN																
B-1	55.8	Bedrock	0	575.1	14.0			0	14.0	561.1	23.5	37.5	537.6	3.3	40.8	534.3
B-2	50.0	Bedrock	0	575.8	12.0	12.0	563.8	18.0	30.0	545.8	5.0	35.0	540.8	5.5	40.5	535.3
B-3	49.0	Bedrock	0	574.0	8.5			0	8.5	565.5	15.5	24.0	550.0	15.0	39.0	535.0
B-4	50.1	Bedrock	0	575.8	8.0	8.0	567.8	17.0			0	25.0	550.8	15.0	40.0	535.8
B-19***	30.5	-------	0	574.1	8.5	8.5	565.6	1.0	9.5	564.6	12.8	22.3	551.8	>8.2		
B-20	22.2	Fill	0	574.1	9.0	9.0	565.1	2.0	11.0	563.1	11.0	22.0	552.1	>0.2		
B-21	21.5	Alluvium	0	574.1	11.5	11.5	562.6	6.5	18.0	556.1	2.7	20.7	553.4	>0.8		
B-22	39.5	Till	0	574.6	10.0	10.0	564.6	9.5			0	19.5	555.1	20.0	39.5	535.1
B-23	30.5	Alluvium	0	575.6	13.0	13.0	562.6	14.5			0	27.5	548.1	>3.0		
B-24	40.5	Till	0	575.6	12.5	12.5	563.1	14.0			0	26.5	549.1	14.0	40.5	535.1
B-25	29.5	Alluvium	0	575.2	12.0	12.0	563.2	13.0	25.0	550.2	3.5	28.5	546.7	>1.0		
B-26***	23.5	-------	0	575.0	13.5	13.5	561.5	4.2	17.7	557.3	>5.8					
B-27	29.5	Alluvium	0	575.3	14.5	14.5	560.8	13.0	27.5	547.8	1.0	28.5	546.8	>1.0		
B-28***	31.5	-------	0	575.2	13.0	13.0	562.2	14.0	27.0	548.2	3.8	30.8	544.4	>0.7		
B-29	38.5	Till	0	575.5	12.5	12.5	563.0	16.0			0	28.5	547.0	10.0		
B-30***	32.5	-------	0	575.7	13.0	13.0	562.7	16.5			0	29.5	546.2	>3.0	38.5	537.0
B-31	41.0	Till	0	576.2	12.5	12.5	563.7	18.0	30.5	545.7	1.4	31.9	544.3	9.1		
B-32***	36.5	Alluvium	0	574.9	18.0	18.0	556.9	12.5	30.5	544.4	5.0	35.5	539.4	>1.0	41.0	535.2
B-33	28.5	Alluvium	0	575.2	14.0	14.0	561.2	13.5	27.5	547.7	>1.0					
B-34D/B-34I	40.0	Till/Alluvium	0	575.9	12.5	12.5	563.4	10.5			0	23.0	552.9	17.0	40.0	535.9
B-35	10.0	Fill	0	574.4	9.8	9.8	564.6	>0.2								

*** Ground surface elevation is estimated to be 1.3 ft. higher than indicated on the logs (average difference of all Wehran wells is 1.3 ft.)

continued....

TABLE 3.1
STRATIGRAPHIC SUMMARY - OVERBURDEN
102ND STREET LANDFILL

			Fill			Alluvium			Clay			Till			Bedrock	
Well Number	Sampled Depth (ft.BG)	Monitored Regime	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)
OLIN																
P-1	13.0	Fill	0	575.3	12.5			0	12.5	562.8	>0.5					
P-2	13.0	Fill	0	575.2	12.5			0	12.5	562.7	>0.5					
P-3	15.0	Fill	0	575.1	14.8			0	14.8	560.3	>0.2					
P-4***	20.0	Fill	0	575.9	17.0	17.0	558.9	1.0	18.0	557.9	>2.0					
P-5	14.0	Fill	0	576.1	12.0	12.0	564.1	>2.0								
P-6	15.0	Fill	0	575.7	14.0	14.0	561.7	>1.0								
P-7	12.5	Fill	0	575.3	11.0	11.0	564.3	>1.5								
P-8	14.0	Fill	0	574.4	12.0	12.0	562.4	>2.0								
P-9	11.0	Fill	0	574.5	10.0	10.0	564.5	>1.0								
P-10	30.5	Alluvium	0	575.9	12.0	12.0	563.9	17.5			0	29.5	546.4	>1.0		
P-11***	14.5	Fill	0	575.6	13.0	13.0	562.6	>1.5								
P-12	13.5	Fill	0	574.6	12.0			0	12.0	562.6	>1.5					
P-13	23.0	Fill	0	575.6	12.5	12.5	563.1	>10.5								
P-14	26.5	Alluvium	0	575.7	13.0	13.0	562.7	13.0			0	26.0	549.7	>0.5		
P-15	22.5	Alluvium	0	574.7	10.0	10.0	564.7	11.5			0	21.5	553.2	>1.0		
P-16	9.5	Fill	0	574.0	7.5			0	7.5	566.5	>2.0					
P-17	11.5	Fill	0	575.9	8.0	8.0	567.9	>3.5								
P-18	8.0	Fill	0	574.6	7.8			0	7.8	566.8	>0.2					

*** Ground surface elevation is estimated to be 1.3 ft. higher than indicated on the logs (average difference of all Wehran wells is 1.3 ft.)

continued....

TABLE 3.1
STRATIGRAPHIC SUMMARY - OVERBURDEN
102ND STREET LANDFILL

			Fill			Alluvium			Clay			Till			Bedrock	
Well Number	Sampled Depth (ft.BG)	Monitored Regime	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)
OLIN																
CW-1	11.5	Fill	0	574.9	11.0			0	11.0	563.9	>0.5					
CW-8	13.0	Fill	0	575.0	12.0	12.0	563.0	>1.0								
CW-9	14.5	Fill	0	575.4	13.5	13.5	561.9	>1.0								
CW-16	8.0	Fill	0	574.1	7.5			0	7.5	566.5	>0.5					
CW-18	12.5	Fill	0	574.5	9.5			0	9.5	565.0	>3.0					
CW-20	11.0	Fill	0	574.2	9.5	9.5	564.7	>1.5								
CW-35	13.0	Fill	0	576.1	11.0	11.0	565.1	>2.0								
16***	6.5	------	0	574.1	6.0	6.0	568.1	>0.5								
OCC/OLIN																
BH1N-87	28.0	-	0	574.0	10.5	10.5	563.5	16.5	27.0	547.0	>1.0					
BH2N-87	29.0	-	0	575.6	11.5	11.5	564.1	17.0	28.5	547.1	>0.5					
BH3N-87	24.0	-	0	565.9	2.0	2.0	563.9	20.0	22.0	543.9	>2.0					
BH4N-87	26.0	-	0	566.2	1.5	1.5	564.7	21.5	23.0	543.2	>3.0					
BH5N-87	30.0	-	0	574.7	12.5	12.5	562.2	15.5	28.0	546.7	>2.0					
BH6N-87	34.0	-	0	574.5	11.4	11.4	563.1	22.1	33.5	541.0	>0.5					
BH7N-87	33.0	-	0	576.6	12.0	12.0	564.6	18.0	30.0	546.6	>3.0					
BH8N-87	32.0	-	0	577.2	16.0	16.0	561.2	15.5	31.5	545.7	>0.5					
BH9N-87	25.0	-	0	569.3	6.0	6.0	563.3	18.8	24.8	544.5	>0.2					
BH10N-87	32.5	-	0	575.0	11.0	11.0	564.0	21.0	32.0	543.0	>0.5					

***Ground surface elevation is estimated to be 1.3 feet higher than indicated on the logs (average difference of all Wehran wells is 1.3 feet).

continued.....

TABLE 3.1
STRATIGRAPHIC SUMMARY - OVERBURDEN
102ND STREET LANDFILL

			Fill			Alluvium			Clay			Till			Bedrock	
Well Number	Sampled Depth (ft.BG)	Monitored Regime	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)
OCC/OLIN																
A-252	9.8	-	-	-----	0	0	561.3	8.5	8.5	552.8	0.5	9.0	552.3	>0.8		
C-283	15.0	-	-	-----	0	0	560.8	6.0	6.0	554.8	3.0	9.0	551.8	>6.0		
C-357	11.0	-	-	-----	0	0	560.4	7.0	7.0	553.4	1.5	8.5	551.9	>2.5		
D-275	17.0	-	-	-----	0	0	561.4	14.0	14.0	547.4	2.5	16.5	544.9	>0.5		
D-426	11.0	-	-	-----	0	0	560.0	5.5	5.5	554.5	>5.5	----	-----	---		
E-286	22.0	-	-	-----	0	0	561.6	17.0	17.0	544.6	2.0	19.0	542.6	>2.5		
E-371	11.0	-	-	-----	0	0	560.7	6.0	6.0	554.7	>5.0	----	-----	---		
F-287	9.0	-	-	-----	0	0	560.8	3.8	3.8	557.0	>5.2	----	-----	---		
G-257	11.0	-	-	-----	0	0	560.8	5.0	5.0	555.8	>6.0	----	-----	---		
I-136	15.0	-	-	-----	0	0	561.2	12.0	---	-----	---	12.0	549.2	>3.0		
LOVE CANAL																
5A	17.0	Fill	0	573.4	16.0	16.0	557.4	>1.0								
5B	46.5	Bedrock	0	573.4	15.2	15.2	558.2	16.8	32.0	541.4	3.0	35.0	538.4	3.0	38.0	535.4
44A	26.0	Clay			0	0	574.6	4.0	4.0	570.6	21.5	25.5	549.1	>0.5		
44B	45.9	Bedrock			0	0	574.6	4.0	4.0	570.6	21.5	25.5	549.1	14.5	40.0	534.6
48A	33.0	Clay			0	0	574.6	7.0	7.0	567.6	>26.0					
48B	43.9	Bedrock			0	0	574.6	7.0	7.0	567.6	28.0	35.0	539.6	3.5	38.5	536.1
56A	23.0	Clay			0	0	574.9	7.0	7.0	567.9	14.0	21.0	553.9	>2.0		
56B,C	225.7	Deep Bedrock			0	0	574.9	7.0	7.0	567.9	14.0	21.0	553.9	16.2	37.2	537.7
96A	14.8	Clay			0	0	574.1	6.0	6.0	568.1	>8.8					
96B	48.2	Bedrock			0	0	574.1	6.0	6.0	568.1	29.5	35.5	538.6	>.1	42.0	531.5

TABLE 3.2

STRATIGRAPHIC SUMMARY - BEDROCK
102ND STREET LANDFILL

		Lockport Dolomite-Oak Orchard			Lockport Dolomite - Eramosa			Lockport Dolomite-Goat Island		
Well Number	Total Depth (ft. BG)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)
OCC										
OW1-79	47.0	32.0	532.8	>15.0						
OW2-79	30.5	30.5	534.2							
OW3-79	51.5	30.5	534.1	>21.0						
OW5-79	60.0	40.0	533.6	>20.0						
OW6-79	40.5	40.5	533.9							
OW7-79	62.0	42.0	531.1	>20.0						
OW8-79	41.5	41.5	532.0							
OW9-79	30.5	30.5	545.1							
OW10-79	68.5	48.5	527.0	>20.0						
OW11-79	40.0	40.0	533.6							
OW13-79	38.0	38.0	536.8							
OW14-79	46.2	46.2	535.5							
OW15-79	36.5	36.5	540.9							
OW16-79	39.5	39.5	534.0							
OW17-79	48.0	48.0	528.4							
OW18-79	35.3	35.3	533.4							
OW19-79	32.0	32.0	532.7							
OW20-79	44.2	44.2	531.3							

continued.....

TABLE 3.2

STRATIGRAPHIC SUMMARY - BEDROCK
102ND STREET LANDFILL

		Lockport Dolomite-Oak Orchard			Lockport Dolomite - Eramosa			Lockport Dolomite-Goat Island		
Well Number	Total Depth (ft. BG)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)
OCC										
OW21-79	42.0	42.0	533.3							
OW22-79	42.7	42.7	532.2							
OW23-79	41.6	41.6	533.9							
OW24-79	44.5	44.5	532.3							
OW41-85	55.3	39.5	534.2	>15.8						
OW42-86*	223.3	39.3	534.3	91.2	130.5	443.1	22.0	152.5	421.1	9.5
OW44-86*	230.7	44.5	532.7	95.5	140.0	437.2	12.1	152.1	425.1	14.3
OW45-85	60.9	45.0	532.2	>15.9						
OW46-86	53.2	38.6	537.0	>14.6						
OW53-86	57.3	41.3	530.3	>16.0						
OW62-86	33.3	33.3	542.9							
BH43-86	44.3	44.3	532.9							
BL1-77	42.0	42.0	534.4							
BL2-77	32.0	32.0	537.6							
BL3-77	36.0	36.0	532.7							
OLIN										
MW-7	56.1	40.5	535.8	>15.6						
MW-8*	229.0	40.5	536.0	100.1	140.6	435.9	13.4	154.0	422.5	16.2
B-1	55.8	40.8	534.3	>15.0						
B-2	50.0	40.5	535.3	>9.5						

* Completed on last page.

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TABLE 3.2

STRATIGRAPHIC SUMMARY - BEDROCK
102ND STREET LANDFILL

		Lockport Dolomite-Oak Orchard			Lockport Dolomite - Eramosa			Lockport Dolomite-Goat Island		
Well Number	Total Depth (ft. BG)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)
OLIN										
B-3	49.0	39.0	535.0	>10.0						
B-4	50.1	40.0	535.8	>10.1						
B-22	39.5	39.5	535.1							
B-24	40.5	40.5	535.1							
B-29	38.5	38.5	537.0							
B-31	41.0	41.0	535.2							
B-34D	40.0	40.0	535.9							
LOVE CANAL										
5B	46.5	38.0	535.4	>8.5						
44B	45.9	40.0	534.6	>5.9						
48B	43.9	38.5	536.1	>5.4						
56B,C	225.7	37.2	537.7	96.3	133.5	441.4	21.4	154.9	420.0	8.4
56C	225.7	163.3	411.6	25.7	189.0	385.9	13.0	202.0	372.9	>23.7
96B	48.2		42.6	531.5	>5.6					

continued.....

TABLE 3.2

STRATIGRAPHIC SUMMARY - BEDROCK
102ND STREET LANDFILL

		Lockport Dolomite-Gasport			Clinton Group-Decew			Clinton Group-Rochester		
Well Number	Total Depth (ft. BG)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)	Depth (ft. BG)	Elev. (ft. AMSL)	Thickness (ft.)
OCC										
OW42-86	223.3	162.0	411.6	42.8	204.8	368.8	12.0	216.8	356.8	>6.5
OW44-86	230.7	166.4	410.8	43.6	210.0	367.2	14.0	224.0	353.2	>6.7
OLIN										
MW-8	229.0	170.2	406.3	37.8	208.0	368.5	12.0	220.0	356.5	>9.0

TABLE 3.3

SUMMARY OF GRAIN SIZE DETERMINATIONS

Designation	Sample Depth (ft.)	Percent Gravel (>4.5 mm)	Percent Sand (4.5-0.075 mm)	Percent Silt (0.075-0.002 mm)	Percent Clay (<0.002 mm)	Estimated Hydraulic Conductivity (Hazen) (cm/sec)
Fill						
MW-5	10.5 - 11.0					2.2×10^{-2}
Alluvium						
DH-5	9.0 - 12.0					6.7×10^{-4}
MW-6	11.0 - 12.0					9.3×10^{-2}
OW3-79	20.0 - 21.5	1.9	90.1	8.0	0.0	5.6×10^{-3}
OW25-80	23.0 - 25.0	0.0	46.0	48.0	6.0	1.6×10^{-5}
OW27-80	14.0 - 16.0	0.0	30.0	62.0	8.0	1.2×10^{-5}
OW30-80	23.0 - 25.0	0.5	56.5	38.5	4.5	7.2×10^{-5}
DH-6	9.0 - 12.0					1.7×10^{-1}
Clay						
OW6-79	30.0 - 31.5	0.0	1.0	36.0	63.0	1.6×10^{-11}
OW11-79	10.0 - 11.5	1.0	10.0	34.0	55.0	9.0×10^{-8}
OW13-79	15.0 - 16.5	0.0	0.5	56.5	43.0	6.3×10^{-10}
DH-10	8.5 - 11.5					1.7×10^{-6}
DH-11	8.0 - 11.0					1.7 X 10-6
Glacial Till						
OW3-79	25.0 - 26.5	2.0	14.0	37.0	47.0	8.1×10^{-11}
OW6-79	39.0 - 40.5	18.0	36.0	42.0	4.0	8.4×10^{-6}
OW8-79	29.0 - 30.5	20.0	28.0	39.5	12.5	3.6×10^{-7}
OW10-79	30.0 - 31.5	16.5	32.5	40.0	11.0	2.3×10^{-6}
OW10-79	35.0 - 36.5	6.0	24.0	52.0	18.0	2.5×10^{-7}

d_{10}^2 = K Hazen (estimated)

TABLE 3.4
LABORATORY HYDRAULIC CONDUCTIVITY DETERMINATIONS

Well Number	Sample Number	Depth of Sample (ft.)	Remolded Permeability k cm/sec	Laboratory Permeability k cm/sec	Liquid Limit	Plastic Limit
Alluvium						
P-11		13.0 - 14.5	6.0×10^{-7}			
B-21		13.5 - 15.5	2.2×10^{-5}			
B-24		13.5 - 15.5	5.7×10^{-6}			
B-29		14.0 - 16.0	5.8×10^{-6}			
B-31		13.5 - 15.5	8.2×10^{-7}			
B-33		15.5 - 17.5	2.7×10^{-6}			
Glaciolacustrine Clay						
OW6-79	7	30.0 - 31.5	5.6×10^{-9}		40.3	18.9
OW13-79	4	15.0 - 16.5	8.8×10^{-9}		32.2	21.8
G-257	-	7.8	-	6.97×10^{-8}	36	22
B-1		17 - 18.5	2.1×10^{-8}			
Glacial Till						
OW3-79	6	25.0 - 26.5	6.7×10^{-9}		29.5	19.4
OW8-79	7	29.0 - 30.5	1.5×10^{-8}		13.6	17.8
OW10-79	9	35.0 - 36.5	1.5×10^{-8}		16.2	14.3
A-252	-	9.0	-	5.65×10^{-8}	50	23
E-286	-	19.9	-	7.42×10^{-8}	29	16
I-136	-	13.5	-	5.96×10^{-8}	17	14

4.0 HYDROGEOLOGIC INVESTIGATION

Several field programs were conducted during the RI which were designed to supplement existing hydrogeologic data. Details of each of these programs have been presented in Project Milestone Reports previously submitted to the EPA/State The following sections of this report present a brief summary of these field activities and their results.

4.1 PURPOSE

The field programs were designed to supplement existing data in order to:

- more accurately assess the nature and extent of chemical presence in the groundwater at the Site, and
- more accurately assess the factors which influence the site hydrogeologic conditions.

4.2 ASSESSMENT OF HYDROGEOLOGIC CONDITIONS

4.2.1 HYDRAULIC HEAD MONITORING

The Hydraulic Head Monitoring Program was conducted in order to:

- assess directions and rates of chemical migration from the Site; and
- determine the hydraulic head variation caused by daily River stage fluctuations and other influences (i.e. weather).

The program was conducted in three phases to assure that appropriate data was being collected to accurately evaluate the site conditions. A review of the data was conducted between each phase and a plan was developed for the next phase of monitoring. The three phases of Hydraulic Head Monitoring conducted during the RI were:

- Initial 5-Day Monitoring Program
- Continuous Hydraulic Head Monitoring Program
- Extended Hydraulic Head Monitoring Program

4.2.1.1 INITIAL 5-DAY MONITORING PROGRAM

An initial hydraulic head monitoring survey of five days duration was conducted from July 14 to 18, 1986. The purposes of this program were

- to assist in the refinement of the directions and rates of chemical migration;
- to evaluate the hydraulic head variation caused by daily river stage fluctuations and other possible influences; and
- to use the river stage-hydraulic head data to estimate the waterbearing characteristics of the Bedrock and the Clay/Till aquitard.

To determine the period of stage fluctuations on the Niagara River, a Stevens™ continuous water level recorder was installed in a stilling basin located at the storm sewer outfall headwall on the Olin property. The recorder was operated continuously for a 2-week period prior to initiating the 5-day survey so that the measurement of hydraulic head in Site monitoring wells during the program could be planned to coincide with daily changes in River stage.

Hydraulic head measurements were recorded twice daily in all functional monitoring wells over the 5-day period. Monitoring wells surveyed are listed on Table 4.1

The program was conducted in accordance with specified protocols (6). Results of the Initial 5-Day Hydraulic Head Monitoring Program have been presented in detail (7).

Based on the data collected during the program (7) the following conclusions were drawn:

- The Niagara River level adjacent to the Site is regulated within a relatively narrow operating band (4.5 feet) and induces the following daily fluctuations in site groundwater:

  i) Fill - fluctuations range from 0.00 to 0.05 feet with no distinct pattern,

ii) Alluvium - fluctuations range from 0.0 feet at approximately 200 feet from the River to 0.2 feet adjacent to the River,

iii) Till - fluctuations range from 0.0 to 0.1 feet,

iv) Bedrock - fluctuations range from 0.05 feet along Buffalo Avenue to 0.2 feet along the River.

- The groundwater levels beneath the Site are controlled over the long term by the surface water level of the Niagara River, but are not significantly influenced by daily fluctuations.

- Groundwater flow at the Site is generally toward the Niagara River with possible short term exceptions in areas near the River at times when the river level rises sharply. In certain areas of the Site, minor groundwater flow may exit the Site via the western, northern or eastern property boundaries, although these flows ultimately discharge into the Niagara River.

Based on these results and conclusions, Continuous and Monthly Hydraulic Head Monitoring Programs were proposed and conducted.

4.2.1.2 CONTINUOUS HEAD MONITORING PROGRAM

A two-week Continuous Head Monitoring Program was conducted March 25 to April 9, 1987. This time period was chosen to coincide with the start of daily cyclic river stage manipulation by the power authorities which began April 1.

Six monitoring wells were chosen for continuous monitoring based on the response observed during the Initial 5-Day Program. These wells are situated in the Alluvium (MW17, P15, B27 and OW30) and the Bedrock (MW7 and OW3) since these are the units which previously exhibited hydraulic response to river stage fluctuations. Stevens™ water level recorders were placed in the six wells listed above as well as in the Niagara River stilling basin.

Review of the continuous data (8) indicates that the groundwater elevation changes closely resemble the river level changes and the following conclusions have been drawn:

- As expected, water levels in the geologic units at the Site respond to changes in river surface elevations. Short term daily fluctuations influence the piezometric levels in the wells, however, there is a time lag in the response, and the magnitude of the response is dampened with distance from the River.

- At all times, the water level in the Alluvium is above the river level, and the groundwater flow direction is constant. Therefore, no flushing action exists.

- Periodically, river levels exceed the piezometric level in the Bedrock and gradient reversal occurs. These reversals, which are typically of short term duration, represent piezometric pressure adjustments due to the increased load of the River and do not alter the general groundwater flow pattern through the Bedrock across the Site.

4.2.1.3 EXTENDED HEAD MONITORING PROGRAM

The Monthly Extended Head Monitoring Program was conducted over the period beginning January 19, 1987 and continuing through June 22, 1987. Two additional rounds of monitoring were conducted in September and December 1987 and are included in the data evaluation.

During this period, the groundwater elevation in each monitoring well located on or around the Site was measured in accordance with the proposed protocols (7).

A detailed report of the Extended Hydraulic Head Monitoring Program has been presented (8).

The monthly monitoring program has shown that the seasonal water level fluctuations in all of the stratigraphic units are generally less than 2 feet. This is primarily due to the relatively constant river stage. Hydraulic gradients, both horizontal and vertical, vary only marginally with the season and river conditions.

Following review of all hydraulic head data collected at the Site, the following conclusions were formulated:

- Groundwater and river level conditions respond as expected and previously reported by OCC (25) and flows would be consistent with those previously reported by Olin (24).
- The water level in the Fill and Alluvium is above the River level at all times, and the groundwater flow direction is constant and therefore, no flushing action exists.
- Periodically, river levels exceed the piezometric level in the Bedrock, and gradient reversal occurs. These reversals are typically of short term duration and do not alter the general groundwater flow pattern through the Bedrock across the Site.
- Since the flow conditions of the Niagara River vary so little, no large deviations in groundwater flow would be expected at the Site.
- Sufficient data are available to define the groundwater flow conditions and the relationship between groundwater flow and river stage.

One additional conclusion formulated as a result of the hydraulic head investigations at the Site was that the groundwater flow regime is hydrogeologically simplistic and therefore there is no need to utilize complex mathematical modeling techniques to predict and interpret groundwater flow conditions. Simpler methods will suffice. A more detailed discussion of modeling considerations was presented (15).

4.2.2 IN SITU HYDRAULIC CONDUCTIVITY TESTING

Determinations of hydraulic conductivity are required to permit definition of the groundwater flow system at the Site. The hydraulic conductivity of the overburden materials at the Site have been determined by means of in situ response tests, laboratory determinations and estimations from grain size distribution curves. In situ response tests were performed on selected wells installed during the RI. The following sections describe the in situ hydraulic conductivity testing.

In situ testing of the hydraulic conductivity at the Site was required to determine the hydrogeologic properties of the various stratigraphic units. Single well response tests were performed on a selected group of monitoring wells. These tests involve changing the water level within a well and monitoring the time required for the level to return to the static position. Methods of accomplishing this include:

i) falling head tests, where a slug of known volume is introduced into the standing water column and the groundwater response is monitored, and
ii) rising head tests, where a known volume of water is removed from the well and the recharge is monitored.

Several methods have been developed for determination of hydraulic conductivity values from response test data. These methods consider well morphology, hydrogeologic setting and time lag response as factors to calculate in situ hydraulic conductivity. The method of Hvorslev (33) is commonly used to analyze the results of response tests and was used in some cases at the Site. In cases where the criterium L/R >8 (see Table 4.2 for definition) is not met, the analysis technique proposed by Bouwer and Rice (32) was used to confirm the value determined by the Hvorslev method. In general, the results are on the same order of magnitude, however, the results of the Bouwer and Rice method are slightly lower. The equations used to analyze the response tests are presented on Table 4.2.

Rising head response tests were performed in a total of 51 wells at the Site during the RI. The field data for these response tests are presented (17). In addition, 33 test values are available from previous investigations. Table 4.3 lists hydraulic conductivities estimated by in situ response test data and laboratory tests. These data are grouped in terms of the geologic unit which they represent. Table 4.4 presents a summary of all hydraulic conductivities by test category. Based on the in situ tests conducted, the geometric means of the hydraulic conductivities of the geologic units are as follows:

Fill	7.8×10^{-3} cm/sec
Alluvium	2.2×10^{-4} cm/sec
Clay	1.6×10^{-8} cm/sec
Till	3.0×10^{-6} cm/sec

Shallow Bedrock 1.0 x 10^{-3} cm/sec

4.2.3 DEEP BEDROCK PROGRAM

The RI included the installation and testing of three deep bedrock wells. During the drilling of each well, which extended to the top of the Rochester Formation, geologic and hydraulic information was collected in accordance with the specified protocols (18). In conjunction with this program, samples for chemical analyses were collected from each waterbearing interval identified in the Bedrock. A waterbearing interval is defined as a layer of rock 15 feet in thickness which is capable of providing 0.6 gpm of water or more from a six-inch diameter borehole or the equivalent thereof.

The testing was completed in 15-foot increments of depth using a packer/pump test assembly. Details of each pump test are summarized on Table 4.5.

At OW44-86, the upper 60 feet of Bedrock was determined to be waterbearing while the interval extending from 15 to 45 feet below the top of Bedrock was determined to be waterbearing at OW42-86. The Olin deep well, MW-8, was determined to be waterbearing in the upper 45 feet and from 60 to 75 feet (see Figures 3.20 and 3.21).

Whenever an interval was determined to be waterbearing, samples were collected for analysis. In three instances, samples were collected from intervals determined to be non-waterbearing. At OW44-86, during the testing of Interval K (150 to 165 feet below top of Bedrock) and following the installation of the 4-inch diameter casing to 186.9 feet below ground surface, the bladder pump was used in the pump test. However, due to the depth, it could not be determined whether the poor groundwater pump rate was a function of the pump's capacity to perform at such depths or the infiltration rate into the test interval. As a result, a sample was collected as a precautionary measure. Subsequent testing of Interval L (165 to 180 feet below top of Bedrock) was conducted by setting a submersible pump at the top of the open corehole and testing the entire 30-foot interval (both intervals K and L). The combined interval was determined to be non-waterbearing and therefore Interval K must also be non-waterbearing.

In the second and third cases, at OW42-86, testing of Intervals D and E produced estimated infiltration rates less than the waterbearing definition of 0.6 gpm. By definition, the tested intervals are non-waterbearing but samples were still collected in the field since the infiltration rate was within the reasonable range of the definition of waterbearing (i.e. 0.51 and 0.45 gpm).

4.2.4 BULKHEAD INVESTIGATION

During the General Site Reconnaissance session held in June 1984, several seepage areas were identified along the toe of the bulkhead embankment. Consequently, as part of the RI, a Bulkhead Investigation and Sampling Program was conducted to identify seep locations and quantify flow and chemical concentrations. A detailed report was presented (16).

For the purpose of this program, a seep was defined as a point from which leachate was visibly flowing from the bulkhead. Based on this criteria, five bulkhead seeps were identified. Flow estimates of each seep were made and samples collected for analysis. The identified seeps are shown on Figure 4.1. Table 4.6 lists the calculated flow rates of the identified seeps. All samples were analyzed for the General Parameters (GP) and Site Specific Indicators (SSI) selected for the Site (see Chapter 5).

At location BS-3, accumulated water in the reservoir appeared to have NAPL present. There was a floating sheen and apparent dark purple-black globules which adhered to the rocks and sediment in the bottom of the sampling reservoir. Subsequent examination in the laboratory revealed only sediment and debris were present in the samples. No NAPL was present. A follow-up site visit was made to better define the possible presence or absence of NAPL at BS-3. Two samples were collected and submitted for analysis. No HNAPL was observed in the HNAPL trap. A layer of floating material did collect in the floating NAPL trap. However, it was not possible in the field to assess if this was floating NAPL or floating non-aqeuous phase materials (i.e. not liquid). NAPL was not found in either of the submitted samples.

In addition, a sample was collected from BS-4 for fecal coliform analysis since this seep is located near the blocked outlet of a drainage ditch east of the Olin property which is known to have carried septic effluent.

An in-depth review of the analytical data and physical conditions at each location has been presented (16) and the conclusions are summarized as follows:

- NAPL was not confirmed in the laboratory in the samples from any of the seeps.

- The seeps identified were relatively minor with measured flow rates between 0.02 and 0.15 gpm per seep.

- For considerable periods of time throughout the year, the seeps would be expected to be below the River surface level and as such would be termed groundwater discharge rather than seeps.

- The seeps appeared to be typically emanating from an elevation consistent with the elevation of the base of Fill disposed on Site.

4.3 GENERAL HYDRAULIC GRADIENTS AND GROUNDWATER FLOW PATHS

The hydrogeologic setting of the Site has been evaluated so that the potential impact of disposed wastes on the environment can be determined. This evaluation is based primarily on the results of the geologic investigations previously described, supplemented by data pertaining to the hydraulic properties of the materials and water level monitoring.

As reported (15), and with the concurrence of EPA/State (52), the use of complex numerical models is not required to simulate the groundwater flow at the Site. Sufficient data is available to estimate the direction and flow of groundwater and subsequent chemical migration from the Site with the use of analytical models.

The Fill and the Alluvium demonstrate moderate to high permeabilities. These two units are hydraulically connected. The Clay and the Till display low hydraulic conductivities and are considered to be an aquitard. The upper Bedrock intervals were identified to be waterbearing and testing of these intervals indicates moderate to high permeabilities. In contrast, the lower Bedrock units (45 to 75 feet below the top of Bedrock) are non-waterbearing by definition (Section 9.2.4 of 18).

Table 4.3 summarizes the hydraulic conductivity determinations for the five main stratigraphic units. The characteristics of each stratigraphic unit are discussed in the following sections.

4.3.1 FILL

The Fill is the uppermost waterbearing unit encountered. While the hydraulic conductivities measured vary as expected from well to well due to the differences in composition, the range of permeabilities is not that extensive. Of the 14 response tests performed in the field for hydraulic conductivity, the range only varied from 5.5×10^{-4} to 5.5×10^{-2} cm/sec with a geometric mean of 7.8×10^{-3} cm/sec.

A contoured plot of the water elevations within the Fill has been prepared and is presented in Figure 4.2. The contours are based on water levels obtained on February 23, 1987 which were deemed to be representative of typical groundwater conditions. As can be seen from the Figure, the plot illustrates a pattern characterized by equipotential lines sub-parallel to the River. The horizontal gradient is toward the River at roughly a uniform 0.007 ft./ft. The "apparent" hydraulic gradient in the Fill increases to 0.02 - 0.04 ft/ft. at the River's edge. This apparent gradient exceeds the actual hydraulic gradient of the water table due to one or more of the following factors:

1. Presence of a seepage face at the discharge boundary
2. Presence of a sediment layer in the river which is lower in hydraulic conductivity than the unit as a whole, resulting in a head loss across the discharge boundary
3. Discharge boundary head loss due to convergence of flow lines
4. The presence of the bulkhead (which contains a compacted clay liner) and the increased topographic slope at the River's edge.

As can be seen in Figure 4.2, groundwater in the Fill generally flows toward the Niagara River but is also influenced by the presence of the Little Niagara River, the 100th Street Storm Sewer which traverses the Site and a ditch to the east of the Olin property. Measurements indicate that the gradient along the northern portion of the eastern Site boundary is not always off site. Gradient reversals were noted during the period of measurement in the vicinity of MW-13.

The westerly flow observed on the western portion of the OCC segment of the Site may also be influenced by the porosity of the Fill on Griffon Park. Essentially comprised of municipal refuse, it could be expected that this waste would be more permeable than the typical wastes deposited on the OCC Landfill (i.e. flyash, brine sludge, etc.). This is supported by the hydraulic conductivity estimates for wells OW48-86, OW49-86, OW51-86, OW54-86 and OW56-86 (see Table 4.3) which range from 1.2×10^{-2} to 5.5×10^{-2} cm/sec while the geometric mean for the Fill, which includes these estimates, is 7.8×10^{-3} cm/sec.

Occasionally, there is a northerly component of groundwater flow in the immediate vicinity of the northern property boundary in certain monitored areas. In order for such a gradient to occur, there must be a groundwater sink in the area that is drawing on the water table. Possible outlets for the groundwater sink are the Niagara River, utility beddings and local sewers. Regardless of the cause of the northerly flow component (i.e. utility bedding, sewer infiltration, more permeable flow path, etc.), the ultimate discharge of the groundwater is still the Niagara River. In any event, any northerly flow component is relatively small compared to the southerly flow across the majority of the Site.

The groundwater level in the Fill is always higher than the River elevation. Consequently, there is no flushing effect of the Fill beneath the Site because there are no reversing flow conditions.

4.3.2 ALLUVIUM

As previously discussed, the Alluvium can be subdivided into an Upper and Lower unit. The Upper Alluvium is typically less permeable than the overlying Fill or Lower Alluvium. Overall, the response test permeability in the Alluvium ranged from 3.1×10^{-6} to 2.3×10^{-2} cm/sec with a geometric mean of 2.2×10^{-4} cm/sec. The wells in the Lower Alluvium (i.e MW-17, MW-19) were at the high end of the scale due to the coarser nature of this unit as described in Section 3.3.1.2.

The Alluvium, although hydraulically connected to the Fill, is partially separated by the organic rich layer of soil identified as the former topsoil band. This layer is not continuous across the Site as evidenced by the stratigraphic logs and would be expected to be compromised, when present, due to differential settlement, differing waste placement techniques and other site disturbing operations. Consequently, the Fill and Alluvium respond similarly.

As expected, the groundwater flow in the Alluvium on Site (See Figure 4.3) follows a more regular pattern than the flow in the Fill with flow generally southerly toward the Niagara River. The gradient is approximately 0.009 ft/ft. The northerly transect wells on OCC property indicate that a slight northerly component of flow may exist immediately adjacent to the northern property boundary. However, as previously explained, the flow would be small. Again, the hydraulic data indicate that gradient reversals across the north Site boundary and toward the Site occur, and are similar to those in the Fill.

Wells MW23 and MW24 were constructed in December 1987 to obtain more detailed water level data in the area east of the Site. Water levels in these and other nearby alluvium wells taken in April 1988 are presented (Figure 4.4). Water levels in the Alluvium on the east side of the Site indicate discharge of groundwater off site to the south and east (Figure 4.3). The additional data shown in Figure 4.4 based on wells MW23 and MW24 indicate that the ditch intercepts flow through the Fill and Upper Alluvium on site, more directly transporting groundwater flow to the Niagara River.

In order to determine the seasonal water level fluctuations in the Fill and Alluvium, a water level hydrograph was prepared comparing two Fill, two Alluvium and two Bedrock wells (Figure 4.5). Examination of this figure shows that in the Fill well closest to the River (OW51-86), the maximum water table fluctuation is approximately 1.4 feet, while in the Alluvium well closest to the River (OW30-80) the water level varies approximately 1.7 feet.

The groundwater level in the Alluvium is always higher than the River elevation. Consequently, there is no flushing effect of the Alluvium beneath the Site because there are no reversing flow conditions.

4.3.3 CLAY

The Clay consists of fine grained materials and is characterized by low hydraulic conductivities. The hydraulic conductivities, estimated by laboratory methods, range from

5.6×10^{-9} to 7.0×10^{-8} cm/sec with a geometric mean of 1.6×10^{-8} cm/sec. Thus, the clay acts as an aquitard, restricting vertical flow with insignificant flow in the horizontal direction.

4.3.4 TILL

The Till consists primarily of fine-grained materials and is characterized by low hydraulic conductivities. Hydraulic conductivity estimates from response tests in the Till were observed to range between 6.8×10^{-9} and 3.4×10^{-4} cm/sec with a geometric mean of 3.0×10^{-6} cm/sec. This wide range reflects the effect of the nonhomogeneity of the Till as discussed in Section 3.3.1.4.

The upper Till, which is typically finer grained than the lower Till, acts as an aquitard, thereby restricting vertical flow with insignificant flow in the horizontal and vertical directions. The lower Till, where present, consists of a thin layer of washed or reworked Till with higher hydraulic conductivities. This layer is hydraulically connected to the Bedrock and is expected to respond similarly to the Bedrock.

4.3.5 BEDROCK

The Bedrock is comprised of several bedrock stratigraphic units. The uppermost Bedrock formation encountered is the dolomite of the Oak Orchard Formation which is massive and dense. Although some porosity and permeability is present within the rock mass, the majority of the porosity and permeability occurs along fracture surfaces, bedding planes, partings and joints. Distribution of these features is irregular and unpredictable. The nature of the Bedrock is also evidenced by the wide range of hydraulic conductivities determined by the in situ response tests. These values vary between 6.9×10^{-6} and 9.4×10^{-2} cm/sec. The geometric mean hydraulic conductivity is 1.0×10^{-3} cm/sec.

Groundwater elevations in the shallow bedrock wells are plotted and contoured on Figure 4.6. The maximum observed head difference between the on-site bedrock wells is 0.7 feet. The groundwater flow is toward the Niagara River with a very shallow gradient.

During the installation of the three deep bedrock monitoring wells, packer/pump tests were performed to provide some information on the waterbearing character of the Bedrock with depth. This testing identified that waterbearing zones exist only within the upper portion of the Oak Orchard Formation as shown on Figure 3.21. No waterbearing zones were found at depth. In fact, no waterbearing intervals were found below a depth of 75 feet into the Bedrock.

The top 15 feet of bedrock at OW42-86 was determined to be non-waterbearing during the packer/pump test. This may be significant. However, the hydraulic conductivity of the upper bedrock determined at OW5-79, which is adjacent to OW42-86, was much greater than that determined at OW42-86. This is indicative of the heterogeneous nature of the fractured bedrock waterbearing unit.

4.3.6 VERTICAL GRADIENTS

From review of the hydrogeologic conditions at the Site, it is apparent that the Fill and Alluvium are hydraulically well connected and the Alluvium and Bedrock are not. In order to evaluate the hydraulic relationship between the units, the water level measurements from February 23, 1987 have been reviewed and the vertical gradients calculated. Table 4.7 presents the comparison of waterbearing units of the wells nested in close proximity to one another.

From Table 4.7, it can be seen that between the Fill and Alluvium, the vertical gradient is generally downward with gradients as steep as 0.20 measured at MW15/MW16. An upward gradient was measured in three pairs of wells, two of which are located on Griffon Park. The third upward gradient was an insignificant event (0.01-foot differential).

The gradient between the Fill/Alluvium and the upper Bedrock was determined to be downward in every case. The steepest gradient was measured to be 0.12 at P-1/B-1. Consequently, the preference for groundwater movement through the Clay/Till is downward.

During the installation of the deep bedrock wells, water level measurements were taken for each 15-foot bedrock interval. These measurements were taken over a period of 39 to 78 days and, given the daily variation in water levels that occur in the Bedrock at the Site, it is not really possible to compare the water levels. The observed maximum head difference of 0.75 feet (see Table 4.8) is well within the range of differences that could be expected simply due to changes in River level. The fact that the differences are so minor allows one to conclude that the vertical gradient in the upper waterbearing zones of the Bedrock are small, although no determination can be conclusively made regarding the vertical direction.

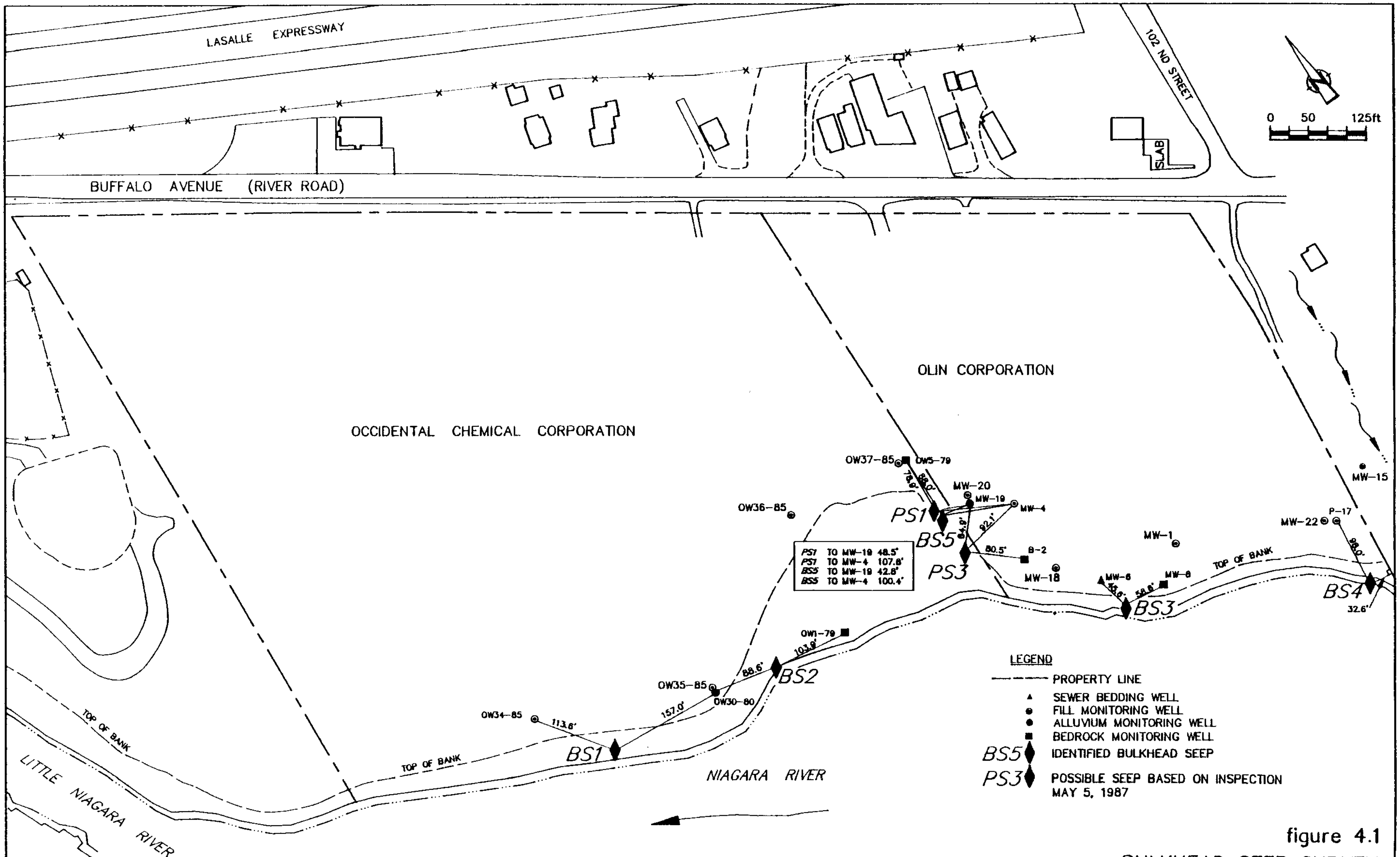

figure 4.1

BULKHEAD SEEP SURVEY
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P124)

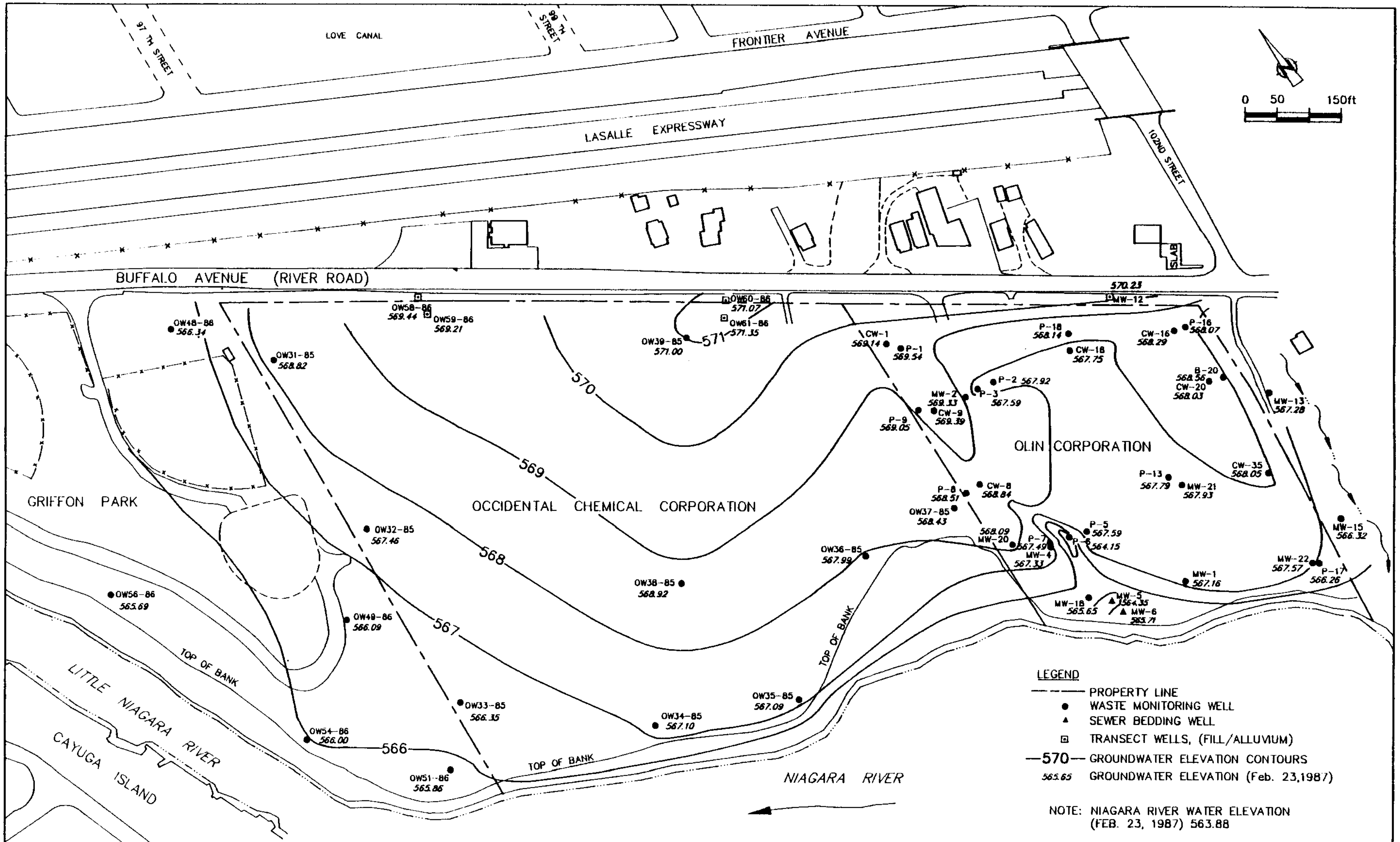

figure 4.2

GROUNDWATER ELEVATIONS IN FILL
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P-118)

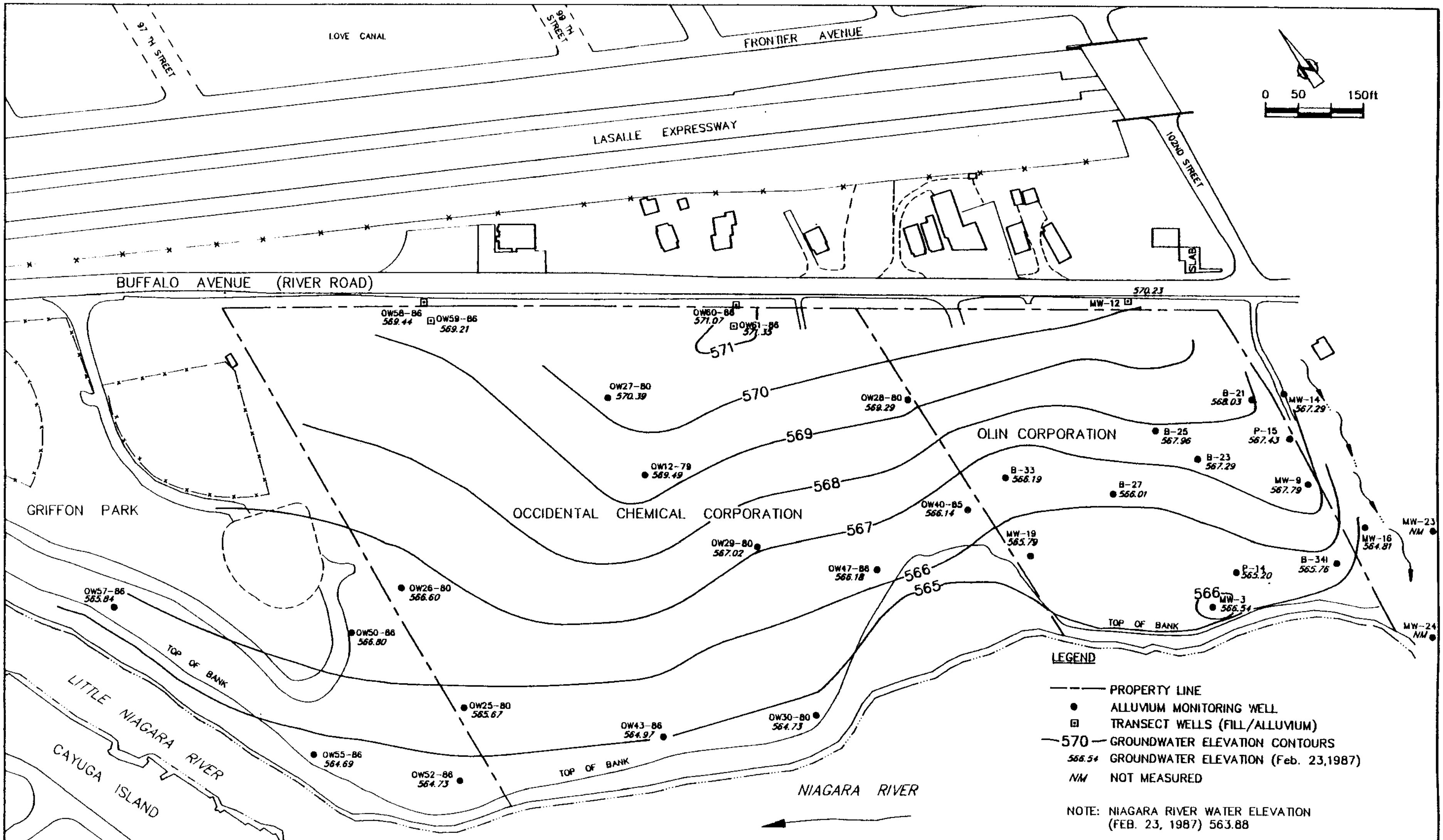

figure 4.3

GROUNDWATER ELEVATIONS IN ALLUVIUM
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (P-117)

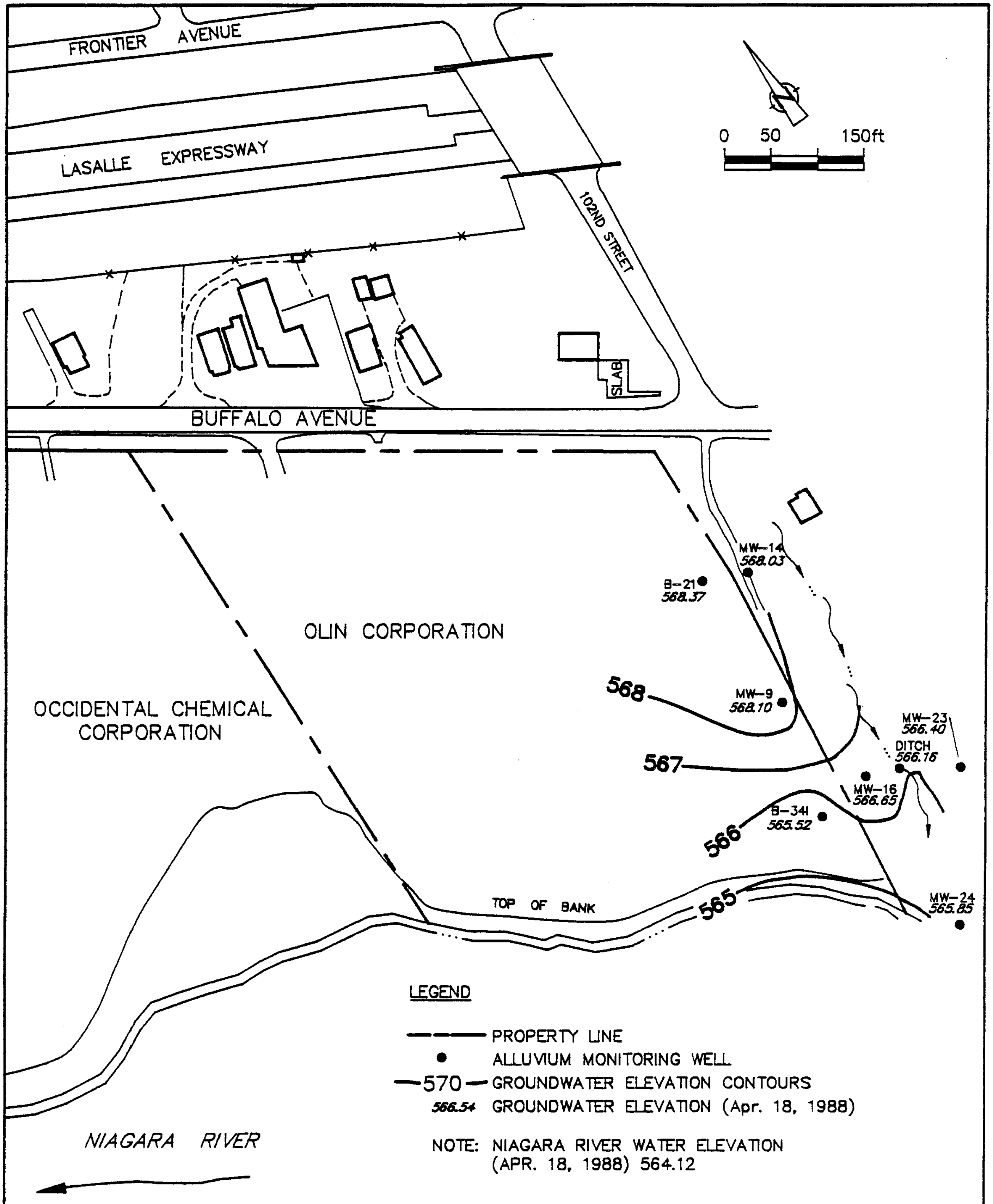

figure 4.4

GROUNDWATER ELEVATIONS IN ALLUVIUM ADJACENT TO DITCH

REMEDIAL INVESTIGATION

CRA/WCC

1431-30/09/88-47-D-1 (P124)

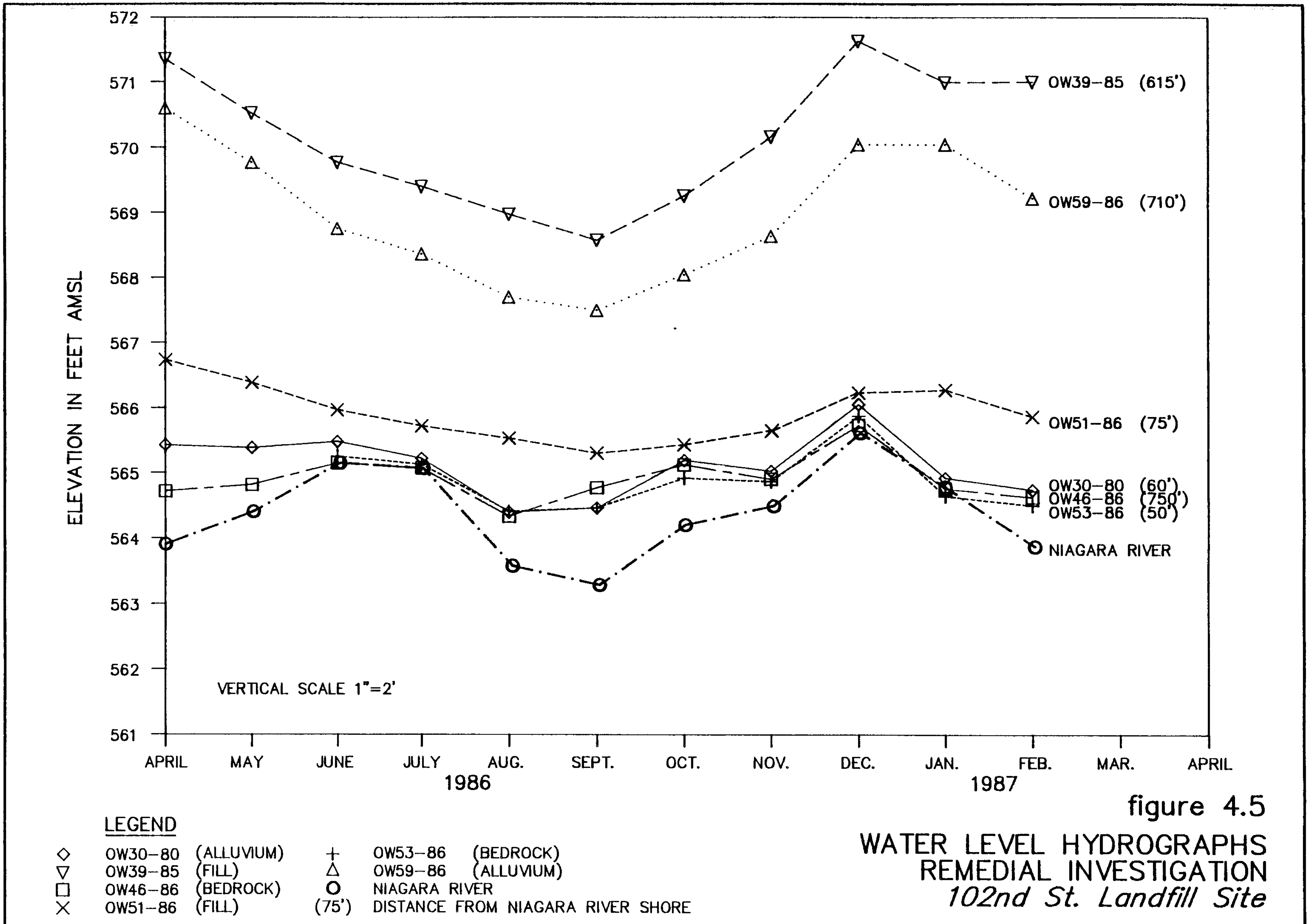

figure 4.5

WATER LEVEL HYDROGRAPHS
REMEDIAL INVESTIGATION
102nd St. Landfill Site

1431-13/07/88-47-D-1 (D-9)

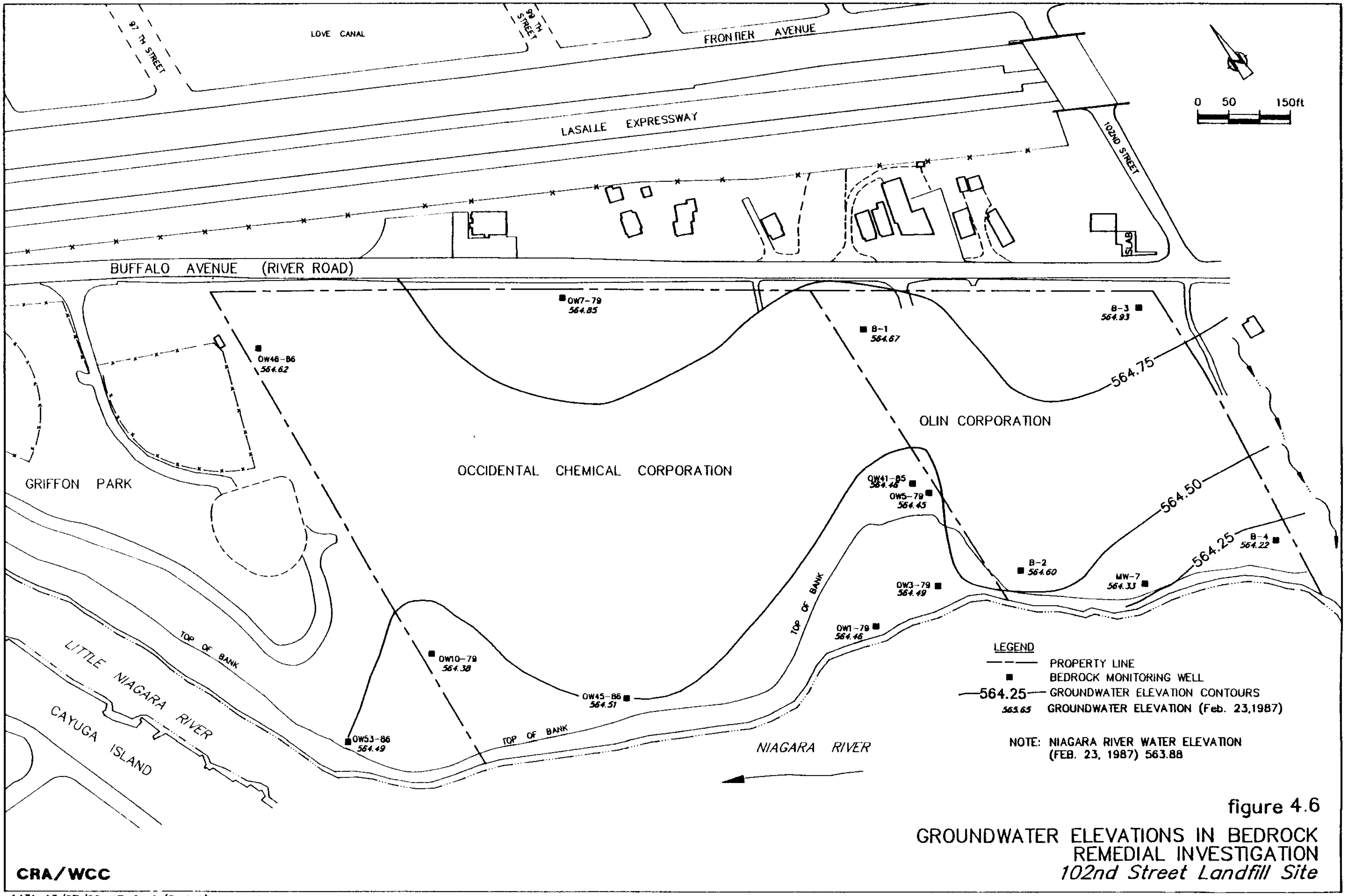

figure 4.6

GROUNDWATER ELEVATIONS IN BEDROCK
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (P-116)

TABLE 4.1

HYDRAULIC HEAD MONITORING
INITIAL 5-DAY PROGRAM
WELLS SURVEYED
OCCIDENTAL CHEMICAL CORPORATION/OLIN CORPORATION
102ND STREET LANDFILL REMEDIAL INVESTIGATION
NIAGARA FALLS, NEW YORK

Fill		Alluvium		Till	Bedrock	Bedrock/ Overburden Interface	Sewer Bedding
MW-1	P-6	MW-3	OW12	B-22	MW-7	OW6	MW-5
MW-2	P-7	MW-9	OW25	B-24	B-1	OW8	MW-6
MW-4	P-9	MW-12	OW26	B-29	B-2	OW9	MW-10
MW-13	P-13	MW-14	OW27	B-31	B-3	OW11	MW-11
MW-15	P-16	MW-16	OW28	B-34D	B-4	OW13	
MW-18	P-17	MW-17	OW29		OW1	OW14	
MW-20	P-18	MW-19	OW30		OW3	OW15	
MW-21	P-8	P-14	OW40		OW5	OW17	
MW-22	OW31	P-15	OW43		OW7	OW19	
CW-1	OW32	B-21	OW47		OW10	OW20	
CW-8	OW33	B-23	OW50		OW41	OW22	
CW-9	OW34	B-25	OW52		OW45	OW23	
CW-16	OW35	B-27	OW55		OW46	OW24	
CW-18	OW36	B-33	OW57		OW53		
CW-20	OW37	B-34I	OW58				
CW-35	OW38		OW59				
B-20	OW39		OW60				
P-1	OW48		OW61				
P-2	OW49						
P-3	OW51						
P-5	OW54						
	OW56						

Note:

Wells MW-8, B-35 and P-10 were considered non-functional and not monitored.

TABLE 4.2

HYDRAULIC CONDUCTIVITY TEST ANALYSIS METHODS

METHOD	EQUATION
A.	$K = \frac{r^2 \ln (L/R)}{2\ LT_o}$ L/R>8 for isotropic conditions
A.*	$K = \frac{r^2 \ln (L/D + [1 + (L/D)^2]^{1/2})}{2LT_o}$ L/R<8 for isotropic conditions
B.	$K = \frac{r^2 \ln (L/R) \ln(y_1/y_2)}{2L\ (t_2 - t_1)}$ L/R>8
C.	$K = \frac{r^2 \ln(Re/R)}{2L} \frac{1}{t} \ln (y_o/y_t)$
D.	Laboratory Tests
E.	In Situ - Equation Unknown

Where:
- L = length of saturated interval (cm)
- r = radius of opening (pipe) where water levels were monitored (cm)
- R = radius of borehole at interval "L" (cm)
- D = 2R
- Re = effective radius, the equivalent radial distance over which head loss y is dissipated in the flow system
- T_o = elapsed time where $\frac{H-h_t}{H-H_o} = 0.37$ (sec)
- H = water level at equilibrium
- H_o = initial water level when slug was introduced/removed
- h_t = water level at time t
- t_1 = elapsed time at H_1
- t_2 = elapsed time at H_2
- y_1 and y_2 = difference from static water level at times t_1 and t_2 respectively
- y_o = $H-H_o$
- y_t = $H-h_t$

REFERENCES

A. &A* Hvorslev, M.J., "Time Lag and Soil Permeability in Groundwater Observation", Bulletin No. 36, Waterway Experiment Station, Corps of Eng., Vicksburg, Miss., April, 1951.

B. Design Manual, Soil Mechanics, Foundations and Earth Structures, Navdocks DM-7, Dept. of the Navy, Bureau of Yards and Docks, Washington 25, D.C. 1962.

C. Bouwer, H. and R.C. Rice, "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells", W.R.R., 12(3), pp423-428, June 1976.

TABLE 4.3

SUMMARY OF HYDRAULIC CONDUCTIVITY ESTIMATES

Well/Borehole Number	Tested Interval (ft. BGS)	Hydraulic Conductivity (cm/sec.)	Analysis[5] Method	Data Source
FILL				
OW31-85	5.0 - 12.0	1.1×10^{-2}	A	CRA, 1987
OW32-85	5.0 - 13.5	4.9×10^{-3} (1) / 2.8×10^{-3}	A/C	CRA, 1987
OW33-85	5.9 - 11.5	3.2×10^{-3} (1) / 2.6×10^{-3}	A/C	CRA, 1987
OW34-85	5.0 - 12.0	5.5×10^{-4} (1) / 7.4×10^{-4}	A/C	CRA, 1987
OW35-85	4.5 - 13.0	1.0×10^{-2} (1) / 3.4×10^{-3}	A/C	CRA, 1987
OW36-85	4.5 - 11.5	1.3×10^{-2} (1) / 7.9×10^{-3}	A/C	CRA, 1987
OW37-85	3.0 - 11.5	1.3×10^{-3}	A	CRA, 1987
OW38-85	6.5 - 14.5	Insufficient Water		CRA, 1987
OW39-85	2.5 - 9.0	2.9×10^{-2}	A	CRA, 1987
OW48-86	4.0 - 10.0	2.3×10^{-2} (1) / 1.2×10^{-2}	A/C	CRA, 1987
OW49-86	3.7 - 12.0	4.8×10^{-2} (1) / 1.9×10^{-2}	A/C	CRA, 1987
OW51-86	3.7 - 10.0	2.1×10^{-2} (1) / 1.7×10^{-2}	A/C	CRA, 1987
OW54-86	4.0 - 10.0	1.8×10^{-2}	A	CRA, 1987
OW56-86	4.0 - 10.0	5.5×10^{-2} (1) / 2.8×10^{-2}	A/C	CRA, 1987
OW63-87	5.8 - 14.5	2.2×10^{-3}	A	CRA, 1987
Geometric Mean =		7.8×10^{-3}		

continued....

TABLE 4.3

SUMMARY OF HYDRAULIC CONDUCTIVITY ESTIMATES

Well/Borehole Number	Tested Interval (ft. BGS)	Hydraulic Conductivity (cm/sec.)	Analysis[5] Method	Data Source
SEWER BEDDING				
MW-5		5.5×10^{-3}	A*	WCC, 1986
MW-6		2.9×10^{-4}	A*	WCC, 1986
MW-10		2.2×10^{-4}	A*	WCC, 1986
ALLUVIAL DEPOSITS				
P-11	13.0 - 14.5	6.0×10^{-7}	D	Wehran, 1978
B-21	13.5 - 15.5	2.2×10^{-5}	D	Wehran, 1981
B-24	13.5 - 15.5	5.7×10^{-6}	D	Wehran, 1981
B-29	14.0 - 16.0	5.8×10^{-6}	D	Wehran, 1981
B-31	13.5 - 15.5	8.2×10^{-7}	D	Wehran, 1981
B-33	15.5 - 17.5	2.7×10^{-6}	D	Wehran, 1981
MW-3	14.5 - 23.0	2.7×10^{-4}	E	WCC, 1986
MW-9	9.4 - 20.0	1.2×10^{-4}	E	WCC, 1986
MW-17	13.0 - 30.0	4.2×10^{-3}	E	WCC, 1986
MW-19	13.0 - 32.0	2.3×10^{-2}	E	WCC, 1986
OW12-79	17.2 - 23.0	3.1×10^{-6}	B	CRA, 1983
OW25-80	19.1 - 25.0	3.2×10^{-4}	A	CRA, 1987

continued....

TABLE 4.3

SUMMARY OF HYDRAULIC CONDUCTIVITY ESTIMATES

Well/Borehole Number	Tested Interval (ft. BGS)	Hydraulic Conductivity (cm/sec.)	Analysis[5] Method	Data Source
ALLUVIAL DEPOSITS (continued)				
OW26-80	17.7 - 23.0	7.8×10^{-5}	A	CRA, 1987
OW27-80	10.8 - 16.0	7.9×10^{-5}	A	CRA, 1987
OW28-80	11.1 - 18.0	7.9×10^{-5}	B	CRA, 1987
OW29-80	21.1 - 27.0	2.0×10^{-5}	A	CRA, 1987
OW30-80	19.8 - 25.0	2.0×10^{-4}	A	CRA, 1987
OW40-85	11.0 - 29.0	5.8×10^{-4}	A	CRA, 1987
OW43-85	14.0 - 32.0	6.9×10^{-4}	A	CRA, 1987
OW47-85	12.0 - 35.5	2.1×10^{-4}	A	CRA, 1987
OW50-86	10.0 - 22.0	5.7×10^{-5}	A	CRA, 1987
OW52-86	11.0 - 22.0	8.0×10^{-5}	A	CRA, 1987
OW55-86	10.0 - 24.0	1.3×10^{-5}	A	CRA, 1987
OW57-86	12.0 - 29.0	2.5×10^{-5}	A	CRA, 1987
OW58-86	2.5 - 10.0	1.6×10^{-3}	A	CRA, 1987
OW59-86	3.0 - 10.0	7.5×10^{-3}	A	CRA, 1987
OW60-86	2.5 - 10.0	9.2×10^{-4}	A	CRA, 1987
OW61-86	3.5 - 10.0	5.6×10^{-4}	A	CRA, 1987
Geometric Mean* =		2.2×10^{-4}		

*Calculated from response tests only

continued....

TABLE 4.3

SUMMARY OF HYDRAULIC CONDUCTIVITY ESTIMATES

Well/Borehole Number	Tested Interval (ft. BGS)	Hydraulic Conductivity (cm/sec.)	Analysis[5] Method	Data Source
GLACIOLACUSTRINE CLAY				
B-1	17.0 - 18.5	2.1×10^{-8}	D	Wehran, 1981
OW6-79	30.0 - 31.5	5.6×10^{-9}	D	CRA, 1980
OW13-79	15.0 - 16.5	8.8×10^{-9}	D	CRA, 1980
G-257	7.8	7.0×10^{-8}	D	CRA, 1987
Geometric Mean =		1.6×10^{-8}		
GLACIAL TILL				
OW2-79	23.7 - 30.5	2.7×10^{-7}	A	CRA, 1983
OW3-79	25.0 - 26.5	6.7×10^{-9}	D	CRA, 1980
OW6-79	34.9 - 40.5	4.5×10^{-5}	A	CRA, 1983
OW8-79	35.6 - 41.5	1.3×10^{-4}	A	CRA, 1983
OW8-79	29.0 - 30.5	1.5×10^{-8}	D	CRA, 1980
OW9-79	24.1 - 30.5	5.8×10^{-7} / 2.3×10^{-5}	A/A	CRA, 1983/87
OW10-79	35.0 - 36.5	1.5×10^{-8}	D	CRA, 1980
OW11-79	34.1 - 40.0	4.9×10^{-7}	A	CRA, 1983
OW13-79	31.8 - 38.0	6.1×10^{-5}	A	CRA, 1983
OW14-79	39.2 - 46.2	1.2×10^{-6}	A	CRA, 1983

continued....

TABLE 4.3

SUMMARY OF HYDRAULIC CONDUCTIVITY ESTIMATES

Well/Borehole Number	Tested Interval (ft. BGS)	Hydraulic Conductivity (cm/sec.)	Analysis[5] Method	Data Source
GLACIAL TILL (continued)				
OW15-79	30.9 - 36.5	1.4×10^{-6}	A	CRA, 1983
OW16-79	32.8 - 39.5	4.2×10^{-5}	A	CRA, 1983
OW17-79	42.3 - 48.0	1.9×10^{-4}	A	CRA, 1983
OW18-79	28.9 - 35.3	8.1×10^{-6}	A	CRA, 1983
OW19-79	24.7 - 32.0	4.3×10^{-7}	A	CRA, 1983
OW20-79	38.5 - 44.2	2.4×10^{-7}	A	CRA, 1983
OW21-79	35.3 - 42.0	3.3×10^{-4}	A	CRA, 1983
OW22-79	36.9 - 42.7	3.2×10^{-6}	A	CRA, 1983
OW23-79	36.5 - 41.6	Insufficient Data[4]		
OW24-79	38.3 - 44.5	1.0×10^{-4}	A	CRA, 1983
OW62-87	27.1 - 33.3	1.0×10^{-5}	A	CRA, 1987
B-22	21.0 - 38.5	5.6×10^{-6}	E	Wehran, 1981
B-24	29.5 - 39.5	3.0×10^{-7}	E	Wehran, 1981
B-29	30.5 - 37.5	1.0×10^{-7}	E	Wehran, 1981
B-31	34.5 - 40.0	7.8×10^{-9}	E	Wehran, 1981

continued....

TABLE 4.3

SUMMARY OF HYDRAULIC CONDUCTIVITY ESTIMATES

Well/Borehole Number	Tested Interval (ft. BGS)	Hydraulic Conductivity (cm/sec.)	Analysis[5] Method	Data Source
GLACIAL TILL (continued)				
B-34D	28.5 - 39.0	6.8×10^{-9}	E	Wehran, 1981
A-252	9.0	5.7×10^{-8}	D	CRA, 1987
E-286	19.9	7.4×10^{-8}	D	CRA, 1987
I-136	13.5	6.0×10^{-8}	D	CRA, 1987
Geometric Mean* =		3.0×10^{-6}		
*Calculated from response tests only				
SHALLOW BEDROCK				
OW1-79	32.0 - 47.0	4.8×10^{-4}	A	CRA, 1987
OW3-79	45.6 - 51.5	1.4×10^{-3}	A	CRA, 1987
OW5-79	53.1 - 60.0	2.1×10^{-3}	A	CRA, 1987
OW7-79	56.1 - 62.0	1.3×10^{-3}	A	CRA, 1987
OW10-79	61.0 - 68.5	6.9×10^{-6}	A	CRA, 1987
OW41-85	39.7 - 55.3	3.3×10^{-5}	A	CRA, 1987
OW45-86	45.7 - 60.9	(2)		
OW46-86	38.0 - 53.2	(3)		

continued....

TABLE 4.3

SUMMARY OF HYDRAULIC CONDUCTIVITY ESTIMATES

Well/Borehole Number	Tested Interval (ft. BGS)	Hydraulic Conductivity (cm/sec.)	Analysis(5) Method	Data Source
SHALLOW BEDROCK (continued)				
OW53-86	41.3 - 57.3	(2)		
B-1	40.8 - 55.8	2.8×10^{-3}	E	WCC, 1987
B-2	40.5 - 50.0	1.1×10^{-3}	E	WCC, 1987
B-3	39.0 - 49.0	2.4×10^{-2}	E	WCC, 1987
B-4	40.0 - 50.1	9.4×10^{-2}	E	WCC, 1987
MW-7	41.5 - 56.1	4.1×10^{-4}	E	WCC, 1987
Geometric Mean =		1.0×10^{-3}		

NOTES:

(1) - L/R <8
(2) - No measureable drawdown occurred.
(3) - 0.25 foot drawdown at end of pumping.
(4) - 99percent recovery within 3 minutes.
(5) - Analysis methods are presented on Table 4.2.

TABLE 4.4

SUMMARY OF HYDRAULIC CONDUCTIVITY DETERMINATIONS

	Number of Tests	Geometric Mean Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity Range (cm/sec)
FILL			
Response Tests	14	7.8×10^{-3}	5.5×10^{-4} - 5.5×10^{-2}
Grain Size Estimate	1	--	2.2×10^{-2}
ALLUVIUM			
Response Tests	22	2.2×10^{-4}	3.1×10^{-6} - 2.3×10^{-2}
Laboratory Tests	6	3.1×10^{-6}	6×10^{-7} - 2.2×10^{-5}
Grain Size Estimate	7	9.7×10^{-4}	1.2×10^{-5} - 1.7×10^{-1}
CLAY			
Laboratory Tests	4	1.6×10^{-8}	5.6×10^{-9} - 7.0×10^{-8}
Grain Size Estimate	5	1.9×10^{-8}	1.6×10^{-11} - 1.7×10^{-6}
TILL			
Response Tests	23	3.0×10^{-6}	6.8×10^{-9} - 3.3×10^{-4}
Laboratory Tests	6	2.7×10^{-8}	6.7×10^{-9} - 7.4×10^{-8}
Grain Size Estimate	5	1.7×10^{-7}	8.1×10^{-11} - 8.4×10^{-6}
SHALLOW BEDROCK (OAK ORCHARD FORMATION)			
Response Tests	11	1.0×10^{-3}	6.9×10^{-6} - 9.4×10^{-2}

TABLE 4.5
DEEP WELL TESTING SUMMARY - OW42-86

Interval	A	B	C	D	E	F	G
Drilled Depth	39.3-55.1 ft.	55.1-70.2 ft.	70.2-85.0 ft.	85.0-100.0 ft.	100.0-115.0 ft.	115.0-130.0 ft.	130.0-145.0 f
Elevation	534.3-518.5 ft.	518.5-503.4 ft.	503.4-488.6 ft.	488.6-473.6 ft.	473.6-458.6 ft.	458.6-443.6 ft.	443.6-428.6 f
Tested Depth	39.3-54.5 ft.	52.9-70.2 ft.	67.3-85.0 ft.	82.8-100.0 ft.	97.7-115.0 ft.	112.8-130.0 ft.	124.3-145.0 f
Elevation	534.3-519.1 ft.	520.7-503.4 ft.	506.3-488.6 ft.	490.8-473.6 ft.	475.9-458.6 ft.	460.8-443.6 ft.	449.3-428.6 f
Pump Rate	0.12 GPM	4.5 GPM	7.0 GPM	0.51 GPM	0.45 GPM	0.37 GPM	0.08 GPM
Estimated Infiltration Rate	0.12 GPM	4.5 GPM	7.0 GPM	0.51 GPM	0.45 GPM	0.37 GPM	0.08 GPM
Water Bearing	No	Yes	Yes	No	No	No	No
Water Loss During Coring	600 gallons	1,918 gallons	2,340 gallons	67 gallons	52 gallons	136 gallons	377 gallons
Water Removed (including test)	909 gallons	681 gallons	910 gallons	229 gallons	214 gallons	740 gallons	210 gallons
Final Tracer Concentration	45/1,000	84/1,000	67/1,000	72/1,000	49/1,000	74/1,000	283/1,000
Sample Collected	No	Yes	Yes	Yes[1]	Yes[1]	No	No

(1) Although the estimated infiltration rate was less than 0.6 GPM and therefore, by definition, the tested interval was non-waterbearing, samples were still collected since the infiltration rate was within the reasonable range of the definition of waterbearing.

continued....

TABLE 4.5
DEEP WELL TESTING SUMMARY - OW42-86

Interval	H	I	J	K	L	M
Drilled Depth	145.0-160.0 ft.	160.0-169.3 ft.	169.3-184.3 ft.	184.3-199.3 ft.	199.3-214.3 ft.	214.3-223.4 ft.
Elevation	428.6-413.6 ft.	413.6-404.3 ft.	404.3-389.3 ft.	389.3-374.3 ft.	374.3-359.3 ft.	359.3-350.2 ft.
Tested Depth	139.7-160.0 ft.	152.1-169.3 ft.	169.3-184.3 ft.	169.3-199.3 ft.	169.3-214.3 ft.	169.3-223.4 ft.
Elevation	433.9-413.6 ft.	421.5-404.3 ft.	404.3-389.3 ft.	404.3-374.3 ft.	404.3-359.3 ft.	404.3-350.2 ft.
Pump Rate	0.34 GPM	0.16 GPM	0 GPM	0.19 GPM	0.42 GPM	0.40 GPM
Estimated Infiltration Rate	0.34 GPM	0.16 GPM	0 GPM	0.19 GPM	0.42 GPM	0.40 GPM
Water Bearing	No	No	No	No (30 ft. tested interval)	No (45 ft. tested interval)	No (54.1 ft. tested interval)
Water Loss During Coring	254 gallons	134 gallons	207 gallons	0 gallons	58 gallons	60 gallons
Water Removed (including test)	240 gallons	104 gallons	60 gallons ±	254 gallons ±	187 gallons ±	72 gallons ±
Final Tracer Concentration	146/1,000	233/1,000	NM	NM	NM	NM
Sample Collected	No	No	No	No	No	No

continued....

TABLE 4.5
DEEP WELL TESTING SUMMARY - OW44-86

Interval	A	B	C	D	E	F	G
Drilled Depth	44.0-59.4 ft.	59.4-74.4 ft.	74.4-89.4 ft.	89.4-104.4 ft.	104.4-119.4 ft.	119.4-134.4 ft.	134.4-149.4 f
Elevation	533.2-517.8 ft.	517.8-502.8 ft.	502.8-487.8 ft.	487.8-472.8 ft.	472.8-457.8 ft.	457.8-442.8 ft.	442.8-427.8 f
Tested Depth	44.0-59.4 ft.	59.1-74.4 ft.	74.0- 89.4 ft.	89.4-104.4 ft.	104.4-119.4 ft.	118.0-134.4 ft.	133.7-149.4 f
Elevation	533.2-517.8 ft.	518.1-502.8 ft.	503.2-487.8 ft.	487.8-472.8 ft.	472.8-457.8 ft.	459.2-442.8 ft.	443.5-427.8 f
Pump Rate	0.32 GPM	0.24 GPM	0.11 GPM	0.87 GPM	0.20 GPM	0.09 GPM	0 GPM
Estimated Infiltration Rate	17.2 GPM*	>0.24 GPM**	>0.11 GPM**	0.87 GPM	0.20 GPM	0.09 GPM	0 GPM
Water Bearing	Yes	Yes	Yes	Yes	No	No	No
Water Loss During Coring	5,150 gallons	1,679 gallons	1,800 gallons	45 gallons	37 gallons	55 gallons	178 gallons
Water Removed (including test)	6,595 gallons	2,558 gallons	2,715 gallons	403 gallons	117 gallons	285 gallons	306 gallons
Final Tracer Concentration	67/1,000	42/1,000	67/1,000	35/1,000	134/1,000	161/1,000	94/1,000
Sample Collected	Yes	Yes	Yes	Yes	No	No	No

* Based on pump rate during purging.

** Limited by capacity of bladder pump. Actual infiltration rate higher based on volume of water removed prior to pump test.

continued....

TABLE 4.5
DEEP WELL TESTING SUMMARY - OW44-86

Interval	H	I	J	K	L	M
Drilled Depth	149.4-164.4 ft.	164.4-179.4 ft.	179.4-186.9 ft.	186.7-201.7 ft.	201.7-216.7 ft.	216.7-230.7 ft.
Elevation	427.8-412.8 ft.	412.8-397.8 ft.	397.8-390.3 ft.	390.5-375.5 ft.	375.5-360.5 ft.	360.5-346.5 ft.
Tested Depth	148.7-164.4 ft.	160.8-179.4 ft.	171.0-186.9 ft.	186.7-201.7 ft.	186.7-216.7 ft.	186.7-230.7 ft.
Elevation	428.5-412.8 ft.	416.4-397.8 ft.	406.2-390.3 ft.	390.5-375.5 ft.	390.5-360.5 ft.	390.5-346.5 ft.
Pump Rate	0.05 GPM	0 GPM	0 GPM	0.05 GPM	0.03 GPM	0.02 GPM
Estimated Infiltration Rate	0.05 GPM	0 GPM	0 GPM	0.05 GPM	0.03 GPM	0.02 GPM
Water Bearing	No	No	No	No	No (30 ft. tested interval)	No (44 ft. tested interval)
Water Loss During Coring	63 gallons	0 gallons	0 gallons	89 gallons	97 gallons	223 gallons
Water Removed (including test)	120 gallons	10 gallons	189 gallons	20 gallons	121 gallons	92 gallons
Final Tracer Concentration	591/1,000	NM	NM	56/1,000	NM	NM
Sample Collected	No	No	No	Yes(1)	No	No

(1) Since it could not be determined whether the poor water return was a function of the bladder pump's capability from such depth or the infiltration rate, samples were collected as a precautionary measure. However, subsequent testing of intervals K, L and M with the submersible pump proved all three intervals to be non-waterbearing.

continued....

TABLE 4.5
DEEP WELL TESTING SUMMARY - MW-8

Interval	A	B	C	D	E	F	G
Drilled Depth	40.5-55.5 ft.	55.5-70.5 ft.	70.5-85.5 ft.	85.5-100.5 ft.	100.5-115.5 ft.	115.5-130.5 ft.	130.5-145.5 f
Elevation	536.0-521.0 ft.	521.0-506.0 ft.	506.0-491.0 ft.	491.0-476.0 ft.	476.0-461.0 ft.	461.0-446.0 ft.	446.0-431.0 f
Tested Depth							
Elevation							
Pump Rate	5.33 GPM	17.2 GPM	3.4 GPM	0.33 GPM	16.8 GPM	0.4 GPM	0.25 GPM
Estimated Infiltration Rate	5.33 GPM	17.2 GPM	3.4 GPM	0.33 GPM	16.8 GPM	0.4 GPM	0.25 GPM
Water Bearing	Yes	Yes	Yes	No	Yes	No	No
Water Loss During Coring	147 gallons	598 gallons	52 gallons	63 gallons	372 gallons	486 gallons (1)	88 gallons
Water Removed (including test)	454 gallons	1,049 gallons	387 gallons	35 gallons	1,007 gallons	28 gallons	31 gallons
Final Tracer Concentration	74/1,000	52/1,000	54/1,000	230/1,000	43/1,000	NM	NM
Sample Collected	Yes	Yes	Yes	No	Yes	No	No

(1) Excessive water loss was attributed to a large fracture reopening at 107 feet (Interval E).

continued....

TABLE 4.5
DEEP WELL TESTING SUMMARY - MW-8

Interval	H	I	J	K	K	M
Drilled Depth	145.0-160.5 ft.	160.5-175.5 ft.	175.5-190.5 ft.	190.5-205.5 ft.	205.5-220.5 ft.	220.5-229.0 ft.
Elevation Tested Depth	431.0-416.0 ft.	416.0-401.0 ft.	401.0-386.0 ft.	386.0-371.0 ft.	371.0-356.0 ft.	356.0-347.5 ft.
Elevation Pump Rate	0.004 GPM	0,02 GPM	0.006 GPM	0.1 GPM	0.07 GPM	0.03 GPM
Estimated Infiltration Rate	0.004 GPM	0.02 GPM	0.006 GPM	0.1 GPM	0.07 GPM	0.03 GPM
Water Bearing	No	No	No	No	No	No
Water Loss During Coring	58 gallons	0 gallons	50 gallons	15 gallons	4 gallons	No data
Water Removed (including test)	11 gallons	43 gallons	1 gallon	6 gallons	4 gallons	3 gallons
Final Tracer Concentration	NM	NM	NM	NM	NM	NM
Sample Collected	No	No	No	No	No	No

TABLE 4.6

ESTIMATED RATES OF FLOW
BULKHEAD SEEP PROGRAM
102ND STREET LANDFILL

Seep #	Rate of Flow (gpm)
BS-1	0.03
BS-2	0.04
BS-3	0.15
BS-4	0.02
BS-5	--*

* Estimate of flow not possible.

TABLE 4.7

VERTICAL HYDRAULIC GRADIENT CALCULATIONS
(February 23, 1987)
-1-

Well Nest	Well Screen Elevation (a)	Well Screen Elevation (b)	dL (a) - (b)	Well (a) Water Level	Well (b) Water Level	dH (b) - (a)	dH/dL
Fill - Alluvium							
OW56-86 OW57-86	566.0	552.6	13.4	565.69	565.84	+0.15	+0.0112
OW49-86 OW50-86	564.6	556.2	8.0	566.09	566.80	+0.71	+0.0888
OW54-86 OW55-86	564.0	554.1	9.9	566.00	564.69	-1.31	-0.1323
OW33-85 OW25-80	566.7	554.0	12.7	566.35	565.67	-0.68	-0.0535
OW51-86 OW52-86	565.4	555.7	9.7	565.86	564.73	-1.13	-0.1165
OW36-85 OW47-86	567.4	551.7	15.7	567.99	566.18	-1.81	-0.1153
OW35-85 OW30-80	567.2	553.4	13.8	567.09	564.73	-2.36	-0.1710

\- = downward gradient
\+ = upward gradient

continued....

TABLE 4.7

VERTICAL HYDRAULIC GRADIENT CALCULATIONS
(February 23, 1987)
-2-

Well Nest	Well Screen Elevation (a)	Well Screen Elevation (b)	dL (a) - (b)	Well (a) Water Level	Well (b) Water Level	dH (b) - (a)	dH/dL
Fill - Alluvium							
MW-13 MW-14	566.5	560.7	5.8	567.28	567.29	+.01	+0.0017
MW-15 MW-16	565.2	557.8	7.4	566.32	564.81	-1.51	-0.2041
MW-20 MW-19	566.5	546.0	20.5	568.09	565.79	-2.30	-0.1122
MW-22 B-34I	566.2	555.4	10.8	567.57	565.76	-1.81	-0.1676

\- = downward gradient
\+ = upward gradient

continued....

TABLE 4.7

VERTICAL HYDRAULIC GRADIENT CALCULATIONS
(February 23, 1987)
-3-

Well Nest	Well Screen Elevation (a)	Well Screen Elevation (b)	dL (a) - (b)	Well (a) Water Level	Well (b) Water Level	dH (b) - (a)	dH / dL
Fill - Bedrock							
OW31-85 OW46-86	567.3	530.0	37.3	568.82	564.62	-4.2	-0.1126
OW34-85 OW45-86	568.7	523.9	44.8	567.10	564.51	-2.59	-0.0578
CW-1 B-1	568.7	526.8	41.9	469.14	564.67	-4.47	-0.1067
P-1 B-1	568.3	526.8	41.5	569.54	564.67	-4.87	-0.1173
OW37-85 OW42-85	566.2	377.9	188.6	568.43	NM		
P-16 B-3	568.8	530.0	38.8	568.07	564.93	-3.14	-0.0809
CW-16 B-3	569.5	530.0	39.5	568.29	564.93	-3.99	-0.1010
MW-22 B-4	568.0	530.8	37.2	567.57	564.22	-3.35	-0.0901
P-17 B-4	569.7	530.8	38.9	566.26	564.22	-2.04	-0.0524

\- = downwardgradient
\+ = upward gradient

continued....

TABLE 4.7

VERTICAL HYDRAULIC GRADIENT CALCULATIONS
(February 23, 1987)
-4-

Well Nest	Well Screen Elevation (a)	Well Screen Elevation (b)	dL (a) - (b)	Well (a) Water Level	Well (b) Water Level	dH (b) - (a)	dH/dL
Alluvium - Bedrock							
OW40-85 OW41-85	553.7	526.2	27.5	566.14	564.46	-1.68	-0.0611

NM = Not Measured.
U.S.G.S. Datum used.

- = downward gradient
+ = upward gradient

TABLE 4.8

COMPARISON OF STATIC WATER LEVELS IN DEEP BEDROCK WELLS

	Uppermost Waterbearing Interval			Lowermost Waterbearing Interval			
	Zone	Interval	Static Water** Level (ft.)	Zone	Interval	Static Water** Level (ft.)	Net Difference (ft.)
OW42	B	52.9-70.2	9.67 BGS	C	67.3-85.0	9.55 BGS	0.12 upward
OW44	A	44.0-59.4	13.49 BGS	D	89.4 - 104.4	13.89 BGS	0.40 downward
MW-8	A	40.5 - 55.5	12.10 BGS	C*	70.5 - 85.5	11.35 BGS	0.75 upward

BGS = Below Ground Surface

* Data from Interval E at MW8 was not available.
** The depth to static water level measurements were taken over a period of 39 to 78 days (see Section 4.3.6).

5.0 GROUNDWATER CHEMICAL DATA

Groundwater chemical survey programs were conducted as part of the RI. The following sections present a summary of these programs and their results.

5.1 PURPOSE

Several field programs were designed to supplement existing data to more accurately assess:

- nature and extent of chemical presence in the groundwater at the Site; and
- variability of the chemical data.

5.2 COMPREHENSIVE WASTE WELL SURVEY

Ten representative wells were sampled for the Comprehensive Waste Analysis Program. The results of this program were used to select the SSI. Well locations were chosen to maximize the possibility of obtaining representative samples of the most contaminated waste areas at the Site, including wells in which the presence of NAPL was identified or suspected.

The final list of wells approved by EPA/State (Figure 5.1) was:

OCC	Olin
OW33-85	CW-18
OW35-85	CW-35
OW36-85	MW-1
OW37-85	MW-2
OW38-85	MW-4

5.2.1 ANALYTICAL METHODS

Samples were analyzed for inorganic and organic chemical constituents in order to select SSI for both on-site and off-site surveys. The samples were analyzed for the following GP:

Laboratory Analysis	Field Analysis
- Total Organic Carbon (TOC)	- Temperature
- Total Organic Halogens (TOX)	- pH
- Total Water-Soluble Phosphorus	- Specific Conductance (SC)
- Total Kjeldahl Nitrogen (TKN)	
- Mercury	

In addition, each sample was analyzed by GC/MS broad scan to identify and quantify organic compounds and by ICP to quantify priority pollutant trace metals. HPLC was also utilized for some analyses.

5.2.2 RESULTS

Results of the comprehensive analyses (9) are presented for Olin wells (Table 5.1) and OCC wells (Table 5.2). The data include a TOX balance calculation.

5.2.3 SELECTION OF SITE-SPECIFIC INDICATORS

On completion of the comprehensive waste well survey, a list of SSI was developed. The following served as the minimum considerations for placing a compound or isomer family on the list:

- Compound or chemical equal to or greater than 5 percent of TOX
- Compounds unique to OCC or Olin in the region
- Primary constituent of NAPL
- Chemical Stability
- Transport properties, including solubility and soil partitioning
- Known major deposition at Site
- Reliable, sensitive analytical method
- Toxicity

Consideration was also given to the frequency of observations and the concentrations observed for each chemical when reviewing the results of each waste well analysis.

Accordingly, all available Site information, the results of the comprehensive waste well analyses, and information regarding the presence of the elements or compounds in the environment were considered in selecting the SSI (9). The chemicals chosen as the SSI for water samples are presented, along with their respective survey levels, in Table 5.3.

Following the selection of the SSI and in order to confirm the representativeness of the SSI in terms of defining the extent of the Site chemistry, the chemicals detected during the comprehensive waste well analyses were subjected to the EPA Superfund health evaluation technique (43) for the RI report. The SSI include chemicals with both low and high K_{oc}.

A representative concentration for each chemical detected during the comprehensive waste well analysis was determined based on the mean of the concentrations detected in the ten waste wells. For the purposes of this analysis non-detects were treated as zero. Chemicals detected exclusively in either the OCC or Olin wells were averaged over five wells rather than ten.

Organic carbon partition coefficient (K_{oc}) values when available were assigned to each chemical from Exhibit A-1 (43). Chemicals with high or low K_{oc} were designated with an H or L respectively. Chemicals for which no K_{oc} data were given were also designated H or L where possible, based on general knowledge of the chemical. The results of this analysis are shown in Table 5.4.

The Potential Carcinogen or Non-Carcinogen Toxicity Constants (PCTC or NCTC) were assigned to each chemical from Exhibits A-3 and A-5 (43). The constants used were the Oral Route, Water Toxicity Constants because these are believed to be the most appropriate. Many of the chemicals did not have Toxicity Constants. Where appropriate, the constant of a similar chemical was assigned; for example, chlorotoluenes were assigned the constant for chlorobenzenes. The product of the representative concentration and the Toxicity Constant was calculated and compared to the values obtained for the other chemicals in the same toxicity class (Potential Carcinogen and Non-Carcinogen). The results are shown in Table 5.5. Table 5.5 is a summary showing those chemicals for which Toxicity Constants were available or were assigned.

The first column of Tables 5.4 and 5.5 designates SSI with a Y. There were relatively few potential carcinogens; therefore, meaningful ranking was difficult. The two highest-ranked potential carcinogens were alpha-HCCH and arsenic. Both of these chemicals were selected as SSI. The four highest-ranked non-carcinogens were also selected as SSI.

Table 5.5 shows that the SSI include chemicals with both high and low K_{OC}. Several chemicals with high K_{OC} were not included because they were detected at very low concentrations which suggested that they would be poor SSI. This analysis shows that the SSI chosen were appropriate, based on the selection process described (43).

5.3 OFF-SITE COMPREHENSIVE SURVEY

Because the properties adjacent to the Site on the east and west are landfills, there was a concern that chemicals not related to the Site might be present in off-site groundwater. In order to identify such chemicals, OCC/Olin elected to perform off-site comprehensive analyses on selected wells.

Olin chose four wells along the east property boundary, MW-13, MW-14, MW-15, and MW-16 for off-site comprehensive analysis. OCC chose three wells near its west property boundary, OW49, OW51, and OW54. Results of the analysis are presented on Table 5.6 (Olin) and Table 5.7 (OCC).

5.4 DESIGN SURVEY

The purpose of the design survey was to select wells for sampling during the extended survey. The design survey was conducted during May 1986 (11). Design survey well selection included 12 interior wells, 37 boundary wells, 9 old Bedrock wells, 4 new Bedrock wells, and 17 off-site wells. A total of 79 wells were selected for sampling, 32 on Olin property, and 47 on OCC property (Table 5.8 and Figure 5.2).

Field measurements were taken at each well for temperatures, pH, and specific conductance. In addition to the measured field parameters, samples were analyzed for the GP (TOC, TOX, TKN, soluble phosphorus, and mercury). The data were originally submitted September 27, 1986 (12). They are included in this report in Volume 2, Appendix A.

5.5 EXTENDED GROUNDWATER SURVEY

The selection of wells included in the extended survey was prepared based on discussions between OCC/Olin and the EPA/State. The SOP required that all off-site wells, all new Bedrock wells (both shallow and deep), and Olin's Bedrock well B-2 be included in the survey. In addition, Table 1 of the SOP specified that 20 on-site boundary wells be selected for analysis for both GP and SSI, and 5 on-site boundary wells be selected for analysis for GP alone. These wells were selected on the basis of:

- Analytical data developed during the design survey.

- Adequate areal distribution along downgradient boundaries in each hydrologic unit of interest, the downgradient direction having been defined by hydraulic head data collected previously during the course of the RI.

The 51 wells originally selected for both on-site and off-site sampling during the extended groundwater survey have been discussed (12). Of this number, four were not sampled. Three of these, monitoring wells MW-8, OW42, and OW44, were deep Bedrock wells installed through the Lockport Dolomite to the top of the Rochester Shale. Groundwater conditions in the deep Bedrock were assessed by sampling and aquifer testing discrete 15-foot depth intervals through the thickness of the Lockport Dolomite during well construction (5). All SSI were below their respective survey levels in each analysis. Of the GP, mercury and soluble phosphorus were below their survey levels in all analyses. GP data are presented (Table 5.9). Because hydraulic testing results showed that the open-hole parts of these wells were located in non-waterbearing units (17), these wells were not sampled during the extended survey portion of the program (5). The fourth well, B-35, screened in the Fill on-site, was deemed dry according to SOP criteria for each sampling event. Two new wells, OW62 and OW63, were installed and added to the survey in the third month in order to supplement data from OW9. Wells selected for the extended survey are presented (Table 5.10). Due to a bent well casing in well OW26, sample collection was performed using a peristaltic pump (13).

Monthly sampling events of the extended survey entailed collection of either SSI and GP, or only GP. In certain months, only on-site overburden and selected Bedrock wells were sampled. Other months required sampling of on-site overburden, selected Bedrock, and off-site overburden monitoring wells.

Detailed results including statistical summaries of these data have been presented (13). A complete compilation of the data, including the November 1987, February and April 1988 sampling events, is presented herein in Volume 2, Appendix A. Statistical summaries of TOX (Table 5.11) and TOC data (Table 5.12) are presented. Tables 5.13 - 5.15 present summary statistics for total SSI in Alluvium, Fill, and Till and Bedrock wells, respectively.

5.6 BULKHEAD INVESTIGATION

A bulkhead investigation and sampling program was conducted on May 5 and 7, 1987 (see Section 4.2.4). The purpose was to identify flowing seep areas, measure and quantify the flow rates, and document the concentrations of chemicals present in the seep waters. Details of the investigation were previously presented (16). A summary of the results is presented (Table 5.16).

5.7 ANALYSIS OF CHEMICAL DATA

The extended groundwater survey provides the most detailed chemical data regarding groundwater at the Site. In particular, Table 5.11 summarizes TOX data, Table 5.12 summarizes TOC data, and Tables 5.13 - 5.15 provide summaries of total SSI data. In order to utilize these data in accurate and realistic loading calculations, the extent of their variability must be evaluated. This section presents separate discussions of the data from Fill, Alluvium, and Till and Bedrock.

For TOX and TOC data, a mean value was calculated. If only one analysis was available, it was treated as the mean value. If two analyses were available, they were averaged to calculate the mean value. If more than two analyses were available, minimum, maximum, mean, standard deviation, and coefficient of variation values were also calculated. Duplicate analyses were averaged prior to use in determining the aforementioned parameters. In cases where the detection limit exceeds the survey level (ND), one-half the survey level was assigned.

Results for individual SSI were summed for statistical evaluation. When calculating total SSI for a particular monitoring well sample, analytes reported as ND were assigned a value of zero only if all results for that analyte from the extended survey samples (from the well in question) were ND. If the chemical reported as ND was quantified above survey levels in one of the other extended survey analyses, the analyte reported as ND was assigned a value of one-half the survey level when calculating the Total SSI.

Linear regression analysis was performed to evaluate the degree to which a linear relationship exists between concentrations of TOX, TOC and Total SSI. The linear regression analysis was performed using the individual paired data points (rather than sample means). For the TOX/Total SSI pairing, Total SSI was converted to units of µg Cl/L prior to the regression analysis.

The results of the linear regression analysis, including the slope, intercept, standard error and correlation coefficient are included in Appendix D. The correlation coefficient, R, which can range between -1 to +1, is indicative of the strength of linear correlation between two variables. The closer R is to zero, the weaker the correlation between variables. Only on-Site wells were used in these statistical analyses. The extended survey groundwater analytical results are discussed below for each unit.

5.7.1 FILL CHEMISTRY

Mean TOX concentrations in the Fill range between 27 ug/L (OW56) and 22,400 ug/L (OW35), with higher values associated with known or suspected occurrences of NAPL. The low value is off-site to the west in Griffon Park. The highest value is on the south-central part of the Site. High values are either associated with NAPL occurrence (MW-20, OW35) or downgradient from NAPL (MW-18). Lowest values tend to be off-site to the west and east.

Mean TOC concentrations in the Fill range between approximately 32,000 ug/L (OW34) and 350,000 ug/L (OW48). Both values are from wells with very low TOX concentrations. There is no apparent relation between higher TOC concentrations and NAPL occurrence. Total SSI concentrations do appear to be related to NAPL distribution as evidenced by elevated levels at OW35 and MW20. The high value at MW-18, although not associated with direct observations of NAPL, is peripheral to possible NAPL observations in MW-5. Mean values range from zero at 4 wells to approximately 28,000 ug/L at OW35.

The linear regression analysis for TOC/TOX yielded a correlation coefficient of 0.45. The TOC/Total SSI correlation coefficient was 0.36. Both results suggest a rather poor linear correlation between concentrations of TOC and halogenated organic chemicals in groundwater samples. The correlation coefficient for TOX paired with total SSI (as Cl) was a rather strong 0.89. This indicates that, within the fill unit, the site specific indicator list was appropriate for monitoring halogenated organic chemicals.

5.7.2 ALLUVIUM CHEMISTRY

Mean TOX concentrations in the Alluvium range between 25 ug/L (one-half the survey level limit at wells OW58 and OW60) and 23,000 ug/L (OW30). The low values are slightly off-site on the north side of the Site. The high value occurs in the same south-central part of the Site as the highest TOX concentration recorded in the Fill. Other high concentrations were in wells known to be associated with NAPL (OW47, OW40, MW-19) or peripheral to apparent NAPL distribution (MW-17). Most low values were off-site to the west and east. The collection of samples using a peristaltic pump at OW26 may have affected the TOX results. However, it is felt that the effect, if any, would have been small.

Mean TOC concentrations in the Alluvium range between 52,000 ug/L (MW-9) and 300,000 ug/L (OW30). As in the Fill wells, there is no apparent association between high concentrations of TOC and NAPL distribution. The highest TOC values are observed with equal frequency in wells associated with NAPL (OW30, MW-19) and in off-site areas not near the extent of NAPL occurrence (OW55, OW57).

Total SSI concentrations, as in the Fill chemistry, are apparently related to NAPL distribution. Mean values range from zero at 10 wells to 71,000 ug/L at OW40. All 5 high values (greater than 20,000 ug/L) are from wells associated with or adjacent to areas of NAPL occurrence (OW40, MW-19, OW47, OW30, and MW-17).

SSI were detected at least once in three off-site Alluvium wells: MW14, MW16, and OW52. The average Total SSI of approximately 840 μg/L at MW14 was, on average, composed of 810 μg/L benzene and 20 μg/L phenol. One SSI, 2-monochlorotoluene, was detected in one sample from MW-16 at a level of 5 μg/L. In one sample from OW52, the three isomers of chlorobenzoic acid were each detected at 100 μg/L.

The linear regression analysis for TOC/TOX yields a correlation coefficient of 0.46 (weak linear correlation). The TOC/Total SSI correlation coefficient of 0.02 shows almost no linear relationship. The correlation coefficient for TOX paired with total SSI (as Cl) was rather a weak 0.44.

5.7.3 BEDROCK AND TILL CHEMISTRY

Mean TOX concentrations in the Bedrock range from 6 ug/L (B-2) to 270 ug/L (B-1). These concentrations are comparable with background levels reported in upgradient Bedrock wells (5). Mean TOC concentrations in the Bedrock range from 5,000 ug/L (MW-7) to 28,000 ug/L (OW46). No background levels for TOC are known in local upgradient Bedrock wells. As with the Fill and Alluvium, a very poor linear correlation between TOX and TOC was calculated (correlation coefficient of 0.11).

The two Till wells had measured mean concentrations of TOX of approximately 480 ug/L (OW62) and 8,000 ug/L (OW9). Mean values of TOC were approximately 82,000 ug/L (OW62) and 120,000 ug/L (OW9). Because of concern over the integrity of the seals in these wells, it was recommended that they be overdrilled, sealed, and abandoned (5). The two Till wells were sampled during the sixth round of the extended survey (November 1987). These data are included in Volume 2, Appendix A. Both wells were removed in December, 1987.

Individual SSI compound concentrations were all below their respective survey levels, resulting in a uniform mean concentration of total SSI of zero at all 8 Bedrock and both Till locations.

5.7.4 ANALYSIS OF TOX BALANCE FOR WELLS OW9, OW26 AND OW31

Data reported (13) for wells OW9, OW26 and OW31 showed average TOX concentrations of 8017, 1003, and 503 ug/L, respectively. No SSI were found above the survey level in samples from OW9 and OW31. OW26 was not analyzed for SSI. The wells are all located on the western boundary of the Site. A review of these data suggested that chlorinated organic parameters not included in the SSI list might be the cause of the elevated TOX levels. Therefore a study was conducted in order to attempt to identify and assess the extent of unknown chlorinated parameters in the wells.

Samples from wells OW9, OW26, OW31 and OW63 (replacement for OW9) were subjected to a battery of analytical tests. Analysis for Target Compound List (TCL) parameters using EPA CLP procedures identified vinyl chloride (13 ug/L) and dichlorobenzoic acid (130 ug/L) in a sample from OW31, but no chlorinated organics in samples from OW9 and OW26. The two compounds identified in OW31 were not present in sufficient quantity to balance the TOX result (503 ug/L). Multiple hexane extraction of samples at high and low pH values did not change the TOX. This result suggested that the halogen was present as a very strong acid, a very strong base or was insoluble in hexane. Anion and cation exchange chromatography were applied, but did not isolate chemistry, suggesting that the halogen was not present as a strong acid or base.

The halogen was removed by activated carbon but could not be desorbed for analysis. Distillation of the water gave a solid residue which was analyzed by probe MS and X-ray fluorescence. The X-ray fluorescence identified the presence of chlorine, but no halogenated organics were identified by MS. Methyl-t-butylether (MTBE) did extract some chlorinated material from the samples. Probe MS of the dried extract showed dichlorophthalic anhydride and two unidentified peaks in a sample from OW26. Mono through tetrachlorophthalic anhydrides and a peak which could be chloromalonic acid were identified in a sample from OW63. GC/MS was performed on derivatized MTBE extracts, tentatively identifying di- and trichloroglutanic acids, but not in sufficient quantity to explain the TOX results.

A second line of research investigated the possibility that the TOX results were false positives caused by inorganic chlorine. Experiments involving filtration, precipitation of chloride with silver nitrate, precipitation of chlorine with sodium sulfite, the effect of aluminum and iron chloride, chlorates, and perchlorates were performed. These experiments showed that the TOX results could not be explained by the presence of inorganic chlorine.

Although some chlorinated organic acids were identified in the samples, the extensive analytical testing performed did not identify sufficient quantities of halogenated parameters to balance the TOX results. OCC believe that the comprehensive analytical program performed represents a reasonable effort to identify the parameters present and that further analytical work at this time would not significantly improve the TOX balance.

Since the estimated total organic chemical loads (TOC/TOX loads given in Chapter 10) are much higher than the predicted SSI loads in Chapter 10, this indicates that some chlorine-containing compounds have not been identified. However, further study (beyond that described above) to characterize these compounds was not undertaken since any unidentified chlorine-containing compounds were accounted for through use of the TOC and TOX results in the loading calculations.

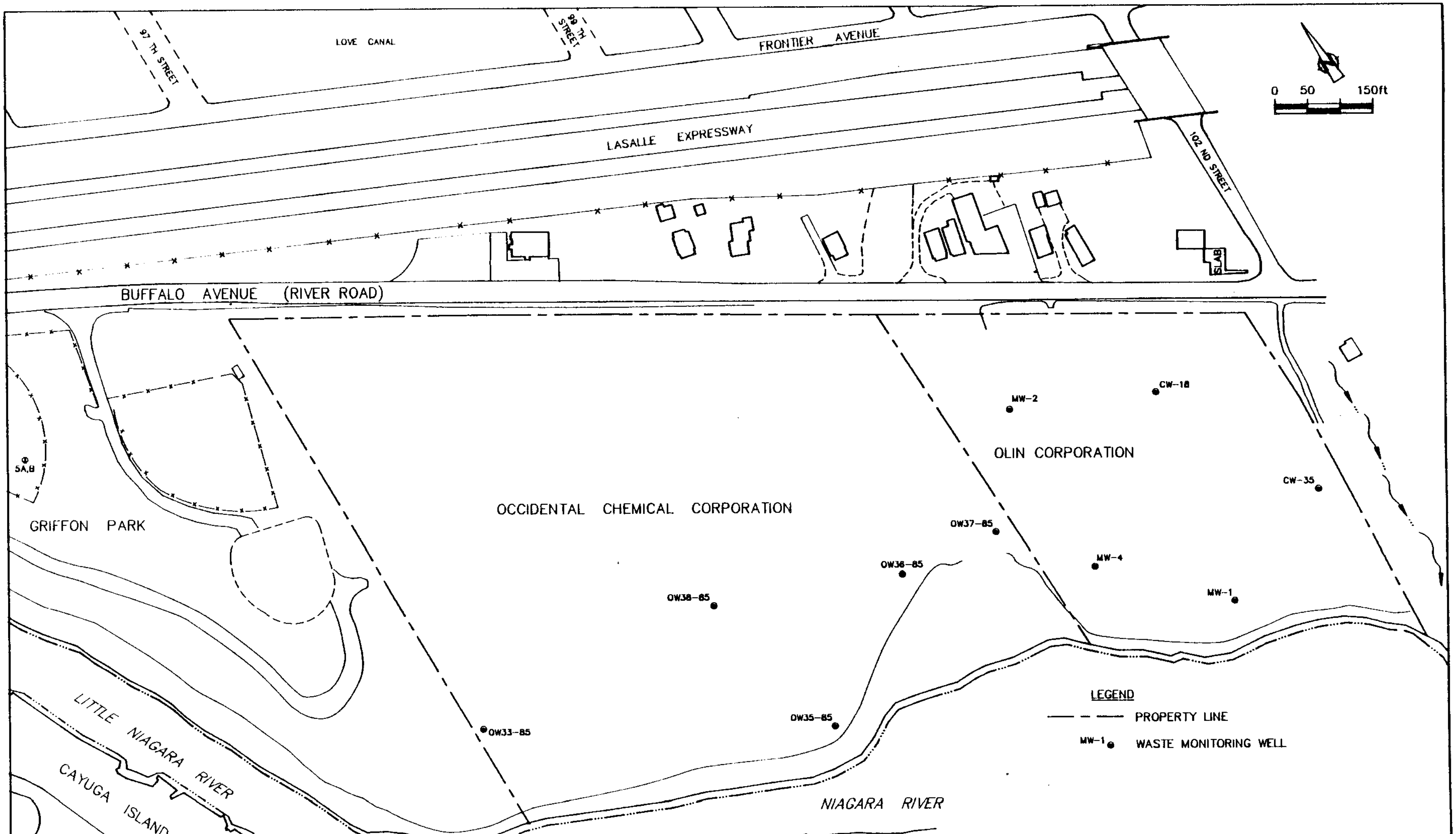

figure 5.1
WELLS SAMPLED DURING THE COMPREHENSIVE SURVEY REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC
1431-27/09/88-47-0-0 (P123)

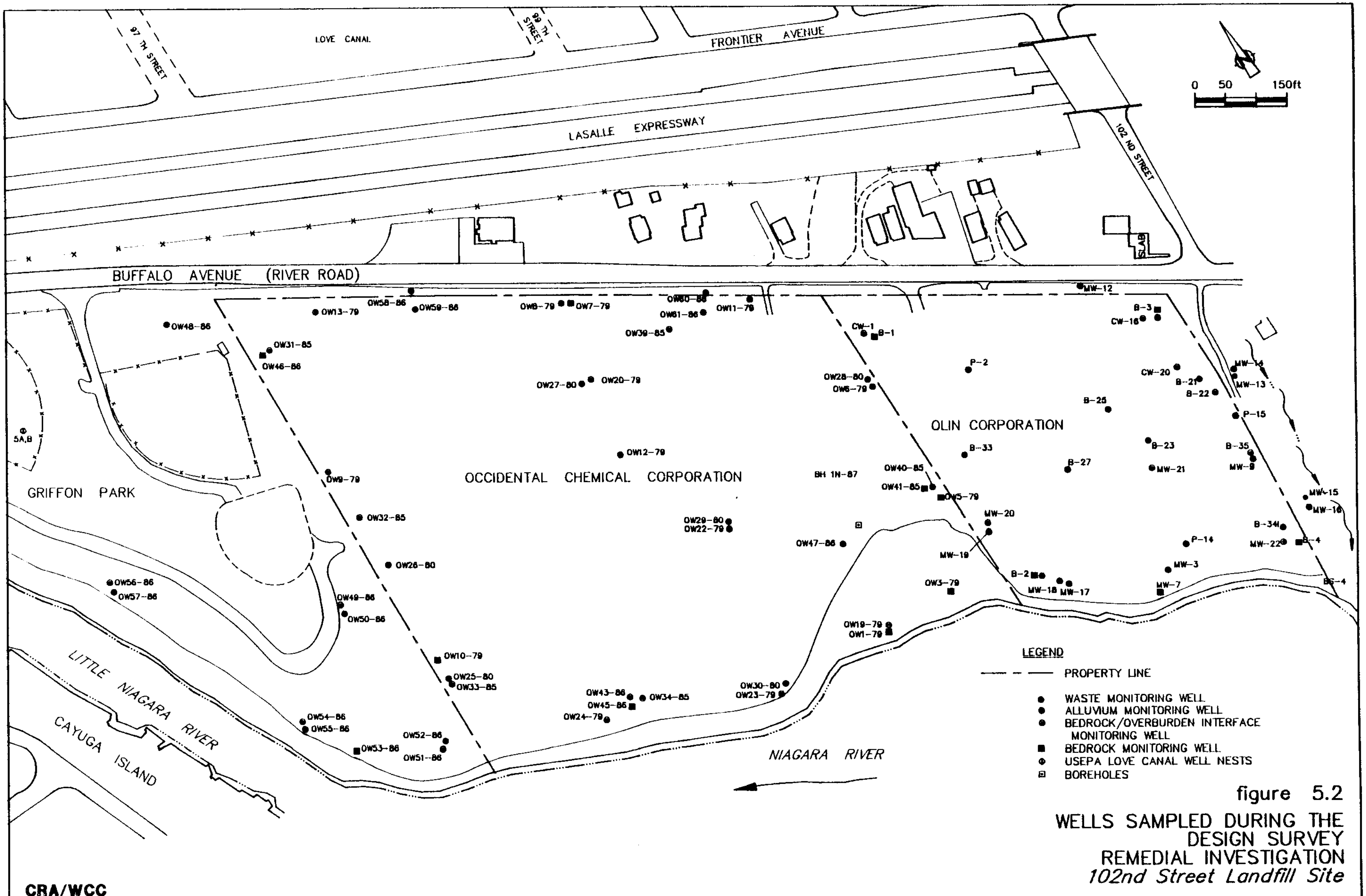

figure 5.2

WELLS SAMPLED DURING THE DESIGN SURVEY
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-27/09/88-47-D-0 (P123)

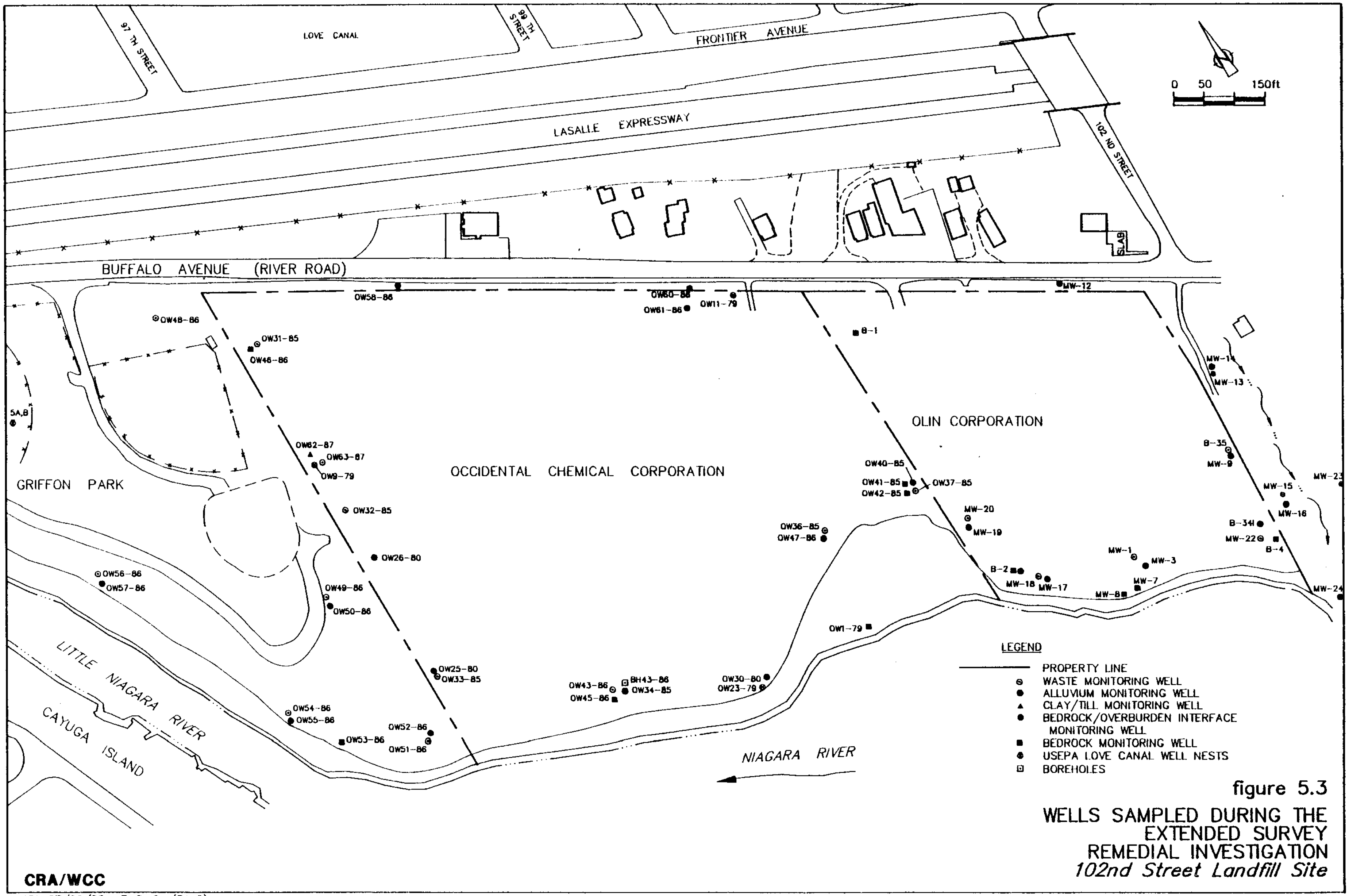

figure 5.3

WELLS SAMPLED DURING THE EXTENDED SURVEY REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-27/09/88-47-D-0 (P148)

TABLE 5.1

COMPREHENSIVE WASTE ANALYSIS SUMMARY OF DETECTIONS/OLIN 102ND STREET LANDFILL PART 1

Concentrations in micrograms per liter, except where noted.

Monitoring Well No.	MW-1	MW-2	MW-2(R)	MW-4	CW-18	CW-35	CW-35(R)
COMPOUND							
VOLATILES							
Benzene	75	1900	1800	8200	240	610	
Chlorobenzene	190	2200	2200	16,000	93	880	
Chloroform		< 44 (1)	< 43 (1)		< 4 (1)	30	
Acetone	20	< 130 (1)	150	< 640 (1)			
Trans-1,2-Dichloroethene	5.4	200	200				
Trichloroethene		160	160				
Tetrachloroethene		430	450				
SEMI-VOLATILES (B/NA)							
1,2-Dichlorobenzene	150	< 43 (1)	< 37 (1)	< 820 (1)	< 15 (1)	28	
1,3-Dichlorobenzene	110	340	310	< 220 (1)	< 18 (1)	30	
1,4-Dichlorobenzene	120	120	110	< 1200 (1)	< 15 (1)	54	
1,2,4-Trichlorobenzene	170	1000	820	2900	370	110	
2,4,5-Trichlorophenol		410	< 290 (1)				
				11,000*	< 8.4 (1)*		
2,4,6-Trichlorophenol		< 8.4 (1)					
PESTICIDES/PCB's							
Alpha Hexachlorocyclohexane	160	200	190	12,000	73	94	
Delta Hexachlorocyclohexane	110	13	10	71,000		100	
GENERAL PARAMETERS (Concentrations in milligrams per kilogram)							
Total Kjeldahl Nitrogen	1.9	4.9		1.6	0.1	0.1	0.3
Total Organic Carbon	27	67		41	14	20	16
Mercury	0.0006	0.026		0.0084	0.0086	0.007	0.0065
Phosphorus (Filtered)	0.21	0.16		0.11	0.16	0.16	0.26
Total Organic Halide (Feb)	2.392	15.21		52.40	2.117	1.20	1.158
Total Organic Halide (Apr)	1.5/1.5	5.2/4.4		43/48	2.1/1.8	1.1/1.2	

* Denotes indistinguishable isomers
Blank indicates not detected at or above survey level.
(1) Estimated concentration used for TOX balance.
(R) Denotes replicate sample.

TABLE 5.1 (Continued)

PRIORITY POLLUTANTS

Metal	Detection Limit	MW-1	MW-1D	MW-2	MW-2D	MW-4	MW-4 (Duplicate)	MW-4D	MW-4D (Duplicate)
Mercury		60	68	52.4	54.2	10.5	9.5	10.5	9.5
Beryllium	0.3								
Cadmium	3	16.7	19.3			6.53	7.36	7.70	8.39
Lead	42			64.7	76.2				
Zinc		21.1	25.4	47	51	153	154	152	155
Copper		20.3	28.4	41.6	44.7	19.9	10	15.6	15.6
Arsenic	53	56.4		68.4			85.1		87.6
Selenium	75								
Chromium	7	8.97	9.04	9.03	10.4				
Nickel	15					89.1	87.8	98.2	88.6
Thallium	40		49.2			47.5	66.2	101	
Antimony	32	54.3	47.2						49.7
Silver	7								

Metal	Detection Limit	CW-18	CW-18D	CW-35	CW-35 (Duplicate)	CW-35D	CW-35D (Duplicate)
Mercury		8.6	9.2	7.8	8.2	8.0	7.9
Beryllium	0.3						
Cadmium	3			3.4			
Lead	42						
Zinc		20.5	21.0	931	796	803	932
Copper		11.0	9.5	14.3	19.3	12.3	14.1
Arsenic	53	60.8	58.2		69.3		
Selenium	75						
Chromium	7						
Nickel	15			26.1	38.5	24.8	23.9
Thallium	40			108	72.8		73.0
Antimony	32		48.9	49.5		69.7	45.1
Silver	7						

* Denotes indistinguishable isomers
Blank indicates not detected at or above survey level.
D Denotes duplicate analysis.

WM-4M

TABLE 5.1 (Continued)

PART 2
COMPOUNDS TENTATIVELY IDENTIFIED IN SOME SAMPLES BUT BELOW DETECTION LIMITS IN ALL SAMPLES

Methylene chloride
Ethylbenzene
Phenol
Bis(2-chloroethyl)ether
2-Chlorophenol
4-Methylphenol
2,4-Dichlorophenol
Naphthalene

NON-TARGETED COMPOUNDS TENTATIVELY IDENTIFIED BY COMPUTER MATCHING

1,3,5-Trichlorobenzene
1,2,3,5-Tetrachlorobenzene
2,5-Dichlorophenol
2-Cyclohexen-1-one
Pentachlorobenzene
Tetrachlorobenzene (isomer not specified)
Halobenzene
Aromatic Halide
Hexane isomer
1-Chloro-2-ethylbenzene
1,4-Dichloro-2-ethylbenzene
Alkyl Phosphonate

(1) These tentative compound identifications are unconfirmed and concentrations are estimated using an assumed response factor. The information is uncertain and cannot be used in loading calculations. The information was used in a sub-calculation to further estimate closure of the TOX balance.

TABLE 5.1 (Continued)

COMPREHENSIVE WASTE ANALYSIS/OLIN
PART 3

TOX BALANCE

Compound	Molecular Weight	Wt Frac Chlorine	MW-1 Total ug/L	MW-1 ug/L CL	MW-1 % of Tot TOX	MW-2 Total ug/L	MW-2 ug/L CL	MW-2 % of Tot TOX
Chlorobenzene	112.56	0.3150	190	59.8	4.0	2200	692.9	14.4
Chloroform	119.38	0.8909		0.0	0.0	< 44 (1)	39.2	0.8
Trans-1,2-Dichloroethene	96.94	0.7314	5.4	3.9	0.3	200	146.3	3.0
Trichloroethene	131.29	0.8101		0.0	0.0	160	129.6	2.7
Tetrachloroethene	160.83	0.8552		0.0	0.0	430	367.7	7.7
Alpha Hexachloro-Cyclohexane	290.83	0.7314	160	117.0	7.8	200	146.3	3.0
Delta Hexachloro-Gyclohexane	290.83	0.7314	110	80.5	5.4	13	9.5	0.2
1,2-Dichlorobenzene	147.01	0.4823	150	72.3	4.8	< 43 (1)	20.7	0.4
1,3-Dichlorobenzene	147.01	0.4823	110	53.1	3.5	340	164.0	3.4
1,4-Dichlorobenzene	147.01	0.4823	120	57.9	3.9	120	57.9	1.2
1,2,4-Trichlorobenzene	181.45	0.5862	170	99.6	6.6	1000	586.2	12.2
2,4,5-Trichlorophenol	197.45	0.5387		0.0	0.0	410	220.9	4.6
2,4,6-Trichlorophenol	197.45	0.5387		0.0	0.0	<8.4 (1)	4.5	0.1
Methylene Chloride	84.93	0.8349		0.0	0.0		0.0	0.0
Bis(2-Chloroethyl)ether	143.02	0.4958	<10 (1)	5.0	0.3		0.0	0.0
2-Chlorophenol	128.56	0.2758	<6.6(1)	1.8	0.1	< 10 (1)	2.8	0.1
2,4-Dichlorophenol	163.00	0.4350	3.8	1.7	0.1	< 24 (1)	10.4	0.2
SUBTOTAL ug/L				552.6			2598.9	
TOTAL TOX				1500			4800	
SUBTOTAL ug/L/TOTAL TOX (%)				36.8	36.8		54.1	54.1
1,3,5-Trichlorobenzene	181.45	0.5862	< 38 (1)	22.3	1.5	<170 (1)	99.6	2.1
1,2,3,5-Tetrachlorobenzene	215.90	0.6568	<130 (1)	85.4	5.7	<1300(1)	853.9	17.8
2,5-Dichlorophenol	163.00	0.4350		0.0	0.0	< 46 (1)	20.0	0.4
Pentachlorobenzene	250.14	0.7087		0.0	0.0	< 71 (1)	50.3	1.0
Tetrachlorobenzene	215.90	0.6568	< 71 (1)	46.6	3.1	<150 (1)	98.5	2.1
Hexachlorocyclohexane	290.83	0.7314	< 84 (1)	61.4	4.1		0.0	0.0
Aromatic Halide (TCB)	181.45	0.5862	<510 (1)	298.9	19.9		0.0	0.0
1-chloro-2-ethyl benzene	140.61	0.2521		0.0	0.0		0.0	0.0
1,4-Dichloro-2-ethyl benzene	175.06	0.4050						
TOTAL ug/L				1067.3			3721.3	
TOTAL TOX(2)				1500			4800	
TOTAL ug/L/TOTAL TOX (2)			71.2	71.2		77.5	77.5	

* Denotes indistinguishable isomers
Blank indicates not detected at or above survey level.
(1) Estimated concentration used for TOX balance.
(2) Calculated from chlorine content of compounds listed.

TABLE 5.1 (Continued)

Compound	Molecular Weight	Wt Frac Chlorine	MW-2(R) Total ug/L	MW-2(R) ug/L CL	MW-2(R) % of Tot TOX	MW-4 Total ug/L	MW-4 ug/L CL	MW-4 % of Tot TOX
Chlorobenzene	112.56	0.3150	2200	692.9		16,000	5039.5	11.1
Chloroform	119.38	0.8909	< 43 (1)	38.3			0.0	0.0
Trans-1,2-Dichloroethene	96.94	0.7314	200	146.3			0.0	0.0
Trichloroethene	131.29	0.8101	160	129.6			0.0	0.0
Tetrachloroethene	165.83	0.8552	450	384.8			0.0	0.0
Alpha Hexachloro-Cyclohexane	290.83	0.7314	190	139.0		12,000	8777.0	19.3
Delta Hexachloro-Cyclohexane	290.83	0.7314	10	7.3		71,000	51,930.6	114.1
1,2-Dichlorobenzene	147.01	0.4823	< 37 (1)	17.8		< 820 (1)	395.5	8.9
1,3-Dichlorobenzene	147.01	0.4823	310	149.5		< 220 (1)	106.1	0.2
1,4-Dichlorobenzene	147.01	0.4823	110	53.1		< 1200 (1)	578.8	1.3
1,2,4-Trichlorobenzene	181.45	0.5862	820	480.7		2900	1699.9	3.7
2,4,5-Trichlorophenol	197.45	0.5387	<290 (1)	156.2		11,000	5925.3	13.0
2,4,6-Trichlorophenol	197.45	0.5387		0.0		*	0.0	0.0
Methylene Chloride	84.93	0.8349		0.0			0.0	0.0
Bis(2-Chloroethyl) ether	143.02	0.4958		0.0			0.0	0.0
2-Chlorophenol	128.56	0.2758	2.2	0.6		*	0.0	0.0
2,4-Dichlorophenol	163.00	0.4350	< 23 (1)	10.0			0.0	0.0
SUBTOTAL ug/L				2406.2			74,452.7	
TOTAL TOX							45,500	
SUBTOTAL ug/L/TOTAL TOX (%)							163.6	163.6
1,3,5-Trichlorobenzene	181.45	0.5862	<140 (1)	82.1			0.0	0.0
1,2,3,5-Tetrachlorobenzene	215.90	0.6568	<960 (1)	630.6			0.0	0.0
2,5-Dichlorophenol	163.00	0.4350		0.0			0.0	0.0
Pentachlorobenzene	250.14	0.7087	< 66 (1)	46.8			0.0	0.0
Tetrachlorobenzene	215.90	0.6568	<480 (1)	262.7		< 1100 (1)	722.5	1.6
Hexachlorocyclohexane	290.83	0.7314		0.0			0.0	0.0
Aromatic Halide (TCB)	181.45	0.5862	<680 (1)	398.6		< 7700 (1)	4513.4	9.9
1-chloro-2-ethylbenzene	140.61	0.2521		0.0			0.0	0.0
1,4-Dichloro-2-ethylbenzene	173.06	0.4050						
TOTAL ug/L				3826.9			79,688.7	
TOTAL TOX(2)							45,500	
TOTAL ug/L/TOTAL TOX (%)						175.1	175.1	

* Denotes indistinguishable isomers
Blank indicates not detected at or above survey level.
(1) Estimated concentration used for TOX balance.
(2) Calculated from chlorine content of compounds listed.

TABLE 5.1 (Continued)

Compound	Molecular Weight	Wt Frac Chlorine	CW-18 Total ug/L	CW-18 ug/L CL	CW-18 % of Tot TOX	CW-35 Total ug/L	CW-35 ug/L CL	CW-35 % of Tot TOX
Chlorobenzene	112.56	0.3150	93	29.3	1.5	880	277.2	24.1
Chloroform	119.38	0.8909	< 4 (1)	3.6	0.2	30	26.7	2.3
Trans-1,2-Dichloroethene	96.94	0.7314		0.0	0.0		0.0	0.0
Trichloroethene	131.29	0.8101		0.0	0.0		0.0	0.0
Tetrachloroethene	165.83	0.8552		0.0	0.0		0.0	0.0
Alpha Hexachloro-Cyclohexane	290.83	0.7314	73	53.4	2.7	94	68.8	6.0
Delta Hexachloro-Cyclohexane	290.83	0.7314		0.0	0.0	180	73.1	6.4
1,2-Dichlorobenzene	147.01	0.4823	<15 (1)	7.2	0.4	28	13.5	1.2
1,3-Dichlorobenzene	147.01	0.4823	<18 (1)	8.7	0.4	30	14.5	1.3
1,4-Dichlorobenzene	147.01	0.4823	<15 (1)	7.2	0.4	54	26.0	2.3
1,2,4-Trichlorobenzene	181.45	0.5862	370	216.9	11.1	110	64.5	5.6
1,2,4-Trichlorophenol	197.45	0.5387	<8.4 (1)	4.5	0.2		0.0	0.0
2,4,6-Trichlorophenol	197.45	0.5387		0.0	0.0		0.0	0.0
Methylene Chloride	84.93	0.8349	<7.8 (1)	6.5	0.3		0.0	0.0
Bis(2-Chloroethyl)ether	143.02	0.4958		0.0	0.0	<7.2 (1)	3.6	0.3
2-Chlorophenol	128.56	0.2758		0.0	0.0	<7.2 (1)	0.6	0.1
2,4-Dichlorophenol	163.00	0.4350	<8.4 (1)	3.7	0.2		0.0	0.0
SUBTOTAL ug/L				341.0			568.5	
TOTAL TOX				1950			1150	
SUBTOTAL ug/L/TOTAL TOX (%)				17.5	17.5		49.4	49.4
1,3,5-Trichlorobenzene	181.45	0.5862	< 24 (1)	14.1	0.7		0.0	0.0
1,2,3,5-Tetrachlorobenzene	215.90	0.6568		0.0	0.0		0.0	0.0
2,5-Dichlorophenol	163.00	0.4350		0.0	0.0		0.0	0.0
Pentachlorobenzene	250.14	0.7087		0.0	0.0		0.0	0.0
Tetrachlorobenzene	215.90	0.6568	< 18 (1)	11.8	0.6		0.0	0.0
Hexachlorocyclohexane	290.83	0.7314	<332 (1)	242.8	12.5	< 78 (1)	51.2	4.5
Aromatic Halide (TCB)	181.45	0.5862	< 38 (1)	22.3	1.1	14	8.2	0.7
1-chloro-2-ethylbenzene	140.61	0.2521		0.0	0.0	<222 (1)	56.0	4.9
1,4-Dichloro-2-ethylbenzene	175.06	0.4050		0	0.0	< 32 (1)	13.0	1.1
TOTAL ug/L				632.0			696.8	
TOTAL TOX(2)				1950			1150	
TOTAL ug/L/TOTAL TOX (%)			32.4	32.4		60.6	60.6	

* Denotes indistinguishable isomers
Blank indicates not detected at or above survey level.
(1) Estimated concentration used for TOX balance.
(2) Calculated from chlorine content of compounds listed.

TABLE 5.2

COMPREHENSIVE WASTE ANALYSIS SUMMARY, OCC
102ND STREET LANDFILL
PART 1

COMPLETE LISTING OF COMPOUNDS (ug/L)

Compound	OW33	OW35	OW36	OW37	OW38
Acetone	800	800		800	800
Aliphatic Hydrocarbons		540			
Aliphatic Sulfur Compounds	19			19	
Aniline		16			18
Arochlor 1242			62		
Benzaldehyde		27			
Benzene		2100		310	2300
Benzene Acetic Acid					25
Benzene Propanoic Acid					89
Benzoic Acid		25,000			
Benzyl Alcohol		110			
Biphenyl Acetic Acid					28
$C_7H_5NO_2Cl$		33			
$C_9H_{10}O$		100			
$C_{10}H_{18}O$		6100			
$C_{13}H_{11}ON_2Cl$					110
$C_{14}H_{14}S$		64			
$C_{14}H_{20}O_2$				35	
Carbon Disulfide			50		
Chlorendic Acid	180	1500			
Chloroaniline		1100			3400
Chlorobenzene		2800	12	210	6900
Chlorobenzene Acetic Acid					11
Chlorobenzoic Acids		10,000			
Chloroform		21			
bis(Chloroethyl)ether				37	
Chlorophenols		230			49
Chlorophenyl Acetamide					14
Chlorothiophene					53
Chlorotoluenes		560			92
Dibutylphthalate		97			
Dichloroaniline		16,000			3900
Dichlorobenzenes		720			3000
Dichlorobenzoic Acids		740			98
Dichlorobutene					9
trans-1,2-Dichloroethylene		10	720		
Dichloromethoxybenzene		700			
Dichloromethylbenzoic Acid					31
Dichlorophenols		1200			190
Dichlorothiophene					16
Dichlorotoluenes		340			24
Dimethylethylphenol					16
Dimethylphenol		87			15
Diphenyl Ketone					6
Dodecanoic Acid		79	3		

TABLE 5.2 (Continued)

Compound	OW33	OW35	OW36	OW37	OW38
Ethoxychloroaniline		300			
2-Ethylcyclohexanone					31
bis(2-Ethyl hexyl)phthalate		25	11	180	12
Ethyl Methyl Benzene				2	
Hexachlorocyclohexane		1210		39	530
Hexathiepane				15	
Methoxychloroaniline		7200			
Methoxydichloroaniline		750			
Methyl Cyclohexanol					14
Methylethylcyclohexanone					15
Methyl Ethyl Phenol					28
Methyl Phenol		39			110
Nitroaniline					56
Nitrobenzoic Acid		2900			
Oxathiane				42	
1,1'-Oxybis(2-chloro)ethane				37	
Pentachlorobenzene		39			100
Pentachlorophenol		36			38
Phenol		110		25	34
Phenylcyclohexanol					50
Phenylethyl Phenol					36
Phosphorus			22		
Propyl Benzene				1	
Propyl Phenol		230			
bis-Sulfonyl Benzene					17
Sulfur			780		
Tetrachlorobenzene		660			2700
Tetrachloroethylene		14			
Tetrachlorophenol		10			540
Thiobisbenzene					10
Toluene		5700			300
Trichlorobenzenes		800			2400
Trichlorocresol		58			
Trichloroethylene		15	730		
Trichlorophenols		420		220	
Trichloropropane					9
Trichlorotoluene		110			
Trifluoromethylbenzamine			58		
Trimethylbenzene				12	
Trimethylbicycloheptanone		2500		7	20
Trioxane			8		
Trithiane			36		
Trithiolane				5	
Vinyl Chloride			22		
Xylene				22	24
Unidentified Chlorinated Compounds		120			100

TABLE 5.2 (Continued)

TOX BALANCE (ug/L)
PART 2

Compound	OW33	OW35	OW36	OW37	OW38
Aroclor 1242			62		
Chlorendic Acid	180	1500			
Chloroaniline		1100			3400
Chlorobenzene		2800	12	210	6900
Chlorobenzoic Acids		10,000			
Chloroform		21			
bis(Chloroethyl)ether				37	
Chlorophenols		230			49
Chlorophenyl Acetamide					14
Chlorothiophene					53
Chlorotoluenes		560			92
Dichloroaniline		16,000			3900
Dichlorobenzenes		720			3100
Dichlorobenzoic Acids		740			98
trans-1,2-Dichloroethylene		10	720		
Dichloromethylbenzoic Acid					31
Dichloromethoxybenzene		700			
Dichlorophenols		1200			190
Dichlorotoluenes		340			24
Ethoxychloroaniline		300			
Hexachlorocyclohexane		1210		39	530
Methoxychloroaniline		7200			
Methoxydichloroaniline		750			
Pentachlorobenzene		39			100
Pentachlorophenol		36			38
Tetrachlorobenzene		660			2700
Tetrachloroethylene		14			
Tetrachlorophenol		10			540
Trichlorobenzenes		830			3100
Trichlorocresol		58			
Trichloroethylene		15	730		
Trichlorophenols		420			214
Trichlorotoluene		110			
Vinyl Chloride			22		
Unidentified Chlorinated Compounds		75			110
Total TOX(1)	110	18,500	1160	113	11,100
OBG TOX(2)	457	43,100	1377	1129	13,225
%	25	43	84	10	84
OCC TOX(3)	300	32,000	1000	900	16,000
%	37	58	116	13	69

(1) Calculated from chlorine content of compounds listed.
(2) O'Brian and Gere laboratory data.
(3) Occidental Chemical Corporation laboratory data

TABLE 5.2 (Continued)

INORGANIC AND GENERAL PARAMETERS (ug/L)
PART 3

Parameter	OW33	OW35	OW36	OW37	OW38
TOX	457	43,100	1377	1129	13,225
TOC	12,000	350,000	22,000	35,000	80,000
TKN	2700	19,700	2400	2400	14,100
Phosphorus	260	50	2430	1320	50
Mercury				2.3	
Antimony		62			
Arsenic		230	62	56	
Beryllium					
Cadmium		33	8	15	10
Chromium		12		3	20
Copper	9	18	11	9	9
Lead		70			
Nickel	10	108	10	5	29
Selenium					
Silver					
Thallium		89			
Zinc	27	233	31	46	36

TABLE 5.3

SITE-SPECIFIC PARAMETERS
GROUNDWATER
102ND STREET LANDFILL

Parameter	Survey Level (ug/L)	Sample Matrix	Analytical Method Reference	Sample Preservation	Holding Time	Container
Benzene	5	Groundwater	EPA 624 (Modified)	Cool, 4°C	7 days	Glass
Toluene	5	"	"	"	"	"
Monochlorobenzene	5	"	"	"	"	"
2-Monochlorotoluene	5	"	"	"	"	"
4-Monochlorotoluene	5	"	"	"	"	"
1,2-Dichlorobenzene	10	"	EPA 625 (Modified)	"	7 days Extraction 30 days analysis	"
1,4-Dichlorobenzene	10	"	"	"	"	"
1,2,3-Trichlorobenzene	10	"	"	"	"	"
1,2,4-Trichlorobenzene	10	"	"	"	"	"
1,2,3,4-Tetrachlorobenzene	10	"	"	"	"	"
1,2,4,5-Tetrachlorobenzene	10	"	"	"	"	"
Hexachlorobenzene	10	"	"	"	"	"
alpha Hexachlorocyclohexane	10	"	"	"	"	"
beta Hexachlorocyclohexane	10	"	"	"	"	"
gamma Hexachlorocyclohexane	10	"	"	"	"	"
delta Hexachlorocyclohexane	10	"	"	"	"	"
2,5-Dichloroaniline	10*	"	"	"	"	"
3,4-Dichloroaniline	10*	"	"	"	"	"*
Phenol	10	"	"	"	"	"
2-Chlorophenol	10	"	"	"	"	"
4-Chlorophenol	10	"	"	"	"	"
2,4-Dichlorophenol	10	"	"	"	"	"
2,5-Dichlorophenol	10	"	"	"	"	"
2,4,5-Trichlorophenol	50	"	"	"	"	"
2,4,6-Trichlorophenol	10	"	"	"	"	"
2-Chlorobenzoic acid	100	"	HPLC	"	30 days	"
3-Chlorobenzoic acid	100	"	"	"	"	"
4-Chlorobenzoic acid	100	"	"	"	"	"
General Parameters	per SSQAR	"	per SSQAR	per SSQAR	per SSQAR	per SSQAR
Arsenic	50	"	EPA 206.2	Filter on-site HNO_3 to pH < 2	6 months	plastic

* Survey Level to be determined by the method validation with a goal of 10 ug/L.

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TABLE 5.4

K_{oc} RANKING FOR COMPOUNDS DETECTED BY THE COMPREHENSIVE WASTE WELL ANALYSIS 102ND STREET LANDFILL

SSI	Compound	Representative (1) Concentration µg/L	K_{oc} (ml/g)	K_{oc} Rank
	Acetone	337	2.2	L (Low)
	Aliphatic hydrocarbons	108		
	Aliphatic sulfur compounds	8		
	Aniline	7		
	Antimony	12		
	Arochlor 1242	12	530,000	H (High)
	Arsenic	70		
	Benzaldehyde	6		L
Y	Benzene	1574	83	L
	Benzene acetic acid	5		L
	Benzene propanoic acid	18		L
	Benzoic acid	5000		L
	Benzyl alcohol	22		L
	Biphenyl acetic acid	5		
	Cadmium	13		
	Carbon disulfide	10	54	L
	Chlorendic acid	336		L
	Chloroaniline	900		L
Y	Chlorobenzene	2929	330	
	Chlorobenzene acetic acid	2		L
Y	Chlorobenzoic acids	2000		L
	Chloroform	5	31	L
	bis(Chloroethyl)ether	8	13.9	L
Y	Chlorophenols	56		L
	Chlorophenyl acetamide	3		L
	Chlorothiophene	10		
Y	Chlorotoluenes	132		
	Chromium	7		
	Copper	11		
	Dibutylphthalate	20	170,000	H
Y	Dichloroaniline	4000		
Y	Dichlorobenzenes	744		

(1) Non-detects were assigned the value of zero.

TABLE 5.4 (Continued)

SSI	Compound	Representative[1] Concentration µg/L	K_{oc} (ml/g)	K_{oc} Rank
Y	1,2-Dichlorobenzene	36	1700	H
Y	1,3-Dichlorobenzene	96	1700	H
Y	1,4-Dichlorobenzene	59	1700	H
	Dichlorobenzoic acids	168		L
	Dichlorobutene	2		
	trans-1,2-dichloroethylene	146	59	L
	Dichloromethoxybenzene	140		
	Dichloromethylbenzoic acid	6		L
Y	Dichlorophenols	280		L
	Dichlorothiophene	3		
	Dichlorotoluenes	73		
	Dimethylethylphenol	3		L
	Dimethylphenol	20		L
	Diphenyl ketone	1		L
	Dodecanoic acid	16		L
	Ethoxychloroaniline	60		L
	2-Ethylcyclohexanone	6		L
	bis(2-Ethylhexyl)phthalate	46		
	Ethylmethylbenzene	1		
Y	Hexachlorocyclohexane	356		
Y	alpha-Hexachlorocyclohexane	2505	3800	H
Y	delta-Hexachlorocyclohexane	14,245	6600	H
	Hexathiepane	3		
	Lead	14		
	Mercury	10		
	Methoxychloroaniline	1440		L
	Methoxydichloroaniline	150		L
	Methylcyclohexanol	3		L
	Methylethylcycohexanone	3		L
	Methylethylphenol	6		L
	Methylphenol	30		L
	Nickel	32		
	Nitroaniline	12		L
	Nitrobenzoic acid	580		L
	Oxathiane	8		
	1,1'-Oxybis(2-chloro)ethane	7		

TABLE 5.4 (Continued)

SSI	Compound	Representative (1) Concentration µg/L	K_{oc} (ml/g)	K_{oc} Rank
	Pentachlorobenzene	28	13,000	H
	Pentachlorphenol	15	53,000	H
Y	Phenol	34	14.2	L
	Phenylcyclohexanol	10		L
	Phenylethylphenol	7		L
	Phosphorus	4		
	Propylbenzene			
	Propylphenol	46		L
	bis-Sulfonylbenzene	3		
	Sulfur	156		
Y	Tetrachlorobenzene	672	1600	H
	Tetrachloroethylene	45	364	
	Tetrachlorophenol	110	98	
	Thallium	18		
	Thiobisbenzene	2		
Y	Toluene	1200	300	
Y	Trichlorobenzenes	640	9200	H
Y	1,2,4-Trichlorobenzene	910	9200	H
	Trichlorocresol	12		
	Trichloroethylene	91	126	
Y	Trichlorophenols	128	89-2240	
Y	2,4,5-Trichlorophenol	82	89	
	Trichloropropane	2		
	Trichlorotoluene	22		
	Trifluoromethylbenzamine	12		
	Trimethylbenzene	2		
	Trimethylbicycloheptanone	505		
	Trioxane	2		
	Trithiane	7		
	Trithiolane	1		
	Vinyl chloride	4	57	L
	Xylene	9		
	Zinc	75		

TABLE 5.5

TOXICITY RANKING FOR COMPOUNDS DETECTED BY THE COMPREHENSIVE WASTE WELL ANALYSES
102ND STREET LANDFILL

SSI	Compound	Representative Concentration µg/L	Koc ml/g	Koc Rank	Potential Carcinogen Toxicity Constant 1/mg	PCTC* Conc *1000	Potential Carcinogen Rank	Non Carcinogen Toxicity Constant 1/mg	NCTC* Conc *1000	Non Carcinogen Rank
	Arochlor 1242	12	530,000	H (High)	0.571	6.85				
	Antimony	12						4.35	52.20	
Y	Arsenic	70			4.07	284.90	2	18	1260.00	1
Y	Benzene	1574	83	L (Low)	0.00771	12.13		0.117	184.10	4
	Cadmium	13						4.45	57.85	
	Carbon disulfide	10	54	L				0.424	4.24	
Y	Chlorobenzene	2929	330					0.143	418.78	2
	Chloroform	5	31	L	0.0563	0.28				
	bis(Chloroethyl)ether	8	13.9	L	0.347	2.78				
	Chlorophenols	56		L				0.0826	4.63	
	Chlorotoluenes	132						0.143	18.88	
	Copper	11						0.714	7.85	
	Dibutylphthalate	20	170,000	H				0.0381	0.76	
Y	Dichlorobenzenes	744						0.0519	38.61	
Y	1,2-Dichlorobenzene	36	1700					0.0519	1.87	
	1,3-Dichlorobenzene	96	1700					0.0519	4.98	
Y	1,4-Dichlorobenzene	59	1700					0.0519	3.05	
	trans-1,2-dichloroethylene	146	59	L				0.0529	7.72	
Y	Dichlorophenols	280		L				0.0826	23.13	
	Dichlorotoluenes	73						0.0519	3.78	
	bis(2-Ethylhexyl)phthalate	46			0.000571	0.03				
Y	Hexachlorocyclohexane	356			1.56	55.36	3			
Y	alpha-Hexachlorocyclohexane	2505	3800		1.56	3908.42	1			
	Lead	14						0.893	12.50	
	Mercury	10						18.4	184.00	5
	Nickel	32						4.26	136.32	8
	Pentachlorobenzene	28	13,000	H				0.0232	0.65	
Y	Phenol	34	14.2	L				0.1	3.40	
Y	Tetrachlorobenzene	672	1600					0.0976	65.59	10
	Tetrachloroethylene	45	364		0.00886	0.40		0.00962	0.43	
Y	Tetrachlorophenol	110	98					1.5	165.00	6
Y	Toluene	1200	300					0.0052	6.24	
Y	Trichlorobenzenes	640	9200					0.214	136.96	7
Y	1,2,4-Trichlorobenzene	910	9200					0.214	194.74	3
	Trichloroethylene	91	126		0.00429	0.39		1.05	95.03	9
Y	Trichlorophenols	128	89-2240					0.102	13.06	
Y	2,4,5-Trichlorophenol	82	89					0.102	8.36	
	Trichlorotoluene	22						0.214	4.71	
	Vinyl chloride	4	57	L	0.00429	0.02		0.0877	0.35	
	Zinc	75						0.107	7.98	

Blank indicates not detected at or above survey level.

TABLE 5.6

SUMMARY TABLE
COMPREHENSIVE OFF-SITE ANALYSIS, OLIN
102ND STREET LANDFILL

Concentrations in micrograms per liter except where noted.

Monitor Well No.	MW-13	MW-14	MW-15	MW-16
COMPOUND				
VOLATILES				
Benzene		2400		
Chlorobenzene	43		36	7.1
Acetone	37			17
Methylene chloride	14			
SEMI-VOLATILES (B/NA)				
4-Methylphenol	27			
PESTICIDES/PCBs				
Alpha-hexachlorocyclohexane	.65	.15	1.3	.15
Beta-hexachlorocyclohexane			.46	.11
Gamma-hexachlorocyclohexane		.05	.39	.08
Delta-hexachlorocyclohexane	.45		.8	.13
GENERAL PARAMETERS (Concentrations in milligrams per liter)				
Total Kjeldahl Nitrogen	14.7	1.5	1.8	3.9
Total Organic Carbon	300	40	30	260
Mercury			.0007	
Phosphorus (Total)				.12
Total Organic Halide	.21	.098	.14	.18

Blanks indicate not detected at or above survey level.

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TABLE 5.6 (Continued)

PRIORITY POLLUTANT METALS

Monitoring Well No. METAL	Detection Limit	MW-13	MW-14	MW-15	MW-16
Mercury	0.0002				
Beryllium	0.005				
Cadmium	0.005				
Lead	0.005	0.0064	0.0054		0.0053
Zinc	0.020	0.003	0.060		0.040
Copper	0.025				0.040
Arsenic	0.010				
Selenium	0.005				
Chromium	0.010				
Nickel	0.040				0.040
Thallium	0.010				
Antimony	0.060				
Silver	0.010	0.020			

COMPOUNDS TENTATIVELY IDENTIFIED IN SOME SAMPLES BUT BELOW DETECTION LIMITS IN ALL SAMPLES

Benzoic acid
Bis(2,-chloroethyl)ether
Butyl benzyl phthalate
Di-n-butylphthalate
Phenol

NON-TARGETED COMPOUNDS TENTATIVELY IDENTIFIED BY COMPUTER MATCHING

A carboxylic acid
Isomer of benzene acetic acid
Benzene propanoic acid
Cyclohexane
Cyclopentanamine,n-ethyl
Isomer of Phosphonic acid, methyl-,bis(1-methylethyl)ester

(1) These tentative compound identifications are unconfirmed and concentrations are estimated using an assumed response factor.

TABLE 5.7

OFF-SITE COMPREHENSIVE SURVEY RESULTS, OCC 102ND STREET LANDFILL

Compound	Summary Table (ug/L) OW49	OW51	OW54
alpha-HCCH			0.2
gamma-HCCH			0.07
Toluene	36		
Ethylbenzene	10		
Dimethylbenzene	65		
Trimethylbenzene	3		
Sulfur		8	
Mercury		1.4	
Arsenic		63	
Lead	30	46	45
Nickel	16		14
Chromium		3	3
Thallium	67		85
Selenium		87	
TOX	370	150	51
TOC	73,000	150,000	71,000
TKN	1500	5700	6300

Blanks indicate not detected at or above survey level.

TABLE 5.8

DESIGN SURVEY MONITORING WELLS
102ND STREET LANDFILL

Well Type	Olin		OCC		
Interior	B-23		OW12-79		
	B-25		OW20-79		
	B-27		OW22-79		
	B-33		OW27-79		
	MW-20 (Replaces P-5)		OW29-80		
	MW-21 (Replaces P-13)				
	P-2				
Boundary	B-21	MW-17 (Replaces P-10)	OW6-79	OW25-80	OW43-86
	B-34I	MW-18 (Replaces P-11)	OW8-79	OW26-80	OW59-86
	B-35	MW-19 (Replaces B-32)	OW9-79	OW30-80	OW61-86
	CW-1	MW-22 (Replaces P-17)	OW11-79	OW31-85	
	CW-16	P-14	OW13-79	OW32-85	
	CW-20	P-15	OW17-79	OW34-85	
	MW-3	P-18	OW19-79	OW39-85	
	MW-9		OW23-79	OW40-85	
			OW24-79	OW47-85	
			OW28-79		
Old Bedrock	B-1		OW1-79	OW7-79	
	B-2		OW3-79	OW10-79	
	B-3		OW5-79		
	B-4				
New Bedrock	MW-7		OW41-85	OW46-86	
			OW45-86		
Off-Site	MW-12 (Transect)		OW48-86	OW54-86	
	MW-13		OW49-86	OW55-86	
	MW-14		OW50-86	OW56-86	
	MW-15		OW51-86	OW57-86	
	MW-16		OW52-86	OW58-86 (Transect)	
			OW53-86 (Rock)	OW60-86 (Transect)	

TABLE 5.9

DEEP BEDROCK ANALYTICAL RESULTS
102ND STREET LANDFILL

WELL OW42

PARAMETER	Survey Level (mg/L)	518.5-503.4	518.5-503.4(D)	503.4-488.6	488.6-473.6	473.6-458.6
Sample Elevation (ft):						
Total Kjeldahl Nitrogen (TKN)	.1	3.6	3.3	3.3	1.8	1
Total Organic Carbon (TOC)	1	10	9	12	9	
Mercury	.0002					
Phosphorus (dissolved)	.01					
Arsenic	.050					
Total Organic Halide (TOX)	.010	.098	.033	.026	.038	.131

WELL OW44

PARAMETER	Survey Level (mg/L)	533.2-517.8	517.8-502.8	502.8-487.8	487.8-472.8
Sample Elevation (ft):					
Total Kjeldahl Nitrogen (TKN)	.1	1.0	.75		1.9
Total Organic Carbon (TOC)	1	26	9.0	25	29
Mercury	.0002				
Phosphorus (dissolved)	.01				
Arsenic	.050				
Total Organic Halide (TOX)	.010	.039	.046	.029	.042

TABLE 5.9 (Continued)

Well MW-8

PARAMETER	Survey Level (mg/L)	536-521	521-506	506-491	476-461
Total Kjeldahl Nitrogen (TKN)	0.1	1.0	1.8	1.0	3.4
Total Organic Carbon (TOC)	1	6	54	40	46
Mercury	.0002				
Phosphorus (dissolved)	0.01				
Arsenic	0.05				
Total Organic Halide (TOX)	0.01	*	*	*	*

Notes:

Blank indicates not detected at or above survey level.

* Matrix interferences in all samples. Unable to meet precision requirements of method:

(D) Field Duplicate

TABLE 5.10

EXTENDED SURVEY WELLS
102ND STREET LANDFILL

OLIN	Boundary Wells	Off-Site Wells	Required Bedrock Wells
ALLUVIUM	MW-3	MW-12 (Transect)	MW-7 (Shallow)
	MW-9	MW-14	MW-8 (Deep) (NS)
	MW-17	MW-16	B-2
	MW-19	MW-23	
	B-34I	MW-24	
FILL	MW-18	MW-13	
	MW-20	MW-15	
	MW-1*		
	MW-22		
	B-35* (NS)		
BEDROCK	B-1 (owner's option)		
	B-4 (Bedrock)		

OCC	Boundary Wells	Off-Site Wells	Required Bedrock Wells
ALLUVIUM	OW25	OW50	OW41 (Shallow)
	OW40	OW52	OW45 (Shallow)
	OW43	OW55	OW46 (Shallow)
	OW47	OW57	OW42 (Deep) (NS)
	OW30	OW58 (Transect)	OW44 (Deep) (NS)
	OW26*	OW60 (Transect)	
	OW63		
FILL	OW31	OW48	
	OW33	OW49	
	OW35	OW51	
	OW36	OW54	
	OW37	OW56	
	OW34		
BEDROCK	OW1*	OW53 (Bedrock)	
TILL	OW9		
	OW62		

* For general parameters only
NS = Not Sampled

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TABLE 5.11

STATISTICAL SUMMARY OF TOX DATA
FROM THE EXTENDED GROUNDWATER SURVEY
102ND STREET LANDFILL

Table 5.11
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Halide (TOX)
Survey Level = 10 ug/1

B-1 (bedrock)

Number of values	6	Range	(1275)
Number of ND's	3	Minimum	(25)
Standard Deviation	510	Maximum	1300
Coefficient of variation	1.91	Mean	(267)

B-2 (bedrock)

Number of values	3	Range	--
Number of ND's	3	Minimum	(5)
Standard Deviation	2.8	Maximum	(10)
Coefficient of variation	0.43	Mean	(7)

B-34I (alluvium)

Number of values	6	Range	6200
Number of ND's	0	Minimum	1200
Standard Deviation	2300	Maximum	7400
Coefficient of variation	0.40	Mean	5820

B-4 (bedrock)

Number of values	6	Range	(375)
Number of ND's	5	Minimum	(5)
Standard Deviation	150	Maximum	380
Coefficient of variation	1.91	Mean	(78)

MW-1 (fill)

Number of values	5	Range	1270
Number of ND's	0	Minimum	330
Standard Deviation	490	Maximum	1600
Coefficient of variation	0.53	Mean	912

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.11
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Halide (TOX)
Survey Level = 10 ug/1

MW-12 (alluvium)

Number of values	2	Range	(255)
Number of ND's	1	Minimum	(25)
		Maximum	280
		Mean	(140)

MW-13 (fill)

Number of values	3	Range	40
Number of ND's	0	Minimum	130
Standard Deviation	21	Maximum	170
Coefficient of variation	0.14	Mean	147

MW-14 (alluvium)

Number of values	3	Range	10
Number of ND's	0	Minimum	51
Standard Deviation	5	Maximum	61
Coefficient of variation	0.09	Mean	57

MW-15 (fill)

Number of values	3	Range	(155)
Number of ND's	1	Minimum	(25)
Standard Deviation	80	Maximum	180
Coefficient of variation	0.89	Mean	(92)

MW-16 (alluvium)

Number of values	3	Range	170
Number of ND's	0	Minimum	120
Standard Deviation	90	Maximum	290
Coefficient of variation	0.50	Mean	183

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.11
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Halide (TOX)
Survey Level = 10 ug/1

MW-3 (alluvium)

Number of values	6	Range	2540
Number of ND's	0	Minimum	460
Standard Deviation	910	Maximum	3000
Coefficient of variation	0.47	Mean	1910

MW-7 (bedrock)

Number of values	3	Range	--
Number of ND's	3	Minimum	(5)
Standard Deviation	11.5	Maximum	(25)
Coefficient of variation	0.98	Mean	(12)

MW-9 (alluvium)

Number of values	7	Range	670
Number of ND's	0	Minimum	230
Standard Deviation	240	Maximum	900
Coefficient of variation	0.32	Mean	746

OW1-79 (bedrock)

Number of values	6	Range	(62)
Number of ND's	5	Minimum	(25)
Standard Deviation	26	Maximum	87
Coefficient of variation	0.64	Mean	(40)

OW25-80 (alluvium)

Number of values	6	Range	235
Number of ND's	0	Minimum	130
Standard Deviation	84	Maximum	365
Coefficient of variation	0.29	Mean	284

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.11
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Halide (TOX)
Survey Level = 10 ug/1

OW26-80 (alluvium)

Number of values	6	Range	830
Number of ND's	0	Minimum	470
Standard Deviation	300	Maximum	1300
Coefficient of variation	0.30	Mean	1000

OW30-80 (alluvium)

Number of values	6	Range	25600
Number of ND's	0	Minimum	6400
Standard Deviation	10700	Maximum	32000
Coefficient of variation	0.46	Mean	23000

OW31-85 (fill)

Number of values	6	Range	290
Number of ND's	0	Minimum	380
Standard Deviation	120	Maximum	670
Coefficient of variation	0.23	Mean	503

OW33-85 (fill)

Number of values	6	Range	250
Number of ND's	0	Minimum	140
Standard Deviation	90	Maximum	390
Coefficient of variation	0.27	Mean	310

OW34-85 (fill)

Number of values	6	Range	(945)
Number of ND's	1	Minimum	(25)
Standard Deviation	310	Maximum	970
Coefficient of variation	0.69	Mean	(443)

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.11
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Halide (TOX)
Survey Level = 10 ug/1

MW-17 (alluvium)

Number of values	6	Range	3000
Number of ND's	0	Minimum	8000
Standard Deviation	1200	Maximum	11000
Coefficient of variation	0.13	Mean	9550

MW-18 (fill)

Number of values	5	Range	6620
Number of ND's	0	Minimum	680
Standard Deviation	3400	Maximum	7300
Coefficient of variation	0.75	Mean	4450

MW-19 (alluvium)

Number of values	6	Range	14000
Number of ND's	0	Minimum	2050
Standard Deviation	5500	Maximum	16000
Coefficient of variation	0.50	Mean	10900

MW-20 (fill)

Number of values	6	Range	5400
Number of ND's	0	Minimum	1400
Standard Deviation	1800	Maximum	6800
Coefficient of variation	0.40	Mean	4450

MW-22 (alluvium)

Number of values	6	Range	2350
Number of ND's	0	Minimum	50
Standard Deviation	820	Maximum	2400
Coefficient of variation	0.93	Mean	884

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.11
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Halide (TOX)
Survey Level = 10 ug/1

OW35-85 (fill)

Number of values	6	Range	20300
Number of ND's	0	Minimum	8700
Standard Deviation	8000	Maximum	29000
Coefficient of variation	0.35	Mean	22400

OW36-85 (fill)

Number of values	6	Range	1160
Number of ND's	0	Minimum	340
Standard Deviation	440	Maximum	1500
Coefficient of variation	0.73	Mean	602

OW37-85 (fill)

Number of values	6	Range	480
Number of ND's	0	Minimum	130
Standard Deviation	180	Maximum	610
Coefficient of variation	0.39	Mean	467

OW40-85 (alluvium)

Number of values	6	Range	10800
Number of ND's	0	Minimum	5200
Standard Deviation	3500	Maximum	16000
Coefficient of variation	0.33	Mean	10400

OW41-85 (bedrock)

Number of values	3	Range	--
Number of ND's	3	Minimum	(5)
Standard Deviation	11.5	Maximum	(25)
Coefficient of variation	0.62	Mean	(18)

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.11
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Halide (TOX)
Survey Level = 10 ug/1

OW43-85 (alluvium)

Number of values	6	Range	2290
Number of ND's	0	Minimum	310
Standard Deviation	850	Maximum	2600
Coefficient of variation	0.42	Mean	1970

OW45-85 (bedrock)

Number of values	3	Range	--
Number of ND's	3	Minimum	(5)
Standard Deviation	26	Maximum	(50)
Coefficient of variation	0.74	Mean	(35)

OW46-85 (bedrock)

Number of values	3	Range	--
Number of ND's	3	Minimum	(5)
Standard Deviation	26	Maximum	(50)
Coefficient of variation	0.74	Mean	(35)

OW47-85 (alluvium)

Number of values	6	Range	(13500)
Number of ND's	1	Minimum	(500)
Standard Deviation	5100	Maximum	14000
Coefficient of variation	0.50	Mean	(10100)

OW48-86 (fill)

Number of values	2	Range	50
Number of ND's	0	Minimum	250
		Maximum	300
		Mean	275

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.11
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Halide (TOX)
Survey Level = 10 ug/1

OW49-86 (fill)

Number of values	2	Range	140
Number of ND's	0	Minimum	430
		Maximum	570
		Mean	500

OW50-86 (alluvium)

Number of values	2	Range	90
Number of ND's	0	Minimum	600
		Maximum	690
		Mean	645

OW51-86 (fill)

Number of values	2	Range	0
Number of ND's	0	Minimum	160
		Maximum	160
		Mean	160

OW52-86 (alluvium)

Number of values	2	Range	57
Number of ND's	0	Minimum	93
		Maximum	150
		Mean	122

OW53-86 (bedrock)

Number of values	2	Range	(24)
Number of ND's	1	Minimum	(10)
		Maximum	34
		Mean	(22)

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.11
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Halide (TOX)
Survey Level = 10 ug/1

OW54-86 (fill)

Number of values	2	Range	39
Number of ND's	0	Minimum	61
		Maximum	100
		Mean	81

OW55-86 (alluvium)

Number of values	2	Range	6
Number of ND's	0	Minimum	94
		Maximum	100
		Mean	97

OW56-86 (fill)

Number of values	2	Range	14
Number of ND's	0	Minimum	20
		Maximum	34
		Mean	27

OW57-86 (alluvium)

Number of values	2	Range	7
Number of ND's	0	Minimum	87
		Maximum	94
		Mean	91

OW58-86 (alluvium)

Number of values	2	Range	--
Number of ND's	2	Minimum	(25)
		Maximum	(25)
		Mean	(25)

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.11
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Halide (TOX)
Survey Level = 10 ug/1

OW60-86 (alluvium)

Number of values	2	Range	--
Number of ND's	2	Minimum	(25)
		Maximum	(25)
		Mean	(25)

OW62-87 (till)

Number of values	4	Range	230
Number of ND's	0	Minimum	380
Standard Deviation	100	Maximum	610
Coefficient of variation	0.20	Mean	475

OW63-87 (alluvium)

Number of values	4	Range	9800
Number of ND's	0	Minimum	3200
Standard Deviation	4500	Maximum	13000
Coefficient of variation	0.68	Mean	6630

OW9-79 (till)

Number of values	6	Range	10400
Number of ND's	0	Minimum	3600
Standard Deviation	4000	Maximum	14000
Coefficient of variation	0.49	Mean	8020

MW-23 (alluvium)

Number of values	1	Range	--
Number of ND's	0	Minimum	310
		Maximum	310

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.11
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Halide (TOX)
Survey Level = 10 ug/1

MW-24 (alluvium)

Number of values	1	Range	--
Number of ND's	0	Minimum	95
		Maximum	95

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

TABLE 5.12

STATISTICAL SUMMARY OF TOC DATA FROM THE EXTENDED GROUNDWATER SURVEY 102ND STREET LANDFILL

Table 5.12
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Carbon (TOC)
Survey Level = 1000 ug/1

B-1 (bedrock)

Number of values	6	Range	35000
Number of ND's	0	Minimum	3000
Standard Deviation	11700	Maximum	38000
Coefficient of variation	0.66	Mean	17800

B-2 (bedrock)

Number of values	3	Range	15000
Number of ND's	0	Minimum	4000
Standard Deviation	7900	Maximum	19000
Coefficient of variation	0.79	Mean	10000

B-34I (alluvium)

Number of values	6	Range	136000
Number of ND's	0	Minimum	24000
Standard Deviation	54000	Maximum	160000
Coefficient of variation	0.49	Mean	110000

B-4 (bedrock)

Number of values	6	Range	(31500)
Number of ND's	2	Minimum	(500)
Standard Deviation	13300	Maximum	32000
Coefficient of variation	1.06	Mean	(12500)

MW-1 (fill)

Number of values	5	Range	128000
Number of ND's	0	Minimum	12000
Standard Deviation	48000	Maximum	140000
Coefficient of variation	0.67	Mean	718000

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.12
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Carbon (TOC)
Survey Level = 1000 ug/1

MW-12 (alluvium)

Number of values	1	Range	--
Number of ND's	0	Minimum	85000
		Maximum	85000

MW-13 (fill)

Number of values	3	Range	60000
Number of ND's	0	Minimum	220000
Standard Deviation	30000	Maximum	280000
Coefficient of variation	0.12	Mean	247000

MW-14 (alluvium)

Number of values	3	Range	70000
Number of ND's	0	Minimum	100000
Standard Deviation	35000	Maximum	170000
Coefficient of variation	0.27	Mean	133000

MW-15 (fill)

Number of values	3	Range	140000
Number of ND's	0	Minimum	10000
Standard Deviation	70000	Maximum	150000
Coefficient of variation	0.88	Mean	80000

MW-16 (alluvium)

Number of values	3	Range	12000
Number of ND's	0	Minimum	120000
Standard Deviation	60000	Maximum	240000
Coefficient of variation	0.33	Mean	177000

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.12
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Carbon (TOC)
Survey Level = 1000 ug/1

MW-17 (alluvium)

Number of values	6	Range	153000
Number of ND's	0	Minimum	27000
Standard Deviation	55000	Maximum	180000
Coefficient of variation	0.64	Mean	85800

MW-18 (fill)

Number of values	4	Range	140000
Number of ND's	0	Minimum	20000
Standard Deviation	68000	Maximum	160000
Coefficient of variation	0.83	Mean	82500

MW-19 (alluvium)

Number of values	6	Range	1169500
Number of ND's	0	Minimum	30500
Standard Deviation	460000	Maximum	170000
Coefficient of variation	1.70	Mean	269250

MW-20 (fill)

Number of values	6	Range	103000
Number of ND's	0	Minimum	17000
Standard Deviation	42000	Maximum	120000
Coefficient of variation	0.62	Mean	67000

MW-22 (fill)

Number of values	6	Range	140000
Number of ND's	0	Minimum	20000
Standard Deviation	54000	Maximum	160000
Coefficient of variation	0.64	Mean	85100

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.12
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Carbon (TOC)
Survey Level = 1000 ug/1

MW-3 (alluvium)

Number of values	6	Range	83000
Number of ND's	0	Minimum	17000
Standard Deviation	32000	Maximum	100000
Coefficient of variation	0.59	Mean	54700

MW-7 (bedrock)

Number of values	3	Range	11000
Number of ND's	0	Minimum	1000
Standard Deviation	61000	Maximum	12000
Coefficient of variation	1.21	Mean	5000

MW-9 (alluvium)

Number of values	7	Range	130000
Number of ND's	0	Minimum	10000
Standard Deviation	48000	Maximum	140000
Coefficient of variation	0.92	Mean	51600

OW1-79 (bedrock)

Number of values	6	Range	(49500)
Number of ND's	1	Minimum	(500)
Standard Deviation	17000	Maximum	50000
Coefficient of variation	0.94	Mean	(18100)

OW25-80 (alluvium)

Number of values	6	Range	185000
Number of ND's	0	Minimum	45000
Standard Deviation	71000	Maximum	230000
Coefficient of variation	0.45	Mean	155000

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.12
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Carbon (TOC)
Survey Level = 1000 ug/1

OW26-80 (alluvium)

Number of values	6	Range	184000
Number of ND's	0	Minimum	86000
Standard Deviation	62000	Maximum	270000
Coefficient of variation	0.31	Mean	194000

OW30-80 (alluvium)

Number of values	6	Range	807000
Number of ND's	0	Minimum	43000
Standard Deviation	280000	Maximum	850000
Coefficient of variation	0.93	Mean	300000

OW31-85 (fill)

Number of values	6	Range	82000
Number of ND's	0	Minimum	8000
Standard Deviation	28000	Maximum	90000
Coefficient of variation	0.46	Mean	61100

OW33-85 (fill)

Number of values	6	Range	114000
Number of ND's	0	Minimum	6000
Standard Deviation	40000.0	Maximum	120000
Coefficient of variation	0.60	Mean	66000

OW34-85 (fill)

Number of values	6	Range	49000
Number of ND's	0	Minimum	11000
Standard Deviation	19000	Maximum	60000
Coefficient of variation	0.59	Mean	31500

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.12
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Carbon (TOC)
Survey Level = 1000 ug/1

OW35-85 (fill)

Number of values	6	Range	253000
Number of ND's	0	Minimum	7000
Standard Deviation	95000	Maximum	260000
Coefficient of variation	0.51	Mean	186000

OW36-85 (fill)

Number of values	6	Range	104000
Number of ND's	0	Minimum	16000
Standard Deviation	38000	Maximum	120000
Coefficient of variation	0.66	Mean	56300

OW37-85 (fill)

Number of values	6	Range	137000
Number of ND's	0	Minimum	18000
Standard Deviation	46000	Maximum	155000
Coefficient of variation	0.54	Mean	84000

OW40-85 (alluvium)

Number of values	6	Range	(209500)
Number of ND's	1	Minimum	(500)
Standard Deviation	73000	Maximum	210000
Coefficient of variation	0.60	Mean	(122000)

OW41-85 (bedrock)

Number of values	3	Range	9000
Number of ND's	0	Minimum	8000
Standard Deviation	4700	Maximum	17000
Coefficient of variation	0.40	Mean	11700

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.12
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Carbon (TOC)
Survey Level = 1000 ug/1

OW43-85 (alluvium)

Number of values	6	Range	105000
Number of ND's	0	Minimum	15000
Standard Deviation	37000	Maximum	120000
Coefficient of variation	0.49	Mean	73200

OW45-85 (bedrock)

Number of values	3	Range	35000
Number of ND's	0	Minimum	5000
Standard Deviation	20000	Maximum	40000
Coefficient of variation	1.19	Mean	16800

OW46-85 (bedrock)

Number of values	3	Range	(54500)
Number of ND's	1	Minimum	(500)
Standard Deviation	27000	Maximum	55000
Coefficient of variation	0.95	Mean	(28500)

OW47-85 (alluvium)

Number of values	6	Range	132000
Number of ND's	0	Minimum	23000
Standard Deviation	48000	Maximum	155000
Coefficient of variation	0.43	Mean	110000

OW48-86 (fill)

Number of values	2	Range	500000
Number of ND's	0	Minimum	100000
		Maximum	600000
		Mean	350000

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.12
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Carbon (TOC)
Survey Level = 1000 ug/1

OW49-86 (fill)

Number of values	1	Range	--
Number of ND's	0	Minimum	120000
		Maximum	120000

OW50-86 (alluvium)

Number of values	2	Range	10000
Number of ND's	0	Minimum	190000
		Maximum	200000
		Mean	195000

OW51-86 (fill)

Number of values	2	Range	60000
Number of ND's	0	Minimum	50000
		Maximum	110000
		Mean	80000

OW52-86 (alluvium)

Number of values	2	Range	95000
Number of ND's	0	Minimum	120000
		Maximum	215000
		Mean	168000

OW53-86 (bedrock)

Number of values	2	Range	9500
Number of ND's	0	Minimum	2000
		Maximum	11500
		Mean	6750

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.12
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Carbon (TOC)
Survey Level = 1000 ug/1

OW54-86 (fill)

Number of values	2	Range	60000
Number of ND's	0	Minimum	130000
		Maximum	190000
		Mean	160000

OW55-86 (alluvium)

Number of values	2	Range	195000
Number of ND's	0	Minimum	40000
		Maximum	235000
		Mean	138000

OW56-86 (fill)

Number of values	2	Range	40000
Number of ND's	0	Minimum	150000
		Maximum	190000
		Mean	170000

OW57-86 (alluvium)

Number of values	2	Range	140000
Number of ND's	0	Minimum	90000
		Maximum	230000
		Mean	160000

OW58-86 (alluvium)

Number of values	2	Range	10000
Number of ND's	0	Minimum	60000
		Maximum	70000
		Mean	65000

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.12
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Carbon (TOC)
Survey Level = 1000 ug/1

OW60-86 (alluvium)

Number of values	2	Range	10000
Number of ND's	0	Minimum	40000
		Maximum	50000
		Mean	45000

OW62-87 (till)

Number of values	4	Range	113000
Number of ND's	0	Minimum	17000
Standard Deviation	47000	Maximum	130000
Coefficient of variation	0.57	Mean	81800

OW63-87 (alluvium)

Number of values	4	Range	300000
Number of ND's	0	Minimum	60000
Standard Deviation	130000	Maximum	360000
Coefficient of variation	0.76	Mean	173000

OW9-79 (till)

Number of values	6	Range	126000
Number of ND's	0	Minimum	54000
Standard Deviation	52000	Maximum	180000
Coefficient of variation	0.44	Mean	117000

MW-23 (alluvium)

Number of values	1	Range	--
Number of ND's	0	Minimum	120000
		Maximum	120000

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

Table 5.12
Historical Range Report
From 12/31/1986 to 01/01/1988
for Total Organic Carbon (TOC)
Survey Level = 1000 ug/1

MW-24 (alluvium)

Number of values	1	Range	--
Number of ND's	0	Minimum	140000
		Maximum	140000

Analytical results which indicate no detection at or above the survey level (ND) are assigned a value of one-half the survey level (or actual detection limit, if higher) for all statistical calculations.

Parentheses indicate that at least one ND was used in the calculations.

Duplicate values are averaged prior to use in statistical calculations.

NF-O2

TABLE 5.13

SUMMARY STATISTICS FOR TOTAL SITE-SPECIFIC INDICATOR COMPOUNDS, EXTENDED SURVEY ALLUVIUM WELLS 102ND STREET LANDFILL

Well	Number of Analyses	Number of Duplicates	Total SSI, in ug/L Minimum	Maximum	Mean
MW-3	3	--	(3,619)	4,042	(3,797)
MW-9	4	--	1,349	1,696	(1,545)
MW-12	2	--	(0)	(0)	(0)
MW-14	4	1	674	1100	840
MW-16	3	--	(2.5)	5	(3)
MW-17	3	2	18,518	22,575	(20,494)
MW-19	3	1	(41,532)	(92,163)	(69,710)
MW-23	1	1	(0)	(0)	(0)
MW-24	1	--	(0)	(0)	(0)
OW25	3	1	(0)	(0)	(0)
OW30	2	--	29,540	40,893	35,217
OW40	3	1	(68,985)	(74,007)	(71,239)
OW43	3	--	(1,423)	(1,892)	(1,719)
OW47	3	1	(24,125)	(71,121)	(50,639)
OW50	2	--	(0)	(0)	(0)
OW52	2	--	(150)	300	(225)
OW55	2	1	(0)	(0)	(0)
OW57	2	--	(0)	(0)	(0)
OW58	2	--	(0)	(0)	(0)
OW60	2	--	(0)	(0)	(0)
OW63	2	1	(0)	(0)	(0)

Duplicate values are averaged for all statistical calculations.
Parentheses indicate that at least one ND was used in the calculations.

TABLE 5.14

SUMMARY STATISTICS FOR TOTAL SITE-SPECIFIC INDICATOR COMPOUNDS, EXTENDED SURVEY FILL WELLS 102ND STREET LANDFILL

Well	Number of Analyses	Number of Duplicates	Total SSI, in ug/L Minimum	Maximum	Mean
MW-13	3	--	8	11	10
MW-15	3	--	(2.5)	22	(15)
MW-18	2	--	7,397	11,059	9,228
MW-20	3	--	5,546	(8,807)	(7,467)
MW-22	3	--	(1,372)	1,410	(1,397)
OW31	3	--	(0)	(0)	(0)
OW33	3	1	(0)	(0)	(0)
OW34	3	--	(48)	(116)	(84)
OW35	3	--	(23,800)	(35,343)	(28,331)
OW36	3	--	28	31	29
OW37	3	1	(50)	(309)	(219)
OW48	2	--	(5)	22	(14)
OW49	2	--	(2.5)	5	(4)
OW51	2	--	(0)	(0)	(0)
OW54	2	--	(5)	22	(14)
OW56	2	--	(0)	(0)	(0)

Duplicate values are averaged for all statistical calculations.
Parentheses indicate that at least one ND was used in the calculations.

TABLE 5.15

SUMMARY STATISTICS FOR TOTAL SITE-SPECIFIC INDICATOR COMPOUNDS, EXTENDED SURVEY BEDROCK AND TILL WELLS 102ND STREET LANDFILL

Well	Number of* Analyses	Number of Duplicates	Total SSI, in ug/L Minimum	Maximum	Mean
BEDROCK					
MW-7	3	--	(0)	(0)	(0)
B-1	3	--	(0)	(0)	(0)
B-2	4	1	(0)	(0)	(0)
B-4	3	--	(0)	(0)	(0)
OW41	4	1	(0)	(0)	(0)
OW45	4	1	(0)	(0)	(0)
OW46	4	1	(0)	(0)	(0)
OW53	3	1	(0)	(0)	(0)
TILL					
OW9	2	--	(0)	(0)	(0)
OW62	1	--	(0)	(0)	(0)

Duplicate values are averaged for all statistical calculations.
Parentheses indicate all or most values below applicable survey level.
* includes Duplicates

TABLE 5.16

ANALYTICAL RESULTS
BULKHEAD SAMPLES (ug/L)
102ND STREET LANDFILL

	BS-1	BS-2	BS-3	BS-4	BS-5
Benzene	2,000	71	560		
Toluene					
Monochlorobenzene	2,200	120	1,700		390
2-Monochlorotoluene					
4-Monochlorotoluene					
1,2-Dichlorobenzene	130	28	400		160
1,4-Dichlorobenzene	420	24	300		260
1,2,3-Trichlorobenzene	83		14		180
1,2,4-Trichlorobenzene	280	35	130		650
1,2,3,4-Tetrachlorobenzene	420		340		380
1,2,4,5-Tetrachlorobenzene	73		65		74
Hexachlorobenzene			15		
alpha-Hexachlorocyclohexane	700		210		310
beta-Hexachlorocyclohexane	150	37	71	30	83
gamma-Hexachlorocyclohexane	1,400		13		240
delta-Hexachlorocyclohexane	4,500		800		920
2,5-Dichloroaniline	580				
3,4-Dichloroaniline					
Phenol	65		25		83
2-Chlorophenol	54		13		12
4-Chlorophenol	240		27		80
2,4-Dichlorophenol	97				75
2,5-Dichlorophenol	97				75
2,4,5-Trichlorophenol	310		72		1,300
2,4,6-Trichlorophenol	240				
2-Chlorobenzoic Acid	130				
3-Chlorobenzoic Acid					
4-Chlorobenzoic Acid	100				
Total Organic Halide (TOX)	10,000	560	2,500	130	5,600
Total Kjeldahl Nitrogen (TKN)	4,700	2,600	2,600	1,800	2,200
Total Organic Carbon (TOC)	170,000	180,000	170,000	80,000	80,000
Phosphorus (dissolved)					100
Mercury			2.3		31.3
Arsenic					

Note: Blank indicates not detected at or above survey level.

6.0 STORM SEWER REVIEW

Data collected from studies conducted prior to the RI established that the storm sewer traversing the Olin property acted, due to groundwater infiltration, as a migration pathway for chemicals leaving the Site. No data were available prior to the RI concerning the presence or absence of a sewer bedding and backfill material, and the extent to which these might be an avenue for chemical migration. Further, no data were available concerning the present physical state of the storm sewer.

6.1 PURPOSE

The purposes of the Storm Sewer Review were:

- to gather information concerning the physical condition of the length of the storm sewer which traverses the Site and the presence or absence of bedding and backfill material; and

- to assess the extent to which the exterior of the storm sewer pipe is associated with a preferential chemical migration pathway.

- to assess the rate of infiltration and potential chemical migration within the storm sewer pipe.

6.2 STORM SEWER REVIEW

The Storm Sewer Review task of the RI was conducted in three phases. Phase I consisted of physical inspection of the pipe interior using a video camera to identify blockages and pipe integrity. The second phase consisted of a subsurface investigation designed to generate soil and water chemistry data, grain-size distribution data, and hydraulic data, and included investigation of the existence of an engineered bedding material. Detailed findings from the two phases of the Storm Sewer Review as well as relevant historical data have been presented previously (2). As agreed upon based on review of the Draft RI Report, infiltration into the sewer pipe was remeasured and reanalyzed (Phase III).

6.2.1 HISTORICAL DATA

The storm sewer, which is owned by the City of Niagara Falls, crosses the Olin portion of the Site and extends almost due south across the Site from Buffalo Avenue to its outfall on the Niagara River (Figure 6.1). Its northern terminus is a T-junction with storm sewers which originate from the Love Canal Area and a short length of Buffalo Avenue. This junction is at the feature labeled "manhole no. 2" (Figure 6.1). Its southern terminus is an exposed outfall headwall at the Niagara River (Figure 6.1). Its path follows the center line of a 40-foot wide easement across the Olin portion of the Site. Design drawings dated November, 1934, and obtained from the City of Niagara Falls indicate that installation occurred over 50 years ago.

6.2.2 PHASE 1 - VIDEO SURVEY

The first phase of the Storm Sewer Review consisted of a video inspection of the length of the sewer pipe interior which was performed on April 28, 1986. The purpose of the video inspection was to observe the presence or absence of physical blockages and infiltration, wall conditions, and the depth of accumulated sediment. The most notable features observed were the very good condition of the pipe and the groundwater infiltration at a number of joints.

The video inspection progressed from the Niagara River outfall to Buffalo Avenue using a black and white video inspection camera. As the camera was pulled slowly through the sewer pipe, distance reference markers were recorded on the video tape. The total distance traversed during the inspection was 597 feet. Detailed results of the inspection have been presented (2).

6.2.3 PHASE II - DRILLING, SAMPLING, TESTING

The second phase of the Storm Sewer Review consisted of a series of soil borings and temporary monitoring well installations at the northern and southern ends of the sewer. These borings were designed to identify if an engineered aggregate bedding material was installed during construction, if the materials found beneath the storm sewer pipe at the Fill/native soils interface could serve as a preferential chemical migration pathway over materials found elsewhere in the Fill, and if there was the potential for chemical migration off-site associated with the exterior of the storm sewer pipe. This was accomplished by collection of soils and groundwater samples for chemical analysis, soils samples for grain-size distribution analysis, measurement of hydraulic head levels, and testing of hydraulic conductivity at the level of the Fill/native soils interface. This phase of the Storm Sewer Review was carried out from December, 1985, through January, 1987.

The second phase included drilling and installation of four temporary monitoring wells adjacent to the storm sewer. The detailed drilling and boring logs and installation reports for these wells have been presented (2, 17). The installation borings for all four monitoring wells were made by advancing an 8-1/4-inch I.D. hollow stem auger through the Site until an interface with native soils or bedding material was identified. The materials encountered were sampled continuously with a split-spoon sampler. At least one sample was obtained, described, and retained for the geologic record from each two feet of depth.

Two wells (MW-5 and MW-6) were installed near the outfall headwall at the south end of the storm sewer, and two wells (MW-10 and MW-11) were installed adjacent to the storm sewer near the northern site boundary (Figure 6.1). At the southern end of the storm sewer, well MW-6 was installed on the east side of the pipe approximately 8 feet north of the top edge of the rip rap; well MW-5 was installed on the west side of the pipe approximately 25 feet further north. At the northern Site boundary, well MW-10 was installed about 5 feet north of the Site fence and on the west side of the storm sewer; well MW-11 was installed on the east side of the pipe about 10 feet south of the Site fence and on the east side of the storm sewer. All four wells were installed within two feet of the sewer pipe outer diameter. The screens used in these wells were two feet in length, and the wells were installed with their screened interval adjacent to the native soils interface.

The drilling program also included the installation of four exploration borings adjacent to the storm sewer pipe. These borings were installed at four locations along the storm sewer pipe within five feet of and directly across the pipe from an existing storm sewer bedding monitoring well. These borings, labeled DH-5, DH-6, DH-10, and DH-11 (Figure 6.1), were installed in December, 1986.

The exploration borings were installed by advancing an 8-1/4-inch I.D. hollow stem auger through the Fill material to just above the level where bedding material or a native soils interface was identified in the corresponding monitoring well. A single 3-foot split-spoon sampler was then driven ahead of the hollow stem augers to collect a sample. The augers were then retrieved an the boring was backfilled with grout. Continuous sampling of materials encountered was not necessary because of the close proximity of the monitoring wells and because the stratigraphy was not expected to vary within five feet. This expectation was based on examination of historic aerial photos which show materials being landfilled over and around the storm sewer pipe.

In situ tests to estimate hydraulic conductivity were performed in three storm sewer bedding wells MW-5, MW-6, and MW-10. Well MW-11 was dry at installation and at the time in situ tests were performed. The static water column in the wells was insufficient to accommodate slug-type hydraulic conductivity testing. Therefore, rising head tests were performed by evacuating the water from the wells with high rate pumping, and obtaining a strip chart recording of well recovery curves utilizing pressure transducers. Actual strip chart records of the well recoveries for MW-5, MW-6 and MW-10 have been presented (2).

Groundwater samples were collected from two of the storm sewer wells, MW-5 and MW-6. These samples were collected in January 1987, in conjunction with the first monthly sampling event of the extended groundwater survey. The samples collected were analyzed for both SSI and GP. An attempt was made to collect groundwater samples from wells MW-10 and MW-11. Well MW-11 was deemed dry for the sampling event in accordance with the SOP sampling protocols (18). Well MW-10 had groundwater within the screen at the time sampling was initiated, but because of the lengthy recovery time, it was deemed dry for the sampling event in accordance with the SOP sampling protocols (18).

Hydraulic head levels were monitored in all four storm sewer bedding wells as part of the initial 5-day and extended hydraulic head monitoring tasks.

6.2.4 PHASE III - SUPPLEMENTAL STORM SEWER STUDY

The 102 St. SOP (18) and Work Plan for the RI (19) focussed on potential migration along the outside of the sewer pipe. Sampling and analytical data from past studies (24) was to be used for loading calculations. Based on their review of the draft RI Report, Olin agreed to remeasure and reanalyze infiltration into the sewer pipe. The details and results of this supplemental study are presented below.

6.2.4.1 FIELD INVESTIGATION

During the 30 days prior to sampling, 4.13 inches of precipitation (on 21 days) was measured at the Niagara Falls International Airport. This is indicative of relatively wet conditions.

Four water samples, one duplicate water sample, one sediment sample and one duplicate sediment sample were collected for the Supplemental Storm Sewer Study (Figure 6.5). Split samples were provided to EPA/State. The sediment sample and field duplicate were obtained on November 11, 1989 from approximately two to four feet into the outfall using a stainless steel spoon. Approximately 8 inches of sediment were present at this location. Except for VOAs, the samples were composited from throughout the sediment layer. VOA samples were collected directly from the most visibly contaminated sediment. There was not enough sediment present at the upgradient locations for sampling.

Water samples were obtained at locations identified as 1 through 4 on Figure 6.5. At the upgradient locations (1,2 and 3), the samples were collected on November 29, 1989, by entering the manhole, using confined space entry procedures (21), and filling the sample bottles directly from the pipes.

The infiltration water samples were obtained at location 4 on December 1, 1989. At approximately 12:30 p.m., inflow from the upgradient pipes was stopped by installing an inflatable plug in the 42-inch line just south of manhole 2 and allowing water to back up in the manhole behind the plug. The Niagara River level was unusually low and the bottom of the outfall was above the river elevation for the entire day. Thus, river inflow into the pipe was not a concern. The pipe was allowed to drain for a period of approximately 4 hours, at which time one water sample and a duplicate were collected from approximately 2 feet into the mouth of the pipe. After sample collection, the flow rate in the pipe was measured using a weir device. The flow rate was measured three times at ten minute intervals.

6.2.4.2 RESULTS

Sediment: Near the mouth of the pipe, there has been an accumulation of approximately 8 inches of sediment. The top 2 inches (approximately) were free of visual signs of contamination such as NAPL or discoloration. Below this level, as the sediment was disturbed a brownish black NAPL was apparent. Each sediment sample fraction contained some of this NAPL in the interstitial fluid.

The sediments were analyzed in accordance with project protocol for GP and SSI. The analytical results of the sediment analyses are presented in Table 6.6.

Water: Water samples from within the mouth of the pipe were obtained approximately two weeks after sediment sampling so that the results would not be influenced by the disturbance of the sediment layer. There were no indications of NAPL in any water samples. The water samples were analyzed in accordance with project protocols for GP and SSI.

The water analyses are presented in Table 6.7. Location 1 is the 90 degree bend in the sewer on the south side of Buffalo Avenue. Drainage at this location is from the Love Canal Area. During the November 1989 sampling, SSI were below survey levels at this location. Flow in the pipe at all locations was clearly in the direction of the River at the time of sampling. At manhole 2, the sample collected from the 42-inch pipe was found to contain 1,2,4-trichlorobenzene and 1,2,3,4-tetrachlorobenzene at concentrations of 25 μg/L and 14 μg/L, respectively. The analysis of water from the 15-inch line showed low concentrations of 1,2,4-trichlorobenzene (23 μg/L), 1,2,3,4-tetrachlorobenzene (13 μg/L) and 4-monochlorotoluene (7 μg/L).

The outfall water samples, representative of infiltrating groundwater into the pipe traversing the site, exhibited higher SSI concentrations. The total SSI concentrations were approximately 1500 μg/L. Mercury was detected at approximately 0.45 μg/L. These values indicate that NAPL does not have a significant impact on the aqueous discharge.

Flow at the outfall was measured immediately after sampling to avoid impacting water quality by disturbing the sediments. Flow was measured at 10 minute intervals over a 30-minute period. In each case, the measured flow rate was 250 ml/sec or approximately 4.0 gpm (5760 gpd), indicating that the system had sufficiently stabilized at the time of sampling.

6.2.4.3 SUPPLEMENTAL STORM SEWER STUDY CONCLUSIONS

There is NAPL-contaminated sediment within the pipe near the outfall. The NAPL-contaminated sediment is overlain by two inches or more of sediment containing no visible traces of contamination. The presence of considerable quantity of sediment, the small gradient of the pipe and the impact of the Niagara River (river stages above the bottom of the pipe will decrease stormwater velocity at the outfall), all indicate that this is an area of sediment deposition. Results of the water analyses indicate that, during the time of sampling, the contaminated sediment did not have a significant impact on effluent chemistry.

No effort has ever been made to clear the pipe of sediment. The NAPL observed during sampling could have entered the pipe long ago, perhaps during active disposal operations, and subsequently been covered with relatively uncontaminated sediments. The lack of NAPL in the surface sediment and infiltrating water samples, and the results of infiltrate analysis, suggest that NAPL does not currently discharge to the pipe and exit the outfall as a separate phase.

Based on the Supplemental Storm Sewer Study, the groundwater infiltration rate was approximately 4 gpm. Chemical analyses indicate off-site transport rate for total SSI of 0.07 pounds per day.

6.3 STORM SEWER DATA

6.3.1 CONSTRUCTION DETAILS

The storm sewer is constructed of steel-reinforced concrete pipe 42-inches I.D. and 51-inches O.D. with a design length of 632 feet in a straight line from the center of manhole no. 2 to the face of the headwall. Field measurements show the current length to be 624 feet. It is assumed that the last 8 feet were not installed. The storm sewer design grade is 0.10 percent, and design invert elevations are 562.63 and 562.0 feet for the manhole and headwall, respectively (Figure 6.2). Field survey of invert elevations at the outfall and manhole no. 2 (563.04 and 562.88 feet, respectively) differ from design specifications. Design drawings show no engineered aggregate bedding material. In fact, design drawings show 51 feet of the storm sewer pipe south from the storm manhole no. 2 being laid on-grade in a trench excavated into existing topography. From 51 feet south of manhole no. 2 to the outfall, design drawings show the pipe being placed on a support of wood plank grillage (Figure 6.2). This grillage design consisted of wood planks placed every two feet on two parallel lines of continuous support sills (Figure 6.3).

Historical air photos (November 1956, Longin Studio) were examined to assess the physical state of the storm sewer at that time. These photos show that at the southern end approximately 50 to 75 feet of the storm sewer was exposed extending outward into the Niagara River. Materials being brought to the Site for disposal were landfilled over and around the exposed storm sewer pipe, resulting in the landfill embankment being advanced southward toward the outfall headwall.

6.3.2 BORING LOG OBSERVATIONS

Detailed descriptions of the materials encountered during the drilling of exploration borings and monitoring wells for the Storm Sewer Review are provided in boring logs (2). The following summarizes the relevant aspects of these observations.

The installation boring for well MW-5 was advanced through a thin surface layer of sandy silty Clay and penetrated the Fill itself. The Fill was composed of varying mixtures of fly ash, apparent demolition rubble and dark sludge-like material. The interface with native soils was encountered at the 564.9-foot level. The Site geologist observed what was believed to be NAPL in the top one-foot of the Alluvium but beneath the native soil interface.

The installation boring for well MW-6 was advanced through a surface layer of silty Clay and penetrated the Fill. The Fill was of varying composition, but consisted primarily of large rock fragments and demolition rubble intermixed with silty Clay. The native soil interface was encountered at 564.3 feet. The Fill penetrated and the native soil encountered directly beneath contained no visual or olfactory evidence of NAPL.

In both MW-5 and MW-6 above the native soils interface, Site materials which were penetrated did not differ significantly in composition or nature from those observed elsewhere in the Fill material. The material immediately above the interface did not have the appearance or composition of a designed or engineered aggregate backfill or bedding material.

Two borings were made to install well MW-10. The first boring, MW-10, was terminated at a depth of 10 feet, grouted, and abandoned. Boring MW-10A was begun about 14 inches closer to the storm sewer centerline. This boring was advanced through driveway Fill. Bedding material penetrated in the installation trench was comparable to bedding material observed elsewhere in the storm sewer bedding material. At a depth of 11.5 feet (elevation 563.5), a very stiff, undisturbed, varved silty Clay was encountered. No engineered bedding material of any kind could be discerned at the interface and there was no visual or olfactory evidence of NAPL. Monitoring well MW-10 was installed in boring MW-10A.

The stratigraphy of the soils encountered in the installation boring for well MW-11 was very similar to that encountered in the installation boring for well MW-10. However, in well MW-11 there was some visual and olfactory evidence for possible chemical presence just above the native soils interface, but no indications of NAPL.

The stratigraphy encountered in each of the exploration borings essentially mirrored that encountered in the adjacent monitoring wells. Boring DH-5 and DH-6 encountered small amounts of sand, fragmented brick, and fragmented concrete debris intermixed with soils immediately above the native soil interface. Borings DH-10 and DH-11 encountered no discernable designed or engineered bedding material.

6.3.3 STORM SEWER PIPE CONDITION - VIDEO INSPECTION

Review of the storm sewer inspection video tape revealed that, on that date, 8 to 10 inches of water were in the pipe at the outfall moving very slowly in the direction of the Niagara River. As the survey progressed northward, 2 to 3 inches of water was more typical encountered in the pipe. Water marks along the inside of the pipe suggest flow at 40 to 80 percent of capacity at some time prior to the inspection. Approximately 4 to 8 inches of sediment have accumulated in the first 100 feet from the River with no sediment observed in the north end of the pipe.

The video survey allowed visual inspection for groundwater infiltration into the storm sewer pipe. The pipe integrity inside appears excellent from the Niagara River outfall to Buffalo Avenue. There were no visible offsets at the joints or cracks in the pipe. Several suspected mortar patches were noted which are probably plugged stub connections, but it was not clear on visual inspection if these features constituted any deficiency in the pipe structure.

The physical integrity of the pipe interior appears excellent, and pipe joints are the only observable infiltration points. Of the 158 joints identified during the survey, significant groundwater infiltration was noted at eight joints and infiltration in the form of slow drips was noted at 15 other joints (2). Visual estimates of the infiltration rates for individual joints range from nominal to 3.5 gpm (5040 gpd), with the total infiltration rate estimated at 4 to 8 gpm (5760 to 11520 gpd) for the day of inspection. It should be noted that these visual estimates are based on a single day observation, are not averages, and reflect some degree of uncertainty. The infiltration rate was measured directly during a 40 minute period on December 19, 1979 at 0.76 gpm (1090 gpd) (24). The infiltration was remeasured and reanalyzed in December 1989. The measured infiltration rate over a 30-minute period was 4.0 gpm (5,670 gpd) . The mass flux calculations in Chapter 10 use 4 gpm (5,760 gpd) for the storm sewer.

6.3.4 SOIL CHEMICAL DATA

Samples of Fill or native soils for SSI analysis were collected at the native soil interface from the four exploration borings. The results of chemical analysis for SSI, including QA/QC samples, are presented in Table 6.1.

The sample submitted from boring DH-5 is notable, with 16 out of 19 SSI at or above survey levels. Total chemical concentration is 1.29 percent (by weight) of the sample. The sample from boring DH-6 contains fewer chemicals, with detection of only 4 of 19 SSI.

Soil samples collected from borings DH-10 and DH-11 indicate chemicals are present with 5 of 19 SSI present at DH-11, and 4 of 19 SSI at DH-10.

6.3.5 GROUNDWATER CHEMICAL DATA

Analytical results for groundwater samples collected from wells MW-5 and MW-6 are presented in Table 6.2. The numbers of chemicals detected and concentrations for most chemicals in well MW-6 are much less than those in MW-5. No groundwater samples were collected from wells MW-10 and MW-11 (Section 6.2.3).

An infiltration flow measurement and chemical analysis was completed as part of a 1980-81 investigation of the storm sewer (24). A second estimate of infiltration was made during the 1986 physical inspection of the storm sewer. A second flow measurement and chemical analyses were performed in December 1989 (Section 6.2). Since the December 1989 measurements and analyses were conducted in accordance with the project SSQAR (22), these results will be used to calculate loading rates from the storm sewer (Chapter 10).

6.3.6 GRAIN SIZE DATA

Soil samples were collected from the interval just above the native soil interface in each exploration boring (DH-5, DH-6, DH-10 , DH-11) and two monitoring well borings (MW-5, MW-6) and were submitted for grain-size distribution analysis. The laboratory reports of grain-size distribution analysis for the respective samples have been presented previously (2).

An empirical relationship between the D_{10} grain size and the hydraulic conductivity (K) was applied to approximate the hydraulic conductivity of materials found above the native soils interface adjacent to the storm sewer. The results of this evaluation are presented in Table 6.3.

6.3.7 IN SITU HYDRAULIC TESTING DATA

The data collected from rising head tests conducted in MW-5, MW-6, and MW-10 were reduced using the basic time lag solution method. Anisotropic conditions in the soils were assumed for the data reduction, with an order of magnitude difference between horizontal and vertical hydraulic conductivity. Although the error in hydraulic conductivity calculations due to incorrect assumption of the degree of anisotropy is generally less than the inherent error in variable head tests, a sensitivity analysis of the method was performed by varying this parameter. This sensitivity analysis showed that calculated hydraulic conductivities of the formation remain within a range of slightly greater than one-half order of magnitude when anisotropy is varied over three orders of magnitude. The hydraulic conductivities calculated from these in situ tests, including sensitivity analysis, are given in Table 6.4.

6.3.8 HYDRAULIC HEAD MONITORING

Hydraulic head measurements were obtained in the storm sewer wells (MW-5, MW-6, MW-10, MW-11) from March 1986 until November 1987. These include measurements collected during the initial five-day hydraulic head survey and during the extended hydraulic head survey. The data from MW-10 and MW-11 are of particular concern as they are useful in assessing chemical migration potential off-site to the north. All historic head data for MW-10 and MW-11 are presented in Table 6.5. Data for MW-5 and MW-6 have been presented previously or as was in Chapter 4.

6.4 DATA ANALYSIS AND INTERPRETATION

6.4.1 PRESENT PHYSICAL STATE OF STORM SEWER INSTALLATION

The video inspection of the storm sewer provides the greatest body of information. It is apparent from the video inspection that groundwater infiltration into the pipe occurs within 300 feet of the River. There is also evidence of infiltration into the storm sewer pipe at points near the north end. Infiltration occurs only at pipe joints. Visual estimates of the infiltration rate on the date of the inspection, which involve a great deal of uncertainty, indicate total infiltration in the range of 4 to 9 gpm (5760-12960 gpd). The infiltration rate was measured directly during a 40 minute period on December 19, 1979 at 0.76 gpm (1090 gpd) (24) and during a 30-minute period on December 1, 1989 at 4.0 gpm (5,760 gpd) (Section 6.2.4). The sediment accumulations in the storm sewer are minimal. They range from not present in the north to about 8-inches thick in the south. The overall integrity of the pipe interior appears excellent.

No engineered or designed aggregate bedding material could be identified at the native soils interface in any of the eight borings installed adjacent to the storm sewer. At the northern end of the pipe in the vicinity of both MW-10 and MW-11, there is no engineered bedding material, the pipe was laid in a trench on-grade, and the native soil is very fine grained. Materials retrieved from the DH-5 and DH-6 borings immediately above the native soils interface contained some coarse-grained materials as indicated by the grain-size distribution analysis. However, the material was primarily composed of various construction rubble ranging up to gravel-sized particles in a finer-grained matrix. These types of material and their presence adjacent to the storm sewer confirm historical evidence that site materials were placed over and around the exposed length of the storm sewer pipe as the embankment was advanced southward. As such, they do not appear to represent a preferential chemical migration pathway associated with the storm sewer.

Historic air photos, design drawings for the original bulkhead construction, and the elevations where the native soil interface was found in MW-5 and MW-6 all indicate that alluvial sediments were deposited around the exposed storm sewer pipe for some distance north from its outfall. The elevation of the native soil interface was identified in the installation borings for wells MW-5 and MW-6 at 564.9 and 564.4 feet, respectively. These elevations are considerably higher than was expected for the bottom of the sewer pipe at the locations of MW-5 and MW-6, based on a 0.10 percent grade from either a design invert at the headwall of 562.0 or a surveyed invert of 563.04. Figure 6.4 shows the well installations overlayed to scale on the outfall section detail taken from the bulkhead reconstruction design drawings. The native soil interface, as encountered in the installation borings, is also plotted. The position of native soils abutting the flanks of the storm sewer pipe, in the vicinity of MW-5 and MW-6, confirms historical air photo identification of river alluvial sediments abutting the pipe before any Fill materials were placed over or around it. Design drawings of the storm sewer (Figure 6.2) also show the sewer pipe laid partially below the surface of the sediments. With respect to the outfall and the area of MW-5 and MW-6, it is concluded that material placed over the storm sewer pipe does not extend to the base of the pipe, and that sediments from the Niagara River were deposited around the exposed length of storm sewer pipe. These sediments fill the voids that may have existed beneath the pipe and extend upward abutting the flanks of the pipe and covering the wood plank grillage which was designed to support the pipe.

In summary, over the majority of its length the storm sewer rests on remnants of a support grillage put in place at the time of construction. For a distance of about sixty feet south from manhole no. 2, the pipe was laid on grade in a trench excavated through native soils. For some distance northward from the outfall, native soils abut the flanks of the pipe to approximately one-half of its diameter. The support grillage and associated voids are probably filled and covered by these sediments. Infiltration of groundwater through the pipe joints is the most obvious defect noted in the storm sewer pipe.

6.4.2 SOIL CHEMISTRY

Chemical analyses of soils collected from the exploration borings at the depth of the native soils interface indicate that the area of DH-5/MW-5 (within the Site itself) has the most highly concentrated chemistry of those investigated during the Storm Sewer Review. Boring logs, chemical analyses, and subsequent studies conducted at the Site tend to confirm that NAPL is present in the upper one foot of the Alluvium at the location of MW-5/DH-5 (see Chapter 9.0). However, there is no indication of NAPL at or above the termination depth of DH-6/MW-6. The analytical results show that the number and concentration of compounds found in the area of DH-6/MW-6 are substantially lower than in the area of DH-5/MW-5.

Chemical analysis of soil samples from DH-10 and DH-11 at the northern end of the storm sewer indicate that chemicals are present in both locations, but are greater both in number and in concentration at DH-11 than at DH-10.

6.4.3 GROUNDWATER CHEMISTRY

Groundwater chemical analyses indicate that, while chemicals exist in groundwater collected from MW-6 (located closest to the River), fewer compounds are found and most are at lower concentrations than in well MW-5 located further into the Site. The total chemical concentration in groundwater from MW-5 is 15,177 μg/L while in MW-6 it is almost 4 times lower at 3,810 μg/L. The higher total chemical concentration in groundwater from MW-5 would tend to verify the observation of NAPL presence during the well installation.

No samples of groundwater were collected from wells MW-10 and MW-11. At the time of sampling, these wells were dry by SOP criteria.

6.4.4 GROUNDWATER FLOW

At the southern end of the storm sewer, groundwater flow is towards the River. Contour maps of head elevations in the Fill (Chapter 4.0) show a significant area of reduced head levels in the water table near the river outfall of the storm sewer. This tends to support the observations during the video survey of most visible infiltration into the storm sewer pipe occurring within 300 feet of the River. Through this infiltration, the pipe acts to drain the Fill unit in this area (see Figure 4.2).

The hydraulic conductivity of the materials at the base of the southern end of the storm sewer pipe has been assessed by both empirical methods and direct measurement through in situ testing. Empirical methods yield rough approximations of hydraulic conductivity ranging from 7×10^{-4} cm/sec to 2×10^{-1} cm/sec. In situ testing yields calculated hydraulic conductivity ranging from 3×10^{-4} cm/sec to 1×10^{-2} cm/sec, depending on the degree of anisotropy assumed. It appears that hydraulic conductivities in this area vary considerably due to the nature of the materials.

At the northern end of the storm sewer, flow usually appears to be towards the south. Hydraulic head data recorded in MW-10 and MW-11 (Table 6.5) represent 24 measurements taken in these wells from March 1986 until November 1987. In six instances, data were insufficient for assessment of gradient magnitude or direction between these wells. In thirteen instances, eight of which are measurements taken over four consecutive days in July 1986, a gradient with a southerly component occurs between these wells. In four instances, a gradient with a northerly component occurs between these wells. In all but one measurement, the hydraulic head levels in MW-10 range between approximately coincident with the invert elevation at the north end of the storm sewer and below the elevation of the top of the storm sewer pipe (566.8). Because the storm sewer carries storm runoff, head levels within the pipe are variable and can be as high as 566.0 (80 percent full). Video inspection of the storm sewer did not reveal visibly flowing points of infiltration into the storm sewer in the vicinity of MW-10 and MW-11 and the degree of exfiltration cannot be assessed from available data. However, an inward gradient from the exterior towards the interior of the pipe can be assumed to be dominant at times of normal River levels.

The hydraulic conductivity of the materials at the base of the northern end of the storm sewer pipe has also been assessed by empirical and in situ methods. Empirical methods yield a rough approximation of 2×10^{-6} cm/sec. A sharp recharge boundary is recognizable from the in situ data from MW-10. Extrapolation of the early data yields a calculated hydraulic conductivity of 1×10^{-4} cm/sec. However, if a best fit line is matched to the entire data plot, calculation of hydraulic conductivity using this line yields a value of 1×10^{-7} cm/sec for the boundary materials. Because MW-10 is screened in the materials backfilled into a relatively narrow installation trench excavated into the Clay, it is concluded that the calculated hydraulic conductivity of 1 x 10^{-4} cm/sec probably represents local conditions in the trench backfill, while the calculated hydraulic conductivity of 1 x 10^{-7} cm/sec probably corresponds to conditions in the boundary materials, specifically the undisturbed Clay or local regions of lower hydraulic conductivity in the backfill.

6.5 CONCLUSIONS

The groundwater infiltration into the pipe from the landfill is a chemical migration pathway which appears to be more significant than any other outflow associated with the storm sewer which might exist. From the data presented, it appears that the likelihood of a chemical migration pathway off-site to the north along the exterior of the storm sewer is small. While it appears that chemicals do exist in the backfill material at this location, hydrogeological data do not substantiate either distant or northward migration, and in fact suggest that it is a localized occurrence. Based on the data, the exterior of the storm sewer pipe near MW-6 and DH-6 does not appear to provide a significant or preferential migration pathway.

NAPL has been observed in areas traversed by the storm sewer and in sewer sediment. However, NAPL has not been observed in the sewer effluent. Thus, while the potential for NAPL migration via infiltration to the storm sewer exists, observed conditions indicate that this is presently not occurring.

Based on the data, it is recommended that evaluations proceed on the feasibility of slip lining the storm sewer as a remedial alternative. The pipe integrity and amount of accumulated sediment favor this alternative, and would allow the greatest expediency. The installation of a sealing collar of bentonite or other suitable low permeability barrier at both the northern and southern ends of the pipe as a secondary remedial step is also recommended. Because potential remedial activities offshore to address Niagara River sediment contamination may affect the storm sewer, it is suggested that the remedial alternative selected must be tied to long term sediment remediations under consideration.

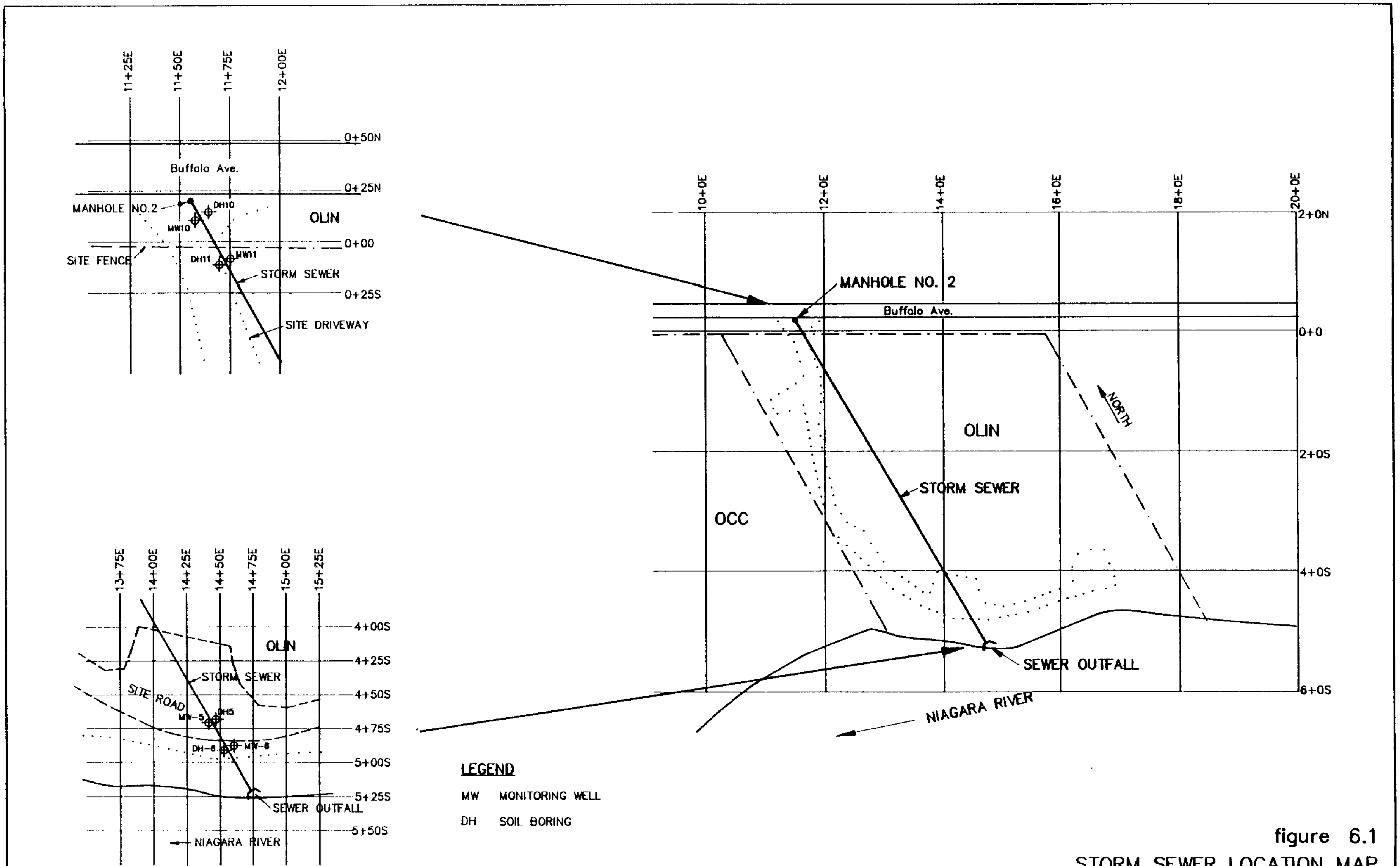


figure 6.1

STORM SEWER LOCATION MAP
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-26/09/88-43-D-0 (P120)

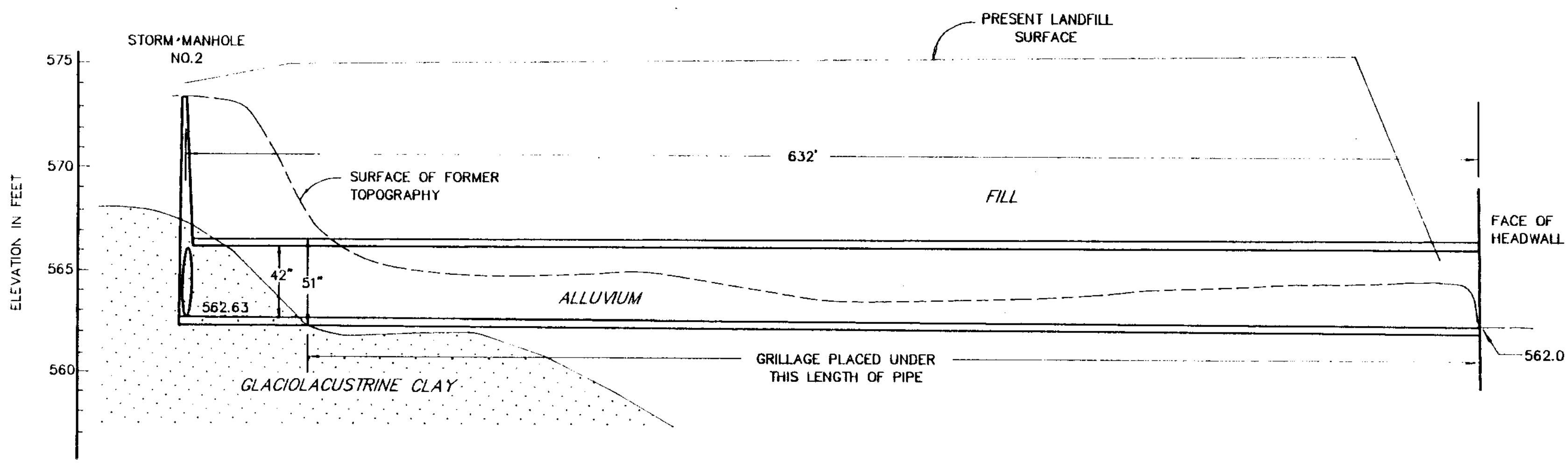


figure 6.2
STORM SEWER DESIGN DIMENSIONS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-27/09/88-47-D-0 (P121)

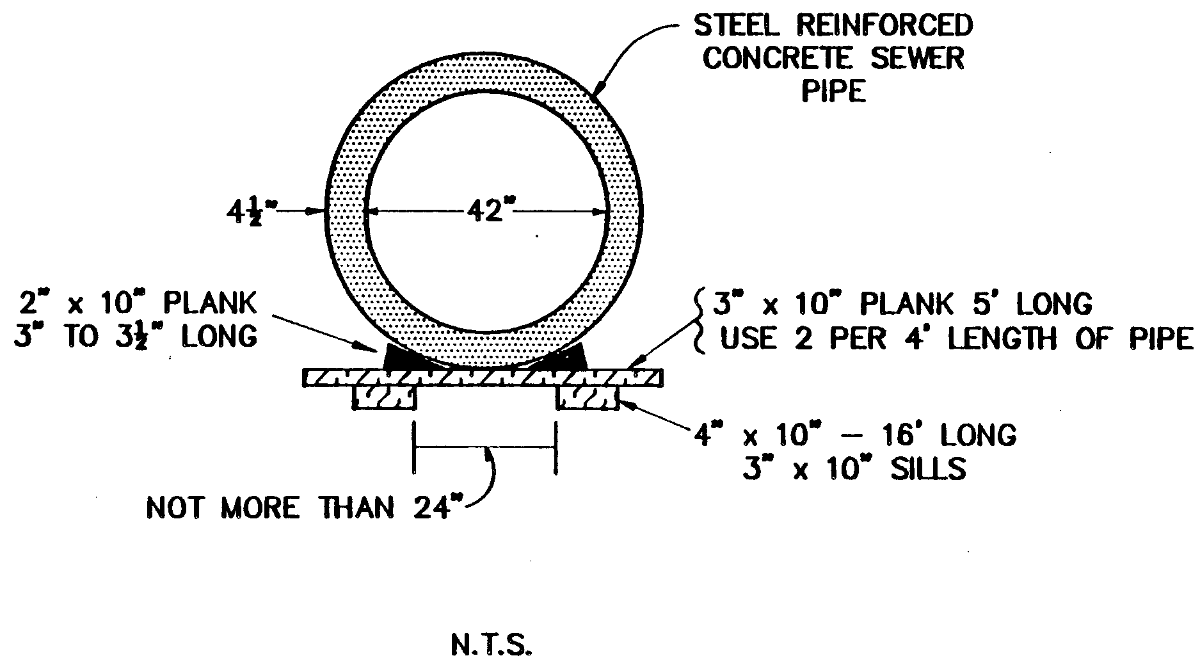
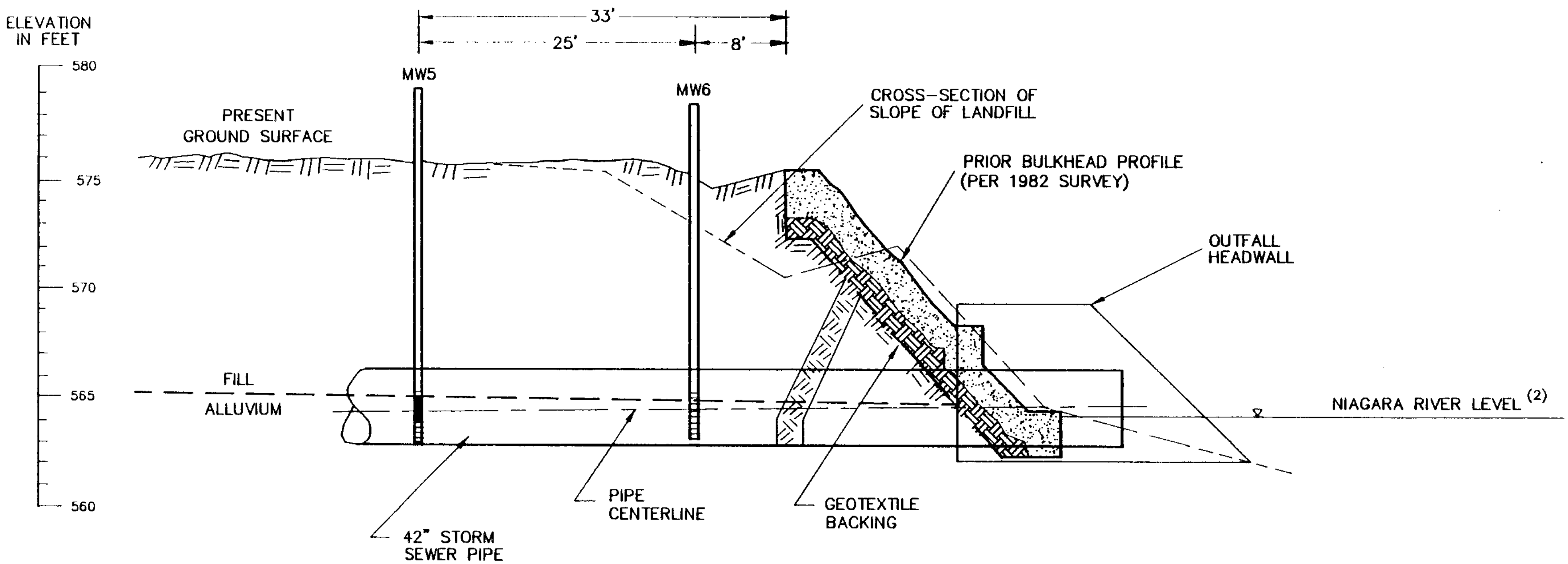


figure 6.3
SUPPORT GRILLAGE INSTALLATION DESIGN
REMEDIAL INVESTIGATION
102nd Street Landfill, Site

CRA/WCC

1431-26/09/88-43-D-0 (P120)



LEGEND:

- RIPRAP BEDDING STONE
- BULKHEAD RIPRAP ARMOR STONE
- EXISTING COMPACTED CLAY LAYER
- NAPL PRESENCE

NOTE:

1) ELEVATIONS CORRECTED TO USGS DATUM
2) NIAGARA RIVER LEVEL SHOWN IS AVERAGE OF SIX MONTHLY MEASUREMENTS (JAN.-JUNE, 1987; MILESTONE REPORT NO. 8)
3) FILL / ALLUVIUM INTERFACE DETERMINED FROM MW-5 AND MW-6 BORING LOG DATA.
4) FIGURE COMPOSED BY OVERLAYING FIELD DATA ON BULKHEAD RECONSTRUCTION DESIGN DETAIL.

SOURCE: WENDEL ENGINEERS
DRAWING NO. D-J047-840-10-31

figure 6.4

PROFILE OF BULKHEAD AT STORM SEWER OUTFALL SHOWING MONITORING WELL
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-27/09/88-47-D-1 (P131)

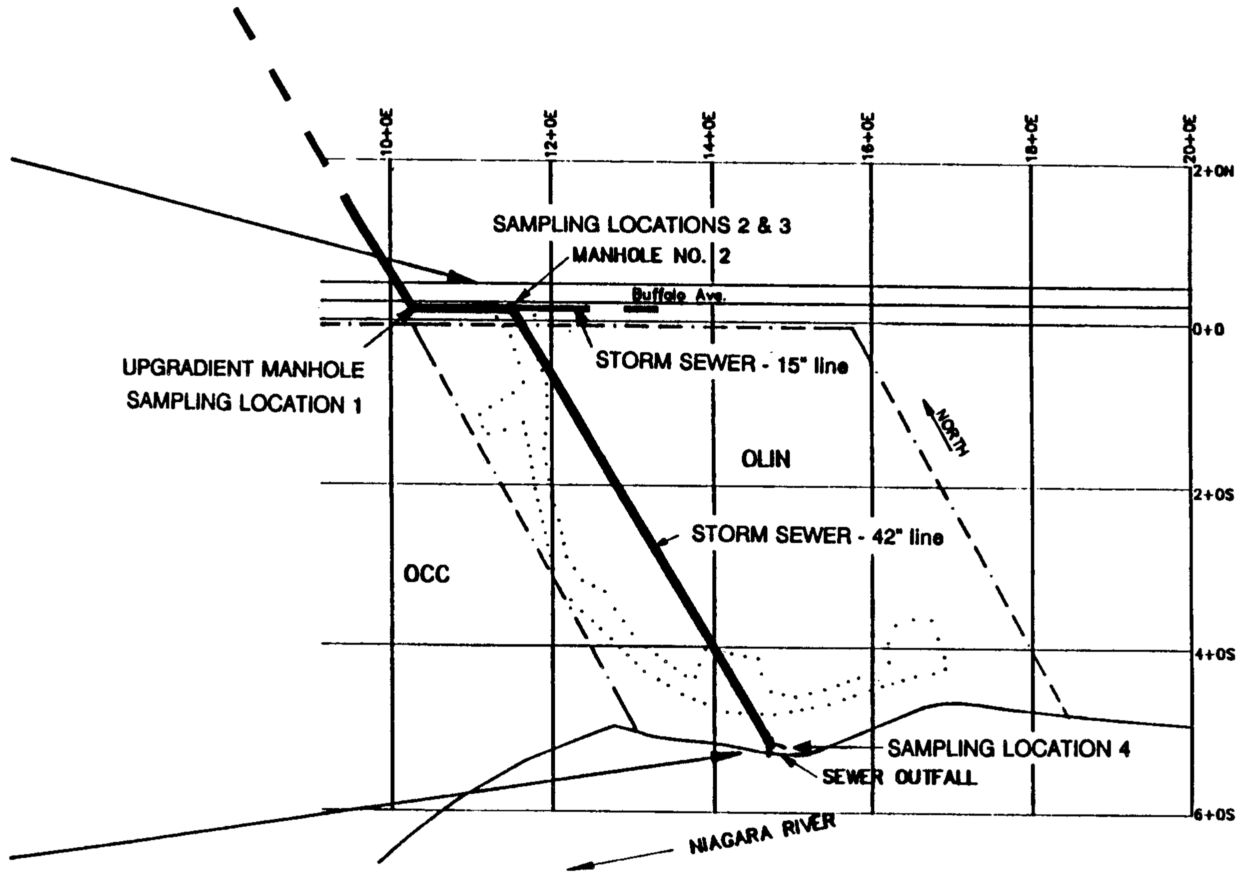


figure 6.5

SAMPLING LOCATION MAP
STORM SEWER INFILTRATION STUDY
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC
1431-26/09/88-43-D-0 (P120)

TABLE 6-1

SOILS ANALYTICAL RESULTS
STORM SEWER SURVEY
102ND STREET LANDFILL

Parameter		DH5-SB	DH6-SB	DHX-SB	DH10-SB	DH11-SB	DH11-SBD	DH11-SBD (R)
2-Monochlorotoluene		ND (1)	ND	ND	ND	ND	ND	ND
4-Monochlorotoluene		ND(1)	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene		3,770	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene		11,100	ND	ND	ND	ND	ND	ND
1,2,3-Trichlorobenzene		43,300	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene		294,000	ND	ND	ND	ND	ND	ND
1,2,3,4-Tetrachlorobenzene		288,000	ND	ND	ND	ND	ND	ND
1,2,4,5-Tetrachlorobenzene		357,000	ND	ND	ND	ND	ND	ND
Pentachlorobenzene		23,600	ND	ND	ND	ND	ND	ND
Hexachlorobenzene		6,050	ND	ND	ND	ND	ND	ND
alpha Hexachlorocyclohexane		5,570,000	4,900	388	6,650	92,500	92,600	86,200
beta Hexachlorocyclohexane		318,000	354	101	1,440	16,500	10,900	10,100
gamma Hexachlorocyclohexane		4,660,000	226	ND	247	3,140	2,900	1,820
delta Hexachlorocyclohexane		1,310,000	ND	ND	ND	825	686	666
2,4-Dichlorophenol		2,210(2)	ND	ND	ND	ND	ND	ND
2,5-Dichlorophenol		ND(2)	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol		5,210	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol		22,500	ND	ND	ND	ND	ND	ND
Mercury (4)		13,000	632	ND(3)	ND	13,000	2,430	- -
Depth Interval:		9' - 12'	9' - 12'	N/A	8.5' - 11.5'	8' - 11'	8' - 11'	8' - 11'
Sample Date:		12/4	12/4	12/4	12/5	12/5	12/5	12/5
Extraction Date:		12/9	12/9	12/9	12/9	12/9	12/9	12/9
Analysis Date:	Low Boiler	12/22-23	12/23	12/23	12/23	12/22	12/22	12/22
	High Boiler	12/18-19	12/18-19	12/19	12/18	12/17	12/17-19	12/17-19

Notes:

Concentration in ug/Kg (PPB)

(1) Detection limit 600 ug/Kg due to sample interference.
(2) 2,4 and 2,5-Dichlorophenol could not be resolved. Value represents DCP.
(3) Average of duplicates
(4) Analysis date: 12/23/86
(R) Lab replicate
D Field duplicate
X Field blank
ND Below survey detection limit of 100 ug/Kg except where noted
- - No analysis

WM-4L

TABLE 6-2

GROUNDWATER ANALYTICAL RESULTS
STORM SEWER SURVEY
102ND STREET LANDFILL

Site-Specific Indicators	Survey Level (μg/L)	MW-5 006	MW-6 006
VOLATILES:			
Benzene	5	3600	650
Toluene	5		
Monochlorobenzene	5	4900	1700
2-Monochlorotoluene	5		
4-Monochlorotoluene	5		
SEMI-VOLATILES:			
1,2-Dichlorobenzene	10	470	200
1,4-Dichlorobenzene	10	850	215
1,2,3-Trichlorobenzene	10	35	
1,2,4-Trichlorobenzene	10	510	109
1,2,3,4-Tetrachlorobenzene	10	50	
1,2,4,5-Tetrachlorobenzene	10	47	
Hexachlorobenzene	10		
alpha-Hexachlorocyclohexane	10	810	58
beta-Hexachlorocyclohexane	10	1800	61
gamma-Hexachlorocyclohexane	10		
delta-Hexachlorocyclohexane	10	1800	290
2,5-Dichloroaniline	10	13	
3,4-Dichloroaniline	10		
Phenol	10	71	84
2-Chlorophenol	10	34	
4-Chlorophenol	10	140	120
2,4-Dichlorophenol	10	31	13
2,5-Dichlorophenol	10	16	
2,4,5-Trichlorophenol	50		310
2,4,6-Trichlorophenol	10		
2-Chlorobenzoic Acid	100		
3-Chlorobenzoic Acid	100		
4-Chlorobenzoic Acid	100		

TABLE 6-2 (Continued)

General Parameters	Survey Level (mg/L)	MW-5	MW-6
Total Kjeldahl Nitrogen (TKN)	0.1	3.2	7.5
Total Organic Carbon (TOC)	1.0	120	37
Mercury	0.2	.0032	.0016
Phosphorus (Dissolved)	0.01	0.71	0.44
Total Organic Halide (TOX)	0.01	3.3	0.38
Arsenic	0.05		
Sample Date:		2/4/87	2/4/87

Notes:

Blanks indicate results below survey levels.
Insufficient water in wells MW-10 and MW-11 for sampling.

TABLE 6-3

CALCULATED HYDRAULIC CONDUCTIVITIES ON EMPIRICAL RELATIONSHIP WITH D_{10} GRAIN SIZE 102ND STREET LANDFILL

Boring Number	Depth Interval	Elevation Interval	D_{10} Grain Size (mm)	Calculated Hydraulic Conductivity C = 1.0
DH-5	9'-12'	566.9-563.9	2.59×10^{-2}	6.71×10^{-4} cm/sec
DH-6	9'-12'	565.9-562.9	4.164×10^{-1}	1.73×10^{-1} cm/sec
DH-10	8.5'-11.5'	566.5-563.5	1.30×10^{-3}	1.69×10^{-6} cm/sec
DH-11	8'-11'	566.7-563.7	1.30×10^{-3}	1.69×10^{-6} cm/sec
MW-6	11'-12'	563.91-562.91	3.05×10^{-1}	9.33×10^{-2} cm/sec
MW-5	10.5'-11.0'	564.5-564.0	1.47×10^{-1}	2.17×10^{-2} cm/sec

Note: Estimates made from analysis of samples from borings DH-10 and DH-11 utilize the D_{49} and D_{50} data respectively. There was no determination of the D_{10} grain size due to the large portion of clay sized particles.

TABLE 6-4

BASIC TIME LAG CALCULATION OF HYDRAULIC CONDUCTIVITY
RISING HEAD TESTS
STORM SEWER SURVEY
102ND STREET LANDFILL

Well No.	Area (A)	Shape Factor (F)	Time Lag (T)	Hydraulic Conductivity (K)
For Isotropic Conditions (K_h/K_v = 1)				
MW-5	20.3 cm^2	119.86	30.6 sec.	5.53×10^{-3} cm/sec
MW-6	20.3 cm^2	119.86	588 sec.	2.88×10^{-4} cm/sec
MW-10	20.3 cm^2	119.86	765 sec. (1)	2.21×10^{-4} cm/sec
MW-10	20.3 cm^2	119.86	1×10^6 sec. (2)	1.69×10^{-7} cm/sec
For Anisotropic Conditions (K_h/K_v = 10)				
MW-5	20.3 cm^2	88.26	30.6 sec.	7.6×10^{-3} cm/sec
MW-6	20.3 cm^2	88.26	588 sec.	3.9×10^{-4} cm/sec
MW-10	20.3 cm^2	88.26	765 sec. (1)	3.0×10^{-4} cm/sec
MW-10	20.3 cm^2	88.26	1×10^6 sec. (2)	2.3×10^{-7} cm/sec
For Anisotropic Conditions (K_h/K_v = 100)				
MW-5	20.3 cm^2	69.50	30.6 sec.	9.55×10^{-3} cm/sec
MW-6	20.3 cm^2	69.50	588 sec.	4.97×10^{-4} cm/sec
MW-10	20.3 cm^2	69.50	765 sec. (1)	3.82×10^{-4} cm/sec
MW-10	20.3 cm^2	69.50	1×10^6 sec. (2)	2.92×10^{-7} cm/sec
For Anisotropic Conditions (K_h/K_v = 1000)				
MW-5	20.3 cm^2	57.43	30.6 sec.	1.16×10^{-2} cm/sec
MW-6	20.3 cm^2	57.43	588 sec.	6.01×10^{-4} cm/sec
MW-10	20.3 cm^2	57.43	765 sec. (1)	4.62×10^{-4} cm/sec
MW-10	20.3 cm^2	57.43	1×10^6 sec. (2)	3.53×10^{-7} cm/sec

Notes:

(1) Time lag based on extrapolation of early data. Recharge probably occurring from backfill material in close proximity to well.

(2) Time lag esimated by log/log plot and extrapolation of total recovery curve. Probably represents recharge from undisturbed clays beyond boundary of trench.

TABLE 6-5

HISTORIC HYDRAULIC HEAD DATA
FROM MW-5, MW-6, MW-10 AND MW-11
OLIN 102ND STREET LANDFILL

Date	MW-5	MW-6	MW-10 (1)	MW-11 (2)	Gradient Direction
March 4, 1986	564.78	565.60	565.36	563.70 (Dry)	South
April 9, 1986	564.99	565.91	564.72	563.70 (Dry)	South
May 13, 1986	564.75	565.53	563.02 (Dry)	563.70 (Dry)	None
June 19, 1986	565.33	565.76	563.02 (Dry)	563.72 (Dry)	None
July 17, 1986	564.97	565.35	564.86	563.85 (Dry)	South
August 25, 1986	564.68	565.00	cap stuck	564.43	ND
July 14, 1986 AM (3)	565.24	565.54	562.96 (Dry)	563.85 (Dry)	None
July 14, 1986 PM (3)	564.99	565.50	562.77 (Dry)	563.69 (Dry)	None
July 15, 1986 AM (3)	565.09	565.39	564.80	563.60 (Dry)	South
July 15, 1986 PM (3)	564.97	565.45	564.82	563.81 (Dry)	South
July 16, 1986 AM (3)	564.96	565.31	564.77	563.84 (Dry)	South
July 16, 1986 PM (3)	564.95	565.36	564.87	563.79(Dry)	South
July 17, 1986 AM (3)	564.97	565.35	564.86	563.85 (Dry)	South
July 17, 1986 PM (3)	564.93	565.38	564.86	563.80 (Dry)	South
July 18, 1986 AM (3)	565.05	565.34	564.90	563.80 (Dry)	South
July 18, 1986 PM (3)	565.11	565.42	564.83	563.91(Dry) (4)	South
January 19, 1987 (5)	565.59	566.66	564.65	563.70 (Dry)	South
February 23, 1987 (5)	564.35	565.71	564.54	Buried under ice	ND
March 23, 1987 (5)	564.53	565.70	570.06	563.70 (Dry)	South
April 20, 1987 (5)	564.91	565.54	564.94	566.70	North
May 6, 1987 (5)	564.37	565.55	565.06	566.17	North
June 22, 1987 (5)	564.71	565.64	565.89	564.63	South
September 21, 1987 (5)	564.99	565.62	563.45	566.54	North
November 2, 1987 (5)	564.19	564.95	563.02 (Dry)	564.77	North

Notes:

ND = No determination of gradient can be made.
(1) Installation date is January 14, 1986. Tip of screen elevation is 563.0.
(2) Installation date is January 24, 1986. Tip of screen elevation is 563.7.
(3) Measurements taken during initial 5-day hydraulic head monitoring program.
(4) Rain the previous night leaked through cap and into well casing.
(5) Measurements taken during the extended hydraulic head monitoring program.

TABLE 6-6

SEDIMENT ANALYTICAL RESULTS[1]
STORM SEWER INFILTRATION STUDY
OLIN 102ND STREET REMEDIAL INVESTIGATION

Sample ID	SED1	SED2
Location Number	4	4
Location Description	River outfall	Field duplicate of SED1
Sampling Date	11/14/89	11/14/89
Parameter (all concentrations in ug/kg dry weight)		
SITE SPECIFIC INDICATORS		
Low Boiler Compounds		
1,2-Dichlorobenzene	810,000	710,000
1,4-Dichlorobenzene	220,000	170,000
2-Monochlorotoluene	570,000	510,000
4-Monochlorotoluene	400,000	350,000
High Boiler Compounds		
2,4-Dichlorophenol	ND[2]	ND[2]
2,5-Dichlorophenol	ND[2]	ND[2]
Hexachlorobenzene	490,000	530,000
alpha-Hexachlorocyclohexane	350,000	400,000
beta-Hexachlorocyclohexane	11,000	9,500
delta-Hexachlorocyclohexane	84,000	78,000
gamma-Hexachlorocyclohexane	89,000	93,000
Pentachlorobenzene	3,500,000	5,100,000
1,2,3,4-Tetrachlorobenzene	21,000,000	22,000,000
1,2,4,5-Tetrachlorobenzene	1,600,000	1,600,000
1,2,3-Trichlorobenzene	890,000	930,000
1,2,4-Trichlorobenzene	3,000,000	4,900,000
2,4,5-Trichlorophenol	ND[2]	ND[2]
2,4,6-Trichlorophenol	ND[2]	ND[2]
Mercury	36,000	24,000

(1) These results have not undergone QA review.
(2) Not detected at 1,000 ug/kg dry.

TABLE 6-7

AQUEOUS ANALYTICAL RESULTS[1]
STORM SEWER INFILTRATION STUDY
OLIN 102ND STREET REMEDIAL INVESTIGATION

Sample ID	UPWAT42	NWAT42	NWAT15	SWAT1	SWAT2
Location Number	1	2	3	4	4
Location Description	42" storm line upgradient of manhole #2	42" storm line at manhole #2	15" storm line at manhole #2	River outfall	Field duplicate of SWAT1
Sampling Date	11/29/89	11/29/89	11/29/89	12/1/89	12/1/89
Parameter (all concentrations in ug/L)					
SITE SPECIFIC INDICATORS					
Benzene	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND
Monochlorobenzene	ND	ND	ND	330	260
2-Monochlorotoluene	ND	ND	ND	28	23
4-Monochlorotoluene	ND	ND	7	15	13
1,2-Dichlorobenzene	ND	ND	ND	32	40
1,4-Dichlorobenzene	ND	ND	ND	110	140
1,2,3-Trichlorobenzene	ND	ND	ND	46	55
1,2,4-Trichlorobenzene	ND	25	23	280	280
1,2,3,4-Tetrachlorobenzene	ND	14	13	300	230
1,2,4,5-Tetrachlorobenzene	ND	ND	ND	32	33
Hexachlorobenzene	ND	ND	ND	ND	ND
alpha-Hexachlorocyclohexane	ND	ND	ND	75	71
beta-Hexachlorocyclohexane	ND	ND	ND	ND	ND
gamma-Hexachlorocyclohexane	ND	ND	ND	33	37
delta-Hexachlorocyclohexane	ND	ND	ND	130	130
2,5-Dichloroaniline	ND	ND	ND	ND	ND
3,4-Dichloroaniline	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	64	76
2-Chlorophenol	ND	ND	ND	ND	ND
4-Chlorophenol	ND	ND	ND	26	39
2,4-Dichlorophenol	ND	ND	ND	ND	ND
2,5-Dichlorophenol	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND
2-Chlorobenzoic Acid	ND	ND	ND	ND	ND
3-Chlorobenzoic Acid	ND	ND	ND	ND	ND
4-Chlorobenzoic Acid	ND	ND	ND	ND	ND
TOTAL SSI	ND	39	43	1501	1427
GENERAL PARAMETERS					
TOX	313	869	7915	4295	866
TKN	11,600	2,700	280	4,200	4,200
TOC	19,100	12,800	7,600	8,900	11,400
Soluble Phosphorus	860	270	ND	67	65
Mercury	ND	ND	ND	0.41	0.49
Arsenic	ND	0.41	ND	ND	ND

(1) These results have not undergone QA review.

7.0 OFF-SITE SOILS INVESTIGATION

An Off-Site Soils Investigation was conducted as part of the RI. A summary of the investigation and its results is presented in the following sections of this report.

7.1 PURPOSE

The purpose of the Off-Site Soils Investigations was to:

- determine the nature and extent of Site-related chemicals in the surface soils surrounding the Site.

The possible routes by which chemicals may have migrated from the Site include:

- airborne particulate migration
- soil erosion via surface water runoff
- soil transport via vehicle undercarriage
- spill-over from materials placed in close proximity to the Site boundaries
- spillage from vehicles entering the Site.

These routes of migration could result in surficial chemical presence in off-site soils and consequently, the soil investigation undertaken off-site used surface soil sampling to identify the extent of migration. The survey of off-site migration was complicated by the fact that deposition of waste materials from various sources had occurred throughout the areas adjoining the Site.

The results of the Off-Site Soils Investigation were presented (4).

7.2 OFF-SITE SOILS SAMPLING PROGRAM

The physical boundaries of the off-site soil survey (Survey Area) were established in the Work Plan and extend to the following limits, as shown on Figure 7.1.

West	-	to the eastern edge of pavement forming the Griffon Park boat launch parking lot.
North	-	to the southern property boundary of the LaSalle Expressway.
East	-	to a line 25 feet east of the open ditch parallel to the Site's eastern property boundary.

Figure 7.1 also presents the alignment of the primary sampling vectors which were used to provide a systematic sampling approach. The spacing between the primary vectors varied from 150 feet to 200 feet as follows:

West of the Site	-	200 feet
North of the Site	-	177 feet
East of the Site	-	150 feet

The initial samples were collected along each of the primary vectors. Due to the iterative nature of the sampling program, it was necessary to await the analytical results from each primary vector before a decision could be made regarding subsequent sampling requirements along that vector. Based on the analytical results obtained from the samples, the sampling continued inwards or outwards from the previous sampling point depending upon whether the sample was identified to contain any of the SSI. Each sample was analyzed for the set of SSI listed in Table 7.1.

The distance between sampling stations along each vector was determined by OCC or Olin, depending upon whose property the vector emanated from.

Once analytical results were obtained in which no SSI were found above the survey levels along a particular primary vector, confirmatory samples were collected between primary vectors. The confirmatory sample stations were located at three equidistant locations between adjacent primary vector sampling locations which did not identify the presence of any SSI. An imaginary line was drawn between pairs of adjacent clean primary vector sampling locations to determine the appropriate distance from the Site boundary to collect the confirmatory samples.

To meet the intent of sample collection and analysis between primary vectors (19), individual samples at each confirmatory sample location were collected and analyzed. The analytical results from the three samples were then averaged. If the averaged analytical results from the confirmatory samples did not identify the presence of any SSI above survey levels, no additional sampling was required. In cases where any of the averaged SSI were present above the survey levels, additional sampling further from the Site was performed to define the areal limit of chemical presence.

7.3 DATA PRESENTATION

A total of 113 locations were sampled during the course of the nine iterative sampling events that were required to complete the program. The locations of these sampling stations are presented in Figure 7.2.

The analytical results from the entire program are presented in Appendix B and are summarized in the figures of this section. All analytical results were reviewed by Quality Assurance/Quality Control procedures (9,22).

The results of the mercury analyses are presented in Figure 7.3. In addition, the analytical results of a background sampling event initiated to identify the concentrations of mercury in on-site and off-site fill and cover material are presented in Figure 7.4.

Figure 7.5 is a pictorial summary of organic chemical presence in the survey area. This figure depicts the number of Organic SSI detected at each sampling station above the survey level. For comparison purposes, a figure depicting the Total Organic SSI concentrations has been prepared and is presented in Figure 7.6. (These concentrations are presented in ug/g rather than the ug/kg concentrations used on other Organic SSI figures).

In order to gain a better appreciation of the organic chemical distribution around the Site, the Organic SSI have been subdivided into smaller groups for presentation purposes. These groups are presented in the following figures:

Total Organic SSI	-	Figure 7.6
Monochlorotoluenes (MCT)	-	Figure 7.7
Dichlorobenzenes (DCB)	-	Figure 7.8
Trichlorobenzenes (TCB)	-	Figure 7.9

Tetrachlorobenzenes (TECB)	-	Figure 7.10
Pentachlorobenzene (P5CB)	-	Figure 7.11
Hexachlorobenzene (HCB)	-	Figure 7.12
Total HCCH (a,b,d and g-HCCH)	-	Figure 7.13
gamma-HCCH	-	Figure 7.14
Chlorophenols (CP)	-	Figure 7.15

7.4 DATA ANALYSIS AND INTERPRETATION

The survey revealed off-site migration of some SSI. The areal distribution of SSI demonstrated that the majority of the parameters were present at elevated concentrations in locations immediately adjacent to the Site boundary and occasionally at lower concentrations in areas within 200 feet from the Site boundary. One of the parameters, mercury, exhibited an entirely different chemical distribution pattern. Mercury was identified to be present above the survey level in almost every sample analyzed. The distribution of SSI is discussed in greater detail in the following subsections.

7.4.1 MERCURY

Mercury was found to be present above the survey level in all but nine of the sampling stations included in the survey. In general, the mercury concentrations were approximately 1 μg/g around the perimeter of the Survey Area, with more elevated concentrations observed adjacent to the Site boundaries, as shown in Figure 7.3. These analytical results indicated that mercury was prevalent throughout the Survey Area. Consequently, a series of samples was collected from locations both on-site and in Griffon Park, as shown in Figure 7.4. Fifteen of these samples were collected from approximately 1.5 to 5 feet below ground surface in order to characterize the mercury content of the waste materials deposited by the City and others at Griffon Park, and to facilitate comparison with mercury in the fill material at the 102nd Street Site. The analyses of the 10 depth samples from Griffon Park Fill revealed mercury concentrations ranging from 0.5 μg/g to 2.31 μg/g, with an average concentration of 0.98 μg/g. Concentrations of this order of magnitude or less are consistent throughout the Survey Area including areas to the north and east of the Site. The 5 samples from the Fill on the 102nd Street Site contained mercury levels ranging from <0.1 μg/g to 45.1 μg/g, with an average concentration in the Fill of 10.1 μg/g.

Review of all of the mercury analytical results clearly indicates that there are multiple sources of mercury in the Survey Area and that the Site is only one possible source. There are four primary means by which mercury migration from the Site could have occurred. As stated previously, these historical modes of transport are:

- airborne particulate migration,
- soil erosion via surface water runoff,
- soil transport via vehicle undercarriage, and
- spill-over from materials placed in close proximity to the Site boundaries.

a) Windborne dispersion of particulates may have been a factor in mercury migration from the Site. Most of the mercury containing wastes brought to the Site was in the form of an odorless brine sludge. Once disposed at the Site, any mercury brine sludge left uncovered could have dried out and, given the fine grained nature of the particles, been susceptible to airborne dispersion.

The dispersion of mercury wastes via airborne modes of transport would have been reduced by the following factors:

- for at least six months of the year, the Site would be snow-covered or wet and less susceptible to airborne migration,
- as filling at the Site progressed, the wastes were covered,
- most of the waste has been covered with imported soil since the early 1970's.

b) Any off-site migration via surface water runoff would tend to have been limited by the following physical characteristics:

- the ditch on the east,
- the southern shoulder of Buffalo Avenue to the north, and
- the low lying depressions and swales bordering Griffon Park on the west side of the Site.

c) Transport of materials via vehicles leaving the Site would be expected to follow along the roadways utilized by such vehicles. If this occurred, it is expected that this would typically be limited to westbound traffic out of the Site back toward the OCC/Olin plants.

d) Spill-over would be expected to be limited to immediately adjacent areas.

e) Spillage, due to insecure loads, may have occurred during transport of the wastes from OCC/Olin plants to the Site. However, it is expected that the majority of such spillage, if any, would have occurred within the plants boundaries prior to transport on public roadways. Thus, it is deemed that the contribution, if any, to the observed chemical concentrations from this mode of transport, is significant compared to the other pathways described above.

The elevated mercury concentrations adjacent to the Site boundary appear consistent with migration patterns that would be expected. The pervasive presence of mercury at approximately 1 ug/g is not consistent with the migration trends observed for all of the remaining SSI. The results of the environmental sampling program, which clearly indicate that wastes placed by others on Griffon Park also contained mercury in the 1 to 2 ug/g range, support the conclusion that the mercury is not attributable to the Site alone.

The presence of mercury along the western limit of the Survey Area is believed to be related to off-site disposal and handling of wastes by others. Similarly, wastes are known to have been placed and are still occasionally being disposed by others along the eastern limit of the Survey Area. This may also be contributing to mercury presence in this area. Along the northern portion of the Site, it appears more likely that mercury presence is due to a combination of factors including off-site disposal by others in isolated areas (i.e. in the FG Vector area), tracked waste by vehicles along the pavement of Buffalo Avenue and windborne dispersion from winds blowing inland off the River.

7.4.2 ORGANIC SITE-SPECIFIC INDICATORS

Generally, the presence of Organic SSI is consistent with migration patterns that would be expected from the Site. Typically, the highest concentrations are typically immediately adjacent to the Site's property boundary and the concentrations decrease with distance from the

Site. Elevated concentrations are also common along Buffalo Avenue. Figures 7.6 through 7.15 demonstrate these typical conditions. However, review of the data revealed the following areas where the data are inconsistent with migration patterns that would be expected from the Site.

- Monochlorotoluenes - Initially, MCT was reported to be 415 ug/kg at P-205, but this result was inconsistent with all of the results measured at the northeast corner of the Site where MCT was not detected. With concurrence of the EPA/State the area was resampled. The results of this resampling did not confirm the present of MCT. Since the original data was inconsistent with migration mechanisms for MCT, it is concluded that the original data is an artifact of the sampling or analytical procedures and is therefore inaccurate.

- Dichlorobenzenes - DCB was present along the southern edge of the LaSalle Expressway on vectors H, I and J at concentrations ranging from 118 to 142 ug/kg. The samples closer to the Site did not reveal DCB to be present suggesting no linkage to the Site exists.

- g-HCCH - an isolated area of g-HCCH presence was observed at location A-125 (185 ug/kg) even though all of the surrounding locations indicated g-HCCH was not present.

In addition to these isolated areas of chemical presence, there is an area of elevated chemical presence at the northwest corner of the Site on the north side of Buffalo Avenue. This location could be the result of one of the following factors:

i) material tracked to or from the Site by vehicles entering or leaving the Site,
ii) deposition of contaminated soils or wastes by others in this area.

The areal extent of organic SSI presence shown on Figure 7.16 suggests that both conditions are possible. However, it is felt that spillage from trucks entering the Site is not a likely source of the chemicals detected. Vehicles leaving the Site and the second factor seem more probable especially in light of the possibility of material adhering to vehicular undercarriages and the construction that has taken place in the area north of Buffalo Avenue (i.e. Frontier Avenue relocation and LaSalle Expressway Construction), and the common occurrence of waste disposal near the Site. There are some other nearby areas of chemical disposal.

The area east of the ditch paralleling the eastern Site boundary is also an area of known waste disposal. In fact, waste disposal is still occasionally occurring in this area. As can be seen simply by observing the surface conditions of the area, the waste types are varied and may contain chemicals. It is therefore difficult to distinguish between Site related and off-site related chemical presence.

Organic SSI have been identified at the areal limit of the Survey Area. The locations and identified chemicals present are:

FG1-500	1,2,4,5-Tetrachlorobenzene	-	ND/105 ug/kg
	Hexachlorobenzene	-	984/1010 ug/kg
	alpha-Hexachlorocyclohexane	-	142/127 ug/kg
	beta-Hexachlorocyclohexane	-	4950/13210 ug/kg
H-122	1,4-Dichlorobenzene	-	118 ug/kg
I-137	1,4-Dichlorobenzene	-	ND/142 ug/kg
J-163	1,4-Dichlorobenzene	-	133 ug/kg
Q-100	beta-Hexachlorocyclohexane	-	116/ND/ 221/239 ug/kg
R-90	beta-Hexachlorocyclohexane	-	466/225 ug/kg

Along the eastern Site boundary, confirmatory samples between primary vectors P and Q, Q and R, and R and S were not collected since the outermost samples collected on the Q and R primary vectors had already identified the presence of an Organic SSI. Similarly, along the northern extent of the Survey Area, at least one Organic SSI was identified at three of the ten vectors. In several cases, mercury was also identified along the northern boundary. Consequently, the combination of organic and mercury presence required no confirmatory sampling along this boundary.

Considering the possible modes of chemical transport from the Site, the data are consistent with the transport mechanisms with the noted exceptions previously discussed. Elevated concentrations of Organic SSI adjacent to the Site could be the result of either soil erosion, spill-over or vehicle tracking of wastes. Windborne dispersion is not expected to have played a major role in off-site migration of the Organic SSI for the following reasons:

- for at least six months of the year, the Site would be snow-covered or wet and less susceptible to airborne migration,
- as filling at the Site progressed, the wastes were covered,
- most of the waste has been covered with imported soil since the early 1970's,
- certain wastes were immediately covered as they were brought to the Site,
- the act of dispersing particulates in the air would tend to strip away any volatile components.

Based upon the analytical results generated from the Off-Site Soils Investigation, the areal extent of chemical presence in the Survey Area was identified. Figure 7.16 presents the areal extent of the Organic SSI present in the off-site soils. The defined areal extent generally includes the area where elevated (greater than approximately 1 ug/kg) mercury concentrations were also observed. The lack of correlation between elevated mercury concentrations and elevated Organic SSI presence throughout the western and eastern segments of the Study Area suggests that the source of certain chemicals is from sources other than the Site. Since the means of transport (i.e. surface water runoff, tracked material by vehicles, airborne dispersion and spill-over at the Site boundary) are the same for all parameters, one would expect that mercury would be part of the same migration pattern as the SSI. This result combined with the fact that mercury has been identified in the waste disposed by others suggests that caution should be exercised when using mercury as an indicator of migration from the Site.

7.5 CONCLUSIONS

The Off-Site Soils Investigation was completed to the specified geographic limits in accordance with the intent of the SOP (18) and the Work Plan (19). No further sampling beyond the geographic limits of the initially defined Survey Area is required in order to develop an appropriate remediation plan for the Site.

7.6 OFF-SITE DIOXIN SOIL SURVEY

An off-site soil sampling program was conducted to determine the extent of any 2,3,7,8-tetrachlorodibenzo-p-dioxin (Dioxin) present in the upper 18 inches of soil that may have migrated from the Site.

This program was conducted in accordance with approved protocols (28).

Samples were collected during the initial round (February 1987) from off-site locations along primary and intermediate off-site soils investigation vectors within approximately one foot of the Site boundary fence.

Total TCDD and 2,3,7,8-TCDD (Dioxin) results of the initial round of sampling are:

Sample	Total TCDD (ppb)	2,3,7,8-TCDD
D/DE-2	4.1	ND
I/IJ-2	30	5.2
J/JK-2	12	2.2

These results indicated the presence of Dioxin at vectors I and J (north side of OCC property) at levels of 5.2 and 2.2 ppb, respectively. In one instance, total TCDD was detected at a concentration of 4.1 ppb, however 2,3,7,8-TCDD (Dioxin) was not detected above the survey level. Total TCDD and Dioxin were not detected above the survey level in all other samples.

Subsequent samples were collected along the same vector lines approximately 20 feet from the fenceline along the edge of the roadway and some subvectors. From these two additional sampling locations, Dioxin was detected in only one (IJ-2-19.0). The concentration in this sample (0.8 ug/kg) was below the action level of 1 ug/kg which was specified (28).

After the boundaries of the area containing Dioxin contaminated soils were identified, corrective measures were implemented to prevent inadvertent contact with soils within this defined area. These measures included the following:

- Miscellaneous debris was removed from the area and disposed in the on-site spoils cell.
- The area was covered with gravel.
- A temporary fence was installed.

Figure 7.17 shows the fenced and covered area.

The extent of off-site Dioxin above 1 ug/kg has been defined, is areally limited, and has been addressed by interim corrective measures.

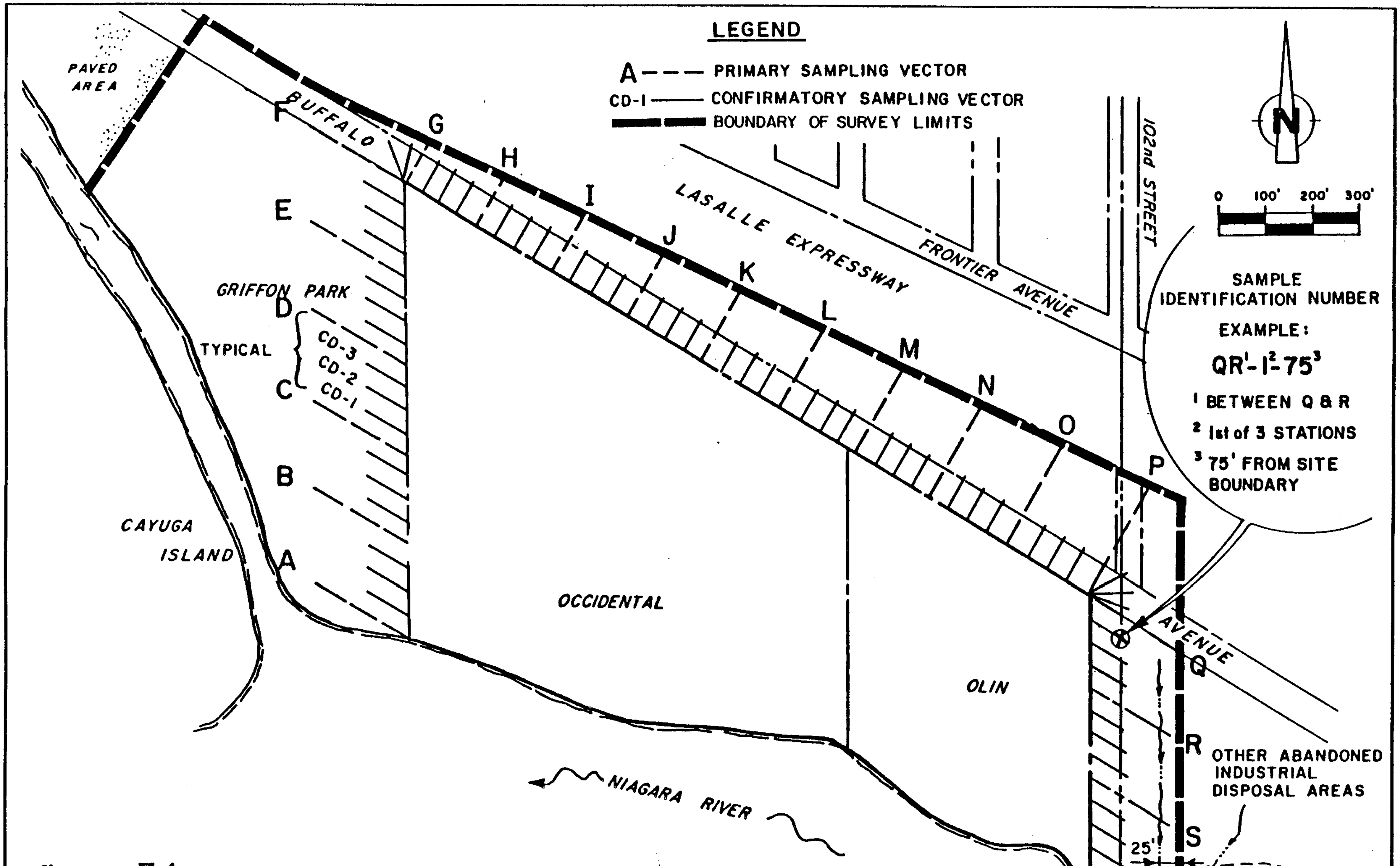


figure 7.1
OFF–SITE SURFACE SOIL INVESTIGATION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-0

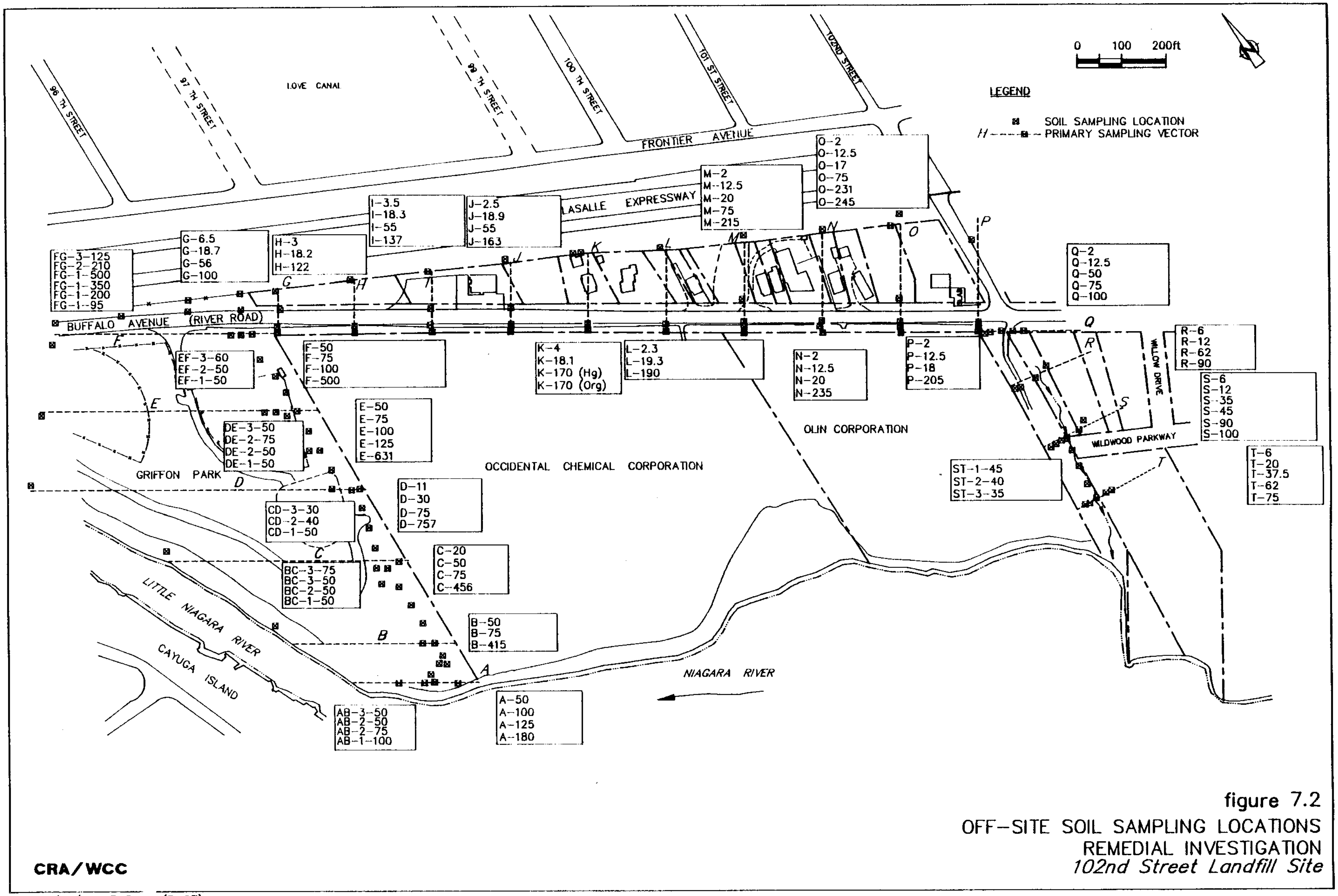


figure 7.2
OFF-SITE SOIL SAMPLING LOCATIONS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (P-97)

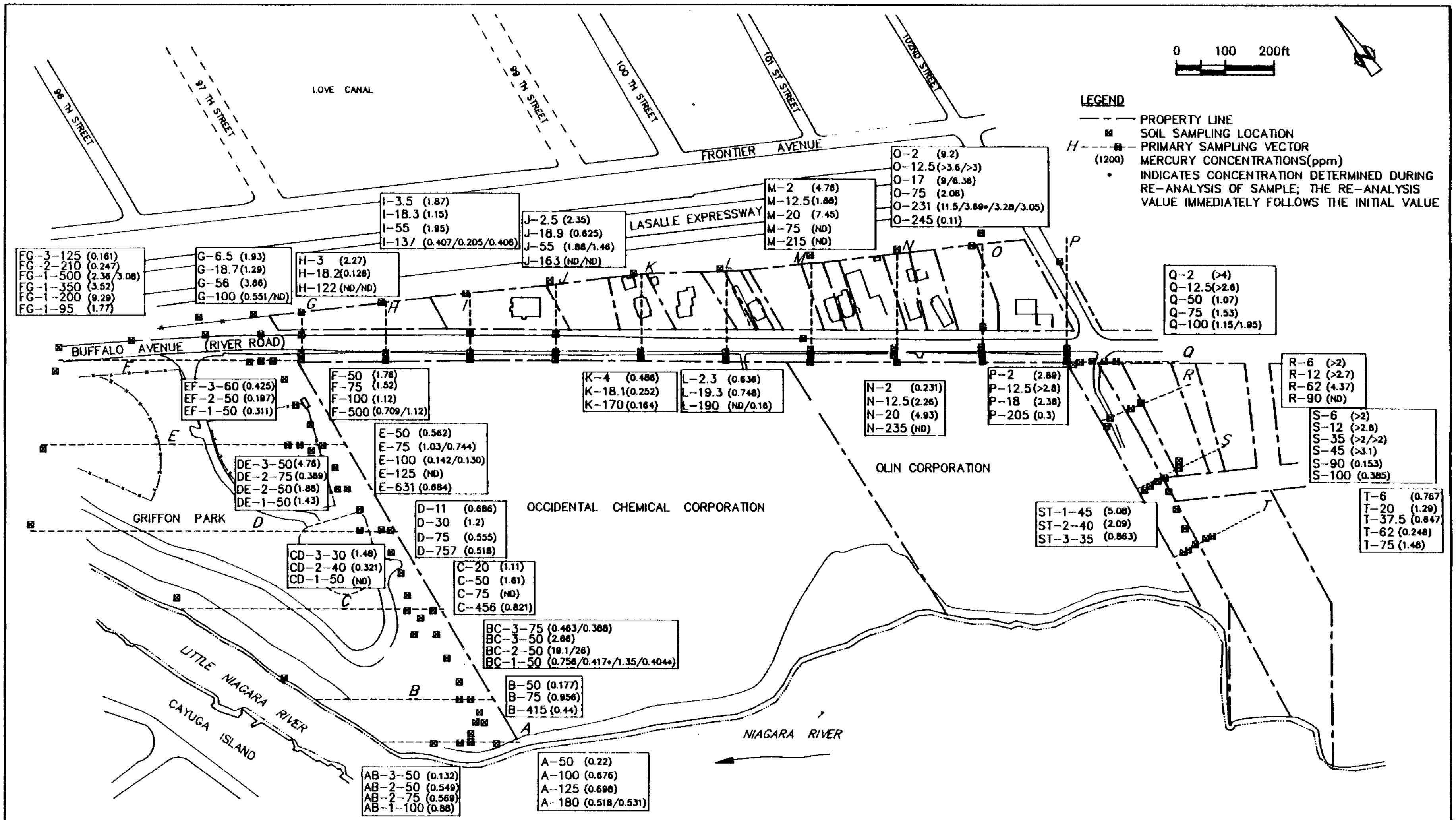


figure 7.3
OFF-SITE SOIL SAMPLING RESULTS-MERCURY
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P-98)

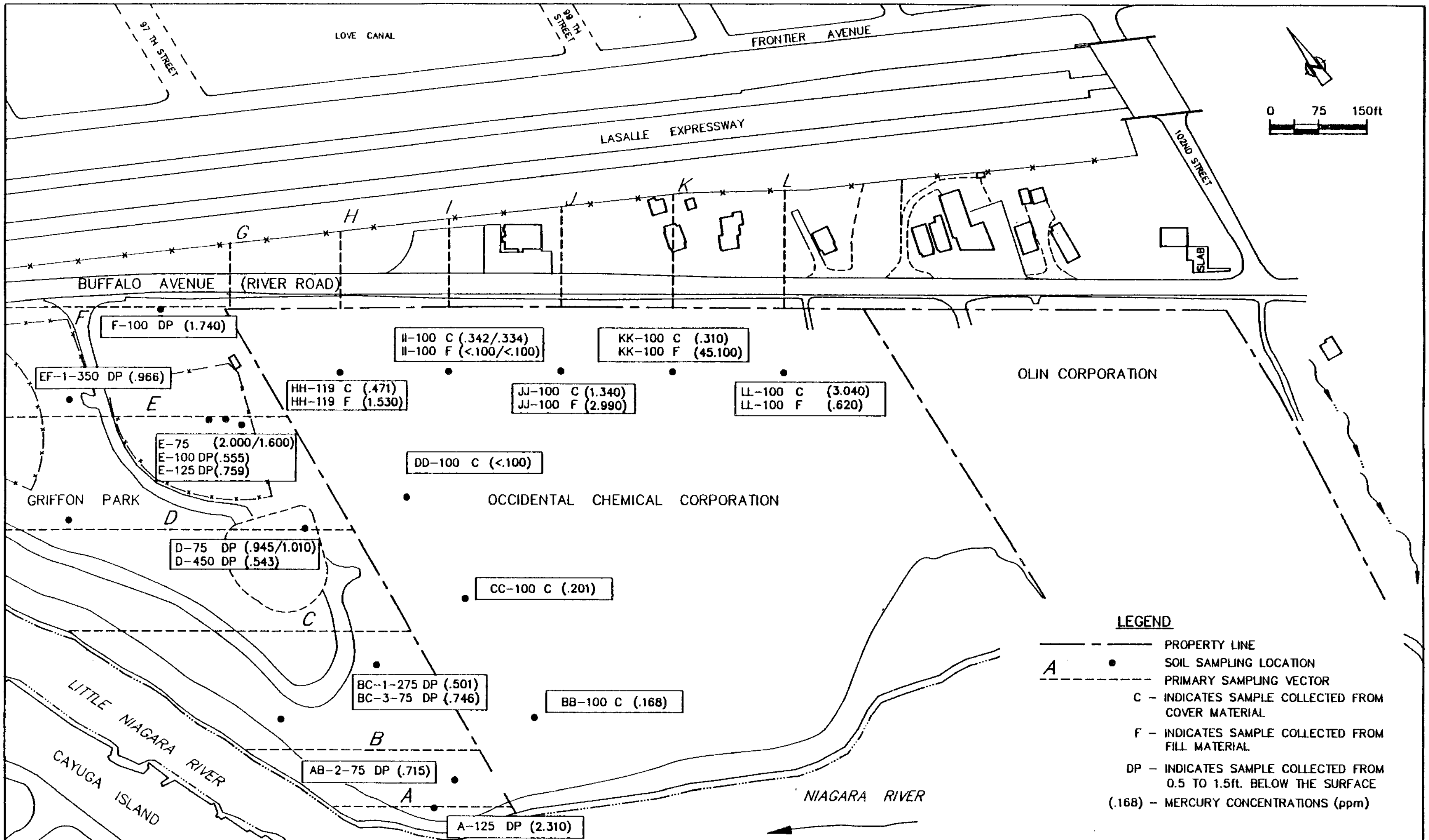


figure 7.4

SOIL SAMPLING RESULTS—MERCURY
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P-96)

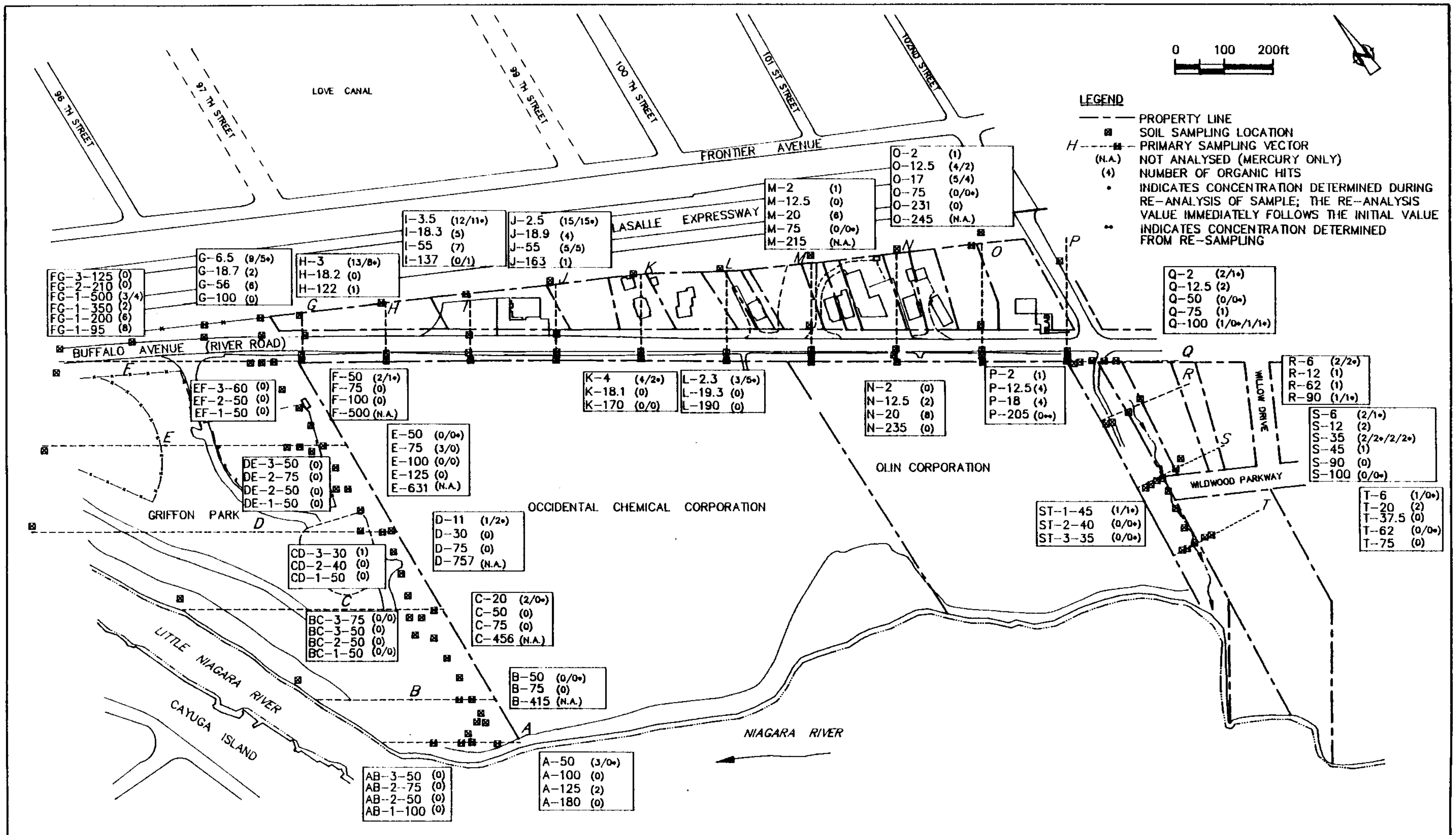


figure 7.5

OFF-SITE SOIL SAMPLING RESULTS
FREQUENCY OF ORGANIC SSI
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P-99)

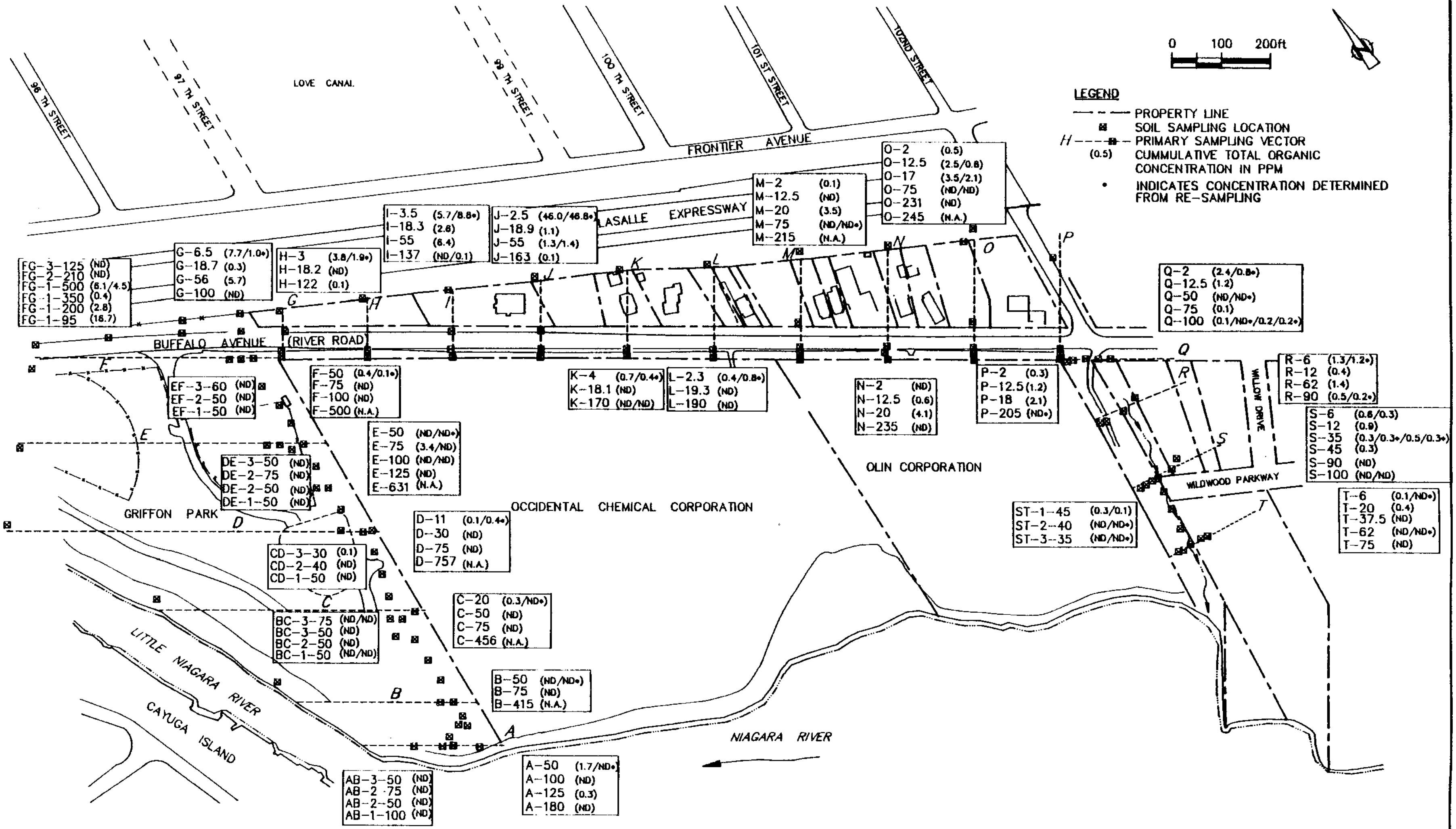


figure 7.6

OFF-SITE SOIL SAMPLING RESULTS
TOTAL ORGANIC SSI
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P-100)

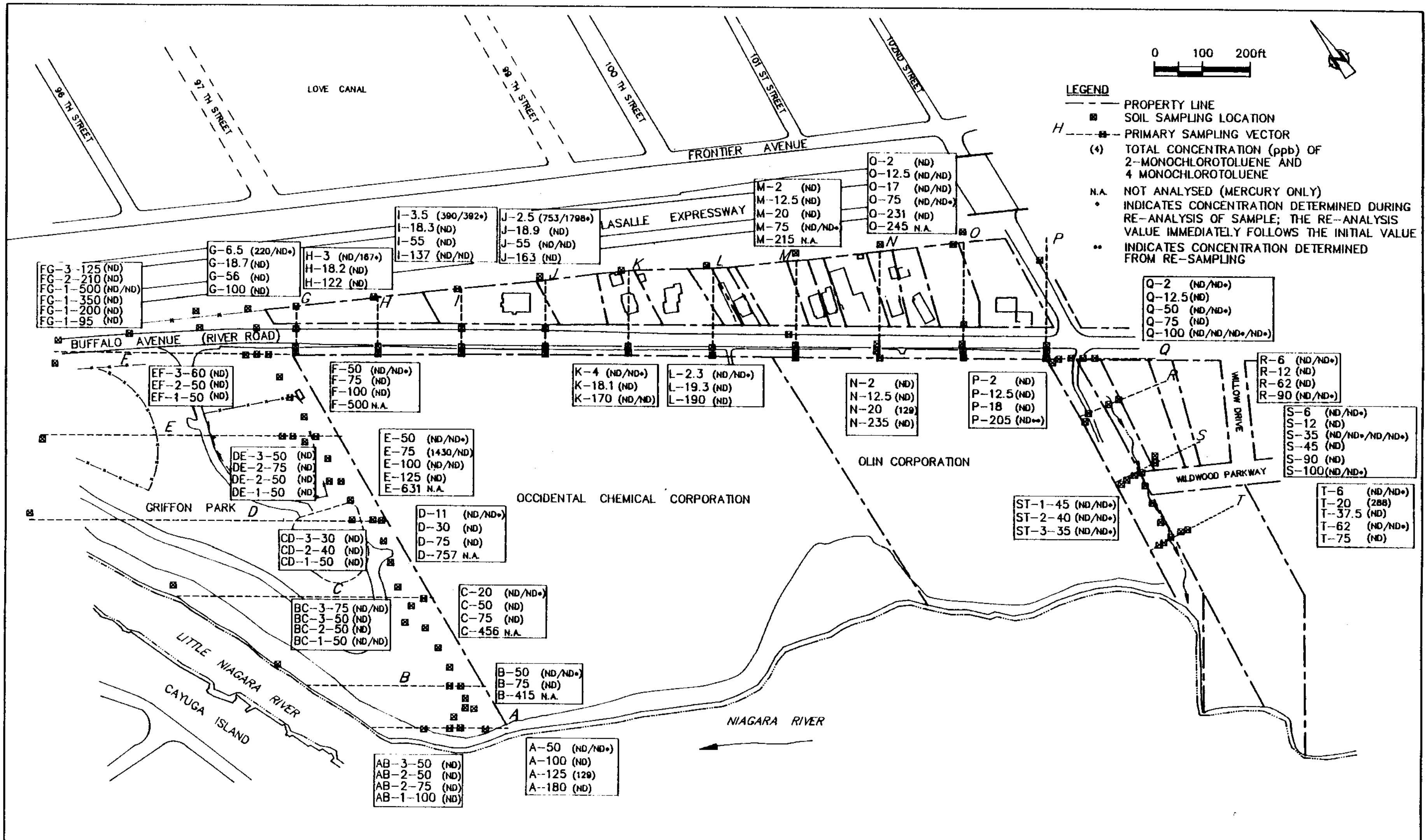


figure 7.7
OFF-SITE SOIL SAMPLING RESULTS – MONOCHLOROTOLUENES
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (P-101)

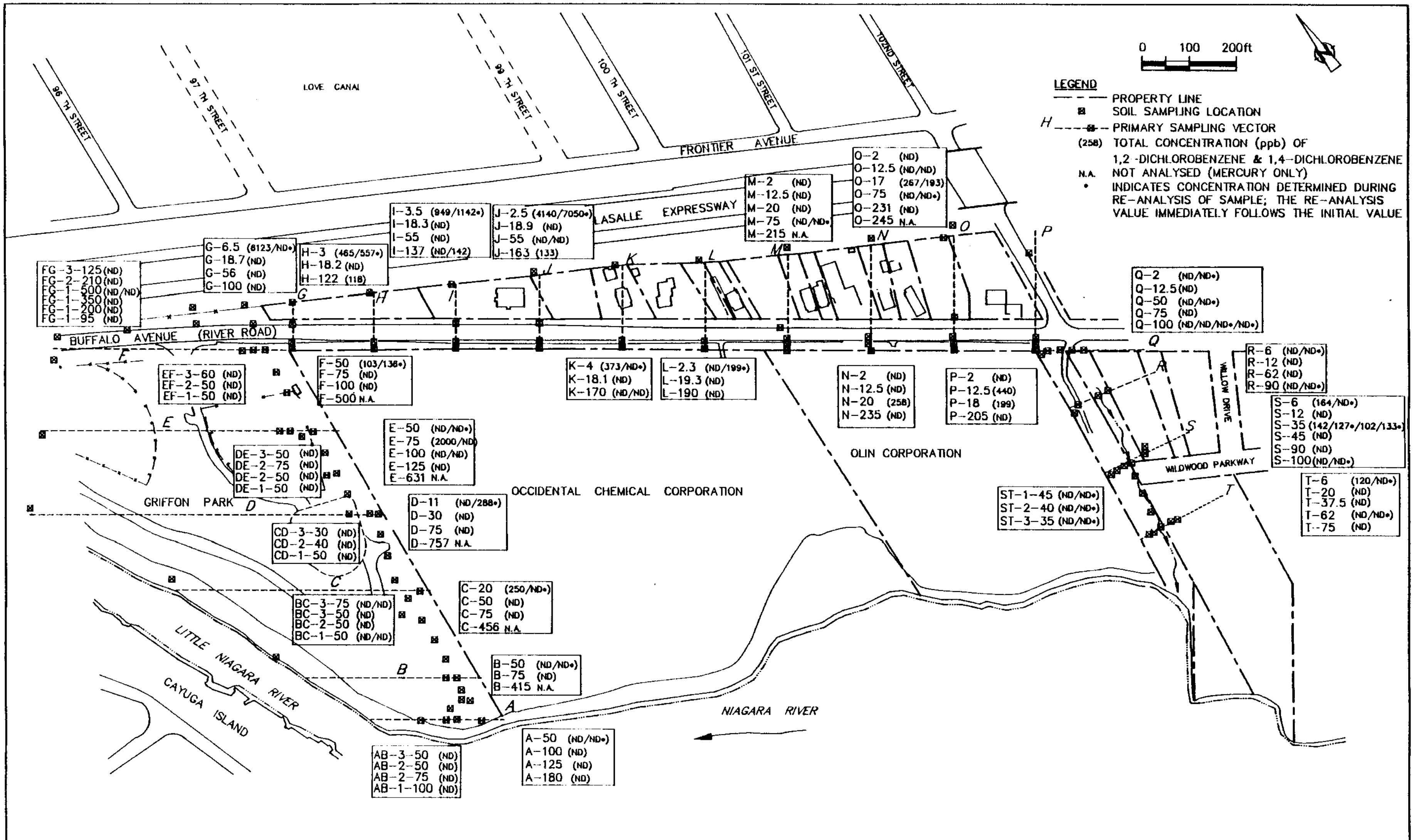


figure 7.8

OFF-SITE SOIL SAMPLING RESULTS – DICHLOROBENZENES
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P-102)

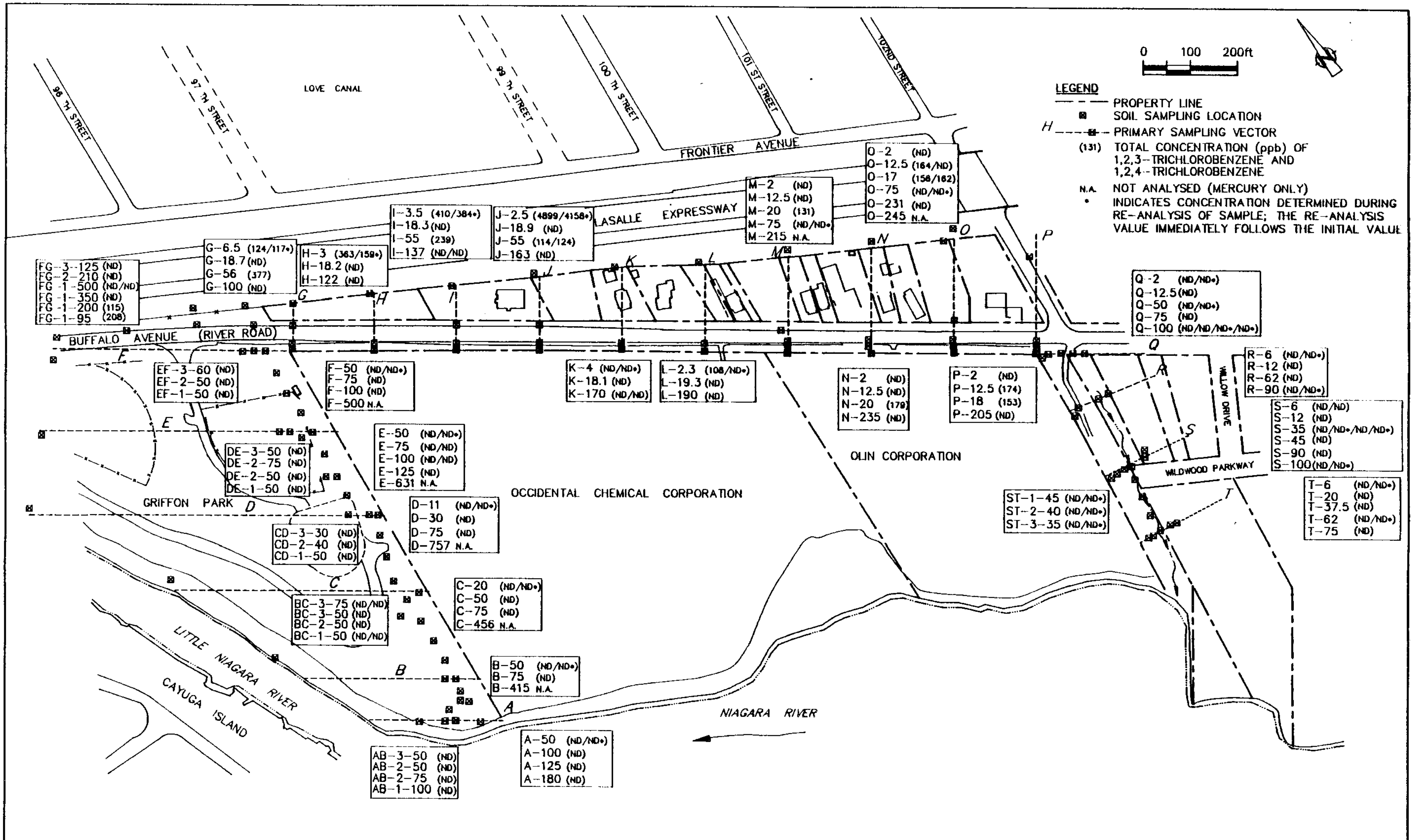


figure 7.9

OFF-SITE SOIL SAMPLING RESULTS – TRICHLOROBENZENES
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P-103)

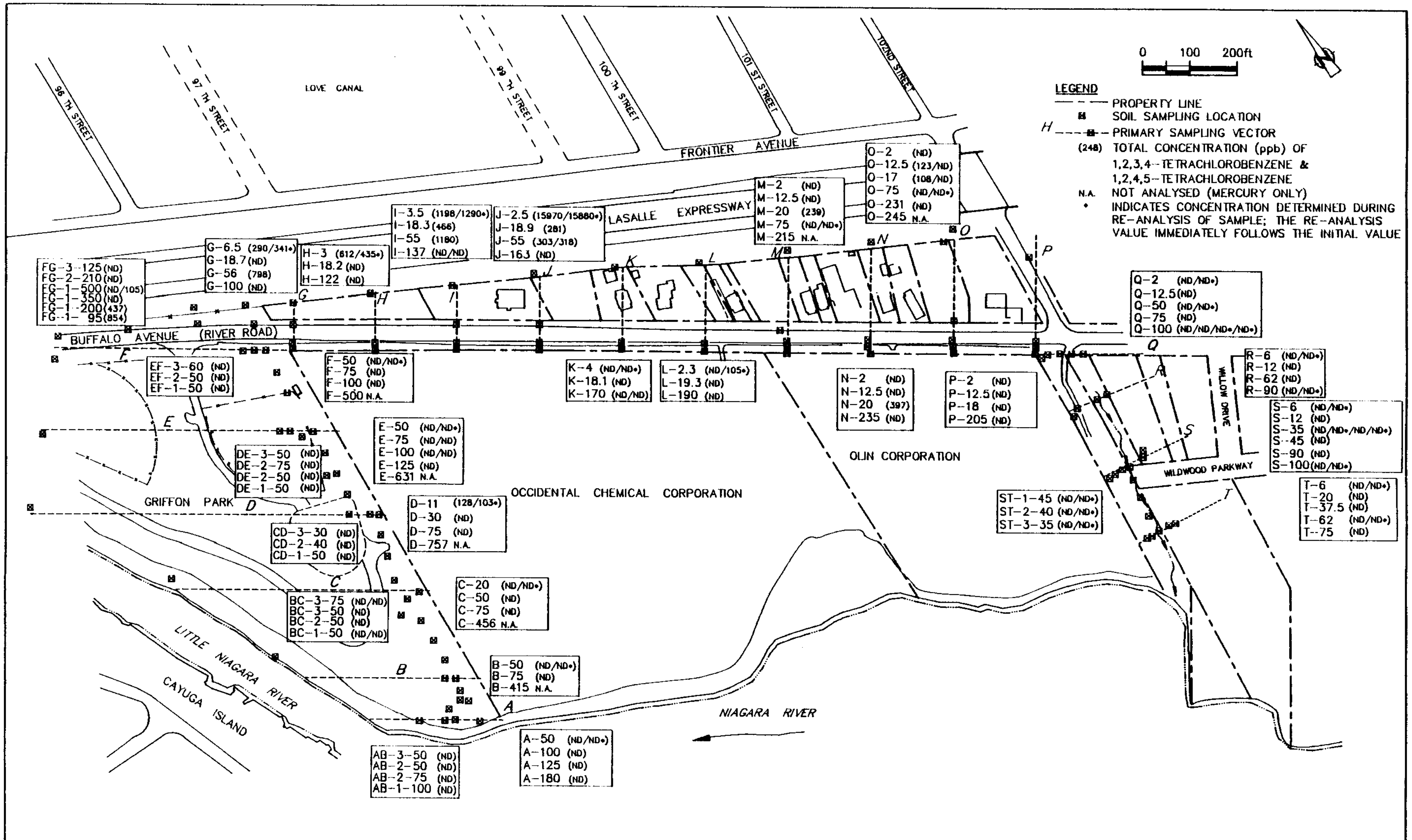


figure 7.10

OFF-SITE SOIL SAMPLING RESULTS – TETRACHLOROBENZENES
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D- (P-104)

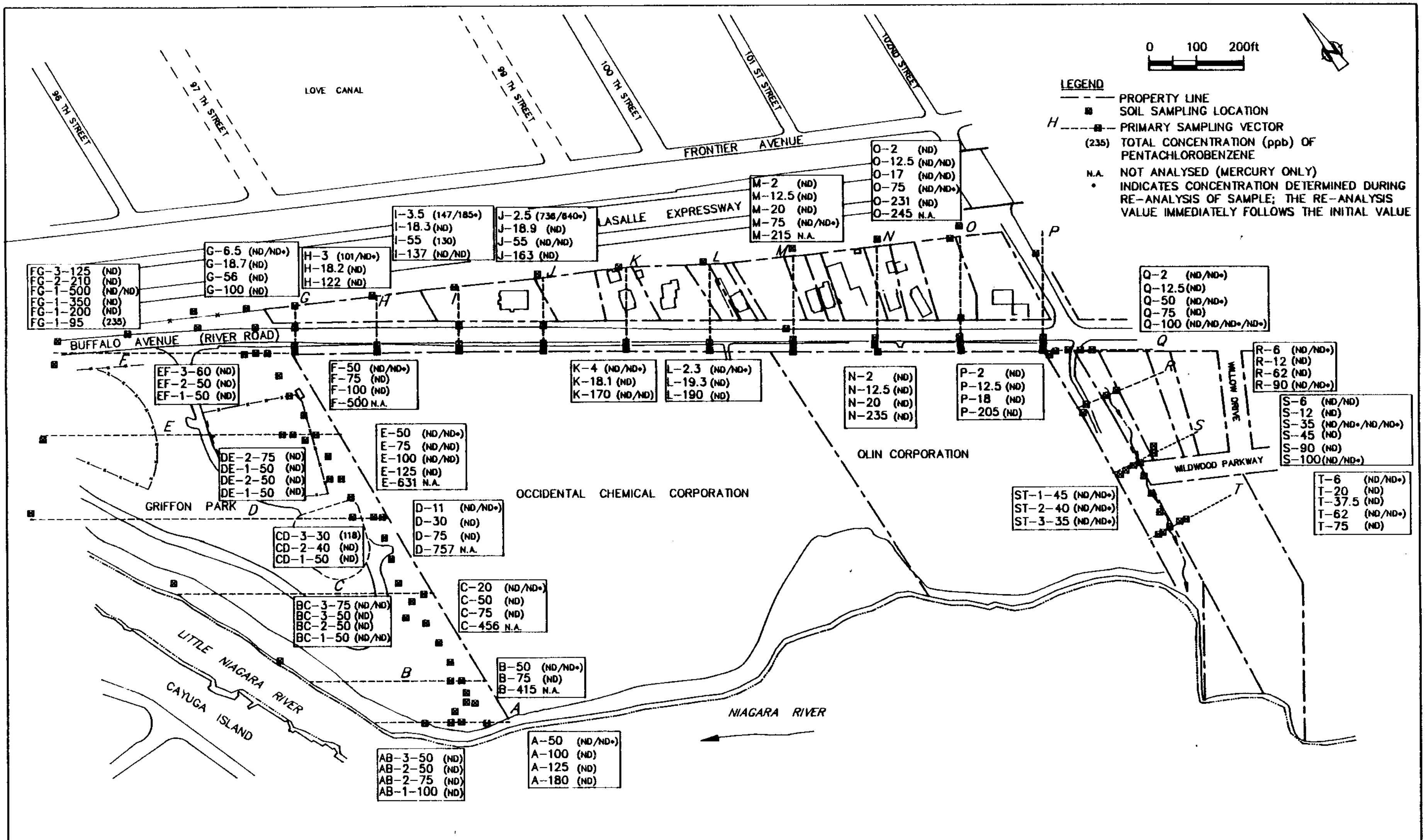


figure 7.11

OFF-SITE SOIL SAMPLING RESULTS – PENTACHLOROBENZENE
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (P-105)

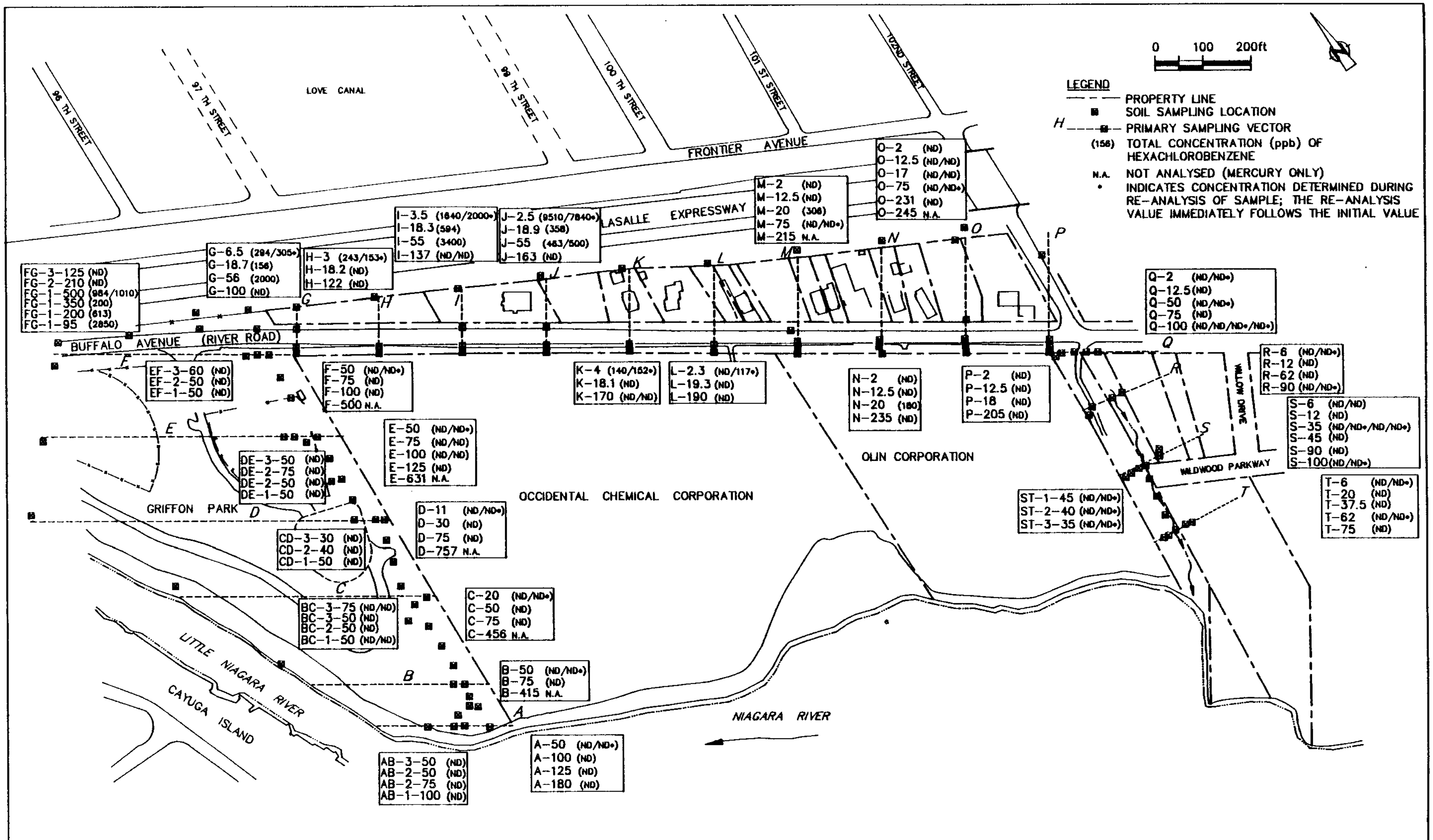


figure 7.12

OFF-SITE SOIL SAMPLING RESULTS – HEXACHLOROBENZENE
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P-106)

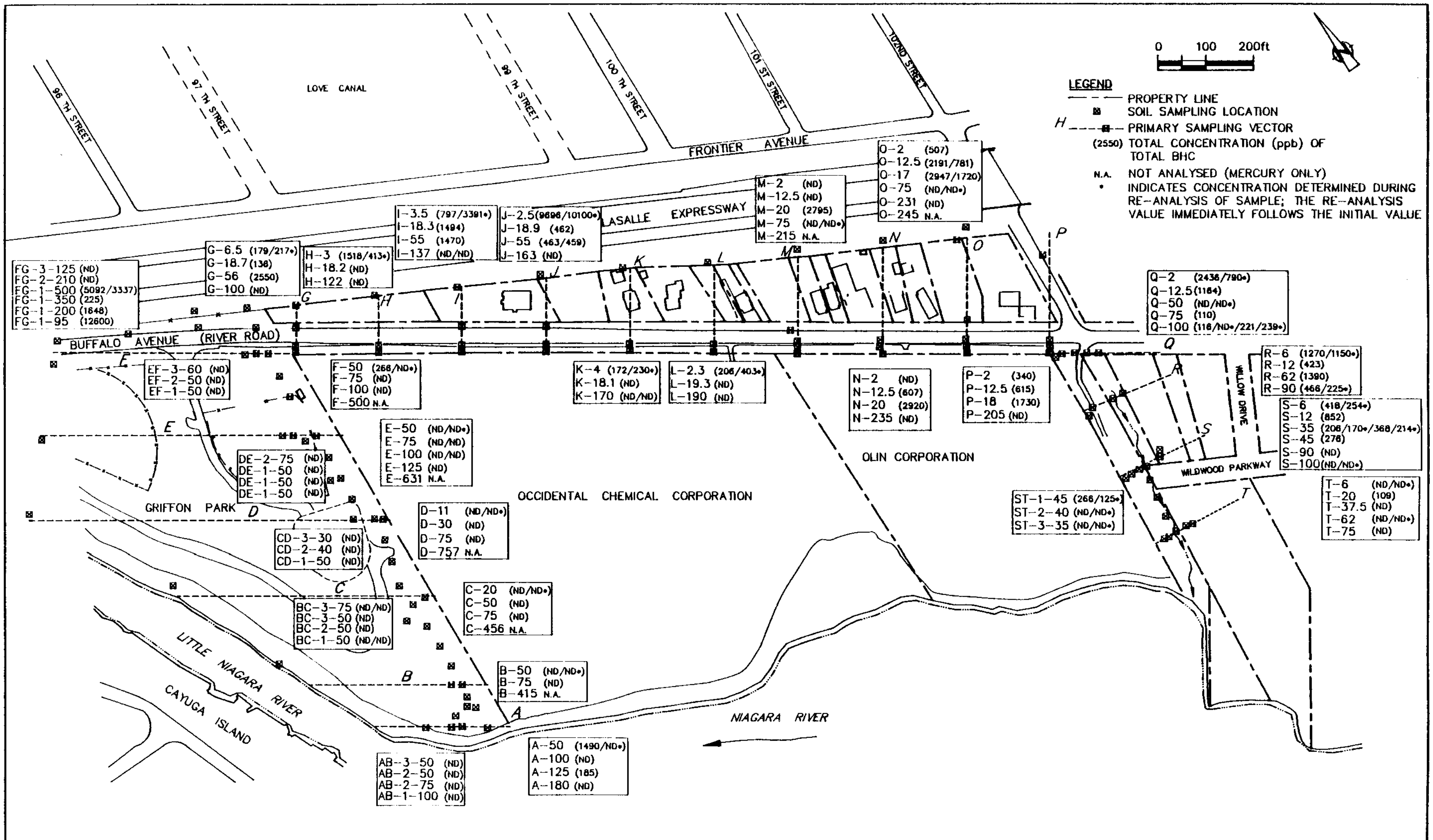


figure 7.13

OFF – SITE SOIL SAMPLING RESULTS – TOTAL HCCH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P108)

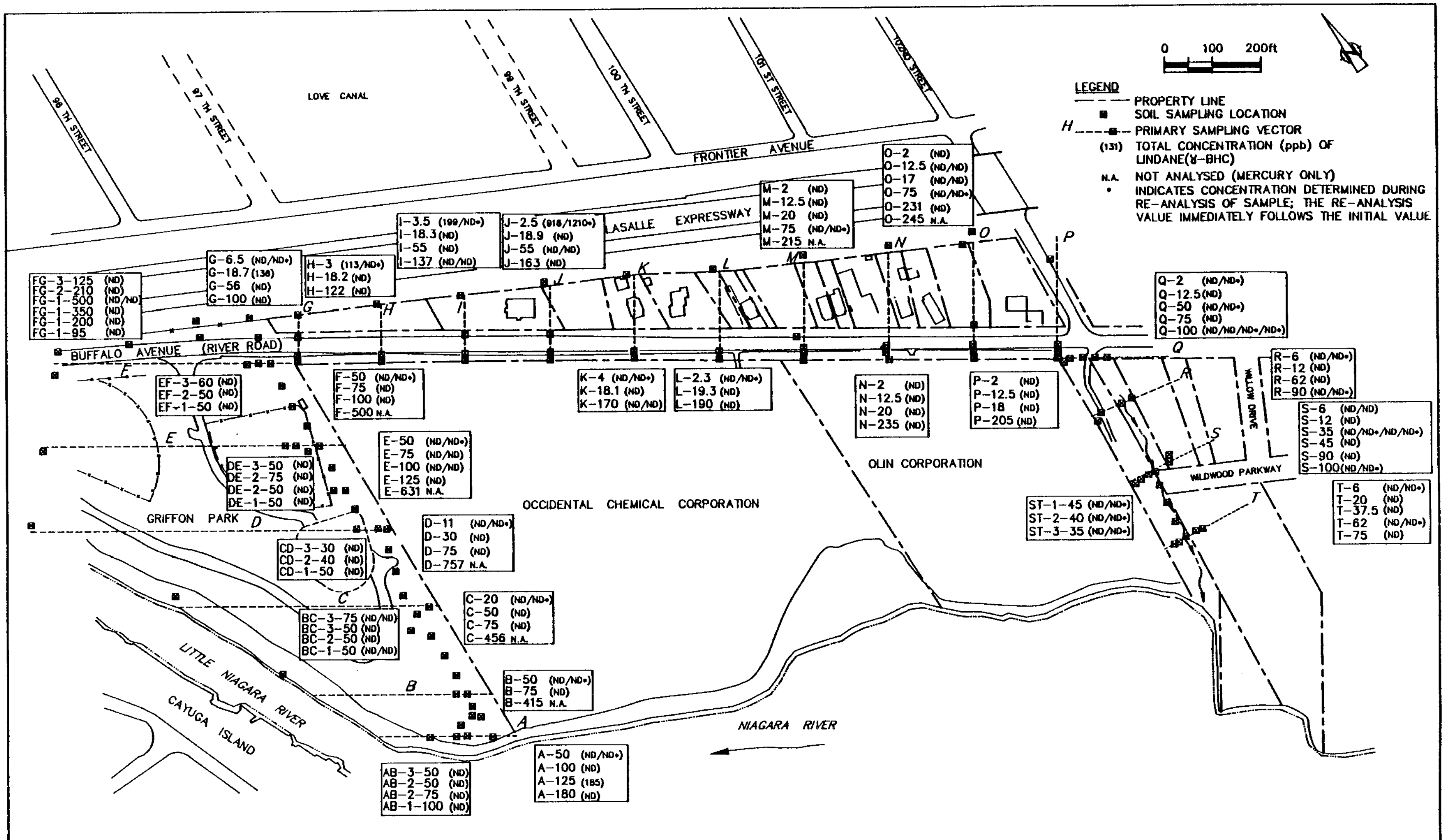


figure 7.14

OFF-SITE SOIL SAMPLING RESULTS – GAMMA-HCCH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-1 (P107)

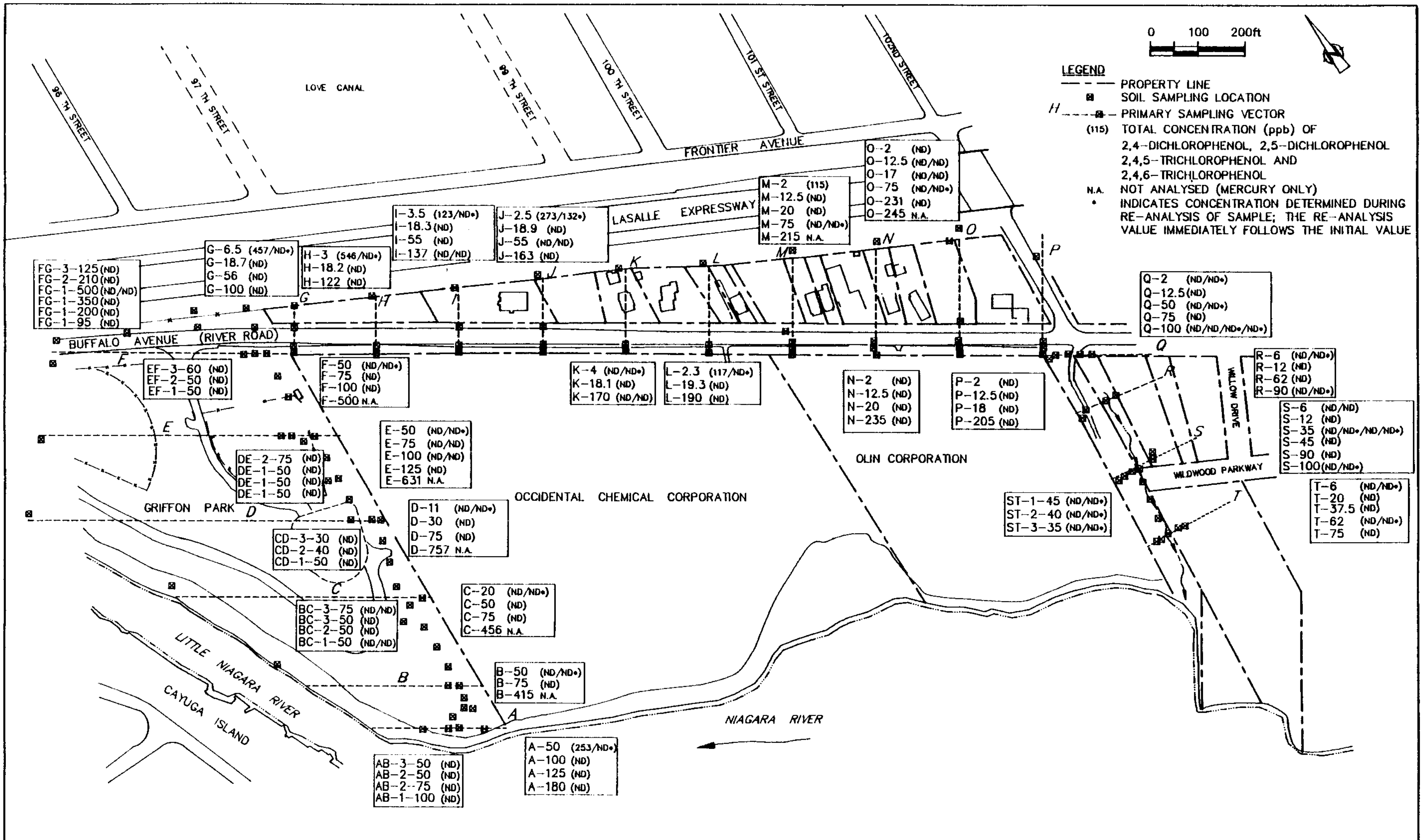


figure 7.15

OFF-SITE SOIL SAMPLING RESULTS – CHLOROPHENOLS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D- (P109)

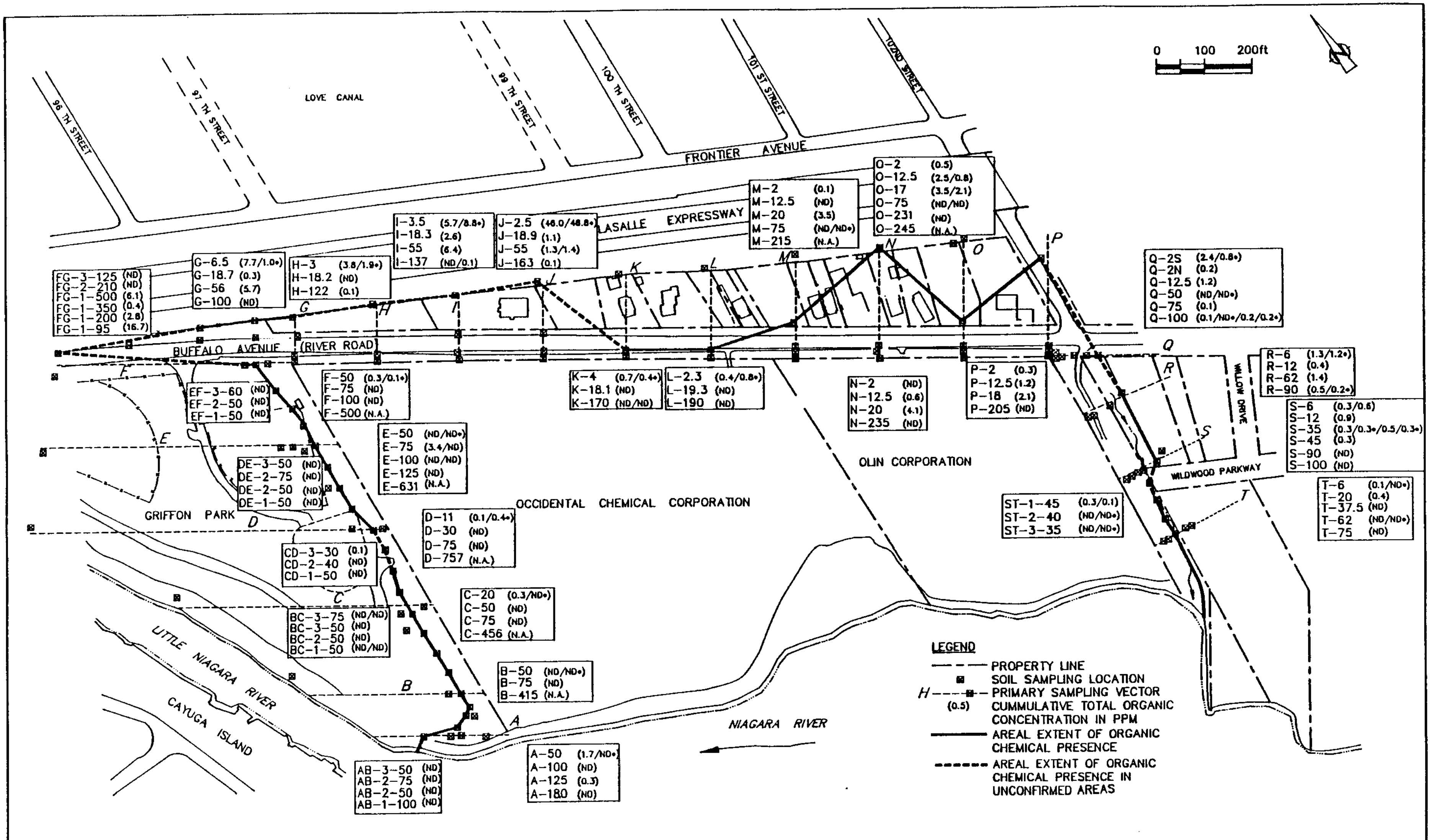


figure 7.16

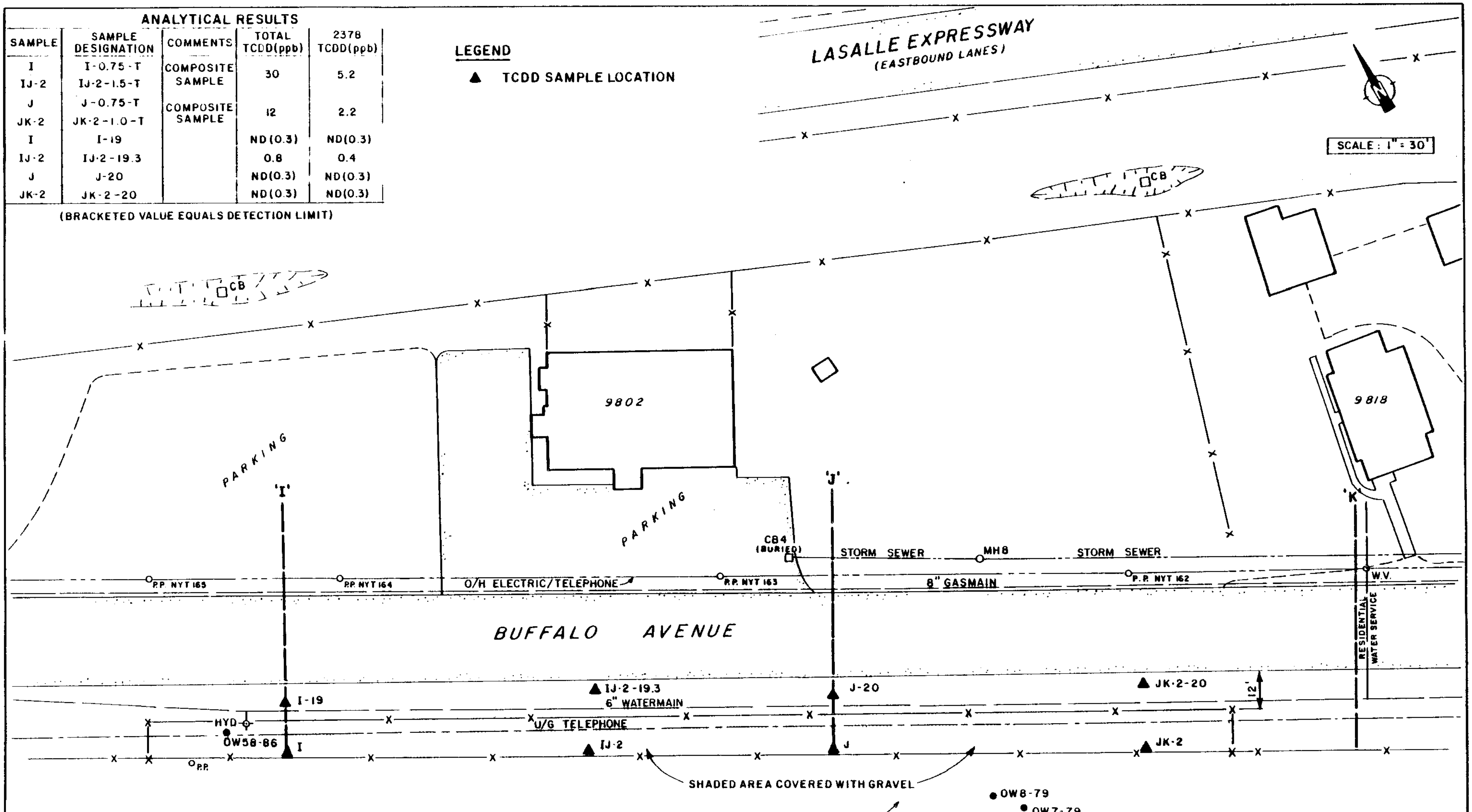
AREAL EXTENT OF ORGANIC SSI PRESENCE
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (P-110)

ANALYTICAL RESULTS

SAMPLE	SAMPLE DESIGNATION	COMMENTS	TOTAL TCDD(ppb)	2378 TCDD(ppb)
I	I-0.75-T	COMPOSITE SAMPLE	30	5.2
IJ-2	IJ-2-1.5-T			
J	J-0.75-T	COMPOSITE SAMPLE	12	2.2
JK-2	JK-2-1.0-T			
I	I-19		ND(0.3)	ND(0.3)
IJ-2	IJ-2-19.3		0.8	0.4
J	J-20		ND(0.3)	ND(0.3)
JK-2	JK-2-20		ND(0.3)	ND(0.3)

(BRACKETED VALUE EQUALS DETECTION LIMIT)



NOTE:
LOCATION OF UTILITIES IS APPROXIMATE, FIELD VERIFICATION REQUIRED FOR ACCURACY

figure 7.17
LOCATION OF DIOXIN SAMPLING POINTS
I, IJ-2, J, JK-2
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-

TABLE 7.1

SITE-SPECIFIC INDICATORS
SOIL MATRIX
102ND STREET LANDFILL

Parameter	Survey Level (µg/kg)
2-Monochlorotoluene	100
4-Monochlorotoluene	100
1,2-Dichlorobenzene	100
1,4-Dichlorobenzene	100
1,2,3-Trichlorobenzene	100
1,2,4-Trichlorobenzene	100
1,2,3,4-Tetrachlorobenzene	100
1,2,4,5-Tetrachlorobenzene	100
Pentachlorobenzene	100
Hexachlorobenzene	100
Alpha-HCCH	100
Beta-HCCH	100
Gamma-HCCH	100
Delta-HCCH	100
2,4-Dichlorophenol	100
2,5-Dichlorophenol	100
2,4,5-Trichlorophenol	100
2,4,6-Trichlorophenol	100
Mercury	100

Note:

HCCH = Hexachlorocyclohexane

8.0 NIAGARA RIVER SEDIMENT SURVEY

Prior investigations of the Niagara River sediments adjacent to the Site indicated the presence of mercury and chlorinated organic chemicals (26). The current RI sediment program was undertaken to refine conditions in the Site area reported in these previous studies.

8.1 PURPOSE

The Niagara River Sediment Sampling and Analysis Program was conducted in order to delineate the extent of chemicals in sediments off-shore from the Site. The purposes of this program were:

- to supplement existing data; and
- to provide greater detail in describing the lateral and vertical extent of chemicals associated with the Site in the River sediment.

The field programs and resultant data collected were reported previously (3).

8.1.1 SITE-SPECIFIC INDICATOR LIST

A list of SSI was developed for sediment matrix. This list of SSI was developed from the results of the comprehensive waste well survey (9). Sediment samples collected during this program were analyzed for all or part of the SSI list. In addition, laboratory analysis included percent water content. The SSI list for sediment with the respective survey levels for individual compounds is presented (Table 8.1).

8.1.2 GEOGRAPHIC LIMITS

The geographic limits of the study area were the Site property boundaries and the 5-foot water depth off-shore. Within those limits samples were taken and analyzed as described below to define the extent of chemical migration from the Site. Other initial geographic limits were represented by extensions of the Site property boundaries.

8.2 SAMPLING PROGRAM

Details of the methodology for collection of sediment samples from the Niagara River have been presented (3).

Nine primary sampling vectors were established, extending outward from the Site shoreline. The eastern and western-most vectors meet the shoreline at the east and west property lines. These primary sampling vectors, designated A through I (Figure 8.1), are oriented perpendicular to and spaced at 178-foot intervals along a line extending from a point 50 feet off-shore along the western Site property boundary in a straight line eastward to a point 50 feet off-shore along the eastern Site property boundary. A tenth primary vector, J, was added during the program to confirm the western extent of chemicals in the sediment.

On most primary vectors, sediment sampling was conducted beginning at the vector orientation line and proceeding outward from shore along the primary vectors. Sampling continued outward in an iterative manner until the SSI were not detected at or above their survey levels. Each primary station consisted of five sampling points -- one central point and four locations ten feet from the central point along the four main compass directions. These five samples were composited into one sample in the field and homogenized in the laboratory for chemical analysis.

Once the limit of SSI had been established along primary vectors, a series of confirmation vectors were established between the primary vectors. Three confirmation vectors spaced equidistant at approximately 44-foot intervals were established between each adjacent pair of primary vectors. Sediment samples were initially collected at stations on the confirmation vectors located approximately at the limit of SSI presence established along the primary vectors. The initial confirmation vector samples collected between two adjacent primary vectors were composited into a single sample in the laboratory and analyzed. In a few instances, the presence of SSI in these composite samples necessitated collection and analysis of individual samples further out along the confirmation vectors.

8.3 DATA PRESENTATION

Figure 8.1 shows the locations of all Niagara River sediment survey program field sampling stations. All field sample stations depicted in Figure 8.1 were surveyed for Site location coordinates and sediment surface elevation at the time of collection (3).

Samples from the 0 to 6-inch depth interval were collected at all field sample stations. However, in order to fulfill the requirement of the Work Plan that 25 percent of the primary vector locations be sampled to a depth of 5 feet, vibrating core samples also were collected at 12 locations selected by EPA/State representatives. These deep sample locations are depicted on Figure 8.2.

In addition to nearshore sample locations, five sampling stations were located further out in the Niagara River at the 5-foot water depth in order to help provide background information. These locations are A-457, C-452, E-528, G-427, and I-405 (Figure 8.1).

The presence of SSI above survey levels along the I-vector necessitated additional sampling to the west. Therefore, a tenth primary vector, designated the J-vector, was added west of the I-vector. Appropriate confirmation vectors were added between the I and J-vectors (Figure 8.1).

8.3.1 ANALYTICAL DATA

Sediment samples were analyzed for the 19 selected SSI (see Table 8.1). These included mercury, isomers of HCCH, and several chlorinated derivatives of toluene, benzene, and phenol. The quality assurance plan for the sediment program is provided in (9, 22).

Detailed analytical results from the Niagara River sediment program are presented in Appendix C. It is important to note that all analytical data reported for the Niagara River sediment survey program are based on dry weight.

8.3.2 BACKGROUND AND UPSTREAM CHEMICAL DATA

No SSI above the survey levels were detected in the sediment samples from the five locations (A-457, C-452, E-528, G-427 and I-405) used to provide information on background chemical concentrations. The data are included in Appendix C.

Several historical studies of Niagara River sediment provide information relevant to upstream chemical concentrations. The available data indicate that some SSI are found in Niagara River sediments as far upstream of the Site as the Buffalo city limits. Summaries of the relevant historical studies are available (26). Figures showing sample location and analytical results are included in Appendix E.

As reported in the October 1984 Report of the Niagara River Toxics Committee, the historical data for River sediment concentration levels were taken from a number of independent studies. These vary not only in geographical coverage, sample site selection criteria, and the chemicals analyzed, but also in their purpose. Some of the studies were designed to determine the chemical content of sediments in areas most likely to have high chemical concentrations, while others investigated sediment quality in depositional areas in order to assess chemical presence caused by sediment which has migrated from contaminated areas and resettled in shallow embayment areas of the River. While the Report of the Niagara River Toxics Committee identifies major industrial pollutant sources along the River, the Report does not correlate, nor do we do so here, areas of high sediment concentration levels with suspected chemical discharges/sources. Any such correlation would be complicated by sediment redistribution resulting from channel dredging and natural sediment scour caused by the River current. Thus, the historical data summarized here do not necessarily represent ambient, or "background", concentration levels occurring throughout River sediments, but rather provide a comparison of relative degrees of sediment chemical presence for a number of upstream areas.

The reported data represent analytical results from both surface "grab" samples and subsurface sediment cores. The reported data suggest that significant levels of certain SSI are present in sediments upstream of the Site. Table 8.2 presents the relevant chemicals and their observed concentration ranges from the above studies.

8.4 DATA ANALYSIS AND INTERPRETATION

8.4.1 OFF-SHORE BATHYMETRY

Figure 8.3 shows a map of off-shore bathymetry. Moving outward from the shoreline, the sediment surface declines at a mild one percent grade. This results in water depths of 5 feet or less at a distance of over 400 feet from shore. Bathymetric contours approximately parallel the shoreline with no apparent irregular mounds or basins. The presence of the Little Niagara River channel is evident in the extreme western part of the survey area.

8.4.2 HORIZONTAL EXTENT OF SSI IN NIAGARA RIVER SEDIMENTS

The horizontal extent of SSI in Niagara River sediments can be assessed from the data given in Appendix C. For evaluation and discussion, the SSI have been grouped into the following categories by chemical class:

Mercury
Total Organic SSI
Monochlorotoluenes (MCT)
Dichlorobenzenes (DCB)
Trichlorobenzenes (TCB)
Tetrachlorobenzenes (TECB)
Pentachlorobenzene (P5CB)
Hexachlorobenzene (HCB)
Total-HCCH
Gamma-HCCH
Chlorophenols

Most sampling locations at which organic SSI were detected above the survey level have low level concentrations (0.100 to 0.400 mg/kg). Within the areas defined by these sampling locations are subareas with elevated concentrations (>0.400 mg/kg).

- **Mercury** - The data indicate mercury is widespread in the Study Area at concentrations ranging from 0.1 to 1 mg/kg. The horizontal distribution of mercury is presented (Figure 8.4). Historical upstream sediment data indicate upstream mercury levels ranging from ND to 1.4 mg/kg (Table 8.2). Recognizing this fact, the survey level of 0.200 mg/kg was agreed to by the EPA/State.

Mercury above the survey level was found at locations further offshore than all the other SSI except along the C and D -vectors (C-240 and D -253) . Except for one isolated area (IJ35-45), detections of mercury at 1 mg/kg or greater are near or adjacent to the Olin property shoreline. The most elevated levels of mercury were present along the A, B, C, and D-vectors. Mercury was detected on the B and C-vectors within 150-250 feet from the shore at concentrations ranging from 1 to 200 mg/kg. The highest mercury level detected was at 75 feet from shore along the C-vector. This location is adjacent to the storm sewer outfall. Mercury levels of 10 mg/kg or greater coincide with the storm sewer outfall and the location of the formerly existing spit. Table 8.3 lists the distances on the primary vectors from the shore to the apparent "clean line" for mercury and the organic parameters in the sediment.

Mercury concentrations slightly above the survey level were found along the sub-vectors between primary vectors D and E, i.e. DE1-250, 0.424 mg/kg; DE2-250, 0.274 mg/kg; and DE3-225, 0.515 mg/kg. However, analysis of the sample at location DE1-275 did not indicate mercury above the survey level. Due to the :

i) reduction of mercury concentrations from 0.424 mg/kg to less than 0.200 µg/kg within 25 feet along sub-vector DE1, and
ii) similar concentrations at the three sampling locations where mercury was found above the survey level at basically equivalent distance from the River's edge, it was deemed appropriate, with the agreement of the EPA/State, to locate the line at which mercury concentrations did not exceed the survey level between primary vectors D and E at 275 feet from the River's edge.

- **Total Organic SSI** - Total organic SSI represent the summation of all SSI detected at or above the 0.100 mg/kg survey level. Figure 8.5 depicts the horizontal distribution of SSI in sediment adjacent to the Site. As can be seen from Figure 8.5, SSI were detected above the survey level at only 16 out of 86 sample locations. Of these, one (A-465) has been identified as anomalous. Further discussion is presented under the sub-title HCCH in this section. At two other locations (C-128 and D-253), averaging of the analytical results including duplicate/reanalysis produces concentrations below the survey level. Of the remaining 13 sample locations, 12 are within 27 to 160 feet from the shoreline along 7 of the 10 primary vectors. Only 1 location (C-240 at .147 mg/kg) has SSI concentrations beyond 160 feet from the shoreline.

Two separate small areas are exceptions to this as they contain SSI at concentrations greater than 200 mg/kg. One zone of SSI at elevated concentrations, extending from east of the H-vector to west of the I-vector and outward to at least 35 feet from shore, contains SSI (Figure 8.5). This zone does not appear to extend significantly east or west beyond the H or I-vectors.

A second zone of SSI at elevated concentrations occurs on the C-vector and extends outward to at least 75 feet (Figure 8.5). This zone is apparently associated with the storm sewer outfall. A formerly existing spit constructed of Fill materials also was located in this area and may contribute to the presence of chemicals. SSI at this location are limited in extent, declining riverward to below survey levels. An area of elevated concentrations which may also be associated with the storm sewer occurs on the D-vector (D-92, D-149).

The frequencies of detected SSI are depicted in Figure 8.6. As is expected, the locations of the highest number of SSI detections corresponds to the locations described above with the greatest total SSI concentrations.

- **Monochlorotoluenes (MCT)** - MCT is the summation of the two isomers of monochlorotoluene on the SSI list. MCT was detected above the survey level at only two locations. Figure 8.7 shows the horizontal distribution of MCT. Therefore, it was not widely distributed.

  MCT is observed at elevated levels at only one location. At 75 feet from shore on the C-vector, MCT is observed at up to 3.0 mg/kg, but rapidly diminishes to below survey levels westward, eastward, and riverward (Figure 8.7). This area is adjacent to the storm sewer outfall and coincides with the location of the formerly existing spit.

MCT is also observed at low levels at one station along the A-vector, 0.150 mg/kg at 46 feet from shore.

- **Dichlorobenzenes (DCB)** - DCB is the summation of the two DCB isomers on the SSI list. The data indicate that DCB is present only adjacent to the Olin property, and is widely distributed in this area at low levels. There is only one sample in which DCB is found at levels above 0.4 mg/kg. The horizontal distribution of DCB is presented (Figure 8.8). Historical data from upstream sediment samples indicate that DCB was detected in 6 of 16 samples (counting individual isomer-specific analyses from the same sample as the one "sample"), with a maximum detected value of 4.0 mg/kg (Table 8.2).

  DCB is 14.4 mg/kg at 75 feet from shore along the C-vector (C-75), diminishing to below survey levels at C-144. DCB levels diminish to below survey levels westward and eastward.

  DCB occurs at low levels (less than 0.2 mg/kg) at three separate isolated locations on the B, C and D-vectors (Figure 8.8). These are B-153, C-240, D-253. The observed concentration of DCB at these locations is within the range of upstream levels (Table 8.2). On the D-vector, all samples outward from D-149 were ND, with the exception of 0.154 mg/kg at D-253. On the C-vector, all samples outward from C-141 were ND, with the exception of 0.147 mg/kg at C-240. Because the two low-level measurements at D-253 and C-240 were surrounded, both shoreward and riverward, by samples with no detections for any SSI (Figure 8.6), the presence of DCB at low levels at these locations is concluded to be not site-related.

- **Trichlorobenzenes (TCB)** - TCB is the summation of the two trichlorobenzene isomers on the SSI list. The horizontal distribution of TCB is given on Figure 8.9. The data indicate that TCB is not widely distributed, and that elevated concentrations (greater than 0.4 mg/kg) occur in only one area.

Historical data from upstream sediments indicate that TCB was detected in 3 of 16 samples, with a maximum detected value of 1.1 mg/kg (Table 8.2).

Elevated levels of TCB are observed at 75 feet from shore on the C-vector. TCB concentration at this location was 314 mg/kg. This location is adjacent to the storm sewer outfall and coincides with the formerly existing spit. No other nearby locations showed evidence of TCB at elevated levels.

The data indicate TCB is also present at two separate isolated locations at low levels (Figure 8.9). At 153 feet from shore on the B-vector, TCB was detected at 0.128 mg/kg. At 27 feet from shore on the I-vector, TCB was 0.358 mg/kg. The observed concentrations of TCB at these locations are within the range of upstream sediments. However, the detection of TCB on the B and I vectors is likely Site related because of the presence of other SSI at the same location.

- **Tetrachlorobenzenes (TECB)** - TECB is the summation of both TECB isomers on the SSI list. These compounds are present in sediments at elevated levels greater than 0.4 mg/kg in only one area. At three other isolated areas, TECB was detected at low levels (up to 0.2 mg/kg). Figure 8.10 shows the horizontal distribution of TECB.

  TECB was detected at a concentration of 607 mg/kg at 75 feet from shore on the C-vector. This area is adjacent to the storm sewer outfall and coincides with the location of the formerly existing spit.

  At 27 feet from shore on the I-vector, 35 feet from the shore on the H vector and 46 feet from shore on the A-vector, TECB concentrations were 0.196, 0.125/ND and 0.108 mg/kg, respectively. At 129 feet from shore on the E-vector, TECB was 0.799 mg/kg. Subsequent reanalysis of the A-46 and E-129 samples did not detect TECB above the survey level. These are isolated occurrences (Figure 8.10). There are no historical data regarding upstream levels of TECB.

- **Pentachlorobenzene (P5CB)** - P5CB was detected above survey levels at two locations. It was detected at 147 mg/kg at least 75 feet from shore on the C-vector. P5CB was also detected at 0.176 mg/kg at 92 feet from shore on the D-vector. This detection may be a false positive as subsequent reanalysis and resampling indicated no detections above survey levels. The area where P5CB was detected (Figure 8.11) is adjacent to the storm sewer outfall and coincides with the location of the formerly existing spit. There are no historical data regarding upstream levels of P5CB.

- **Hexachlorobenzene (HCB)** - The horizontal distribution of HCB is shown on Figure 8.12. HCB is neither widespread in sediments nor, with the exception of one area, at elevated concentrations above 0.2 mg/kg .

  One area along the C-vector and extending at least 75 feet from shore shows concentration of 10 mg/kg (Figure 8.12). This area is directly adjacent to the storm sewer outfall and also coincides with the formerly existing spit.

  Three areas near to shore on the D-vector at 92 feet, on the F-vector at 47 feet and on the I-vector at 27 feet show low level concentrations of HCB. The F and I-vector areas show up to 0.236 mg/kg of HCB and appear to be limited in extent. HCB concentration at D-92 is 0.140 mg/kg. HCB was not detected above the survey level during sample reanalysis and resampling and analysis. Historical data do not indicate significant levels of HCB in upstream sediments for comparison.

- **Total Hexachlorocyclohexanes (HCCH)** - The data indicate the HCCH at elevated levels are widely distributed in the sediments relative to most of the other SSI. Their horizontal distribution is presented on Figure 8.13.

  Historic data indicate that levels of HCCH in upstream sediments except one location, range from ND to 0.390 mg/kg depending on which HCCH isomer is considered. The one location had HCCH levels up to 3.25 mg/kg. The maximum HCCH concentrations for all other samples were several orders of magnitude lower.

  Total HCCH were detected above the survey level in isolated areas along six of the ten primary sampling vectors. Elevated levels of HCCH ranging from greater than 10 to 4295 mg/kg are observed in two separate areas adjacent to the Site. One area from east of the H-vector to west of the I-vector has HCCH present at elevated levels. HCCH are found at up to 198 mg/kg extending at least 35 feet from shore on the

H-vector (Figure 8.13). HCCH increase in concentration westward up to 4295 mg/kg at least 27 feet from shore on the I-vector (Figure 8.13). They diminish to below survey levels westward, eastward, and riverward from these locations.

A second area of elevated HCCH occurs on the C-vector at 75 feet from shore. HCCH are observed at up to 2900 mg/kg at this location, but diminish to below survey levels outward beyond this point. This area coincides with the formerly existing spit and is also adjacent to the storm sewer outfall.

Isolated occurrences of HCCH exceeding survey levels were observed extending approximately 150 feet distance from shore along the B, C and D-vectors. Concentrations ranged from 0.2 to 1.1 mg/kg. Concentrations of less than 3.25 mg/kg, lay within the ranges observed in the historical upstream data (Table 8.2) (26).

There was a single report of HCCH on the A-vector at the A-465 sample point. Because the result appeared to be anomalous an additional sample (A-457), slightly shoreward from A-465, was taken on a later sampling iteration and analyzed for HCCH. No HCCH was detected. It was concluded that, based on the non-detect analysis at location A-457, the physical location of the sampling point (in the mainstream of the River channel), and the lack of any other positive detections on the A-vector, the original result was anomalous.

- **Gamma-Hexachlorocyclohexane (g-HCCH)** - The presence of g-HCCH is not widely distributed in the sediments and its occurrence at levels above survey levels is limited to two areas. Figure 8.14 presents the horizontal distribution of g-HCCH in the sediments.

g-HCCH is present in the sediments from east of the H-vector to west of the I-vector at concentrations ranging from less than survey levels to up to 55.4 mg/kg . It has been observed at least 35 feet from shore on the H-vector at 0.843 mg/kg and at least 27 feet from shore on the I-vector at 55.4 mg/kg. It diminishes to below survey levels westward, eastward, and riverward from these locations. g-HCCH was present in historical data in upstream sediments at levels ranging from less than 0.001 to 3.25 mg/kg (26).

g-HCCH is found at 6.8 mg/kg at least 75 feet from shore on the C-vector (Figure 8.14). This coincides with the location of a formerly existing spit and is adjacent to the storm sewer outfall. There are no other detections of g-HCCH adjacent to the Olin shoreline.

- **Chlorophenols (CP)** - CP is the summation of all chlorinated phenolics on the SSI list. CP were detected above the survey level in four isolated locations, one each along the C, D, F and I vectors. This indicates that CP are not widely distributed. The horizontal distribution of CP is presented on Figure 8.14.

CP has been been observed at elevated levels at least 75 feet off-shore along the C-vector (Figure 8.15). At this location, CP was measured at 6.5 mg/kg , however the data indicate that the levels diminish rapidly westward, eastward, and riverward to below survey levels. Only one nearby detection at slightly above survey levels (D-92) is noted, and this concentration is within the range observed in upstream sediments.

CP was also observed at elevated levels at least 27 feet from shore along the I-vector (Figure 8.14). At this location, CP is observed at up to 4.3 mg/kg . CP was not detected at any other nearby locations.

An isolated low level detection of CP (0.367 mg/kg)was observed 47 feet from shore along the F-vector. This is within reasonable upstream ranges, along with other SSI along the F-vector.

8.4.3 VERTICAL EXTENT

Data are available which allow some assessment of the vertical extent of SSI. Vibrating core sediment samples were collected to a depth of approximately 4 feet at twelve locations (Figure 8.2). These data presented in Appendix C were evaluated to assess the vertical extent of SSI.

Five of twelve sample locations in the middle or B depth interval had mercury concentrations above the survey level of 0.2 mg/kg . Sample C-85B+ had the largest concentration of mercury at the middle depth interval at 0.6 mg/kg .

Mercury was detected above the survey level of 0.2 mg/kg in samples from the lower depth interval on three primary vectors (B-153C, E-35C and G- 80C). The mercury concentrations detected in these samples were greater than those in the samples at shallower intervals at the same location.

HCCH were not detected in the middle or lower depth intervals.

DCB were detected in the C-128B, C-128C, D-92B, D-92C, D-196B, I-50B and I-50C samples above survey levels. In the C-128B, D-92C, D-196B, and I-50 B and C samples, DCB was detected at higher concentrations than the shallow sediment samples. No other chlorinated benzenes were detected in the middle or lower depth intervals.

The concentrations observed in the vicinity of C-128 may be attributed to the former spit. The concentration observed in the other locations may be attributable to historical erosion which was subsequently overlain by additional sediments. All the locations at which the chemical concentrations at depth are higher than in the shallow sample are within the "clean" line shown Figure 8.16.

2,5-Dichlorophenol was detected in one lower depth sample on the D-vector (D-92C at 0.1 and 0.5 mg/kg). It was not detected in the shallower depth sample at the same location (D-92B).

8.4.4 MIGRATION PATHWAYS

The horizontal distribution patterns of the various SSI suggest possible migration pathways from the Site and into the sediment. Specifically, several sources and migration pathways are considered because of physical proximity of elevated SSI levels in the sediments. River sediment chemistry data are:

(1) consistent with historical data for the Site (26);

(2) indicate that the concentrations of 102nd Street Landfill chemicals in excess of background in river sediments are generally limited to the area within 46 to 304 feet of the River's edge (see Figures 8.16 and 8.17); and

(3) with the exceptions noted in Section 8.4.3, evidence a decrease in chemical concentrations with depth in the river sediment.

The sources and migration pathways considered are the former spit (see Figure 8.1), the storm sewer, historical surface soil/waste erosion or spillage , and groundwater.

Three nearshore areas consistently show elevated levels of SSI. These are from the shore to about 75 feet off-shore along the C-vector, from shore to about 47 feet off-shore along the F-vector, and an area extending to about 30 feet off-shore of the H and I-vectors.

The location along the C-vector had the highest levels of SSI. This location coincides with the former location of a spit (see Figure 8.1), constructed during the late 1950's and removed during the bulkhead construction project. The storm sewer outfall is also directly adjacent to the C-vector. It is well documented that groundwater infiltration from the 102nd Street Site enters this sewer, which was the outfall for infiltration and storm runoff (including sediment) from the southern section of the Love Canal area.

The RI programs have shown that groundwater flowing through the Alluvium on-site to the River contains SSI (Chapter 4, 6). Groundwater carrying chemicals and passing through a porous medium will impart some of that chemical load to the medium by means of partitioning between the liquid and solid phases. This survey sampled sediments to a depth of 5 feet and found that few SSI were present below the 0 to 6-inch depth.

The three bulkhead seeps BS-1, BS-2, and BS-3, each had elevated levels of chemicals. BS-2 and BS-3 are near, respectively, the F-vector and C-vector. BS-1 is between the G- and H-vectors. There is no consistent correlation between chemical presence in the River sediments and in the bulkhead seeps.

8.4.5 CONCLUSIONS

These conclusions can be drawn from the data gathered during this survey with regard to migration of SSI from the Site:

- Distribution of chemicals off-shore near the Site is similar to data from historical studies at the Site;

- Distribution of chemicals off-shore is very limited in extent (up to 304 feet from the River's edge); and

- Surface sources are the primary sources of chemicals observed in the River sediments; upward leakage of groundwater at most sampling locations does not appear to be a primary source of the observed river sediment chemistry where chemicals were detected in the surficial river sediments.

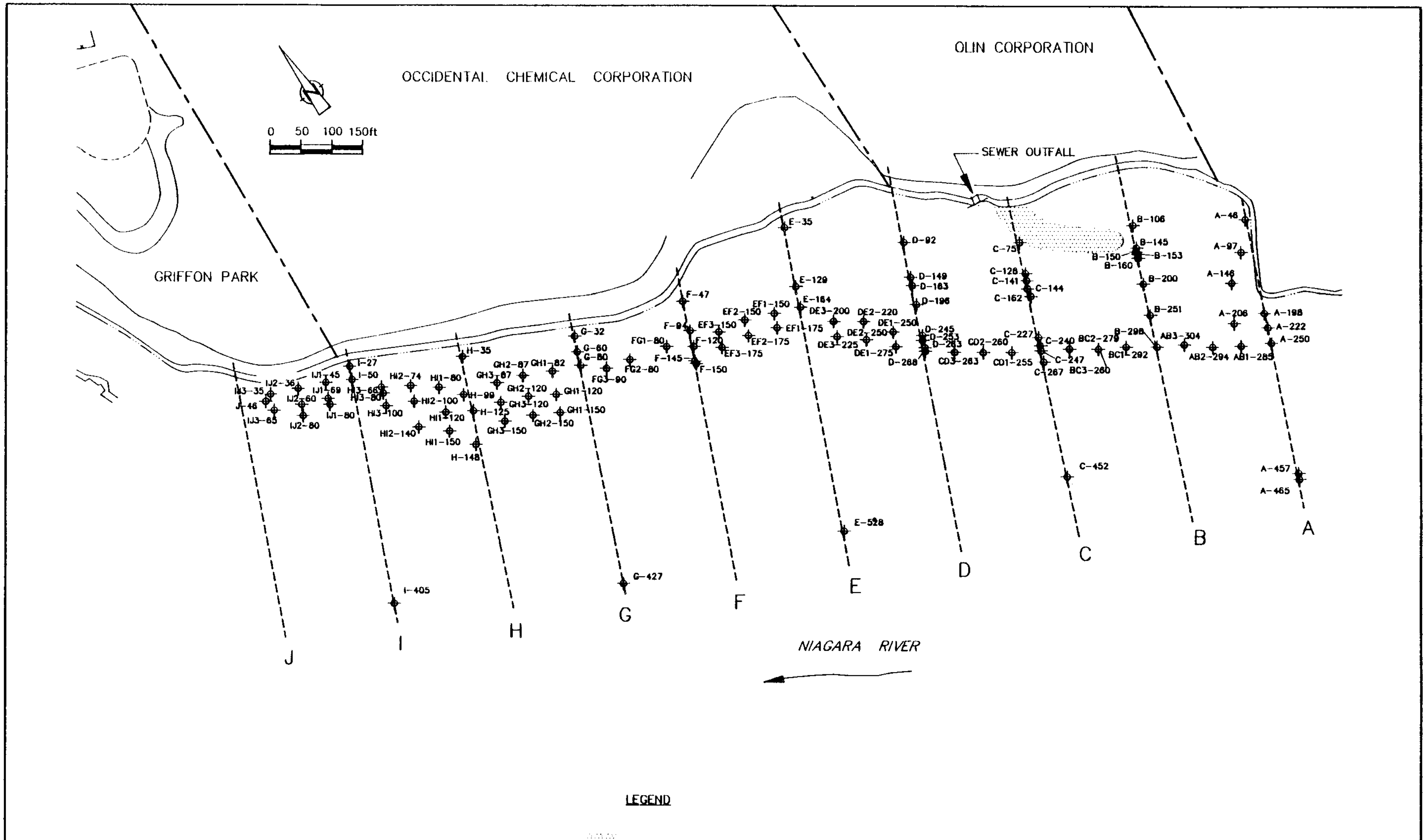


figure 8.1
SEDIMENT SAMPLE LOCATIONS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-26/09/88-47-D-1 (P122)

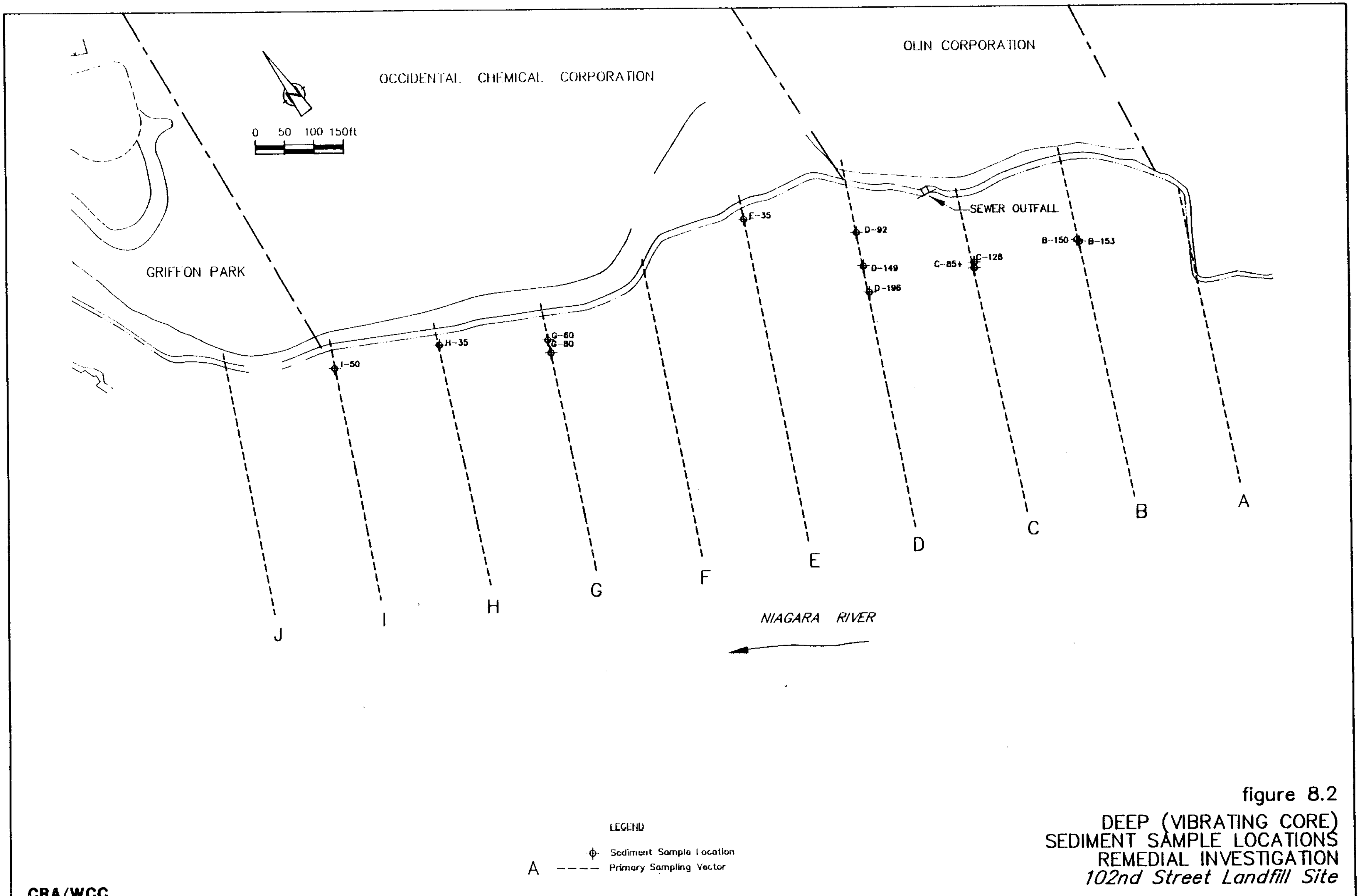


figure 8.2

DEEP (VIBRATING CORE)
SEDIMENT SAMPLE LOCATIONS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-26/09/88 43 D 1 (P122)

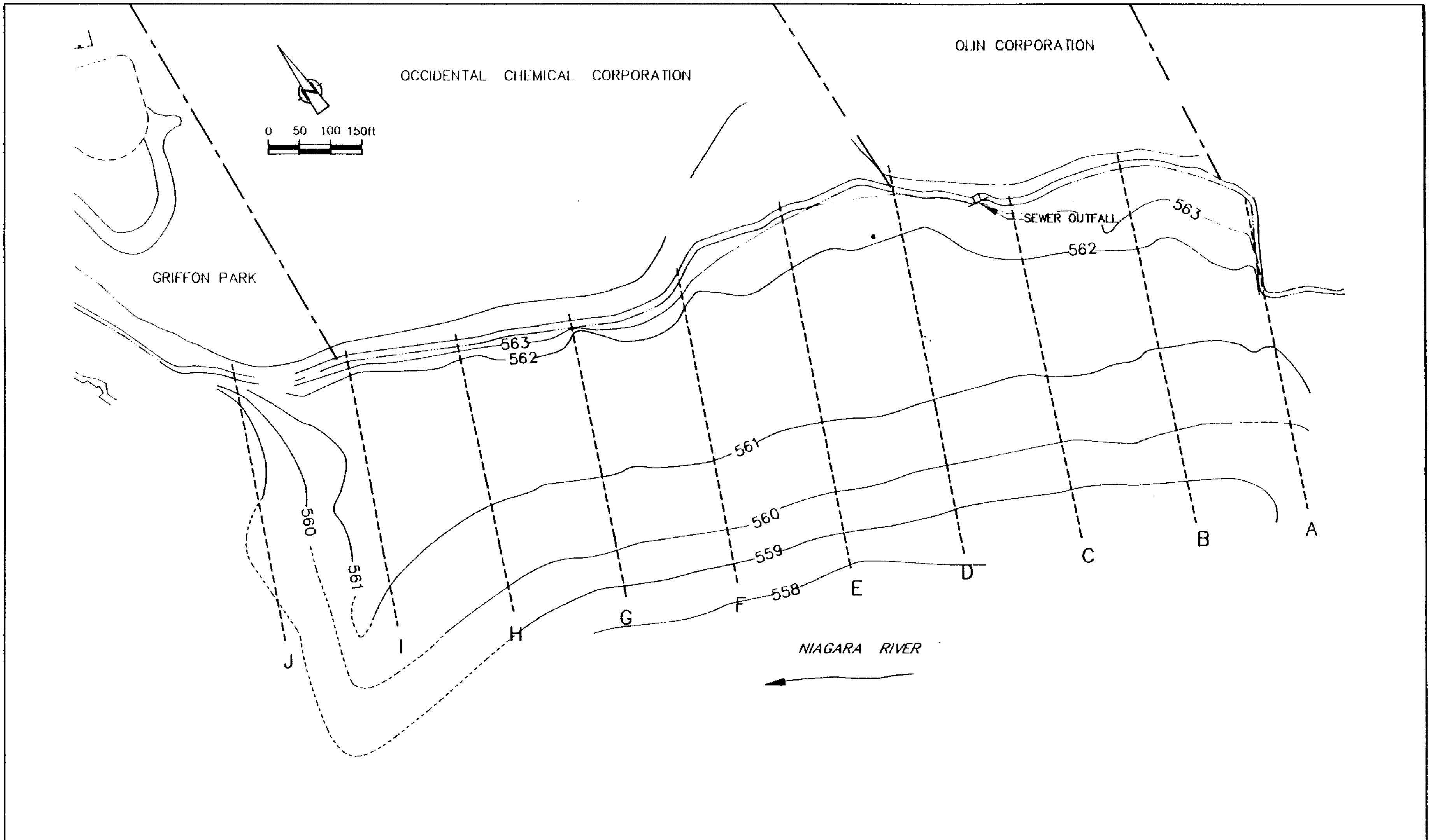
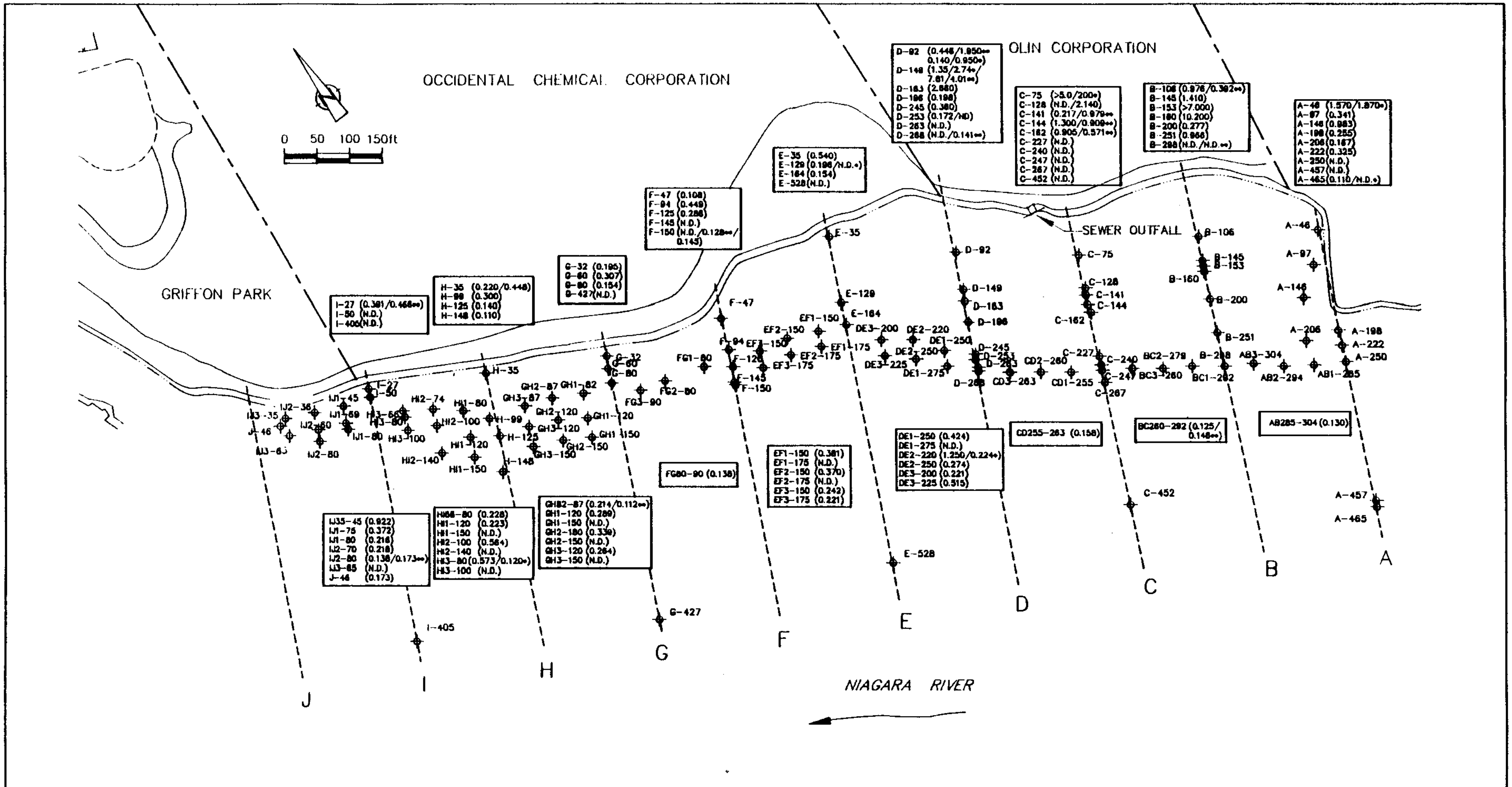


figure 8.3
OFF-SHORE BATHYMETRIC CONTOURS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-26/09/88-43-D-1 (P122)



LEGEND:

(1.0) Concentration in ppm

* Reanalysis Value

** Field Duplicate Value

N.D. Not detected above survey level

N.A. Not analyzed, Mercury analysis only

⌖ Sediment Sample Location

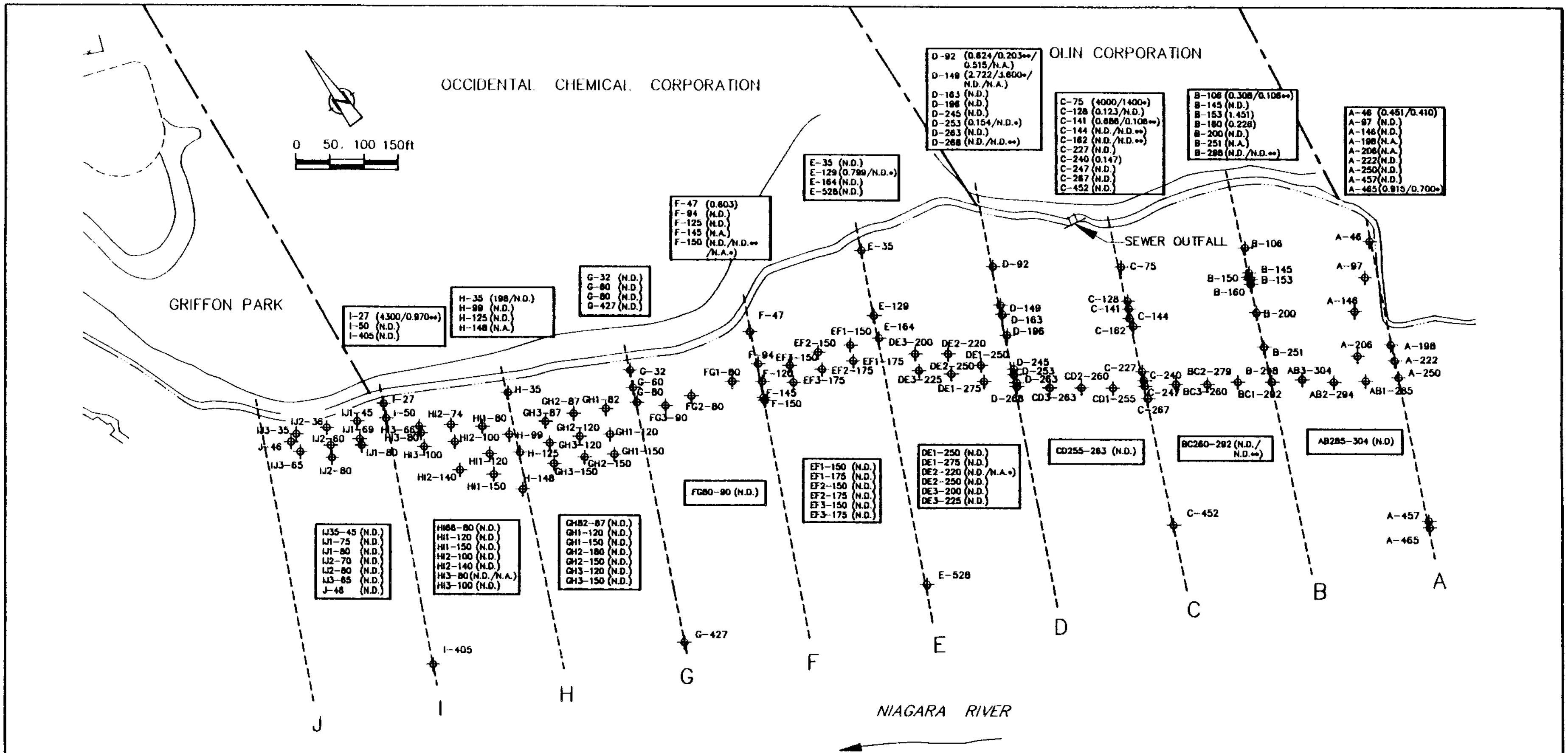
A - - - Primary Sampling Vector

figure 8.4

DISTRIBUTION OF MERCURY
0 TO 6-INCH DEPTH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-31/01/90-47-0 (P134)



LEGEND:

(0.603) Sum of Total Organic SSI concentrations in ppm

• Reanalysis Value

•• Field Duplicate Value

N.D. Not detected above survey level

N.A. Not analyzed, Mercury analysis only

⊕ Sediment Sample Location

— — — Primary Sampling Vector

figure 8.5

DISTRIBUTION OF ORGANIC SSI
0 TO 6-INCH DEPTH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1471-26/09/88-47-D-1 (P135)

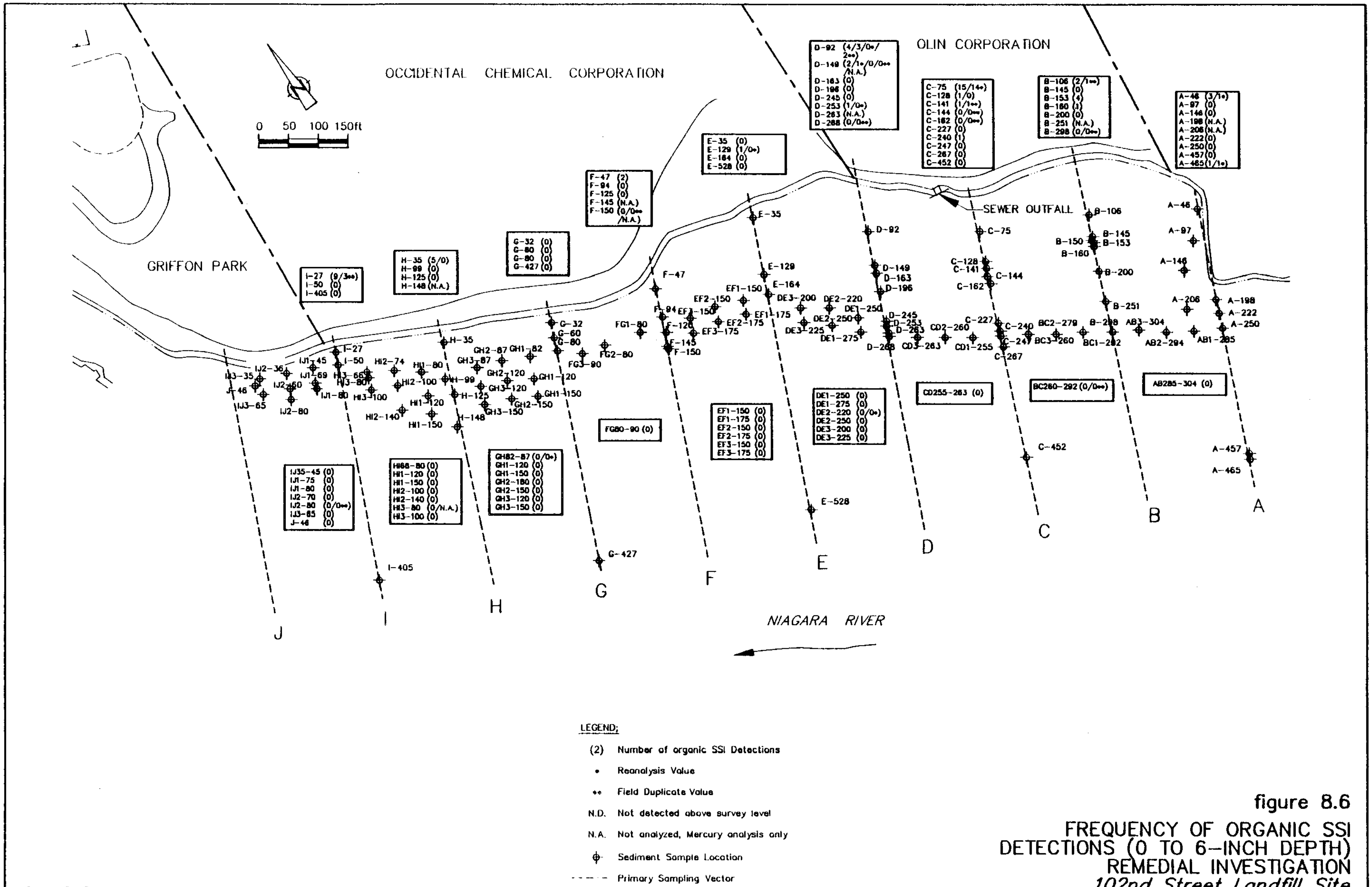
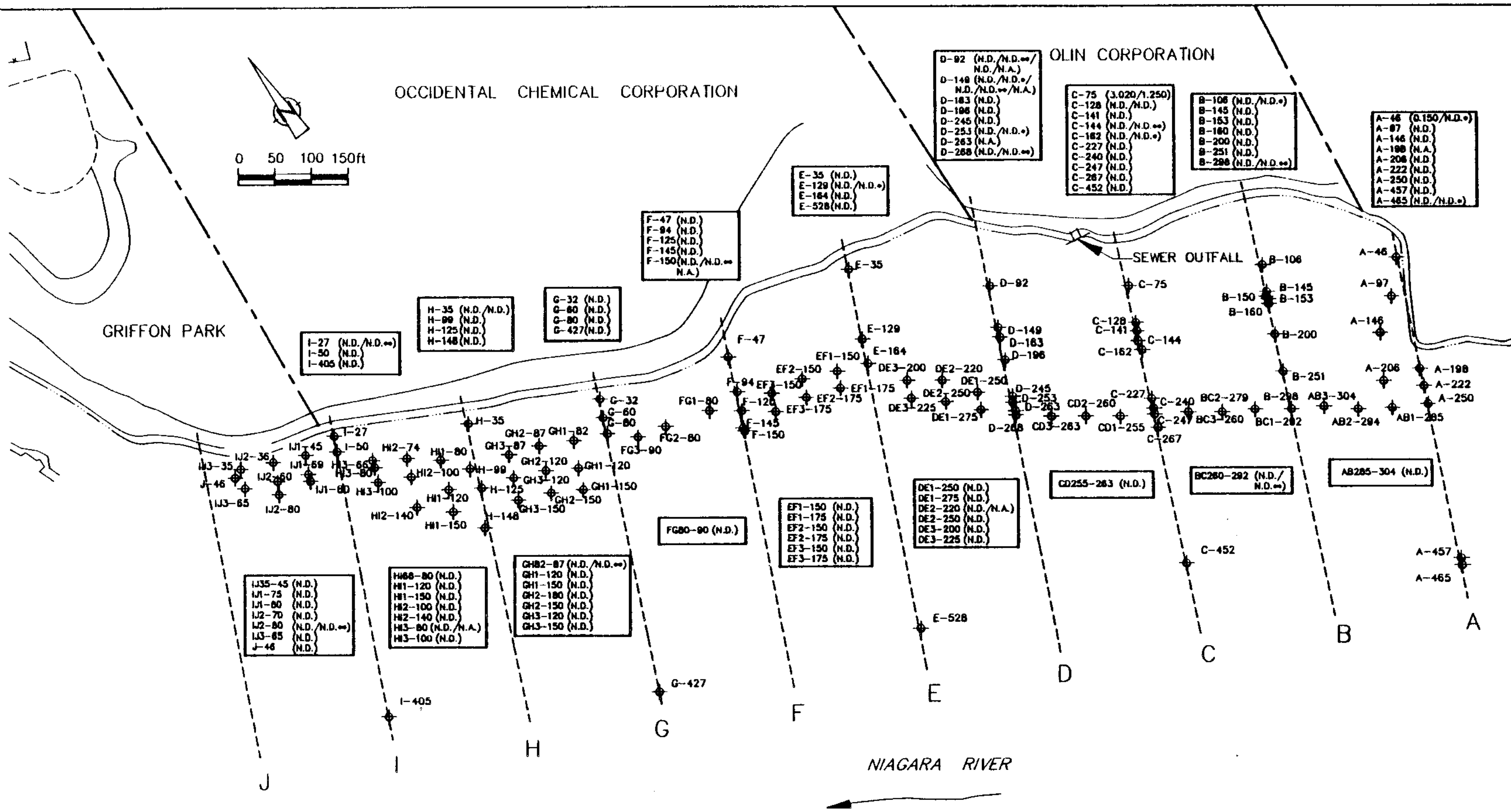


figure 8.6

FREQUENCY OF ORGANIC SSI DETECTIONS (0 TO 6-INCH DEPTH)
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1471-26/09/88-47-D-1 (P136)



LEGEND;

(1.0) Concentration in ppm

* Reanalysis Value

** Field Duplicate Value

N.D. Not detected above survey level

N.A. Not analyzed, Mercury analysis only

⊕ Sediment Sample Location

— - — Primary Sampling Vector

figure 8.7

DISTRIBUTION OF MONOCHLOROTOLUENES
0 TO 6-INCH DEPTH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1471-26/09/88-47-D-1 (P137)

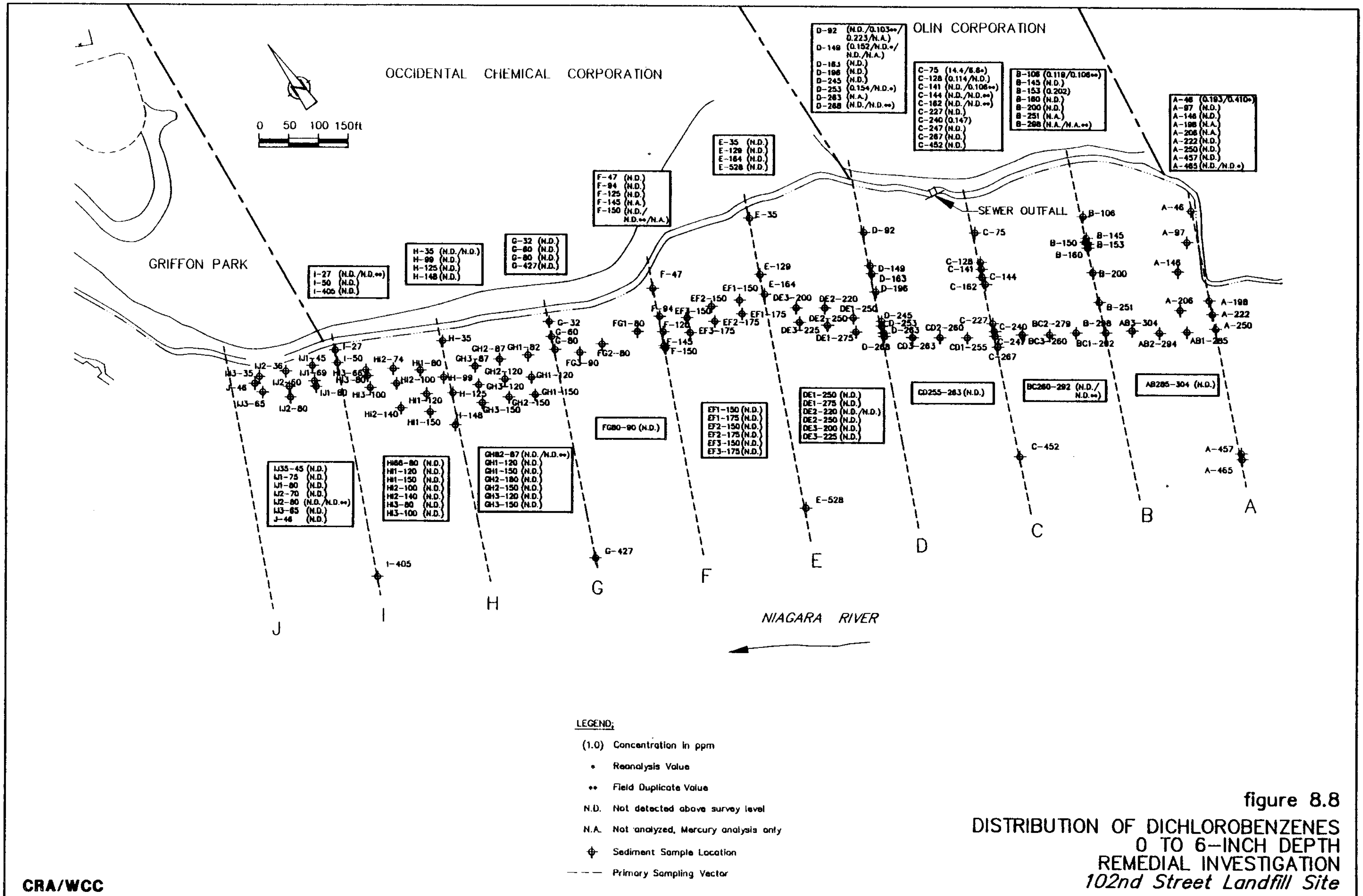
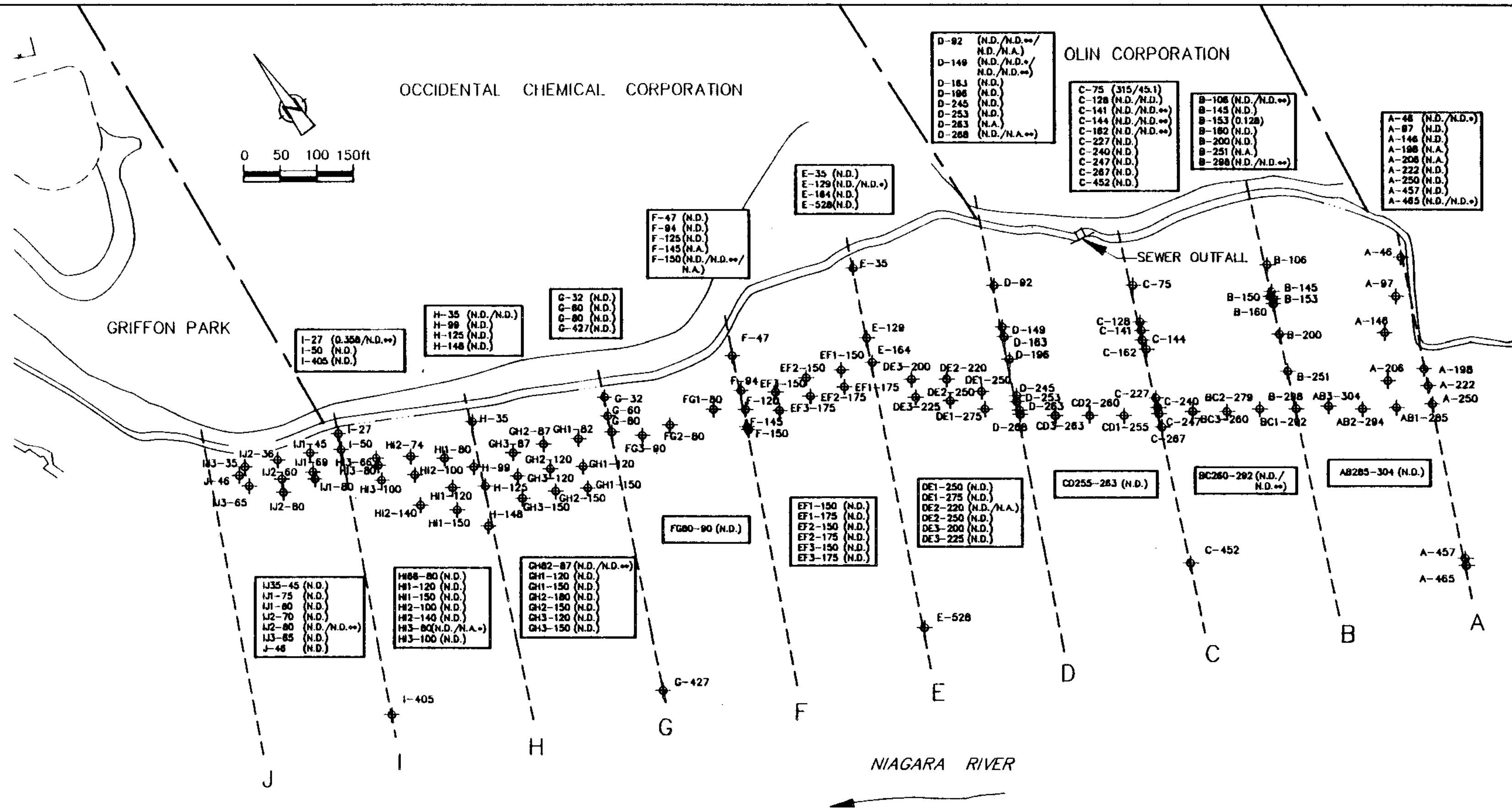


figure 8.8
DISTRIBUTION OF DICHLOROBENZENES
0 TO 6-INCH DEPTH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1471-26/09/88-47-D-1 (P13B)



LEGEND:

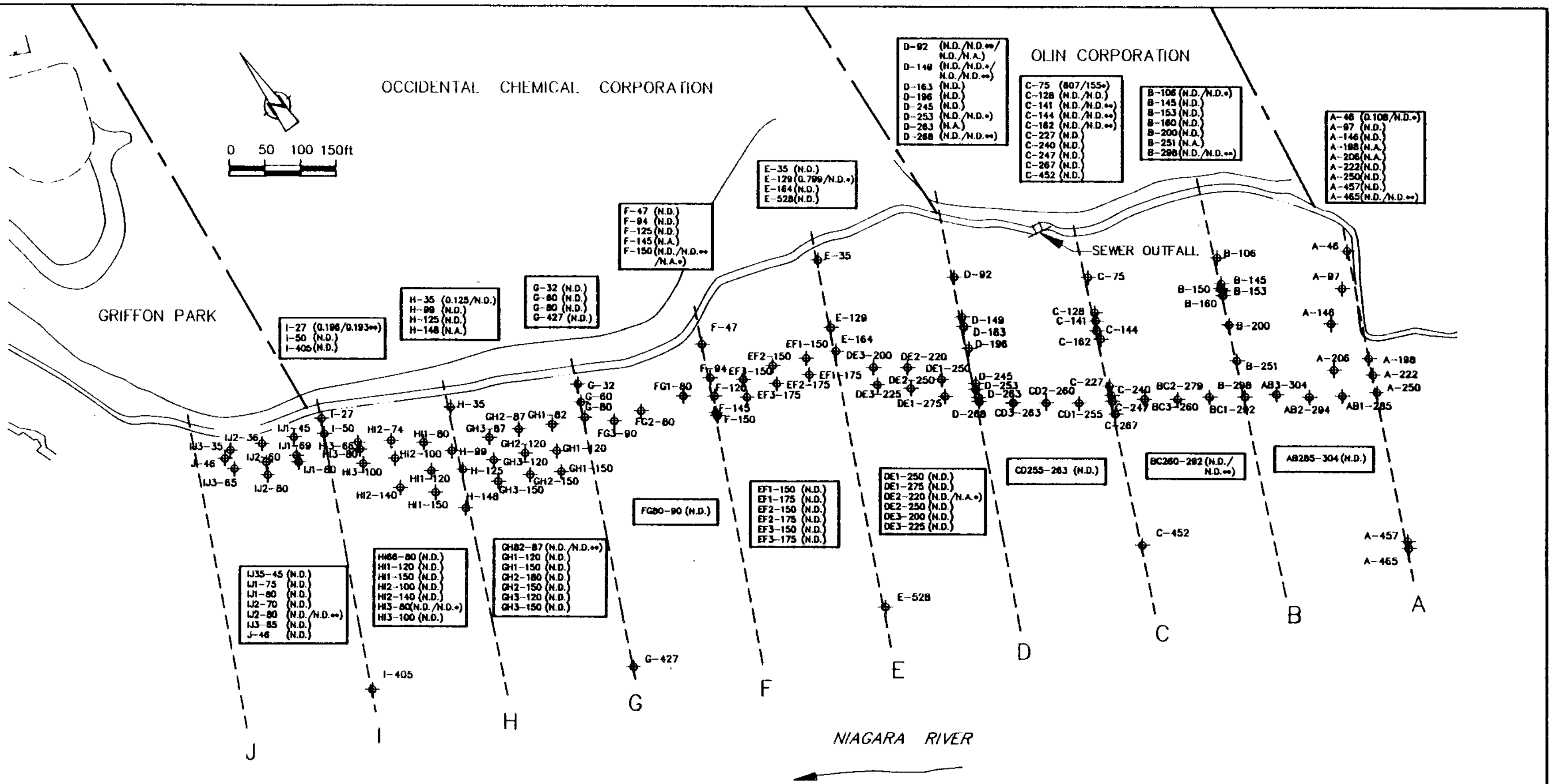
(1.0) Concentration in ppm
• Reanalysis Value
•• Field Duplicate Value
N.D. Not detected above survey level
N.A. Not analyzed, Mercury analysis only
⌖ Sediment Sample Location
A— — Primary Sampling Vector

CRA/WCC

figure 8.9

DISTRIBUTION OF TRICHLOROBENZENES
0 TO 6–INCH DEPTH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-26/09/88-47-D-1 (P139)



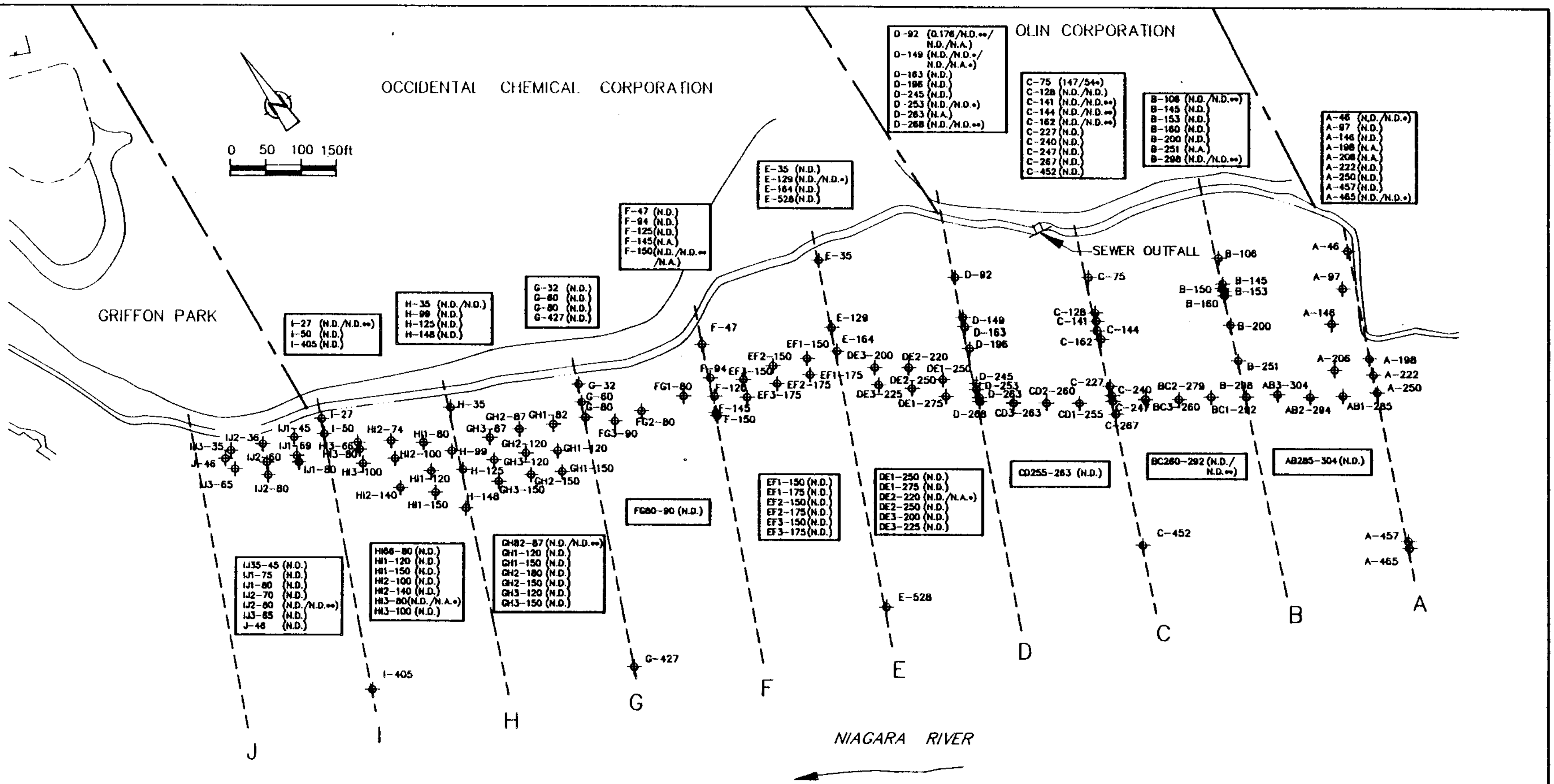
LEGEND:

(1.0) Concentration in ppm
• Reanalysis Value
•• Field Duplicate Value
N.D. Not detected above survey level
N.A. Not analyzed, Mercury analysis only
⊕ Sediment Sample Location
A— — — Primary Sampling Vector

figure 8.10
DISTRIBUTION OF TETRACHLOROBENZENES
0 TO 6-INCH DEPTH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-26/09/88-47-D-1 (P140)



LEGEND:

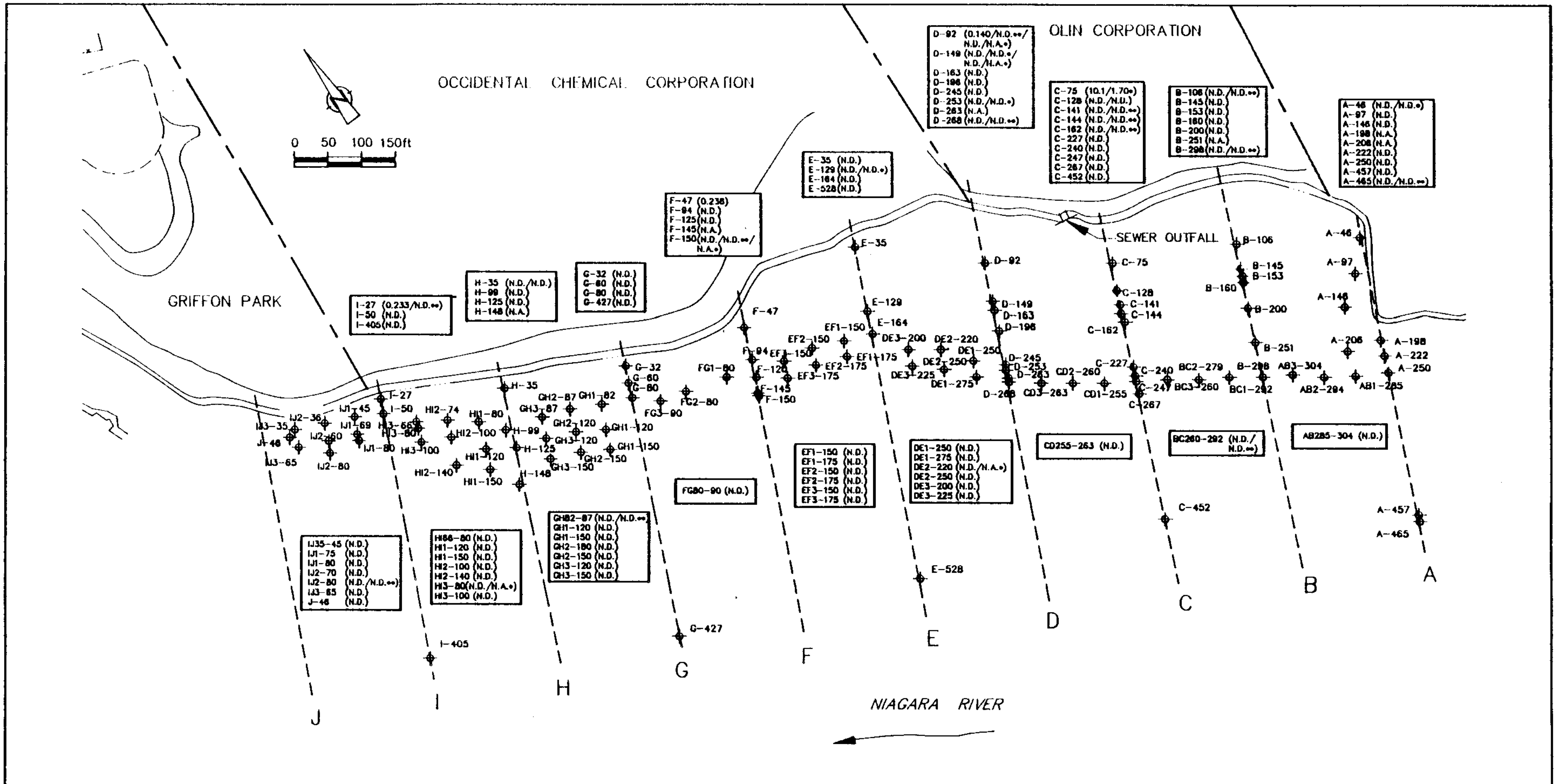
- (1.0) Concentration in ppm
- * Reanalysis Value
- ** Field Duplicate Value
- N.D. Not detected above survey level
- N.A. Not analyzed, Mercury analysis only
- ⌖ Sediment Sample Location
- A— — Primary Sampling Vector

CRA/WCC

figure 8.11

DISTRIBUTION OF PENTACHLOROBENZENES
0 TO 6-INCH DEPTH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-26/09/88-47-D-1 (P141)



LEGEND:

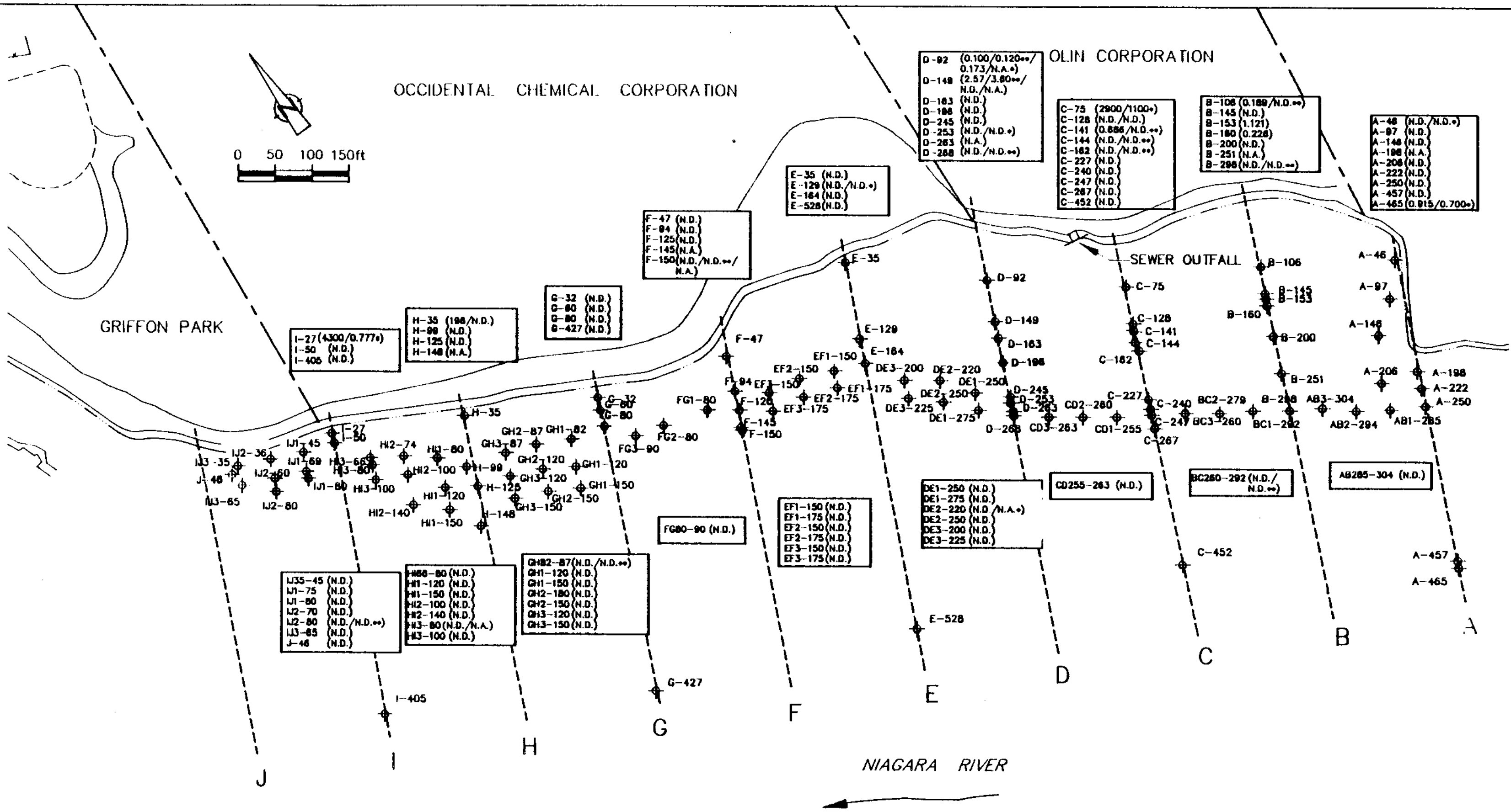
(1.0) Concentration in ppm
• Reanalysis Value
•• Field Duplicate Value
N.D. Not detected above survey level
N.A. Not analyzed, Mercury analysis only
⊕ Sediment Sample Location
A— — Primary Sampling Vector

figure 8.12

DISTRIBUTION OF HEXACHLOROBENZENE
0 TO 6–INCH DEPTH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-26/09/88 47-D-1 (P142)



LEGEND:

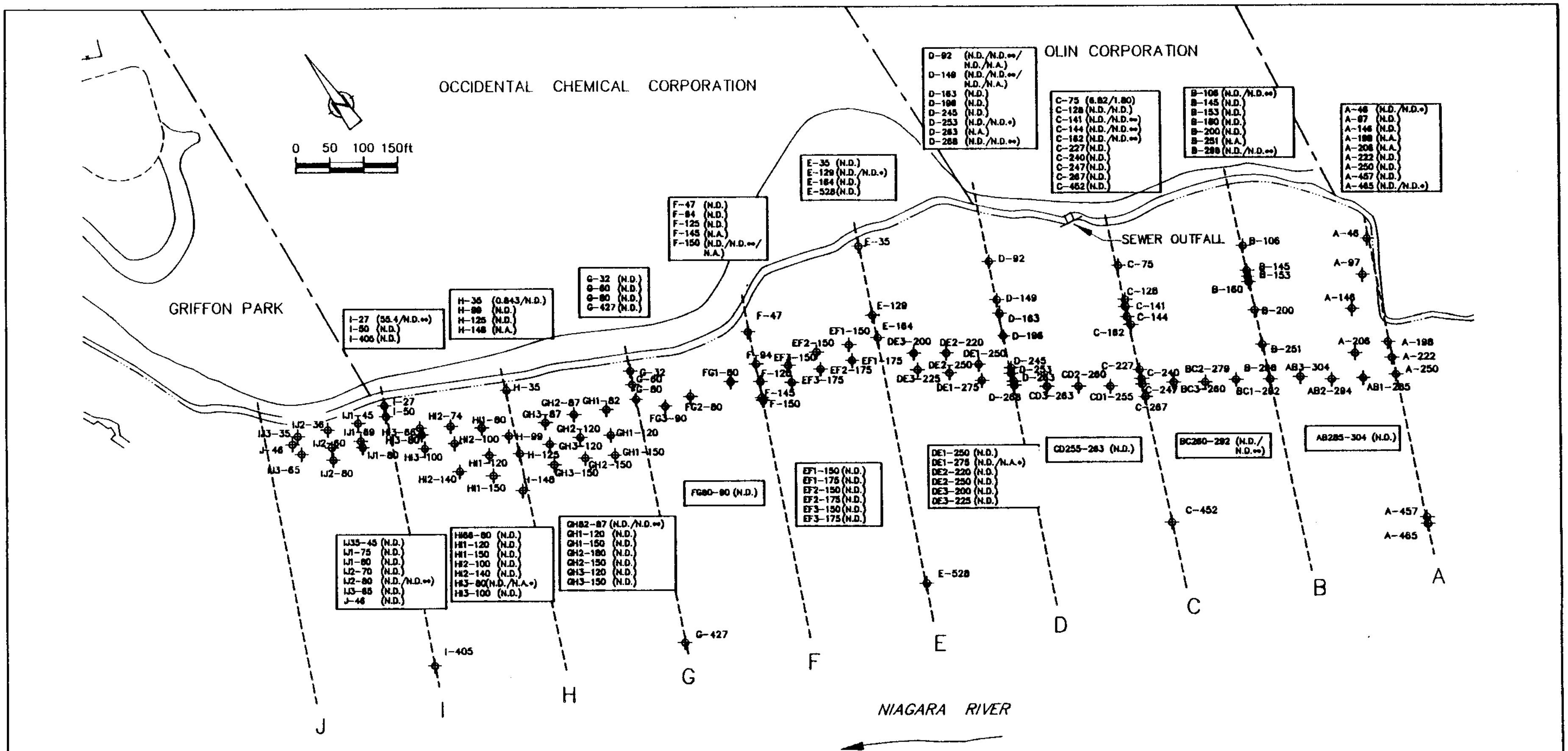
- (1.0) Concentration in ppm
- * Reanalysis Value
- ** Field Duplicate Value
- N.D. Not detected above survey level
- N.A. Not analyzed, Mercury analysis only
- ⌖ Sediment Sample Location
- A - - - Primary Sampling Vector

figure 8.13

DISTRIBUTION OF TOTAL HCCH
0 TO 6-INCH DEPTH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-31/01/90-47-0 (P143)



LEGEND:

(1.0) Concentration in ppm

* Reanalysis Value

** Field Duplicate Value

N.D. Not detected above survey level

N.A. Not analyzed, Mercury analysis only

⊕ Sediment Sample Location

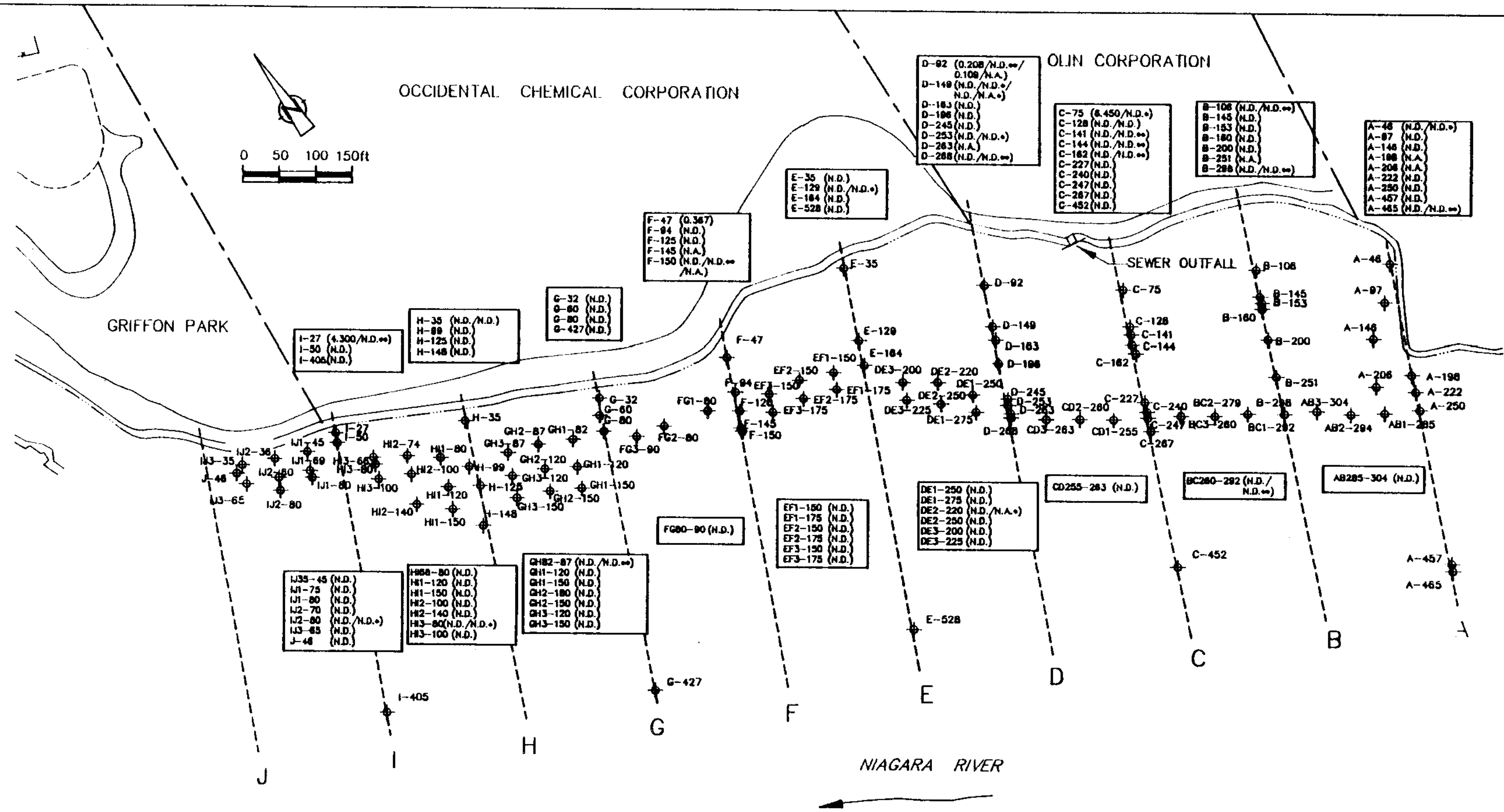
A ---- Primary Sampling Vector

figure 8.14

DISTRIBUTION OF GAMMA HCCH
0 TO 6-INCH DEPTH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-31/01/90-47-0 (P144)



LEGEND:

(1.0) Concentration in ppm
* Reanalysis Value
** Field Duplicate Value
N.D. Not detected above survey level
N.A. Not analyzed, Mercury analysis only
⌀ Sediment Sample Location
A - - - Primary Sampling Vector

figure 8.15
DISTRIBUTION OF CHLOROPHENOLS (TOTAL)
0 TO 6-INCH DEPTH
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-31/01/90-47-0 (P145)

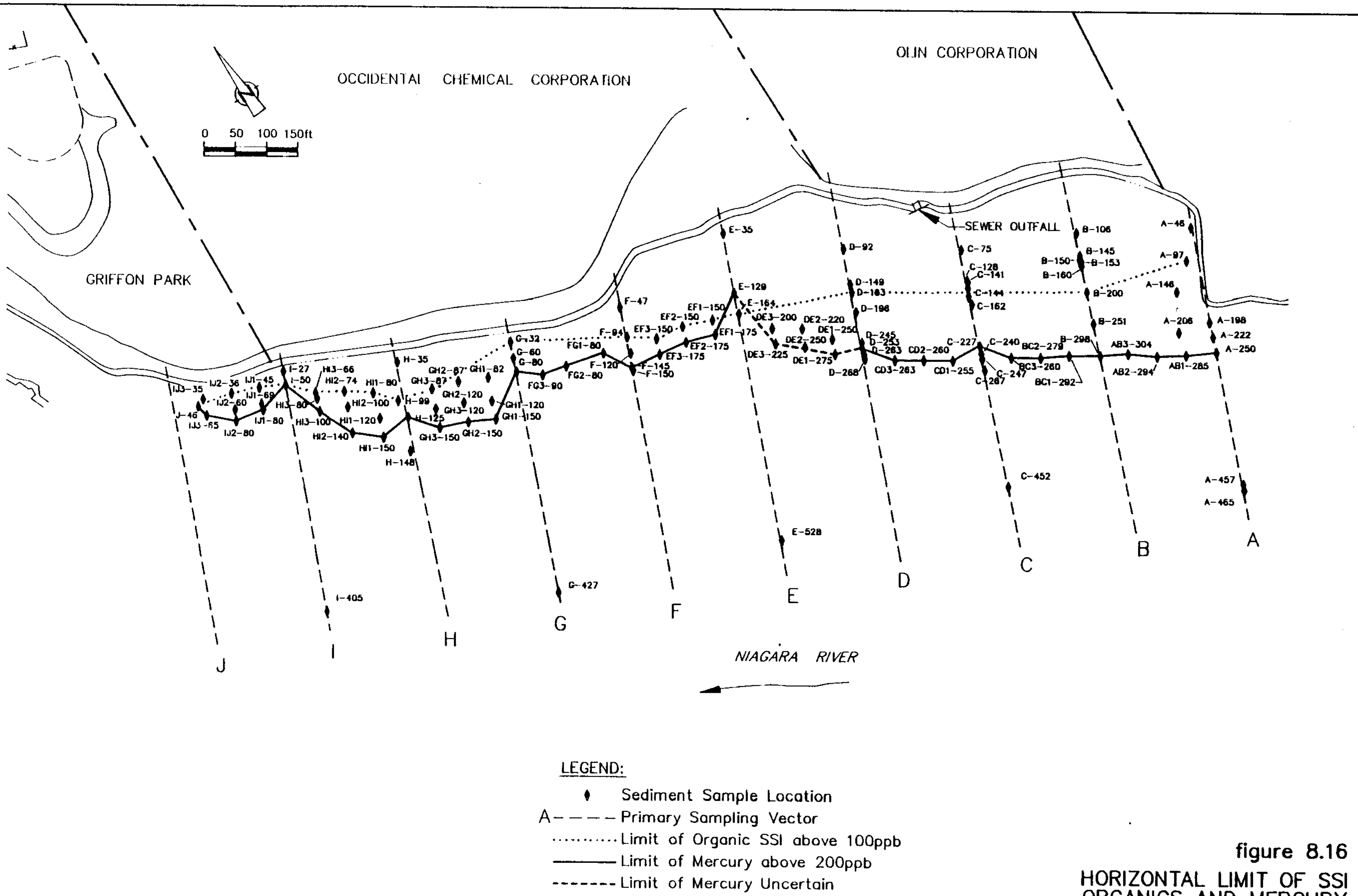
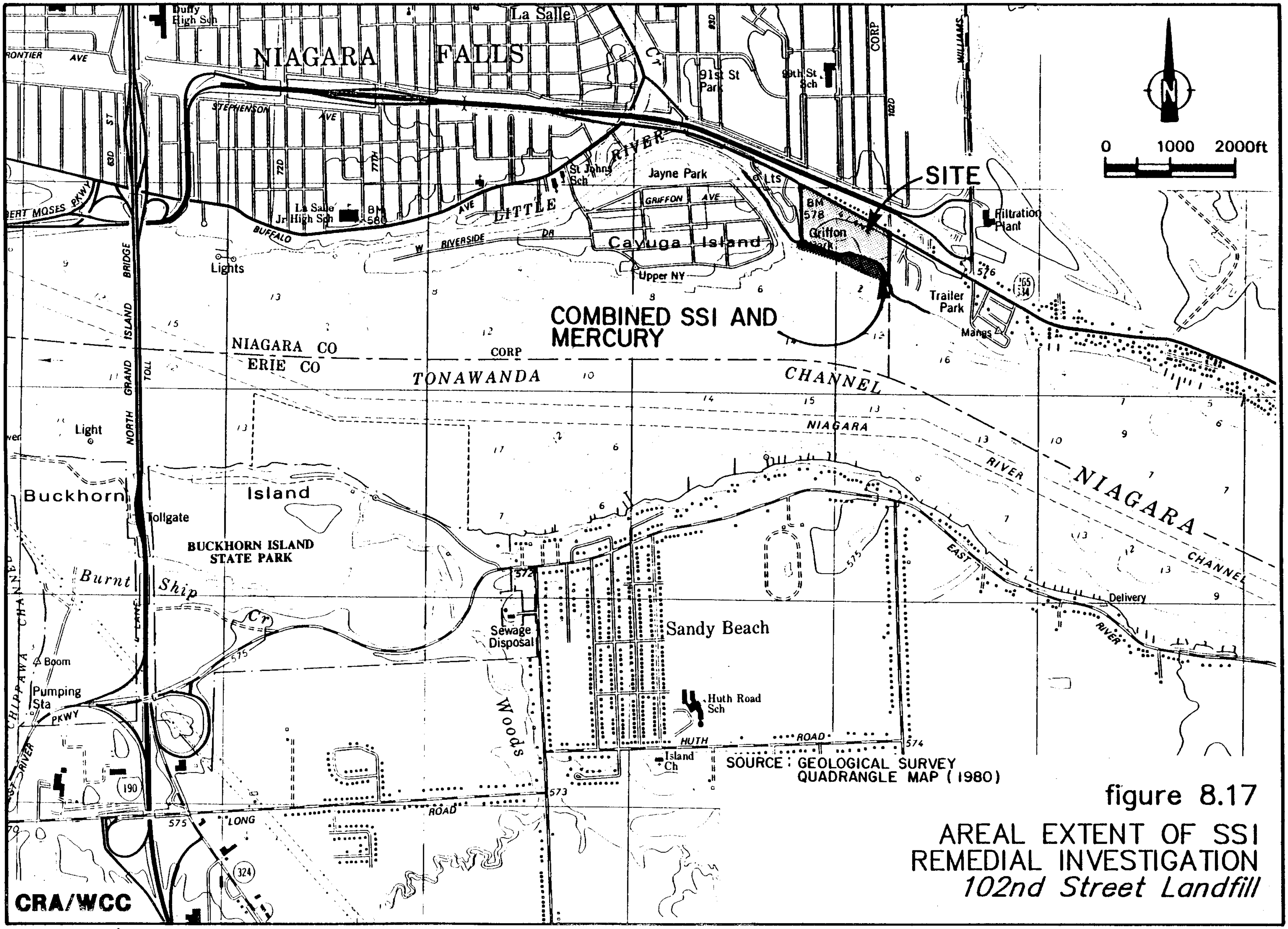


figure 8.16

HORIZONTAL LIMIT OF SSI ORGANICS AND MERCURY
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-26/09/88-47-D-1 (P146)



CRA/WCC

figure 8.17

AREAL EXTENT OF SSI
REMEDIAL INVESTIGATION
102nd Street Landfill

1431-27/09/88-47-D-1

TABLE 8.1

SITE-SPECIFIC INDICATORS
SEDIMENT MATRIX
102ND STREET LANDFILL

Compound	Survey Level (ug/kg)
Mercury	200
2-Monochlorotoluene	100
4-Monochlorotoluene	100
1,2-Dichlorobenzene	100
1,4-Dichlorobenzene	100
1,2,3-Trichlorobenzene	100
1,2,4-Trichlorobenzene	100
1,2,3,4-Tetrachlorobenzene	100
1,2,4,5-Tetrachlorobenzene	100
Pentachlorobenzene	100
Hexachlorobenzene	100
alpha-HCCH	100
beta-HCCH	100
delta-HCCH	100
gamma-HCCH	100
2,4-Dichlorophenol	100
2,5-Dichlorophenol	100
2,4,5-Trichlorophenol	100
2,4,6-Trichlorophenol	100

TABLE 8-2

**RANGES FOR SSI
OBSERVED IN UPSTREAM SEDIMENTS
102ND STREET LANDFILL (1)**

Parameter	No. of Analyses	No. of Analyses Above Detection Level	Maximum Concentrations (mg/kg)	Minimum Concentrations (mg/kg)
Mercury	25	18	1.44	<0.05
alpha-HCCH	8	2	<0.3	<0.001
beta-HCCH	16	7	1.23	<0.001
gamma-HCCH	20	6	3.25	<0.001
Dichlorobenzenes (total)	16	6	4.0	<0.05
Trichlorobenzenes (total)	16	3	1.1	<0.002

(1) Collated from historical studies (26).

TABLE 8-3

HORIZONTAL EXTENT OF SITE-SPECIFIC CHEMICALS IN NIAGARA RIVER SEDIMENT NIAGARA RIVER SEDIMENT SURVEY 102ND STREET REMEDIAL INVESTIGATION NIAGARA FALLS, NEW YORK

Primary Vector	Extent of Clean Line (1) (in feet from shore) Mercury	Organics
A	250	97
B	298	200
C	227	144 (2)
D	253	163 (3)
E	129	164
F	145	94
G	80	32
H	125	99
I	50	50
J	46	46

Notes:

(1) "Clean Line" is defined as distance from shore (in feet) in which analytical results indicate the presence of mercury at less than 200 µg/kg to total organics at less than 100 µg/kg in the 0" to 6" depth interval.

(2) Although a small value for organics was found out on the C-vector (147 µg/kg at C-240), the absence of organic compounds at C-162 and C-227 and at nearby sample C-247 supports the likelihood that the "hit" at C-240 is not site-related and may be an artifact of sample non-homogeneity.

(3) Although a small value for organics was found further out on the D-vector (154 µg/kg at D-253), the absence of organic compounds at D-196 and at nearby samples D-245 and D-268 supports the likelihood that the "hit" at D-253 is not site-related and may be an artifact of sample non-homogeneity.

9.0 NAPL INVESTIGATION

OCC/Olin undertook investigations on the nature and extent of non-aqueous phase liquids (NAPL), including physical and chemical properties. During the investigation, all samples, regardless of matrix, were examined for the presence of NAPL.

9.1 PURPOSE

The purposes of the NAPL investigations were to:

- identify the presence of NAPL at the Site;
- define the nature and extent of NAPL; and
- evaluate the migration potential of NAPL.

Based on physical and chemical differences between types of NAPL, light NAPL (LNAPL) and heavy NAPL (HNAPL) were distinguished. LNAPL is characterized by density lower than that of water (1.00). HNAPL is characterized by density higher than that of water.

9.2 OCCURRENCE, DISTRIBUTION, AND EXTENT

The occurrence of NAPL at the 102nd Street Site was documented. Historical data related to occurrence, including drilling programs, field surveys, and laboratory analyses, have been summarized (14). Related programs included a subsequent supplemental NAPL survey (23), offshore investigations (27) and the bulkhead investigation (16).

9.2.1 NAPL RELATED STRATIGRAPHY

Subsurface exploration at the 102nd Street Site has enabled detailed stratigraphic correlations to be completed (see Chapter 3). There are at least two known excavations into the native soils. In the northwestern part of Olin property, construction of the storm sewer involved excavation of shallow soil. On OCC property, Love Canal construction resulted in a trench into the Alluvium. The occurrences of NAPL are restricted to the Fill and Alluvium.

The Clay/Till are both of low permeability. Because these units are considered important in controlling migration of HNAPL at the Site, a contour map of the primary confining surface formed by the combined top of the Clay and Till (see Figure 3.15 and 3.17) is important in understanding of HNAPL migration pathways.

9.2.2 RI NAPL SURVEYS

Based on evaluations of existing lithologic and chemical data, a field survey of overburden monitoring wells for the presence of LNAPL and HNAPL was conducted in April 1987 (14). All overburden monitor wells on OCC property were surveyed. On Olin property, all Fill and Alluvium wells were surveyed. Static groundwater was extracted from the top and bottom of the water column in the well, and examined for the presence of NAPL. Where visual or olfactory evidence suggested the presence of NAPL, a standardized field procedure was used to confirm these observations. Occurrence of LNAPL was defined as observation of a distinct, floating immiscible liquid phase. Occurrence of HNAPL was confirmed by the presence of a dense, sinking immiscible liquid phase. Where an adequate volume of sample was available, laboratory examination and chemical and physical analyses were performed.

Additional field work was recommended to further define the occurrence of NAPL in the shallow geologic units (14). HNAPL was subsequently noted in 5 of the 10 boreholes drilled in August and September 1987. A well removal program in late 1987 detected HNAPL in two wells. Investigation of groundwater seepage faces bordering the Site at the Niagara River were further discussed (16). Some occurrences of black, oily liquids (possible HNAPL) were noted during the U.S. Environmental Protection Agency Dioxin screening (written comments, USEPA, February 11, 1986). A summary table of all documented occurrences of NAPL on-site is presented (Table 9.1).

Figures 9.1 and 9.2 distinguish HNAPL occurrences between Fill and Alluvium. Some wells set in the Alluvium have reported occurrences of HNAPL only in the Fill. HNAPL was not observed in the screened intervals of these wells during the field survey. It is assumed that HNAPL is restricted to the Fill unit at these locations.

HNAPL on OCC Property. Documentation of HNAPL is available on the following samples:

Fill	Alluvium			Both
OW38-85	OW20-79	BH4N-87	BH9N-87	OW12-79
	OW27-80	BH6N-87	BH42-86	
	OW47-86	BH7N-87	BH47B-86	
	BH3N-87			

Possible HNAPL occurrences, with either uncertain field observations of "oily liquids" or "black liquids" or conflicting evidence between field and laboratory observations were noted in certain instances. In the cases cited below, the borings were considered to include HNAPL even though data were inconsistent, resulting in a conservative, worst-case scenario of HNAPL distribution. These observations occurred at:

Fill		Alluvium
OW22-79	BH-8	OW40-85
OW36-85	BH-9	

All other locations surveyed were free of indications of HNAPL.

In the Fill, HNAPL has been documented in previous studies only in the central part of the OCC property. In the Alluvium, HNAPL is somewhat more widespread, where it has been documented in previous studies in the central and southeastern part of OCC property. During the RI, HNAPL has been observed in both the Fill and Alluvium in only the central and southeastern parts of the OCC property. The high levels of Benzene (2,000 μg/L), MCB (2,200 μg/L), gamma-HCCH (1,400 μg/L), and delta-HCCH (4,500 μg/L) in water samples from bulkhead BS-1, with a TOC concentration of 170,000 μg/L are indirect evidence of possible NAPL influence in this area.

LNAPL on OCC Property. LNAPL has been clearly observed in only one Fill sample, boring BH47C-86. LNAPL is possibly present in OW35-85, but available data are inconclusive. Field observations of iridescent sheen and strong chemical odor were not confirmed by laboratory analysis because of insufficient sample size. Results of bulkhead sample BS-1 (16) did not identify LNAPL, although an iridescent sheen was noted. A sheen, without a distinct floating immiscible phase, was not interpreted as LNAPL.

HNAPL on Olin Property. HNAPL has been documented in the following samples:

Fill		Alluvium
MW-20	P-7	MW-19
P-3	CW-35	B-25
P-6		

Possible HNAPL occurrences, with either field observations of indeterminate "oily liquids" or "black liquids" or conflicting evidence between field and laboratory observations were noted in certain instances. In the cases cited below, the borings were considered to include HNAPL even though data were inconsistent, resulting in a conservative, worst-case scenario of HNAPL distribution. These observations occurred at:

Fill		Alluvium
BH-2	P-2	MW-2
BH-6	P-4	MW-5
MW-2	B-28	B-23
MW-4	BS-3	B-27
MW-9		B-31
		B-33

LNAPL on Olin Property. There have been no observations of LNAPL on the Olin property.

9.3 ANALYTICAL DATA

Samples of HNAPL from Olin property were analyzed at the Olin Research Center at Cheshire, Connecticut. Samples of HNAPL and LNAPL from OCC property were analyzed at the Occidental Central Sciences at Grand Island, New York. Summaries of chemical data are presented (Tables 9.2 - 9.5). Physical data are summarized (Table 9.6). Detailed discussions of all laboratory procedures used in the analyses have been presented (14, 30).

9.3.1 CHEMICAL DATA

HNAPL on OCC Property. Chemical analysis of HNAPL for samples OW12-80, OW27-80, OW38-85, OW47-85, BH3N-87, BH6N-87, and BH7N-87 are shown (Table 9.2). All samples were analyzed for the USEPA Contract Laboratory Protocol (CLP) Target Compound List (TCL) parameters, and an attempt was made to identify the remaining peaks in the chromatograms. Water content and major element composition were also determined for some samples. Mass balances ranged from 58 to 137 percent. Fourier transform infrared spectroscopy (FTIR) and nuclear magnetic resonance (NMR) analyses were performed to attempt identification of other components. It was concluded that aliphatic hydrocarbons are probably the majority of compounds not quantified by GC/MS. Because these compounds exhibit a relatively poor GC/MS response, their detection in the samples using FTIR/NMR is not unexpected. In addition to aliphatic hydrocarbons, high-molecular weight polymeric compounds are also not readily quantified by GC/MS and contribute to a mass balance less than 100%.

Most analyses from HNAPL samples collected on OCC property were dominated by TECB followed by TCB and P5CB. Other identified compounds were mostly other chlorinated aromatics and aliphatic hydrocarbons. Concentrations greater than 1% of HCCH (OW47-85, BH3N-87, BH6N-87, and BH7N-87) and DCB (OW27-80, OW38-85, OW47-85 AND BH3N-87) were also detected. Unidentified chlorinated aromatic compounds, which were not uniquely identified, comprised the majority of the organic component of sample OW12-80.

Sample OW27-80 was dominated by monochlorinated aliphatic compounds, primarily chlorododecane. The low sp. gr. of the sample, averaging 1.04, did not permit a consistent separation from the aqueous phase, resulting in highly variable mass balances (Table 9.2). Results of FTIR, along with the lack of reproducibility among the three analyses and the low mass balance of the 1986 sample is most likely due to the high water content of the sample. The 1980 sample results are ratios relative to the total concentration of chemicals detected, not percentages.

LNAPL on OCC Property. A mass balance for the single LNAPL sample BH47C-86 is presented (Table 9.3). The analysis is 95 weight percent aliphatic hydrocarbons, in contrast to the HNAPL chemistry. No differentiation of molecular ions was possible because of the excessive fragmentation found with these compounds.

HNAPL on Olin Property. Chemical analyses of HNAPL for samples B-33, B-25, MW-19 and P-3 are presented (Table 9.4). All samples were analyzed for the USEPA priority pollutants, and additional peaks were identified when possible (14). The samples were all dominated by TECB, with significant quantities of TCB and P5CB. Most other identified compounds are other chlorinated aromatics. Concentrations greater than 1% of CB (MW-19, B-25); TECA, TECE and HCB (P-3); and benzene and DCB (B-25) were also detected.. HCCH were present throughout these samples. Table 9.5 presents results of PCDD and PCDF analyses in B-33, B-25, and MW-19.

9.3.2 PHYSICAL DATA

When sufficient sample volume was collected, samples were tested for physical properties. Specific gravity and viscosity data are presented (Table 9.6). Sp. gr. ranged from 0.883 in BH47C (less than water) to 1.613 in P-3 (significantly greater than water). Viscosity measurements (centistokes) ranged between 0.66 (OW27) and 16.13 (OW12) measured at 40°C and 1.5 (B-25) and 2.89 (P-3) measured at 25°C. A representative range of viscosities for selected liquids is presented in the table for comparison. Sample OW27-80 was distinctive among the reported HNAPL samples, with an average sp. gr. of 1.04 and a viscosity of 0.66 centistokes. This may be due to a large amount of water being present in the sample.

9.4 PAST DISPOSAL HISTORY

In order to help understanding of potential NAPL flow at the Site, the history of NAPL disposal was investigated. Suspected NAPL disposal areas are shown (Figure 9.3). Analytical data were compared to distinguish potentially different types of NAPL.

9.4.1 NAPL SOURCES

HNAPL on OCC Property. There is no documented information of possible HNAPL sources on OCC property. The occurrence of HNAPL is limited to the central and southeastern parts of the OCC property (Figure 9.4). Given the southeasterly sloping surface of the top of low permeability strata in this area (see Section 3, Figures 3.15, 3.17), the original placement of HNAPL would be expected in the area corresponding to the property of Hooker Electrochemical, approximately between OW27-80 and BH7N-87 (Figure 9.3).

There is no evidence that the Niagara Alkali and Olbury parts of OCC property were used for disposal of organic materials (see Figure 1.2). There is no evidence of on-site placement of organic wastes in these areas.

LNAPL on OCC Property. There is no evidence of on-site placement of LNAPL on OCC property. The single documentation of LNAPL on OCC property in boring BH47C-86 is believed to result from material from an electrical transformer (14).

HNAPL on Olin Property. The origin of HNAPL on the Olin property has been investigated using a review of historical documents and air photos, and correlating these data with chemical analyses.

TECB and TCB are the two most significant components, by weight percent, of analyzed HNAPL samples from the Site. The origin of these compounds in the Fill unit can be directly traced in part to the disposal inventory (14, 19).

9.4.2 HNAPL DIFFERENTATION

Analytical data were useful in differentiating between types of HNAPL present at the Site. Concentrations of the chlorinated benzenes in the HNAPL were compiled to facilitate comparisons (Table 9.7). The most evident differences among the samples are in concentrations and isomeric forms of TCB,TECB, and P5CB (see Table 9.4).

Because of the many variables related to well construction, sampling, analysis, and variable water contents, the relative ratios of chemicals are considered to be more consistent and informative for assessing individual plumes and sources of NAPL than absolute concentrations (Table 9.8). The ratios of TCB to TECB are especially significant because of large differences in measured concentrations of the compounds. Isomer data (see Table 9.4), particularly the two isomers of TECB, were also useful in differentiating some of the HNAPL occurrences.

Different types of HNAPL were distinguished based on evaluation of the chemical and physical data and distribution of the sample locations. Two different representations of the areal distribution of HNAPL are presented on Figure 9.4. The "approximate location of HNAPL presence" indicates all known occurrences of HNAPL at the time of the NAPL investigation (14). Subsequent field sampling and laboratory analysis (16, 23) permitted better delineation of the HNAPL, designated on Figure 9.4 as the "most likely limit of HNAPL presence." The primary differences are the more detailed recognition on the most likely limit maps of limited occurences of HNAPL based on chemical differences and topographic and structural controls, the expansion of HNAPL extent to the south toward BH-2N, and the expansion of HNAPL extent to the south toward BS-3. Five areas of HNAPL are suggested (Figure 9.4):

1) Site OW27 showed the largest ratio of the TCB to TECB. Combined with a low density and viscosity and the abundance of chlorinated aliphatic hydrocarbons, this sample appears to be from a localized source distinct from other HNAPL. This material is indicated by Area 1 (Figure 9.4).

2) The sample from OW12 is characterized by the lack of either TECB or P5CB. Combined with a low density of 1.244 and a high viscosity, components of this sample may represent a distinct type of HNAPL. It is shown by Area 2.

3) Sample B-25, in the east central part of Olin property, had relatively large proportions of the DCB and TCB. Since this sample is not downslope from any of the known sources of NAPL (see Figure 9.3), a different, localized, source is likely. The large differences in concentrations of specific chlorobenzene isomers (see Table 9.4) between HNAPL from B-25 and HNAPL from other wells further substantiate the likelihood that easternmost occurring HNAPL on Olin property is of a different origin. Area 3 on Figure 9.4 includes all easternmost occurrences of HNAPL.

4) The sample from P-3, located in an area of known disposal, has several unique chemical characteristics. The sp. gr. of 1.6 was the largest measured. Tetrachlorobenzene was the dominant chemical, and the 1,2,3,4-isomer was dominant (in contrast to isomer data from other wells). This finding is believed to be significant. During its brief venture into the manufacture of chlorinated organic chemicals, Olin used an integrated organics operation where intermediates or residues from one process were used as raw materials or feedstock to other processes. Olin did not manufacture Lindane, nor did Olin dispose of wastes containing Lindane. Olin did, however, produce a product with an upgraded gamma-BHC (gamma isomer of hexachlorocyclohexane). Commercial BHC contained about 14% of gamma-isomer. While Olin initially sold the commercial BHC, it ultimately produced a product containing approximately 36% gamma-BHC. The upgraded product was made by separation of the gamma-BHC from the other isomeric forms (predominantly alpha and beta isomers).

The excess of non-gamma isomers, termed alpha-beta cake, was further processed into other products. The alpha-beta cake was "cracked" with hydrochloric acid to form trichlorobenzene. The trichlorobenzene was further chlorinated to form tetrachlorobenzene. Two isomers of tetrachlorobenzene were formed - vincinal (v-tetrachlorobenzene, or 1,2,3,4-tetrachlorobenzene) and symmetrical (s-tetrachlorobenzene, or 1,2,4,5-tetrachlorobenzene). These two isomers were separated with the "v-tetra" going to the production of pentachloronitrobenzene and the "s-tetra" going to the manufacture of 2,4,5-trichlorophenol.

It was critical to Olin's operations therefore to separate the v- and s-tetras. As is typical of organic chemical reactions of this sort, the reactions and separations did not produce pure product. Percent recoveries of percent efficiencies were standard and important measures of performance. V-tetra had some s-tetra present as well as some trichlorobenzenes and the other chlorobenzenes. As the various production operations started and stopped or as material was rejected or declared unusable, disposal occurred at the 102nd Street site. Such organics disposal was not routine and portions of the s-tetra or v-tetra were disposed at different times in different locations. Since the wastes went to the site separately, they were disposed of separately at the site.

It is likely that a deposition of predominantly 1,2,3,4-tetrachlorobenzene can be separate and distinct from deposition of predominantly 1,2,4,5-tetrachlorobenzene. Therefore, Area 4 is proposed as the location of a localized occurrence of HNAPL. However, because no borings were drilled between Area 4 and Area 5 (Figure 9.4), it is not possible to determine whether these Areas overlap.

5) The remaining samples are all characterized by a very low relative weight percent of dichlorobenzene. Olin wells B-33 and P-3 each has a large ratio of TCB and DCB, and greater sp. gr. than the other samples. Olin wells MW-19, and OCC wells OW38 and OW47, and borings BH3N, BH6N, and BH7N are in the topographic low in the south-central part of the Site. This area contains the most heterogeneous chemical mix. It is likely comprised of several types of wastes which have partially mixed, either prior to or on disposal or as a result of migration. Data are inadequate to better discriminate within Area 5.

The approximate extent of the HNAPL presence has been reevaluated from earlier work. The different types of HNAPL chemistry observed probably result from different process waste streams at the Site. Stratigraphic features (particularly the top of the Clay/Till surface) affect the distribution and potential mixing of these localized occurrences of HNAPL. The differentiation of five areas of HNAPL based on analytical and stratigraphic data is a useful tool in defining the full extent of HNAPL distribution. Chemical differences in the central part of OCC property are suggestive of a least three distinctive HNAPL sources in this area, corresponding to Areas 1 and 2 and part of Area 5 (see Figure 9.4). Similarily, the central part of Olin property seems to include at least two distinct HNAPL types, corresponding to Areas 3 and 4. Area 5, the largest area, coincides with the stratigraphic low on the top of the confining unit (see Figures 3.15, 3.17). The five areas, include sites with no documentation of HNAPL, rather than designing a complicated area of occurrence to exclude those sites.

Six representative cross-sections (Figures 9.6-9.11) conceptually illustrate the relations among observed HNAPL, drilling and sampling observations, and estimates of the postulated distribution of HNAPL. The posulated distribution patterns are based on present understanding of potential movement of HNAPL as described in the literature (14,36).

Section A-A' shows three distinct occurrences of HNAPL, crossing through HNAPL Areas 1,2 and 5 (see Figure 9.4). The distinctions are based primarily on differences in HNAPL chemistry among the three areas. The unusual distribution pattern of HNAPL shown on Section B-B' is postulated as a result of a fine sand and silt layers at depth in well OW22. This lithologic unit is assumed poorly permeable to HNAPL, resulting in the warping of the downward migration pathway of HNAPL toward BH6N and OW47. Section C-C' illustrates the likelihood of HNAPL following the slope of the top of the confining Clay/Till surface. The HNAPL in the Fill/Upper Alluvium might be connected to the deeper HNAPL, but because HNAPL was not observed at intermediate depths in MW-19, the upper and lower occurrences are assumed discontinuous. HNAPL at depth (along the top of the Clay/Till surface) is also shown as separate occurrences. Although the Clay/Till slope between P-4 and B-33 suggests that HNAPL could migrate toward B-33, the markedly different chemistry between analyses from P-3 and B-33 supports a localized HNAPL occurrence (and consequent limited distribution) near P-3.

Section D-D' intercepts part of Area 5. The topographic separation between the two HNAPL occurrences is evident between wells B-29 and P-5. Although chemical data from these wells were not available, it is reasonable to expect that they are separate occurences with distinctive chemistry. HNAPL was not detected over most of the Fill/Alluvium on Section D-D". HNAPL at depth on this section is postulated to originate from a source area near well B-25. Section E-E' illustrates several occurrences of HNAPL in Areas 3 and 5. The failure to observe HNAPL in the Fill in wells B-23, B-24, and B-25 supports the proposition that HNAPL distribution is localized .

9.5 MIGRATION POTENTIAL

Currently available data from the Site evidence the physical and chemical characteristics of NAPL as well as the approximate distribution and extent of NAPL occurences. In combination with subsurface information and historical data regarding disposal practices, it is possible to consider questions regarding the possible rate and fate of HNAPL migration. Any discussion of HNAPL migration must, however, include the realization that HNAPL distribution in the Fill/Alluvium is highly complex, and that representations on Figures 9.6-9.11 are conceptual.

Movement of HNAPL in the subsurface environment is affected by many parameters, including:

- hydrogeologic factors, including hydraulic conductivity, groundwater flow direction and gradient, slope of the upper surface of the confining unit, and vertical stratification;
- history of disposal practices at the Site;
- physical properties of the NAPL; and
- manmade passageways, that is, the storm sewer on Olin property and the trench extension on OCC property.

9.5.1 LNAPL MIGRATION

The LNAPL sample from BH47C-86 is the only documentation of LNAPL at the Site. Because of its low density, LNAPL flow should be controlled by the local water-table gradient. Except for LNAPL trapped by residual saturation in the unsaturated zone or by sorption on particulate matter in the saturated zone, the potential for migration is dependent on the volume of

LNAPL deposited and the slope of the water table. Based on the single observation of LNAPL, the volume and extent of LNAPL migration at the Site appears to be minimal.

9.5.2 HNAPL MIGRATION

Migration of HNAPL in the subsurface environment at the Site is much more complex than migration of LNAPL. Because it is more dense than water, HNAPL at the Site migrates downward under the force of gravity until it encounters a lithologic unit relatively impermeable to its further vertical movement. That is, the capillary pressure forces throughout the subsurface material are able to balance the density differential between HNAPL and water. Superimposed on these competing forces are the effects of hydrodynamic groundwater dispersion.

In particular, HNAPL which can overcome capillary pressures within the Fill would be expected to settle at the base of the Fill on the relatively low permeable discontinuous original topsoil layer found at the top of the Upper Alluvium. Where this layer is absent, the HNAPL would then be expected to continue migrating downward until it reaches the top of the low permeable Clay/Till surface. In either case, the HNAPL would then migrate laterally along the top of the layer encountered, with a rate of movement controlled by the slope of that surface, the thickness, density, and viscosity of the HNAPL, and aqueous phase capillary pressure within the confining unit. The extent of movement both horizontally and vertically is controlled in large measure by the volume of NAPL available.

In fact, physical properties (viscosities) of the HNAPL suggest that most of the non-aqueous fluid has a low mobility. Consequently, much of the HNAPL may be effectively trapped in the sediments. If the HNAPL were to migrate significant distances laterally, the most likely limit of HNAPL presence (see Figure 9.4) could suggest possible migration paths distinctive to each area of occurrence.

Areas 1 and 2 are both in the central part of OCC property. The unique density, viscosity, and chemistry of samples from each of these areas suggests that there has been minimal mixing of these HNAPL materials.

HNAPL in Area 3 (see Figures 9.4, 9.10 and 9.11) appears to be both chemically and stratigraphically distinct from the rest of the Site. Stratigraphic contours of the top of the

Clay/Till (see Figures 3.15, 3.17) suggest that HNAPL in this area would migrate from B-25 toward the local low near B-23. Although MW-9 is also upgradient, there is no evidence of HNAPL in the Alluvium at MW-9. Further migration from B-25 would be along the topographic low toward P-13 and MW-21. Since neither of these locations shows evidence of HNAPL, the HNAPL must be traveling at a very slow rate or not at all since it has not appeared at either P-13 or MW-21. There could also be a directional component of HNAPL flow from B-25 toward B-27. However, as with P-13 and MW-21, HNAPL has not been observed at depth at B-27.

HNAPL in Area 4 occurs directly beneath one of the suspected NAPL disposal areas (see Figure 9.3). The distinctive chemistry from well P-3 supports the conclusion that HNAPL in this area is of limited occurrence.

The largest and most complex area of HNAPL distribution is in Area 5 (see Figures 9.4, 9.9, and 9.11). HNAPL in this area, if mobile, is accumulating in stratigraphic lows in southeastern OCC property. The HNAPL in this area can be separated into three spatial groupings. One grouping in the southwestern part of Olin property occurs primarily in the Fill. A second grouping is on the southeastern part of OCC property, primarily in the Alluvium. Both these groupings would tend to migrate toward the confining surface low in the southeastern corner of OCC property. A third grouping of HNAPL occurrences is in the south-central part of OCC property. Most of the HNAPL in this area would be expected to stay in the local stratigraphic low. Some could migrate away from near well OW47, which straddles the two low areas, following the gradient defined by the stratigraphic contours. For the ultimate goal of HNAPL recovery from this area, these stratigraphic lows are convenient sinks for HNAPL collection and potential recovery.

HNAPL was observed to be present in the Lower Alluvium at only one location (BH9N-87) within 50 feet of the River's edge. Because of the proximity of this boring to the River, it is possible that HNAPL extends southward of BH9N-87 in the Alluvium beneath the Niagara River. Because of the limited thickness of HNAPL observed at BH9N-87, the absence of HNAPL or even any chemical odors in the Niagara River borings, and the slope of the Clay/Till surface near the River (see Figure 9.6), the extent of HNAPL migration in the Alluvium beneath the River is likely to be minimal.

Similarly, HNAPL was suspected to be present in the Fill at only one location (BS-3) immediately adjacent to the Niagara River. Because of the proximity of this bulkhead seep to the

River, it is possible that HNAPL could reach the River at or near this location. Although HNAPL at this location was not confirmed (16), there is a possibility that HNAPL could migrate beneath the River in this vicinity. However, the possibility of HNAPL migration offshore in the Fill is considered minimal since there were no indications of HNAPL in any of the adjacent Fill, River borings or sediment samples.

9.6 CONCLUSIONS

The nature and extent of LNAPL and HNAPL has been documented in the Fill and Alluvium beneath the Site. Based on analytical data, hydrogeologic factors, and a reconstruction of the history of disposal practices at the Site, the nature and extent of the non-aqueous phases was assessed. The primary conclusions are:

- The extensive search for NAPL at the Site, in over 150 wells and borings and in numerous soil and sediment samples, revealed that the extent of HNAPL is limited. The localized occurrence supports the idea of a limited volume of HNAPL in the subsurface.

- LNAPL was only positively identified in one well. It is concluded that the presence of LNAPL is of very limited extent and significance at the Site.

- HNAPL can be subdivided into five areas of most likely occurrence based on chemical, physical, and spatial discrimination. These areas are believed to describe the extent of HNAPL occurrence at the Site. Within these areas, the HNAPL distribution is expected to be highly complex.

- Most HNAPL appears to be present in the Alluvium rather than Fill, possibly because of downward migration of the HNAPL.

- HNAPL, although areally extensive in five separate areas, is vertically thin throughout much of the area and considered of limited volume.

- Most HNAPL is in the south-central part of the Site, apparently accumulating in the stratigraphic low defined by the top the Clay/Till confining layer.

- One purpose of the Bedrock sampling program was specifically to look for NAPL in the Bedrock. No LNAPL or HNAPL were observed below the Alluvium in the Clay/Till or Bedrock. The thick overlying confining unit and the lack of aqueous phase chemicals in Bedrock wells support the observation that NAPL has not migrated downward into the Bedrock.

- NAPL migration, if any, from the Site appears to be very limited. It is not possible to reliably estimate the rate, if any, of NAPL migration off -site. Boreholes to define the southern limit of NAPL migration will be installed in preparation for the Design of the Site Containment System.

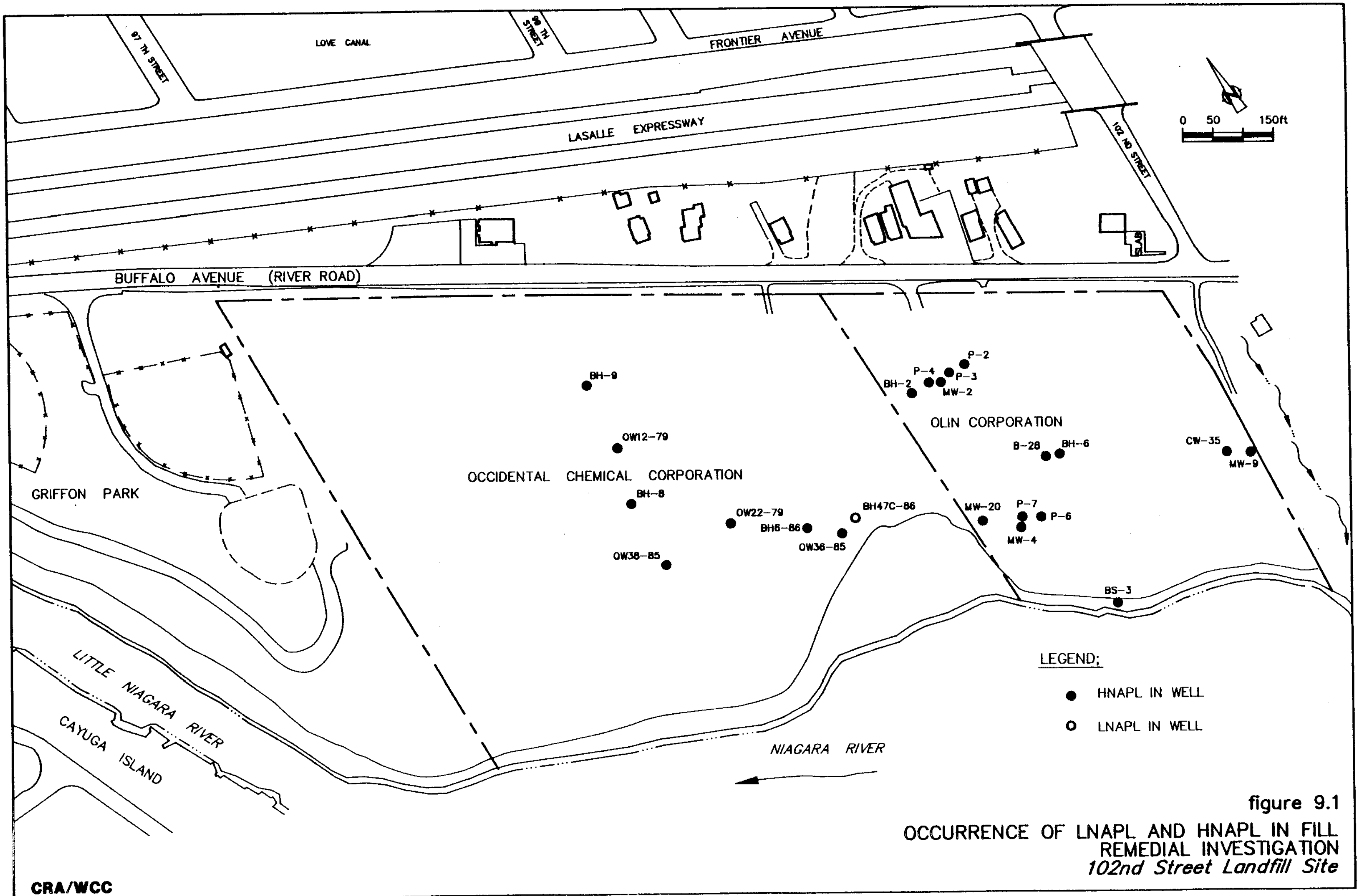


figure 9.1

OCCURRENCE OF LNAPL AND HNAPL IN FILL
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-27/09/88-47-D-1 (P149)

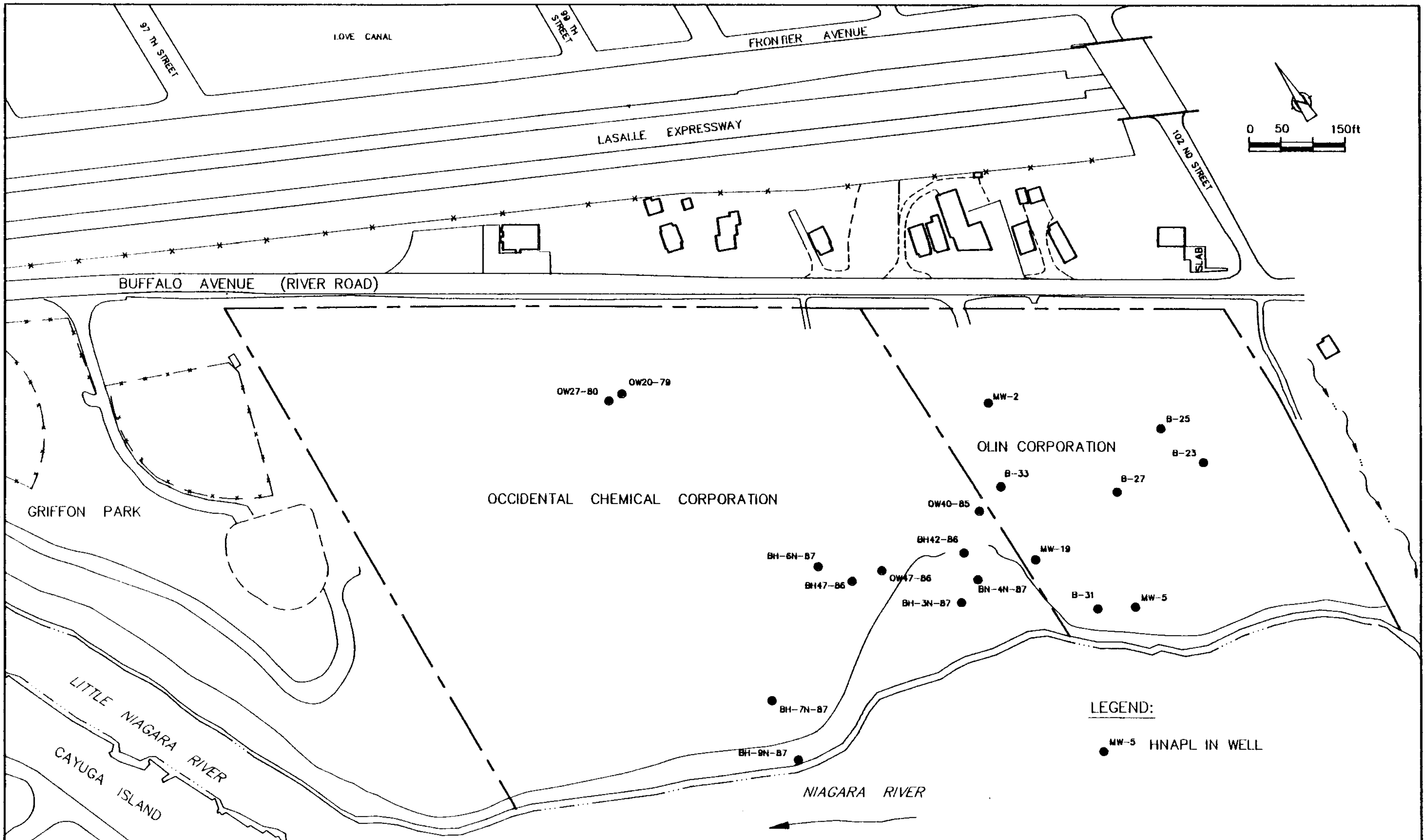


figure 9.2

OCCURRENCE OF HNAPL IN ALLUVIUM
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-27/09/88-47-D-1 (P150)

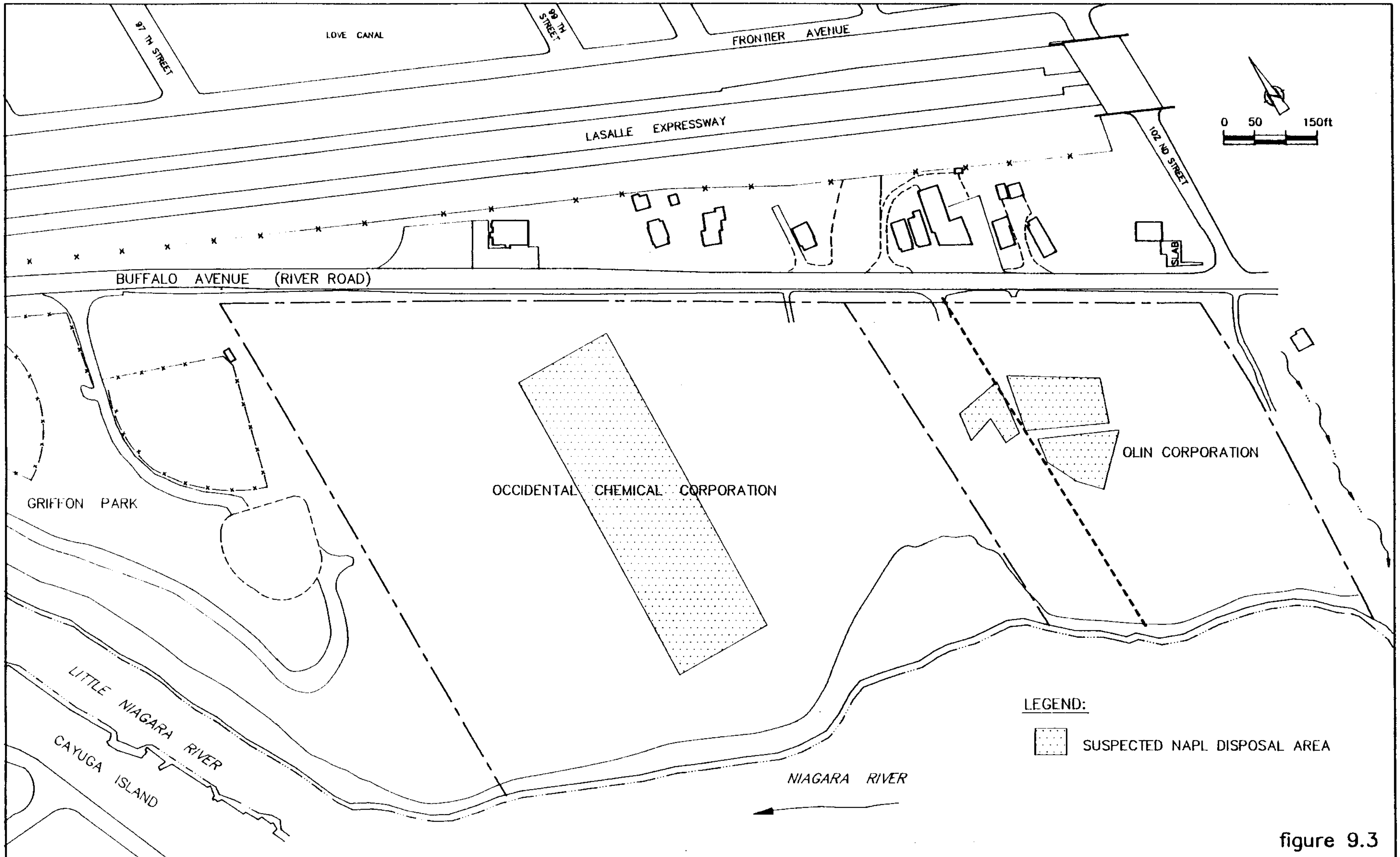


figure 9.3
SUSPECTED NAPL DISPOSAL AREAS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-27/09/88-47-D-1 (P123)

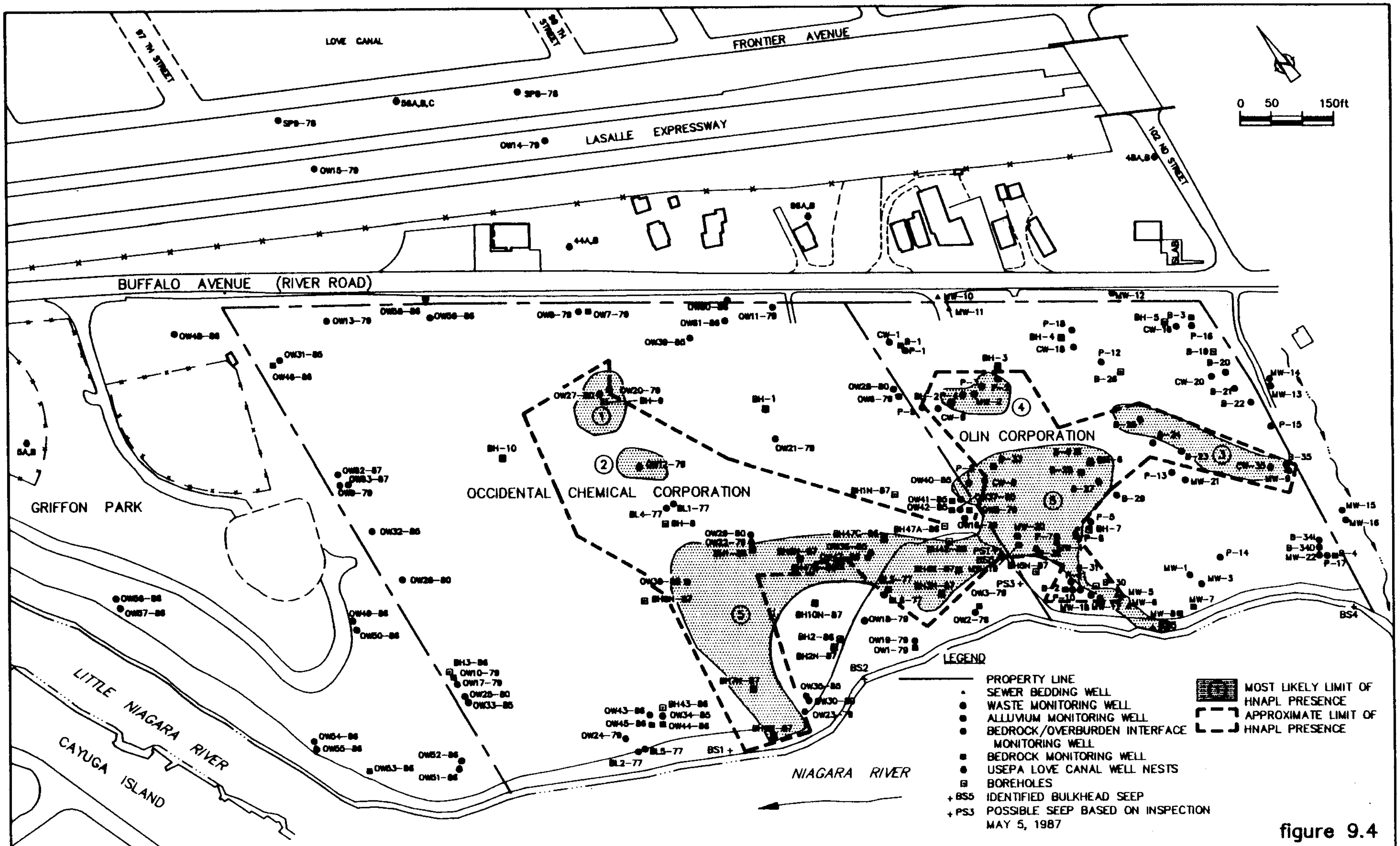


figure 9.4

APPROXIMATE EXTENT OF HNAPL
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-27/09/88-47-D-1

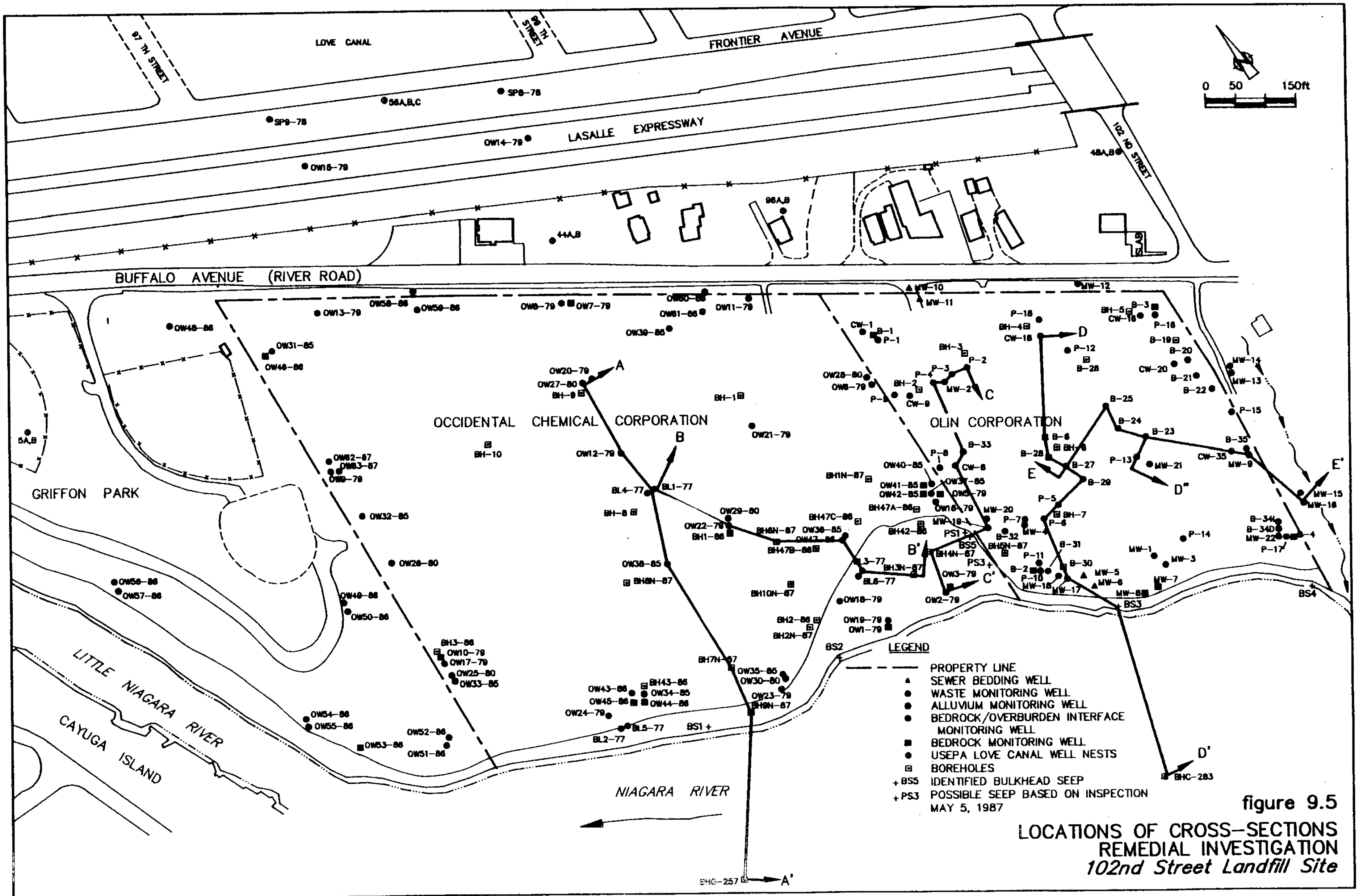


figure 9.5

LOCATIONS OF CROSS-SECTIONS
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-27/09/88-47-D-1 (P126)

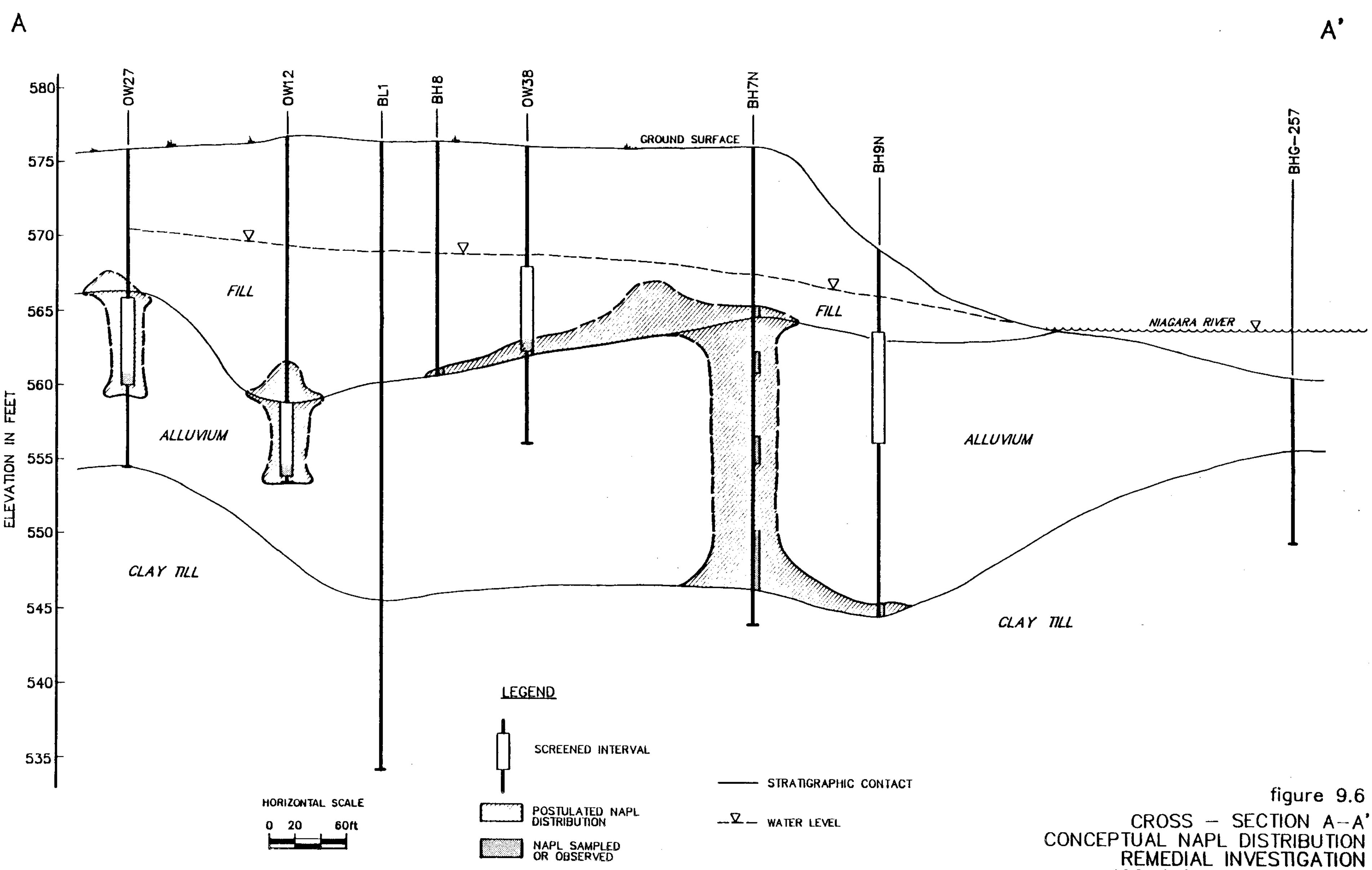


figure 9.6

CROSS – SECTION A–A'
CONCEPTUAL NAPL DISTRIBUTION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-27/09/88-47-D-2

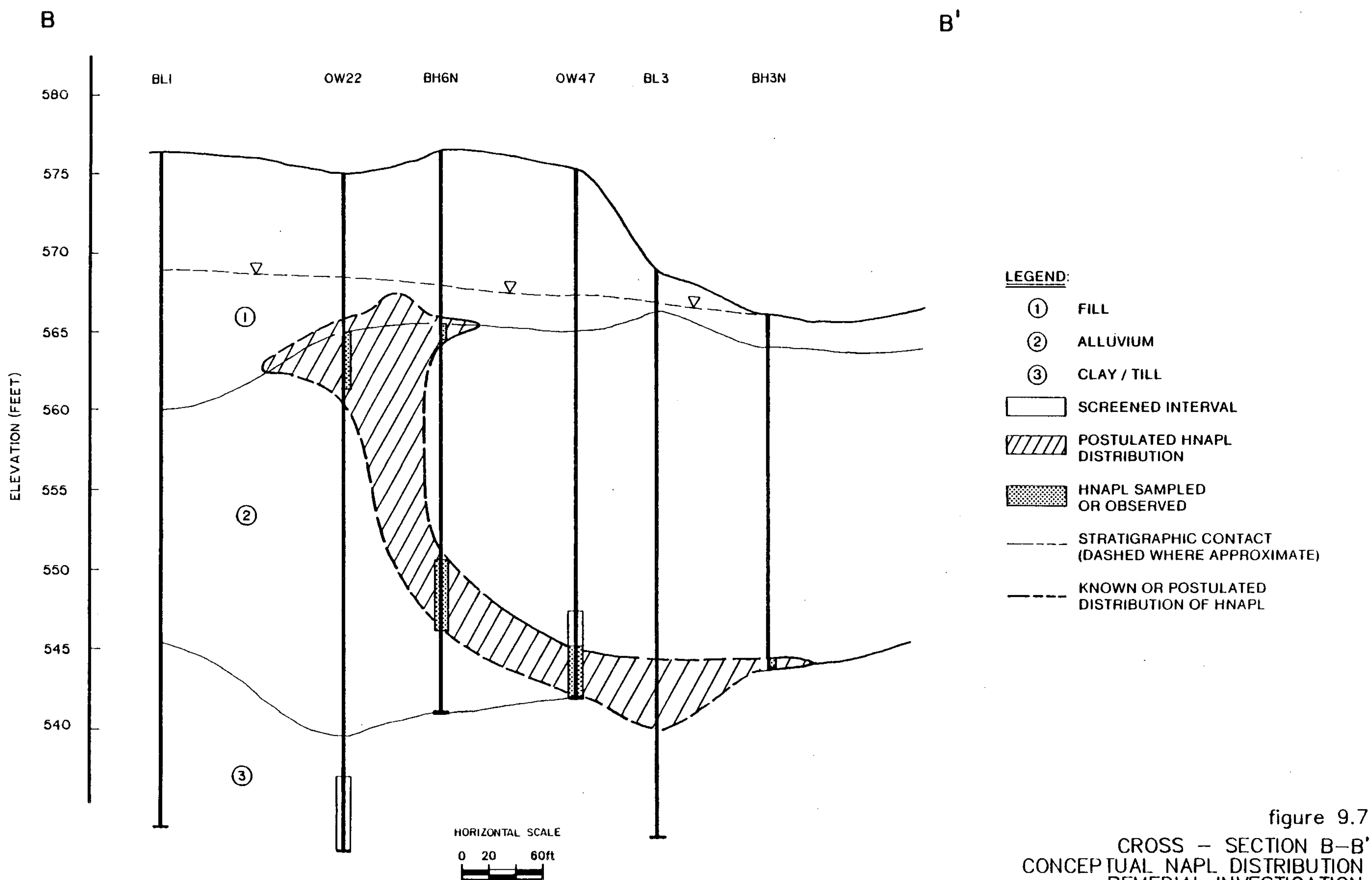


figure 9.7

CROSS – SECTION B–B'
CONCEPTUAL NAPL DISTRIBUTION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-27/09/88-47-D-2

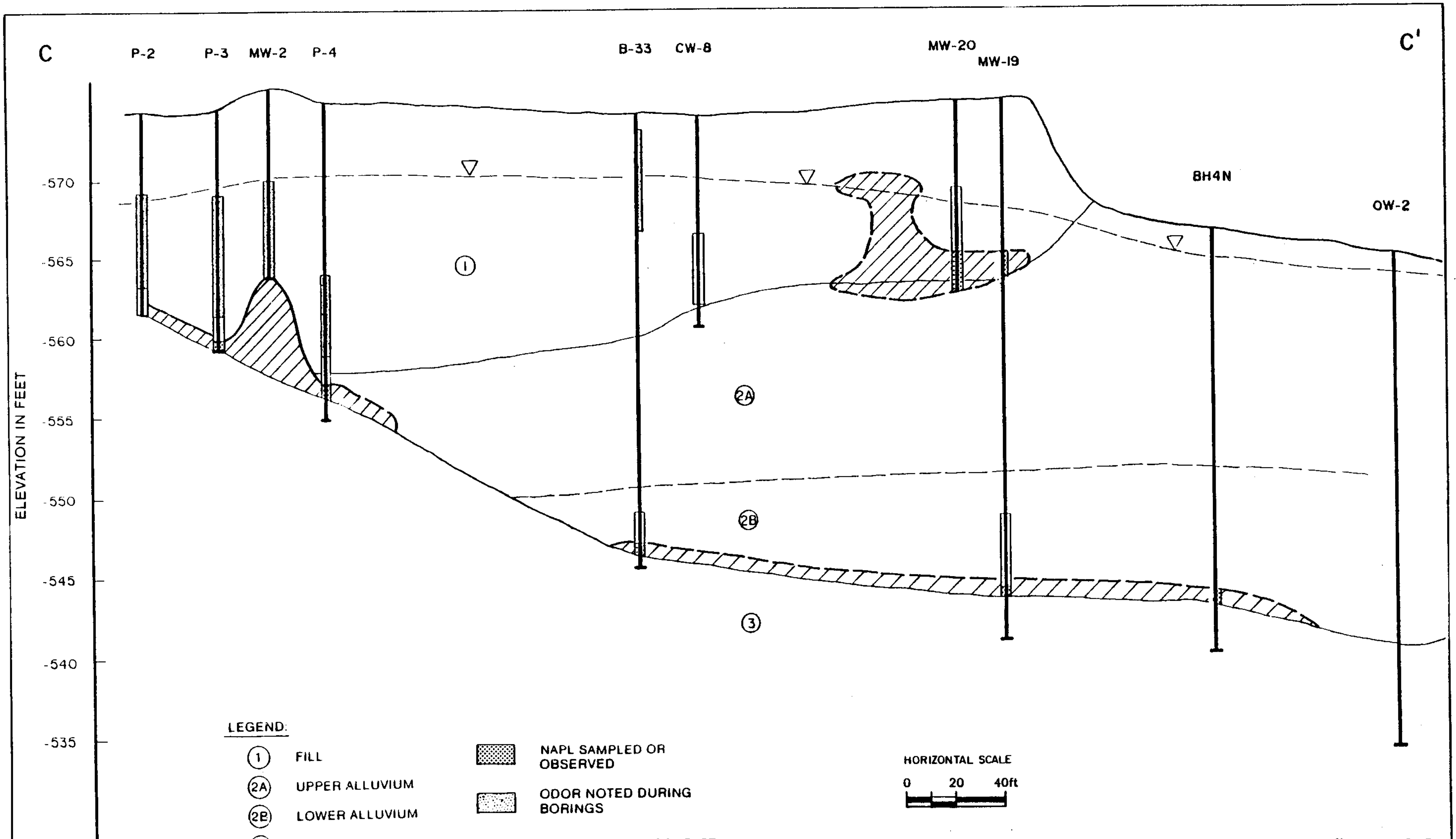


figure 9.8

CROSS – SECTION C–C'
CONCEPTUAL NAPL DISTRIBUTION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-27/09/88-47-D-2

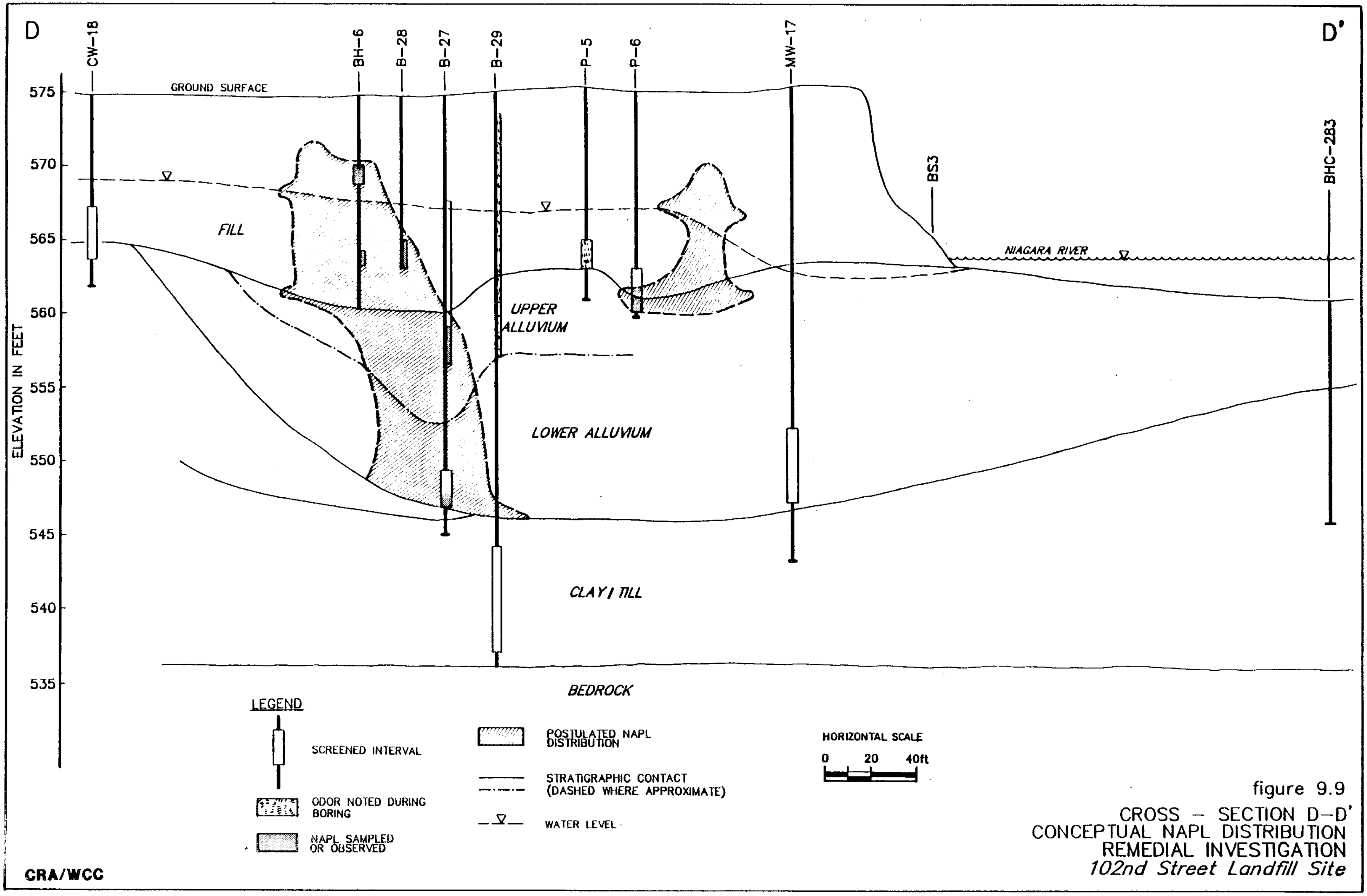


figure 9.9

CROSS – SECTION D–D'
CONCEPTUAL NAPL DISTRIBUTION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-27/09/88-47-D-2

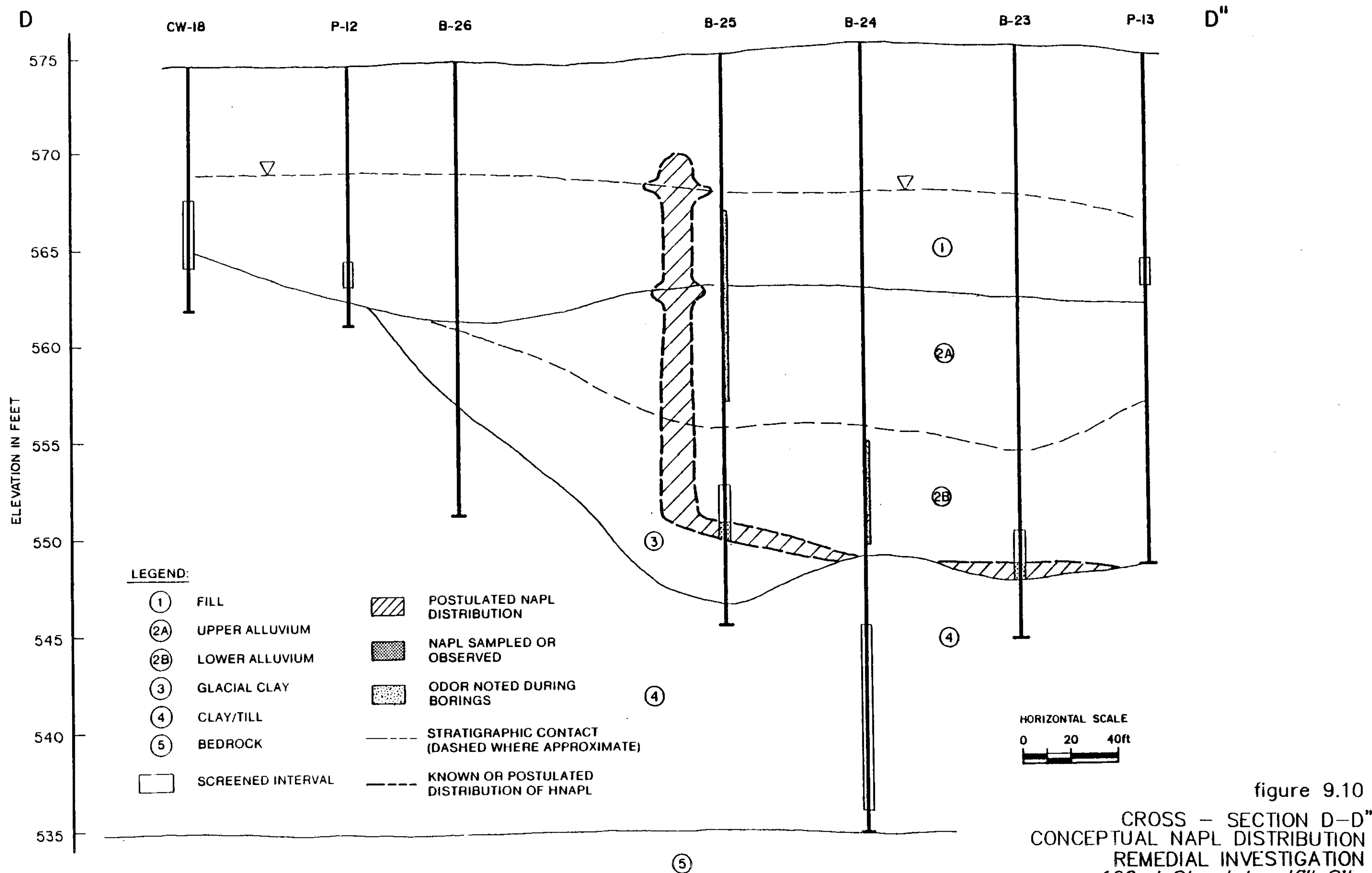


figure 9.10

CROSS – SECTION D–D"
CONCEPTUAL NAPL DISTRIBUTION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431–27/09/88–47–D–1

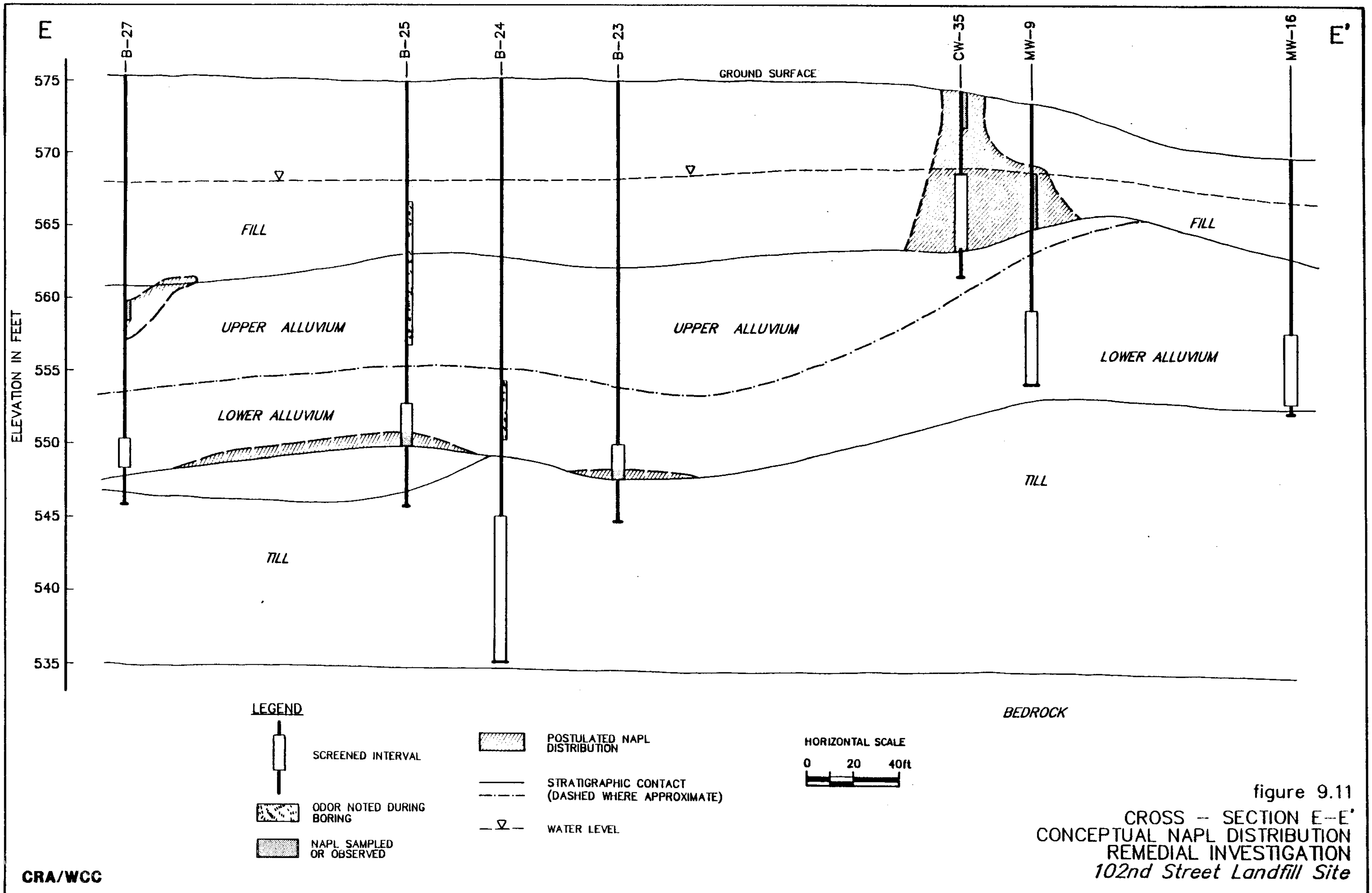


figure 9.11

CROSS – SECTION E–E'
CONCEPTUAL NAPL DISTRIBUTION
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-27/09/88-47-D-1

TABLE 9-1

SUSPECTED OR CONFIRMED NAPL OBSERVATION SUMMARY
102ND STREET LANDFILL

Site Number	Depth below Surface (feet)	Date Sampled	Data Source	Remarks
OCC, FILL				
BH-8	14.0 - 16.0	1985	USEPA	Boring log description. Black, oily.
BH-9	14.0 - 16.0	1985	USEPA	Boring log description. Oily.
OW12	–	1986	WCC	Brown NAPL.
OW22	10.1 - 13.4	1979/87	Wehran/CRA	Boring log description/well removal - trace NAPL.
OW35	–	1987	OCC	Sheen. LNAPL suspected.
OW36	10.0 - 12.0	1985	OCC	Oily globules. Sampled.
OW38	–	1987	OCC	Light brown NAPL. Sampled.
BH47C	10.0 - 13.0	1986	OCC	Light brown NAPL. Sampled.
OCC, ALLUVIUM				
BH42	26.5 - 28.0	1985	Wehran	Brown NAPL. Sampled.
BH47B	33.0 - 33.5	1986	Wehran	Oily brown NAPL. Sampled.
BH3N	21 - 22	1987	CRA	Brown liquid. Sampled.
BH4N	23.0	1987	CRA	Brown liquid.
BH6N	33.5	1987	CRA	Brown liquid.
BH7N	12.0 - 30.0	1987	CRA	Brown liquid.
BH9N	25.0	1987	CRA	Brown liquid. Oily.
OW12	–	1987	WCC	Brown globules. Sampled.
OW20	44.0	1987	CRA	Well removal. Trace NAPL.
OW27	–	1980/1986/87	OCC	Brown liquid. NAPL. Sampled.
OW40	–	1987	OCC	Brown globules.
OW47	30.0 - 33.0	1985/87	OCC	Oily brown NAPL. Sampled.
OLIN, FILL				
BH-2	8.5 - 8.9	1985	USEPA	TCDD soil sampling. Black liquid.
BH-6	4.0 - 10.5	1985	USEPA	TCDD soil sampling. Oil, oily liquid.
B-28	9.5 - 11.5	1980	Wehran	Boring log description.
CW-35	0.0 - 3.0	1980	Wehran	Boring log description.
BS-3	–	1987	WCC	Bulkhead seep. Sheen and black globules on rocks. Apparent NAPL.

TABLE 9-1 (Continued)

Site Number	Depth below Surface (feet)	Date Sampled	Data Source	Remarks
OLIN, FILL - continued				
MW-2	4.0 - 7.0	1985	WCC	Boring log description. Oily sheen.
MW-4	4.0 - 7.0	1985	WCC	Boring log description.
MW-10	4.5 - 8.5	1986	WCC	Boring log description.
MW-20	10.0 - 12.0	1986	WCC	Boring log description. Oily black NAPL.
P-2	4.0 - 12.5	1978	Wehran	Boring log description. Oily.
P-3	–	1987	WCC	NAPL Survey. Sampled.
P-4	–	1979	USEPA	TCDD sampling.
P-6	–	1987	WCC	NAPL survey. Sampled.
P-7	–	1987	WCC	NAPL survey. Sampled.
OLIN, ALLUVIUM				
B-23	–	1986	WCC	NAPL survey. Sampled.
B-25	–	1986/87	WCC	NAPL survey. Sampled.
B-27	15.5 - 17.5	1980/86	Wehran/WCC	Boring log description. Oily residue. NAPL survey. Suspected NAPL.
B-31	–	1980	Wehran	Boring log description. Oily residue.
B-33	–	1986	WCC	NAPL survey. Suspected NAPL.
MW-2	–	1987	WCC	NAPL survey. Oily globules.
MW-5	11.0 - 12.5	1985	WCC	Suspected NAPL below sewer bedding.
MW-19	10.0 - 11.0	1986	WCC	Boring log description. Oily black NAPL.
MW-19	31.0 - 31.5	1986/87	WCC	NAPL survey. Oily black odorous NAPL. Sampled.

TABLE 9.2

CHEMICAL ANALYSES OF HNAPL, OCC PROPERTY
102ND STREET LANDFILL
All data in Weight Percent

Sample No.	OW12-80	OW27-80	OW27-86	OW27-87	OW38-85
Sample Date	4-13-87	1980	5-09-86	4-09-87	4-13-87
COMPOUND					
ALIPHATIC HYDROCARBONS (unidentified)					0.53
Cyclohexadecane					0.46
Cyclohexane					
Dimethylcyclohexane		0.7			
Hexane	0.024	2.2		0.0032	
Hexadecane					0.27
Methylcyclopentane	0.0041				
Trimethylpentene				0.0104	0.053
AROMATIC HYDROCARBONS					
Benzene	0.021				0.07
Benzoic acid					
1,1-biphenyl		0.8			
Diphenyl ether					
Naphthalene					
Toluene	0.079	0.7		0.36	0.037
CHLORINATED AROMATIC HYDROCARBONS (unidentified)	28.6			0.016	
Chlorobenzene	0.14			0.08	0.64
Dichlorobenzene	0.37	1.3		0.16	1.9
Trichlorobenzene	0.038	2.2		0.24	7
Tetrachlorobenzene		3		0.48	33.3
Pentachlorobenzene				0.18	11
Hexachlorobenzene		2.5	0.13	0.74	0.52
Chloromethylbenzene	0.47				0.046
Bromodichlorobenzene					0.056
Trichloro(methyl, ethyl) benzene	0.25			0.4	
Trichloropropylbenzene		1.2			
Chloroethylbenzene					
Dichloroethylbenzene					
Trichloromethoxybenzene					

TABLE 9.2 (Continued)

Sample No.	OW12-80	OW27-80	OW27-86	OW27-87	OW38-85
Sample Date	4-13-87	1980	5-09-86	4-09-87	4-13-87
COMPOUND					
Chlorotoluene	1.72	2.1	0.38	0.43	
Dichlorotoluene	0.789				
Trichlorotoluene	0.063				
Tetrachlorotoluene					
Pentachlorotoluene					
2,4,5-Trichlorophenol					
2,4,6-Trichlorophenol					
Chloronaphthalene					
Dichloronaphthalene					
Trichloronaphthalene					
Chlorobenzotrifluoride					
Dichlorobiphenyl					
Tetrachlorothiophene					0.21
Trichlorobiphenyl					0.24
Tetrachlorobiphenyl					0.07
Pentachlorocyclohexene					0.54
Chlorobenzaldehyde	0.13				
CHLORINATED ALIPHATIC HYDROCARBONS (unidentified)					
Carbon tetrachloride					
Chloroform					
Hexachlorobutadiene		2.9	0.25	0.34	0.057
1-chlorododecane		49	7.8		
1-chlorotetradecane		25			
1-chlorohexadecane		4.9			
1-chloroctadecane		1.5	0.4		
Methylene chloride	0.06				
Trichloroethylene					
1,1,2,2-tetrachloroethane					
1,1,2,2-tetrachloroethene					
Tetrachloroethylene					

TABLE 9.2 (Continued)

Sample No. / Sample Date	QW12-80 4-13-87	QW27-80 1980	QW27-86 5-09-86	QW27-87 4-09-87	QW38-85 4-13-87
COMPOUND					
PESTICIDES					
alpha-HCCH					
beta-HCCH					
delta-HCCH					
gamma-HCCH					
Arochlor 1248					
Arochlor 1260					
p,p'-DDT					
p,p'-DDE	0.18				
p,p'-DDD					
Heptachlor					
OTHER (minor constituents, totaled)	9.05	1.9	16	0.97	1
WATER	63.8			56.3	0.23
TOTAL	108	102 (1)	25 (2)	65	58

Blanks indicate below detection limit.

(1) Not a mass balance. These are relative concentrations from the GC/MS scan.
(2) The low mass balance is the result of a large amount of water in the sample.

TABLE 9.2 (Continued)

Sample No. / Sample Date	OW47-85 1-09-86	OW47-85 4-13-87	BH3N-87	BH6N-87	BH7N-87
COMPOUND					
ALIPHATIC HYDROCARBONS (unidentified)		1.19	0.79	0.80	0.02
Cyclohexadecane					
Cyclohexane		0.0078			
Dimethylcyclohexane					
Hexane					0.01
Hexadecane					
Methylcyclopentane					
Trimethylpentene		0.0027			
AROMATIC HYDROCARBONS (unidentified)					0.017
Benzene	0.081	0.5	1.5	0.03	0.018
Benzoic acid			0.018		
1,1-biphenyl					
Diphenyl ether			0.17		
Naphthalene			0.017	0.053	
Toluene	0.021	0.037	0.031	0.015	0.015
CHLORINATED AROMATIC HYDROCARBONS (unidentified)			0.058		
Chlorobenzene	0.75	0.84	1.4	0.5	0.34
Dichlorobenzene	1.063	1.224	1.4	1.5	0.92
Trichlorobenzene	18	42	18.1	15.1	11.6
Tetrachlorobenzene	49.4	67	32.6	30.9	42.1
Pentachlorobenzene	6.4	17	4.5	3.6	6.8
Hexachlorobenzene	0.39	0.33	0.4		0.54
Chloromethylbenzene		0.22			
Bromodichlorobenzene					
Trichloro(methyl, ethyl) benzene					
Trichloropropylbenzene					
Chloroethylbenzene			0.032		
Dichloroethylbenzene			0.05		
Trichloromethoxybenzene			0.029		

TABLE 9.2 (Continued)

Sample No. / Sample Date	OW47-85 1-09-86	OW47-85 4-13-87	BH3N-87	BH6N-87	BH7N-87
COMPOUND					
Chlorotoluene			0.092	0.31	0.039
Dichlorotoluene		0.62	0.023	0.1	
Trichlorotoluene			0.036	0.1	0.013
Tetrachlorotoluene		0.35	0.047		
Pentachlorotoluene		0.17			
2,4,5-Trichlorophenol			0.013		0.019
2,4,6-Trichlorophenol					0.016
Chloronaphthalene			0.042	0.11	
Dichloronaphthalene		1	0.091	0.25	
Trichloronaphthalene		0.299	0.017	0.076	
Chlorobenzotrifluoride				0.077	
Dichlorobiphenyl		0.59			0.07
Tetrachlorothiophene		0.77			
Trichlorobiphenyl					0.01
Tetrachlorobiphenyl					
Pentachlorocyclohexene					
Chlorobenzaldehyde					
CHLORINATED ALIPHATIC HYDROCARBONS (unidentified)			0.051		
Carbon tetrachloride			0.012		
Chloroform			0.029		
Hexachlorobutadiene			0.02	0.02	
1-chlorododecane				0.11	
1-chlorotetradecane					
1-chlorohexadecane					
1-chloroctadecane					
Methylene chloride	2.4				
Trichloroethylene		0.015	0.024		
1,1,2,2-etrachloroethane	0.052	0.031	0.15		
1,1,2,2-tetrachloroethene		0.076	0.19		
Tetrachloroethylene	0.073				

TABLE 9.2 (Continued)

Sample No.	OW47-85	OW47-85	BH3N-87	BH6N-87	BH7N-87
Sample Date	1-09-86	4-13-87			
COMPOUND					
PESTICIDES					
alpha-HCCH	1.1		1.3	0.43	1.27
beta-HCCH			0.075	0.022	0.05
delta-HCCH	0.4		0.67	0.13	0.34
gamma-HCCH	0.58		0.069	0.19	0.19
Arochlor 1248			0.31	0.4	0.24
Arochlor 1260			0.21	0.31	0.24
p,p'-DDT			0.044	0.015	
p,p'-DDE					
p,p'-DDD			0.048	0.14	
Heptachlor			0.037	0.021	
OTHER (minor constituents, totaled)	0.085		0.51	0.99	0.36
WATER		0.08	0.73	1.32	18
TOTAL	81	135	66	58	83

Blanks indicate below detection limit.

(1) Not a mass balance. These are relative concentrations from the GC/MS scan.
(2) The low mass balance is the result of a large amount of water in the sample.

TABLE 9.2 (Continued)

Page 1
Report Date: 04/27/89

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

102ND STREET
NAPL - DIOXIN ANALYSIS

Special Codes: D - FIELD DUPLICATE

Analytes:	Units:	Detection Limit:	08/19/87 BH 3M 87	08/19/87 BH 3M 87 DUP	05/08/86 BH 47 C 86	04/09/87 OW 27	04/13/87 OW 38	04/13/8 OW 47
Special Code:				D				
2,3,7,8-TETRACHLORO-DIBENZO-P-DIOXIN	ng/g	1	60	60	ND	ND	ND	10
TOTAL OTHER TETRACHLORODIBENZO-p-DIOXINS	ng/g	10	10	10	ND	20	ND	50
1,2,3,7,8-PENTACHLORODIBENZODIOXIN	ng/g	10	30	20	ND	ND	20	ND
TOTAL OTHER PENTACHLORODIBENZO-p-DIOXINS	ng/g	10	300	200	ND	5000	20	400
2,3,7,8,X,X HxCDD	ng/g	10	1000	1000	ND	2000	30	300
TOTAL OTHER HEXACHLORODIBENZO-p-DIOXINS	ng/g	10	2000	2000	ND	4000	100	1000
2,3,7,8,X,X,X HpCDD	ng/g	10	8000	8000	ND	1000	100	4000
TOTAL OTHER HEPTACHLORODIBENZO-p-DIOXINS	ng/g	10	5000	6000	ND	2000	100	3000
OCTACHLORODIBENZODIOXIN	ng/g	100	10000	10000	ND	610	100	6000
2,3,7,8-TETRACHLORODIBENZOFURAN	ng/g	1	200	40	ND	ND	ND	500
TOTAL OTHER TETRACHLORODIBENZOFURANS	ng/g	10	60	30	ND	ND	10	300
2,3,7,8,X PeCDF	ng/g	10	3000	2000	ND	100	5000	3000
TOTAL OTHER PENTACHLORODIBENZOFURANS	ng/g	10	1000	900	ND	100	2000	4000
2,3,7,8,X,X HxCDF	ng/g	10	6000	5000	10	200	10000	7000
TOTAL OTHER HEXACHLORODIBENZOFURANS	ng/g	10	1000	800	ND	1000	1000	2000
2,3,7,8,X,X,X HpCDF	ng/g	10	7000	8000	ND	5000	10000	12000
TOTAL OTHER HEPTACHLORODIBENZOFURANS	ng/g	10	3000	4000	ND	2000	3000	3000
OCTACHLORODIBENZOFURAN	ng/g	100	5000	6000	ND	700	2000	4000

ND - Not Detected above detection limit

TABLE 9-3

CHEMICAL ANALYSIS OF LNAPL, OCC PROPERTY
102ND STREET LANDFILL

SAMPLE: BH47C-86

SAMPLE DATE: May 8, 1986

ALIPHATIC HYDROCARBONS	95
PESTICIDES	
Arochlor 1260	0.002
Water	1
TOTAL	96

WM-4M

TABLE 9.4

CHEMICAL ANALYSES OF HNAPL, OLIN PROPERTY
102ND STREET LANDFILL
All data in Weight Percent

Site: / Sample Date:	MW-19 5/01/86	MW-19 (1) 5/01/86	MW-19 4/09/87	MW-19 (1) 4/09/87
COMPOUND				
VOLATILE ORGANICS				
trans-1,2-Dichloroethene				
Chloroform			0.016	
Trichloroethene	0.0065	0.0045		
Benzene	0.1280	0.1623	2.62	2.54
1,1,2,2-Tetrachloroethane	0.0803	0.1165	0.189	0.152
Tetrachloroethene	0.0992	0.1258	0.234	0.215
Toluene	0.0083	0.0064		
Chlorobenzene	1.0208	1.0907	1.662	1.665
Ethylbenzene	0.0600	0.0569		
Carbon Tetrachloride				
BASE NEUTRALS				
2-Chloroethylether	0.0008	0.0103	0.015	0.012
1,3-Dichlorobenzene			0.535 (4)	0.502 (4)
1,4-Dichlorobenzene	0.2969 (5)	0.2037 (5)		
1,2-Dichlorobenzene	0.5899	0.4130	0.455	0.412
1,2,4-Trichlorobenzene	14.1533	24.0230	16.205	15.584
An Isomeric Trichlorobenzene	4.5066	6.2551	4.883	4.728
Naphthalene		0.0060		
Hexachlorobenzene	0.3012	0.3498	0.331	0.353
Phenanthrene		0.0102	0.009	0.008
Anthracene	0.0301		0.007	0.007
Fluoranthene	0.0198	0.0125	0.013	0.011
Pyrene	0.0159	0.0090	0.011	0.009
Benzo(a)anthracene	0.0107	0.0076	0.028 (2)	0.025 (2)
Chrysene	0.0105	0.0076		
Bis-2-(ethylhexyl)phthalate	0.0378	0.0256	0.012	0.008
Benzo(k)fluoranthene	0.0072 (3)	0.0057 (3)	0.029 (3)	0.027 (3)
Benzo(a)pyrene	0.0042			
1,2,3,4-Tetrachlorobenzene	20.8258	20.046	33.848	30.427
1,2,4,5-Tetrachlorobenzene	4.9539	3.8131	8.195	6.911
Pentachlorobenzene	6.3086	5.1061	9.654	7.441

TABLE 9.4 (Continued)

Site: / Sample Date:	MW-19 5/01/86	MW-19 (1) 5/01/86	MW-19 4/09/87	MW-19 (1) 4/09/87
COMPOUND				
PESTICIDES				
Arochlor-1254	0.1171	0.1259	0.049	0.043
Arochlor-1260	0.2247	0.2227	0.038	0.040
alpha-HCCH	2.4828	3.0393	1.066	1.005
beta-HCCH	0.1473	0.1978	0.032	0.030
gamma-HCCH	1.9923	2.4121	0.788	0.750
delta-HCCH	1.0256	1.2345	0.506	0.447
Heptachlor				
Endosulfan II	0.0045	0.0047		
p,p'-DDD	0.0096	0.0097		
p,p'-DDT	0.0106	0.0121		
TOTAL	59	69	81	73

Blanks indicate below detection limit.

(1) Lab replicate.
(2) Includes chrysene.
(3) Includes benzo(b)fluoranthene.
(4) Includes 1,4-dichlorobenzene.
(5) Includes 1,3-dichlorobenzene.

TABLE 9.4 (Continued)

Site: / Sample Date:	B-25 3/14/86	B-33 3/13/86	P-3 4/09/87	P-3 (1) 4/09/87
COMPOUND				
VOLATILE ORGANICS				
trans-1,2-Dichloroethene		0.0105		
Chloroform	0.0125		0.028	0.029
Trichloroethene				
Benzene	5.5444	0.1709	0.012	0.013
1,1,2,2-Tetrachloroethane	0.0119	0.4631	5.808	5.635
Tetrachloroethene	0.0147	0.5709	7.809	7.312
Toluene				
Chlorobenzene	5.7884	0.1827	0.074	0.078
Ethylbenzene				
Carbon Tetrachloride			0.088	0.083
BASE NEUTRALS				
2-Chloroethylether	0.0047	0.0098		
1,3-Dichlorobenzene	0.4686	0.1038	0.087 (4)	0.084 (4)
1,4-Dichlorobenzene	0.4878	0.1429		
1,2-Dichlorobenzene	1.1649	0.1746	0.070	0.065
1,2,4-Trichlorobenzene	38.2755	14.3488	4.620	4.809
An Isomeric Trichlorobenzene	13.2447	1.4367	1.558	1.434
Naphthalene				
Hexachlorobenzene	0.2021	0.5063	1.324	1.332
Phenanthrene				
Anthracene				
Fluoranthene				
Pyrene				
Benzo(a)anthracene				
Chrysene				
Bis-2-(ethylhexyl)phthalate	0.0156	0.0807		
Benzo(k)fluoranthene				
Benzo(a)pyrene				
1,2,3,4-Tetrachlorobenzene	3.5548	7.8489	62.375	72.567
1,2,4,5-Tetrachlorobenzene	10.3547	42.5893	11.452	11.548
Pentachlorobenzene	4.8277	12.1039	20.144	20.008

TABLE 9.4 (Continued)

Site: Sample Date:	B-25 3/14/86	B-33 3/13/86	P-3 4/09/87	P-3 (1) 4/09/87
COMPOUND				
PESTICIDES				
Arochlor-1254	0.0196		0.102	0.096
Arochlor-1260		0.2103	0.104	0.102
alpha-HCCH	0.5254	0.9817	0.936	0.787
beta-HCCH	0.0316	0.0299	0.009	0.010
gamma-HCCH	0.3328	0.3038	0.110	0.126
delta-HCCH	0.1007	0.0724	0.261	0.290
Heptachlor	0.0050			
Endosulfan II				
p,p'-DDD				
p,p'-DDT				
TOTAL	85	82	117	126

Blanks indicate below detection limit.

(1) Lab replicate.
(2) Includes chrysene.
(3) Includes benzo(b)fluoranthene.
(4) Includes 1,4-dichlorobenzene.

TABLE 9-5

CHLORINATED DIOXIN AND FURAN ANALYSES
FROM HNAPL SAMPLES, OLIN PROPERTY,
102ND STREET LANDFILL
Concentrations in ppm

		Well Number		
Chlorinated Dibenzodioxins (CDD)	TEF	B-25	B-33	MW-19
2,3,7,8-Tetra CDD (TCDD)	1	0.060 (0.060)	0.059 (0.059)	0.19 (0.19)
Total TCDD	0.01	0.060 (0.001)	0.10 (0.001)	0.78 (0.008)
Total Penta CDD (PECDD)	0.5	0.15 (0.075)	4.0 (2.0)	8.9 (4.45)
Total Hexa CDD (HXCDD)	0.04	2.2 (0.088)	26 (1.04)	27 (1.08)
Total Hepta CDD (HPCDD)	0.001	23 (0.023)	49 (0.049)	47 (0.047)
Total Octa CDD (OCDD)	0	25 (0.0)	430 (0)	54 (0)
Total EQ(1)		(0.247)	(3.149)	(5.775)
Chlorinated Dibenzofurans (CDF)				
2,3,7,8-Tetra CDF (TCDF)	0.1	0.11 (0.011)	0.25 (0.025)	0.64 (0.064)
Total TCDF	0.001	0.33 (0)	0.81 (0.001)	1.7 (0.002)
Total Penta CDF (PECDF)	0.1	0.95 (0.095)	2.8 (0.28)	8.1 (0.81)
Total Hexa CDF (HXCDF)	0.01	5.4 (0.054)	9.8 (0.098)	18 (0.18)
Total Hepta CDF (HPCDF)	0.001	11 (0.011)	28 (0.028)	48 (0.048)
Total Octa CDF (OCDF)	0	16 (0)	82 (0)	34 (0)
Total EQ(1)		(0.171)	(0.432)	(1.104)
Total EQ (CDD plus CDF)		(.418)	(3.58)	(6.88)

(1) Concentration in parentheses is the equivalent 2,3,7,8-TCDD. This value was obtained by multiplying each concentration by a toxicity equivalence factor (TEF). The TEF is an assigned relative toxicity which allows comparison of different compounds. 2,3,7,8-TCDD has been assigned a maximum TEF = 1.

TABLE 9.6

PHYSICAL PROPERTIES OF NAPL
102ND STREET LANDFILL

Sample Number	Density(3)	Viscosity (centistokes)	Temperature of Viscosity Measurement (°C)
B-33 (001)	1.483	- -	
B-25 (002)	1.349	1.50	25
MW-19 (1987) (1)	1.421	2.57	25
MW-19 (1986)	1.549	- -	
P-3	1.613	2.89	25
OW12-80	1.244	16.13	40
OW27-80 (1987)	1.006	0.66	40
OW27-80 (1986)	1.079	- -	
OW38-85	1.415	3.67	40
OW47-85 (1986)	1.324	5.29	40
OW47-85 (1987)	1.364	5.24	40
BH47B-86	- -	0.77	40
BH47C-86	0.883	9.05	40
BH3N-87	1.455	3.60	38
BH6N-87	1.359	- -	
BH7N-87	1.440	- -	

Liquid	Viscosity of Selected Liquids: Viscosity at 25°C	Viscosity at 40°C	Viscosity at 65.7°C
Carbon tetrachloride	0.58	0.48	-
Gasoline	0.62	0.55	-
Water(2)	0.90	0.66	-
Medium fuel oil	3.52	2.40	-
Olive oil	-	-	16.8
Tallow	-	-	19.6
Medium lubricating oil	96	41	-
Heavy fuel oil	118	53	-

(1) Inorganic residue = 500 ppm. Surface tension = 32.9 dynes/cm at 23°C.
(2) The viscosity of water at 20°C is 1.00.
(3) All density measurements at 25 ± 2° C.

TABLE 9.7

COMPARISONS OF SELECTED COMPOUNDS IN NAPL
102ND STREET LANDFILL
(All concentrations in weight percent)

Sample	Dichlorobenzenes	Trichlorobenzenes	Tetrachlorobenzenes	Pentachlorobenzenes
B-33	0.42	15.8	50.4	12.1
B-25	2.1	51.5	13.9	4.8
MW-19 (1986)	0.9	18.7	25.8	6.3
MW-19 (1986) replicate	0.6	30.3	23.9	5.1
MW-19 (1987)	.99	21.1	42.0	9.7
MW-19 (1987) replicate	.91	20.3	37.3	7.4
P-3	.16	6.2	73.8	20.1
P-3 (replicate)	.15	6.2	84.1	20.0
OW12	0.37	0.04	--	--
OW27-80	1.3	2.2	3	--
OW27-86	--	--	--	--
OW27-87	0.16	0.24	0.48	0.18
OW38-85	1.9	7	33.3	11
OW47-86	1.06	18	49.4	6.4
OW47-87	1.22	43	67	17
BH3N-87	1.4	18.1	32.6	4.5
BH6N-87	1.5	15.1	30.9	3.6
BH7N-87	0.92	11.6	42.1	6.8

WM-4M

TABLE 9.8

RELATIVE RATIOS OF SELECTED COMPOUNDS IN HNAPL
102ND STREET LANDFILL

Sample	Dichlorobenzenes / Tetrachlorobenzenes	Trichlorobenzenes / Tetrachlorobenzenes	Pentachlorobenzenes / Tetrachlorobenzenes	Trichlorobenzenes / Dichlorobenzenes
B-25	.15	3.7	.35	25
B-33	0.01	0.31	0.24	38
MW-19(1)	0.02	.70	0.22	27
P-3(2)	.002	0.08	0.25	40
OW12-79	--	--	--	0.10
OW27-80(2)	0.38	0.62	0.37	1.6
OW38-85	0.06	0.21	0.33	3.7
OW47-86	0.02	0.36	0.13	17
OW47-87	0.02	0.64	0.25	35
BH3N-87	0.04	0.56	0.14	12.9
BH6N-87	0.05	0.49	0.12	10.1
BH7N-87	0.02	0.28	0.16	12.6

(1) Mean of four available analyses used in calculation.
(2) Average of two available analyses used in calculation.

10.0 CHEMICAL LOADINGS

One of the primary objectives of the RI is to determine the pathways by which chemicals migrate from the Site into the surrounding environment and the rates at which migration occurs. Discussions in previous chapters of this report have identified the pathways. Based upon the information presented in previous chapters, the two pathways which need further evaluation are groundwater migration and migration via the 100th Street storm sewer. It is not possible to reliably estimate chemical loadings, if any, due to NAPL migration from the Site.

10.1 PURPOSE

The purposes of this chapter are to:

- present the assumptions and procedures used to estimate chemical migration to the environment via these two pathways, and
- estimate the rates of chemical migration in order to evaluate appropriate remedial alternatives for the Site.

10.2 GROUNDWATER

Groundwater flow is essentially directly to the Niagara River except for small areas along the north boundary of the Site which also ultimately discharge to the Niagara River. Consequently, in order to estimate chemical loadings to the River, it is appropriate to select wells in the permeable geologic units along the downgradient boundary of the Site as being representative of groundwater quality leaving the Site. For the groundwater flow calculations, specific wells along the boundary of the Site in the Fill and Alluvium were selected. Based upon the well selection, the horizontal flow zones for the Fill and Alluvium associated with each well were then drawn. The variability of chemistry in the wells along the discharge boundary was also considered in the selection of the representative wells and corresponding flow zones. The wells selected for the Fill and Alluvium are listed on the tables.

The Clay and Till have been identified to be aquitards (Sections 4.3.4 and 4.3.5) and are therefore insignificant in terms of horizontal groundwater flow and consequently chemical flux. As a result, the Clay and Till are not considered further. Subsequent discussions in this section will indicate why the Bedrock was not considered to be a route of chemical migration attributable to the Site.

10.2.1 SITE WATER BALANCE

The first step in estimating the subsurface mass flux of chemicals from the Site to the Niagara River is to estimate the groundwater flow rates for the hydrogeologic units. Once the flow rates were estimated, the chemical results for the extended survey sampling program were used to estimate the flux for those hydrogeologic units that provide significant pathways from the source (Site) to the discharge point (Niagara River).

The hydrogeologic units of potential concern at the Site, as encountered with depth from the surface, are:

i) Fill
ii) Alluvium
iii) Upper Bedrock

In order to quantify groundwater flow, the site water balance (SWB) needs to be reviewed. In general, a water balance can be represented by the equation:

$$SWB = P - ET - R + IF + DS - OF$$

where: $I = P-R-ET$

P	=	precipitation
R	=	surface runoff
ET	=	evapotranspiration
I	=	infiltration
DS	=	change in storage
IF	=	upgradient inflow
OF	=	downgradient outflow

For subsurface chemical flux estimates, the parameters of interest are I, DS, OF and IF. For this study, steady-state conditions will be assumed, thus DS = 0. Thus,

SWB = I + IF - OF

The assumptions used and calculations for the flow components shown on Figure 10.1 are presented in the following sections. The groundwater elevations measured on February 23, 1987 are typical of groundwater conditions and are used for the calculations. The groundwater flow from the Site toward the River remains relatively constant through the Fill and Alluvium (8). Thus, the choice of which date used to estimate chemical flux to the River only slightly affects the chemical flux estimates.

The groundwater flow rates are calculated using the Darcy equation:

$$Q = KiA$$

where	Q	=	flow(gpd)
	K	=	hydraulic conductivity (ft/day)
	i	=	gradient
	A	=	cross-sectional area of flow (ft^2)

The groundwater flux through the Upper Bedrock was not calculated in this manner. The only source of Site attributable chemical flux in the Bedrock is due to vertical percolation of groundwater from the Fill/Alluvium to the Upper Bedrock through the Clay/Till aquitard. Consequently, the Bedrock flux can be calculated by estimating the rate of groundwater percolation through the aquitard. The only change in groundwater discharge volume in the Bedrock at the downgradient Site boundary over that observed at the upgradient Site boundary is the addition of percolation flow through the Clay/Till aquitard.

The hydraulic conductivity estimates for the Fill and Alluvium, as listed on Table 4.3 and summarized on Table 4.4, range over two orders of magnitude for the Fill, and approximately four orders of magnitude for the Alluvium. It was deemed inappropriate to estimate groundwater flow for each flow zone using the hydraulic conductivity estimates for the individual wells in each zone, recognizing that the response tests were short-term tests which are indicative of conditions local to the tested well but possibly not representative of the overall conditions in that flow zone. In order to account for the areal variability observed in the hydraulic conductivity estimates across the Site, a geometric mean hydraulic conductivity estimate calculated using response test results from tested wells within the flow zone and immediately adjacent flow zones was used.

The other factor affecting flow, the gradient, has been estimated using the change in groundwater elevation between the north boundary of the Site and the River.

The calculated flows for each unit are presented in the following sub-sections:

Inflow - Fill ($Q_1 \approx$ 3,400 gpd)

The data presented on Figure 10.2 indicates that the general groundwater flow direction is to the Niagara River. The observed groundwater pattern on the Olin property is influenced by the 100th Street sewer and the ditch to the east of the Olin portion of the Site, and is more irregular than that observed on the OCC portion of the Site.

Using the flow zones shown on Figure 10.2 and the parameter values listed on Table 10.1, Q_1 was estimated to be 3400 gpd.

Inflow - Alluvium ($Q_2 \approx$ 600 gpd)

The groundwater contours on Figure 10.3 indicate that the general flow direction of groundwater in the Alluvium is to the Niagara River.

Using the flow zones shown on Figure 10.3 and the parameter values listed on Table 10.2, Q_2 was estimated to be 600 gpd.

The combined Fill and Alluvium inflow is 4000 gpd.

Inflow - Glaciolacustrine Clay and Glacial Till ($Q_3 \approx Q_4 \approx 0$)

Due to the low hydraulic conductivity values for these two units (see Table 4.3), insignificant horizontal flow occurs via these two units. For purposes of this analysis, Q_3 and Q_4 are assumed equal to zero.

Inflow - Bedrock (Q_5 ≈ not calculated)

As previously discussed, the groundwater flow in the Upper Bedrock has not been estimated using the Darcy Equation.

Leakage Through Clay/Till (Q_6 ≈ 200 gpd)

Assuming a downward vertical gradient of 0.087 (calculated from Table 4.7), an area of 963,000 ft^2 and a vertical hydraulic conductivity of 1×10^{-7} cm/sec, Q_6 = 200 gpd which is equivalent to an infiltration rate through the Clay/Till of 0.1 in/yr. The value of 1×10^{-7} cm/sec is larger than the highest laboratory determined hydraulic conductivity (7.4×10^{-8}) for the Clay/Till aquitard is therefore a conservative estimate of leakage through the Clay/Till. Laboratory determined hydraulic conductivities are usually considered more representative of vertical than horizontal hydraulic conductivities.

Outflow - Fill (Q_7 ≈ 9,100 gpd)

Using the flow zones shown on Figure 10.2 and the parameter values listed on Table 10.3, Q_7 was estimated to be 9,100 gpd.

Outflow - Alluvium (Q_8 ≈ 6,500 gpd)

Using the flow zones shown on Figure 10.3 and the parameter values listed on Table 10.4, Q_8 was estimated to be 6,500 gpd.

The combined Fill and Alluvium outflow is 15,600 gpd.

Outflow - Glaciolacustrine Clay and Glacial Till
(Q_9 ≈ Q_{10} ≈ 0)

Due to the low hydraulic conductivity values for these two units, insignificant horizontal flow occurs via these two units. Thus Q_9 and Q_{10} are assumed equal to zero for this analysis.

Outflow - Bedrock ($Q_{11} \approx Q_5$ + 200 gpd)

The Upper Bedrock outflow is equal to the Upper Bedrock inflow (Q5) plus the vertical percolation 200 gpd (Q_6) through the Clay/Till aquitard.

Infiltration ($Q_{12} = Q_7 + Q_8 + Q_{11} - Q_1 - Q_2 - Q_5$)

After the groundwater inflow and outflow for the Fill and Alluvium and the vertical percolation through the Clay/Till is estimated, the quantity of surficial recharge due to infiltration can be calculated to complete the SWB.

Applying all of the flow factors into the SWB, a recharge of approximately 7.2 inches per year infiltrates into the Site. An area of 963,000 ft^2 was used to calculate the recharge estimate. This estimate agrees favorably with infiltration estimates based on studies for other sites within the Niagara Falls area which range from 3 to 15 inches per year (29, 45, 34).

A sensitivity analysis was performed to determine whether the use of adjacent zone geometric mean hydraulic conductivity provides reasonable estimates of flow. The hydraulic conductivity variations used in the sensitivity analysis were:

i) minimum estimate of the flow zone and immediately adjacent flow zones, and
ii) maximum estimate of the flow zone and immediately adjacent flow zones.

These two scenarios provided unrealistically low (4.1 in/yr) and high (28 in/yr) recharge estimates based upon the meteorologic conditions (36 in/yr of rainfall) and Site conditions (flat topography with depressions in a material with a geometric mean hydraulic conductivity of 7.8×10^{-3} cm/sec). Due to Site conditions, it is expected that infiltration at the Site would range between 5 and 10 inches. Thus, it was deemed appropriate to estimate groundwater flow using the adjacent zone geometric mean.

The infiltration estimate (7.2 in/yr) for the flow scenario is realistic considering the Site and meteorological conditions previously discussed. To provide a range of estimated groundwater chemical flux, the flux will be estimated using infiltration values of 5.0, 7.2 and 10.0 inches/year.

10.2.2 DISCUSSION

The values for the SWB are listed on Table 10.5. The estimate for Q_6 (200 gpd) represents only 1 percent of the groundwater discharging from the Site through the Fill and Alluvium. Therefore, groundwater from the Fill (Q_7) and Alluvium (Q_8) directly to the Niagara River accounts for 99 percent of the discharge.

10.3 GROUNDWATER CHEMICAL FLUX ESTIMATES

The Aqueous Phase Liquid (APL) chemical flux estimates to the Niagara River are presented in this section. The upgradient chemical flux into the Site was not subtracted from the chemical flux leaving the Site, thus providing a conservative estimate.

Recognizing the inherent uncertainty in estimating the chemical mass flux rates, minimum, mean and maximum concentration values were used to provide a range of possible chemical mass flux rates.

NAPL investigations completed under the RI (Chapter 9) indicate that NAPL migration, if any, from the Site appears to be very limited. Therefore, it is not possible to reliably estimate the rate, if any, of NAPL migrating off-site. Some of the groundwater discharging from the Site has been in contact with the NAPL and therefore, the influence of NAPL on the flux calculations is included in the estimate.

As discussed in Section 10.2.1, the significant pathways of subsurface chemical migration via the groundwater are the Fill and Alluvium. It is assumed that lateral chemical migration through the Clay and Till is negligible due to the fine-grained nature of the units. The Upper Bedrock is not considered to be a significant pathway of Site attributable chemical flux due to:

i) the small quantity of groundwater infiltration to the Bedrock through the Clay/Till aquitard,

ii) attenuation in the Clay/Till would retard the flux of chemicals through the aquitard, and

iii) no SSI were detected above the survey levels in the bedrock wells sampled during the RI (see Table 5.15).

Therefore chemical migration via the Bedrock is negligible and assumed equal to zero for this analysis.

In order to estimate the chemical flux, the flow rates determined for each flow zone were factored with the associated chemical concentrations for the downgradient wells. The chemical data used in the flux calculations were taken from the extended survey. Although the well locations are not at the immediate River's edge, the effect of retardation was not considered in the Fill and Alluvium mass flux estimates. Thus, it is possible that chemical concentrations may decrease due to the distance between the well locations and the River. Due to the fact that not all of the parameters present in the groundwater discharging from the Site have been analyzed for, an alternative means of providing a reasonable flux calculation was employed. This method involved the use of TOC and TOX concentrations to approximate all of the organic chemicals present in the groundwater. The sum of these two measurements, with an appropriate correction factor to account for non-carbon and non-halogen compounds, can be used to estimate total chemical concentrations. The basis for the above methodology is presented in detail (9).

Combined TOX/TOC concentrations at the downgradient boundaries for three chemical scenarios; low case (lowest reported concentration), most likely case (mean concentration), and maximum case (maximum reported concentration), were calculated. These concentrations were then adjusted by a well-specific correction factor (WSCF). Contrary to the conditions that were expected to have occurred and presented in previously submitted documents (9), the SSI do not adequately account for all of the TOX/TOC. As shown on Tables 10.6 and 10.7, the percent of most likely SSI concentrations with respect to the summation of corrected most likely TOX/TOC concentrations vary from 0 to 40.3. This SSI-TOX/TOC balance is not as good as expected and consequently, the calculation of the WSCF using the presented methodology (9) is inappropriate. If all of the chemicals present in the groundwater were accounted for, it is expected that the WSCF would more realistically be approximately 0.75. The WSCF accounts for other components (P, O, N and H) which are present but are not measured by TOX/TOC. Thus, this value is used in order to provide a more reasonable estimate of the loadings.

One problem identified in estimating the SSI chemical fluxes was the uncertainty of how to deal with non detect concentrations. For the purpose of estimating the fluxes, the following methodology was employed. When calculating the mean concentration, if an SSI was detected at least once in a well, all other sampling events for which the particular SSI compound was not detected above the survey level were assigned a value of one-half the survey level and the minimum concentration was set at half the survey level. If an SSI was not detected for all analyses, a value of 0 was assigned for minimum, mean, and maximum concentrations. Duplicate analyses were averaged before inclusion in the calculation of the overall average. The summary statistics for TOX, TOC and SSI along with calculation assumptions presented in Tables 5.11 and 5.12 for the TOX and TOC and in Tables 5.13, 5.14 and 5.15 for SSI were calculated based on a sampling event basis. The minimum and maximum SSI values calculated for flux estimation were based on a compound by compound basis. Thus, the individual compound minimums and maximums, which may have been measured on different sampling events, were summed (e.g. OW34, Table 5.4 - minimum (48 μg/L), maximum (116 μg/L); Table 10.16 - minimum (25 μg/L), maximum (142 μg/L)). This procedure provides a larger range of concentration values than the procedure used in Chapter 5.

The groundwater flow rates for each flow zone, as listed on Tables 10.3 and 10.4 were used in conjunction with the TOX/TOC concentration values shown on Tables 10.6 and 10.7. Tables 10.8 and 10.9 list the estimated groundwater TOX/TOC mass efflux for the Fill and Alluvium. Similarly, the concentrations shown on Tables 10.10 and 10.11 for mercury, Tables 10.12 and 10.13 for phosphorus and Tables 10.14 and 10.15 for arsenic were combined with the same flow rates. Mass flux estimates for these three inorganic chemicals were calculated since they were chemicals of concern during the RI. Chemical concentrations for each individual SSI are listed on Table 10.16 for the Fill and Table 10.17 for the Alluvium. Mass flux estimates for the individual SSI are listed on Table 10.18 for the Fill and Table 10.19 for the Alluvium and are summarized by flow zone on Table 10.20. Only the extended survey data were used to estimate mass flux for the detected compound for these chemicals. Compounds not detected above the survey level were assigned values following the procedure used for SSI.

The mass flux estimates were calculated for nine scenarios; minimum, mean and maximum concentration combined with estimated infiltration rates of 5.0, 7.2 and 10.0 in/yr.

10.3.1 DISCUSSION

The results presented on Tables 10.8 through 10.20 and summarized on Tables 10..21 and 10.22 indicate the following:

a) Fill

i) an estimated TOX/TOC mass flux ranging from 2.7 to 27.6 lbs/day with a most likely value at an infiltration rate of 7.2 in/yr of 11.0 lbs/day;

ii) an estimated mercury mass flux ranging from 0.000012 to 0.000240 lbs/day with a most likely value at an infiltration rate of 7.2 in/yr of 0.000070 lbs/day;

iii) an estimated phosphorus mass flux ranging from 0.26 to 3.4 lbs/day with a most likely value at an infiltration rate of 7.2 in/yr of 1.0 lbs/day;

iv) an estimated arsenic mass flux ranging from 0 to 0.00265 lbs/day with a most likely value at an infiltration rate of 7.2 in/yr of 0.000763 lbs/day; and

v) an estimated SSI mass flux ranging from 0.11 to 0.32 lbs/day with a most likely value at an infiltration rate of 7.2 in/yr of 0.19 lbs/day.

Within the Fill, the TOX/TOC mass flux is relatively uniform through all the flow zones with slightly higher mass flux occurring in flows zones near the west and east Site boundaries. The majority of the TOX/TOC mass flux is due to TOC. Flow zones 3 to 10 account for greater than 80 percent of the TOX mass flux from the Site, with flow zone 7 itself accounting for approximately 65 percent of the TOX mass flux.

All of the mercury flux in the Fill occurs in flow zones 7 through 10, inclusive, with the flux distributed relatively uniformly among the four flow zones.

The majority of the phosphorus flux in the Fill occurs in flow zones 4, 6 and 7 (95 to 97 percent).

All of the SSI flux occurs in flow zones 4 through 10 with the exception of less than 1 percent that occurs in flow zone 11 (see Table 10.20).

The total mass flux for each flow zone for the mean concentration case with an infiltration rate of 7.2 in/yr. is shown on Figure 10.2.

Chemical mass flux via the seeps is not calculated separately since the seeps are the discharge of groundwater from the Fill at the bulkhead and are already accounted for in the Fill groundwater flow since the wells are upgradient of the seeps.

b) Alluvium

i) an estimated TOX/TOC mass flux ranging from 1.4 to 66.7 lbs/day with a most likely value at an infiltration rate of 7.2 in/yr of 13.9 lbs/day;

ii) an estimated mercury mass flux ranging from 0.000063 to 0.00043 lbs/day with a most likely value at an infiltration rate of 7.2 in/yr of 0.00018 lbs/day;

iii) an estimated phosphorus mass flux ranging from 1.62 to 79.0 lbs/day with a most likely value at an infiltration rate of 7.2 in/yr of 23.6 lbs/day;

iv) an estimated arsenic mass flux of 0 lbs/day since arsenic was not detected above the survey level in any of the alluvium wells used for estimation; and

v) an estimated SSI mass flux ranging from 1.06 to 4.43 lbs/day with a most likely value at an infiltration rate of 7.2 in/yr of 2.29 lbs/day.

Within the Alluvium, the majority of the TOX/TOC mass flux occurs through flow zones 5, 8 and 9 (77 to 95 percent) with the remaining percentage distributed relatively uniformly among the remaining nine flow zones. Flow zones 3 through 10 account for approximately 99 percent of TOX mass flux through the Alluvium from the Site.

All of the mercury flux in the Alluvium occurs in flow zones 7, 8 and 10 with the majority of the flux occurring in flow zone 8 (96 to 100 percent).

The majority of the phosphorus flux in the Alluvium occurs in flow zones 7 and 8 (98 to 99 percent).

All of the SSI flux occurs in flow zones 4 through 10 (see Table 10.20).

The estimates listed in Tables 10.21 and 10.22 indicate that TOX/TOC chemical flux via groundwater to the River occurs in approximately the same amounts for both the Fill and the

Alluvium. The TOX/TOC chemical mass flux range for the sum of the Fill and the Alluvium (4.1 to 94.3 lbs/day) is similar to that reported in (45) (6.4 - 39.5 lbs/day).

Mercury flux is essentially uniformly distributed between the Fill and Alluvium. Phosphorus flux is largest in the Alluvium with approximately an order of magnitude decrease in the flux from the Fill.

The TOX and SSI flux estimates indicate that chemical efflux attributable to the Site occurs predominantly in flow zones 3 through 10, the zones directly south of the Site.

10.4 100TH STREET STORM SEWER

The groundwater flow and chemical flux estimates for the 100th Street storm sewer that traverses the Olin portion of the Site are presented in this section.

The infiltration rate into the sewer was measured at 0.76 gpm (1094 gpd) (24) on December 19, 1979. Subsequent remeasurement of the infiltration rate on December 1, 1989 provided a measured flow rate of 4 gpm (5,760 gpd). Visual estimates of infiltration above the water level in the sewer range up to 8 gpm with an additional 1 gpm accounting for estimated infiltration below the water level into the sewer. To illustrate the effect of flow variability on chemical mass flux estimates, the two flow measurements (0.76 and 4 gpm) and the visual flow estimate of 9 gpm are utilized in estimating mass flux.

As reported (24), sewer infiltration samples were collected on December 19, 1979 by temporarily sealing the contributing upstream sections of the sewer at Buffalo Avenue and collecting the infiltrate to the sewer at the outfall. Following a similar procedure (Sections 6.2.4 and 6.3.3), sewer infiltration was collected and analyzed on December 1, 1989. The analytical results from the December 1, 1989 sampling event were used to estimate the chemical flux from the sewer.

A summary of the chemical analyses for the sewer infiltrate is presented on Table 10.23. Using the previously indicated flow rates and the above analyses, the estimated chemical mass fluxes are shown on Table 10.23.

The TOC/TOX sewer mass flux (0.98 lbs/day) attributable to the Site using the sewer infiltrate flow estimate of 4 gpm is approximately four percent of the most likely (infiltration rate of 7.2 in/yr) TOX/TOC Fill/Alluvium groundwater mass flux (24.9 lbs/day). The mass flux of soluble phosphorus, mercury and arsenic in the sewer attributable to the Site for the same flow rate is 0.0032 lbs/day (0.01%), 0.000022 lbs/day (8.9%) and 0 lbs/day (0%), respectively. The SSI mass flux for the same scenario is 0.07 lbs/day (2.8%).

10.5 SUMMARY

The major conclusions of this chapter are summarized as:

i) Groundwater flow through the Fill and Alluvium is the principal pathway of dissolved chemical migration from the Site to the environment.

ii) The Clay/Till aquitard acts as an effective barrier against vertical migration from the Fill/Alluvium to the Bedrock. This is demonstrated by the TOC/TOX chemical concentrations and the absence of any SSI observed above survey levels in the bedrock groundwater.

iii) Since no SSI were detected above the survey level in the Bedrock, groundwater flow through the Bedrock is not a significant pathway of chemical migration from the Site.

iv) The sewer appears to be a minor pathway of chemical migration from the Site to the environment. During the recent (11/89 and 12/89) storm sewer sampling investigation, NAPL was found in the lower sediment sample. The absence of NAPL in the surface sediment and infiltration water samples, and the results of infiltrate analysis, suggest that NAPL does not currently discharge to the pipe and exit the outfall as a separate phase.

v) NAPL migration, if any, from the Site appears to be very limited. It is not possible to reliably estimate the rate, and subsequent chemical loading ,if any, of NAPL migration off site.

vi) Estimated chemical mass fluxes for the various units using average concentrations with an infiltration rate of 7.2 in/yr for the FIll and Alluvium and a flow rate of 4 gpm for the sewer are:

Mass Flux (lbs/day)

	Fill	Alluvium	Sewer	Total
TOX/TOC	10.98	13.91	0.98	25.87
Mercury	0.000070	0.000177	0.000022	0.000269
Phosphorus	1.00	23.6	0.0032	24.6
Arsenic	0.000763	0.00	0	0.000763
SSI	0.19	2.29	0.070	2.55

Maximum estimated chemical loads calculated for the Site are 269% (96 lbs/day - TOX/TOC) and 92% (4.9 lbs/day - SSI) greater than the most likely estimates.

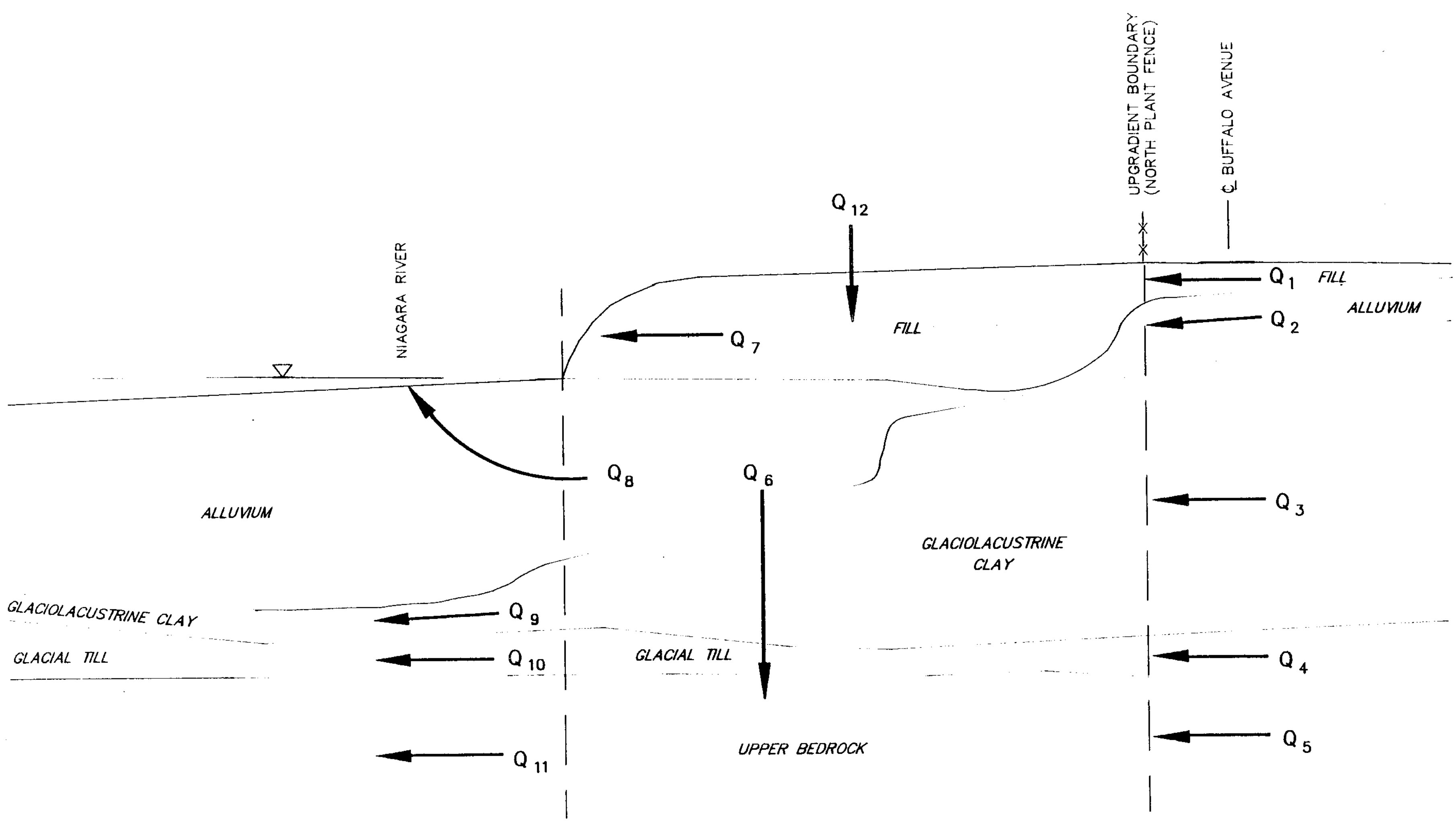


figure 10.1

CONCEPTUAL SITE WATER BALANCE
REMEDIAL INVESTIGATION
102nd Street Landfill Site

CRA/WCC

1431-13/07/88-47-D-0 (P-94)

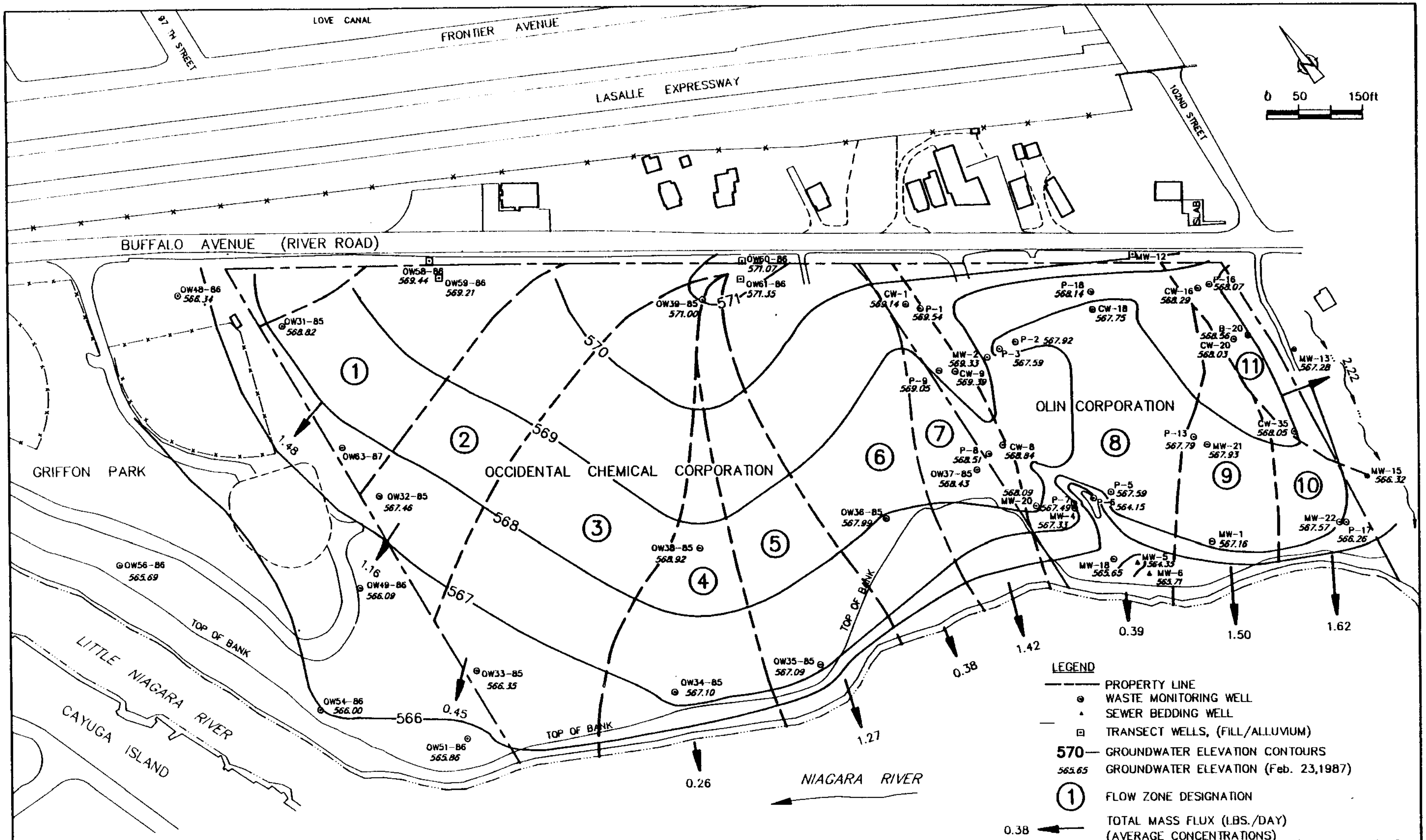


figure 10.2

FILL FLOW ZONES
REMEDIAL INVESTIGATION
102nd Street Landfill Site

NOTE: NIAGARA RIVER WATER ELEVATION (FEB. 23, 1987) 563.88

CRA/WCC

1431-13/07/88-47-D-1 (P111)

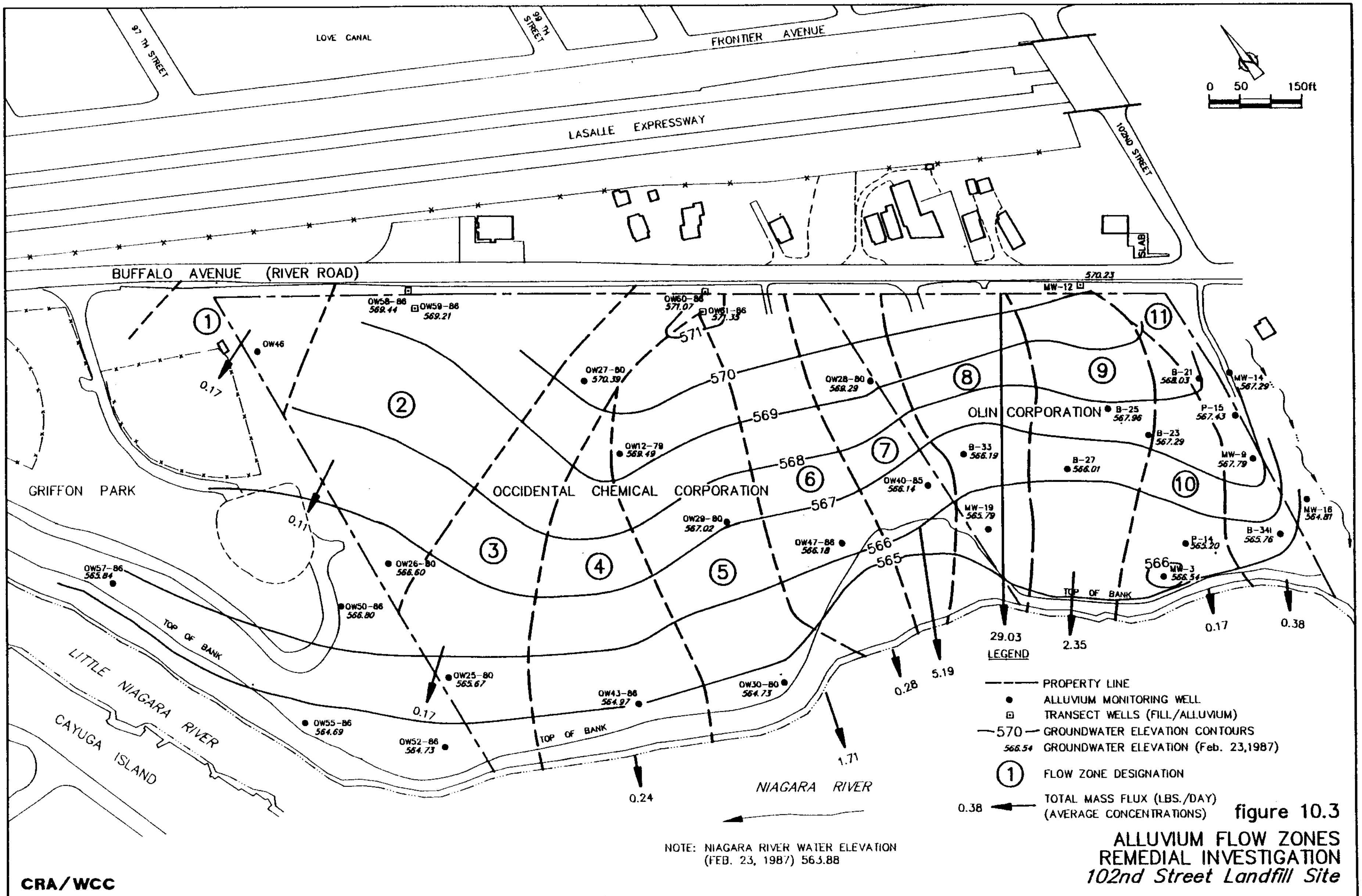


figure 10.3

ALLUVIUM FLOW ZONES
REMEDIAL INVESTIGATION
102nd Street Landfill Site

1431-13/07/88-47-D-1 (P112)

TABLE 10.1

GROUNDWATER INFLOW ESTIMATES FOR FILL (Q1)

Zone	Well	Gradient	Saturated [1] Thickness (ft)	Width (ft)	Hydraulic Conductivity cm/sec Geometric Mean Adj. Zones	Flow (gpd)
1	OW58/OW59	0.0072	2.3	210	7.0E-03 [a]	516
2	OW59/OW39	0.0068	5	150	2.8E-03 [b]	303
3	OW39	NA	5.4	0	NA	0
4	OW39	NA	5.4	0	NA	0
5	OW39	NA	5.4	0	NA	0
6	OW60/OW61	0.011	3.3	250	3.9E-03 [c]	750
7	OW-1/P-1	0.011	6	50	1.6E-03 [d]	112
8	P-18/CW-18	0.012	2	415	7.8E-03 *	1647
9	NA	NA	NA	0	NA	0
10	NA	NA	NA	0	NA	0
11	CW-16/P-16	0.0032	1.7	100	7.8E-03 *	90
						3419

Notes:

* Geometric mean from Table 4.3
[1] Average of saturated thickness for indicated wells.
[a] Wells OW58, OWW59, OW39 used to calculate Adjacent Zone Geometric Mean.
[b] Wells OW58, OW59, OW 39, OW60, OW61 used to calculate Adjacent Zone Geometric Mean.
[c] Wells OW59, OW39, OW60, OW61 and Site Geometric Mean from Table 4.3 used to calculate Adjacent Zone Geometric Mean.
[d] Wells OW60, OW61 and Site Geometric Mean from Table 4.3 used to calculate Adjacent Zone Geometric Mean.

TABLE 10.2

GROUNDWATER INFLOW ESTIMATES FOR ALLUVIUM (Q2)

Zone	Well	Gradient	Saturated [1] Thickness (ft)	Width (ft)	Hydraulic Conductivity cm/sec Geometric Mean Adj. Zones	Flow (gpd)
1	OW58/OW59	0.0073	1	240	3.5E-03	130
2	OW58/OW59/OW7	0.0073	2	370	2.2E-03 [a]	252
3	OW60/OW61	0.0075	1	70	1.6E-03 [b]	18
4	NA	NA	NA	0	NA	0
5	NA	NA	NA	0	NA	0
6	OW60/OW61	0.011	1	120	4.8E-04 [c]	13
7	B-1/CW-1/P-1	0.013	4	150	3.5E-04 [d]	58
8	B-1/CW-1/P-1	0.013	4	215	2.2E-04 *	52
9	MW-12	0.012	5	120	2.2E-04 *	34
10	NA	NA	NA	0	NA	0
11	MW-12/B-3	0.010	2.5	115	2.2E-04 *	13
						570

Notes:

* Geometric mean from Table 4.3

[1] Average of saturated thickness for indicated wells

[a] Wells OW58, OW59, OW60 used to calculate Adjacent Zone Geometric Mean

[b] Wells OW58, OW59, OW60, OW61 used to calculate Adjacent Zone Geometric Mean

[c] Wells OW60, OW61 and Site Geometric Mean used to calculate Adjacent Zone Geometric Mean

[d] Well OW61 and Site Geometric Mean used to calculate Adjacent Zone Geometric Mean

TABLE 10.3

GROUNDWATER OUTFLOW ESTIMATES FOR FILL (Q7)

Zone	Well	Gradient [1]	Saturated Thickness (ft)	Width (ft)	Hydraulic Conductivity cm/sec Geometric Mean Adj. Zones	Flow (gpd)
1	OW31/OW63	0.0072	3.5	310	6.9E-03 [a]	1143
2	OW32/OW49	0.0068	2.6	230	6.2E-03 [b]	535
3	OW33/OW51	0.009	2.4	330	4.0E-03 [c]	605
4	OW34	0.012	2.2	280	3.5E-03 [d]	549
5	OW35	0.010	3.7	230	2.7E-03 [e]	487
6	OW36	0.011	3.6	130	3.3E-03 [f]	360
7	OW37	0.011	4.7	110	5.7E-03 [g]	687
8	MW-18	0.012	2.4	190	3.2E-03 [h]	371
9	MW-1	0.016	3.5	200	7.8E-03 *	1852
10	MW-22	0.022	2.7	170	7.8E-03 *	1670
11	CW20/CW35	0.0032	5.2	290	7.8E-03 *	798
						9058

Notes:

* Geometric mean from Table 4.3.
[1] Gradient calculated from northern upgradient boundary to river.
[a] Wells OW31, OW32, 0W48, OW49, OW63 used to calculate Adjacent Zone Geometric Mean
[b] Wells OW31, OW32, OW33, OW49, OW51, OW63 used to calculate Adjacent Zone Geometric Mean
[c] Wells OW32, OW33, OW34, OW49, OW51, OW63 used to calculate Adjacent Zone Geometric Mean
[d] Wells OW51, OW34, OW35 used to calculate Adjacent Zone Geometric Mean
[e] Wells OW34, OW35, OW36 used to calculate Adjacent Zone Geometric Mean
[f] Wells OW35, OW36, OW37 used to calculate Adjacent Zone Geometric Mean
[g] Wells OW36, OW37, and Site Geometric Mean used to calculate Adjacent Zone Geometric Mean
[h] Well OW37 and Site Geometric Mean used to calculate Adjacent Zone Geometric Mean

TABLE 10.4

GROUNDWATER OUTFLOW ESTIMATES FOR ALLUVIUM (Q8)

Zone	Well	Gradient [1]	Saturated Thickness (ft)	Width (ft)	Hydraulic Conductivity cm/sec Geometric Mean Adj. Zones	Flow (gpd)
1	OW26	0.0073	9.0	260	2.2E-4 *	80
2	OW26/OW50	0.0073	11.1	310	1.0E-4 [a]	53
3	OW25/OW52	0.0075	11.3	240	1.5E-4 [b]	65
4	OW43	0.0110	18.0	290	2.2E-4 [c]	268
5	OW30	0.0110	21.0	290	3.1E-4 [d]	440
6	OW47	0.011	22.5	100	2.9E-4 [e]	152
7	OW40	0.012	19.5	45	1.4E-3 [f]	313
8	MW-19	0.013	20.0	130	3.8E-3 [g]	2724
9	MW-17	0.012	16.5	150	3.0E-3 [h]	1889
10	MW-3	0.012	8.3	230	5.1E-4 [i]	248
11	B-34I/MW-16	0.010	10.5	580	1.8E-4 [j]	232
						6464

Notes:

* Geometric mean from Table 4.3.
[1] Gradient calculated from northern upgradient boundary to river.
[a] Wells OW25, OW26, OW50, OW52 used to calculate Adjacent Zone Geometric Mean
[b] Wells OW25, OW26, OW43, OW50, OW52 used to calculate Adjacent Zone Geometric Mean
[c] Wells OW52, OW43, OW30 used to calculate Adjacent Zone Geometric Mean
[d] Wells OW43, OW30, OW47 used to calculate Adjacent Zone Geometric Mean
[e] Wells OW30, OW47, OW40 used to calculate Adjacent Zone Geometric Mean
[f] Wells OW47, OW40, MW-19 used to calculate Adjacent Zone Geometric Mean
[g] Wells OW40, MW-19, MW-17 used to calculate Adjacent Zone Geometric Mean
[h] Wells MW-19, MW-17, MW-3 used to calculate Adjacent Zone Geometric Mean
[i] Wells MW-17, MW-3, MW-9 used to calculate Adjacent Zone Geometric Mean
[j] Wells MW-3, MW-9 used to calculate Adjacent Zone Geometric Mean

TABLE 10.5

SUMMARY OF SITE WATER BALANCE COMPONENTS

Component	Inflow (Flow, gpd)	Outflow (Flow, gpd)
Q1	3419	
Q2	570	
Q3		
Q4		
Q5	* See below	
Q6	[178]	
Q7		9058
Q8		6464
Q9		
Q10		
Q11		178
	3989	15700
Q12	11711	
Infiltration (in/yr) Area = 9.63 E+5 ft^2		7.12

* Q11 = Q5 + Q6, therefore the bedrock outflow (Q11) is larger than the bedrock inflow (Q5) by 178 gpd.

TABLE 10.6

FILL WELL RESULTS
102ND STREET LANDFILL

ZONE	Well No.	TOX (mg/l) Min.	TOX (mg/l) Mean	TOX (mg/l) Max.	TOC (mg/l) Min.	TOC (mg/l) Mean	TOC (mg/l) Max.	TOX + TOC (mg/l) Min.	TOX + TOC (mg/l) Mean	TOX + TOC (mg/l) Max.	WSCF [1]	(TOX + TOC)/WSCF (mg/l) Min.	(TOX + TOC)/WSCF (mg/l) Mean	(TOX + TOC)/WSCF (mg/l) Max.	Mean SSI* (mg/l)	SSI x 100 / (TOX + TOC)/WSCF (percent) Mean
	Upgradient - No appropriate wells available.															
	Downgradient															
1	OW31/OW63	0.29	2.95	13.00	8.0	114.4	360.0	8.3	117.4	373.0	0.75	11.1	156.5	497.3	0.00	0.0
2	OW32/OW49	0.35	0.45	0.57	120.0	195.0	270.0	120.4	195.5	270.6	0.75	160.5	260.6	360.8	0.00	0.0
3	OW33	0.14	0.31	0.39	6.0	64.2	120.0	6.1	64.5	120.4	0.75	8.2	86.0	160.5	0.00	0.0
4	OW34	0.01	0.40	1.00	11.0	32.0	60.0	11.0	32.4	61.0	0.75	14.7	43.2	81.3	0.08	0.2
5	OW35	8.70	22.40	29.00	7.0	190.0	260.0	15.7	212.4	289.0	0.75	20.9	283.2	385.3	28.50	10.1
6	OW36	0.20	0.60	1.50	16.0	56.0	120.0	16.2	56.6	121.5	0.75	21.6	75.5	162.0	0.03	0.04
7	OW37	0.10	0.50	0.80	17.0	84.0	155.0	17.1	84.5	155.8	0.75	22.8	112.7	207.7	0.22	0.2
8	MW-18	0.70	4.50	7.30	20.0	82.0	160.0	20.7	86.5	167.3	0.75	27.6	115.3	223.1	9.23	8.0
9	MW-1	0.30	0.90	1.60	12.0	72.0	140.0	12.3	72.9	141.6	0.75	16.4	97.2	188.8	- -	- -
10	MW-22	0.10	0.90	2.40	20.0	85.0	160.0	20.1	85.9	162.4	0.75	26.8	114.5	216.5	1.40	1.2
11	MW-13	0.10	0.20	0.20	220.0	250.0	280.0	220.1	250.2	280.2	0.75	293.5	333.6	373.6	0.01	0.0

Notes:

[1] Well Specific Correction Factor.
* See Chapter 5
- - No data available

TABLE 10.7

ALLUVIUM WELL RESULTS
102ND STREET LANDFILL

ZONE	Well No.	TOX (mg/l) Min.	TOX (mg/l) Mean	TOX (mg/l) Max.	TOC (mg/l) Min.	TOC (mg/l) Mean	TOC (mg/l) Max.	TOX + TOC (mg/l) Min.	TOX + TOC (mg/l) Mean	TOX + TOC (mg/l) Max.	WSCF [1]	(TOX + TOC)/WSCF (mg/l) Min.	(TOX + TOC)/WSCF (mg/l) Mean	(TOX + TOC)/WSCF (mg/l) Max.	Mean SSI* (mg/l)	SSI x 100 / (TOX + TOC)/WSCF (percent) Mean
	Upgradient.															
	OW58	0.00	0.01	0.03	60.0	65.0	70.0	60.0	65.0	70.0	0.75	80.0	86.7	93.4	0	0.0
	OW60	0.00	0.01	0.03	40.0	45.0	50.0	40.0	45.0	50.0	0.75	53.3	60.0	66.7	0	0.0
	MW-12	0.00	0.10	0.30	85.0	85.0	85.0	85.0	85.1	85.3	0.75	113.3	113.5	113.7	0	0.0
	Downgradient															
1	OW26	0.47	1.00	1.30	86.0	189.3	230.0	86.5	190.3	231.3	0.75	115.3	253.7	308.4	0.00	0.0
2	OW26	0.47	1.00	1.30	86.0	189.3	230.0	86.5	190.3	231.3	0.75	115.3	253.7	308.4	0.00	0.0
3	OW25	0.13	0.28	0.40	44.0	150.0	230.0	44.1	150.3	230.4	0.75	58.8	200.4	307.2	0.00	0.0
4	OW43	0.30	2.00	2.60	15.0	73.0	120.0	15.3	75.0	122.6	0.75	20.4	100.0	163.5	1.70	1.7
5	OW30	6.40	23.00	32.00	43.0	300.0	850.0	49.4	323.0	882.0	0.75	65.9	430.7	1176.0	35.20	8.2
6	OW47	0.50	10.10	14.00	23.0	110.0	155.0	23.5	120.1	169.0	0.75	31.3	160.1	225.3	50.60	31.6
7	OW40	5.20	10.40	16.00	0.5	120.0	210.0	5.7	130.4	226.0	0.75	7.6	173.9	301.3	70.10	40.3
8	MW-19	2.00	10.90	16.00	15.0	270.0	1200.0	17.0	280.9	1216.0	0.75	22.7	374.5	1621.3	69.70	18.6
9	MW-17	5.80	9.60	16.00	27.0	86.0	180.0	32.8	95.6	196.0	0.75	43.7	127.5	261.3	17.20	13.5
10	MW-3	0.50	1.90	3.00	17.0	55.0	100.0	17.5	56.9	103.0	0.75	23.3	75.9	137.3	3.80	5.0
11	B-341	1.20	5.80	7.40	24.0	110.0	160.0	25.2	115.8	167.4	0.75	33.6	154.4	223.2	- -	0.0
11	MW-16	0.10	0.20	0.30	120.0	180.0	240.0	120.1	180.2	240.3	0.75	160.1	240.3	320.4	0.00	0.0

Notes:

[1] Well Specific Correction Factor
* See Chapter 5
- - No data available

TABLE 10.8

TOX/TOC CHEMICAL MASS EFFLUX

FILL

			(TOX + TOC)/WSCF (mg/l)			MASS EFFLUX FLOW (lbs/day) Q12= 7.2 in/yr			MASS EFFLUX FLOW (lbs/day) Q12= 5.0 in/yr			MASS EFFLUX FLOW (lbs/day) Q12= 10.0 in/yr		
Flow Zone	Well	Flow (gpd)	Min.	Mean	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.
1	OW31/OW63	1143	11.1	156.5	497.3	0.11	1.49	4.74	0.07	1.04	3.29	0.15	2.07	6.59
2	OW32/OW49	535	160.5	260.6	360.8	0.72	1.16	1.61	0.50	0.81	1.12	0.99	1.62	2.24
3	OW33	605	8.2	86.0	160.5	0.04	0.43	0.81	0.03	0.30	0.56	0.06	0.60	1.13
4	OW34	549	14.7	43.2	81.3	0.07	0.20	0.37	0.05	0.14	0.26	0.09	0.27	0.52
5	OW35	487	20.9	283.5	385.3	0.08	1.15	1.57	0.06	0.80	1.09	0.12	1.60	2.17
6	OW36	360	21.6	75.5	162.0	0.06	0.23	0.49	0.05	0.16	0.34	0.09	0.31	0.68
7	OW37	687	22.8	112.7	207.7	0.13	0.65	1.19	0.09	0.45	0.83	0.18	0.90	1.65
8	MW-18	371	27.6	115.3	223.1	0.09	0.36	0.69	0.06	0.25	0.48	0.12	0.50	0.96
9	MW-1	1852	16.4	97.2	188.8	0.25	1.50	2.92	0.18	1.04	2.03	0.35	2.09	4.05
10	MW-22	1670	26.8	114.5	216.5	0.37	1.60	3.02	0.26	1.11	2.09	0.52	2.22	4.19
11	MW-13	798	293.5	333.6	373.6	1.95	2.22	2.49	1.36	1.54	1.73	2.71	3.08	3.45
		9058				3.88	10.99	19.89	2.69	7.63	13.81	5.39	15.26	27.62

TABLE 10.9

TOX/TOC CHEMICAL MASS EFFLUX

ALLUVIUM

Flow Zone	Well	Flow (gpd)	(TOX + TOC)/WSCF (mg/l) Min.	Mean	Max.	MASS EFFLUX FLOW (lbs/day) Q12= 7.2 in/yr Min.	Most Likely	Max.	MASS EFFLUX FLOW (lbs/day) Q12= 5.0 in/yr Min.	Most Likely	Max.	MASS EFFLUX FLOW (lbs/day) Q12= 10.0 in/yr Min.	Most Likely	Max.
1	OW26	80	115.3	253.7	308.4	0.08	0.17	0.21	0.05	0.12	0.14	0.11	0.24	0.29
2	OW26	53	115.3	253.7	308.4	0.05	0.11	0.14	0.04	0.08	0.09	0.07	0.16	0.19
3	OW25	65	58.8	200.4	307.2	0.03	0.11	0.17	0.02	0.08	0.12	0.04	0.15	0.23
4	OW43	268	20.4	100.0	163.5	0.05	0.22	0.37	0.03	0.16	0.25	0.06	0.31	0.51
5	OW30	440	65.9	430.7	1176.0	0.24	1.58	4.32	0.17	1.10	3.00	0.34	2.20	6.00
6	OW47	152	31.3	160.1	225.3	0.04	0.20	0.29	0.03	0.14	0.20	0.06	0.28	0.40
7	OW40	313	7.6	173.9	301.3	0.02	0.45	0.79	0.01	0.32	0.55	0.03	0.63	1.09
8	MW-19	2724	22.7	374.5	1621.3	0.52	8.51	36.84	0.36	5.91	25.59	0.72	11.82	51.17
9	MW-17	1889	43.7	127.5	261.3	0.69	2.01	4.12	0.48	1.40	2.86	0.96	2.79	5.72
10	MW-3	248	23.3	75.9	137.3	0.05	0.16	0.28	0.03	0.11	0.20	0.07	0.22	0.39
11	B-34I/MW-16*	232	96.9	197.4	271.8	0.19	0.38	0.53	0.13	0.27	0.37	0.26	0.53	0.73
B-34I (individual (TOX+TOC)/WSCF)			33.6	154.4	223.2									
MW-16 (individual (TOX+TOC)/WSCF)			160.1	240.3	320.4									
		6464				1.95	13.91	48.03	1.35	9.66	33.36	2.70	19.32	66.71

NOTES:
* Average (TOX+TOC)/WSCF values for Zone 11

TABLE 10.10

CHEMICAL MASS EFFLUX: MERCURY

FILL

			CONCENTRATION (mg/l)			MASS EFFLUX FLOW (lbs/day) Q12= 7.2 in/yr			MASS EFFLUX FLOW (lbs/day) Q12= 5.0 in/yr			MASS EFFLUX FLOW (lbs/day) Q12= 10.0 in/yr		
Flow Zone	Well	Flow (gpd)	Min.	Mean	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.
1	OW31/OW63	1143	ND	ND	ND	--	--	--	--	--	--	--	--	--
2	OW32/OW49	535	ND	ND	ND	--	--	--	--	--	--	--	--	--
3	OW33	605	ND	ND	ND	--	--	--	--	--	--	--	--	--
4	OW34	549	ND	ND	ND	--	--	--	--	--	--	--	--	--
5	OW35	487	ND	ND	ND	--	--	--	--	--	--	--	--	--
6	OW36	360	ND	ND	ND	--	--	--	--	--	--	--	--	--
7	OW37	687	ND	0.0004	0.0006	--	2.29E-06	3.44E-06	--	1.59E-06	2.39E-06	--	3.18E-06	4.78E-06
8	MW-18	371	0.0024	0.0029	0.0033	7.43E-06	8.98E-06	1.02E-05	5.16E-06	6.23E-06	7.09E-06	1.03E-05	1.25E-05	1.42E-05
9	MW-1	1852	0.0006	0.0031	0.0075	9.27E-06	4.79E-05	1.16E-04	6.44E-06	3.33E-05	8.05E-05	1.29E-05	6.65E-05	0.000161
10	MW-22	1670	ND	0.0008	0.0031	--	1.11E-05	4.32E-05	--	7.74E-06	3E-05	--	1.55E-05	6E-05
11	MW-13	798	ND	ND	ND	--	--	--	--	--	--	--	--	--
		9058				1.67E-05	7.03E-05	1.73E-04	1.16E-05	4.88E-05	1.20E-04	2.32E-05	9.76E-05	2.40E-04

TABLE 10.11

CHEMICAL MASS EFFLUX: MERCURY

ALLUVIUM

Flow Zone	Well	Flow (gpd)	CONCENTRATION (mg/l)			MASS EFFLUX FLOW (lbs/day) Q12= 7.2 in/yr			MASS EFFLUX FLOW (lbs/day) Q12= 5.0 in/yr			MASS EFFLUX FLOW (lbs/day) Q12= 10.0 in/yr		
			Min.	Mean	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.
1	OW26	80	ND	ND	ND	--	--	--	--	--	--	--	--	--
2	OW26	53	ND	ND	ND	--	--	--	--	--	--	--	--	--
3	OW25	65	ND	ND	ND	--	--	--	--	--	--	--	--	--
4	OW43	268	ND	ND	ND	--	--	--	--	--	--	--	--	--
5	OW30	440	ND	ND	ND	--	--	--	--	--	--	--	--	--
6	OW47	152	ND	ND	ND	--	--	--	--	--	--	--	--	--
7	OW40	313	ND	0.0011	0.0015	--	2.87E-06	3.92E-06	--	1.99E-06	2.72E-06	--	3.99E-06	5.44E-06
8	MW-19	2724	0.0040	0.0076	0.0130	9.09E-05	1.73E-04	2.95E-04	6.31E-05	1.20E-04	2.05E-04	1.26E-04	2.40E-04	4.10E-04
9	MW-17	1889	ND	ND	ND	--	--	--	--	--	--	--	--	--
10	MW-3	248	ND	0.0009	0.0043	--	1.86E-06	8.90E-06	--	1.29E-06	6.18E-06	--	2.59E-06	1.24E-05
11	B-34I/MW-1	232	ND	ND	ND	--	--	--	--	--	--	--	--	--
B-34I (individual Mercury value)			ND	ND	ND									
MW-16 (individual Mercury value)			ND	ND	ND									
		6464				9.09E-05	1.77E-04	3.08E-04	6.31E-05	1.23E-04	2.14E-04	1.26E-04	2.46E-04	4.28E-04

Notes:

* average Mercury values for Zone 11

TABLE 10.12

CHEMICAL MASS EFFLUX: PHOSPHORUS

FILL

Flow Zone	Well	Flow (gpd)	CONCENTRATION (mg/l) Min.	Mean	Max.	MASS EFFLUX FLOW (lbs/day) Q12 = 7.2 in/yr Min.	Most Likely	Max.	MASS EFFLUX FLOW (lbs/day) Q12 = 5.0 in/yr Min.	Most Likely	Max.	MASS EFFLUX FLOW (lbs/day) Q12 = 10.0 in/yr Min.	Most Likely	Max.
1	OW31/OW63	1143	ND	0.27	1.80	- -	2.57E-03	1.72E-02	- -	1.79E-03	1.19E-02	- -	3.58E-03	2.38E-02
2	OW32/OW49	535	ND	0.24	0.40	- -	1.07E-03	1.79E-03	- -	7.44E-04	1.24E-03	- -	1.49E-03	2.48E-03
3	0W33	605	2.90	3.15	3.70	1.46E-02	1.59E-02	1.87E-02	1.02E-02	1.10E-02	1.30E-02	2.03E-02	2.21E-02	2.59E-02
4	OW34	549	3.70	12.70	43.00	1.69E-02	5.82E-02	1.97E-01	1.18E-02	4.04E-02	1.37E-01	2.35E-02	8.08E-02	2.74E-01
5	OW35	487	ND	0.37	1.10	- -	1.50E-03	4.47E-03	- -	1.04E-03	3.10E-03	- -	2.09E-03	6.21E-03
6	OW36	360	20.00	50.80	160.00	6.01E-02	1.53E-01	4.81E-01	4.17E-02	1.06E-01	3.34E-01	8.34E-02	2.12E-01	6.67E-01
7	OW37	687	49.00	134.20	300.00	2.81E-01	7.69E-01	1.72E+00	1.95E-01	5.34E-01	1.19E+00	3.90E-01	1.07E+00	2.39E+00
8	MW-18	371	ND	1.00	3.80	- -	3.09E-03	1.18E-02	- -	2.15E-03	8.17E-03	- -	4.30E-03	1.63E-02
9	MW-1	1852	ND	0.08	0.37	- -	1.21E-03	5.72E-03	- -	8.37E-04	3.97E-03	- -	1.67E-03	7.94E-03
10	MW-22	1670	ND	0.34	1.10	- -	4.71E-03	1.53E-02	- -	3.27E-03	1.06E-02	- -	6.54E-03	2.13E-02
11	MW-13	798	ND	0.53	0.85	- -	3.54E-03	5.66E-03	- -	2.46E-03	3.93E-03	- -	4.92E-03	7.86E-03
		9058				0.37	1.01	2.48	0.26	0.70	1.72	0.52	1.41	3.44

TABLE 10.13

CHEMICAL MASS EFFLUX: PHOSPHORUS

ALLUVIUM

Flow Zone	Well	Flow (gpd)	CONCENTRATION (mg/l)			MASS EFFLUX FLOW (lbs/day) Q12 = 7.2 in/yr			MASS EFFLUX FLOW (lbs/day) Q12 = 5.0 in/yr			MASS EFFLUX FLOW (lbs/day) Q12 = 10.0 in/yr		
			Min.	Mean	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.
1	OW26	80	1.60	3.25	4.40	1.07E-03	2.17E-03	2.94E-03	7.42E-04	1.51E-03	2.04E-03	1.48E-03	3.01E-03	4.08E-03
2	OW26	53	1.60	3.25	4.40	7.07E-04	1.44E-03	1.95E-03	4.91E-04	9.98E-04	1.35E-03	9.83E-04	2.00E-03	2.70E-03
3	OW25	65	27.00	107.50	200.00	1.46E-02	5.83E-02	1.08E-01	1.02E-02	4.05E-02	7.53E-02	2.03E-02	8.10E-02	1.51E-01
4	OW43	268	2.20	5.03	11.00	4.92E-03	1.12E-02	2.46E-02	3.42E-03	7.81E-03	1.71E-02	6.83E-03	1.56E-02	3.42E-02
5	OW30	440	ND	0.48	1.40	- -	1.76E-03	5.14E-03	- -	1.22E-03	3.57E-03	- -	2.45E-03	7.14E-03
6	OW47	152	3.30	8.38	22.00	4.18E-03	1.06E-02	2.79E-02	2.91E-03	7.38E-03	1.94E-02	5.81E-03	1.48E-02	3.87E-02
7	OW40	313	400.00	1746.00	3420.00	1.04E+00	4.56E+00	8.93E+00	7.25E-01	3.17E+00	6.20E+00	1.45E+00	6.33E+00	1.24E+01
8	MW-19	2724	55.00	833.00	2100.00	1.25E+00	1.89E+01	4.77E+01	8.68E-01	1.31E+01	3.31E+01	1.74E+00	2.63E+01	6.63E+01
9	MW-17	1889	0.64	1.34	2.00	1.01E-02	2.11E-02	3.15E-02	7.00E-03	1.47E-02	2.19E-02	1.40E-02	2.93E-02	4.38E-02
10	MW-3	248	ND	0.06	0.34	- -	1.26E-04	7.03E-04	- -	8.76E-05	4.88E-04	- -	1.75E-04	9.77E-04
11	B-34I/MW-16	232	ND	0.39	1.17	- -	7.45E-04	2.26E-03	- -	5.17E-04	1.57E-03	- -	1.03E-03	3.15E-03
B-34I (individual value)			ND	0.48	1.60									
MW-16 (individual value)			ND	0.29	0.74									
		6464				2.33	23.60	56.86	1.62	16.39	39.48	3.24	32.77	78.97

Notes:

* average Phosphorus values for Zone 11

TABLE 10.14

CHEMICAL MASS EFFLUX: ARSENIC

FILL

Flow Zone	Well	Flow (gpd)	CONCENTRATION (mg/l)			MASS EFFLUX FLOW (lbs/day) Q12 = 7.2 in/yr			MASS EFFLUX FLOW (lbs/day) Q12 = 5.0 in/yr			MASS EFFLUX FLOW (lbs/day) Q12 = 10.0 in/yr		
			Min.	Mean	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.
1	OW31/OW63	1143	ND	0.08	0.20	--	7.63E-04	1.91E-03	--	5.30E-04	1.32E-03	--	1.06E-03	2.65E-03
2	OW32/OW49	535	ND	ND	ND	--	--	--	--	--	--	--	--	--
3	OW33	605	ND	ND	ND	--	--	--	--	--	--	--	--	--
4	OW34	549	ND	ND	ND	--	--	--	--	--	--	--	--	--
5	OW35	487	ND	ND	ND	--	--	--	--	--	--	--	--	--
6	OW36	360	ND	ND	ND	--	--	--	--	--	--	--	--	--
7	OW37	687	ND	ND	ND	--	--	--	--	--	--	--	--	--
8	MW-18	371	ND	ND	ND	--	--	--	--	--	--	--	--	--
9	MW-1	1852	NR	NR	NR	--	--	--	--	--	--	--	--	--
10	MW-22	1670	ND	ND	ND	--	--	--	--	--	--	--	--	--
11	MW-13	798	ND	ND	ND	--	--	--	--	--	--	--	--	--
		9058				0.00	7.63E-04	1.91E-03	0.00	5.30E-04	1.32E-03	0.00	1.06E-03	2.65E-03

TABLE 10.15

CHEMICAL MASS EFFLUX: ARSENIC

ALLUVIUM

Flow Zone	Well	Flow (gpd)	CONCENTRATION (mg/l)			MASS EFFLUX FLOW (lbs/day) Q12 = 7.2 in/yr			MASS EFFLUX FLOW (lbs/day) Q12 = 5.0 in/yr			MASS EFFLUX FLOW (lbs/day) Q12 = 10.0 in/yr		
			Min.	Mean	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.	Min.	Most Likely	Max.
1	OW26	80	ND	ND	ND	--	--	--	--	--	--	--	--	--
2	OW26	53	ND	ND	ND	--	--	--	--	--	--	--	--	--
3	OW25	65	NA	NA	NA	--	--	--	--	--	--	--	--	--
4	OW43	268	ND	ND	ND	--	--	--	--	--	--	--	--	--
5	OW30	440	ND	ND	ND	--	--	--	--	--	--	--	--	--
6	OW47	152	ND	ND	ND	--	--	--	--	--	--	--	--	--
7	OW40	313	ND	ND	ND	--	--	--	--	--	--	--	--	--
8	MW-19	2724	ND	ND	ND	--	--	--	--	--	--	--	--	--
9	MW-17	1889	ND	ND	ND	--	--	--	--	--	--	--	--	--
10	MW-3	248	ND	ND	ND	--	--	--	--	--	--	--	--	--
11	B34I/MW16*	232	ND	ND	ND	--	--	--	--	--	--	--	--	--
B-34I (individual Arsenic value)			NR	NR	NR									
MW-16 (individual Arsenic value)			ND	ND	ND									
		6464				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes:
* average Arsenic values for Zone 11

Table 10.16

FILL SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

Analytes:	Units	Survey Levels	WELL OW31 Min	WELL OW31 Mean	WELL OW31 Max	WELL OW63 Min	WELL OW63 Mean	WELL OW63 Max
BENZENE	ug/l	5	0	0	0	0	0	0
TOLUENE	ug/l	5	0	0	0	0	0	0
CHLOROBENZENE	ug/l	5	0	0	0	0	0	0
2-CHLOROTOLUENE	ug/l	5	0	0	0	0	0	0
4-CHLOROTOLUENE	ug/l	5	0	0	0	0	0	0
1,2-DICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,4-DICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
HEXACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
2,5-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
3,4-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
PHENOL	ug/l	10	0	0	0	0	0	0
2-CHLOROPHENOL	ug/l	10	0	0	0	0	0	0
4-CHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2,4-DICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2,5-DICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	ug/l	50	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0

Table 10.16

FILL SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

Analytes:	Units	Survey Levels	WELL OW32 Min	WELL OW32 Mean	WELL OW32 Max	WELL OW49 Min	WELL OW49 Mean	WELL OW49 Max
BENZENE	ug/l	5	NA	NA	NA	2.5	3.8	5
TOLUENE	ug/l	5	NA	NA	NA	0	0	0
CHLOROBENZENE	ug/l	5	NA	NA	NA	0	0	0
2-CHLOROTOLUENE	ug/l	5	NA	NA	NA	0	0	0
4-CHLOROTOLUENE	ug/l	5	NA	NA	NA	0	0	0
1,2-DICHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
1,4-DICHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
1,2,3-TRICHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
1,2,4-TRICHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
HEXACHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
a-HEXACHLOROCYCLOHEXANE	ug/l	10	NA	NA	NA	0	0	0
b-HEXACHLOROCYCLOHEXANE	ug/l	10	NA	NA	NA	0	0	0
g-HEXACHLOROCYCLOHEXANE	ug/l	10	NA	NA	NA	0	0	0
d-HEXACHLOROCYCLOHEXANE	ug/l	10	NA	NA	NA	0	0	0
2,5-DICHLOROANALINE	ug/l	10	NA	NA	NA	0	0	0
3,4-DICHLOROANALINE	ug/l	10	NA	NA	NA	0	0	0
PHENOL	ug/l	10	NA	NA	NA	0	0	0
2-CHLOROPHENOL	ug/l	10	NA	NA	NA	0	0	0
4-CHLOROPHENOL	ug/l	10	NA	NA	NA	0	0	0
2,4-DICHLOROPHENOL	ug/l	10	NA	NA	NA	0	0	0
2,5-DICHLOROPHENOL	ug/l	10	NA	NA	NA	0	0	0
2,4,5-TRICHLOROPHENOL	ug/l	50	NA	NA	NA	0	0	0
2,4,6-TRICHLOROPHENOL	ug/l	10	NA	NA	NA	0	0	0
2-CHLOROBENZOIC ACID	ug/l	100	NA	NA	NA	0	0	0
3-CHLOROBENZOIC ACID	ug/l	100	NA	NA	NA	0	0	0
4-CHLOROBENZOIC ACID	ug/l	100	NA	NA	NA	0	0	0

Table 10.16

FILL SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

Analytes:	Units	Survey Levels	WELL OW33 Min	WELL OW33 Mean	WELL OW33 Max	WELL OW34 Min	WELL OW34 Mean	WELL OW34 Max
BENZENE	ug/l	5	0	0	0	2.5	5	10
TOLUENE	ug/l	5	0	0	0	0	0	0
CHLOROBENZENE	ug/l	5	0	0	0	2.5	7.7	18
2-CHLOROTOLUENE	ug/l	5	0	0	0	0	0	0
4-CHLOROTOLUENE	ug/l	5	0	0	0	0	0	0
1,2-DICHLOROBENZENE	ug/l	10	0	0	0	5	28.3	47
1,4-DICHLOROBENZENE	ug/l	10	0	0	0	5	13	19
1,2,3-TRICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	ug/l	10	0	0	0	5	26	38
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
HEXACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	5	6.7	10
g-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
2,5-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
3,4-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
PHENOL	ug/l	10	0	0	0	0	0	0
2-CHLOROPHENOL	ug/l	10	0	0	0	0	0	0
4-CHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2,4-DICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2,5-DICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	ug/l	50	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0

Table 10.16

FILL SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

Analytes:	Units	Survey Levels	WELL OW51 Min	WELL OW51 Mean	WELL OW51 Max	WELL OW35 Min	WELL OW35 Mean	WELL OW35 Max
BENZENE	ug/l	5	0	0	0	1800	2200	2600
TOLUENE	ug/l	5	0	0	0	1500	2000	2300
CHLOROBENZENE	ug/l	5	0	0	0	2600	2730	2800
2-CHLOROTOLUENE	ug/l	5	0	0	0	2.5	201	360
4-CHLOROTOLUENE	ug/l	5	0	0	0	2.5	168	300
1,2-DICHLOROBENZENE	ug/l	10	0	0	0	220	243	290
1,4-DICHLOROBENZENE	ug/l	10	0	0	0	420	490	600
1,2,3-TRICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	ug/l	10	0	0	0	770	847	960
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	0	0	0	380	460	550
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	0	0	0	97	106	120
HEXACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	550	637	730
b-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	50	85	140
g-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	50	72	100
d-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	260	313	400
2,5-DICHLOROANALINE	ug/l	10	0	0	0	6400	9830	14000
3,4-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
PHENOL	ug/l	10	0	0	0	50	60	66
2-CHLOROPHENOL	ug/l	10	0	0	0	190	240	280
4-CHLOROPHENOL	ug/l	10	0	0	0	720	813	1000
2,4-DICHLOROPHENOL	ug/l	10	0	0	0	1600	1900	2100
2,5-DICHLOROPHENOL	ug/l	10	0	0	0	65	1255	2100
2,4,5-TRICHLOROPHENOL	ug/l	50	0	0	0	150	177	190
2,4,6-TRICHLOROPHENOL	ug/l	10	0	0	0	190	213	230
2-CHLOROBENZOIC ACID	ug/l	100	0	0	0	600	737	860
3-CHLOROBENZOIC ACID	ug/l	100	0	0	0	530	690	860
4-CHLOROBENZOIC ACID	ug/l	100	0	0	0	1850	1990	1950

Table 10.16

FILL SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

Analytes:	Units	Survey Levels	WELL OW36 Min	WELL OW36 Mean	WELL OW36 Max	WELL OW37 Min	WELL OW37 Mean	WELL OW37 Max
BENZENE	ug/l	5	2.5	4.8	6	130	158	180
TOLUENE	ug/l	5	0	0	0	0	0	0
CHLOROBENZENE	ug/l	5	12	12.3	13	51	60	68
2-CHLOROTOLUENE	ug/l	5	7	8	10	0	0	0
4-CHLOROTOLUENE	ug/l	5	2.5	3.7	6	0	0	0
1,2-DICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,4-DICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
HEXACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
2,5-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
3,4-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
PHENOL	ug/l	10	0	0	0	0	0	0
2-CHLOROPHENOL	ug/l	10	0	0	0	0	0	0
4-CHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2,4-DICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2,5-DICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	ug/l	50	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	ug/l	100	0	0	0	50	98	123

Table 10.16

FILL SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

Analytes:	Units	Survey Levels	WELL MW-18 Min	WELL MW-18 Mean	WELL MW-18 Max	WELL MW-1 Min	WELL MW-1 Mean	WELL MW-1 Max
BENZENE	ug/l	5	1300	2450	3600	NA	NA	NA
TOLUENE	ug/l	5	0	0	0	NA	NA	NA
CHLOROBENZENE	ug/l	5	4700	5100	5500	NA	NA	NA
2-CHLOROTOLUENE	ug/l	5	0	0	0	NA	NA	NA
4-CHLOROTOLUENE	ug/l	5	0	0	0	NA	NA	NA
1,2-DICHLOROBENZENE	ug/l	10	220	265	310	NA	NA	NA
1,4-DICHLOROBENZENE	ug/l	10	270	380	490	NA	NA	NA
1,2,3-TRICHLOROBENZENE	ug/l	10	0	0	0	NA	NA	NA
1,2,4-TRICHLOROBENZENE	ug/l	10	31	40	49	NA	NA	NA
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	0	0	0	NA	NA	NA
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	0	0	0	NA	NA	NA
HEXACHLOROBENZENE	ug/l	10	0	0	0	NA	NA	NA
a-HEXACHLOROCYCLOHEXANE	ug/l	10	200	220	240	NA	NA	NA
b-HEXACHLOROCYCLOHEXANE	ug/l	10	31	31	31	NA	NA	NA
g-HEXACHLOROCYCLOHEXANE	ug/l	10	44	67	90	NA	NA	NA
d-HEXACHLOROCYCLOHEXANE	ug/l	10	390	455	520	NA	NA	NA
2,5-DICHLOROANALINE	ug/l	10	13	14	15	NA	NA	NA
3,4-DICHLOROANALINE	ug/l	10	0	0	0	NA	NA	NA
PHENOL	ug/l	10	39	54	69	NA	NA	NA
2-CHLOROPHENOL	ug/l	10	24	30	36	NA	NA	NA
4-CHLOROPHENOL	ug/l	10	62	69	75	NA	NA	NA
2,4-DICHLOROPHENOL	ug/l	10	31	54	76	NA	NA	NA
2,5-DICHLOROPHENOL	ug/l	10	0	0	0	NA	NA	NA
2,4,5-TRICHLOROPHENOL	ug/l	50	0	0	0	NA	NA	NA
2,4,6-TRICHLOROPHENOL	ug/l	10	0	0	0	NA	NA	NA
2-CHLOROBENZOIC ACID	ug/l	100	0	0	0	NA	NA	NA
3-CHLOROBENZOIC ACID	ug/l	100	0	0	0	NA	NA	NA
4-CHLOROBENZOIC ACID	ug/l	100	0	0	0	NA	NA	NA

Table 10.16

FILL SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

Analytes:	Units	Survey Levels	WELL MW-22			WELL MW-13*		
			Min	Mean	Max	Min	Mean	Max
BENZENE	ug/l	5	2.5	24	58	0	0	0
TOLUENE	ug/l	5	0	0	0	0	0	0
CHLOROBENZENE	ug/l	5	1000	1030	1100	8	9.7	11
2-CHLOROTOLUENE	ug/l	5	0	0	0	0	0	0
4-CHLOROTOLUENE	ug/l	5	0	0	0	0	0	0
1,2-DICHLOROBENZENE	ug/l	10	15	21	27	0	0	0
1,4-DICHLOROBENZENE	ug/l	10	15	21	29	0	0	0
1,2,3-TRICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
HEXACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	ug/l	10	5	36	67	0	0	0
b-HEXACHLOROCYCLOHEXANE	ug/l	10	32	37	47	0	0	0
g-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	ug/l	10	66	86	101	0	0	0
2,5-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
3,4-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
PHENOL	ug/l	10	0	0	0	0	0	0
2-CHLOROPHENOL	ug/l	10	30	37	45	0	0	0
4-CHLOROPHENOL	ug/l	10	58	71	91	0	0	0
2,4-DICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2,5-DICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	ug/l	50	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0

* CW20/CW35 were not included in the extended survey

Table 10.17

ALLUVIUM SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

			WELL OW26			WELL OW25		
Analytes:	Units	Survey Levels	Min	Mean	Max	Min	Mean	Max
BENZENE	ug/l	5	NA	NA	NA	0	0	0
TOLUENE	ug/l	5	NA	NA	NA	0	0	0
CHLOROBENZENE	ug/l	5	NA	NA	NA	0	0	0
2-CHLOROTOLUENE	ug/l	5	NA	NA	NA	0	0	0
4-CHLOROTOLUENE	ug/l	5	NA	NA	NA	0	0	0
1,2-DICHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
1,4-DICHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
1,2,3-TRICHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
1,2,4-TRICHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
HEXACHLOROBENZENE	ug/l	10	NA	NA	NA	0	0	0
a-HEXACHLOROCYCLOHEXANE	ug/l	10	NA	NA	NA	0	0	0
b-HEXACHLOROCYCLOHEXANE	ug/l	10	NA	NA	NA	0	0	0
g-HEXACHLOROCYCLOHEXANE	ug/l	10	NA	NA	NA	0	0	0
d-HEXACHLOROCYCLOHEXANE	ug/l	10	NA	NA	NA	0	0	0
2,5-DICHLOROANALINE	ug/l	10	NA	NA	NA	0	0	0
3,4-DICHLOROANALINE	ug/l	10	NA	NA	NA	0	0	0
PHENOL	ug/l	10	NA	NA	NA	0	0	0
2-CHLOROPHENOL	ug/l	10	NA	NA	NA	0	0	0
4-CHLOROPHENOL	ug/l	10	NA	NA	NA	0	0	0
2,4-DICHLOROPHENOL	ug/l	10	NA	NA	NA	0	0	0
2,5-DICHLOROPHENOL	ug/l	10	NA	NA	NA	0	0	0
2,4,5-TRICHLOROPHENOL	ug/l	50	NA	NA	NA	0	0	0
2,4,6-TRICHLOROPHENOL	ug/l	10	NA	NA	NA	0	0	0
2-CHLOROBENZOIC ACID	ug/l	100	NA	NA	NA	0	0	0
3-CHLOROBENZOIC ACID	ug/l	100	NA	NA	NA	0	0	0
4-CHLOROBENZOIC ACID	ug/l	100	NA	NA	NA	0	0	0

Table 10.17

ALLUVIUM SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

			WELL OW43			WELL OW30		
Analytes:	Units	Survey Levels	Min	Mean	Max	Min	Mean	Max
BENZENE	ug/l	5	76	84	98	3600	3650	3700
TOLUENE	ug/l	5	0	0	0	0	0	0
CHLOROBENZENE	ug/l	5	1000	1100	1300	8200	8350	8500
2-CHLOROTOLUENE	ug/l	5	0	0	0	0	0	0
4-CHLOROTOLUENE	ug/l	5	0	0	0	0	0	0
1,2-DICHLOROBENZENE	ug/l	10	15	20	22	140	180	220
1,4-DICHLOROBENZENE	ug/l	10	94	145	180	3000	3900	4800
1,2,3-TRICHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	ug/l	10	600	607	620	450	615	780
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
HEXACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	0	0	0
2,5-DICHLOROANALINE	ug/l	10	17	19	21	6700	9850	13000
3,4-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
PHENOL	ug/l	10	0	0	0	50	62	73
2-CHLOROPHENOL	ug/l	10	0	0	0	170	215	260
4-CHLOROPHENOL	ug/l	10	5	11	18	2500	3200	3900
2,4-DICHLOROPHENOL	ug/l	10	0	0	0	1000	1350	1700
2,5-DICHLOROPHENOL	ug/l	10	0	0	0	1000	1350	1700
2,4,5-TRICHLOROPHENOL	ug/l	50	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	ug/l	100	0	0	0	430	440	450
3-CHLOROBENZOIC ACID	ug/l	100	0	0	0	210	215	220
4-CHLOROBENZOIC ACID	ug/l	100	0	0	0	1880	1940	2000

Table 10.17

ALLUVIUM SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

			WELL OW47			WELL OW40		
Analytes:	Units	Survey Levels	Min	Mean	Max	Min	Mean	Max
BENZENE	ug/l	5	6800	11767	17000	46000	49000	52000
TOLUENE	ug/l	5	300	343	420	0	0	0
CHLOROBENZENE	ug/l	5	5200	5430	5800	14000	15000	16000
2-CHLOROTOLUENE	ug/l	5	2.5	114	190	0	0	0
4-CHLOROTOLUENE	ug/l	5	2.5	84	140	0	0	0
1,2-DICHLOROBENZENE	ug/l	10	620	807	1100	95	135	190
1,4-DICHLOROBENZENE	ug/l	10	1200	1450	1900	470	600	720
1,2,3-TRICHLOROBENZENE	ug/l	10	1300	2667	4500	60	99	140
1,2,4-TRICHLOROBENZENE	ug/l	10	4600	7767	15000	430	863	1200
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	2500	13500	40000	270	503	760
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	260	2203	6000	50	97	140
HEXACHLOROBENZENE	ug/l	10	5	105	360	0	0	0
a-HEXACHLOROCYCLOHEXANE	ug/l	10	340	532	840	48	63	81
b-HEXACHLOROCYCLOHEXANE	ug/l	10	91	99	120	0	0	0
g-HEXACHLOROCYCLOHEXANE	ug/l	10	230	425	720	14	18	25
d-HEXACHLOROCYCLOHEXANE	ug/l	10	500	763	1200	19	22	25
2,5-DICHLOROANALINE	ug/l	10	200	282	390	0	0	0
3,4-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
PHENOL	ug/l	10	69	125	180	5	14	25
2-CHLOROPHENOL	ug/l	10	10	16.3	22	0	0	0
4-CHLOROPHENOL	ug/l	10	5	51.3	180	470	493	510
2,4-DICHLOROPHENOL	ug/l	10	11	13.7	18	11	17	25
2,5-DICHLOROPHENOL	ug/l	10	5	11.7	18	5	14	25
2,4,5-TRICHLOROPHENOL	ug/l	50	50	68	80	0	0	0
2,4,6-TRICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0

Table 10.17

ALLUVIUM SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

			WELL MW-19			WELL MW-17		
Analytes:	Units	Survey Levels	Min	Mean	Max	Min	Mean	Max
BENZENE	ug/l	5	33000	53800	79000	2700	3680	4800
TOLUENE	ug/l	5	0	0	0	0	0	0
CHLOROBENZENE	ug/l	5	7600	9170	12000	8300	8970	9600
2-CHLOROTOLUENE	ug/l	5	0	0	0	0	0	0
4-CHLOROTOLUENE	ug/l	5	0	0	0	0	0	0
1,2-DICHLOROBENZENE	ug/l	10	30	337	540	250	422	550
1,4-DICHLOROBENZENE	ug/l	10	26	347	590	570	998	1300
1,2,3-TRICHLOROBENZENE	ug/l	10	94	746	1200	750	983	1200
1,2,4-TRICHLOROBENZENE	ug/l	10	370	2820	4800	3300	3730	4800
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	110	690	1100	660	833	970
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	21	144	240	100	120	130
HEXACHLOROBENZENE	ug/l	10	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	ug/l	10	42	312	480	240	290	340
b-HEXACHLOROCYCLOHEXANE	ug/l	10	5	63	98	59	85	100
g-HEXACHLOROCYCLOHEXANE	ug/l	10	40	342	550	25	36	42
d-HEXACHLOROCYCLOHEXANE	ug/l	10	78	600	970	200	280	350
2,5-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
3,4-DICHLOROANALINE	ug/l	10	0	0	0	0	0	0
PHENOL	ug/l	10	5	7	11	0	0	0
2-CHLOROPHENOL	ug/l	10	0	0	0	0	0	0
4-CHLOROPHENOL	ug/l	10	16	322	775	30	41	53
2,4-DICHLOROPHENOL	ug/l	10	5	18	39	5	16	28
2,5-DICHLOROPHENOL	ug/l	10	5	15	39	5	9	16
2,4,5-TRICHLOROPHENOL	ug/l	50	79	175	290	0	0	0
2,4,6-TRICHLOROPHENOL	ug/l	10	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	ug/l	100	0	0	0	0	0	0

Table 10.17

ALLUVIUM SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

			WELL MW-3			WELL B-341		
Analytes:	Units	Survey Levels	Min	Mean	Max	Min	Mean	Max
BENZENE	ug/l	5	260	297	350	NA	NA	NA
TOLUENE	ug/l	5	0	0	0	NA	NA	NA
CHLOROBENZENE	ug/l	5	2800	2870	3000	NA	NA	NA
2-CHLOROTOLUENE	ug/l	5	0	0	0	NA	NA	NA
4-CHLOROTOLUENE	ug/l	5	0	0	0	NA	NA	NA
1,2-DICHLOROBENZENE	ug/l	10	140	172	195	NA	NA	NA
1,4-DICHLOROBENZENE	ug/l	10	90	114	130	NA	NA	NA
1,2,3-TRICHLOROBENZENE	ug/l	10	0	0	0	NA	NA	NA
1,2,4-TRICHLOROBENZENE	ug/l	10	0	0	0	NA	NA	NA
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	0	0	0	NA	NA	NA
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	0	0	0	NA	NA	NA
HEXACHLOROBENZENE	ug/l	10	0	0	0	NA	NA	NA
a-HEXACHLOROCYCLOHEXANE	ug/l	10	23	51	72	NA	NA	NA
b-HEXACHLOROCYCLOHEXANE	ug/l	10	5	31	76	NA	NA	NA
g-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0	NA	NA	NA
d-HEXACHLOROCYCLOHEXANE	ug/l	10	120	143	160	NA	NA	NA
2,5-DICHLOROANALINE	ug/l	10	0	0	0	NA	NA	NA
3,4-DICHLOROANALINE	ug/l	10	0	0	0	NA	NA	NA
PHENOL	ug/l	10	0	0	0	NA	NA	NA
2-CHLOROPHENOL	ug/l	10	12	18	26	NA	NA	NA
4-CHLOROPHENOL	ug/l	10	79	89	96	NA	NA	NA
2,4-DICHLOROPHENOL	ug/l	10	5	10	20	NA	NA	NA
2,5-DICHLOROPHENOL	ug/l	10	0	0	0	NA	NA	NA
2,4,5-TRICHLOROPHENOL	ug/l	50	0	0	0	NA	NA	NA
2,4,6-TRICHLOROPHENOL	ug/l	10	5	7	10	NA	NA	NA
2-CHLOROBENZOIC ACID	ug/l	100	0	0	0	NA	NA	NA
3-CHLOROBENZOIC ACID	ug/l	100	0	0	0	NA	NA	NA
4-CHLOROBENZOIC ACID	ug/l	100	0	0	0	NA	NA	NA

Table 10.17

ALLUVIUM SSI CONCENTRATIONS

102ND STREET REMEDIAL INVESTIGATION

WELL
MW-16

Analytes:	Units	Survey Levels	Min	Mean	Max
BENZENE	ug/l	5	0	0	0
TOLUENE	ug/l	5	0	0	0
CHLOROBENZENE	ug/l	5	0	0	0
2-CHLOROTOLUENE	ug/l	5	0	0	0
4-CHLOROTOLUENE	ug/l	5	0	0	0
1,2-DICHLOROBENZENE	ug/l	10	0	0	0
1,4-DICHLOROBENZENE	ug/l	10	0	0	0
1,2,3-TRICHLOROBENZENE	ug/l	10	0	0	0
1,2,4-TRICHLOROBENZENE	ug/l	10	0	0	0
1,2,3,4-TETRACHLOROBENZENE	ug/l	10	0	0	0
1,2,4,5-TETRACHLOROBENZENE	ug/l	10	0	0	0
HEXACHLOROBENZENE	ug/l	10	0	0	0
a-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0
b-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0
g-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0
d-HEXACHLOROCYCLOHEXANE	ug/l	10	0	0	0
2,5-DICHLOROANALINE	ug/l	10	0	0	0
3,4-DICHLOROANALINE	ug/l	10	0	0	0
PHENOL	ug/l	10	0	0	0
2-CHLOROPHENOL	ug/l	10	0	0	0
4-CHLOROPHENOL	ug/l	10	0	0	0
2,4-DICHLOROPHENOL	ug/l	10	0	0	0
2,5-DICHLOROPHENOL	ug/l	10	0	0	0
2,4,5-TRICHLOROPHENOL	ug/l	50	0	0	0
2,4,6-TRICHLOROPHENOL	ug/l	10	0	0	0
2-CHLOROBENZOIC ACID	ug/l	100	0	0	0
3-CHLOROBENZOIC ACID	ug/l	100	0	0	0
4-CHLOROBENZOIC ACID	ug/l	100	0	0	0

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW31

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	0	0	0	0	0	0	0	0	0
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	0	0	0	0	0	0	0	0	0
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,4-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW63

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 7.2 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 10.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max
BENZENE	0	0	0	0	0	0	0	0	0
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	0	0	0	0	0	0	0	0	0
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,4-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW32

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4-TETRACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4,5-TETRACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
a-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
b-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
g-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
d-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,5-DICHLOROANALINE	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,4-DICHLOROANALINE	NA	NA	NA	NA	NA	NA	NA	NA	NA
PHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-CHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-CHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-DICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,5-DICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-CHLOROBENZOIC ACID	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-CHLOROBENZOIC ACID	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-CHLOROBENZOIC ACID	NA	NA	NA	NA	NA	NA	NA	NA	NA
	0	0	0	0	0	0	0	0	0

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW49

	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
Analytes:	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	7.78E-06	1.18E-05	1.55E-05	1.12E-05	1.70E-05	2.23E-05	1.56E-05	2.36E-05	3.1E-05
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	0	0	0	0	0	0	0	0	0
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,4-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0	1.18E-05	1.55E-05	0	1.70E-05	2.23E-05	0	2.36E-05	3.10E-05

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW33

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	0	0	0	0	0	0	0	0	0
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	0	0	0	0	0	0	0	0	0
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,4-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW51

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	0	0	0	0	0	0	0	0	0
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	0	0	0	0	0	0	0	0	0
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,4-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0	0	0	.0	0	0	0	0	0

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW34

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	7.95E-06	1.59E-05	3.18E-05	1.14E-05	2.29E-05	4.58E-05	1.59E-05	3.18E-05	6.36E-05
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	7.95E-06	2.45E-05	5.72E-05	1.14E-05	3.53E-05	8.24E-05	1.59E-05	4.9E-05	0.000114
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	1.59E-05	9E-05	0.000149	2.29E-05	1.30E-04	2.15E-04	3.18E-05	0.00018	0.000299
1,4-DICHLOROBENZENE	1.59E-05	4.13E-05	6.04E-05	2.29E-05	5.95E-05	8.70E-05	3.18E-05	8.27E-05	0.000121
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	1.59E-05	8.27E-05	0.000121	2.29E-05	1.19E-04	1.74E-04	3.18E-05	0.000165	0.000242
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	1.59E-05	2.13E-05	3.18E-05	2.29E-05	3.07E-05	4.58E-05	3.18E-05	4.26E-05	6.36E-05
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	7.95E-05	2.76E-04	4.52E-04	1.14E-04	3.97E-04	6.50E-04	1.59E-04	5.52E-04	9.03E-04

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW35

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	5.08E-03	6.21E-03	7.34E-03	7.31E-03	8.94E-03	1.06E-02	1.02E-02	1.24E-02	1.47E-02
TOLUENE	4.23E-03	5.64E-03	6.49E-03	6.09E-03	8.13E-03	9.34E-03	8.46E-03	1.13E-02	1.30E-02
CHLOROBENZENE	7.34E-03	7.70E-03	7.90E-03	1.06E-02	1.11E-02	1.14E-02	1.47E-02	1.54E-02	1.58E-02
2-CHLOROTOLUENE	7.05E-06	5.67E-04	1.02E-03	1.02E-05	8.17E-04	1.46E-03	1.41E-05	1.13E-03	2.03E-03
4-CHLOROTOLUENE	7.05E-06	4.74E-04	8.46E-04	1.02E-05	6.83E-04	1.22E-03	1.41E-05	9.48E-04	1.69E-03
1,2-DICHLOROBENZENE	6.21E-04	6.86E-04	8.18E-04	8.94E-04	9.87E-04	1.18E-03	1.24E-03	1.37E-03	1.64E-03
1,4-DICHLOROBENZENE	1.18E-03	1.38E-03	1.69E-03	1.71E-03	1.99E-03	2.44E-03	2.37E-03	2.76E-03	3.39E-03
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	2.17E-03	2.39E-03	2.71E-03	3.13E-03	3.44E-03	3.90E-03	4.34E-03	4.78E-03	5.42E-03
1,2,3,4-TETRACHLOROBENZENE	1.07E-03	1.30E-03	1.55E-03	1.54E-03	1.87E-03	2.23E-03	2.14E-03	2.60E-03	3.10E-03
1,2,4,5-TETRACHLOROBENZENE	2.74E-04	2.99E-04	3.39E-04	3.94E-04	4.31E-04	4.88E-04	5.47E-04	5.98E-04	6.77E-04
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	1.55E-03	1.80E-03	2.06E-03	2.23E-03	2.59E-03	2.97E-03	3.10E-03	3.59E-03	4.12E-03
b-HEXACHLOROCYCLOHEXANE	1.41E-05	2.40E-04	3.95E-04	2.03E-05	3.45E-04	5.69E-04	2.82E-05	4.79E-04	7.90E-04
g-HEXACHLOROCYCLOHEXANE	1.41E-05	2.03E-04	2.82E-04	2.03E-05	2.93E-04	4.06E-04	2.82E-05	4.07E-04	5.64E-04
d-HEXACHLOROCYCLOHEXANE	7.34E-04	8.83E-04	1.13E-03	1.06E-03	1.27E-03	1.63E-03	1.47E-03	1.77E-03	2.26E-03
2,5-DICHLOROANALINE	1.81E-02	2.77E-02	3.95E-02	2.60E-02	3.99E-02	5.69E-02	3.61E-02	5.55E-02	7.90E-02
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	1.41E-05	1.69E-04	1.86E-04	2.03E-05	2.44E-04	2.68E-04	2.82E-05	3.39E-04	3.72E-04
2-CHLOROPHENOL	5.36E-04	6.77E-04	7.90E-04	7.72E-04	9.75E-04	1.14E-03	1.07E-03	1.35E-03	1.58E-03
4-CHLOROPHENOL	2.03E-03	2.29E-03	2.82E-03	2.93E-03	3.30E-03	4.06E-03	4.06E-03	4.59E-03	5.64E-03
2,4-DICHLOROPHENOL	4.51E-03	5.36E-03	5.92E-03	6.50E-03	7.72E-03	8.53E-03	9.03E-03	1.07E-02	1.18E-02
2,5-DICHLOROPHENOL	1.83E-04	3.54E-03	5.92E-03	2.64E-04	5.10E-03	8.53E-03	3.67E-04	7.08E-03	1.18E-02
2,4,5-TRICHLOROPHENOL	4.23E-04	4.99E-04	5.36E-04	6.09E-04	7.19E-04	7.72E-04	8.46E-04	9.99E-04	1.07E-03
2,4,6-TRICHLOROPHENOL	5.36E-04	6.01E-04	6.49E-04	7.72E-04	8.65E-04	9.34E-04	1.07E-03	1.20E-03	1.30E-03
2-CHLOROBENZOIC ACID	1.69E-03	2.08E-03	2.43E-03	2.44E-03	2.99E-03	3.49E-03	3.39E-03	4.16E-03	4.85E-03
3-CHLOROBENZOIC ACID	1.50E-03	1.95E-03	2.43E-03	2.15E-03	2.80E-03	3.49E-03	2.99E-03	3.89E-03	4.85E-03
4-CHLOROBENZOIC ACID	5.22E-03	5.61E-03	5.50E-03	7.52E-03	8.08E-03	7.92E-03	1.04E-02	1.12E-02	1.10E-02
	0.059	0.080	0.101	0.085	0.116	0.146	0.119	0.161	0.202

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW36

	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
Analytes:	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	5.22E-06	0.00001	1.25E-05	7.51E-06	1.44E-05	1.80E-05	1.04E-05	2.00E-05	2.50E-05
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	0.000025	2.56E-05	2.71E-05	3.60E-05	3.69E-05	3.90E-05	5.00E-05	5.13E-05	5.42E-05
2-CHLOROTOLUENE	1.46E-05	1.67E-05	2.09E-05	2.10E-05	2.40E-05	3.00E-05	2.92E-05	3.33E-05	4.17E-05
4-CHLOROTOLUENE	5.21E-06	7.71E-06	1.25E-05	7.51E-06	1.11E-05	1.80E-05	1.04E-05	1.54E-05	2.5E-05
1,2-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,4-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	5.00E-05	6.00E-05	7.30E-05	7.20E-05	8.64E-05	1.05E-04	1.00E-04	1.20E-04	1.46E-04

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW37

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	5.17E-04	6.29E-04	7.16E-04	7.45E-04	9.06E-04	1.03E-03	1.03E-03	1.26E-03	1.43E-03
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	2.03E-04	2.39E-04	2.71E-04	2.92E-04	3.44E-04	3.90E-04	4.06E-04	4.78E-04	5.41E-04
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,4-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	1.99E-04	3.90E-04	4.90E-04	2.87E-04	5.62E-04	7.05E-04	3.98E-04	7.81E-04	9.79E-04
	9.19E-04	1.26E-03	1.48E-03	1.32E-03	1.81E-03	2.13E-03	1.84E-03	2.52E-03	2.95E-03

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
MW-18

	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
Analytes:	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	2.79E-03	5.27E-03	7.74E-03	4.02E-03	7.58E-03	1.11E-02	5.59E-03	1.05E-02	1.55E-02
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	1.01E-02	1.10E-02	1.18E-02	1.45E-02	1.58E-02	1.70E-02	2.02E-02	2.19E-02	2.36E-02
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	4.73E-04	5.70E-04	6.66E-04	6.81E-04	8.20E-04	9.59E-04	9.46E-04	1.14E-03	1.33E-03
1,4-DICHLOROBENZENE	5.80E-04	8.17E-04	1.05E-03	8.36E-04	1.18E-03	1.52E-03	1.16E-03	1.63E-03	2.11E-03
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	6.66E-05	8.60E-05	1.05E-04	9.59E-05	1.24E-04	1.52E-04	1.33E-04	1.72E-04	2.11E-04
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	4.30E-04	4.73E-04	5.16E-04	6.19E-04	6.81E-04	7.43E-04	8.60E-04	9.46E-04	1.03E-03
b-HEXACHLOROCYCLOHEXANE	6.66E-05	6.66E-05	6.66E-05	9.59E-05	9.59E-05	9.59E-05	1.33E-04	1.33E-04	1.33E-04
g-HEXACHLOROCYCLOHEXANE	9.46E-05	1.44E-04	1.93E-04	1.36E-04	2.07E-04	2.79E-04	1.89E-04	2.88E-04	3.87E-04
d-HEXACHLOROCYCLOHEXANE	8.38E-04	9.78E-04	1.12E-03	1.21E-03	1.41E-03	1.61E-03	1.68E-03	1.96E-03	2.24E-03
2,5-DICHLOROANALINE	2.79E-05	3.01E-05	3.22E-05	4.02E-05	4.33E-05	4.64E-05	5.59E-05	6.02E-05	6.45E-05
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	8.38E-05	1.16E-04	1.48E-04	1.21E-04	1.67E-04	2.14E-04	1.68E-04	2.32E-04	2.97E-04
2-CHLOROPHENOL	5.16E-05	6.45E-05	7.74E-05	7.43E-05	9.28E-05	1.11E-04	1.03E-04	1.29E-04	1.55E-04
4-CHLOROPHENOL	1.33E-04	1.48E-04	1.61E-04	1.92E-04	2.14E-04	2.32E-04	2.67E-04	2.97E-04	3.22E-04
2,4-DICHLOROPHENOL	6.66E-05	1.16E-04	1.63E-04	9.59E-05	1.67E-04	2.35E-04	1.33E-04	2.32E-04	3.27E-04
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0.0158	0.0198	0.0239	0.0228	0.0286	0.0344	0.0316	0.0397	0.0477

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
MW-1

	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
Analytes:	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4-TETRACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4,5-TETRACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
a-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
b-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
g-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
d-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,5-DICHLOROANALINE	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,4-DICHLOROANALINE	NA	NA	NA	NA	NA	NA	NA	NA	NA
PHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-CHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-CHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-DICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,5-DICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-CHLOROBENZOIC ACID	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-CHLOROBENZOIC ACID	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-CHLOROBENZOIC ACID	NA	NA	NA	NA	NA	NA	NA	NA	NA
	0	0	0	0	0	0	0	0	0

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
MW-22

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	2.42E-05	2.32E-04	5.61E-04	3.48E-05	3.34E-04	8.08E-04	4.84E-05	4.64E-04	1.12E-03
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	9.67E-03	9.96E-03	1.06E-02	1.39E-02	1.43E-02	1.53E-02	1.93E-02	1.99E-02	2.13E-02
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	1.45E-04	2.03E-04	2.61E-04	2.09E-04	2.93E-04	3.76E-04	2.90E-04	4.06E-04	5.22E-04
1,4-DICHLOROBENZENE	1.45E-04	2.03E-04	2.81E-04	2.09E-04	2.93E-04	4.04E-04	2.90E-04	4.06E-04	5.61E-04
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	4.84E-05	3.48E-04	6.48E-04	6.97E-05	5.02E-04	9.33E-04	9.67E-05	6.97E-04	1.30E-03
b-HEXACHLOROCYCLOHEXANE	3.10E-04	3.58E-04	4.55E-04	4.46E-04	5.15E-04	6.55E-04	6.19E-04	7.16E-04	9.09E-04
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	6.39E-04	8.32E-04	9.77E-04	9.19E-04	1.20E-03	1.41E-03	1.28E-03	1.66E-03	1.95E-03
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	2.90E-04	3.58E-04	4.35E-04	4.18E-04	5.15E-04	6.27E-04	5.80E-04	7.16E-04	8.71E-04
4-CHLOROPHENOL	5.61E-04	6.87E-04	8.80E-04	8.08E-04	9.89E-04	1.27E-03	1.12E-03	1.37E-03	1.76E-03
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0.0118	0.0132	0.0151	0.0170	0.0190	0.0218	0.0237	0.0264	0.0303

TABLE 10.18

FILL SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
MW-13

	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
Analytes:	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	0	0	0	0	0	0	0	0	0
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	3.70E-05	4.49E-05	5.08E-05	5.33E-05	6.46E-05	7.32E-05	7.40E-05	8.97E-05	1.02E-04
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,4-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	3.70E-05	4.49E-05	5.08E-05	5.33E-05	6.46E-05	7.32E-05	7.40E-05	8.97E-05	1.02E-04

TABLE 10.19

ALLUVIUM SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW26

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 7.2 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 10.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max
BENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4-TETRACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4,5-TETRACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA	NA	NA
a-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
b-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
g-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
d-HEXACHLOROCYCLOHEXANE	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,5-DICHLOROANALINE	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,4-DICHLOROANALINE	NA	NA	NA	NA	NA	NA	NA	NA	NA
PHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-CHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-CHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-DICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,5-DICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-CHLOROBENZOIC ACID	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-CHLOROBENZOIC ACID	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-CHLOROBENZOIC ACID	NA	NA	NA	NA	NA	NA	NA	NA	NA
	0	0	0	0	0	0	0	0	0

TABLE 10.19

ALLUVIUM SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW25

	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
Analytes:	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	0	0	0	0	0	0	0	0	0
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	0	0	0	0	0	0	0	0	0
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,4-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0

TABLE 10.19

ALLUVIUM SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW43

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 7.2 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 10.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max
BENZENE	1.18E-04	1.30E-04	1.52E-04	1.70E-04	1.88E-04	2.19E-04	2.36E-04	2.61E-04	3.04E-04
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	1.55E-03	1.71E-03	2.02E-03	2.24E-03	2.46E-03	2.91E-03	3.11E-03	3.42E-03	4.04E-03
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	2.33E-05	3.11E-05	3.42E-05	3.35E-05	4.47E-05	4.92E-05	4.66E-05	6.21E-05	6.83E-05
1,4-DICHLOROBENZENE	1.46E-04	2.25E-04	2.79E-04	2.10E-04	3.24E-04	4.02E-04	2.92E-04	4.50E-04	5.59E-04
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	9.31E-04	9.44E-04	9.65E-04	1.34E-03	1.36E-03	1.39E-03	1.86E-03	1.89E-03	1.93E-03
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	2.64E-05	2.95E-05	3.26E-05	3.80E-05	4.25E-05	4.70E-05	5.28E-05	5.90E-05	6.52E-05
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	7.76E-06	1.71E-05	2.79E-05	1.12E-05	2.46E-05	4.02E-05	1.55E-05	3.42E-05	5.58E-05
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0.00280	0.00309	0.00351	0.00404	0.00444	0.00505	0.00561	0.00617	0.00702

TABLE 10.19

ALLUVIUM SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW30

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	9.18E-03	9.30E-03	9.43E-03	1.32E-02	1.34E-02	1.36E-02	1.84E-02	1.86E-02	1.89E-02
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	2.09E-02	2.13E-02	2.17E-02	3.01E-02	3.06E-02	3.12E-02	4.18E-02	4.26E-02	4.33E-02
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	3.57E-04	4.59E-04	5.61E-04	5.14E-04	6.61E-04	8.08E-04	7.14E-04	9.18E-04	1.12E-03
1,4-DICHLOROBENZENE	7.65E-03	9.94E-03	1.22E-02	1.10E-02	1.43E-02	1.76E-02	1.53E-02	1.99E-02	2.45E-02
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	1.15E-03	1.57E-03	1.99E-03	1.65E-03	2.26E-03	2.86E-03	2.29E-03	3.14E-03	3.98E-03
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	1.71E-02	2.51E-02	3.31E-02	2.46E-02	3.62E-02	4.77E-02	3.42E-02	5.02E-02	6.63E-02
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	1.27E-04	1.58E-04	1.86E-04	1.84E-04	2.28E-04	2.68E-04	2.55E-04	3.16E-04	3.72E-04
2-CHLOROPHENOL	4.33E-04	5.48E-04	6.63E-04	6.24E-04	7.89E-04	9.54E-04	8.67E-04	1.10E-03	1.33E-03
4-CHLOROPHENOL	6.37E-03	8.16E-03	9.94E-03	9.18E-03	1.17E-02	1.43E-02	1.27E-02	1.63E-02	1.99E-02
2,4-DICHLOROPHENOL	2.55E-03	3.44E-03	4.33E-03	3.67E-03	4.96E-03	6.24E-03	5.10E-03	6.88E-03	8.67E-03
2,5-DICHLOROPHENOL	2.55E-03	3.44E-03	4.33E-03	3.67E-03	4.96E-03	6.24E-03	5.10E-03	6.88E-03	8.67E-03
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	1.10E-03	1.12E-03	1.15E-03	1.58E-03	1.62E-03	1.65E-03	2.19E-03	2.24E-03	2.29E-03
3-CHLOROBENZOIC ACID	5.35E-04	5.48E-04	5.61E-04	7.71E-04	7.89E-04	8.08E-04	1.07E-03	1.10E-03	1.12E-03
4-CHLOROBENZOIC ACID	4.79E-03	4.95E-03	5.10E-03	6.90E-03	7.12E-03	7.34E-03	9.58E-03	9.89E-03	1.02E-02
	0.0748	0.0900	0.1053	0.1077	0.1296	0.1516	0.1495	0.1800	0.2106

TABLE 10.19

ALLUVIUM SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW47

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 7.2 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 10.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max
BENZENE	5.99E-03	1.04E-02	1.50E-02	8.62E-03	1.49E-02	2.16E-02	1.20E-02	2.07E-02	2.99E-02
TOLUENE	2.64E-04	2.99E-04	3.70E-04	3.80E-04	4.31E-04	5.33E-04	5.28E-04	5.99E-04	7.40E-04
CHLOROBENZENE	4.58E-03	4.78E-03	5.11E-03	6.59E-03	6.89E-03	7.35E-03	9.16E-03	9.56E-03	1.02E-02
2-CHLOROTOLUENE	2.20E-06	1.00E-04	1.67E-04	3.17E-06	1.45E-04	2.41E-04	4.40E-06	2.01E-04	3.35E-04
4-CHLOROTOLUENE	2.20E-06	7.40E-05	1.23E-04	3.17E-06	1.07E-04	1.78E-04	4.40E-06	1.48E-04	2.47E-04
1,2-DICHLOROBENZENE	5.46E-04	7.11E-04	9.69E-04	7.86E-04	1.02E-03	1.39E-03	1.09E-03	1.42E-03	1.94E-03
1,4-DICHLOROBENZENE	1.06E-03	1.28E-03	1.67E-03	1.52E-03	1.84E-03	2.41E-03	2.11E-03	2.55E-03	3.35E-03
1,2,3-TRICHLOROBENZENE	1.14E-03	2.35E-03	3.96E-03	1.65E-03	3.39E-03	5.71E-03	2.29E-03	4.70E-03	7.93E-03
1,2,4-TRICHLOROBENZENE	4.05E-03	6.84E-03	1.32E-02	5.83E-03	9.85E-03	1.90E-02	8.10E-03	1.37E-02	2.64E-02
1,2,3,4-TETRACHLOROBENZENE	2.20E-03	1.19E-02	3.52E-02	3.17E-03	1.71E-02	5.07E-02	4.40E-03	2.38E-02	7.04E-02
1,2,4,5-TETRACHLOROBENZENE	2.29E-04	1.94E-03	5.28E-03	3.30E-04	2.79E-03	7.61E-03	4.58E-04	3.87E-03	1.06E-02
HEXACHLOROBENZENE	4.40E-06	9.25E-05	3.17E-04	6.34E-06	1.33E-04	4.56E-04	8.81E-06	1.85E-04	6.34E-04
a-HEXACHLOROCYCLOHEXANE	2.99E-04	4.68E-04	7.40E-04	4.31E-04	6.75E-04	1.07E-03	5.99E-04	9.37E-04	1.48E-03
b-HEXACHLOROCYCLOHEXANE	8.01E-05	8.72E-05	1.06E-04	1.15E-04	1.26E-04	1.52E-04	1.60E-04	1.74E-04	2.11E-04
g-HEXACHLOROCYCLOHEXANE	2.03E-04	3.74E-04	6.34E-04	2.92E-04	5.39E-04	9.13E-04	4.05E-04	7.48E-04	1.27E-03
d-HEXACHLOROCYCLOHEXANE	4.40E-04	6.72E-04	1.06E-03	6.34E-04	9.68E-04	1.52E-03	8.81E-04	1.34E-03	2.11E-03
2,5-DICHLOROANALINE	1.76E-04	2.48E-04	3.43E-04	2.54E-04	3.58E-04	4.95E-04	3.52E-04	4.97E-04	6.87E-04
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	6.08E-05	1.10E-04	1.59E-04	8.75E-05	1.59E-04	2.28E-04	1.22E-04	2.20E-04	3.17E-04
2-CHLOROPHENOL	8.81E-06	1.41E-05	1.94E-05	1.27E-05	2.03E-05	2.79E-05	1.76E-05	2.82E-05	3.87E-05
4-CHLOROPHENOL	4.40E-06	4.49E-05	1.59E-04	6.34E-06	6.47E-05	2.28E-04	8.81E-06	8.98E-05	3.17E-04
2,4-DICHLOROPHENOL	9.69E-06	1.23E-05	1.59E-05	1.39E-05	1.78E-05	2.28E-05	1.94E-05	2.47E-05	3.17E-05
2,5-DICHLOROPHENOL	4.40E-06	1.06E-05	1.59E-05	6.34E-06	1.52E-05	2.28E-05	8.81E-06	2.11E-05	3.17E-05
2,4,5-TRICHLOROPHENOL	4.40E-05	5.99E-05	7.04E-05	6.34E-05	8.62E-05	1.01E-04	8.81E-05	1.20E-04	1.41E-04
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0.0214	0.0428	0.0847	0.0308	0.0617	0.1220	0.0428	0.0856	0.1694

TABLE 10.19

ALLUVIUM SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
OW40

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	8.34E-02	8.89E-02	9.43E-02	1.20E-01	1.28E-01	1.36E-01	1.67E-01	1.78E-01	1.89E-01
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	2.54E-02	2.72E-02	2.90E-02	3.66E-02	3.92E-02	4.18E-02	5.08E-02	5.44E-02	5.80E-02
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	1.72E-04	2.45E-04	3.45E-04	2.48E-04	3.53E-04	4.96E-04	3.45E-04	4.90E-04	6.89E-04
1,4-DICHLOROBENZENE	8.52E-04	1.09E-03	1.31E-03	1.23E-03	1.57E-03	1.88E-03	1.70E-03	2.18E-03	2.61E-03
1,2,3-TRICHLOROBENZENE	1.09E-04	1.80E-04	2.54E-04	1.57E-04	2.59E-04	3.66E-04	2.18E-04	3.59E-04	5.08E-04
1,2,4-TRICHLOROBENZENE	7.80E-04	1.56E-03	2.18E-03	1.12E-03	2.25E-03	3.13E-03	1.56E-03	3.12E-03	4.35E-03
1,2,3,4-TETRACHLOROBENZENE	4.90E-04	9.07E-04	1.38E-03	7.05E-04	1.31E-03	1.98E-03	9.79E-04	1.81E-03	2.76E-03
1,2,4,5-TETRACHLOROBENZENE	9.07E-05	1.76E-04	2.54E-04	1.31E-04	2.53E-04	3.66E-04	1.81E-04	3.52E-04	5.08E-04
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	8.70E-05	1.14E-04	1.47E-04	1.25E-04	1.65E-04	2.12E-04	1.74E-04	2.28E-04	2.94E-04
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	2.54E-05	3.26E-05	4.53E-05	3.66E-05	4.70E-05	6.53E-05	5.08E-05	6.53E-05	9.07E-05
d-HEXACHLOROCYCLOHEXANE	3.44E-05	3.99E-05	4.53E-05	4.96E-05	5.74E-05	6.53E-05	6.89E-05	7.97E-05	9.07E-05
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	9.07E-06	2.54E-05	4.53E-05	1.31E-05	3.66E-05	6.53E-05	1.81E-05	5.08E-05	9.07E-05
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	8.52E-04	8.96E-04	9.25E-04	1.23E-03	1.29E-03	1.33E-03	1.70E-03	1.79E-03	1.85E-03
2,4-DICHLOROPHENOL	1.99E-05	3.08E-05	4.53E-05	2.87E-05	4.44E-05	6.53E-05	3.99E-05	6.17E-05	9.07E-05
2,5-DICHLOROPHENOL	9.07E-06	2.54E-05	4.53E-05	1.31E-05	3.66E-05	6.53E-05	1.81E-05	5.08E-05	9.07E-05
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0.1123	0.1214	0.1303	0.1618	0.1748	0.1877	0.2247	0.2427	0.2606

TABLE 10.19

ALLUVIUM SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
MW-19

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 7.2 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 10.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max
BENZENE	5.21E-01	8.49E-01	1.25E+00	7.50E-01	1.22E+00	1.80E+00	1.04E+00	1.70E+00	2.49E+00
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	1.20E-01	1.45E-01	1.89E-01	1.73E-01	2.08E-01	2.73E-01	2.40E-01	2.89E-01	3.79E-01
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	4.73E-04	5.32E-03	8.52E-03	6.82E-04	7.66E-03	1.23E-02	9.47E-04	1.06E-02	1.70E-02
1,4-DICHLOROBENZENE	4.10E-04	5.48E-03	9.31E-03	5.91E-04	7.89E-03	1.34E-02	8.21E-04	1.10E-02	1.86E-02
1,2,3-TRICHLOROBENZENE	1.48E-03	1.18E-02	1.89E-02	2.14E-03	1.70E-02	2.73E-02	2.97E-03	2.35E-02	3.79E-02
1,2,4-TRICHLOROBENZENE	5.84E-03	4.45E-02	7.57E-02	8.41E-03	6.41E-02	1.09E-01	1.17E-02	8.90E-02	1.51E-01
1,2,3,4-TETRACHLOROBENZENE	1.74E-03	1.09E-02	1.74E-02	2.50E-03	1.57E-02	2.50E-02	3.47E-03	2.18E-02	3.47E-02
1,2,4,5-TETRACHLOROBENZENE	3.31E-04	2.27E-03	3.79E-03	4.77E-04	3.27E-03	5.45E-03	6.63E-04	4.54E-03	7.57E-03
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	6.63E-04	4.92E-03	7.57E-03	9.54E-04	7.09E-03	1.09E-02	1.33E-03	9.85E-03	1.51E-02
b-HEXACHLOROCYCLOHEXANE	7.89E-05	9.94E-04	1.55E-03	1.14E-04	1.43E-03	2.23E-03	1.58E-04	1.99E-03	3.09E-03
g-HEXACHLOROCYCLOHEXANE	6.31E-04	5.40E-03	8.68E-03	9.09E-04	7.77E-03	1.25E-02	1.26E-03	1.08E-02	1.74E-02
d-HEXACHLOROCYCLOHEXANE	1.23E-03	9.47E-03	1.53E-02	1.77E-03	1.36E-02	2.20E-02	2.46E-03	1.89E-02	3.06E-02
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	7.89E-05	1.10E-04	1.74E-04	1.14E-04	1.59E-04	2.50E-04	1.58E-04	2.21E-04	3.47E-04
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	2.52E-04	5.08E-03	1.22E-02	3.64E-04	7.32E-03	1.76E-02	5.05E-04	1.02E-02	2.45E-02
2,4-DICHLOROPHENOL	7.89E-05	2.84E-04	6.15E-04	1.14E-04	4.09E-04	8.86E-04	1.58E-04	5.68E-04	1.23E-03
2,5-DICHLOROPHENOL	7.89E-05	2.37E-04	6.15E-04	1.14E-04	3.41E-04	8.86E-04	1.58E-04	4.73E-04	1.23E-03
2,4,5-TRICHLOROPHENOL	1.25E-03	2.76E-03	4.58E-03	1.80E-03	3.98E-03	6.59E-03	2.49E-03	5.52E-03	9.15E-03
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0.655	1.103	1.621	0.944	1.589	2.334	1.311	2.207	3.242

TABLE 10.19

ALLUVIUM SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
MW-17

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 7.2 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max	Q12 = 10.0 in/yr Mass Efflux (lbs/day) Min	Most Likely	Max
BENZENE	2.95E-02	4.03E-02	5.25E-02	4.25E-02	5.80E-02	7.56E-02	5.91E-02	8.05E-02	1.05E-01
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	9.08E-02	9.82E-02	1.05E-01	1.31E-01	1.41E-01	1.51E-01	1.82E-01	1.96E-01	2.10E-01
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	2.74E-03	4.62E-03	6.02E-03	3.94E-03	6.65E-03	8.67E-03	5.47E-03	9.24E-03	1.20E-02
1,4-DICHLOROBENZENE	6.24E-03	1.09E-02	1.42E-02	8.98E-03	1.57E-02	2.05E-02	1.25E-02	2.18E-02	2.85E-02
1,2,3-TRICHLOROBENZENE	8.21E-03	1.08E-02	1.31E-02	1.18E-02	1.55E-02	1.89E-02	1.64E-02	2.15E-02	2.63E-02
1,2,4-TRICHLOROBENZENE	3.61E-02	4.08E-02	5.25E-02	5.20E-02	5.88E-02	7.56E-02	7.22E-02	8.16E-02	1.05E-01
1,2,3,4-TETRACHLOROBENZENE	7.22E-03	9.12E-03	1.06E-02	1.04E-02	1.31E-02	1.53E-02	1.44E-02	1.82E-02	2.12E-02
1,2,4,5-TETRACHLOROBENZENE	1.09E-03	1.31E-03	1.42E-03	1.58E-03	1.89E-03	2.05E-03	2.19E-03	2.63E-03	2.85E-03
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	2.63E-03	3.17E-03	3.72E-03	3.78E-03	4.57E-03	5.36E-03	5.25E-03	6.35E-03	7.44E-03
b-HEXACHLOROCYCLOHEXANE	6.46E-04	9.30E-04	1.09E-03	9.30E-04	1.34E-03	1.58E-03	1.29E-03	1.86E-03	2.19E-03
g-HEXACHLOROCYCLOHEXANE	2.74E-04	3.94E-04	4.60E-04	3.94E-04	5.67E-04	6.62E-04	5.47E-04	7.88E-04	9.19E-04
d-HEXACHLOROCYCLOHEXANE	2.19E-03	3.06E-03	3.83E-03	3.15E-03	4.41E-03	5.52E-03	4.38E-03	6.13E-03	7.66E-03
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	3.28E-04	4.49E-04	5.80E-04	4.73E-04	6.46E-04	8.35E-04	6.57E-04	8.97E-04	1.16E-03
2,4-DICHLOROPHENOL	5.47E-05	1.75E-04	3.06E-04	7.88E-05	2.52E-04	4.41E-04	1.09E-04	3.50E-04	6.13E-04
2,5-DICHLOROPHENOL	5.47E-05	9.85E-05	1.75E-04	7.88E-05	1.42E-04	2.52E-04	1.09E-04	1.97E-04	3.50E-04
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0.188	0.224	0.266	0.271	0.323	0.383	0.376	0.449	0.532

TABLE 10.19

ALLUVIUM SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
MW-3

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	3.74E-04	4.27E-04	5.03E-04	5.38E-04	6.14E-04	7.24E-04	7.47E-04	8.53E-04	1.01E-03
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	4.02E-03	4.12E-03	4.31E-03	5.79E-03	5.94E-03	6.21E-03	8.05E-03	8.25E-03	8.62E-03
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	2.01E-04	2.47E-04	2.80E-04	2.90E-04	3.56E-04	4.03E-04	4.02E-04	4.94E-04	5.60E-04
1,4-DICHLOROBENZENE	1.29E-04	1.64E-04	1.87E-04	1.86E-04	2.36E-04	2.69E-04	2.59E-04	3.28E-04	3.74E-04
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	3.30E-05	7.33E-05	1.03E-04	4.76E-05	1.06E-04	1.49E-04	6.61E-05	1.47E-04	2.07E-04
b-HEXACHLOROCYCLOHEXANE	7.18E-06	4.45E-05	1.09E-04	1.03E-05	6.41E-05	1.57E-04	1.44E-05	8.91E-05	2.18E-04
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	1.72E-04	2.05E-04	2.30E-04	2.48E-04	2.96E-04	3.31E-04	3.45E-04	4.11E-04	4.60E-04
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	1.72E-05	2.59E-05	3.74E-05	2.48E-05	3.72E-05	5.38E-05	3.45E-05	5.17E-05	7.47E-05
4-CHLOROPHENOL	1.14E-04	1.28E-04	1.38E-04	1.63E-04	1.84E-04	1.99E-04	2.27E-04	2.56E-04	2.76E-04
2,4-DICHLOROPHENOL	7.18E-06	1.44E-05	2.87E-05	1.03E-05	2.07E-05	4.14E-05	1.44E-05	2.87E-05	5.75E-05
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	7.18E-06	1.01E-05	1.44E-05	1.03E-05	1.45E-05	2.07E-05	1.44E-05	2.01E-05	2.87E-05
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0.00508	0.00546	0.00594	0.00732	0.00787	0.00855	0.01017	0.01092	0.01188

TABLE 10.19

ALLUVIUM SSI MASS EFFLUX

102ND STREET REMEDIAL INVESTIGATION

WELL
B-34I/MW-16

Analytes:	Q12 = 5.0 in/yr Mass Efflux (lbs/day)			Q12 = 7.2 in/yr Mass Efflux (lbs/day)			Q12 = 10.0 in/yr Mass Efflux (lbs/day)		
	Min	Most Likely	Max	Min	Most Likely	Max	Min	Most Likely	Max
BENZENE	0	0	0	0	0	0	0	0	0
TOLUENE	0	0	0	0	0	0	0	0	0
CHLOROBENZENE	0	0	0	0	0	0	0	0	0
2-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
4-CHLOROTOLUENE	0	0	0	0	0	0	0	0	0
1,2-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,4-DICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4-TRICHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,3,4-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
1,2,4,5-TETRACHLOROBENZENE	0	0	0	0	0	0	0	0	0
HEXACHLOROBENZENE	0	0	0	0	0	0	0	0	0
a-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
b-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
g-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
d-HEXACHLOROCYCLOHEXANE	0	0	0	0	0	0	0	0	0
2,5-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
3,4-DICHLOROANALINE	0	0	0	0	0	0	0	0	0
PHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
4-CHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,5-DICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,5-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2,4,6-TRICHLOROPHENOL	0	0	0	0	0	0	0	0	0
2-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
3-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
4-CHLOROBENZOIC ACID	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0

TABLE 10.20

SSI MASS FLUX (lbs/day)
Fill

Fill Flow Zone	Q12 = 5.0 in/yr Min	Q12 = 5.0 in/yr Most Likely	Q12 = 5.0 in/yr Max	Q12 = 7.2 in/yr Min	Q12 = 7.2 in/yr Most Likely	Q12 = 7.2 in/yr Max	Q12 = 10.0 in/yr Min	Q12 = 10.0 in/yr Most Likely	Q12 = 10.0 in/yr Max
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.0001	0.0003	0.0005	0.0001	0.0004	0.0007	0.0002	0.0006	0.0009
5	0.0594	0.0803	0.1013	0.0855	0.1156	0.1458	0.1188	0.1606	0.2025
6	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
7	0.0009	0.0013	0.0015	0.0013	0.0018	0.0021	0.0018	0.0025	0.0029
8	0.0158	0.0198	0.0239	0.0228	0.0286	0.0344	0.0316	0.0397	0.0477
9	NA (1)	NA (2)	NA (3)	NA (1)	NA (2)	NA (3)	NA (1)	NA (2)	NA (3)
10	0.0118	0.0132	0.0151	0.0170	0.0190	0.0218	0.0237	0.0264	0.0303
11	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Total	0.108	0.140	0.173	0.147	0.191	0.235	0.196	0.255	0.315

Notes:
(1) Value of 0.020 assumed
(2) Value of 0.025 assumed
(3) Value of 0.030 assumed

SSI MASS FLUX (lbs/day)
Alluvium

Alluvium Flow [illegible]	Q12 = 5.0 in/yr Min	Q12 = 5.0 in/yr Most Likely	Q12 = 5.0 in/yr Max	Q12 = 7.2 in/yr Min	Q12 = 7.2 in/yr Most Likely	Q12 = 7.2 in/yr Max	Q12 = 10.0 in/yr Min	Q12 = 10.0 in/yr Most Likely	Q12 = 10.0 in/yr Max
[illegible]	.00(1)	0.00(1)	0.00(1)	0.00(1)	0.00(1)	0.00(1)	0.00(1)	0.00(1)	0.00(1)
[illegible]	0(1)	0.00(1)	0.00(1)	0.00(1)	0.00(1)	0.00(1)	0.00(1)	0.00(1)	0.00(1)
[illegible]	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
[illegible]	.0[illegible]	0.0031	0.0035	0.0040	0.0044	0.0051	0.0056	0.0062	0.0070
[illegible]	[illegible]	0.0900	0.1053	0.1077	0.1296	0.1516	0.1496	0.1800	0.2106
[illegible]	[illegible]	428	0.0847	0.0308	0.0617	0.1220	0.0428	0.0856	0.1694
[illegible]	[illegible]	[illegible]14	0.1303	0.1618	0.1748	0.1877	0.2247	0.2427	0.2606
[illegible]	[illegible]	[illegible]	1.6208	0.9440	1.5890	2.3340	1.3111	2.2069	3.2417
[illegible]	[illegible]	24[illegible]	0.2660	0.2710	0.3230	0.3830	0.3764	0.4486	0.5319
[illegible]	[illegible]	[illegible]5	0059	0.0073	0.0079	0.0086	0.0102	0.0109	0.0119
[illegible]	[illegible]	[illegible]	00	0.00	0.00	0.00	0.00	0.00	0.00
[illegible]	[illegible]	[illegible]	[illegible]	1.527	2.291	3.193	2.121	3.182	4.434

[illegible] ssumed

TABLE 10.21

TOTAL MASS FLUX (lbs/day)
Fill

Fill Flow Zone	Q12 = 5.0 in/yr Min	Most Likely	Max	Q12 = 7.2 in/yr Min	Most Likely	Max	Q12 = 10.0 in/yr Min	Most Likely	Max
1	0.08	1.03	3.30	0.11	1.48	4.76	0.15	2.06	6.61
2	0.50	0.81	1.12	0.72	1.16	1.61	1.00	1.61	2.24
3	0.04	0.31	0.58	0.05	0.45	0.83	0.08	0.62	1.15
4	0.06	0.18	0.39	0.09	0.26	0.57	0.12	0.36	0.79
5	0.11	0.88	1.19	0.17	1.27	1.72	0.23	1.76	2.39
6	0.08	0.27	0.67	0.12	0.38	0.97	0.17	0.53	1.35
7	0.29	0.99	2.02	0.41	1.42	2.91	0.57	1.97	4.04
8	0.08	0.27	0.51	0.11	0.39	0.74	0.16	0.54	1.02
9	0.17	1.04	2.03	0.25	1.50	2.93	0.35	2.09	4.06
10	0.27	1.13	2.12	0.39	1.62	3.06	0.54	2.26	4.25
11	1.35	1.54	1.73	1.95	2.22	2.50	2.71	3.09	3.47
Total	3.03	8.44	15.68	4.37	12.16	22.58	6.07	16.89	31.37

TOTAL MASS FLUX (lbs/day)
Alluvium

Alluvium Flow Zone	Q12 = 5.0 in/yr Min	Most Likely	Max	Q12 = 7.2 in/yr Min	Most Likely	Max	Q12 = 10.0 in/yr Min	Most Likely	Max
1	0.06	0.12	0.15	0.08	0.17	0.21	0.11	0.24	0.30
2	0.04	0.08	0.10	0.05	0.11	0.14	0.07	0.15	0.20
3	0.03	0.12	0.18	0.04	0.17	0.26	0.06	0.23	0.37
4	0.04	0.17	0.27	0.05	0.24	0.40	0.08	0.33	0.55
5	0.24	1.19	3.11	0.35	1.71	4.47	0.49	2.38	6.21
6	0.05	0.19	0.30	0.07	0.28	0.44	0.10	0.38	0.60
7	0.85	3.60	6.88	1.23	5.19	9.90	1.70	7.21	13.76
8	1.88	20.16	60.35	2.71	29.03	86.90	3.76	40.32	120.69
9	0.67	1.63	3.15	0.97	2.35	4.53	1.35	3.27	6.29
10	0.04	0.11	0.20	0.06	0.17	0.29	0.08	0.23	0.41
11	0.13	0.27	0.37	0.19	0.38	0.53	0.26	0.53	0.73
Total	3.97	27.52	74.91	5.80	39.80	108.08	7.95	55.03	149.82

TABLE 10.22

Summary of Groundwater Mass Flux (lbs/day)

FILL	Q12 = 5.0 in/yr			Q12 = 7.2 in/yr			Q12 = 10.0 in/yr		
	Min.	Most Likely	Max	Min.	Most Likely	Max	Min.	Most Likely	Max
TOX/TOC	2.69	7.62	13.81	3.88	10.98	19.89	5.38	15.25	27.63
Mercury	0.000012	0.000049	0.000120	0.000017	0.000070	0.000173	0.000023	0.000098	0.000240
Phosphorus	0.26	0.70	1.72	0.37	1.01	2.48	0.52	1.41	3.44
Arsenic	0.00	0.000530	0.001320	0.00	0.000763	0.001910	0.00	0.001060	0.002653
SSI	0.108	0.140	0.173	0.147	0.191	0.235	0.196	0.255	0.315

ALLUVIUM	Q12 = 5.0 in/yr			Q12 = 7.2 in/yr			Q12 = 10.0 in/yr		
	Min.	Most Likely	Max	Min.	Most Likely	Max	Min.	Most Likely	Max
TOX/TOC	1.35	9.66	33.36	1.95	13.91	48.03	2.70	19.32	66.71
Mercury	0.000063	0.000123	0.000214	0.000091	0.000177	0.000308	0.000126	0.000246	0.000428
Phosphorus	1.62	16.39	39.48	2.33	23.60	56.86	3.24	32.77	78.97
Arsenic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SSI	1.061	1.591	2.217	1.527	2.291	3.193	2.121	3.182	4.434

TABLE 10.23

SEWER CHEMICAL MASS FLUX
INDICATOR COMPOUNDS, EXTENDED SURVEY FILL WELLS

Parameter	Average Concentration (µg/L)	Q = 0.76 gpm	Mass Flux (lbs/day) Q = 4 gpm	Q = 9 gpm
SITE SPECIFIC INDICATORS				
Benzene	ND	0	0	0
Toluene	ND	0	0	0
Monochlorobenzene	295	2.69E-03	0.0142	0.0319
2-Monochlorotoluene	26	2.37E-04	1.25E-03	2.81E-03
4-Monochlorotoluene	14	1.28E-04	6.73E-04	1.51E-03
1,2-Dichlorobenzene	36	3.29E-04	1.73E-03	3.89E-03
1,4-Dichlorobenzene	125	1.14E-03	6.01E-03	0.0135
1,2,3-Trichlorobenzene	51	4.66E-04	2.45E-03	5.51E-03
1,2,4-Trichlorobenzene	280	2.56E-03	0.0135	0.0303
1,2,3,4-Tetrachlorobenzene	265	2.42E-03	0.0127	0.0287
1,2,4,5-Tetrachlorobenzene	33	3.01E-04	1.59E-03	3.57E-03
Hexachlorobenzene	ND	0	0	0
alpha-Hexachlorocyclohexane	73	6.66E-04	3.51E-03	7.89E-03
beta-Hexachlorocyclohexane	ND	0	0	0
gamma-Hexachlorocyclohexane	35	3.20E-04	1.68E-03	3.78E-03
delta-Hexachlorocyclohexane	130	1.19E-04	6.25E-03	0.0141
2,5-Dichloroaniline	ND	0	0	0
3,4-Dichloroaniline	ND	0	0	0
Phenol	70	6.39E-04	3.36E-03	7.57E-03
2-Chlorophenol	ND	0	0	0
4-Chlorophenol	33	3.01E-04	01.59E-03	3.57E-03
2,4-Dichlorophenol	ND	0	0	0
2,5-Dichlorophenol	ND	0	0	0
2,4,5-Trichlorophenol	ND	0	0	0
2,4,6-Trichlorophenol	ND	0	0	0
2-Chlorobenzoic Acid	ND	0	0	0
3-Chlorobenzoic Acid	ND	0	0	0
4-Chlorobenzoic Acid	'ND	0	0	0
TOTAL SSI	1466	0.0134	0.0704	0.1585
GENERAL PARAMETERS				
TOX	6880*	0.0628	0.331	0.744
TKN	4200	0.0383	0.202	0.454
TOC	13530*	0.124	0.650	1.463
Soluble Phosphorus	66	6.03E-04	3.17E-03	7.14E-03
Mercury	0.45	4.11E-06	2.16E-05	4.87E-05
Arsenic	ND	0	0	0

* Corrected with WSCF = 0.75

REFERENCES

Reference No.	*Milestone Report No.*	*Title*	*Issued By*	*Issue Date*
1	1	Utilities Investigation	WCC	March 05 1986
2	2	Revision 2 - Storm Sewer Review	WCC	June 13, 1988
3	3	Niagara River Sediment Survey, Revision 1	WCC	January 17, 1989
4	4	Off-Site Soil Survey, Revision 1	CRA	October 1988
5	5	Additional Well Assessment - Revision 3	CRA	October 1988
6	6	Hydraulic Head Monitoring	WCC	June 09, 1986
7	7	Initial 5-Day Hydraulic Head Monitoring Program Data Presentation - Proposals for Future Monitoring Programs	WCC	April 17, 1987
8	8	Hydraulic Head Monitoring Program	CRA	September 17, 1987
9	9	Site-Specific Indicator Chemicals Survey Levels and Analytical Procedure Selection	OCC/Olin	September 16, 1986
		Appendix A - On-Site Comprehensive Analysis Results	OCC	June 17, 1986