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OCCIDENTAL CHEMICAL CORPORATION

Durez Division

North Tonawanda, N.Y.

REMEDIAL INVESTIGATION REPORT

FOR THE

INLET

(DUREZ SITE)

Volume 1: Text

Prepared by

Dunn Geoscience Corporation

August 1990

Revised: May 1991

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List of Acronyms

APL	Aqueous phase liquid, miscible
ARP	Approved Remedial Plan, Appendix A of the PCJ
AWL	Average water level
DCB	Dichlorobenzene
DNAPL	Distinct, dense, sinking, immiscible non-aqueous phase liquid
GLC	Glacio-lacustrine clay
HCB	Hexachlorobenzene
IGLD	International Great Lakes Datum
LNAPL	Distinct, light, floating, immiscible non-aqueous phase liquid
LWL	Lockport Water Line; unpressurized, raw water intake
MCB	Monochlorobenzene
MP	Measuring point
MSL	Mean sea level, USGS 1929 datum
NA	Not analyzed
NAPL	Distinct, visible, immiscible non-aqueous phase liquid
NCHD	Niagara County Health Department
ND	Not detected
NTWL	North Tonawanda Water Line; pressurized, treated water
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OCC	Occidental Chemical Corporation
P5CB	Pentachlorobenzene
PCF	Pettit Creek Flume
PCJ	Stipulation and Partial Consent Judgment
PPB	Parts per billion
PPM	Parts per million
RAA	Durez Remedial Alternatives Assessment
SCF	Silt-clay fill
SG	Staff gauge for measuring River water level
SS	Soft Sediment
SSC	Chemicals assumed to be Durez Site-Specific compounds
T	Glacial till
TCB	Trichlorobenzene
TCDD	Tetrachlorodibenzo-p-dioxin
TECB	Tetrachlorobenzene
USACOE	United States Army Corps of Engineers
USGS	United States Geological Survey

1.0 EXECUTIVE SUMMARY

1.1 Site and Project Background

This report summarizes a remedial investigation conducted by Occidental Chemical Corporation (OCC) at the Inlet, as part of the remedial program for OCC's Durez Division plant in North Tonawanda, New York.

The Durez Site remedial program is divided into three operable units, the Durez Plant Property, the City of North Tonawanda sewers, and the Inlet. Remedial investigations conducted at the Plant Property and City Sewers in 1977-1988 adequately defined the nature and extent of chemistry in those areas, and enabled the plant and sewers to proceed jointly to the remedial stage. An Approved Remedial Plan (ARP) is presently being implemented to remediate certain conditions existing on the Plant Property and affected City Sewers. The ARP is annexed to the Partial Consent Judgment (PCJ) executed by the Honorable Judge John T. Curtin on June 21, 1989 (USDCWDNY, Index No. 83-552-C).

Investigations at the Inlet, which were initiated in 1986, have continued as the remedial negotiations, plans, design and construction have proceeded for the plant and sewers. OCC, working cooperatively with State and local authorities, has engaged in an extensive investigation effort at the Inlet. The findings of many of the work elements and tasks completed thus far have already been documented in individual reports submitted to State and local agencies.

1.2 Purpose of Report

The purpose of this report is to present the methods and findings of the most recent investigation activities and to summarize and update the findings presented in previous reports. The final document will serve as a principal technical reference for the Inlet remedial alternatives assessment which is underway.

1.3 Inlet Area Description

The Inlet area is complex in terms of subsurface investigation and remediation. This complexity is attributable to the fact that the Inlet area includes several separate elements within a small area.

- Inlet Cove (the Inlet) - the Pettit Creek Flume storm sewer discharge area that contains Soft Sediments and underlying soil known to contain hazardous substances, including non-aqueous phase liquids (NAPL); it is a 3/4 acre area zoned for General Industry and located between the City of Lockport pumping station and the Little Niagara River in North Tonawanda, New York; the area has been fenced-in by OCC and the State;

- **Pettit Creek Flume (PCF)** - a major storm sewer that receives effluent from much of the City of North Tonawanda, including the Durez plant;

- **City of Lockport Water Line (LWL)** - an active, 82-year old municipal raw water intake line that passes through and 15-25 feet beneath the Inlet bottom;

- **City of North Tonawanda Water Line (NTWL)** - an active, approximately 100-year old pressurized municipal water main located underground near the southern boundary of the Inlet; and

- **Inlet Perimeter Property immediately north of the Inlet Cove** - the southwest portion of the site of a former iron works plant underlain by soil and groundwater that contains chemistry originating from the Inlet.

1.4 Investigation Objectives

The objectives of the remedial investigation were as follows:

- to locate accurately and evaluate the condition of the LWL;

- to determine the physical characteristics of the study area;

- to define the nature and lateral and vertical extent of typical Durez Site chemicals, i.e. chlorobenzenes, in fill, sediment, soil and groundwater, including the backfill for the LWL;

- to estimate groundwater flow directions and rates; and

- to identify potential routes of chemical migration.

1.5 Investigation Scope

In order to achieve these objectives, OCC undertook a series of tasks that progressed in a phased manner. The work was conducted in accordance with State-approved work plans and included, but was not limited to, the following activities:

- document, aerial photograph and map review;

- geophysical surveys;
- 49 soil borings;
- 54 sediment depth probe tests;
- 27 monitoring well and 4 piezometer installations;
- 230 chemical analyses for soil, groundwater and NAPL samples;
- geotechnical laboratory analyses;
- field hydraulic conductivity tests; and
- groundwater level monitoring.

The investigation included the following OCC activities related to the Lockport Water Line and NTWL.

- Two inspections of the interior of the LWL using a combination of divers and a remotely operated vehicle equipped with a video camera;
- A geophysical survey to determine accurately the lateral location and depth of the LWL from the City of Lockport pump station to Tonawanda Island;
- Drilling of 6 borings in the bedding of the LWL to collect soil samples for chemical and physical analyses; and
- A geophysical survey to map the location of the PCF and NTWL and to estimate the depth of the NTWL.

1.6 Study Area

The study area is divided into two major areas, the **Inlet (Inlet cove)** and the **Inlet perimeter**. The geographic boundaries of the Inlet perimeter study area were defined generally as the investigation progressed. Since the investigation of the Little Niagara River was outside the scope of the remedial investigation study defined in the State-approved work plan, the western boundary of the Inlet cove and Inlet perimeter was taken as the east shoreline of the River.

1.7 Hydrogeologic Conditions

Four principal geologic strata have been identified in the Inlet area overlying the shale bedrock. In order of increasing depth from the ground surface, they are: surficial fill, alluvium, glacio-lacustrine clay, and glacial till.

The **surficial fill** has been deposited as a result of the past 150 years of human activities in the area. It is a heterogeneous mix of slaggy gravel, sand and silt, with brick, concrete, cinders, ash, clay and organic matter. It blankets the area and averages 7-8 feet thick.

Alluvium is a relatively permeable post-glacial river deposit consisting of silt, sand and gravel. It comprises, along with the lower saturated part of the fill, the principal water bearing unit at the Inlet. The alluvium has a wedge-shaped geometry, approximately 26-feet thick at the River and gradually thinning out to 0 feet thick 150 to 300 feet east of the River. The alluvium was deposited on a River-eroded surface of glacial lake clay on the east (near the pump station) and clayey till on the west (near the River).

Glacio-lacustrine clay was deposited in a glacial lake on a relatively level surface of glacial till. Subsequent erosion by a rapidly flowing river, located in the same vicinity as the existing Little Niagara River, resulted in a westward sloping surface. The clay was completely eroded in the approximately western 100 feet of the Inlet area, exposing the underlying clayey till. The relatively impermeable glacio-lacustrine clay, along with the clayey till, comprise an extensive lower confining layer for groundwater and chemistry at the Inlet.

Glacial till is a relatively dense, slightly plastic, mixture of clay, silt, sand and gravel. The till is overlain by glacio-lacustrine clay in the eastern part of the Inlet, and alluvium in the western part adjacent to the River. The till surface that underlies the alluvium has been scoured to form an elongate north-south oriented shallow depression. The till is approximately 37-47 feet thick and overlies shale bedrock, which is present about 75 feet beneath the ground surface.

Construction operations for the installation of the **Lockport water line** in 1907-1908 resulted in the excavation of an approximately 120-foot wide, 30-foot deep trench at the mouth of Pettit Creek. Fill, alluvium, glacio-lacustrine clay and some till were removed in the process and replaced with backfill consisting of a relatively thin (typically 3 feet thick), relatively permeable (compared to the clay-rich strata above and below) layer of silty fine sand **bedding** for the LWL pipe, overlain by a thicker layer of relatively impermeable **silt-clay fill**. The excavation was never completely backfilled, so for the past 82 years it has served as a basin, i.e. **Inlet cove**, for the accumulation of sediments, i.e. **Soft Sediments**, debris and chemicals discharged from the Pettit Creek, and later the Pettit Creek Flume. The thickness of these materials averages about five feet.

Groundwater in the Inlet area flows under unconfined conditions towards the Inlet and River. Flow rates are slow because of the typically low hydraulic gradients, especially adjacent to the River. River level fluctuations greatly impact groundwater levels and can result in local temporary flow reversals whereby River water flows a short distance into the River bank. Many Inlet monitoring wells near the River are closely interconnected hydraulically with the River.

1.8 Nature and Extent of Chemistry

Chemicals at the Inlet are present in three physical forms as:

- non-aqueous phase liquid (NAPL);
- dissolved constituents in water forming an aqueous phase liquid (APL); and
- molecules adsorbed to solid or dissolved matter.

Organic vapors were also detected during drilling and sampling activities, but only upon disturbance of the subsurface in areas with relatively high concentrations of chemistry. The migration of chemicals as vapor is not considered significant at the Inlet (though it must be considered during remediation).

Durez-type chemicals, including NAPLs, have been detected in the Inlet and Inlet perimeter. The NAPLs observed are denser than water and tend to sink. They migrate downward under gravity until they encounter a barrier to their movement at which point they may accumulate and spread laterally. The NAPLs consist predominantly of chlorobenzene compounds.

Concentrations of chemistry are substantially higher in the Inlet cove and immediately adjacent area than in the Inlet perimeter. The highest concentrations of chemistry were detected in the Soft Sediment at levels ranging from 19 ppm to 23,000 ppm (2.3 percent), total chlorobenzenes. Dioxin was detected in Soft Sediment at concentrations ranging from 1 to 67 ppb.

The lateral extent of the Soft Sediment generally coincides with the high River shoreline, except on the south side of the Inlet where Soft Sediment has been buried by fill. The lower part of the fill immediately overlying Soft Sediment also contains some chemicals. This zone of buried Soft Sediment, a transitional zone, extends approximately 50 feet south of the Inlet to the approximate location of the NTWL. The transitional zone extends slightly south of the NTWL at the southwest corner of the Inlet.

The silt-clay fill, which directly underlies the Soft Sediment, contains chemicals in some areas. Certain areas of silt-clay fill directly over the LWL near the PCF outfall were saturated with NAPL.

Chemistry below the silt-clay fill was detected in close proximity to the LWL. Relatively high concentrations of chemistry, including NAPL, were observed immediately below and adjacent to the LWL in the central part of the bedding. Chemistry is also present at the alluvium/confining layer interface.

In the area around the Inlet, soil and groundwater chemistry are limited generally to an approximately 100-foot wide lobe adjacent to the River and extending approximately 200 feet north of the Inlet. The chemistry is typically at a depth of 30-35 feet, and associated with the bottom of the alluvium near its interface with the underlying confining layer. NAPL has been observed in the lobe and is a source of dissolved chemicals in the area. On several occasions during the investigation, NAPL was bailed from one of the wells located adjacent to the Inlet near the south end of the lobe. The topography of the confining layer in this area probably has helped to confine the NAPL to this lobe. The fact that groundwater flow is typically westerly toward the Inlet and toward the River has restricted the extent of spreading of dissolved chemicals in groundwater away from the Inlet.

1.9 Chemical Migration

While NAPL may be mobile or non-mobile, APL is mobile. As mobile NAPL and APL migrate through environmental media, they may leave chemistry behind. Migration pathways identified at the Inlet area are as follows:

NAPL can migrate downward from the Soft Sediment layer in certain areas within and immediately adjacent to the Inlet. NAPL can migrate laterally at the base of the fill/alluvium layer on the underlying clayey confining layer, along the LWL and its bedding and possibly beneath the River bottom. The available data support the conclusion that the chemicals are not migrating into the LWL.

Dissolved chemicals migrate in groundwater in response to hydraulic flow gradients. Groundwater containing dissolved chemicals is migrating towards the River. This flow is primarily through and along the bottom of the relatively permeable and water-bearing fill/alluvium unit. Chemicals dissolved in the Inlet surface water will also ultimately flow to the River.

Migration of solid particles to which chemicals have adsorbed may occur as windblown dust, should such particles become exposed and desiccated, or as suspended sediments should they be eroded by water. It is not expected that migration of windblown dust is a significant pathway at the Inlet, though it must be a consideration during remediation. Migration of terrigenous soil also is not a concern though it must be a consideration during remediation. Migration of Inlet Soft Sediment to the Niagara River as resuspended sediment in surface water is not expected to be significant during the typical ambient low flow conditions, as the Inlet is a low energy environment. It is probable, however, that some Soft Sediment can be resuspended under certain conditions during episodic storm events and mobilized when PCF discharge to the River increases significantly above ambient rates. The presence of a delta at the relatively wide western end of the Inlet indicates that some mobilized sediment is redeposited within the Inlet. The vegetation, existing floating booms and a silt curtain that extends to the Inlet bottom at the mouth of the Inlet, help contain sediment within the Inlet.

1.10 Lockport Water Line

At this time there are no identified adverse impacts to, or problems with, the Lockport Water Supply that can be attributed to chemicals present in the Inlet. Underwater inspections of the interior of the LWL during the investigation indicate that the liner is in good condition and has no defects or imperfections. The City of Lockport conducts its own inspections on a periodic basis to help ensure the continued integrity of the liner. Monitoring of the City of Lockport's water quality by the City and NYS Department of Health indicates that the drinking water consistently meets or exceeds drinking water standards.

The presence of NAPL in the bedding outside and adjacent to the LWL is a potential concern that will be addressed by an appropriate removal action described in the Inlet remedial alternatives assessment. Although the NTWL is pressurized and therefore should not enable the ingress of groundwater, the NTWL will be specifically addressed by the LWL removal action.

1.11 Conclusion

The additional investigations at and around the Inlet have been conducted in cooperation with State and local authorities. These investigations have achieved project objectives, defined the physical characteristics of the study area and documented the nature, extent and potential migration pathways of Durez-type chemicals in the Inlet and Inlet perimeter sufficiently to enable development of the remedial alternatives assessment.

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2.0 INTRODUCTION

2.1 Purpose of Report

This report summarizes a phased remedial investigation (RI) conducted by Occidental Chemical Corporation (OCC) at the Inlet, as part of the Durez Site remedial program. The findings of many of the work elements and tasks completed thus far have already been documented in individual reports submitted to State and local agencies. Analytical data generated since prior reports have also been provided to the State. The purpose of this report is as follows:

- to present the methods and findings of the most recent investigation activities;
- to summarize and update the findings presented in the previous reports;
- to compile and present technical studies conducted incidentally to the field investigation, but not presented previously in a formal response; and
- to integrate this information into one package that can serve as a principal technical reference for the Inlet remedial alternatives assessment which is underway.

2.2 Project Background

2.2.1 Description

The Durez Site remedial program is divided into three operable units, the Durez Plant Property, the City of North Tonawanda sewers, and the Inlet, which is located downstream of the plant and City Sewers (Figure 2-1). The Durez Division plant is an industrial resins and plastics manufacturing facility located in North Tonawanda, Niagara County, New York. It has been in continuous operation since 1926. The City Sewers are the surrounding network of North Tonawanda storm and sanitary sewers in the vicinity of the plant, and include the Pettit Creek Flume (PCF). The PCF storm sewer is an underground concrete box culvert that extends approximately 9700 feet from the vicinity of the Durez plant to an outfall structure located at the northeast corner of a small embayment, the Inlet, on the Little Niagara River, also in North Tonawanda.

Alleged past spills and disposal practices at the Durez plant, especially in the approximate period from 1940 to 1970, have resulted in the release of chemicals to soil and groundwater at the Plant Property, storm and sanitary sewers, and the Inlet. In 1977, OCC and the NYSDEC entered into negotiations regarding investigation and remediation of areas on the Plant Property. Surface and subsurface remedial investigations for the Durez Site began that same year. OCC, working cooperatively with State and local authorities, engaged in extensive investigation efforts at the Durez Site. Field investigations focused on ascertaining conditions at both the plant and adjacent properties and identifying possible pathways for exposure to chemicals.

The investigations conducted at the Plant Property and City Sewers in 1977-1988 adequately defined the nature and extent of chemistry in those areas, and enabled them to proceed jointly to the remedial stage. Investigations at the Inlet, which were initiated in 1986, have continued as the remedial negotiations, plans, design and construction have proceeded for the plant and sewers (DUNN, July 1989 and May 1990). Table 2-1 summarizes the field investigations and related activities at the Inlet.

Investigations at the Inlet have revealed a complex situation in terms of subsurface investigation and remediation. This complexity is attributable to the fact that the Inlet area includes several separate elements within a small area:

- **Inlet Cove** - discharge area for the PCF comprised of sediments and underlying soil known to contain non-aqueous phase liquids and hazardous substances;

- **Pettit Creek Flume** (PCF) - a storm sewer that receives effluent from much of the City of North Tonawanda, including the Durez plant;

- **Lockport Water Line** (LWL) - an active, 82-year old municipal raw water intake line that passes through and 15-25 feet beneath the Inlet;

- **North Tonawanda Water Line** (NTWL) - an active, approximately 100-year old pressurized municipal water main located underground near the southern boundary of the Inlet; and

- **Property immediately north of the Inlet Cove** - the southwest portion of the site of a major former iron works plant underlain by soil and groundwater that contains chemistry originating from the Inlet.

2.2.2 Previous Investigations by OCC

OCC initiated its investigation of the Inlet in 1986 as part of the Phase 2 Durez sewer investigation. Inlet sediment was sampled using a barge and tripod mounted soil coring device, known as a vibracore. Selected samples were analyzed for Durez-type indicator chemicals. The survey was described in the Phase 2 Sewer Report (OCC, Sept. 1986), and summarized in the Remedial Alternatives Assessment (RAA) for the Durez Site, December 1986. The RAA also presented, among other things, a conceptual plan for remediating the Durez Site, including the Inlet.

A local source of chemicals in the Inlet is the discharge from the PCF. In 1986, OCC conducted a video inspection of the interior of the PCF to evaluate the physical condition of the PCF and estimate the volume of sediment (DUNN, March 1987). The inspection indicated that the general condition of the PCF was fair to good. Measurements of sediment depth inside the PCF were used in the RAA to estimate the volume of contained sediment. Subsequent sampling of that sediment for laboratory grain size analysis (ESI, Oct. 1989) and chemical analysis (DUNN, May 1990) were used for remedial design for the PCF and related permit applications.

Two surface soil samples (DR-001 and DR-002) were collected on the property immediately south of the Inlet in November 1987, prior to installation of a security fence. The analytical results are included in DUNN, October 1988.

As part of the technical negotiations for the Durez Site remediation, a work plan for an Inlet investigation (DUNN, March 1988) was developed by OCC and approved by the State. The purpose was to collect geotechnical and hydrogeologic data to help refine the conceptual remedial plan described in the RAA. A series of soil borings were drilled at the Inlet in early 1988 to gather information. The results of those borings are included herein. In the course of conducting these initial borings, it became apparent that the lateral extent of Durez-type chemistry extended beyond the area defined by the Inlet's shoreline. A work plan for additional investigations at the Inlet (DUNN, Oct. 1988a) was subsequently developed by OCC and approved by the State. The work plan outlined a series of investigative tasks to characterize the Inlet and address issues identified during the technical negotiations. The additional investigations at the Inlet are the main topic of this remedial investigation report.

In an effort to keep officials apprised of OCC's progress at the Inlet, OCC has submitted a series of reports to the State (DUNN, Oct. 1988, Mar. 1989, Aug. 1989, Oct. 1989). Copies of all available soil and groundwater analyses were submitted to the State in May 1990. A list of the other Inlet-related reports that OCC has submitted to the State is presented in Table 2-2.

2.2.3 Previous Remediation at the Durez Site

Remedial activities at the Durez plant have included measures to reduce and control chemical releases to the City Sewers. An Approved Remedial Plan (U.S. District Court, April 1988) is being implemented to remediate certain conditions existing on the Plant Property and affected City Sewers. As part of this plan a groundwater Interceptor Trench is being constructed to prevent groundwater in the overburden from moving away from Durez Plant Property. Groundwater collected by the Interceptor Trench and certain Plant Property storm sewers have been rerouted through a newly constructed water treatment plant on Plant Property. Storm sewers on and off Plant Property will be cleaned.

2.3 Objectives of Project

The objectives of the Inlet remedial investigation were:

- to locate precisely and evaluate the condition of the LWL;
- to determine the physical characteristics of the study area;
- to identify and determine the nature and extent of subsurface strata in the Inlet area including the Soft Sediment layer;
- to estimate groundwater flow directions and rates in the area surrounding the Inlet;
- to define further the nature and extent of Durez-type chemistry in the various environmental media of the study area, including the backfill for the LWL; and
- to identify potential routes of chemical migration and the factors affecting migration.

2.4 Scope of Project

Based on the State-approved Work Plan, the scope of work for the Inlet investigation has been divided as follows:

Task 1 - Inspection of the interior of the LWL at the Inlet using a combination of divers and remotely operated vehicles, both before and after Inlet drilling activities; this task also included review of available underwater inspection records provided by the City of Lockport;

Task 2 - Subbottom Profiling, including accurately locating the line and depth of the LWL from the City of Lockport Pump Station to Tonawanda Island, determining bottom contours of the Little Niagara River adjacent to the Inlet, and investigating River subbottom stratigraphy using geophysical techniques;

Task 3 - Inlet Perimeter Investigation, including the following components:

- drilling of 37 soil borings to determine physical properties, identify strata and their boundaries and collect and classify soil samples;
- installation of 4 temporary piezometers to measure water table elevations;

- geotechnical analyses of selected soil samples in a soils laboratory to determine physical properties;

- chemical analyses of 107 soil samples for selected compounds to help define the nature and extent of these compounds;

- installation of 26 groundwater monitoring wells at 14 well cluster locations to collect groundwater samples, perform hydraulic conductivity tests and measure groundwater levels;

- installation of two staff gauges to measure Inlet and River levels;

- completion of slug and bail tests at selected wells to determine hydraulic conductivities for use in flow calculations and assessing potential flow pathways;

- collection of two rounds of groundwater samples for chemical analyses;

- chemical analyses of 51 groundwater samples for selected compounds to help determine the nature and extent of these compounds; and

- measurement of groundwater levels first at weekly intervals, then at monthly intervals, to help estimate hydraulic gradients, flow directions and rates.

Task 4 - Inlet drilling at six locations in water, including sampling and chemical analysis of 18 soil samples for selected compounds to determine the nature of soil underlying the Soft Sediment and help evaluate the extent of these compounds;

Task 5 - Sediment depth probing, including penetration-resistance probes at 54 locations in the Inlet to help estimate the extent and thickness of Soft Sediment; and

Task 6 - Six LWL bedding borings at five locations, including the sampling and analysis of 53 soil samples for selected compounds to determine the nature and extent of chemistry adjacent to the water line; and the collection and chemical analysis of a sample of NAPL for the Target Compound List (by Contract Laboratory Protocol).

Other tasks were completed that did not fall into one of the six task categories listed above. These tasks include the following:

- Compilation and review of available chemical data collected by State and local authorities as part of routine and special water quality monitoring programs for the City of Lockport pump station;

- Compilation and review of historic maps, photographs, and documents to obtain information useful to the remedial investigation; and

- Completion of geophysical surveys to precisely locate the NTWL near the south boundary of the Inlet and the PCF upstream of the outfall structure.

The geographic boundaries of the Inlet perimeter study area were defined generally as the investigation progressed. Since the investigation of the Little Niagara River was outside the scope of the remedial investigation study defined in the State-approved work plan, the western boundary of the Inlet cove and Inlet perimeter was taken as the east shoreline of the River. A timber piling wall, visible only at low river stage and present at that location since the 1800's, helps to isolate the Inlet from the River. The piling affects surface water flow, and erosional and depositional patterns in the Inlet and extends along the shoreline north and south of the Inlet.

2.5 Report Organization

Remedial investigations at the Inlet have been conducted in accordance with a series of work plans developed in cooperation with State and local officials. The nature, purpose and scope of these plans have evolved as additional information has become available. Reports summarizing progress to date have been submitted to the State to keep them apprised of findings. This report attempts to consolidate these extensive investigations in one document.

A general description of the Inlet area, including the physical and regional settings, is presented in Section 3.0. This section provides background information and is largely based on a review of published and unpublished data, with one exception. This exception is the discussion of utility lines at the Inlet. Utility lines, including the PCF, LWL and NTWL, have been an important focus of this investigation, and are therefore described in greater detail than other topics.

The investigations can be divided into three technical program categories, geology and geotechniques, groundwater hydrology, and chemistry. All three categories have field and laboratory components. The geology and geotechnical program is addressed in Section 4.0 groundwater hydrology in Section 5.0, and chemistry in Section 6.0. Methods and findings are presented within each section. Investigations already described in State-approved work plans and previous reports are briefly summarized or referenced and updated data and findings are presented. The intent has been to develop each section using the information presented previously in this report, and to integrate all findings in the discussion of the nature and extent of chemistry (Section 6.2) and chemical migration (Section 6.3).

Terms and definitions used frequently in this report are presented in Appendix A.

3.0 INLET AREA DESCRIPTION

3.1 Physical Setting

3.1.1 Inlet Cove

The Inlet cove is located at the confluence of the PCF and Little Niagara River, approximately 200 feet west of the City of Lockport Pumping Station on River Road. Tonawanda Island is west of the Inlet on the opposite shore of the 400-foot wide Little Niagara River (Figure 2-1).

The Inlet is a three-quarter acre (100-feet wide and 300-feet long) U-shaped depression, approximately 5 feet lower in elevation than its banks to the north and south. Relief on the Inlet bottom is generally 2 feet, except for an approximately 4-foot deep scour hole at the northeast corner where the PCF discharges into the Inlet. The shallow relief on the bottom results in a greatly changing shoreline as River levels vary; such variations can occur in a matter of hours. A topographic and bathymetric map of the Inlet area is presented in Figure 3-1.

The Inlet was formed at the mouth of Pettit Creek in 1907-1908 predominantly as a result of construction activities for the LWL (see Appendix B). The construction included dredging and excavation of a trench through the mouth of the Pettit Creek at the eastern shoreline of the Little Niagara River, and inland 400 feet to a former pump station structure that was located at the site of the current pump station. The Inlet has accumulated sediment from the PCF and adjacent areas. A principal early objective of the Inlet investigation was to determine the characteristics of this sediment, i.e. Soft Sediment.

The shape of the Inlet shown on the plan maps presented herein coincides with the maximum monthly mean (1968-1988) River level of 567.6 feet, mean sea level. This level gives a reasonable representation of the distribution of Soft Sediment, except for the south shore where the Soft Sediment is buried by recent terrestrial fill. This 50-foot wide (north-south) area of buried sediment is referred to in this report as a transitional zone. The southern edge of the zone generally coincides with the location of the NTWL.

3.1.2 Land Use

The Inlet is an undeveloped marshy and overgrown area located on private property behind the City of Lockport's pump station. Debris including old tires, concrete-filled tanks, scrap and rubbish are strewn across the area. A chain-link fence with locked gates has been constructed on three landbound sides around the Inlet to restrict access. Warning signs have been posted at the Inlet by OCC and NYSDEC to alert pedestrians and boaters that access is restricted. The signs are located on the fence and at the mouth of the Inlet facing toward the Little Niagara River.

Population density in the immediate area is sparse. A large vacant lot (site of the former Tonawanda Iron Works plant) is located to the north, Off-Track Betting property (including a commercial building) is to the northeast, Lockport pumping station to the east, and a privately owned marina (formerly a lumber yard, then junk yard) to the south. Easements through the Inlet area include the LWL and the NTWL (see Plate 1).

The Inlet area shown on Plate 1, which include the properties listed above, is zoned for General Industry (North Tonawanda, 1984). The area south of the marina is zoned Light Manufacturing. Tonawanda Island, across the Little Niagara River from the Inlet, is zoned Special Industrial. A brief history of past land use in the area is presented in Appendix B.

3.1.3 Utilities

The Inlet area is served by public utilities including electric, gas, water and telephone. Three utility lines of particular importance at the Inlet are the PCF, LWL and NTWL.

3.1.3.1 Pettit Creek Flume

The PCF is a major drainageway of the North Tonawanda storm sewer system. The PCF's approximately 1.1 square mile drainage basin, which includes the Durez plant and other commerical/industrial facilities, has been a major source of sediment for the Inlet. Two floating booms are in place in the Inlet to trap floating debris from the PCF. These booms also trap some sediment. A third floating boom with attached silt curtain that extends to the bottom of the Inlet was installed at the mouth of the Inlet during the investigation.

A geophysical survey was conducted during the Inlet investigation to locate the buried portion of the PCF upstream from its outfall. A Geonics Ltd. EM-31 terrain conductivity meter was used for the survey. The interpreted alignment of the PCF under the OTB parking lot, including a bend, is shown in Figure 3-1.

The PCF was constructed generally in the channel of the Pettit Creek in 1927-1928. At its outfall at the Inlet, the PCF is 5-feet high and 8-feet wide. The invert elevation of the PCF reportedly ranges from 565.5 feet MSL at its downstream end at the Inlet to 569.6 feet at Wilson Avenue west of the Durez plant. (Average River level is 565.6 feet). Appendix B presents a brief history of the PCF. Physical characteristics of the PCF, including its sediments, are described in a previous report (DUNN, Mar. 1987). Chemical analyses performed on the sediment also have been summarized (OCC, Sept. 1986, May 1990; DUNN, Dec. 1986).

3.1.3.2 Lockport Water Line

The Lockport Water Line is a raw water intake for the City of Lockport Water System. The LWL, a 48-inch diameter, approximately 2600-foot long steel intake pipe, conveys raw River water under gravity flow from an intake structure in the East Branch (Tonawanda Channel) of the Niagara River to a wet well in the nearby City of Lockport Pump Station. From the wet well the water is pumped 13 miles northeast to the City of Lockport. The LWL is located within a 10-foot wide easement corridor through the central part of the Inlet. The LWL passes beneath the Inlet at depths ranging from approximately 15 to 23 feet. Typical flow through the pipe is five to nine million gallons per day.

A 40-inch (nominal) diameter polyethylene liner was installed by the City of Lockport along the entire length of the LWL in 1977 (Wendel, May 1966) as a health and safety precaution after chemicals were observed in the wet well in a localized depression at the sluice gate near the junction with the LWL (NYSDOH, undated). An extension to this liner was placed at the pump station end of the liner in 1979 when it was discovered that the thermal properties of the liner caused it to contract in cold water. A conceptual sketch of the LWL in the Inlet is presented on Figure 3-2. A description of its construction is summarized in Appendix B.

The City of Lockport conducts biannual underwater inspections of the liner, especially at the joint for the liner extension. These inspections usually coincide with the time of maximum and minimum River water temperature when thermal expansion/contraction are at a maximum. Routine maintenance is performed as necessary to ensure the continued integrity of the joint.

Sampling and analyses of the untreated (raw) and treated (finished) water are conducted regularly by the City of Lockport, with review by NYSDOH. In addition to its normal water quality monitoring program for bacteria and chemicals, since 1984 the City has been monitoring water monthly for potential indicator chemicals including certain chlorobenzenes. Results of these analyses indicate that the finished water meets or exceeds all State standards for drinking water for these chemicals. Monthly monitoring results since 1986 have shown no detectable levels of these chemicals in the finished drinking water (NYSDOH, January 1990) and only one questionable occurrence at a very low level at or about the detection level in the raw water. Supplemental water monitoring conducted in 1990 is summarized later in this section.

The LWL has been the subject of several tasks conducted during the investigation. State personnel from NYSDOH or NYSDEC have been present to observe all these activities. An inspection of the interior of the LWL (Work Plan Task 1) was performed by OCC in August 1988 using divers and a remotely operated vehicle equipped with a video camera. The video inspection extended from the pump station to Tonawanda Island across the Little Niagara River from the Inlet. An unused bolt hole was found in the liner under the pump station and was plugged. The inspection indicated that the LWL was in good condition.

In November 1988, OCC conducted a geophysical survey (Task 2) to locate precisely and accurately the line and grade of the LWL. The method consisted of pulling and floating a conductor and depth sonde through the LWL and measuring their response signal at the ground (or water) surface. The results have used to map the LWL and develop a depth profile. Subsequent probing alongside the LWL during the investigation confirmed the accuracy of these locational techniques. A report summarizing the survey has been submitted to the State (OSI, Dec. 1988).

Another objective of the Task 2 geophysical survey was, to identify and locate the LWL below the Niagara River bottom. A non-invasive and indirect method, known as seismic subbottom profiling was used. One of the seismic profiles developed during the survey appears to have detected the LWL backfill. Interpretation of the profile indicates a LWL trench width at River bottom of approximately 110 feet (Figure 3-3). This estimate agrees with the width of the LWL trench determined from the geologic cross-sections presented in Section 4.0 of this report.

In December 1989, OCC sampled soil immediately adjacent to the exterior of the LWL as part of the Task 6 drilling program. OCC discovered chemicals (NAPL) in soil adjacent and in close proximity to the outside of the LWL in the Inlet. In response to the discovery of NAPL outside the LWL, extensive sampling and analyses were initiated by the City of Lockport in an intensive 30-day water sampling program to assess the integrity of the LWL. The sampling program found no site-specific chemicals analyzed for, with the possible exception of tetrachlorobenzene reported at a very low concentration near the detection limit in a questionable sample of raw water. No chemicals were detected in the finished water. Results of the water sampling program are presented on Table 3-4. The report concluded that the liner is not adversely affected by the chemicals at the Inlet (Lockport Water Department, 1990).

After the completion of the Task 6 drilling alongside the LWL in January, 1990, OCC conducted a follow-up underwater inspection of the interior of the LWL. The inspection included both remote video and penetration diving for the length of the Inlet. The inspection did not detect any cracks, discontinuities, deformations or other defects in the liner. The liner appears to be in excellent condition. This and the previous inspection are described in more detail in two reports previously submitted to the State (Seaway Divers, Aug. 1988; Norsea, Apr. 1990). Copies of video tapes documenting the inspections were provided by OCC to the City of Lockport and the State.

3.1.3.3 North Tonawanda Water Line

The North Tonawanda Water Line (NTWL) is a 24-inch diameter, flexible joint, cast iron water main that conveys pressurized treated water from the City treatment plant on Tonawanda Island to the City's distribution system. The NTWL is estimated to be approximately 100 years old. It is located in a 12-foot wide easement through the southern part of the study area.

A surface geophysical survey was conducted by OCC in June 1990 to determine the location and depth of the NTWL. The field equipment consisted of a Schoenstedt MAC 51B magnetic and cable locator. Measurements were taken at 5-foot intervals along the pipeline. The results were consistent with available utility maps provided by the City, and identified the two minor bends in the NTWL.

The estimated location of the NTWL is shown on an enlarged site map (Figure 3-4). The estimated depth of the NTWL is typically 5 to 6 feet adjacent to most of the Inlet, but it appears to deepen abruptly near the River on its descent to the River bottom. A vertical railroad rail observed during the survey and described in City maps, is believed to mark the location where the pipe starts to deepen (see Figure 3-4). The subbottom profiling survey described above may have detected the backfill for the NTWL (Figure 3-3).

Although the NTWL is pressurized and therefore should not enable the ingress of groundwater, the NTWL will be specifically addressed by the Inlet remedial alternatives assessment. The NTWL is located at the south edge of the transitional zone.

3.1.4 Topography and Drainage

Plate 2 illustrates the topography of the general Inlet area and the approximate location of the surface water divide. The area of the drainage basin is approximately 4 acres. Based on the texture of sampled surface soils and the results of hydraulic conductivity tests in shallow wells, the surficial fill is judged to be permeable. Infiltration of precipitation is anticipated to be generally high and surface water runoff should be low.

3.2 Regional Setting

3.2.1 Climate

Monthly temperature and precipitation data for the Inlet area (Buffalo, New York weather station) are presented in Table 3-1. The mean daily temperature is 47 degrees Fahrenheit; the monthly mean ranges from 24 degrees in January to 70 degrees in July. The average annual rainfall for Buffalo is 36.1 inches, while the North Tonawanda area receives about 31 inches. Lake Erie, to the west of the Inlet area, has a moderating effect on temperature and also provides additional moisture to the air passing over it. There is little seasonal variation in precipitation (Erie and Niagara Counties Regional Planning Board, 1981). Additional regional and annual climatological information are provided in Appendix C (NOAA, 1987).

3.2.2 Niagara and Little Niagara Rivers

The Little Niagara River, a branch of the East Branch Niagara River (Tonawanda Channel), flows around the east side of Tonawanda Island. It rejoins the East Branch approximately 500 feet downstream from the Inlet. The Little Niagara River is approximately 400 feet wide and 20 to 25 feet deep adjacent to the Inlet. Bottom topography (bathymetry) adjacent to the Inlet was mapped during the Task 2 subbottom profiling; the contours are shown on Figure 3-1. The deepest part of the channel detected was at elevation 542 feet MSL, approximately 200 feet offshore.

3.2.2.1 Niagara River Levels

River level data are recorded by the U S. Army Corps of Engineers at the Tonawanda Island gauging station. Historic maximum and minimum River stage data for the Niagara River (USACOE, 1989) are summarized in Table 3-2. The maximum monthly mean for 1968-1988 was 567.6 feet, mean sea level, measured in February 1985. This is the River elevation used to delineate the Inlet shoreline for the base maps in this report as described in Section 3.1.1. The water depth in the Inlet would be about 3.5 feet at this River level. The average daily mean River level for the same period is 565.6 feet, MSL. The shoreline corresponding to this level is shown in Figure 3-4. Inlet water depth would be about 1.5 feet.

The 100-year flood level for the Inlet area is elevation 570 feet MSL (FEMA, 1982). Figure 3-5 shows the shoreline for such an event. The crest of the north bank, at elevation 570 feet, would not be overtopped. The south bank of the Inlet, which is not as steep or as well-defined as the north bank, would be overtopped and a small island would be formed. Such a flood would surcharge the entire PCF storm sewer system. Instantaneous high and low River water levels, listed in order of their magnitude, are summarized in Table 3-3. According to the available water level records, the 100-year flood elevation was essentially attained on February 26, 1975, due to an ice jam.

3.2.2.2 Niagara River Fluctuations

Fluctuations in the levels of the Upper Niagara River have a potential impact on the hydrologic system in the vicinity of the Inlet. The Upper Niagara River is approximately 20 miles in length and flows northward from the eastern end of Lake Erie at Buffalo, New York, to the Niagara Falls. The River (average flow 206,000 cfs) divides and flows around Grand Island, the eastern Tonawanda Channel (average flow 86,520 cfs) being slightly longer than the western Chippewa Channel (average flow 119,480 cfs). The Inlet, which is located on the Little Niagara River (average flow 7787 cfs), is located immediately east of the downstream (north) end of Tonawanda Island in the Tonawanda Channel.

Several gauging stations are located on the Upper Niagara River and are maintained and monitored by the U.S. Army Corps of Engineers and National Oceanic and Atmospheric Administration (NOAA). Stage data is collected on an hourly basis and an extensive database has been developed over the past several decades. One of the gauging stations is located on the west side of the upstream end of Tonawanda Island (Tonawanda gauge, station 3018), less than one mile upstream (south) from the Inlet.

Figure 3-6 shows the hourly fluctuation of River level at the Tonawanda gauge for a three-month period in 1975. Data are also presented for the eastern end of Lake Erie (Buffalo gauge, station 3020) and the Upper Niagara River a short distance upstream from the falls (Niagara Intake gauge, station 3012). All of the data presented in Figure 3-6 were converted from the 1955 International Great Lakes Datum (IGLD) to the 1929 mean sea level datum by the addition of 1.23 feet (O'Dell, 1989).

River level is indirectly controlled by (a) the level of Lake Erie at its eastern end, (b) ice jams and (c) power generation structures located upstream from Horseshoe Falls on the Ontario, Canada side and the American Falls on the New York side of the River. Lake Erie level is a primary controlling factor and displays both long-term (e.g., months to years) and short-term (e.g., hours to days) fluctuations. The long-term fluctuations are gradual and caused by natural variations in precipitation received by the drainage basin from year to year and seasonal changes in runoff and evapotranspiration rates. The short-term fluctuations are more dramatic, as shown in Figure 3-6, and result from storm surges, seiches and tides.

Lake Erie displays the largest storm surges of any of the Great Lakes because it is shallow (i.e., average depth of 60 feet) and oriented in the general direction of prevailing winds. Storm surges typically result in higher lake levels at Buffalo and corresponding lower lake levels at Toledo, Ohio although the opposite occurs on a less frequent basis. Figure 3-6 shows several examples of storm surges including a 3.5 feet lake level rise in mid April and a 2.5 feet drop in mid March. These fluctuations are transmitted downstream to Tonawanda Island where fluctuations of one to two feet commonly result. Although storm surges occur throughout the year, they are more frequent and larger in the late fall and winter months.

Ice jams, though seasonal, can also result in significant changes in the level of the Upper Niagara River. They are reportedly more common in the late winter and early spring months in the area where the Tonawanda and Chippewa Channels join. Figure 3-6 shows an increase of River level at the Tonawanda gauge during late February, 1975, in excess of 7.0 feet. This increase was caused by an ice jam, perhaps initially triggered by a storm surge, in the lower reaches of the Upper Niagara River. The River level remained elevated for several days, well into early March. This was the largest ice jam effect recorded during the 1963 - 1978 period, except for a single event in 1972 which lasted for a short period only.

Lastly, river level is directly controlled during the tourist season by gates and a dam associated with power generation. By regulation, 50,000 cubic feet per second (cfs) of flow must be maintained over the falls during daylight hours from April through October, inclusive. Gates in the dam are closed during the early morning hours to provide temporary storage and then opened during the day to release the temporarily stored River water and maintain the required flow over the falls. This control produces cyclical, diurnal River level fluctuations. As shown in Figure 3-6, these fluctuations typically range from 0.8 to 1.2 feet at the Niagara Intake gauge but are attenuated to 0.3 to 0.5 feet at the Tonawanda gauge. At the Niagara Intake gauge, high and low River level typically occur at 7:00 a.m. and 9:00 p.m., respectively. High and low River level typically occur at 9:00 a.m. and 10:00 p.m., respectively, at Tonawanda Island.

3.2.3 Regional Geology

A regional geologic column showing the various geologic strata that underlie the general Inlet area is shown on Figure 3-7. All of the strata shown down to and including the Camillus Shale are known to exist at the Inlet

3.2.3.1 Regional Physiography

The Inlet area is situated within the Northern Plain Physiographic Province which extends between the Onondaga escarpment to the south and the parallel Niagara escarpment to the north. This plain is a nearly level surface that was created in Late Pleistocene and Recent time by deposition in glacial and post-glacial lakes. This lake plain is structurally a shallow east-west trending trough currently drained westward along its axis by small creeks and tributaries into Lake Erie and the Niagara River.

3.2.3.2 Regional Surficial Geology

The surficial geology of the region consists of sediments deposited during the Pleistocene and Recent time. Glacial deposits consist of till, lake (lacustrine), and outwash deposits. Till, which is commonly deposited directly on bedrock at the base of a glacier, is a compact, poorly sorted unit, and may consist of boulders, cobbles, or gravel in a matrix of sand, silt and clay.

Lacustrine deposits, which usually consist of clay and silt with some sand, were deposited in glacial lakes dammed by downstream "plugs" and filled with water released by the melting ice.

Alluvial deposits consist of sand, silt, and sometimes gravel, and have been formed by a number of different mechanisms. Often, they result from deposition of sediment carried off by glacial meltwater.

Material deposited during Recent times may consist of clay, silt, sand and/or gravel. These materials have been eroded, reworked, and deposited by lakes, rivers, and streams.

Figure 3-8, a map of Regional Surface Geology, indicates that the Inlet area is underlain by lake silt, sand and clay (symbol HIC). A strand line, which marks the shoreline of an ancestral beach along the shoreline of the extinct lake, is located approximately 1/2 mile south and southwest of the Inlet.

3.2.3.3 Regional Bedrock Geology

The bedrock groups in the general Inlet area form the northern edge of the Allegheny Basin. Bedrock geology is mapped regionally as the Late Silurian Camillus Shale (see Figure 3-9). The Camillus has an uneroded thickness of approximately 400 feet and has a composition that includes thin-bedded shale and massive mudstone. The regional bedrock dip is to the south about 40 feet per mile (LaSala, 1968). The Inlet area may be located over a buried bedrock valley, floor elevation 490-500 feet MSL, that includes the area where the Tonawanda and Ellicott Creeks join (Yaeger, 1990; Kappel, 1988).

3.2.3.4 Regional Hydrogeology

Groundwater in the region occurs in both the unconsolidated overburden material and in bedrock. In the overburden tight clay-rich units, such as till and lacustrine clay, impede groundwater flow and act as aquitards or confining layers which separate the groundwater regimes above and below the unit. Sandy alluvial units allow for more rapid flow of water. There are no mapped primary water supply aquifers in the unconsolidated materials in the immediate region of the Inlet (Miller, 1988). However, some unconsolidated units in the region may yield sufficient quantities of water to supply individual households.

The bedrock aquifers in the region consist of shale, limestone, dolostone, and gypsum. Water moves through these units in bedding planes, fractures, joints, and in solution cavities which exist in various concentrations throughout the different types of rock. These conduits may not exist in parts of the rock mass, and therefore, groundwater movement may be very slow or nonexistent. Yields of over 1000 gallons per minute have been pumped from the Camillus Shale (LaSala, 1968). However, groundwater quality in the Camillus is poor. Water derived from this formation is not suitable for a public water supply, but can be used for industrial supply. Principal natural constituents of the groundwater include chloride and sulfate in concentrations exceeding existing potable water standards.

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4.0 GEOLOGICAL AND GEOTECHNICAL INVESTIGATION

This section of the report addresses the geological and geotechnical investigation program. The objectives, methods and results are summarized below in Section 4.1. Findings are presented in Sections 4.2 and 4.3.

4.1 Geotechnical Investigation Programs

Geotechnical investigations at the Inlet have consisted of drilling (Section 4.1.1) and laboratory soil analyses (Section 4.1.2) to characterize geologic strata and assess their physical properties. In addition, geophysical surveying (Section 4.1.3) was conducted to locate underground utilities.

4.1.1 Subsurface Drilling Programs

The *Work Plan for Additional Subsurface Investigations at the Inlet* (DUNN, October 1988a) formally established six Tasks. Four of these tasks are listed below; two other tasks, Inspection of the LWL (Task 1) and Subbottom Profiling (Task 2) are addressed in Sections 3.1.3, Utilities, and 4.1.3, Geophysical Surveys. This work plan, as amended by subsequent status reports and correspondence (DUNN, March 1989; October 1989; November 1989), was developed in cooperation with the NYSDEC and NYSDOH, and is hereafter referred to as the Work Plan.

Two State-approved drilling programs listed below, Vibracore drilling in the Inlet (OCC, May 1986), and the February 1988, soil boring program at the Inlet perimeter (DUNN, March 1988) preceded the Work Plan.

Most investigation tasks at the Inlet have involved subsurface drilling and sampling. All drilling was conducted with full-time observation by a geologist or engineer. Soil samples were logged and classified in the field according to the Modified Burmister and Unified Soil Classification systems. Boring logs are presented in Appendix D.

Following the convention used throughout this report, the drilling programs are grouped geographically into "Inlet perimeter" and "Inlet cove" borings.

Task 3 Inlet Perimeter Borings

- Phase 1 - borings I-1 through I-6, I-8, I-10; February-March 1988;
- Phase 2 - borings I-7, I-9, I-11 through I-20; September 1988;

- **Phase 3** - borings I-21 through I-30, and shallow auger holes HA-1 through HA-3; June-July 1989; and

- **Phase 4** - borings MW-1 through MW-14 for monitoring well installations, and borings SB-1 through SB-4 for confirmation of selected previous results; November 1989 - February 1990.

Inlet Cove Borings (in chronological order)

- **Durez Phase 2 Sewers Investigation** - Inlet Vibracore Drilling - vibracores 1-10; July 1986;

- **Task 5** - Inlet Sediment Depth Probing - probes 1-54; December 1988, January 1990, July 1990;

- **Task 4** - Inlet Water Borings - IW-1 through IW-6; November 1989; and

- **Task 6** - Lockport Water Line Bedding Borings - WL-1 through WL-5; December 1989-January 1990.

- **Sampling for additional PCDD/PCDF Analyses** - PCF-1 through PCF-3; November 1990.

4.1.1.1 Inlet Perimeter Borings

Inlet perimeter borings, i.e. borings drilled outside the Inlet's high water shore line, were drilled in four phases. The purpose and scope of each phase evolved based upon previous findings and discussions with State and local agencies.

Phases 1 - 3 were intended to fulfill the following objectives:

(1) to identify the extent and thickness of subsurface strata around the Inlet for site characterization;

(2) to determine the physical properties of these strata for preliminary remedial engineering purposes; and

(3) to collect selected samples for soil chemical analyses to be used for assessing the lateral and vertical extent of Durez-type chemistry in soil adjacent to the Inlet.

In Phase 4, the purpose and scope of the Inlet perimeter investigation were expanded to address groundwater. In addition to the objectives listed above, Phase 4 borings were drilled:

(1) to install monitoring wells,

(2) to collect groundwater samples for chemical analyses to define the nature and extent of selected chemicals in groundwater; and

(3) to perform field hydraulic conductivity testing.

Thirty-one borings (I-1A,I-1 through I-30) were drilled during Phases 1-3. Data and preliminary findings from the Phase 1 (DUNN, October 1988), Phase 2 (DUNN, March 1989) and Phase 3 (DUNN, August 1989) investigations have been presented in the referenced reports submitted previously to the State. Preliminary geologic maps and cross sections have also been submitted (DUNN, October 1989).

This report incorporates the previous data in tables, figures and appendices, and presents the results of the Phase 4 monitoring well investigation.

Phase 4 soil borings were drilled at 14 locations (MW-1 through MW-14) shown on Figure 4-1. In general, methods used were the same as the previous borings, i.e. using 4 1/4-inch I.D. hollow stem augers with continuous split-spoon sampling in accordance with standard ASTM D-1586 procedures. An exception was the method of drilling into the underlying clay aquitard for deep monitoring wells where chemistry was known or suspected. The modifications agreed to by NYSDEC and adopted to minimize the potential for carrydown of chemicals, are described in Section 5.1.3.

Three additional borings were drilled to confirm previous results at selected locations. SB-1 and SB-2 were drilled in the vicinity of boring I-22 to confirm the possible presence of chemistry in the upper 10-feet of fill at that location. SB-4 was drilled at I-26 to investigate suspicious data that indicated the possible presence of chemistry in the underlying glacio-lacustrine clay. (SB-3 was drilled near MW-5 to verify the depth of clay till at that location, but was aborted due to adverse drilling conditions.)

A summary of all Task 3 Inlet perimeter land borings, including depths, elevations and thicknesses of the stratigraphic units encountered, is presented on Table 4-1. Those Task 3 borings that encountered Inlet Soft Sediment are also included in Table 4-5, with Task 4 and Task 6 Inlet boring results.

4.1.1.2 Inlet Cove Vibracore Drilling

While the vibracore drilling program has been described in previous reports (OCC, September,1986; DUNN, December, 1986), it is repeated here to place the vibracore data into perspective with more recent findings.

Vibracore drilling was conducted at 10 locations spread across the Inlet to collect samples for chemical analysis. Three vibracore samples were collected at each of the ten locations. Estimated locations (1-10) are shown on Figure 4-2.

The vibracore assembly consisted of a mini-vibracore unit suspended from a barge-mounted tripod. The core tube was vibrated down through the sediments and a few feet into the underlying clay unit to refusal. The ease of penetration through the sediments led to adoption of the term "Soft Sediment" for these sampled deposits. The texture, consistency, and origin of the clayey Inlet bottom material underlying the Soft Sediment led to the clay's later designation as silt-clay fill. The results of the drilling operation are summarized in Table 4-2.

A minimum of one-foot of clay was recovered in the bottom of most cores. Recovery of Soft Sediment overlying the clay averaged only 63%. Based on the depth of penetration into the underlying clay and the lengths of clay and Soft Sediment recovered, an estimate was made of the minimum and maximum thickness of Soft Sediment at each location (see Table 4-2).

The "minimum" thickness (2.8 feet) assumed that all core loss was attributed to the silt-clay fill and that the actual Soft Sediment thickness was only that which was observed in the recovered core sample. The "maximum" thickness (5.3 feet) assumed that all vibracore sample loss was attributed to Soft Sediment displacement (the sediment never entered the sampler), compaction (the sediment settled within the sampler), or flow out of the top or bottom of the core tube (judged to be minor based on visual observations). An average thickness of 4.0 feet was used for making preliminary estimates of Soft Sediment volume.

4.1.1.3 Inlet Cove Sediment Depth Probing

Sediment depth probing (Task 5 of the Work Plan) was conducted at 54 locations in the Inlet to refine the estimate of Soft Sediment thickness determined from the vibracore data, and to estimate the volume of Soft Sediment. The data were also used to help map the surface elevation of the underlying silt-clay fill.

The results of the first 32 sediment depth probes have been presented to the State in a previous report (DUNN, March 1989). Those data are repeated herein to consolidate the findings of this task.

The probing'consisted of manually advancing a 3/8-inch diameter steel probe through the Soft Sediments and into the underlying clay until an increase in penetration resistance could be detected. The probe was withdrawn and the presence of the clay substratum confirmed by the clay residue on the tip of the probe; in only a few instances was clay not recovered. The 54 probes (1-54) were made in a grid pattern across the Inlet. Surveyed locations are shown on Figure 4-3. The results of the probing are presented in Table 4-3.

Similar to the vibracore data, the depth probe results provide only an estimate of Soft Sediment thickness. The absence of sample recovery and the possible presence of overlying modern fill and underlying soft alluvium complicate the interpretation of probe data and prevent precise quantification of actual thickness. The average Soft Sediment thickness estimated from the probing was 5.4 feet, with a range from 1.0 to 10.0 feet.

This average thickness value is close to the maximum possible sediment thickness of 5.3 feet determined from vibracore sampling. Although the vibracore and probe data were not collected at the same locations, the broad areal coverage of the Inlet for both methods enables a comparison of the results to be made. The similarity of the probe (5.4 feet) and maximum vibracore thickness (5.3 feet) estimates, suggests that the 37% loss of vibracore sample is probably attributable primarily to Soft Sediment displacement or compaction. This observation suggest that the Soft Sediment may be highly compressible and subject to liquefaction and flow upon disturbance. The Soft Sediment may be subject to significant volumetric changes between its in-place and excavated condition.

4.1.1.4 Inlet Cove Water Borings

Task 4 soil borings were drilled in a uniform pattern over the entire Inlet in an attempt to obtain a representative sampling of subsurface conditions below the Soft Sediment in the Inlet. These borings were drilled in the normally submerged portions of the Inlet. The objectives of the Inlet water borings were as follows:

(1) to determine the thickness and physical properties of the strata underlying the Soft Sediments (Ooze) in the submerged part of the Inlet;

(2) to collect soil samples for chemical analysis evaluate the presence, if any, of Durez-type chemicals in these strata;

(3) to provide an opportunity to evaluate and modify the drilling procedures planned for the subsequent Task 6 soil borings in the LWL bedding; and

(4) to provide preliminary geological information to help plan the Task 6 borings.

Six borings (IW-1 through IW-6) were drilled from a barge at locations shown on Figure 4-1. Boreholes were advanced through the Soft Sediment and underlying soils and into a minimum of five feet of the underlying native clay confining layer, either glacio-lacustrine clay or till. Methods used were the same as Task 6 (see Section 4.1.1.5), except that probing in advance of the drilling to verify the absence of obstructions was not necessary. Probing was conducted, however, to estimate the thickness of Soft Sediment and plan the depth of the 8-inch diameter surface casing during drilling. All Task 4 borings were grouted upon completion.

Borings IW-3 and IW-5 were special-application borings. They were drilled closer to the LWL than the other IW borings, i.e. 12 feet north and 13 feet south, respectively, to obtain initial geological information for the subsequent Task 6 borings (see Table 4-4). By chance, these two borings encountered the LWL bedding and therefore are similar to Task 6 borings. All other Task 4 borings were in the LWL backfill, but not the bedding. IW-6 was drilled in addition to the five borings originally proposed, to investigate the possible presence of chemistry in the north central part of the Inlet.

Sediment disturbance during the Task 4, and subsequent Task 6, drilling operations was kept to a minimum by the use of a crane to lift the barge and drilling equipment to and from boreholes and the decontamination pad. A crane was used because the water depth in the Inlet was too shallow to enable floating the barge into position. Unavoidable sediment disturbances were controlled by an absorbent boom and silt curtain installed across the mouth of the Inlet before drilling began. This barrier consisted of a string of expanded polystyrene flotation bales, with an attached 3-foot skirt and chain ballast to reach the Inlet bottom. A permeable geotextile fabric was sewn into the skirt to allow egress of normal Inlet water. The boom was functional for all Inlet drilling activities, including Tasks 4, 5 and 6, and was left in place at the conclusion of drilling.

All drill water and cuttings were collected and placed in drums for proper disposal.

A summary of the Inlet water borings, including depths, elevations and thicknesses of the stratigraphic units encountered, is presented in Table 4-5.

4.1.1.5 Lockport Water Line Bedding Borings

OCC included in the Work Plan a task for drilling along, and immediately adjacent to the LWL to determine if chemistry detected in the Soft Sediment overlying the LWL had migrated 20 to 25 feet downward to the LWL. The objectives of this drilling (Task 6) were as follows:

(1) to verify the location of the LWL;

(2) to determine the nature and physical properties of the backfill placed under and around the outside of the LWL during construction; and

(3) to collect soil samples for chemical analysis.

Six borings (WL-1A, WL-1 through WL-5) were drilled at locations shown on Figure 4-1, two more than originally proposed in the Work Plan. One boring, WL-5, was added to provide fill-in data at the east end of the Inlet. Another, WL-1A, was added when the preceding boring, WL-1, did not encounter LWL backfill. The LWL trench is very narrow at the location near the pump station.

Borings were drilled two to four feet north or south of the 15- to 23- foot deep LWL (see Table 4-4). Adequate precautions were taken during drilling to protect the integrity of the LWL while achieving the objective of drilling and sampling as close to the LWL as reasonable. This task was completed safely and without incident through implementation of the following procedures:

- sequencing the borings in expected order of increasing difficulty;
- utilizing the LWL location and depth survey data (Task 2);
- probing in advance of the drilling using Task 5 methods to detect possible obstructions;
- using proven (Task 4), and relatively non-aggressive drilling and sampling techniques;
- taking precautions during drilling, such as the use of multiple casings, flushing, positive pressure heads, and in-situ testing of annular bentonite casing seals to prevent carrydown of chemicals;
- City officials temporarily stopping water flow through the LWL pipe when the boring advanced near the elevation of the LWL;
- careful monitoring by experienced City of Lockport, NYSDEC, NYSDOH and senior-level technical personnel;
- promptly tremie grouting the boreholes upon the completion of drilling;
- having a diving crew familiar with the LWL on standby in the event of an incident requiring immediate underwater attention; and

- repeating an inspection of the interior of the LWL (Task 1) to verify the integrity of the LWL liner.

A summary of the stratigraphy encountered during drilling is presented in Table 4-5.

4.1.1.6 Sampling For Additional PCDD/PCDF Analyses

Three samples of Soft Sediment were collected by the State in November 1990 for analyses of polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF). OCC collected sample splits to perform preliminary screening analyses for PCDD/PCDF. The samples, PCF-1 through PCF-3, were collected manually within the approximately upper six inches of sediment at locations shown on Figure 4-1. The samples were in addition to a previous vibracore sample collected by OCC and analyzed for total tetrachlorodibenzodioxin (TCDD) and 2,3,7,8-TCDD.

4.1.2 Geotechnical Laboratory Testing Program

Geotechnical laboratory testing data for Soft Sediment samples collected during vibracoring in 1986 were included in a previous report (DUNN, October 1988). Selected samples were analyzed for water content, plasticity indices (Atterberg limits), and grain size analysis by hydrometer. These analyses and all subsequent analyses are summarized in Tables 4-6A to 4-6F.

The purpose of the geotechnical testing was to aid in soil classification, identify index parameters and determine physical properties of subsurface materials sufficiently to enable initial development of design recommendations for remedial alternatives. Laboratory testing was conducted on selected soil samples in accordance with ASTM standard procedures. The following test procedures were used.

- Water content - ASTM D2216
- Atterberg limits (plasticity indices) - ASTM D4318
- Gradation analysis (grain size distribution) - ASTM D422 (hydrometer), C136 (sieve analysis), and C117 (wash loss)
- Undrained shear strength by unconsolidated, undrained triaxial (UU) -ASTM D2850, by consolidated undrained triaxial (CU) tests-D4767
- Hydraulic conductivity by flexible wall triaxial permeameter - USACOE EM 1110-2-1906, Appendix VII

Field standard penetration tests ("N", SPT or blow counts), pocket penetrometer and torvane measurements were also used to expand upon the laboratory soil strength data.

Geotechnical laboratory testing results are summarized in Table 4-6A for density, Table 4-6B for Atterberg limits, Table 4-6C for gradation analysis, Table 4-6D for undrained shear strength and Table 4-6E for hydraulic conductivity. In addition, water contents estimated for the Soft Sediment from moisture content data developed by OCC during chemical analyses of the Soft Sediments are summarized in Table 4-6F. The method of estimation is presented in the table. Appendix E summarizes the geotechnical soil testing data for the various geologic units sampled.

4.1.3 Geophysical Surveys

The following non-invasive geophysical surveys were conducted during the Inlet investigation and have been summarized in previous reports.

- Preliminary magnetometer and terrain conductivity surveying to locate the LWL and NTWL (DUNN, October 1988);

- Electromagnetic survey to determine the location and depth of the LWL (OSI, December 1988); and

- Seismic subbottom survey to determine Little Niagara River bathymetry and shallow stratigraphy (OSI, December 1988).

The preliminary magnetometer survey located the LWL and NTWL, but the precision required by the project objectives could not be reliably attained. Subsequent surveys were conducted to increase reliability.

The electromagnetic survey to locate the LWL was successful, as indicated by later drilling and probing activities. The survey results have been used to map the LWL and to help guide the Task 6 drilling.

The seismic subbottom survey successfully mapped River bathymetry and appears to have delineated the buried LWL trench in the River bottom. The interpretation of subbottom stratigraphy is inconclusive based on the available data.

Recent surveys have included a terrain conductivity survey to map the upstream section of the PCF and a magnetic locator survey to refine the estimated location and depth of the NTWL. These surveys are briefly described in Section 3.1.3, Utilities, and provide the basis, along with the geophysical surveys listed above, for the approximate underground utility locations presented on the figures and plates herein (see Plate 1).

4.2 Geologic Conditions

The Inlet perimeter and the Inlet cove comprise the study area. The Inlet perimeter area can be divided into north, east, and south areas. These areas can be seen on the Inlet Surficial Geology Map presented on Figure 4-4. This map provides a general representation of the geologic units subcropping just below the layer of modern surficial fill at the ground surface. The north and south perimeter areas are underlain by alluvium, and the east area is underlain by natural glacio-lacustrine clay, except for the silt-clay fill, i.e. LWL trench backfill. The Inlet is underlain by Soft Sediment, which directly overlies the silt-clay fill.

A transitional zone, is present at the south edge of the Inlet. This approximately 50-foot wide zone contains Soft Sediment that was deposited when the Inlet extended farther to the south than it currently does, and was subsequently buried by an average of approximately 4-feet of recent terrestrial fill. Review of aerial photographs suggests that the fill was placed within the past 40 years. Stratigraphy appears to be relatively complex in the transitional zone.

Eight stratigraphic units have been identified in the Inlet area. Their physical properties are summarized below. Hydrogeologic and chemical characteristics, especially as they relate to these physical properties, are addressed later.

4.2.1 Stratigraphic Units - Inlet Perimeter

Typical stratigraphy in the Inlet perimeter is summarized on Figure 4-5. In order of increasing age and depth, the geologic units are fill, alluvium, glacio-lacustrine clay, till and bedrock. All of these deposits continue laterally under part or all of the Inlet cove where, except for bedrock, they were partly or completely excavated during the LWL construction. The following descriptions are based on the findings of the subsurface investigation.

4.2.1.1 Fill

Fill is a surficial soil deposited as a result of human activities. It covers the entire Inlet perimeter and comprises a relatively thin upper part of the fill/alluvium hydrogeologic unit. In some areas the fill is in direct lateral contact with the Soft Sediment.

On the north side of the Inlet, fill is a relatively permeable, heterogeneous mix of predominantly slaggy gravel, sand and silt with brick, concrete, railroad ballast, cinders and ash. This mix is indicative of the past intensive industrial land use of this area. Fill on the north side typically ranges from 4 to 13 feet thick, and averages about 8 feet. It is typically compact, but highly variable in relative density, with standard penetration resistance ranging from 3 to 50 blows per foot. Drilling refusal was encountered on occasion in the upper 4 feet of fill.

On the south side of the Inlet, including the transitional area, fill is typically a dark brown clayey silt and medium to fine sand with organic matter. Concrete, slag, ash, and bricks are occasionally present. It typically ranges 4 to 11 feet thick, and averages about 7 feet. It may closely resemble Soft Sediment; therefore contacts between the two units may be gradational and difficult to distinguish. The south fill is typically firm to loose; penetration resistances varied from 3 to 11 blows per foot. On a few boring logs for borings in certain areas of the transitional zone, e.g. I-1, I-3 and MW-8D, the deeper fill is reported as "oily".

4.2.1.2 Alluvium

Alluvium is a relatively thick and permeable granular deposit that underlies the fill and comprises the principal water-bearing unit at the Inlet. It also directly underlies silt-clay fill at the northwest and southwest parts of the Inlet. Alluvium is a river deposit; however, granular fill deposits may be included within "alluvium", especially immediately adjacent to the River. It is commonly difficult to distinguish natural and disturbed coarse granular deposits; such a distinction is not practically necessary from a hydrogeological standpoint.

The alluvium can be divided generally into an upper fine grained layer and a lower coarse layer. The upper layer consists of dark gray brown clayey silt to fine to medium sand, with some silt and frequently with roots, organic matter, and bark. It grades coarser with depth. It may be a "rich bottom lands" soil (see Appendix B) and difficult to distinguish from organic-rich fill or Soft Sediment deposits. It is typically 2 to 4 feet thick, where present, e.g. borings I-7, I-22 and I-23. The relative density of the upper alluvium is loose, with penetration resistances typically ranging from 2 to 10 blows per foot.

The lower alluvium is generally a gray fine to coarse sand with some medium to fine gravel and trace silt. Occasional gravel pockets are present, especially in the bottom 5 feet of this deposit, e.g. MW-1 and MW-5. Pieces of wood and small calcareous shell fragments occur throughout. The lower alluvium layer is thicker than the upper fine grained layer, and ranges up to 20 to 23 feet thick near the River. Drilling and sampling this coarse layer was difficult in some areas due to a problem with loose running sands and poor sample recovery, e.g.I-5, I-9, I-13, I-22 and MW-5. The relative density of the alluvium is typically loose to compact, with penetration resistances ranging from 1 to 15 blows per foot. Penetration resistances are higher in gravelly zones, commonly ranging above 30 blows per foot.

The alluvium layer occurs in a broad wedge-shaped deposit, approximately 26 feet thick near the River and pinching out 150 to 300 feet east of the River. This unit was deposited by a rapidly flowing River that first eroded the underlying clay soils and then deposited the sand and gravel layer, probably in association with a post-glacial rise in lake level.

A contour map of the top of alluvium is presented in Figure 4-6. The LWL excavation scar is the most conspicuous feature on this map. Figure 4-7 is an isopach (thickness) map that shows the eastward thinning of alluvium from 26 feet to 0 feet along a line that intersects the PCF outfall. The LWL excavation completely removed the relatively permeable sand and gravel alluvium from the Inlet.

The isopach map also shows a localized thickening of alluvium in the north perimeter area near borings I-22 and I-23. This thickening is associated with a topographic depression, in the surface of the underlying clayey till.

4.2.1.3 Glacio-Lacustrine Clay

Glacio-lacustrine clay (GLC) is one of two strata that comprise the lower clay confining layer at the Inlet; the other, glacial till, is described below. The lower clay confining layer forms the surface upon which the fill/alluvium unit was deposited, and may help control the distribution and migration direction of dense non-aqueous phase liquids.

The glacio-lacustrine clay is a medium plastic, brownish red silty clay, occasionally with a trace of sand and gravel. It characteristically contains varves, fine lamina of alternating silty and clayey layers, which represent seasonal deposition in glacial Lake Warren. Horizontal fine sand seams are also occasionally present.

Consistent with observations made elsewhere in North Tonawanda, the upper part of the uneroded GLC is stiffer than the lower part. In the eastern area of the Inlet perimeter, where the clay surface was not subjected to extensive alluvial erosion, the upper 6 to 8 feet of clay is usually stiff to very stiff in consistency. Penetration resistances typically range from 9 to 52 blows per foot, with an average of about 14 blows per foot. Below this depth, which generally coincides with an elevation between 558 and 561 feet, MSL, the clay becomes very soft to soft, with penetration resistances typically ranging from 0 to 4 blows per foot, and averaging 1-2 blows per foot.

The topography of the surface of the combined GLC-till confining layer is shown on Figure 4-8. The Figure shows the uniformly westward sloping, erosional surface in the Inlet perimeter area, and the sharp cut made into and through the GLC in the LWL trench. The figure also shows the approximate position of the boundary along which the clay has been completely eroded. West of this boundary the confining surface is till. (Till also extends east of the line, but underlies the GLC). The glacio-lacustrine clay ranges in thickness from greater than 22 feet thick inland, to zero near the River where it is completely eroded.

4.2.1.4 Till

Glacial till directly underlies glacio-lacustrine clay and forms the western part of the clay confining surface where the GLC has been removed by erosion.

Till is typically unstratified, slightly plastic, reddish brown clay and silt, with trace to some fine sand, and trace to some medium to fine gravel. Fine sand seams, and clay, silt, and gravel pockets are occasionally present. Till and GLC may resemble each other, especially for thin occurrences. It is possible that till may be logged as GLC, e.g. I-23, and GLC may be logged as till, e.g. MW-13, in isolated occurrences. In general, however, till typically contrasts with the overlying glacio-lacustrine clay by till's relatively poorer sorting of grain sizes; lower content of clay, lower plasticity, higher content of sand and gravel, greater angularity of gravel, higher density and higher penetration resistance. The till is stiff to very stiff in consistency. Penetration resistances ranged from 5 to 30 blows per foot and averaged approximately 13 blows per foot. The upper few feet are commonly softer than the underlying material.

Available drilling data indicate that the surface of the till is at a relatively uniform elevation. Till was typically encountered at an elevation between 536 and 542 feet, MSL, with an average of approximately 540 feet.

The top of till was observed at relatively lower elevations in borings I-4 (536.3 feet), I-22 (535.7 feet) and I-23 (533.1 feet) than in other borings. (Boring I-23 reportedly has 3.6 feet of glacio-lacustrine clay overlying the till.) These three borings were used to map a stratigraphic depression in the till surface extending north of the northwest corner of the Inlet (Figure 4-8). This depression appears to be oriented in a north-south direction and may be associated with post-glacial river scour. A series of borings west and northwest of the depression, e.g. I-9, I-21, MW-2, suggest that the till depression does not extend to the River, except possibly in the vicinity of I-4. It is likely that unmapped topographic variations may exist. The depression will be referred to later in the text during discussions on the extent and migration of chemicals.

Based on two borings, I-3 and I-21, that penetrated the full thickness of till, the consistency of till becomes hard at an elevation of approximately 520 feet. Penetration rates abruptly increased to greater than 100 blows per foot at that elevation. This may represent a distinct, deeper lodgement till unit. The total thickness of till observed in these borings ranges from 37 to 47 feet.

4.2.1.5 Bedrock

Bedrock is present at depth of approximately 75 feet at the Inlet area. The overburden of unconsolidated deposits includes a minimum of approximately 35 feet of till. Bedrock was encountered in two borings, I-3 and I-21, at elevations of 494 and 504 feet, respectively. In I-21 bedrock was logged as calcareous shale; regional mapping (Figure 3-9) indicates that this is the Camillus Shale. Section 3.2.3.3 presents a geologic description.

4.2.2 Stratigraphic Units - Inlet Cove (LWL Backfill)

The stratigraphy in the Inlet is complex and different than the Inlet perimeter. Excavation and subsequent backfilling for the LWL greatly disturbed the local geology. The Inlet subsurface resembles a backfilled notch that widens and deepens toward the River. A plug of mostly relatively impermeable silt and clay and other fill replaced relatively permeable alluvium formerly present at this location. Incomplete backfilling of the excavation enlarged the mouth of Pettit Creek, creating the cove-shaped Inlet. The Inlet subsequently served as a small basin that accumulated sediment discharged first from Pettit Creek (at that time a "State Ditch") and later the PCF storm sewer and adjacent areas.

Figure 4-9 shows the sequence of five strata identified at the LWL in the Inlet. In order of increasing depth, these deposits are Soft Sediment, silt-clay fill, bedding, glacio-lacustrine clay and till. Alluvium, which underlies silt-clay fill in the northwest and southwest parts of the Inlet, away from the LWL, is not shown. The alluvium, glacio-lacustrine clay and till in the Inlet have been described already and will not be addressed further in this section.

4.2.2.1 Soft Sediment

The Soft Sediment has been given considerable attention because field observations, analytical results and historical background suggest the Soft Sediment is generally associated with Inlet chemistry. It represents Inlet sediments deposited since 1908.

Soft Sediment is typically a dark gray, brown, or black, occasionally sandy, fine grained deposit. Its texture ranges from organic silty clay to clayey silt, with little fine sand and trace amounts of gravel. Sand and gravel seams or lenses, with relatively higher resistance to penetration by probes, are frequently present. These coarser grained sediments may indicate relatively higher energy episodic hydrologic events or deposition at the point of discharge of the PCF into the Inlet.

The soft sediment is a quiet-water deposit and typically contains abundant natural organic matter, including twigs, roots and fibrous plant material. Pieces of gravel and other debris including logs, tires, brick, slag, and metallic-looking flakes are also present, especially near the south shoreline. Gravel, possibly originating as fill, is particularly prevalent in the southwest part of the Inlet. Some Soft Sediment samples have been described as "oily" or containing blebs of NAPL. In some retained vibracore samples portions of the Soft Sediment have been observed to cause crazing in the Lexan liner or change to an orange color after long exposure to light or air.

Soft Sediment is very soft and compressible, especially in those areas of the Inlet that have been continually submerged. Its natural water content exceeds its liquid limit and therefore the Soft Sediment is expected to have very low strength. Standard penetration resistances through this deposit typically ranged from 0 to 4 blows per foot, averaging approximately 2 blows per foot. Areas having relatively higher gravel content gave higher penetration resistances, occasionally to 19 blows per foot. Plasticity ranges from low to high.

Figure 3-1 shows the generalized topography of the Soft Sediment surface. Shallow channels at elevation 563-564 feet, and a scour hole at elevation 562 feet at the east end of the Inlet near the discharge point of the PCF to the Inlet, are apparent. A triangular-shaped delta of Soft Sediment can be observed during periods of low water level at the western end of the Inlet where the Inlet widens.

Figure 4-10 presents a contour map showing the approximate thickness and lateral extent of Soft Sediment. This map was developed from sediment depth probes, and Task 3 Inlet perimeter borings. A transitional zone, where Soft Sediment is buried by recent terrestrial fill, is shown as a shaded area on the figure. The lateral extent of the zone is based on boring logs I-2, -3, -15, -25, -27, MW-8D and -9D, and on topography and depth probe data. Soft Sediment resembles and may grade into and be indistinguishable from the overlying terrigenous fill deposit.

The isopach map in Figure 4-10 does not incorporate the thickness of these overlying fill deposits in the contours. A thin zone of Soft Sediment may also be buried at the north edge of the Inlet based on the depth probe data.

The thickness of the soft sediment averages approximately 5.3 feet, with a maximum of 10 feet, at the southeast corner of the Inlet in the vicinity of boring WL-5. Relatively thick areas are also present along the south edge and in the northwest corner and may be related to structures formerly located in these areas. These structures may have been boat houses, possibly for skiffs used to service the dock areas along the River (see Appendix B). Sediment depth probing indicate that Soft Sediment extends south of the NTWL at the mouth of the Inlet.

4.2.2.2 Silt-Clay Fill

Silt-clay fill is relatively impermeable deposit that probably acts in most areas as a confining layer below the Soft Sediment. The silt-clay fill was placed apparently as backfill during construction for the LWL. It was observed to underlie Soft Sediment in all areas drilled, except for a few locations around the periphery of the Inlet, e.g. IW-6 and MW-9, where the sampling interval and gradational nature of stratigraphic contacts may have obscured the possible presence of the silt-clay fill in these areas.

Laboratory testing of a single sample indicated a very low vertical hydraulic conductivity of 5.0 x 10^{-8} cm/sec. indicating that this unit typically may act as a confining layer below the Soft Sediment.

The silt-clay fill is typically a uniform brownish red silty clay with occasional traces of sand and fine to medium gravel. It is more clayey than its name would suggest. Red streaks, mottles, and varves (frequently disturbed), are commonly evident in samples, especially at the eastern half of the Inlet. These characteristics are probably inherited from the glacio-lacustrine clay parent material. Local pockets of silt and fine sand are also observed, especially at the south edge of the Inlet. Wood fragments have also been noted. Plasticity ranges from slight to high.

The silt-clay fill has a soft consistency, with penetration resistances typically ranging from 0 to 5 blows per foot and averaging 2 blows per foot. Laboratory-determined water contents of the silt-clay fill are lower than the overlying Soft Sediment. This may be a cause of the relatively increased penetration resistance observed during the vibracoring and sediment depth probes in the silt-clay fill.

Two areas of the silt-clay fill appear to be atypical. The silt-clay fill observed in the upper part of boring WL-4 at the mouth of the Inlet contained more coarse sand and fine to medium gravel than observed elsewhere. The relatively coarser texture, lower plasticity, and greater penetration resistance of this material suggest that the parent material at this location may have been till, which it resembles, rather than GLC. This is reasonable considering that the GLC is completely eroded in this area and may not have been available for use as backfill. Silt-clay fill in the lower part of WL-4 was more typical of the Inlet and resembled GLC.

The silt-clay fill in WL-1A was predominantly brown, red, gray and tan, fine to medium sand and silty clay. This contrast in color and texture with other silt-clay fill is probably attributable to WL-1A's proximity to the pump station, where different materials and construction techniques, i.e. land-based excavation rather than dredging, may have been used.

A surface contour map for the silt-clay fill is presented in Figure 4-11. Of potential interest on this map is the presence of two elongated depressions in the surface that may represent former surface water flow channels or irregularities in the LWL backfill. One is located along the north side of the Inlet near borings IW-6 and IW-1. The other, located along the south side of the Inlet, is apparently wider near borings WL-2 and WL-5. The LWL is located along the north edge of this southern depression. These depressions may accumulate DNAPL, especially in the southern depression. NAPL has been observed extensively in the silt-clay fill in only two borings, WL-2 and WL-5; these borings are located in the depression. The silt-clay fill topography will be addressed later in the presentation on chemical migration.

A silt-clay fill isopach map is presented in Figure 4-12. The figure depicts the thickening of silt-clay fill toward the mouth of the Inlet toward WL-3 and WL-4 where this deposit is 16 to 17 feet thick. Silt-clay is typically underlain by alluvium, glacio-lacustrine clay or by bedding described below.

4.2.2.3 Bedding

Bedding is considered an important unit because of its association with chemicals, probable relatively higher permeability than adjacent clays, and possible role as a DNAPL migration pathway.

"Bedding" is a term used to describe the relatively coarser fill observed 19 to 29 feet deep at the base of the silt-clay fill in the vicinity of the LWL. Bedding may include material that settled, sloughed or washed onto the sides (q.v. IW-4) and bottom of the dredged or excavated trench during LWL construction.

The bedding is predominantly dark gray fine sand and silt as observed in borings WL-2, WL-3 and WL-4. The bottom of the bedding is commonly sandier than the top. The bedding grades to finer grained silt and silty clay east of WL-5 at the east edge of the Inlet. No penetration resistance data are available for the bedding due to the non-aggressive drilling methods used adjacent to the LWL. The permeability is expected to be low because of the relatively high silt content; however, the bedding should be much more permeable than the overlying silt-clay fill and underlying glacio-lacustrine clay or till.

The characteristics of the bedding vary along the LWL. This is probably attributable to LWL construction and the local stratigraphy. Under the Inlet where the LWL trench was excavated by dredging, the LWL pipe was supported by wood cribbing, and the cohesionless alluvial sand predominated, the bedding is relatively coarser textured, thicker and contains numerous wood "chunks." In contrast, in the area east of the Inlet, starting in the general vicinity of WL-5, where the dredging activities may have terminated and the cohesive GLC predominates; the bedding is finer grained, thinner and lacks wood "chunks."

The estimated width of the bedding shown on Figure 4-13 is based on Task 4 and Task 6 borings, interpreted seismic subbottom profiles, and stratigraphic considerations. The width in the Inlet is estimated based on the detection of bedding material in borings IW-3 and IW-5, which were drilled 12 feet north and 13 feet south of the LWL, respectively. The bedding is shown to widen at the mouth of the Inlet based on the apparent width of the LWL trench in subbottom profile 11 (Figure 3-3). The bedding is shown to narrow at the east end of the Inlet, where the walls of the LWL excavation should be steeper because the non-cohesive alluvium pinches out and the thickness of stiff cohesive GLC increases. The LWL trench is very narrow near the pump station; boring WL-1 was drilled an estimated 3 feet from the LWL and failed to encounter LWL backfill. WL-1A was drilled an estimated 2 feet from the LWL and encountered the backfill.

The elevation of the top surface of the bedding is represented in Figure 4-13. This surface appears to slope toward the western third of the Inlet where the bedding surface appears to level off. This elevation is about 25 feet below River level; approximately the same elevation as the deepest part of the River bottom adjacent to the Inlet.

The thickness of bedding material is represented on Figure 4-14. The thickness typically ranges from 1 to 5 feet, and averages 3 feet thick. The greatest thickness, 5.7 feet, was observed at IW-5, where the bedding is relatively coarse sand with little to some gravel. The bedding appears to be continuous under the Inlet and west of WL-5, but it is possible that undetected zones of very low permeability may be present.

The total thickness of fill deposits in the Inlet is shown on the Total Fill Isopach Map (Figure 4-15). This map represents the thickness of all the fill and Soft Sediment in the Inlet deposited above native soil.

4.2.3 Stratigraphic Relationships

Figure 4-16 is a plan map displaying the locations of geologic cross-sections A-A' through M-M', which are presented on Figure 4-16A through 4-16M. Table 4-7 summarizes cross-section interpretations that will be used during the discussion in Section 6.0 on the extent and migration of chemicals.

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5.0 GROUNDWATER HYDROLOGY

5.1 Groundwater Hydrology Investigation Programs

Groundwater investigations were conducted during Phases 3 and 4 of the Task 3 Inlet perimeter drilling program. The investigations included installation of piezometers, staff gages, and monitoring wells; performance of hydraulic conductivity tests in the monitoring wells; and monitoring of groundwater and surface water levels.

5.1.1 Piezometer Installation

Temporary piezometers, consisting of slotted PVC standpipes, were placed at the water table in open borings I-21, I-22, I-23, and I-28 at the conclusion of Phase 3 drilling activities. These borings are located in the north perimeter area at locations shown on Figure 4-1.

The purpose of the piezometers was to measure water table elevations and make preliminary estimates of groundwater flow directions to help plan the locations of future soil borings and help interpret the observed extent of soil chemistry. The piezometers were monitored for a short period and were removed during the Phase 4 monitoring well installation program.

5.1.2 Staff Gage Installation

Two staff gages have been installed to monitor surface water levels in conjunction with groundwater levels. The staff gages are located at the outfall structure of the PCF (SG-1) and at the steel sheet piling structure at the north perimeter shoreline (SG-2). Original locations are shown on Figure 4-1. Gage SG-2 was relocated approximately 80 feet south in October 1990; the new elevation is 566.55 feet MSL.

5.1.3 Groundwater Monitoring Well Construction

Monitoring wells were installed at 14 locations around the Inlet perimeter during the last phase (Phase 4) of the Task 3 Inlet perimeter investigation (DUNN, October 1989). The wells were installed in clusters of one to three wells per location. Screen depths were classified as shallow (S), intermediate (I), or deep (D). Shallow wells were installed generally at the water table, intermediate wells at the bottom of the fill/alluvium unit, and deep wells below the water table in glacio-lacustrine clay or till. Locations are shown on Figure 4-1. The primary purposes for the monitoring wells were to define the nature and extent of chemicals in groundwater and to estimate groundwater flow directions and rates.

The wells were constructed in accordance with the Work Plan. Most wells were installed with 8-inch O.D., 4-1/4-inch I.D. hollow stem augers. Two-inch diameter flush thread Schedule 40

PVC wells were installed through the hollow stem. Continuous soil sampling with 2-inch O.D. split spoons was completed on one boring per well cluster. Screen lengths of either 2, 5, or 10 feet were selected during construction to achieve the hydraulic and chemical monitoring required. Flush-mounted watertight steel valve boxes were installed at grade in all monitoring wells. Locks were installed on all PVC caps, which are recessed inside the protective steel valve boxes.

The method of drilling deep wells was revised from the Work Plan at certain locations to minimize the potential for carrydown of chemicals in areas known to contain chemistry. A 6-inch steel casing was driven through the alluvium and 1.5 feet into the underlying clay to seal off any chemistry present. After the 6-inch casing was keyed into clay, a 4-inch diameter steel casing with a wood plug was installed through a bentonite slurry inside the 6-inch casing and driven an additional 6 inches into clay. The wood plug was split and knocked out to enable continuous split spoon sampling and the driving of 4-inch steel casing after every sample interval to borehole completion.

Figure 5-1 is a sketch of a typical monitoring well. A summary of monitoring well construction details is presented in Table 5-1. Boring logs are included in Appendix D and monitoring well completion logs in Appendix F.

Modifications were made to the proposed monitoring well network (DUNN, October 1989) immediately prior to the start of work. These changes were made in cooperation with the NYSDEC and included the addition of well MW-1S and the deletion of well cluster MW-14 (DUNN, November 1989). Well MW-1D was added to the program as the investigation progressed in response to the presence of a low concentration of chemistry detected in the soil from boring MW-1I. Well MW-14S was added to provide additional hydraulic and chemical data at the south edge of the study area. More recently, two shallow water table wells were added at MW-12 and MW-13 to define the water table and flow directions in those areas.

Development of all monitoring wells was completed in two rounds. Each development sequence included the evacuation of three well volumes of water, including the annular sand pack volume. In some instances, only one volume of water was evacuated, or the well was bailed dry, due to the well's low permeability and water recovery rate. The second round of development for the low permeability wells was then delayed to allow adequate groundwater recharge.

Initial well development was completed as soon as possible after installation to remove any drill water and foreign matter that might have entered the well during installation. In addition, development removed fines and accumulated sediments from the formation and well screen to improve well production for more representative groundwater sampling, scheduled for two weeks after the completion of development. Physical parameters monitored during well development included color, turbidity, odor and volume of water evacuated. There was some lightening of color and decrease in turbidity as the wells were developed.

Water was removed from the wells with pre-cleaned, dedicated, PVC bailers and was collected in 5-gallon plastic pails. Water with an odor or PID reading much above background was collected in 55-gallon drums for subsequent treatment at a permitted commercial wastewater treatment plant. Water not treated commercially was filtered through a drum containing activated carbon (Calgon Filtasorb) and discharged on the ground at a location at least 25 feet from the shoreline or a monitoring well.

5.1.4 Hydraulic Conductivity Testing

Hydraulic conductivity tests (slug and bail) were performed on fifteen wells during the week of May 7, 1990. Slug and bail tests were used to determine the hydraulic conductivity of the screened sections of shallow and intermediate wells. Hydraulic conductivity testing was not performed at wells screened solely within the clay rich materials (glacio-lacustrine clays and till). At these locations, there was little or no response after the initial perturbation of the water level and therefore, it was not practical to obtain enough recovery data to calculate accurate hydraulic conductivities.

Slug and bail testing involves observing the recovery of water levels towards an equilibrium level after an initial perturbation. In each test, a pressure transducer set below the water level was used to record water level recovery after the removal of a known volume of water (bail test) or addition of a known volume (slug test). Bail testing included the introduction and removal of one of the following: a dedicated 1-inch O.D. PVC bailer, 3/4-inch O.D. solid steel bar or a 1 1/4-inch sealed, PVC drop-pipe unit. Slug testing included the introduction of the steel bar or the drop pipe unit. The pressure transducer, steel bar and drop pipe unit were decontaminated between each well location. The decontamination procedure included scrubbing with distilled water then rinsing the equipment with methanol followed by hexane and another methanol rinse and a final distilled water rinse. Water generated from bailing and the fluids generated from decontamination procedures were containerized or treated on-site with activated carbon. Throughout slug and bail testing, water level recovery data was recorded on a strip chart recorder (Enviro-Labs Model DL-240 Data Logger). Thus, a chart of pressure (at a specific measuring point) versus time is obtained for use in calculating hydraulic conductivities.

Data obtained were analyzed according to the method developed by Hvorslev (1951). Results were checked using a second analysis method developed by the U.S. Department of the Navy (1971) and described by Cedergren (1977).

A method of interpreting the water level versus time data that arise from bail tests or slug tests is the Hvorslev (1951) method. The principle behind Hvorslev's method is that a plot of recovery data versus time theoretically follows an exponential decline and theoretically forms a straight line on semi-log paper. Horizontal hydraulic conductivity (K) is then calculated as follows:

$$K = \frac{r^2 \ln(L/R)}{2LT_0}$$

where: K = hydraulic conductivity

r = radius of riser in which water level fluctuations occur

R = radius of well screen

L = well screen length

T_0 = basic time lag

The basic time lag (T_0) is found from the straight-line fit to recovery data and is the time at which $H\text{-}h/H\text{-}H_0 = 0.37$ or $\ln(H\text{-}h/H\text{-}H_0) = -1$. The computer program used to calculate hydraulic conductivity by this method utilizes linear regression techniques applied to the recovery data after logarithmic transformation:

$$\ln(H\text{-}h/H\text{-}H_0) = b_0 + b_1 t$$

where: H = head at equilibrium

h = head at some time (t)

H_0 = head at t = 0

b_0 = y-intercept

b_1 = slope

t = time

This methodology results in a quantitative and objective "forcing" of a straight line to the recovery data. The slope (b_1) and y-intercept (b_0) can be used to find T_0 and thus K. The accuracy of the fit can be assessed using the R-squared (coefficient of determination) and residuals.

Hydraulic conductivity (K) was also calculated using the following equation (Department of the Navy, 1971):

$$K = \frac{R^2 \ln(L/R) \ln(H_1/H_2)}{2L(T_2-T_1)}$$

where: K = hydraulic conductivity

R = inside radius or casing/screen

L = length of uncased/screened portion of well

H = pressure/distance of water level from equilibrium value

T = time expired from test start

A summary of hydraulic conductivity test results (bail testing, Hvorslev method) and geometric mean of hydraulic conductivities are presented in Table 5-2. Even though geometric means are presented for the different units, it is recognized that variations within each unit will occur.

5.1.5 Water Level Monitoring

5.1.5.1 Piezometer Measurements

Groundwater levels were measured in the temporary piezometers for a one-month period during the summer of 1989. Measurements were made on a daily to weekly schedule and included monitoring of the river level staff gage SG-2. The data were used to prepare a water table contour map that was included in a previous report to the State (DUNN, October 1989).

Recent reevaluation of the relative response of the piezometers indicated that I-23 was not responding adequately, probably because of relatively low permeability backfill placed during installation. The data from this well has subsequently been deleted. The remaining data, including calculated average water levels, are summarized in Table 5-3.

5.1.5.2 Monitoring Well Measurements

Data concerning water levels were collected from Inlet perimeter wells and staff gages from January 1990 through September 13, 1990. Initial data were collected at irregular intervals as the wells were being constructed and developed. For the period of March 5 through June 5, data were collected on a biweekly basis; from June 5, they were collected monthly. Groundwater elevations measured since March 27, when most wells began to stabilize, are summarized in Table 5-4. The depth to the water table typically ranges from 5 to 8 feet below grade north and south of the Inlet.

5.2 Hydraulic Head Monitoring

5.2.1 River Effects on Groundwater

The River exerts a significant effect on groundwater flow in portions of the Inlet perimeter near the River. River level fluctuations are described in Section 3.2.2. The results of hydraulic head monitoring in piezometers and monitoring wells lead to the conclusion that caution must be exercised when interpreting water level data and determining flow directions and rates in the vicinity of the River.

Piezometer Data

Several observations were made upon review of the water level data obtained from the piezometers and staff gages. Piezometer data collected in 1989 indicate that significant changes may occur in the magnitude and direction of hydraulic gradients over short periods of time, i.e. hours. The piezometric relationship between River and groundwater levels is dynamic. River levels may change abruptly and alter apparent hydraulic gradients. This effect lags as it is transmitted into the hydrogeologic unit. Each well may have a different time lag.

The use of instantaneous water level measurements at the Inlet perimeter, i.e. measurements made over a relatively short period of time, may not manifest the average hydrologic conditions that would prevail over longer durations. However, the use of average water levels collected over a period may be more representative. Piezometer water levels (Table 5-3) calculated for a one-month period indicate that groundwater flows toward the River at a low gradient, as expected.

Monitoring Well Data

Review of water level hydrographs for shallow (Figure 5-2S), intermediate (Figure 5-2I) and deep (Figure 5-2D) wells, for data collected through July 18, 1990, leads to the following conclusions regarding the hydraulic relationship between the River and wells. The River is hydraulically connected to the fill and alluvium (S and I wells) in wells MW-1, MW-2, MW-5, MW-8 and MW-11. These wells are located close to the River and have water levels which show very little difference from the River elevation through time. They also show similar fluctuations to those seen in the River with little time lag.

Wells MW-3I, MW-4S, MW-4I, MW-6I, MW-7S, MW-9S and MW-14S are influenced by the River to a lesser degree than the wells listed above as they are located farther away from the River, are not as well connected hydraulically, and have higher average water levels than the River. In the case of MW-4, the main influence and cause of head variations seems to be precipitation events, rather than the River.

No deep wells, screened within the glacio-lacustrine clay or till, respond to influences of the River. This can be seen by the long recovery times of the wells after development and sampling, and the dissimilarity of deep well and River water level fluctuations. As of July 18, 1990, some wells (MW-10D, -12D, and -13D) still appeared to be recovering from purging and sampling in April, 1990.

5.2.2 Vertical Gradients

Approximate vertical hydraulic gradients were calculated from averages of water levels recorded between June 5, 1990 and August 6, 1990 (Table 5-5). Gradients were calculated between the S and I wells (fill/alluvium), S and D wells (fill/alluvium and clay/till), and I and D wells (alluvium and clay/till). Although the relatively long screen lengths in some wells prevent measurement of true vertical components of the hydraulic gradient, some general trends are indicated.

As shown in Table 5-5, a downward gradient appears to be common between the well pairs. Although this may indicate a downward component of flow between the fill/alluvium and the clay/till, the very low permeability of the relatively thick confining clay/till layer is expected to impede the downward flow of water.

The largest average gradients were downward gradients observed in the fill/alluvium in MW-4 (0.0308 ft/ft) and between the alluvium and clay/till in MW-2 (0.0321 ft/ft) and MW-1 (0.0235 ft/ft). Generally similar downward gradients were observed for these wells in the June 18 data. MW-4 is in a groundwater recharge zone; a downward gradient is expected there.

5.3 Hydrogeologic Units

Based on the geologic, geotechnical, and hydrologic data collected, two hydrogeologic units have been identified in the Inlet perimeter, a fill/alluvium unit and a glacio-lacustrine clay/till aquitard or confining layer.

5.3.1 Fill/Alluvium

The fill and alluvium are the uppermost water-bearing units encountered. They are relatively permeable and hydraulically connected with each other and the River. Groundwater occurs and flows in these deposits under hydraulically unconfined conditions.

These units together are considered to comprise the fill/alluvium hydrogeologic unit. At the River, the saturated thickness ranges from approximately 25 to 29 feet north of the Inlet and 15 to 25 feet thick south of the Inlet. The thickness rapidly diminishes to the east, especially south of the Inlet. Most of the unit is alluvium.

Hydraulic conductivity tests were conducted in 11 wells in which the screens were installed in either fill/alluvium or fill alone. The results of these tests are summarized in Table 5-2 and indicate a hydraulic conductivities ranging from 2.56 x 10^{-1} to 5.13 x 10^{-5} cm/sec. These variations are due to the varying composition and heterogeneity of the materials screened. A geometric mean hydraulic conductivity of 2.17 x 10^{-3} cm/sec has been calculated for fill/alluvium based on nine tests.

5.3.2 Glacio-Lacustrine Clay/Till

The fine grained glacio-lacustrine clay and till are considered to be an aquitard or confining layers beneath the fill/alluvium and Inlet deposits. These clay-rich units display very low hydraulic conductivities, as indicated by the slow recovery of wells after development and sampling, and the results of laboratory and field hydraulic conductivity tests. In addition, available chemistry data typically display rapidly decreasing concentrations of chemistry with depth in the upper part of these units, indicating their low permeability to chemistry.

A single field hydraulic conductivity test conducted in glacio-lacustrine clay in well MW-3D indicated a hydraulic conductivity of 6.29 x 10^{-7} cm/sec. A laboratory hydraulic conductivity test on GLC from boring IW-6 yielded a value of 7.3 x 10^{-8} cm/sec for vertical hydraulic conductivity. A laboratory test on till indicated a vertical hydraulic conductivity of 1.4 x 10^{-7} cm/sec. Horizontal hydraulic conductivities may be higher due to the presence of horizontal silt and fine sand lamina and seams. These are all very low values of hydraulic conductivity, 45 orders of magnitude lower than the fill/alluvium.

5.4 Groundwater Flow

The average of water level measurements recorded on four dates between June 5 and August 6, 1990 were used to characterize groundwater flow conditions in the fill/alluvium hydrogeologic unit. The water level data from wells within this unit indicate that, on the north side of the Inlet, groundwater within the fill and upper portions of the alluvium discharges to the Inlet as well as the River and that groundwater within the lower portions of the alluvium predominantly discharges into the River. Two groundwater contour maps were constructed to delineate the differing flow conditions between the fill/upper alluvium (Figure 5-3S) and the lower alluvium (Figure 5-3D).

Variations in groundwater flow conditions in the fill/alluvium hydrogeologic unit are likely due to the influence of the Inlet. Groundwater in the lower alluvium north of the Inlet discharges more toward the River than toward the Inlet because of the relatively low permeability of the silt-clay fill in the Inlet; therefore, a hydraulic boundary exists at the lower alluvium/silt-clay fill interface. The approximate location of this boundary is shown on Figure

5-3I. Groundwater in the fill/upper alluvium does however, appear to flow toward the surface water of the Inlet.

Average water level data do not indicate that groundwater flow conditions differ vertically through the fill/alluvium hydrogeologic unit on the east and south side of the Inlet as they do on the north side of the Inlet. Therefore, the flow conditions in this area were not differentiated (see Figure 5-3S). The fill/alluvium south of the Inlet is connected hydraulically to the River as evidenced by the low horizontal hydraulic gradients toward the River.

MW-4 is located in a groundwater recharge area northeast of the Inlet. This is indicated by the water level contour maps, and the well's downward hydraulic gradient and response to precipitation events. However, the effect of the recharge area at MW-4 appears to be relatively more pronounced in the fill/upper alluvium than the fill/lower alluvium unit due to the discharge occurring to the Inlet as discussed above. MW-13 also appears to be located in a groundwater recharge area. The magnitude of observed water level fluctuations in the recharge area is greater than in wells located closer to the River; therefore water levels in the recharge area may exert a significant effect on controlling local flow directions, gradients and rates. Such water level fluctuations may be responses to daily and seasonal recharge events.

A groundwater contour map was developed for the low permeability glacio-lacustrine clay/till hydrogeologic unit and is presented in Figure 5-3D. This map utilizes a water level data set recorded from the deep (D) wells on August 6, 1990, which is representative of typical flow conditions in this unit. In this unit, groundwater flow appears to be directly to the River; the Inlet does not appear to significantly affect flow directions.

Groundwater flow rates have been calculated for selected flow paths in the fill/alluvium which are shown on Figures 5-3S and 5-3I. Table 5-6 summarizes the flow rate assumptions and calculations. Based on the assumptions for the flow paths indicated, estimated flow rates range from 17 to 107 ft/year through the portion of the Inlet perimeter area known to contain chemistry. Seasonal and spatial variations may occur.

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6.0 CHEMISTRY

6.1 Chemical Data Collection

Samples of sediment, soil or groundwater were collected and analyzed during eight stages of field work. Table 6-1 summarizes the sampling events.

6.1.1 Sampling and Analytical Protocols

All sampling and analyses, including the selection of analytes and detection levels, were conducted in accordance with State-approved work plans referenced in Section 4.0 and the analytical protocols for the Durez Site referenced on Table 6-1.

6.1.2 Sampling Methods

6.1.2.1 Sediment and Soil Sampling

The location and number of sediment and soil samples selected for analysis depended upon specific task objectives. During the vibracoring operation in 1986, each core tube of Soft Sediment was divided into three sections corresponding to depth intervals of 0-0.5, 0.5-2.0, and 2.0-5.0 feet below the Inlet bottom. The upper shallow samples, and selected deeper samples, were analyzed for selected chemicals (OCC, September 1986). The results are addressed in Section 6.2.3.2.

During the Phase 1 geotechnical investigation in the Inlet perimeter, one soil sample was analyzed from each of four borings. As a result of the findings, chemical sampling was increased for the subsequent Inlet perimeter drilling operations. During Phases 2 and 3, one soil sample was collected for analysis from each stratum encountered, in each boring drilled. The selection of samples included one sample from immediately above the clayey confining layer and one at least 5 feet into the confining layer.

A similar sampling schedule was followed for the Task 4, IW-series Inlet borings. For the Phase 4 monitoring well installation program, soil samples were collected from each stratum in selected boreholes.

For all tasks, field personnel selected samples that appeared most likely to contain chemistry, based on visual, olfactory, instrumental, and stratigraphic considerations. Visual observations and instrumental values (HNU photoionization detector measurements) of organic vapors are recorded on boring logs included in Appendix D. The HNU measurements were made only for health and safety purposes and are provided for reference.

Samples were collected continuously for Task 6, the LWL bedding investigation. Every two adjacent samples were composited in the lab for analysis. In addition, an individual sample(s) was obtained from the bottom of the bedding and the underlying clay confining layer.

Efforts were made during drilling to prevent chemical carrydown and adulteration of deeper samples. Precautions taken were task-specific and at different times included the following: (1) recognizing possible situations and modifying drilling and sampling procedures; (2) minimizing delays and downtime during drilling; (3) using one or more nested drill casings; (4) driving casing and keying it into low permeability strata; (5) using annular bentonite slurry seals; (6) flushing the drillhole; and (7) evaluating and trimming samples. It is possible that undocumented carrydown occurred, especially in earlier Inlet perimeter borings before the dense nature of the chemistry was recognized.

6.1.2.2 Groundwater Sampling

Two rounds of groundwater sampling and analyses were completed. The first round was collected two weeks after well development, and the second round was collected approximately 30 days after completion of the first round. Prior to sampling, three to five well volumes were bailed from each well, or fewer if the well was bailed to dryness. After sufficient recharge occurred, the dedicated bailers were rinsed with distilled water and the wells were sampled.

Physical parameters monitored qualitatively during sampling included color, turbidity, and odor. Temperature, pH, and specific conductance were measured quantitatively before and after well purging and during sampling. These measurements are provided in Appendix H.1.

6.1.3 Analytical Parameters

Analytical parameters consistent with the Durez Site investigation were selected by OCC in cooperation with the State. Sediment and soil samples were analyzed for the following Durez Site compounds:

2-chlorotoluene

monochlorobenzene

1,2-dichlorobenzene

1,4-dichlorobenzene

1,2,3-trichlorobenzene

1,2,4-trichlorobenzene

1,2,3,4-tetrachlorobenzene

1,2,4,5-tetrachlorobenzene

pentachlorobenzene

hexachlorobenzene

In addition, the vibracore sediment samples and Phase 1 and 3 soil samples from the Inlet perimeter drilling program were analyzed for benzene and toluene.

All groundwater samples were analyzed for benzene, toluene, monochlorobenzene (MCB), dichlorobenzenes (DCBs) and trichlorobenzenes (TCBs).

6.1.4 Quality Assurance/Quality Control

OCC reviewed the results of the sediment, soil, groundwater and chemical analyses and has judged the reported results technically acceptable; laboratory analytical QA/QC reports are on file. NYSDEC has collected and analyzed splits of selected samples. The following summarizes QA/QC programs for the latest rounds of soil and groundwater sampling.

6.1.4.1 QA/QC Program for Soil Samples

Field QA/QC procedures for soil included the completion of chain of custody forms, and the collection of field rinsate blanks and duplicates for the Task 6 LWL bedding investigation. Laboratory QA/QC procedures included the spiking of samples with a surrogate and measuring percent recoveries, replicate analysis of extracts, and the collection of sample splits by NYSDEC for selected samples.

6.1.4.2 QA/QC Program for Groundwater Samples

Field QA/QC procedures for groundwater included the completion of chain of custody forms, and the collection of field duplicates and field blanks. Laboratory QA/QC procedures included the spiking of samples with a surrogate and measuring percent recoveries, method blanks, laboratory duplicates, method spikes, matrix spikes and analysis of reagent blank water.

6.1.5 Analytical Results

The analytical results of soil chemical analyses, including quantitation levels and stratigraphic information, are presented in Appendix G.1. Appendix G.2 presents other chemical analytical results not conducted by or for OCC, including analyses of Inlet sediment samples collected by the NYSDEC in 1985.

A summary of groundwater analytical parameters measured during groundwater field sampling is included in Appendix H.1. OCC groundwater analyses, with method detection levels, are presented in Appendix H.2.

6.2 Nature and Extent of Chemistry

Durez Site-Specific Chemicals (SSCs) were detected in the Inlet including the LWL bedding. Lower concentrations of SSCs were detected in the soil and groundwater in the Inlet perimeter. Concentrations generally decrease in the study area with increasing distance from the Inlet. Non-aqueous phase liquid (NAPL) has been observed in some areas in the Inlet, LWL bedding and Inlet perimeter.

The following sections integrate the findings of the geological, geotechnical and groundwater hydrological data with the results of chemical analyses. A description of the characteristics of NAPL, and other visual observations, is followed by a discussion on the nature and extent of SSCs for each stratum.

6.2.1 NAPL

The location, nature, depth and elevation of observed and suspected NAPL occurrences are summarized in Table 6-2. NAPL "observations" refers to the presence of distinct mobile brown liquids or relatively immobile discrete globules or ganglia that were visually observed during drilling. "Suspected" NAPL pertains to those samples where NAPL was not visually observed, but may be present based on indirect evidence including the sample's location and elevation in relation to the observed NAPL distribution and on other visual observations.

The volume of NAPL at the Inlet below the Soft Sediment has been estimated based on results of the Inlet remedial investigation. The estimate applies to those areas where NAPL was free to flow, i.e. where the conspicuous brown liquid flowed out of soil samples and/or into the boring or monitoring well. This occurs where the NAPL head is sufficient to overcome the viscous and capillary forces resisting movement. NAPL is potentially recoverable from these areas. Relatively isolated and immobile blobs and ganglia of NAPL observed in a few boreholes during drilling are not recoverable and therefore are not included in the volume estimate.

Of the 49 borings drilled at the Inlet, NAPL was observed in 7 borings. NAPL appeared to be freely mobile in 4 of 7 borings, i.e. MW-5I, WL-2, WL-3, and WL-5. The NAPL volume estimate is based on these four borings. NAPL in the remaining three borings, I-23, I-27 and MW-8D, was manifested as isolated globules floating on drilling water, smeared onto drilling equipment or locally coating some soil grains. The distribution of NAPL is shown on Figure 6-3.

The NAPL volume estimate is based on the following general assumptions.

1. The lateral extent of NAPL shown on Figure 6-3A is representative. Borehole and sample data are sufficient to characterize the distribution and extent of free NAPL.

2. The thickness of NAPL observed in the borings is representative of the thickness of free NAPL in the three zones identified. Free NAPL did not go undetected.

3. Distribution of NAPL is relatively uniform within the defined zones.

The volume of free NAPL was calculated for three distinct zones related to site stratigraphy where free NAPL was detected during the remedial investigation. These zones are the LWL bedding, the silt-clay fill and the north lobe alluvium. The location and estimated areal extent of these zones is shown on Figure 6-3A. The factors used to estimate NAPL volume were areal extent, thickness of the soil zone that contained NAPL, porosity, and NAPL saturation. Calculations are summarized in Table 6-2A and discussed below.

Bedding

Free NAPL was observed in borings WL-2, WL-3, and WL-5 in the portion of the LWL bedding immediately adjacent to the LWL. This bedding zone is approximately 12-feet wide and 265 feet long. The geometry is constrained laterally by the absence of NAPL in borings IW-3, IW-5 and WL-4 and by the pinching out of granular bedding east of WL-5. The estimated thickness of this zone, 2.7 feet, is based on an average of borings WL-2 and WL-3. The bedding was relatively thin in boring WL-5 at the end of the zone and was not factored into the average. Intergranular porosity was estimated at 30 percent based on the silty sand texture. NAPL saturation of this available pore space was estimated at 30 percent based on visual examination of soil samples. The volume of free NAPL in the bedding zone is estimated on the basis of the above described assumptions as being approximately 5,500 gallons.

Silt-Clay Fill

NAPL was observed in only 2 of 11 borings drilled through the silt-clay fill in the Inlet cove. Since these 2 borings, WL-2 and WL-5, near the PCF discharge coincide with the LWL and a topographic depression on the silt-clay fill surface, it is estimated that the silt-clay fill NAPL zone directly overlies the eastern 120 feet of the LWL bedding zone described above. The estimated thickness of the silt-clay fill zone is 9.2 feet, an average of the silt-clay fill thickness in WL-2 and WL-5. The porosity is estimated at about 50 percent based on the soft consistency and relatively high clay content. NAPL saturation was estimated at 15%. The volume of free NAPL in the silt-clay fill zone is estimated on the basis of the above described assumption as being approximately 7,400 gallons.

North Lobe Alluvium

Free NAPL was observed in only 1 of 9 borings in the north lobe area, i.e. western half of the north perimeter area. NAPL was reported in a relatively coarse-grained gravel pocket in MW-5I, which is located near the northwest corner of the Inlet cove. It is estimated that NAPL is present in a 30-feet wide, 120-feet long area generally centered on MW-5I and coinciding with the coarse deposits and a topographic depression in the underlying clay till confining surface. The width was estimated based on the absence of NAPL in adjacent borings. On the north, the zone approaches I-23 where only minor NAPL blobs and smears were reported during drilling, and on the south the zone intersects the LWL bedding zone.

The zone thickness is based on the 0.7 feet of NAPL observed in soil in MW-5I. The total porosity of the zone is estimated at 30 percent based on the texture of the gravel in MW-5I; the NAPL saturation is estimated at 50 percent based on visual examination during sampling. The volume of free NAPL in the north lobe alluvium is estimated on the basis of the above described assumptions as being approximately 2,800 gallons.

The total volume of free NAPL in the three zones combined is 15,700 gallons. This "best" estimate is subject to change if additional data become available. The recovery of NAPL by extraction wells is addressed in Section 4.1.5 of the Inlet Remedial Alternatives Assessment report.

Table 6-3 presents the results of an analysis of a NAPL sample that was collected at a depth of 14 to 15 feet in boring WL-2. The sample was analyzed for the Target Compound List in accordance with Contract Laboratory Protocols. The analysis accounted for 78.7 percent of the sample's mass. This is considered a good mass balance for this type of sample; 94.1 percent of this mass was identified as chlorobenzenes.

Physical properties for the chemicals detected in the NAPL are summarized, with other chemicals, in Table 6-4. The low aqueous solubility of the NAPL chemicals and their density relative to water are responsible for the characterization of the liquid as a dense NAPL, i.e. DNAPL. NAPLs that are lighter than water, i.e. LNAPLs, were not observed during the investigation.

6.2.2 Other Visual Observations

Incidental visual observations are reported in the boring logs. Observations, including sheens, oily lusters, and black stains seen during drilling, and small bleb-like residues observed adsorbed to the walls of the archived sample jars, may indicate the presence of some types of chemistry under certain conditions. However, these observations are indirect and are not considered sufficient evidence by themselves, to confirm that NAPL, as defined above, is present.

6.2.3 Inlet Chemistry

This section describes the nature and extent of SSCs in the Inlet strata, i.e. Soft Sediment, silt-clay fill and bedding. It also addresses the presence of chemistry in the transitional zone fill, alluvium that underlies silt-clay fill near the north and south edges of the Inlet, and glacio-lacustrine clay and till confining layer underlying the Inlet cove.

Analytical results for the Inlet are summarized in a three-dimensional representation in Figure 6-1 for the cove, and in Figure 6-2 for the transitional zone. Table 6-5 summarizes all available OCC analyses for Soft Sediment. An additional analysis of the sediment conducted by the State in 1985 is presented in Appendix G.2. The State's analysis includes metals and other non-SSCs. Table 6-6 summarizes the analytical results for Inlet cove soil samples collected below the Soft Sediment during Tasks 4 and 6. Concentrations of total chlorobenzenes are presented in order of decreasing concentrations down to 1 mg/kg (ppm). Samples where DNAPL was observed are indicated. Table 6-7 is a similar presentation for analyses conducted during the Task 3 Inlet perimeter soil boring program. Total chlorobenzenes are summarized for the transitional zone and the Inlet perimeter, and are also listed in order of decreasing concentration.

The results of dioxin analyses for samples of Soft Sediment collected by OCC in July 1986 (Vibracore-10) and by NYS in November 1990 (PCF-1, -2, and -3) are presented in Table 6-5A. The locations of the samples are shown on Figure 4-1. OCC only performed qualitative screening analyses for PCF-1 through PCF-3, the results of which are consistent with the State's more quantitative analyses presented in the table.

The analytical results indicate that concentrations of SSCs are highly variable in the Soft Sediment, ranging from 19 to 23,000 ppm. In addition, the four samples analyzed for dioxin in the upper six inches of Soft Sediment indicate concentrations of 2, 3, 7, 8-tetrachlorodibenzodioxin (TCDD) ranging from 1 to 67 ppb. This range includes a value of 15 ppb measured in 1986, and values of 1, 67, and 18 ppb measured recently in PCF-1, -2, and -3, respectively.

Below the Soft Sediment, relatively high concentrations of chemistry were detected in silt-clay fill and bedding material in close proximity to the LWL. Relatively high levels of chemistry were also detected in the alluvium north and south of the LWL bedding. SSCs are present at the bottom of the alluvium in the northwest part of the Inlet in the area east of the timber piling and at a shallower depth in alluvium in the approximately 50-foot wide transitional zone on the south side of the Inlet.

6.2.3.1 Inlet Transitional Zone Fill Chemistry

SSCs were observed in the single sample analyzed from the transitional zone fill. A concentration of 99 mg/kg (ppm) total chlorobenzenes was detected in boring I-1A (Table 6-7) near the southwest corner of the Inlet (Figure 6-4). This analysis indicates that SSCs are present in parts of the transitional zone fill overlying Soft Sediment.

The boring log reported "oily" material at fill horizons immediately overlying Soft Sediment. This may be indirect evidence of SSCs; however, historic land use for this property includes an automobile junk yard so the reporting of "oily" material should be interpreted cautiously.

6.2.3.2 Inlet Soft Sediment Chemistry

All analyses of Soft Sediment detected SSCs. The concentrations of total SSCs in the Inlet cove were highly variable, ranging from 0.003 percent (30 ppm) in vibracore sample number 5 to 2.3 percent (23,000 ppm) in vibracore sample number 3 (Table 6-5). In the transitional zone the concentrations ranged from 0.002 percent (19 ppm) to 0.5 percent (5279 ppm). Additional evidence of chemicals was provided by the strong chemical odor encountered variably during drilling through the Soft Sediment in the Inlet cove. Figure 6-5 shows the maximum total SSCs observed at each of the 15 Soft Sediment sampling points distributed throughout the Inlet.

6.2.3.3 Inlet Silt-Clay Fill Chemistry

SSCs, including DNAPL, were detected in localized areas of the silt-clay fill. Figure 6-6 shows the distribution of total chlorobenzenes analyzed in silt-clay fill at each boring; the value shown is the maximum concentration detected in each boring. Total chlorobenzenes detected in the silt-clay fill ranged from ND in IW-2 and IW-3, to 5010 mg/kg (ppm) in WL-2. The highest concentrations were observed along and immediately to the south of the LWL.

DNAPL was observed almost throughout the entire thickness of silt-clay fill in borings WL-2 and WL-5, and at the bottom of the silt-clay fill in WL-4. In WL-2, DNAPL was first detected two-feet below the top of silt-clay fill and was observed from a depth of 10.8 feet to 24.0 feet. All but the bottom 5 feet was in silt-clay fill. In this boring, DNAPL was described as saturating the silt-clay fill soil sample. In WL-5 DNAPL was observed from 11.0 feet to 15.0 feet deep in the silt-clay fill. The presence of DNAPL at WL-2 and WL-5 may be associated with the proximity of the PCF outfall and with a shallow depression in the surface of silt-clay fill at those two locations.

6.2.3.4 LWL Bedding Chemistry

LWL bedding material was encountered in six borings. SSCs were detected in all of the Inlet bedding samples collected from the borings except for IW-3. Concentrations detected in the bedding immediately adjacent to the LWL were, along with samples from the Soft Sediment and silt-clay fill, the highest concentrations observed during the investigation.

Figure 6-7 shows the lateral distribution of maximum total chlorobenzenes detected in the bedding. Concentrations appear to increase in a westerly direction from 399 ppm at WL-5 to 7307 ppm at WL-4. The bedding analysis at WL-1A near the pump station was ND. The concentrations of total chlorobenzenes detected in the bedding in the two IW-series borings (IW-3 and IW-5) were more than 2-3 orders of magnitude lower than in the WL-series borings (WL-2, WL-3, WL-4, WL-5).

DNAPL was observed in the bedding samples at all WL-boring locations tested, except for WL-4. The DNAPL was observed and suspected in the bedding at depth ranging from 19 to 28 feet beneath the Inlet bottom. DNAPL was not detected in the IW borings. The IW borings were located 12 to 13 feet from the LWL in contrast to 2 to 4 feet for the WL borings. It can be concluded that chemistry, including DNAPL, has concentrated within a relatively narrow zone of the bedding in close proximity to the LWL. The width of this potential zone is estimated at approximately 10-feet based on the 4-foot diameter of the LWL, and WL borings located 3-feet north and south of the east-west trending LWL.

6.2.3.5 Inlet Alluvium Chemistry

SSCs were detected in localized areas in alluvium underlying and immediately adjacent to the Inlet. DNAPL also was detected in the transitional zone. The DNAPL appeared to be relatively immobile.

Figure 6-8 details the distribution of maximum chlorobenzene concentrations in the alluvium. The concentrations of total chlorobenzenes in the alluvium are highly variable under the Inlet ranging from ND to 699 ppm. The highest concentrations occur on the south shore in the western part of the transitional zone, and in the northwest corner near the timber piling. The highest concentration detected in the Inlet alluvium was 699 ppm in MW-8D near the southwest corner of the Inlet. In this boring, alluvium directly underlies Soft Sediment, no intermediate clay confining layer was reported on the drilling log.

Chemicals were detected near the alluvium/confining layer interface in borings IW-1 and IW-2 at the west side of the Inlet. The low concentrations of chemicals in the overlying silt-clay fill and upper alluvium at these borings suggests that lateral migration of chemistry may have occurred along the interface. Concentrations of 547 ppm and 0.5 ppm were detected at the bottom of the alluvium in samples IW-1 and IW-2, respectively. These concentrations were higher than the concentrations (13 ppm and ND respectively) detected in the immediately overlying silt-clay fill.

DNAPL was observed at scattered locations in the alluvium beneath the transitional zone, but not beneath the Inlet cove. DNAPL was detected as a relatively immobile ganglion at a depth of 20-feet in MW-8D in the transitional zone. Blackish brown globules were observed in drill water approximately 14 to 17 feet deep in alluvium in boring I-27 to the northeast of MW-8D. DNAPL was not observed at IW-1 in the northwest corner of the Inlet.

6.2.3.6 Inlet Glacio-Lacustrine Clay and Till Chemistry

SSCs were detected in till at the WL boring locations along the LWL bedding, and in the transitional zone at I-27. DNAPL was observed at the top of, but not in, glacio-lacustrine clay and till below the LWL bedding. This confining layer ranges from 20-27 feet deep along the LWL.

The concentrations of SSCs in the clay/till confining layer are typically significantly lower than in the overlying deposits. The concentrations and number of analytes in the confining layer appear to decrease further with depth. Analytes detected in the clay are typically the more mobile SSCs, i.e. MCB and DCB. The trend of generally decreasing concentrations of chemicals with depth substantiates that the clay and till act as a barrier to the downward migration of chemicals. The GLC/till units represent a confining layer under the Inlet to block the vertical migration of chemicals and direct their lateral migration.

Figure 6-9 shows the lateral distribution of maximum total chlorobenzene concentrations observed in each boring in the GLC/till layer. The highest concentrations were detected immediately beneath the LWL. These concentrations range from 27 to 150 mg/kg (ppm) and were all measured in samples collected near the top of the clay layer. The concentrations in deeper clay samples were typically lower than the shallower values.

6.2.4 Inlet Perimeter Chemistry

The results of analyses conducted on soil samples collected from the Inlet perimeter are shown spatially in a three-dimensional representation on Figure 6-2. Table 6-7 summarizes the concentrations of total chlorobenzenes detected in each sample collected from the Inlet perimeter. These results are listed in order of decreasing concentrations down to 1 mg/kg (ppm). Samples where DNAPL was observed are also indicated.

The analytical results indicate that chemistry in soil in the Inlet perimeter is limited to an approximately 100-foot wide lobe adjacent to the River and extending approximately 200 feet north of the Inlet. The chemistry is associated with the bottom of the alluvium, near its interface with the underling clay till confining layer at depths of 30-35 feet. DNAPL was observed in samples collected from two borings in this area.

The following sections discuss the nature and distribution of chemistry in the fill, alluvium, clay/till confining layer and groundwater in the Inlet perimeter area.

6.2.4.1 Inlet Perimeter Fill Chemistry

Concentrations of SSCs in fill were relatively low in the Inlet perimeter area. As shown in Figure 6-4, all analyses of shallow terrestrial fill ("modern fill" on the figure) were ND, except for a few isolated analyses. The concentration of 99 mg/kg (ppm) detected in the Inlet transition zone has been discussed in Section 6.2.3.1.

The only other areas that suggested the presence of chemistry were at boring I-30 near the southwest corner of the Inlet and in the vicinity of I-22 in the north perimeter area. Total chlorobenzene concentrations in these areas were very low, 0.2 and 3 ppm, respectively. Chemicals detected in these areas were the less-chlorinated chemicals, MCB and DCBs. The presence of chemicals at I-22 may be associated with a pig iron unloading facility, which was part of the former iron works plant on this property.

6.2.4.2 Inlet Perimeter Alluvium Chemistry

Figure 6-8 summarizes the concentrations of total chlorobenzenes in the alluvium in the Inlet perimeter. The alluvium can be divided into three areas based on the distribution of chemistry detected. These areas are south of the Inlet, northeast of the Inlet and northwest of the Inlet.

Alluvium samples analyzed from the perimeter areas south and northeast of the Inlet were all ND.

SSCs were present in soil 30- to 35- feet deep in an area extending approximately 100 feet east of the River and approximately 200 feet north of the Inlet. Concentrations and number of analytes detected generally decreased to the north with increasing distance from the Inlet. Concentrations ranged from ND at I-21 (north) to 184 mg/kg (ppm) at I-4 adjacent to the Inlet.

The highest concentrations were detected at the bottom of the alluvium, near the interface with the underlying clayey till confining layer. Chemistry in this area appears to be associated with a possible north-south oriented depression in the surface of the confining layer (Figure 4-8), i.e. the till depression.

Mobile DNAPL was observed in well MW-5I and potentially mobile DNAPL was observed at boring I-23. Several bailers containing brown liquid were removed from MW-5I when it was developed and sampled (see Section 6.3.1.3). Brown globules and ganglia were also observed in I-23 during drilling. DNAPL appears to be present hydraulically upgradient of I-4 and I-9, based on their relative locations near MW-5I and I-23, and the presence of chemicals in soil samples collected at the alluvium/till interface in those areas. The presence of DNAPL in the till depression should be a consideration during the remedial alternatives assessment.

Relatively low concentrations of SSCs, less than 1 ppm, were detected at several horizons in the alluvium at MW-1I and also in the overlying fill. These occurrences may be associated with the relatively low levels of MCBs and DCBs detected in the fill in I-22 and SB-2 in this general area, and discussed in Section 6.2.4.1.

6.2.4.3 Inlet Perimeter Glacio-Lacustrine Clay and Till Chemistry

SSCs have been detected in the north perimeter area in the vicinity of the till depression. The concentrations detected are expected to decrease rapidly with depth due to the low permeability of the confining layer.

Figure 6-9 summarizes the concentrations of total chlorobenzenes detected in GLC and till samples. Concentrations in till and clay samples from the north perimeter area are substantially lower than concentrations reported for the overlying alluvium. The two apparent exceptions are 34.5 - 36 feet at boring I-9 (153 mg/kg (ppm)) and 36.9 - 38 feet at boring I-23 (40mg/kg (ppm)). These two samples were collected immediately below the alluvium/clay interface and may be representative of concentrations at the bottom of the alluvium layer.

In the south perimeter area, a sample collected from I-26 at a depth of 20-22 feet below the ground surface, and 6 feet below the GLC surface, had a reported concentration of 35 ppm (benzene, MCB and DCBs). In contrast, the analysis for an overlying sample of GLC from the same boring did not detect chemistry. A confirmatory soil boring drilled nearby (SB-4), and sampled at a similar depth, could not confirm the presence of chemistry at 20-22 feet in I-6, therefore, the reported concentration of 35 ppm in the clay may be suspect.

6.2.4.4 Perimeter Groundwater Chemistry

Groundwater from Inlet monitoring wells was sampled in March and April 1990 and analyzed for SSCs. The analytical data for the two rounds are summarized in Table 6-8 and are included in Appendix H.2. QA/QC review of analytical techniques employed during Round 1 and Round 2 indicated that chemical carry-over during analysis was probably the source of the trace level chemistry in Round 1 for wells MW-8D, MW9-D, MW-11I and MW-14S. Selected chemical data for those wells have been disqualified. Figure 6-10 summarizes the groundwater analyses for the second round of sampling.

Hydrocarbons were detected in two wells (MW-7S and MW-14S) and may be indicative of other sources of chemicals in the area. Well MW-7S is located adjacent to the PCF and well MW-14S is located at the south edge of the study area in the vicinity of a former junkyard.

The lateral extent of SSCs detected in groundwater is restricted to a very localized area in the transitional zone and north of the Inlet adjacent to the River . The chemistry generally appears to be associated with either Soft Sediment or certain portions of the fill/alluvium unit. The fill/alluvium as a whole does not contain chemicals at any consistently detectable levels. In general, chemistry was detected in groundwater in areas that indicted the presence of soil chemistry. Total chemistry analytical results for the shallow and intermediate wells screened in the fill/alluvium are presented on Figure 6-11. These results represent the highest concentrations reported during the two sampling rounds.

Chemicals were not detected in groundwater samples collected from the outer ring of monitoring wells around the periphery of the study area (Figure 6-11).

The highest concentrations of total chemistry were detected in wells screened at the bottom of alluvium, i.e. in wells MW-5I at 266 mg/l (ppm), MW-8I at 42.3 mg/l (ppm) and MW-2I at 54.2 mg/l (ppm). Several bailers containing NAPL were removed from MW-5I prior to sampling. The groundwater sample reportedly contained small droplets of NAPL at the time of sampling despite efforts during sampling to purge the well of NAPL; therefore analyses from that well may not be representative of aqueous phase chemistry.

A soil sample from alluvium in the screened portion of MW-8I contained an immobile NAPL ganglion; however, NAPL was not reported in the groundwater sample at this location. Soft Sediment is also present in the screened portion of the well and may explain some of the chemistry detected.

Groundwater chemistry at MW-2I is probably associated with the soil chemistry observed in the lower alluvium in the till depression. Considering that the prevailing groundwater flow direction is toward the River in this area, it is likely that the source of chemistry detected in this well is located either at the well or to the east, which is where the depression is located.

Figure 6-12 displays the distribution of total chemistry in the deep wells screened in the confining layer. All analyses were ND except for MW-2D. The chemistry in this well may be attributed to the presence of chemicals in the overlying alluvium. A relatively high pH of 12 (typical ambient values are 6-8) measured in this well during sampling indicates that cement-bentonite grout from the well seal may be present in the screened area. This suggests that the presence of a slowly leaking well seal may be enabling groundwater from the alluvium to slowly seep down the well bore to the screened interval in till.

Figure 6-13 displays the lateral extent of observed chemistry in groundwater, i.e. APL, based on available data. The figure also shows locations where DNAPL has been observed. All DNAPL occurrences are within the boundary of the APL distribution.

6.3 Chemical Migration

SSCs detected at the Inlet probably were deposited initially in or with Soft Sediment after transport through the PCF. The investigation has indicated that chemistry, including DNAPL, has migrated below and beyond the Soft Sediment.

Chemicals at the Inlet area are present in three physical forms:

- as dense non-aqueous phase liquid (DNAPL);
- as dissolved constituents in water forming an aqueous phase liquid (APL); and
- as sorbate adsorbed to solid matter. Floating or light NAPL (LNAPL) was not observed at the Inlet during the investigation.

Organic chemical vapors were detected during drilling and sampling activities, but only upon disturbance of the subsurface in areas having relatively high concentrations of chemistry. Volatilization and migration of chemicals in the vapor phase is not considered significant under ambient conditions at the Inlet and will not be addressed further in this report though it will be addressed in the remedial alternatives assessment.

The following section presents a general description of migration mechanisms, environmental factors that affect migration, potential source areas and potential migration pathways.

6.3.1 DNAPL Migration

6.3.1.1 Migration Characteristics of DNAPL

DNAPL may be mobile or non-mobile. In general, mobile or free DNAPL will flow directly in response to the force of gravity, rather than to a hydraulic gradient. High hydraulic gradients that can drive DNAPL movement are not anticipated in groundwater at the Inlet area. DNAPL will migrate downward until it encounters a barrier, at which point it will spread laterally, seeking lower elevations. Commonly, the result is a highly channeled and irregular distribution of mobile DNAPL in pools and relatively immobile DNAPL in globules and ganglia.

A barrier to DNAPL migration can consist of any soil or sediment for which the driving head or displacement pressure of DNAPL is insufficient to overcome the capillary forces and surface tension necessary to penetrate the pores of that media. Such capillary forces tend to increase with decreasing grain size and permeability; for example, DNAPL can be immobilized in a gravel pocket surrounded by sand. The principal underlying barrier at the Inlet area is the glacio-lacustrine clay and clayey till confining layer. The migration rate and extent of DNAPL is largely controlled by the magnitude of DNAPL head available as a driving force.

As DNAPLs migrate, they commonly leave behind relatively immobile residual NAPL as round globules or as irregularly shaped ganglia in the pores of the medium. These globules and ganglia may remobilize if existing, local environmental conditions change. Such changes may include temperature increases, the introduction of solvents or surfactants, or disturbance to the soil media by drilling or excavation. As groundwater flows past and dissolves DNAPL, a plume of APL may evolve. Factors affecting the rate of dissolution include the solubility of the individual compounds comprising DNAPL, cosolvency effects, surface area, and the relative flow rate of groundwater.

6.3.1.2 Potential Chemical Source Areas in the Inlet Cove

Potential DNAPL migration routes and the mechanisms affecting DNAPL migration are highly complex. However, certain findings during the investigation indicate that the distribution of chemicals in the Inlet cove may be related to direct deposition by PCF discharges, historic surface water flow channels and past land use. DNAPL may follow relatively localized infiltration pathways related to the silt-clay fill topography. Following is a summary of relevant observations.

Historic Flow Channels and Structures - North Side

Based on a review of aerial photographs, surface water flow through the Inlet has been by discrete channels. The distribution of DNAPL in the Inlet may be related to these previous stream flow channels.

In the 1938 and 1942 airphotos, the principal flow channel in the Inlet was along the north shore; the south channel was relatively minor in comparison. Water discharging from the PCF flowed along the north bank of the Inlet before being deflected to the south at the timber piling. This deflection point may have promoted deposition of the streamload, including chemicals. It should be noted that the highest concentration of chemistry detected in the vibracore Soft Sediment samples was found in this area at location 3.

A small building or dock structure was observed in 1938 and 1942 aerial photographs in the northwest corner of the Inlet cove where the north channel was deflected to the south. This structure was situated at the approximate site of sediment depth probe number 24, immediately east of the timber piling. The thickness of Soft Sediment at probe number 24 was 7.9 feet, greater than thicknesses observed in other probes in this area (see Figure 4-10). This increased thickness may be associated with erosion, excavation or sedimentation related to the structure. It may represent a location where Soft Sediment or chemistry, including DNAPL, could have accumulated.

The northwest corner is of interest because it is adjacent to boring I-4 and monitoring well MW-5, in the Inlet perimeter immediately to the north. These two drillholes encountered relatively high levels of chemistry, and at MW-5, an accumulation of DNAPL.

Historic Flow Channels and Building Structures - South Side

A striking collinearity exists between the PCF outfall and borings WL-2, I-27, and MW-8 that contained DNAPL. This linear trend roughly coincides with the ancestral channel of the Pettit Creek and the southern of two discharge channels from the PCF (see Appendix B). Review of aerial photographs indicates that the southern channel was near the south bank of the Inlet from at least 1927 through 1966. DNAPL may have been deposited along the channel bed.

For many years, this ancestral channel flowed directly under a boathouse formerly located at the approximate site of boring I-27. The boathouse was observed on maps dating back to 1889 and on aerial photographs observed through 1942; it was not observed on photographs dated 1951. The boathouse was removed from the property sometime between 1942 and 1951.

Human activities in the vicinity of the boathouse may have resulted in the development of local depressions or structures that affected local erosion and deposition, contributing to the accumulation and infiltration of DNAPL at this location. Interpretation of aerial photographs suggests that the boathouse channel may have been maintained. Such maintenance may have included localized dredging. The complex stratigraphy in this area (see Figure 4-16C) may be the result of these maintenance activities.

In summary, the distribution of DNAPL below the Soft Sediment may be associated with a former southern channel that passed under a former boathouse. Relatively high levels of chemistry may be present along a northern channel, especially where this channel was deflected by the timber piling.

Silt-Clay Fill Topography

DNAPL moves by gravity; therefore potential source areas for DNAPL infiltration include areas where DNAPL is topographically elevated. The elevations of the soil zones where free DNAPL was observed appear to fall into two ranges. In eastern and southern Inlet areas including WL-2, WL-5 and I-27, the DNAPL was observed at elevations 554-557 feet. In the LWL bedding and area north of the Inlet, DNAPL was observed at elevations in the range of 539-541 feet (Table 6-2). The only exception to these two groupings is MW-8D in the transition zone, where a single small ganglion was observed at a intermediate elevation of 549.5 feet.

The higher-elevation occurrences of DNAPL represent potential DNAPL source areas for the deeper soil, such as bedding and alluvium. These higher elevations are associated with silt-clay fill that contains DNAPL. The presence of DNAPL in low permeability silt-clay fill probably indicates locations of vertical infiltration. The only major accumulations of DNAPL in silt-clay fill were observed in borings WL-2 and WL-5. These borings are associated with a topographic depression in the top of the silt-clay surface that may have accumulated DNAPL. The depression is broadest at the east end of the Inlet near the outfall of the PCF and narrows to the west as it follows along the south side of the LWL alignment. The cause of the depression is uncertain; causes may include earlier water flow channel or soil consolidation and settlement.

6.3.1.3 DNAPL Migration Pathways

DNAPL may migrate vertically or horizontally. Potential downward migration or infiltration may occur through silt-clay fill in the Inlet, and fill/alluvium strata at the periphery of the Inlet. DNAPL may migrate laterally along the alluvium/confining layer interface, or the LWL bedding/confining layer interface.

A possible DNAPL migration pathway downward through silt-clay fill has been described previously (Section 6.3.1.2).

Infiltration may occur at the edges of the Inlet if free DNAPL is present in Soft Sediment in close proximity to the relatively permeable fill and alluvium strata. This situation potentially exists along the north and south shorelines of the Inlet, west of the PCF outfall (see Figures 4-16-D, G, E and M). This is a potential pathway for DNAPL migration to monitoring well MW-5I immediately north of the Inlet.

Lateral migration of DNAPL may occur in the Inlet perimeter area at the bottom of relatively permeable alluvium near its interface with either the glacio-lacustrine clay or clayey till confining layer. This movement will be driven by gravity and primarily controlled by DNAPL volume and fluid properties, variations in permeability, and confining layer topography. The map of the confining layer surface presented on Figure 4-8 shows a topographic depression in the surface of the till confining layer north of the Inlet that could possibly affect DNAPL movement and accumulation in this area.

DNAPL was observed on three occasions during the drilling of boring I-23 located within this depression. The DNAPL was observed between two auger joints, floating on drilling fluid and as a ganglion in soil near the bottom of the alluvium. These observations indicate that DNAPL has migrated at least this far north from the Inlet. DNAPL was not observed in borings I-9, I-13 or MW-2 located at the west side of the depression suggesting that DNAPL has not migrated to this part of the Inlet perimeter or to the River.

DNAPL was observed in well MW-5I located near the south end of the till depression. During two rounds of well development, free DNAPL was recovered from this well. In each instance, approximately 3.5 feet of DNAPL was measured in the bottom of the well after bailing, but much of this thickness may be attributable to upwelling caused by the bailing itself. The thickness of DNAPL observed in soil from this boring was only 0.7 feet. DNAPL has most likely migrated to this location from the Inlet, laterally along the alluvium/till interface, downward from the Soft Sediment/silt-clay fill interface or a combination of these or other potential pathways. DNAPL at MW-5I may be migrating north into the till depression, west toward the River (but around nearby boring I-4 which did not have DNAPL), or it may be relatively stationary in an isolated, permeable gravel pocket connected to a source of DNAPL recharge.

DNAPL can migrate along the LWL and its bedding, where the bedding is relatively permeable and accessible to a source of free DNAPL. As the bedding is completely confined by silt-clay fill above and till below (see Figure 4-16G), DNAPL migration in the bedding is expected primarily westward along the LWL, following the slope of the LWL and underlying till surface.

There is no evidence to suggest that DNAPL or dissolved chemicals are migrating into the LWL. Inspections of the interior of the LWL during the investigation, including remote video and penetration diving inspections, did not detect any problems with the liner's integrity or any defects associated with chemicals (see Section 3.1.3.2). In addition, the City of Lockport and State Department of Health have been monitoring the LWL water quality at least monthly since 1984 for selected compounds including dichlorobenzenes, tetrachlorobenzenes and hexachlorobenzenes. The monitoring program was expanded upon discovery of DNAPL in the LWL bedding and concluded that the chemicals are not adversely affecting the liner. The State has indicated that the City of Lockport's treated water meets the drinking water standards for these compounds, and that, with a single questionable exception described in Section 3.1.3.2, none of the compounds have been detected in the raw untreated water since 1987 (NYSDOH, 1990; Lockport, 1991). The available data indicate that DNAPL migration specifically and chemical migration in general, are confined to the exterior of the LWL liner and that the integrity of the LWL is sound.

DNAPL, where present in the bedding, may potentially migrate downslope north of the bedding where the northern side of the LWL bedding is in lateral contact with relatively permeable alluvium (see Figure 4-16D). In order for DNAPL to migrate, however, it would have to be at a higher elevation than the top of the till confining layer. The elevation of DNAPL observed in bedding boring WL-3 was 541 feet, which is higher than the confining till layer at approximately elevations 538-540 feet; therefore northwest migration may take place in this area. Variations in topography of the till surface would control if and where such DNAPL migration may take place. While it is possible that DNAPL may be migrating along the bedding beyond the western boundary of the study area and below the River bottom, DNAPL was not observed in bedding boring WL-4 at the west end of the Inlet.

6.3.2 APL Migration

6.3.2.1 Migration Characteristics of APL

APL consists of water containing dissolved chemicals. APL is mobile and flows along surface water and groundwater pathways in accordance with the principles of solute transport. The driving force of APL migration is hydraulic gradient. In general, groundwater gradients at the Inlet area are low, and hydraulic conductivities range from moderate for the fill/alluvium to very low for the confining layer.

6.3.2.2 Environmental Fate Processes for APL

As APL flows through environmental media such as soil and sediment, it is subject to certain physio-chemical processes. These processes may alter the concentrations of the chemicals in the groundwater, as well as the media through which it passes. Physio-chemical processes that may affect the concentration of chemicals in APL at the Inlet include volatilization, dissolution of NAPL, biodegradation, and adsorption. Of these processes, volatilization and dissolution have been addressed in Section 6.3.1. Biodegradation by aquatic microorganisms may be eventual for monochlorobenzenes under certain conditions, but in general, the more highly chlorinated the compounds become, the more resistant they are to biodegradation. Adsorption (sorption) is addressed below in Section 6.3.3. Other potential chemical transformation processes such as hydrolysis, oxidation, and direct photolysis are not expected to occur at appreciable rates at the Inlet because of the physio-chemical nature of the SSCs. In general, the SSCs are relatively persistent.

6.3.2.3 APL Migration Pathways

Hydraulic gradients at the Inlet area are generally directed toward the Inlet and River, although local flow reversals may occur for short periods during flooding, especially during ice jams. Based on calculated hydraulic gradients and water quality data for samples collected from monitoring wells, it appears that groundwater containing dissolved chemicals is migrating toward the Inlet from the fringe areas, especially the transitional zone. Chemicals are also migrating directly toward the River via groundwater discharge in the north perimeter zone and the transitional zone. Most flow is through the fill/alluvium and is predominantly horizontal.

Chemical concentrations measured in groundwater and soil samples collected in the Inlet area typically are highest near the alluvium/confining layer interface and may be indicative of the nearby presence of DNAPL. Where DNAPL is not present, this chemistry may originate from the lateral flow of APL that evolved from DNAPL located hydraulically upgradient. In the north Inlet perimeter area near the River, the chemistry near the bottom of alluvium may be related to the possible presence of DNAPL east of and hydraulically upgradient of borings I-4 and I-9 and well MW-2.

The estimated loading of chemicals from the Inlet toward the River via groundwater and surface water flow has been quantified (see Supplemental Appendix J). Groundwater loadings for the Durez site-specific compounds were estimated based on a calculated total groundwater flux to the river of approximately 2700 gallons per day from the fill/alluvium hydrologic unit. Groundwater chemical concentrations were determined from laboratory analyses of water samples collected from monitoring wells during the investigation. The chemical loading from groundwater is estimated at approximately 1.8 pounds per day based on the assumptions, field and analytical data, and calculation methodology presented in Appendix J.1.

Surface water loadings derived directly from Inlet sediments were calculated based on an estimated concentration gradient and the upward diffusion of pore water chemistry from the Soft Sediments into the overlying column of surface water. The concentration of chemistry in the pore water was calculated using the equilibrium partitioning method described in the DEC's sediment criteria guidelines. The chemical loading of chemistry derived from the Soft Sediment and dissolved in surface water is estimated at approximately 0.1 pounds per day based on the assumptions, field and analytical data, and calculation methodology presented in Appendix J.2.

Based on the available data and the best estimates developed from the data and assumptions referred to above, the total chemical loading to the Little Niagara River area from groundwater and surface water sources is estimated at approximately 1.9 pounds per day. This estimate is subject to revision as additional information becomes available.

6.3.3 Soil and Sediment-Bound Chemistry Migration

6.3.3.1 Migration Characteristics of Soil and Sediment

Soil and sediment particles may contain chemicals sorbed from an APL. Adsorption (sorption) is a dynamic equilibrium process that affects the concentrations of chemicals in both the APL and solid particles. The amount of adsorption is related to many factors, including the chemical species involved, concentrations in the APL, available particle surface area, and the percent organic carbon on the solid particles.

The chlorinated SSCs are hydrophobic and typically have a very high affinity for adsorption to solids relative to their solubilities, which are typically very low. Reported soil partition coefficients and solubilities are summarized in Table 6-4. In general, the higher the partition coefficient, the greater the propensity for that compound to adsorb to solid particles. The fine-grained, organic-rich nature of the Soft Sediment should lead to a high adsorption rate of SSCs. This explains, along with the presence of NAPL in some areas, why the concentration of SSCs is relatively high in certain Soft Sediment samples analyzed.

6.3.3.2 Soil and Sediment Migration Pathways

Soil and sediment particles may become mobile as a result of exposure, desiccation, and transportation by air as windblown dust, or by erosion and transportation by surface water. It is not expected that migration of terrigenous soil as dust is a significant pathway as the Inlet is marshy and vegetated. Such erosion and transport, however, must be a consideration during remediation.

Migration of Soft Sediments to the Niagara River as resuspended sediment in surface water is not expected to be significant during the ambient low flow conditions in the Inlet, as the Inlet is a low energy environment. Additionally, the presence of vegetation and the existence of floating booms and a silt curtain across the mouth of the Inlet help contain sediment within the Inlet. In view of the typically low flow velocity and the existence of the booms and silt curtain, the amount of sediment loading from the Soft Sediments may be minor. It is probable, however, that some Soft Sediment can be resuspended during episodic storm events and mobilized during certain conditions of increased storm water runoff when PCF discharge into the Inlet increases significantly above ambient rates. The geometry of the Inlet, i.e. wide mouth at the river, favors redeposition of much of this sediment within the Inlet itself. The presence of a low delta at the relatively wide western end of the Inlet indicates that some mobilized sediment is redeposited within the Inlet.

The Soft Sediment-bound chemical loading rate from the Inlet to the Niagara River, exclusive of suspended sediment that travels directly from the PCF to the river, is a function of the water flow rate, the rate of resuspension of Soft Sediments, the concentration of chemistry sorbed to Soft Sediment, if any, transported out of the Inlet, and other factors listed below. The average daily flow rate is uncertain but could be estimated based on conventional runoff calculations. However, the lack of data on total resuspended sediments, the unknown concentrations of sorbed chemicals, the absence of field data on the effectiveness of the silt curtain, the undetermined frequency and magnitude of Niagara River surges into the Inlet, and the spatial and temporal variation of Inlet bottom resuspension processes contribute to the unreliability of a sediment-chemistry loading rate from the Inlet to the Niagara River.

A range of estimated values may be developed for each of these factors but, when taken together, the resulting chemistry loading rate is described by an even wider range of uncertainty, approaching two orders of magnitude. The available data cannot be used to calculate an estimate without making so many assumptions that the resulting estimate is neither meaningful nor reliable. The RI report therefore, does not estimate the loading rate of sediment-bound chemicals to the river. Transport modeling was considered, but there are no known models for quantifying the resuspension of silt and clay sediment. It would be technically difficult, and perhaps not practicable, to sample and collect the data necessary to verify the assumptions and develop a reliable estimate of the annual loading rate. Similar difficulties are reported for estimating loading to the Niagara River from the Buffalo River (Litten, 1987; p 53).

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7.0 CONCLUSION

7.1 Lockport Water Line

At this time there are no identified adverse impacts to, or problems with, the Lockport Water Supply that can be attributed to chemicals present in the Inlet. Underwater inspections of the interior of the LWL during the investigation indicate that the liner is in good condition and has no defects or imperfections. The City of Lockport conducts its own inspections on a periodic basis to help assure the continued integrity of the liner. Monitoring of the City of Lockport's water quality by the City, with NYSDOH review, indicates that the water consistently meets or exceeds all current drinking water standards. A recent report by the City of Lockport concludes, on the basis of a 30-day water sampling program, that the LWL liner is not adversely affected by the chemicals at the Inlet.

The presence of DNAPL in the bedding outside and adjacent to the LWL is a potential concern that will be addressed by an appropriate removal action described in the Inlet remedial alternatives assessment. Although the NTWL is pressurized and therefore should not enable the ingress of groundwater, the NTWL will be specifically addressed by the LWL removal action.

7.2 Inlet Cove and Perimeter

The additional investigations at and around the Inlet have been conducted in cooperation with State and local authorities. The investigations have defined the physical characteristics of the study area, achieved project objectives, and documented the nature, extent and potential migration pathways of SSCs in the Inlet and Inlet perimeter sufficiently to enable development of the remedial alternatives assessment.

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8.0 REFERENCES CITED

BOOKS, JOURNAL ARTICLES, AND REPORTS

Cedergren, H. R., 1977. *Seepage, Drainage, and Flow Nets*. New York : John Wiley and Sons, Inc. p. 66-76.

Dept. of the Navy. 1982. *Soil Mechanics Design Manual* 7.1. Dept. of the Navy, Naval Facilities Engineering Command. p. 103-108.

Dunn Geoscience Corporation. November 22, 1985. *Site Operations Plan, Investigation of the Durez Area Storm and Sanitary Sewers*. Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation. December 1986. *Remedial Alternatives Assessment for the Durez Site*. Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation. March 1987. *Video Inspection of the Pettit Creek Flume, North Tonawanda, New York*. Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation, March 7, 1988. Technical Negotiations, Work Plans C.2.a and C.3.b, *Geotechnical Investigation of Inlet*. Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation, March 7, 1988a. *Technical Negotiations, Work Plan A.3.b Part 2, Proposed Soil Chemistry Investigation for Groundwater Interceptor Trench*. Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation. October 17, 1988. *Summary of Subsurface Investigations at Inlet, 1987-1988*. Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation, October 17, 1988a. *Work Plan for Additional Subsurface Investigations at Inlet*. Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation. March 15, 1989. *Additional Subsurface Investigations at Inlet (Status Report I)*. Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation. August 30, 1989. *Inlet Investigation. (Status Report II)* Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation. October 23, 1989. *Additional Subsurface Investigation at Inlet (Status Report III)*. Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation, Albany, N.Y. Letter to Jackson, Craig; NYS Department of Environmental Conservation, Albany, N.Y., 22 Nov. 1989.

Dunn Geoscience Corporation. August 1990. *Draft Remedial Investigation Report for the Inlet (Durez Site)*. Vols. 1 (text) and 2 (Appendices). Albany, N.Y. : Dunn Geoscience Corporation.

Empire Soils Investigations, Inc., October, 1989. *Geotechnical Testing Report, Sewer Sediment Testing*, Number G018.001. Middleport, N.Y. : Empire Soils Investigations, Inc.

Erie and Niagara Counties Regional Planning Board. 1981. *Drainage Design Manual*. Albany, N.Y. : New York State Department of State.

Hawley, Gessner G., Editor. 1981. *The Condensed Chemical Dictionary, 10th Edition.* New York : Van Nostrand Reinhold Company.

Hvorslev, M. J. 1951. *Time Lag and Soil Permeability in Groundwater Investigations.* Vicksburg, Miss. : U.S. Army Corp of Engineers, Waterways Experimental Station. Bull. 36.

La Sala, A.M. Jr. 1968. *Ground Water Resources of the Erie -Niagara Basin, New York.* Washington, DC : U.S. Department of the Interior / Geological Survey.

Lockport Water Department. December, 1990. *30 Day Water and Sediment Sampling Program Report.* Lockport, New York : New York State Department of Health.

Litten, Simon. 1987. *Niagara River Area Sediments.* (Results of the Niagara River Implementation Plan Sediment Study and the Buffalo River Sediment Study). Albany : New York State Department of Environmental Conservation.

National Library of Medicine. 1989. *The Hazardous Substances Databank (HSDB).* Profiles for Benzene, 1,2-Dichlorobenzene, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene. (This is a fully referenced and peer-reviewed data bank).

National Oceanic and Atmospheric Administration. 1987. *Local Climatological Data annual summary with comprehensive data, Buffalo, N.Y.* Asheville, N.C. : National Climatic Data Center.

New York State Department of Environmental Conservation. 1989. *Remedial Action Plan OCC-Durez Site, City of North Tonawanda, New York, Record of Decision.* Site Number 9-32-018, Albany, N.Y. : NYS Department of Environmental Conservation.

New York State Department of Health. 1990. *Factsheet : Update, Lockport Water Intake Line.* Albany : New York State Department of Health.

New York State Department of Health. *Preliminary Investigation of City of Lockport, Intake Contamination.* Albany : New York State Department of Health

Norsea Corporation. April 23, 1990. *Inspection at City of Lockport Raw Water Intake at North Tonawanda, New York.* Troy, N.Y. : Norsea Corporation.

North Tonawanda, City of, April 9, 1984. *Zoning District Map,* North Tonawanda, N.Y.

Occidental Chemical Corporation. May 13, 1986. *Proposal for Phase 2, Investigation of the Durez Area Storm Sewers.* Niagara Falls, N.Y. : Occidental Chemical Corporation.

Occidental Chemical Corporation. September 1986. *Report of Continuing Field Investigations, Phase 2 Report, Durez Area Sewer Investigation.* Niagara Falls, N.Y. : Occidental Chemical Corporation.

Occidental Chemical Corporation. July 1989. *Durez Remediation, Final Design, Engineering Report for Interceptor Trench.* Niagara Falls, N.Y. : Occidental Chemical Corporation

Occidental Chemical Corporation. May 16, 1990. *Durez Remediation Project, Final Design, Engineering Report for City Sewer Cleaning, Number 91-857.* Niagara Falls, N.Y. : Occidental Chemical Corporation

Ocean Surveys, Inc. December 21, 1988. *Final Report, Subsurface Investigation, Pettit Flume Inlet and Little Niagara River, North Tonawanda, New York.* Old Saybrook, CT : Ocean Surveys, Inc.

Seaway Diving and Salvage Co., Inc. August 24, 1988. *City of Lockport Raw Water Intake Line Inspection.* Clifton Park, N.Y. : Seaway Diving and Salvage Co., Inc.

U.S. Army Corps of Engineers. 1970. *Laboratory Soils Testing.* Engineer Manual EM 1110-2-1906, Appendix VII. Washington, D.C. : U.S. Army Corps of Engineers.

U.S. Army Corps of Engineers. 1989. *Niagara River Water Levels* 1968-1988. Detroit, MI : U.S. Army Corps of Engineers.

U.S. District Court. 1988. *Stipulation and Partial Consent Judgment.* Index No. 83-552-C. Niagara Falls, N.Y. : Occidental Petroleum Corporation.

U.S. Environmental Protection Agency. 1975. *Use Of The Water Balance Method for Predicting Leachate Generation from Solid Waste Disposal Sites. (EPA-SW-186).*

U.S. Environmental Protection Agency. 1986. *Superfund Public Health Evaluation Manual. (EPA 540/1-86/060),* Washington, D.C. : U.S. Environmental Protection Agency.

Vershuren, Karel. 1983. *Handbook of Environmental Chemicals.* Second Edition. New York : Van Nostrand Reinhold Company.

Weast, Robert, Editor. 1978. *CRC Handbook of Environemntal Chemistry and Physics.* 59th Edition. West Palm Beach, FL. : CRC Press, Inc.

Whiteman, Osterman & Hanna, Albany, N.Y. Letter to Washington, Val E. and Bronson, Albert M., Attorneys at Law; NYS Dept. of Law, Albany, N.Y., 17 Mar. 1988.

MAPS

Federal Emergency Management Agency (FEMA). 1982. *Flood Insurance Rate Map,* City of North Tonawanda, New York, Niagara County. Panel 0001-0004. Community Panel No. 360508. Washington, D.C.: U.S. Dept. of Housing and Urban Development.

City of North Tonawanda, New York; Niagara County. Panel 0001-0004. Community Panel No. 360508. Wash., D.C. : U.S. Dept. of Housing and Urban Development.

McNamee, Porter and Seeley. June 6, 1978. *As-Built, Proposed Plastic Liner for Existing 48" Steel Intake, City of Lockport, New York, Water Intake Pipe Relining.* Contract 76-W-1. Ann Arbor, MI : McNamee, Porter and Seeley.

Miller, Todd S. 19 . *Potential Yields of Wells in Unconsolidated Aquifers in Upstate New York - Niagara Sheet.* Water Resources Investigation 88-4076. Denver, CO : U.S. Geological Survey.

Muller, E. H. 1977. *Quaternary Geology of New York, Niagara Sheet.* Map and Chart Series Number 28. Albany, N.Y. : N.Y.S. Education Department / N.Y.S. Museum and Science Service.

North Tonawanda, City of, *Zoning District Map.* Rev. Jul 14, 1981. : City of North Tonawanda.

Rickard, L. V. and Fisher, D. W. 1970. *Geologic Map of New York, Niagara Sheet*. Map and Chart Series Number 15, Albany, N.Y. : N.Y.S. Education Department / N.Y.S. Museum and Science Service.

Wendel, L. May 18, 1966. *As built DWG - Jan 1969, General Location and Plot Plan, City of Lockport Raw Water Pumping Station*. Sheet A-2 of 23, Job No. 509-2D-65. Lockport, N.Y. : Leon Wendel Consulting Engineer.

PERSONAL COMMUNICATIONS

O'Dell, P.M., Chief Engineering Division, Great Lakes Hydraulics Branch, Dept. of the Army, Detroit, MI. Letter to the author, 14 June, 1989.

Yaeger, R., Hydrologist; U.S. Geological Survey, Ithaca, N.Y. Telephone conversation, June 6, 1990.

Kappel, W., Hydrologist; U.S. Geological Survey, Ithaca, N.Y. Telephone conversation, March 17, 1988.

TABLES

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TABLE 2-1
Summary of Field Investigation and Related Activities
OCC Durez Inlet

Time Year	Month	Activity
1985	September	NYSDEC collects vibracore sample of Inlet sediment.
1986	June	Durez Continuing Field Investigation includes vibracore sampling of Inlet sediment (cores 1 - 10).
	October	Video inspection of interior of Pettit Creek Flume.
	December	Durez Remedial Alternatives Assessment (RAA) report.
1987	July	NYS samples Lockport water supply as part of 20 Water Supply Study.
	September	NYSDEC approves outline for Durez Technical Negotiations; Inlet identified as work element "C."
	November	Surface soil samples (DR-Series) collected on south side of Inlet.
	December	NYSDOH issues press release for 20 Water Supply Study.
1988	February	NYS resamples water and sediment from Lockport's water supply.
	February	Initial "Phase I" Inlet perimeter drilling (borings I-1 through I-6, I-8, I-10); soil analyses for I-1, I-2, I-4, I-8.
	February	Initial surface geophysics to locate LWL.
	March	NYS retests Lockport Water as a follow-up to 20 Water Supply Study.
	April (?)	NYSDEC installs a fence at Inlet.
	May	OCC installs perimeter fence.
	July	Inlet investigation bifurcates from Durez plant and sewer remediation.
	August	"Task 1" Diver/Video inspection of LWL by OCC.
	September	OCC field trailer mobilized to Inlet.
	September	"Task 3", "Phase 2" Inlet perimeter drilling (borings I-7, I-9, I-11 through I-20).
	September	NYS issues Proposed Remedial Action Plan (PRAP) for Durez Site.
	October	Final Work Plan for Additional Investigations at Inlet approved by NYS.

TABLE 2-1 (continued)
Summary of Field Investigation and Related Activities
OCC Durez Inlet

Time: Year	Month	Activity
	(continued)	
1988	November	"Task 2" Subbottom Profiling and LWL geophysics.
	December	"Task 5" Inlet sediment depth probes.
1989	February	Record of Decision (ROD) issued for Durez site.
	April	Stipulation and Partial Consent Judgment (PCJ) for Durez site signed.
1989	June	"Task 3" Inlet perimeter drilling initiated (borings I-21 through I-30, HA-1 through HA-3).
	November	"Task 4" Inlet water borings drilling initiated (IW-1 through IW-6).
	November	"Task 3" Inlet perimeter monitoring well installations begin (MW-1 through MW-14), soil drilling continued (SB-1 through SB-4).
	December	"Task 6" LWL backfill borings initiated (WL-1 through WL-5).
1990	January	Video and diver inspection of LWL after "Task 6" completed.
	January	NYSDOH releases chemical data for February/March 1988 sampling of Lockport Water System.
	February	Lockport initiates revised water sampling program.
	February	First round groundwater sampling.
	April	Geophysical investigation to locate North Tonawanda Water Line (NTWL).
	April	Second round groundwater sampling.
	May	Field hydraulic conductivity testing of monitoring wells.
	May	Inlet chemistry results submitted to NYS.
	August	Inlet Remedial Investigation Report completed.
	November	Inlet samples collected for PCDD/PCDF analyses

TABLE 2-2

Summary of OCC Inlet-Related Reports Submitted to New York State

Dunn Geoscience Corporation. December 1986. *Remedial Alternatives Assessment for the Durez Site.* Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation. March 1987. *Video Inspection of the Pettit Creek Flume, North Tonawanda, New York.* Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation. October 17, 1988. *Summary of Subsurface Investigations at Inlet, 1987-1988.* Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation. March 15, 1989. *Additional Subsurface Investigations at Inlet (Status Report I).* Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation. August 30, 1989. *Inlet Investigation, Data Package, (Status Report II).* Albany, N.Y. : Dunn Geoscience Corporation.

Dunn Geoscience Corporation. October 23, 1989. *Additional Subsurface Investigation at Inlet (Status Report III).* Albany, N.Y.: Dunn Geoscience Corporation.

Norsea Corporation. April 23, 1990. *Inspection at City of Lockport Raw Water Intake at North Tonawanda, New York.* Troy, N.Y. : Norsea Corporation.

Occidental Chemical Corporation. July 1986. *Report of Continuing Field Investigations, Phase 1 Report, Durez Area Sewer Investigation.* Niagara Falls, N.Y. : Occidental Chemical Corporation.

Occidental Chemical Corporation. September 1986. *Report of Continuing Field Investigations, Phase 2 Report, Durez Area Sewer Investigation.* Niagara Falls, N.Y. : Occidental Chemical Corporation.

Occidental Chemical Corporation. July 1989. *Durez Remediation, Final Design, Engineering Report for Interceptor Trench.* Niagara Falls, N.Y. : Occidental Chemical Corporation

Occidental Chemical Corporation. May 16, 1990. *Durez Remediation Project, Final Design, Engineering Report for City Sewer Cleaning, Number 91-857.* Niagara Falls, N.Y. : Occidental Chemical Corporation

Ocean Surveys, Inc. December 21, 1988. *Final Report, Subsurface Investigation, Pettit Flume Inlet and Little Niagara River, North Tonawanda, New York.* Old Saybrook, CT : Ocean Surveys, Inc.

Seaway Diving and Salvage Co., Inc. August 24, 1988. *City of Lockport Raw Water Intake Line Inspection.* Clifton Park, N.Y. : Seaway Diving and Salvage Co., Inc.

*U.S. District Court. 1988. *Stipulation and Partial Consent Judgment.* Index No. 83-552-C. Niagara Falls, N.Y. : Occidental Petroleum Corporation.

* Prepared by NYS and OCC for U.S. Court.

Abbreviations:		
	DUNN	Dunn Geoscience Corporation
	OCC	Occidental Chemical Corporation
	NORSEA	Norsea Corporation
	OSI	Ocean Surveys, Inc.
	SEAWAY	Seaway Diving and Salvage Co., Inc.

TABLE 3-1

MONTHLY TEMPERATURE AND PRECIPITATION

Month	Mean Daily Temperature (oF)	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, New York, Weather Station for the data years 1939 to 1978.

Table 3-2

Historic Niagara River Stage Data
Tonawanda Island
Station Number 3018

Year	Maximum Stages (ft MSL) Monthly Mean	Maximum Stages (ft MSL) Daily Mean	Maximum Stages (ft MSL) Instantaneous High	Minimum Stages (ft MSL) Monthly Mean	Minimum Stages (ft MSL) Daily Mean	Minimum Stages (ft MSL) Instantaneous Low
1968	Aug - 565.46	5 Dec - 567.15	5 Dec - 568.62	Nov 564.85	12 Nov 564.18	16 Nov 563.33
1969	Aug - 566.19	1 Jan - 567.30	1 Jan - 568.23	Mar 565.13	31 Dec 564.47	19 Apr 563.15
1970	Jul - 565.62	9 Jan - 567.03	9 Jan - 567.89	Feb 564.81	3 Mar 564.19	1 Nov 562.73
1971	Jun - 566.68	30 Jan - 566.59	30 Jan - 567.68	Nov 565.13	22 Feb 564.29	22 Feb 563.90
1972	Dec - 566.27	25 Jan - 567.71	25 Jan - 569.78	Feb 565.26	14 Nov 564.47	12 Nov 563.36
1973	Jan - 566.45	18 Mar - 567.61	1 Nov - 568.18	Dec 565.51	17 Dec 564.83	24 Dec 564.67
1974	Apr - 566.31	15 Apr - 567.43	15 Apr - 568.40	Nov 565.38	1 Dec 564.70	2 Feb 564.67
1975	Mar - 566.19	26 Feb - 568.71	26 Feb - 569.99	Dec 565.26	12 Dec 564.58	21 Dec 564.09
1976	Mar - 566.22	13 Mar - 567.30	13 Mar - 568.00	Nov 565.20	5 Dec 564.34	2 Mar 564.08
1977	Dec - 565.57	9 Dec - 568.28	9 Dec - 568.28	Feb, Mar 565.98	23 Feb 564.39	13 Feb 563.81
1978	Jan - 566.16	10 Jan - 568.65	10 Dec - 568.65	Nov 564.89	12,20 Nov 564.45	27 Nov 564.15
1979	Aug - 565.74	6 Apr - 568.08	6 Apr - 568.08	Feb 564.66	25 Feb 564.18	26 Feb 563.75
1980	Aug - 565.83	26 Oct - 567.11	12 Jan - 568.21	Nov, Dec 565.23	27 Nov 564.69	27 Nov 564.42
1981	Jun - 565.73	22 Jun - 566.13	22 Jun - 566.94	Feb 565.03	14 Feb 564.69	20 Nov 564.35
1982	Apr - 565.99	5 Apr - 566.92	- - - - -	Oct 565.10	10 Nov 564.59	9 Oct 564.16
1983	Dec - 566.45	26 Dec - 567.77	26 Dec - 567.95	Feb 565.09	11 Feb 564.54	21 Mar 563.99
1984	Nov - 566.10	29 Dec - 576.50 *	29 Nov - 576.77 *	Feb 565.16	14 Dec 564.29	14 Dec 563.65
1985	Feb - 567.59	23 Jan - 569.37	2 Dec - 569.89	Oct 565.51	11 Jan 564.89	28 Nov 564.51
1986	Jan - 566.79	9 Jan - 568.53	10 Jan - 568.78	Sep 565.78	1 Dec 564.83	*1 Dec 565.22
1987	Jan - 566.32	24 Jan - 567.61	12 Jan - 568.06	Dec 565.35	22 Nov 564.52	15 Dec 563.96
1988	Apr - 565.55	24 Apr - 566.33	4 Jan - 567.15	Mar 565.12	19 Jan 564.81	19 Jan 564.31
Average	**566.15**	**567.58**	**568.36**	**565.21**	**564.52**	**564.00**
Std. Dev.	**0.50**	**0.84**	**0.82**	**0.31**	**0.23**	**0.56**

Note: Mean sea level elevation is mean water level at Father Point, Quebec, I.G.L.D. (1955) plus 1.23 feet.

Data obtained from Great Lakes Hydraulics and Hydrology Branch, U.S. Army Corps of Engineers, Detroit, Michigan.

* This elevation results from a key punch error as per U.S. Army Corps of Engineers, May 30, 1989.

TABLE 3-3
INSTANTANEOUS HIGH AND LOW RIVER LEVELS
TONAWANDA ISLAND GAUGE, NIAGARA RIVER

	High Levels			Low Levels		
Rank	Water Level (IGLD)	Water Level (MSL)	Date	Water Level (IGLD)	Water Level (MSL)	Date
1	568.76	569.99	2/26/75	561.50	562.73	11/1/70
2	568.66	569.89	12/2/85	561.92	563.15	4/19/69
3	568.55	569.78	1/25/72	562.10	563.33	11/16/68
4	567.55	568.78	1/10/86	562.13	563.36	11/12/72
5	567.42	568.65	12/10/78	562.42	563.65	12/14/84
6	567.39	568.62	12/5/68	562.52	563.75	2/26/79
7	567.17	568.40	4/18/74	562.58	563.81	2/13/77
8	567.05	568.28	12/9/77	562.67	563.90	2/22/71
9	567.00	568.23	1/1/69	562.73	563.96	2/15/87
10	566.98	568.21	1/12/80	562.76	563.99	3/21/83
11	566.95	568.18	11/13/73	562.85	564.08	3/2/76
12	566.85	568.08	4/6/79	562.86	564.09	12/21/75
13	566.83	568.06	1/12/87	562.92	564.15	11/27/78
14	566.77	568.00	3/13/76	562.93	564.16	10/9/82
15	566.72	567.95	12/26/83	563.08	564.31	1/19/88
16	566.66	567.89	1/9/70	563.12	564.35	11/20/81
17	566.45	567.68	1/30/71	563.19	564.42	11/27/80
18	565.92	567.15	2/6/88	563.24	564.47	2/2/74
19	565.71	566.94	6/22/81	563.28	564.51	11/28/85
20				563.44	564.67	12/24/73

Note: Add 1.23 feet to IGLD elevations to obtain MSL elevations. Period of record 1968-1988; data from 12/1/86 is in error and is not included; 1982 data not available for high levels.

TABLE 3-4

CITY OF LOCKPORT WATER TESTING

Surrogate Chemical Testing
City of Lockport
Raw Water Wet Well
March 7 to March 28, 1990

Analysis
Advance Environmental Services
2186 Liberty Drive
Niagara Falls, N.Y. 14304

Units of Measure: Micrograms/liter or ppb

Analytical Parameters	Method No.	Quant. Limit	Sample No. / Date / Sample	2204 03/07/90 Raw	2203 03/07/90 Fin	2271 03/08/90 Raw	Lab Blank	2309 03/09/90 Raw	Lab Blank	2376 03/12/90 Raw	2419 03/13/90 Raw
1,2-Dichlorobenzene	8120	0.1		BQL *	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,4-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,3-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,4-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,4,5-Tetrachlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,3,4-Tetrachlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Hexachlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Benzene	502.2	0.2		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Toluene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Monochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Ortochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

* Below Quantifiable Limits
** See Comment

Adapted from Lockport Water Department, 1990.

TABLE 3-4

CITY OF LOCKPORT WATER TESTING (CONT'D)

Surrogate Chemical Testing
City of Lockport
Raw Water Wet Well
March 7 to March 28, 1990

Analysis
Advance Environmental Services
2186 Liberty Drive
Niagara Falls, N.Y. 14304

Units of Measure: Micrograms/liter or ppb

Analytical Parameters	Method No.	Quant. Limit	Sample No. / Date / Sample	2465 03/14/90 Raw	Lab Blank	2540 03/15/90 Raw	2541 03/15/90 Fin	2638 03/16/90 Raw	Lab Blank	2708 03/19/90 Raw	2731 03/20/90 Raw
1,2-Dichlorobenzene	8120	0.1		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,4-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,3-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,4-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,4,5-Tetrachlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,3,4-Tetrachlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Hexachlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Benzene	502.2	0.2		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Toluene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Monochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Ortochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

* Below Quantifiable Limits
** See Comment

TABLE 3-4

Surrogate Chemical Testing
City of Lockport
Raw Water Wet Well
March 7 to March 28, 1990

CITY OF LOCKPORT WATER TESTING (CONT'D)

Analysis
Advance Environmental Services
2186 Liberty Drive
Niagara Falls, N.Y. 14304

Units of Measure: Micrograms/liter or ppb

Analytical Parameters	Method No.	Quant. Limit	Sample No. / Date Sample	2756 03/21/90 Raw	Lab Blank	2792 03/22/90 Raw	2793 03/22/90 Fin	04/03/90 Method Blank	03/26/90 Method Blank	2882 03/23/90 Raw	04/03/90 Lab Blank
1,2-Dichlorobenzene	8120	0.1		BQL	BQL	BQL	BQL		BQL	BQL	
1,4-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL		BQL	0.74 **	
1,2,3-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL		BQL	BQL	
1,2,4-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL		BQL	BQL	
1,2,4,5-Tetrachlorobenzene	"	"		BQL	BQL	BQL	BQL		BQL	BQL	
1,2,3,4-Tetrachlorobenzene	"	"		BQL	BQL	BQL	BQL		BQL	BQL	
Hexachlorobenzene	"	"		BQL	BQL	BQL	BQL		BQL	BQL	
Benzene	502.2	0.2		BQL	BQL	BQL	BQL	BQL		BQL	BQL
Toluene	"	"		BQL	BQL	BQL	BQL	BQL		BQL	BQL
Monochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL		BQL	BQL
Ortochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL		BQL	BQL

* Below Quantifiable Limits
** See Comment

TABLE 3-4

CITY OF LOCKPORT WATER TESTING
(CONT'D)

Surrogate Chemical Testing
City of Lockport
Raw Water Wet Well
March 7 to March 28, 1990

Analysis
Advance Environmental Services
2186 Liberty Drive
Niagara Falls, N.Y. 14304

Units of Measure: Micrograms/liter or ppb

			Sample No.	2906	2956		2989	2988	
Analytical	Method	Quant.	Date	03/26/90	03/27/90	04/05/90	03/28/90	03/28/90	04/03/90
Parameters	No.	Limit	Sample	Raw	Raw	Method Blank	Fin	Raw	Method Blank
1,2-Dichlorobenzene	8120	0.1		BQL	BQL	BQL	BQL *	BQL *	
1,4-Dichlorobenzene	"	"		0.62 **	BQL	0.36 **	BQL	BQL	
1,2,3-Trichlorobenzene	"	"		BQL	0.15 **	BQL	BQL	BQL	
1,2,4-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	
1,2,4,5-Tetrachlorobenzene	"	"		BQL	0.13 **	BQL	BQL	BQL	
1,2,3,4-Tetrachlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	
Hexachlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	
Benzene	502.2	0.2		BQL	BQL		BQL	BQL	BQL
Toluene	"	"		BQL	BQL		BQL	BQL	BQL
Monochlorobenzene	"	"		BQL	BQL		BQL	BQL	BQL
Ortochlorobenzene	"	"		BQL	BQL		BQL	BQL	BQL

* Below Quantifiable Limits
** See Comment

TABLE 3-4

Surrogate Chemical Testing
City of Lockport
Raw Water Wet Well
March 29 to April 18, 1990

CITY OF LOCKPORT WATER TESTING (CONT'D)

Analysis
Advance Environmental Services
2186 Liberty Drive
Niagara Falls, N.Y. 14304

Units of Measure: Micrograms/liter or ppb

Analytical Parameters	Method No.	Quant. Limit	Sample No. / Date / Sample	3034 03/29/90 Raw	3113 03/30/90 Raw	04/05/90 Method Blank	3165 04/02/90 Raw	3221 04/03/90 Raw	04/04/90 Method Blank	3263 04/04/90 Raw	04/05/90 Method Blank
	502.2	0.2									
Benzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Toluene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Monochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Ortochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,4-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,3-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,3-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,4-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,4,5-Tetrachlorobenzene	8120	0.1		BQL	BQL		BQL	BQL		BQL	
1,2,3,4-Tetrachlorobenzene	"	"		BQL	BQL		BQL	BQL		BQL	
Hexachlorobenzene	"	"		BQL	BQL		BQL	BQL		BQL	

* Below Quantifiable Limits
** See Comment

TABLE 3-4

CITY OF LOCKPORT WATER TESTING (CONT'D)

Surrogate Chemical Testing
City of Lockport
Raw Water Wet Well
March 29 to April 18, 1990

Analysis
Advance Environmental Services
2186 Liberty Drive
Niagara Falls, N.Y. 14304

Units of Measure: Micrograms/liter or ppb

Analytical Parameters	Method No.	Quant. Limit	Sample No. / Date / Sample	3303 04/05/90 Raw	3334 04/06/90 Raw	3335 04/06/90 Fin	04/12/90 Method Blank	3447 04/09/90 Raw	04/19/90 Method Blank	3516 04/10/90 Raw	3567 04/11/90 Raw
	502.2	0.2									
Benzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Toluene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Monochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Ortochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,4-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,3-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,3-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,4-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,4,5-Tetrachlorobenzene	8120	0.1		BQL	BQL	BQL		BQL		BQL	BQL
1,2,3,4-Tetrachlorobenzene	"	"		BQL	BQL	BQL		BQL		BQL	BQL
Hexachlorobenzene	"	"		BQL	BQL	BQL		BQL		BQL	BQL

* Below Quantifiable Limits
** See Comment

Surrogate Chemical Testing
City of Lockport
Raw Water Wet Well
March 29 to April 18, 1990

TABLE 3-4

CITY OF LOCKPORT WATER TESTING (CONT'D)

Analysis
Advance Environmental Services
2186 Liberty Drive
Niagara Falls, N.Y. 14304

Units of Measure: Micrograms/liter or ppb

Analytical Parameters	Method No.	Quant. Limit	Sample No.	3641	3642	3718		3730		3796	3797
			Date	04/12/90	04/12/90	04/16/90	04/28/90	04/17/90	04/30/90	04/18/90	04/18/90
			Sample	Raw	Fin	Raw	Method Blank	Raw	Method Blank	Raw	Fin
	502.2	0.2									
Benzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Toluene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Monochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Ortochlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,4-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,3-Dichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,3-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,4-Trichlorobenzene	"	"		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,4,5-Tetrachlorobenzene	8120	0.1		BQL	BQL	BQL		BQL		BQL	BQL
1,2,3,4-Tetrachlorobenzene	"	"		BQL	BQL	BQL		BQL		BQL	BQL
Hexachlorobenzene	"	"		BQL	BQL	BQL		BQL		BQL	BQL

* Below Quantifiable Limits
** See Comment

TABLE 3-4

Surrogate Chemical Testing
City of Lockport
Raw Water Wet Well
March 29 to April 18, 1990

CITY OF LOCKPORT WATER TESTING (CONT'D)

Analysis
Advance Environmental Services
2186 Liberty Drive
Niagara Falls, N.Y. 14304

Units of Measure: Micrograms/liter or ppb

Analytical Parameters	Method No.	Quant. Limit	Sample No. Date Sample	05/01/30 Method Blank	04/12/90 Method Blank Extraction	04/16/90 Method Blank Extraction	04/17/90 Method Blank Extraction	04/19/90 Method Blank Extraction	05/03/90 Lab Blank	05/05/90 Lab Blank
	502.2	0.2								
Benzene	*	*		BQL						
Toluene	*	*		BQL						
Monochlorobenzene	*	*		BQL						
Ortochlorobenzene	*	*		BQL						
1,2-Dichlorobenzene	*	*		BQL						
1,4-Dichlorobenzene	*	*		BQL						
1,3-Dichlorobenzene	*	*		BQL						
1,2,3-Trichlorobenzene	*	*		BQL						
1,2,4-Trichlorobenzene	*	*		BQL						
1,2,4,5-Tetrachlorobenzene	8120	0.1			BQL	BQL	BQL	BQL	BQL	BQL
1,2,3,4-Tetrachlorobenzene	*	*			BQL	BQL	BQL	BQL	BQL	BQL
Hexachlorobenzene	*	*			BQL	BQL	BQL	BQL	BQL	BQL

* Below Quantifiable Limits
** See Comment

TABLE 3-4

** Comment:

CITY OF LOCKPORT WATER TESTING (CONT'D)

From Advanced Environmental Services
Report of April 18, 1990

All positive identifications were qualitaively confirmed via GC/MS. During the confirmation analysis, instrument blanks involving Hexane and Methylene Chloride were analyzed. The Methylene Chloride source solvent that was used for extractions was found to contain Di and Tri Chlorobenzene Contamination while the Hexane did not. The Tetrachlorobenzene found in sample 2956 was confirmed qualitatively via GC/MS and no source of solvent contamination was determined.

TABLE 4-1
SUMMARY OF INLET PERIMETER LAND BORINGS
TASK 3

Boring	Total Depth	Ground Elevation	FILL Depth Range	FILL Thickness	ALLUVIUM Depth Range	ALLUVIUM Elevation Top of Unit	ALLUVIUM Thickness	GLACIO-LACUSTRINE CLAY Depth Range	GLACIO-LACUSTRINE CLAY Elevation Top of Unit	GLACIO-LACUSTRINE CLAY Thickness	TILL Depth Range	TILL Elevation Top of Unit	TILL Thickness	ROCK Depth Range	ROCK Elevation Top of Unit	ROCK Thickness
PHASE I																
I-1	34.0	569.1	0.0 - 12.0	12.0	12.0 - 21.5	557.1	9.5	21.5 - 28.0	547.6	6.5	28.0 - 34.0+	541.1	>6.0	-----	-----	-----
I-1a	5.0	569.2	0.0 - 5.0+	>5.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
*I-2	18.0	569.0	0.0 - 3.0	3.0	10.0 - 13.5	559.0	3.5	13.5 - 18.0+	555.5	>4.5	-----	-----	-----	-----	-----	-----
*I-3	75.0	569.0	0.0 - 5.0	5.0	-----	-----	0	14.0 - 27.0	555.0	13.0	27.0 - 74.0	542.0	47.0	74.0 - 75.0+	495.0	>1.0
I-4	40.0	571.3	0.0 - 9.5	9.5	9.5 - 35.0	561.8	25.5	-----	-----	0	35.0 - 40.0+	536.3	>5.0	-----	-----	-----
I-5	26.0	571.8	0.0 - 5.5	5.5	5.5 - 22.0	566.3	16.5	22.0 - 26.0+	549.8	>4.0	-----	-----	-----	-----	-----	-----
I-6	18.0	570.1	0.0 - 5.0	5.0	5.0 - 13.0	565.1	8.0	13.0 - 18.0+	557.1	>5.0	-----	-----	-----	-----	-----	-----
I-8	34.0	570.4	0.0 - 8.0	8.0	8.0 - 28.0	562.4	20.0	28.0 - 30.0	542.4	2.0	30.0 - 34.0+	540.4	>4.0	-----	-----	-----
I-10	26.0	570.2	0.0 - 5.0	5.0	5.0 - 19.0	565.2	14.0	19.0 - 26.0+	551.2	>7.0	-----	-----	-----	-----	-----	-----
PHASE II																
I-7	22.0	569.8	0.0 - 10.0	10.0	10.0 - 16.8	559.8	6.3	16.8 - 22.0+	553.0	>5.2	-----	-----	-----	-----	-----	-----
I-9	40.0	573.7	0.0 - 10.5	10.5	10.5 - 34.5	563.2	24.0	-----	-----	0	34.5 - 40.0+	539.2	>5.5	-----	-----	-----
I-11	30.0	571.3	0.0 - 6.4	6.4	6.4 - 25.1	564.9	18.7	25.1 - 30.0+	546.2	>4.9	-----	-----	-----	-----	-----	-----
I-12	12.0	572.2	0.0 - 4.4	4.4	4.4 - 7.4	567.8	3.0	7.4 - 12.0+	564.8	>4.6	-----	-----	-----	-----	-----	-----
I-13	40.0	573.1	0.0 - 13.1	13.1	13.1 - 35.9	560.0	22.8	-----	-----	0	35.9 - 40.0+	537.2	>4.1	-----	-----	-----
I-14	20.0	573.6	0.0 - 5.5	5.5	5.5 - 14.2	568.1	8.7	14.2 - 20.0+	559.4	>5.8	-----	-----	-----	-----	-----	-----
*I-15	14.0	569.2	00 - 4.0	4.0	-----	-----	0	12.0 - 14.0+	557.2	>2.0	-----	-----	-----	-----	-----	-----
I-16	24.0	569.9	0.0 - 10.6	10.6	10.6 - 19.8	559.3	9.2	19.8 - 24.0+	550.1	>4.2	-----	-----	-----	-----	-----	-----
I-17	10.0	571.4	0.0 - 4.9	4.9	-----	-----	0	4.9 - 10.0+	566.5	>5.1	-----	-----	-----	-----	-----	-----
I-18	20.0	569.7	0.0 - 8.8	8.8	8.8 - 15.5	560.9	6.7	15.5 - 20.0+	554.2	>4.5	-----	-----	-----	-----	-----	-----
I-19	20.0	571.0	0.0 - 8.7	8.7	8.7 - 15.5	562.3	6.8	15.5 - 20.0+	555.5	>4.5	-----	-----	-----	-----	-----	-----
I-20	14.0	572.9	0.0 - 8.0	8.0	-----	-----	0	8.0 - 14.0+	564.9	>6.0	-----	-----	-----	-----	-----	-----
PHASE III																
I-21	70.0	573.7	0.0 - 10.0	10.0	10.0 - 32.8	563.7	22.8	-----	-----	0	32.8 - 69.7	540.9	36.9	69.7 - 70.0+	504.0	>0.3
I-22	44.0	573.7	0.0 - 10.0	10.0	10.0 - 38.0	563.7	28.0	-----	-----	0	38.0 - 44.0+	535.7	>6.0	-----	-----	-----
I-23	48.0	573.6	0.0 - 10.0	10.0	10.0 - 36.9	563.6	26.9	36.9 - 40.5	536.7	3.6	40.5 - 48.0+	533.1	>7.5	-----	-----	-----
*I-24	8.0	566.5	0.0 - 0.0	0.0	-----	-----	0	-----	-----	-----	-----	-----	-----	-----	-----	-----
*I-25	18.0	568.3	0.0 - 2.0	2.0	-----	-----	0	14.0 - 18.0+	554.3	>4.0	-----	-----	-----	-----	-----	-----
I-26	24.0	569.9	0.0 - 8.0	8.0	8.0 - 15.3	561.9	7.3	15.3 - 24.0+	554.6	>8.7	-----	-----	-----	-----	-----	-----
*I-27	22.0	569.5	0.0 - 4.0	4.0	14.0 - 16.6	555.5	2.6	16.6 - 22.0+	552.9	>5.4	-----	-----	-----	-----	-----	-----
I-28	44.0	573.9	0.0 - 9.0	9.0	9.0 - 33.8	564.9	24.8	-----	-----	0	33.8 - 44.0+	540.1	>10.2	-----	-----	-----
I-29	14.0	571.4	0.0 - 4.2	4.2	-----	-----	0	4.2 - 14.0+	567.2	>9.8	-----	-----	-----	-----	-----	-----
I-30	30.0	566.0	0.0 - 8.5	8.5	8.5 - 23.4	557.5	14.9	23.4 - 26.5	542.6	3.1	26.5 - 30.0+	539.5	>3.5	-----	-----	-----
MONITORING WELLS																
MW-1	53.0	573.6	0.0 - 8.8	8.8	8.8 - 35.5	564.8	26.7	-----	-----	0	35.5 - 53.0+	538.1	>17.5	-----	-----	-----
MW-2	50.5	573.4	0.0 - 12.8	12.8	12.8 - 33.8	560.6	21.0	-----	-----	0	33.8 - 50.5+	539.6	>16.7	-----	-----	-----
MW-3	38.0	573.6	0.0 - 8.4	8.4	8.4 - 25.0	565.2	16.6	25.0 - 33.1	548.6	8.1	33.1 - 38.0+	540.5	>4.9	-----	-----	-----
MW-4	18.0	573.1	0.0 - 6.3	6.3	6.3 - 15.0	566.8	8.7	15.0 - 18.0+	558.1	>3.0	-----	-----	-----	-----	-----	-----
MW-5	50.0	570.9	0.0 - 6.4	6.4	6.4 - 31.7	564.5	25.3	-----	-----	0	31.7 - 50.0+	539.2	>18.30	-----	-----	-----
MW-6	22.0	570.3	0.0 - 4.5	4.5	4.5 - 20.8	565.8	16.3	20.8 - 22.0+	549.5	>1.2	-----	-----	-----	-----	-----	-----
MW-7	18.0	570.9	0.0 - 4.0	4.0	4.0 - 4.6	566.9	0.6	4.6 - 18.0+	566.3	>13.4	-----	-----	-----	-----	-----	-----
*MW-8	36.5	569.2	0.0 - 8.0	8.0	12.8 - 21.0	556.4	8.2	21.0 - 27.3	548.2	6.3	27.3 - 36.5+	541.9	>9.2	-----	-----	-----
*MW-9	30.0	568.7	0.0 - 4.0	4.0	12.0 - 14.0	556.7	2.0	14.0 - 26.5	554.7	12.5	26.5 - 30.0+	542.2	>3.5	-----	-----	-----
MW-10	26.0	572.6	0.0 - 4.4	4.4	-----	-----	0	4.4 - 26.0+	568.2	>21.6	-----	-----	-----	-----	-----	-----
MW-11	18.0	570.1	0.0 - 8.0	8.0	8.0 - 17.2	562.1	9.2	17.2 - 18.0+	552.9	>0.8	-----	-----	-----	-----	-----	-----
MW-12	26.0	573.2	0.0 - 6.0	6.0	-----	-----	0	6.0 - 26.0+	567.2	>20.0	-----	-----	-----	-----	-----	-----
MW-13	31.0	575.3	0.0 - 12.0	12.0	-----	-----	0	12.0 - 30.4	563.3	18.4	30.4 - 31.0+	544.9	>0.6	-----	-----	-----
MW-14	12.0	570.9	0.0 - 4.8	4.8	4.8 - 12.0+	566.1	>7.2	-----	-----	-----	-----	-----	-----	-----	-----	-----
CONFIRMATION BORINGS																
SB-1	10.0	573.5	0.0 - 8.7	8.7	8.7 - 10.0+	564.8	>1.3	-----	-----	-----	-----	-----	-----	-----	-----	-----
SB-2	12.0	573.9	0.0 - 10.0	10.0	10.0 - 12.0+	563.9	>12.0	-----	-----	-----	-----	-----	-----	-----	-----	-----
SB-3	42.0	571.3	0.0 - 6.4	6.4	6.4 - 31.7	564.9	25.3	-----	-----	0	31.7 - 42.0+	539.6	>10.3	-----	-----	-----
SB-4	24.0	569.9	0.0 - 8.0	8.0	8.0 - 14.5	561.9	6.5	14.5 - 24.0+	555.4	>9.5	-----	-----	-----	-----	-----	-----

NOTES:
1. See Table 4-5 for Inlet stratigraphy for borings with *.
2. Depth range and thickness in feet.
3. Elevation in feet above mean sea level (amsl).
4. Drilling locations shown on Figure 4-1.

TABLE 4-2
Vibracore Drilling Summary

Sample	Water Depth (Ft. Below Datum)	Soft Sediment Penetration (Ft.)	Total Sample Recovery (Ft.)	Total Sample Recovery (%)	Silt-Clay Fill Recovered (Ft.)	Soft Sediment Recovered (Ft.)	Maximum Possible Soft Sed. Thickness (Ft.)	Average Sed. Thickness (Ft.)
1-1	3.0	7.0	5.5	78.6	3.0	2.5	4.0	3.2
1-2	3.1	5.5	3.3	60.0	0.8	2.5	4.7	3.6
1-3	5.0	7.0	4.5	64.3	4.2	0.2	2.8	1.5
1-Average	**3.7**	**6.5**	**4.4**	**67.6**	**2.7**	**1.7**	**3.8**	**2.8**
2-1	2.2	3.0	1.4	46.7	0.0	1.4	3.0	2.2
2-2	2.5	5.8	2.8	48.3	1.8	1.0	4.0	2.5
2-3	2.2	6.3	4.5	71.4	2.3	2.2	4.0	3.1
2-Average	**2.3**	**5.0**	**2.9**	**55.5**	**1.4**	**1.5**	**3.7**	**2.6**
3-1	2.6	6.4	2.8	43.8	1.0	1.8	5.4	3.6
3-2	2.3	6.6	1.0	15.2	0.0	1.0	6.6	3.8
3-3	2.6	6.3	3.3	52.4	1.4	1.9	4.9	3.4
3-Average	**2.5**	**6.4**	**2.4**	**37.1**	**0.8**	**1.6**	**5.6**	**3.6**
4-1	2.2	8.1	6.9	77.8	0.0	6.9	8.1	7.2
4-2	2.2	8.4	5.9	70.2	1.8	4.1	6.6	5.4
4-3	2.2	6.7	6.4	95.5	1.3	5.1	5.4	5.3
4-Average	**2.2**	**7.7**	**6.4**	**81.2**	**1.0**	**5.4**	**6.7**	**6.0**
5-1	1.8	7.5	6.0	80.0	1.3	4.7	6.2	5.5
5-2	1.7	10.1	5.5	54.5	4.3	1.2	5.8	3.5
5-3	2.0	7.2	3.0	41.7	1.5	1.5	5.7	3.6
5-Average	**1.8**	**8.3**	**4.8**	**58.7**	**2.4**	**2.5**	**5.9**	**4.2**
6-1	2.7	7.7	4.9	63.6	1.5	3.4	6.2	4.8
6-2	2.7	7.9	5.0	63.3	1.6	3.4	6.3	4.9
6-3	2.7	7.9	4.9	62.0	1.1	3.8	6.8	5.3
6-Average	**2.7**	**7.8**	**4.9**	**63.0**	**1.4**	**3.5**	**6.4**	**5.0**
7-1	2.7	7.3	3.8	52.0	ND	2.2	ND	2.2
7-2	2.8	7.1	3.9	54.9	ND	2.2	ND	2.2
7-3	2.6	6.8	3.3	48.5	1.7	1.6	5.1	3.4
7-Average	**2.7**	**7.1**	**3.7**	**51.8**	**1.7**	**2.0**	**5.1**	**2.6**
8-1	2.0	8.0	7.0	87.5	2.9	4.1	5.1	4.6
8-2	2.2	7.0	2.9	41.4	0.0	2.9	7.0	5.0
8-3	2.0	7.2	6.1	84.7	1.7	4.4	5.5	5.0
8-Average	**2.1**	**7.4**	**5.3**	**71.2**	**1.5**	**3.8**	**5.9**	**4.9**
9-1	2.0	6.5	5.1	78.5	1.8	3.3	4.7	4.0
9-2	2.1	7.8	6.5	83.3	2.5	4.0	5.3	4.7
9-3	2.2	6.6	4.6	69.7	1.3	3.3	5.3	8.6
9-Average	**2.1**	**7.0**	**5.4**	**77.2**	**1.9**	**3.5**	**5.1**	**5.8**
10-1	3.8	6.4	5.1	79.7	2.2	2.9	4.2	3.6
10-2	3.7	6.0	4.0	66.7	2.2	1.8	3.8	2.8
10-3	3.7	6.2	3.4	54.8	1.4	2.0	4.8	3.4
10-Average	**3.7**	**6.2**	**4.2**	**67.1**	**1.9**	**2.2**	**4.3**	**3.3**
Average	**2.6**	**6.9**	**4.4**	**63.0**	**1.7**	**2.8**	**5.3**	**4.1**

(1) All water depths have been normalized such that they measure depths below 565.30 IGLD.
(2) Three vibracores were taken at each of ten locations.
(3) ND - not determined.
(4) Drilling locations shown in Figure 4-2.

TABLE 4-3

Summary of Inlet Soft Sediment Depth Probes
Task 5

Probe Number	Elevation at Ground Surface	Penetration Depth (ft)	Interpreted Elevation Bottom of Soft Sediment (ft MSL)	Estimated Thickness of Soft Sediments (ft)	Comments
1	564.4	5.3	559.1	5.3	
2	564.4	5.8	558.6	5.8	
3	564.4	5.1	559.3	5.1	
4	564.5	5.5	559.0	5.5	
5	564.3	3.9	560.4	3.9	
6	564.5	5.8	558.7	5.8	
7	564.4	6.5	557.9	6.5	
8	564.0	4.8	559.2	4.7	
9	564.2	5.4	558.8	5.4	
10	564.2	5.1	559.1	5.1	
11	564.0	6.0	558.0	6.0	
12	563.6	4.7	558.9	4.7	
13	564.3	4.9	559.4	4.9	
14	564.2	4.2	560.0	4.2	
15	564.3	6.3	558.0	6.3	
16	564.2	5.7	558.5	5.7	
17	564.5	6.2	558.3	6.2	
18	564.4	5.9	558.5	5.9	
19	564.6	5.1	559.5	5.1	
20	563.5	4.0	559.5	4.0	
21	563.8	7.2	556.6	7.2	
22	564.4	7.3	557.1	7.3	
23	564.1	4.5	559.6	4.5	
24	563.9	7.9	556.0	7.9	
25	564.1	5.6	558.5	5.6	
26	561.9	3.2	558.7	3.2	
27	563.7	4.5	559.2	4.5	
28	563.0	4.5	558.5	4.5	
29	562.8	6.0	556.8	6.0	
30	563.6	4.5	559.1	4.5	
31	563.7	3.9	559.8	3.9	
32	563.4	3.7	559.7	3.7	
33	567.8	5.0	562.8	5.0	
34	568.2	4.0	564.2	4.0	
35	568.9	15.0	553.9	10.0	5.0' of overlying fill
36	567.2	8.0	559.2	7.0	1.0' of overlying fill
37	566.4	1.0	565.4	1.0	
38	567.2	8.5	558.7	8.0	0.5' of overlying fill
39	566.1	5.8	560.3	5.8	
40	566.5	7.5	559.0	7.0	0.5' of overlying fill
41	565.7	7.0	558.7	7.0	

TABLE 4-3 (continued)

Summary of Inlet Soft Sediment Depth Probes
Task 5

Probe Number	Elevation at Ground Surface	Penetration Depth (ft)	Interpreted Elevation Bottom of Soft Sediment (ft MSL)	Estimated Thickness of Soft Sediments (ft)	Comments
			(continued)		
42	566.1	7.5	558.6	7.0	0.5' of overlying fill
43	566.5	8.0	558.5	6.5	1.5' of overlying fill
44	565.9	7.5	558.4	6.5	1.0' of overlying fill
45	566.0	9.0	557.0	5.0	4.0' of overlying fill
46	564.4	5.0	559.4	4.5	0.5' of overlying fill
47	564.1	5.5	558.6	5.5	
48	566.0	9.0	557.0	5.0	4.0' of overlying fill
49	564.5	2.0	562.5	2.0	
50	566.2	6.0	560.2	6.0	
51	565.8	6.0	559.8	6.0	
52	565.7	10.5	555.2	6.0	4.5' of overbank dep
53	566.8	8.5	558.3	6.0	2.5' of overbank dep
54	566.0	6.0	560.0	2.0	4.0' of overlying fill
Average	564.9	6.0	559.0	5.4	

Note:

1. Estimated thickness of soft sediment is based on penetration resistance and recovery of clay underlying the soft sediment.
2. Presence of fill or overbank deposits overlying the soft sediment is inferred from boring and geologic cross sections.
3. Probe locations shown on Figure 4-3.

TABLE 4-4
PROXIMITY OF BORINGS TO THE LWL
TASKS 4 AND 6

Boring	Approximate Distance Between Boring and LWL (ft)	Elevation Top of LWL (ft MSL)	Depth to Top of LWL (ft)	Elevation Invert of LWL (ft MSL)	Depth to Invert of LWL (ft)
IW-3	12	547.7	16.7	543.7	20.7
IW-5	13	547.7	18.0	543.7	22.0
WL-1	3	554.0	21.2	550.0	25.2
WL-1A	2	554.0	21.2	550.0	25.2
WL-2	3	549.3	16.1	545.3	20.1
WL-3	3	545.3	19.0	541.3	23.0
WL-4	4	540.7	22.8	536.7	26.8
WL-5	3	552.3	15.1	548.3	19.1

Note: Lockport Water Line (LWL) elevation and depth information from OSI, Inc., 1988.

Boring locations shown on Figure 4-1. All borings were located south of the LWL, except for IW-3 and WL-3, which were north.

TABLE 4-5
SUMMARY OF INLET COVE BORINGS
TASKS 3, 4, AND 6

Boring	Total Depth	Ground Elevation	FILL Depth Range	FILL Thickness	SOFT SEDIMENT Depth Range	SOFT SEDIMENT Elevation Top of Unit	SOFT SEDIMENT Thickness	SILT-CLAY FILL Depth Range	SILT-CLAY FILL Elevation Top of Unit	SILT-CLAY FILL Thickness
*I-2	18.0	569.0	0.0-3.0	3.0	3.0-10.0	565.5	7.0	-----	-----	-----
*I-3	75.0	569.0	0.0-5.0	5.0	5.0-7.0	564.0	2.0	7.0-14.0	562.0	7.0
*I-15	14.0	569.2	0.0-4.0	4.0	4.0-9.5	565.2	5.5	9.5-12.0	559.7	2.5
*I-24	8.0	566.5	-----	0	0.0-2.6	566.5	2.6	2.5-8.0+	563.9	>5.4
*I-25	18.0	568.3	0.0-2.0	2.0	2.0-10.6	566.3	8.6	10.6-14.0	557.7	3.4
*I-27	22.0	569.5	0.0-4.0	4.0	4.0-10.6	565.6	6.6	10.6-14.0	559.0	3.4
IW-1	31.0	564.5	-----	0	0.0 - 4.7	564.5	4.7	4.7 - 9.5	559.8	4.8
IW-2	27.5	560.6	-----	0	0.0 - 3.9	560.0	3.9	3.9 - 9.0	556.7	5.1
IW-3	34.0	564.4	-----	0	0.0 - 8.0	564.1	8.0	8.0 - 22.8	556.4	14.8
IW-4	19.0	561.9	-----	0	0.0 - 0.8	561.9	0.8	0.8 - 6.2	561.1	5.4
IW-5	35.4	565.7	-----	0	0.0 - 9.4	565.7	9.4	9.4 - 24.1	556.3	14.7
IW-6	17.5	565.6	-----	0	0.0 - 7.5	565.6	7.5	-----	-----	0
*MW-8	36.5	569.2	0.0-8.0	8.0	8.0-12.8	561.2	4.8	-----	-----	-----
*MW-9	30.0	568.7	0.0-4.0	4.0	4.0-12.0	564.7	8.0	-----	-----	-----
WL-1	30.0	575.2	0.0 - 8.8	8.8	-----	-----	0	-----	-----	0
WL-1A	32.0	565.2	0.0 - 8.8	8.8	-----	-----	0	8.8 - 22.0	556.4	13.2
WL-2	32.0	565.4	-----	0	0.0 - 8.0	565.4	8.0	8.0 - 19.9	557.4	11.9
WL-3	32.0	564.3	-----	0	0.0 - 6.0	564.3	6.0	6.0 - 23.3	558.3	17.3
WL-4	42.0	563.5	-----	0	0.0 - 6.0	563.5	6.0	6.0 - 22.4	557.5	16.4
WL-5	27.0	567.4	-----	0	0.0 - 10.0	565.4	10.0	10.0 - 19.0	557.4	9.0

Boring	BEDDING Depth Range	BEDDING Elevation Top of Unit	BEDDING Thickness	ALLUVIUM Depth Range	ALLUVIUM Elevation Top of Unit	ALLUVIUM Thickness	GLACIO-LACUSTRINE CLAY Depth Range	GLACIO-LACUSTRINE CLAY Elevation Top of Unit	GLACIO-LACUSTRINE CLAY Thickness	TILL Depth	TILL Elevation Top of Unit	TILL Thickness
*I-2	-----	-----	-----	10.0-13.5	559.0	3.5	13.5-18.0+	555.5	>4.5	-----	-----	-----
*I-3	-----	-----	-----	-----	-----	-----	14.0-27.0	555.0	13.0	27.0-74.0	542.0	47.0
*I-15	-----	-----	-----	-----	-----	-----	12.0-14.0+	557.2	>2.0	-----	-----	-----
*I-24	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
*I-25	-----	-----	-----	-----	-----	-----	14.0-18.0+	554.3	>4.0	-----	-----	-----
*I-27	-----	-----	-----	14.0-16.6	555.6	2.6	16.6-20.0+	553.0	>3.4	-----	-----	-----
IW-1	-----	-----	0	9.5 - 23.5	555.0	14.0	-----	-----	0	23.5 - 31.0+	541.0	>7.5
IW-2	-----	-----	0	9.0 - 19.5	551.6	10.5	-----	-----	0	19.5 - 27.5+	541.1	>8.0
IW-3	22.8 - 25.7	541.6	2.9	-----	-----	0	-----	-----	0	25.7 - 34.0+	538.7	>8.3
IW-4	-----	-----	0	-----	-----	0	6.2 - 19.0+	555.7	>12.8	-----	-----	-----
IW-5	24.1 - 29.8	541.6	5.7	-----	-----	0	-----	-----	0	29.8 - 35.4+	535.9	>5.6
IW-6	-----	-----	0	7.5 - 13.0	558.1	5.5	13.0 - 17.5+	552.6	>4.5	-----	-----	-----
*MW-8	-----	-----	-----	12.8-21.0	556.4	8.2	21.0-27.3	548.2	6.3	27.3-36.5+	541.9	>9.2
*MW-9	-----	-----	-----	12.0-14.0	556.7	2	14.0-26.5	554.7	12.5	26.5-30.0+	542.2	>3.5
WL-1	-----	-----	0	-----	-----	0	8.8 - 30.0+	566.4	>21.2	-----	-----	-----
WL-1A	22.0 - 24.0	553.2	2.0	-----	-----	0	24.0 - 32.0+	541.2	>8.0	-----	-----	-----
WL-2	19.9 - 24.0	545.5	4.1	-----	-----	0	-----	-----	0	24.0 - 32.0+	541.4	>8.0
WL-3	23.3 - 25.9	541.0	2.6	-----	-----	0	-----	-----	0	25.9 - 32.0+	538.4	>6.1
WL-4	22.4 - 27.0	541.1	4.6	-----	-----	0	-----	-----	0	27.0 - 42.0+	536.5	>15.0
WL-5	19.0 - 19.9	548.4	0.9	-----	-----	0	19.9 - 25.0	547.5	5.1	25.0 - 27.0+	542.4	>2.0

NOTES:
1. See Table 4-1 for Inlet perimeter stratigraphy for borings with *.
2. Depth range and thickness in feet.
3. Elevation in feet above mean sea level (amsl).
4. Drilling locations shown on Figure 4-1.

TABLE 4-6A

SUMMARY OF GEOTECHNICAL LABORATORY ANALYSES
DENSITY

Boring	Sample	Mid-Depth (ft)	Unit	Natural Water Content, (%)	Density Dry (Pcf)	Density Wet (Pcf)
WL-4	U-5d	15.0	Silt-Clay Fill	13.3	124.0	140.5
	U-5e	15.0	Silt-Clay Fill	13.7	122.5	139.2
	U-5f	15.0	Silt-Clay Fill	13.6	121.7	138.2
IW-6	U-7c	16.5	Glacio-Lacustrine Clay	41.8	78.4	111.2
	U-7d	16.5	Glacio-Lacustrine Clay	42.1	78.9	112.1
IW-1	U-10c	26.0	Glacial Till	16.6	112.9	131.6
	U-10d	26.0	Glacial Till	15.5	121.2	140.0

TABLE 4-6B

SUMMARY OF GEOTECHNICAL LABORATORY ANALYSES
ATTERBERG LIMITS

Boring	Sample	Mid-Depth (ft)	Unit	Natural Water Content %	Liquid Limit %	Plastic Limit %	Plasticity Index %
2	212	1.3	Soft Sediment	55.1	51	26	25
3	322	1.3	Soft Sediment	104.6	80	41	39
	332B	1.3	Soft Sediment	68.5	61	30	31
	332C	1.3	Soft Sediment	19.3	23	14	9
5	522A	1.3	Soft Sediment	57.6	53	32	21
	522B	1.3	Soft Sediment	43.5	52	21	30
	Comp.	2.8	Soft Sediment	67.9	49	31	18
6	Comp.	2.8	Soft Sediment	64.9	49	31	18
8	Comp.	2.8	Soft Sediment	71.4	46	31	15
IW-2	S-2	7.0	Silt-Clay Fill	44.3	61	25	36
WL-4	U-5	15.0	Silt-Clay Fill	17.9	19	13	6
I-1	S-13	25.0	Glacio-Lacustrine Clay	---	48	22	26
I-3	S-10	19.0	Glacio-Lacustrine Clay	---	42	21	22
IW-6	S-6g	15.0	Glacio-Lacustrine Clay	42.5	50	23	27
	U-7b	16.5	Glacio-Lacustrine Clay	43.6	46	20	26
I-1	S-17	33.0	Glacial Till	---	20	12	7
I-21	S-20	39.0	Glacial Till	---	21	11	9
	S-25b	49.0	Glacial Till	---	21	10	11
I-3	S-16	31.0	Glacial Till	---	22	12	10
	S-22	43.0	Glacial Till	---	24	13	11
IW-1	U-10b	26.0	Glacial Till	24.7	22	14	9
IW-2	S-12g	26.8	Glacial Till	12.7	23	13	10
MW-5D	S-6	35.0	Glacial Till	18.4	29	15	14
WL-4	S-19	39.0	Glacial Till	20.2	25	14	11

TABLE 4-6C

SUMMARY OF GEOTECHNICAL LABORATORY ANALYSES GRADATION

Boring	Sample	Mid-Depth (ft)	Unit	Natural Water Content %	Gravel %	Sand %	Silt %	Clay %
2	212	1.3	Soft Sediment	55.1	---	36	52	12
3	322	1.3	Soft Sediment	104.6	---	20	58	22
5	522A	1.3	Soft Sediment	57.6	---	14	70	16
	522B	1.3	Soft Sediment	43.5	---	2	30	68
	Comp.	2.8	Soft Sediment	67.9	---	0	74	26
6	Comp.	2.8	Soft Sediment	64.9	---	0	78	22
8	832	1.3	Soft Sediment	61.8	---	62	32	6
	Comp.	2.8	Soft Sediment	71.4	---	30	52	18
I-15	S-6	11.0	Fill	---	1	11	39	49
I-19	S-4	7.0	Fill	---	39	18	42	NT
MW-5D	S-1	6.0	Fill	51.2	78	21	1	NT
IW-3	S-3	15.0	Silt-Clay Fill	---	1	1	35	63
IW-4	S-1	4.0	Silt-Clay Fill	---	5	3	31	61
WL-4	S-3	11.8	Silt-Clay Fill	37.3	11	15	38	36
	U-5	15.0	Silt-Clay Fill	17.9	18	23	59	NT
I-11	S-4	7.0	Alluvium	---	0	82	18	NT
	S-5	9.0	Alluvium	---	17	61	23	NT
	S-7	13.0	Alluvium	---	0	73	27	NT
	S-11	21.0	Alluvium	---	31	61	8	NT
I-21	S-8	15.0	Alluvium	---	4	81	15	NT
	S-11	21.0	Alluvium	---	5	91	4	NT
	S-16	31.0	Alluvium	---	33	61	6	NT
I-9	S-6	11.0	Alluvium	---	19	37	44	NT
	S-11	21.0	Alluvium	---	16	74	10	NT
MW-5D	S-3	15.0	Alluvium	23.6	9	90	2	NT
I-15	S-7	13.0	Glacio-Lacustrine Clay	---	0	4	39	57
I-16	S-11	21.0	Glacio-Lacustrine Clay	---	8	9	83	NT

NT = not tested
(Silt is total Silt & Clay)

TABLE 4-6D

SUMMARY OF GEOTECHNICAL LABORATORY ANALYSES
UNDRAINED SHEAR STRENGTH, SU

Boring	Sample	Mid-Depth (ft)	Unit	Natural Water Content (%)	Pocket Penetro-meter (Ksf)	Torvane (Ksf)	UU (Ksf)	CU (Ksf)	CP (Ksf)
IW-1	U-10c	26.0	Glacial Till	16.6	0.00	0.20	0.22	---	1.01
	U-10d	26.0	Glacial Till	15.5	0.00	---	---	0.86	0.43
	U-10e	26.0	Glacial Till	22.4	0.67	0.86	---	---	---
IW-2	S-2	7.0	Silt-Clay Fill	---	0.00	0.16	---	---	---
	U-11a	25.0	Glacial Till	16.7	0.00	0.40	---	---	---
	U-11b	25.0	Glacial Till	18.2	0.00	0.20	---	---	---
	U-11d	25.0	Glacial Till	15.5	1.03	0.64	---	---	---
	S-12	26.8	Glacial Till	12.7	1.00	---	---	---	---
	S-12g	26.8	Glacial Till	12.7	1.68	0.80	---	---	---
IW-3	S-3	15.0	Silt-Clay Fill	---	0.00	---	---	---	---
	S-4	17.0	Silt-Clay Fill	45.8	0.00	0.20	---	---	---
IW-4	S-1	4.0	Silt-Clay Fill	---	0.00	---	---	---	---
IW-6	S-6g	15.0	Glacio-Lacustrine Clay	42.5	0.00	0.20	---	---	---
	U-7b	16.5	Glacio-Lacustrine Clay	43.6	0.25	---	---	---	---
	U-7c	16.5	Glacio-Lacustrine Clay	41.8	0.63	0.64	0.43	---	0.52
	U-7d	16.5	Glacio-Lacustrine Clay	42.1	---	---	---	0.42	0.52
	U-7e	16.5	Glacio-Lacustrine Clay	57.1	0.00	0.48	---	---	---
WL-4	S-4	13.3	Silt-Clay Fill	---	0.93	0.60	---	---	---
	U-5a	15.0	Silt-Clay Fill	12.7	0.67	0.92	---	---	---
	U-5d	15.0	Silt-Clay Fill	13.3	---	---	0.35	---	1.73
	U-5e	15.0	Silt-Clay Fill	13.7	---	---	---	1.29	1.73
	U-5f	15.0	Silt-Clay Fill	13.6	---	---	---	0.75	0.43
	U-20a	41.0	Glacial Till	25.5	0.00	0.20	---	---	---
	U-20b	41.0	Glacial Till	32.7	0.00	0.20	---	---	---
	U-20h	41.0	Glacial Till	24.8	0.10	0.44	---	---	---
	U-20i	41.0	Glacial Till	22.5	0.23	---	---	---	---

UU = Unconsolidated, Undrained Triaxial; CU = Consolidated, Undrained Triaxial; CP = Confining Pressure.

TABLE 4-6E

SUMMARY OF GEOTECHNICAL LABORATORY ANALYSES
HYDRAULIC CONDUCTIVITY

Boring	Sample	Mid-Depth (ft)	Unit	Permeability (cm/sec)
WL-4	U-5f	15.0	Silt-Clay Fill	5.0E -08
IW-6	U-7d	16.5	Glacio-Lacustrine Clay	7.3E -08
IW-1	U-10d	26.0	Glacial Till	1.4E -07

TABLE 4-6F

SUMMARY OF WATER CONTENTS - SOFT SEDIMENT

Sample	Mid-Depth (ft)	Moisture (M) %, Total Sample Basis	Water Content (WC) %, Solids Basis
101	0.3	43	75
201	0.3	40	67
301	0.3	47	89
401	0.3	45	82
501	0.3	37	59
601	0.3	64	178
701	0.3	61	156
801	0.3	48	92
901	0.3	47	89
1001	0.3	53	113
102	1.3	32	47
403	3.5	38	61
702	1.3	34	52
1002	1.3	28	39

Note:

Moisture data (percent total sample basis) were provided by OCC as part of chemical laboratory analyses of vibracore Soft Sediment samples. Values were converted to geotechnical water content by use of the following equation:

$$WC = (100 \times M) / (100 - M)$$

TABLE 4-7
GENERAL COMMENTS ON GEOLOGIC CROSS-SECTIONS

North - South Sections (listed West to East)

D-D'
- Soft Sediment is in lateral contact with fill and possibly alluvium.
- Soft Sediment is relatively thinner in south central part of Inlet.
- Soft Sediment is buried at south side of Inlet, and possibly extends above and south of NTWL.
- Top of bedding is co-planar with top of till.
- Depression exists in till surface at I-4.

G-G'
- Soft Sediment is in lateral contact with alluvium.
- Soft Sediment is buried at south side of Inlet, and north of NTWL.
- Soft Sediment is possibly buried at north edge of Inlet.
- Bedding is confined laterally by glacio-lacustrine clay (GLC) and till.
- Top of confining clay surface slopes to the north

E-E'
- Section E-E' is similar to Section G-G', but the depth of confinement of the bedding in clay is greater than in section G-G.'

M-M'
- Section M-M' is similar to Section E-E', but Soft Sediment is thicker at south side of Inlet, and is in closer proximity to the NTWL than in Section E-E'.
- LWL trench is confined by GLC.

F-F'
- Section F-F' is similar to Section M-M', but alluvium is not present at LWL trench in F-F'.
- Soft Sediment is thickest at the south side of Inlet.

K-K'
- Soft Sediment is completely confined by clay, has its greatest thickness at WL-5, and is buried under south shore.
- LWL trench is confined in GLC.

East - West Sections (listed North to South)

J-J'
- A depression is evident in the till surface at I-22.
- The elevation of till at MW-2D is 540 feet, approximately 6 feet below River bottom.

L-L'
- Section L-L' is similar to Section J-J', but L-L' shows the GLC pinch-out and topographic high on the till surface..

A-A'
- Section A-A' displays a complete representation of the alluvium wedge and the GLC erosional surface. A topographic high may exist on the till surface west of I-4 to help explain why DNAPL has accumulated at MW-5I.

B-B'
- Section B-B' is along the LWL and shows the slope of bedding toward the River and the incision of the LWL trench into till.

C-C'
- Section C-C'shows the complexity of stratigraphy along the south side of the Inlet.

H-H'
- Section H-H' shows a projection of the NTWL. A possible depression exists in the GLC surface in the vicinity of I-7.

TABLE 5-1

Summary of Monitoring Well Construction Details

Monitoring Well	Unit	Elev. Meas. Pt.	Elev. Ground	Depth Top/Seal	Depth Top/Sand	Depth Top/Screen	Depth Bot/Screen	Depth Bot/Sand	Depth Well	Length Seal	Length Screen
MW1											
S	Alluvium	573.10	573.4	4.0	6.0	6.5	11.5	12.0	11.5	2.0	5.0
I	Alluvium	572.62	573.3	18.3	21.5	23.5	33.5	40.0	33.5	3.2	10.0
D	Till	572.83	573.6	37.0	40.5	42.5	52.5	53.0	52.5	3.5	10.0
MW2											
S	Fill	573.15	573.4	4.0	6.0	6.5	11.5	12.2	11.5	2.0	5.0
I	Alluvium, Gl. Clay	573.53	573.6	17.6	21.8	23.8	33.8	34.9	33.8	4.2	10.0
D	Till	572.89	573.4	34.9	37.9	39.8	49.8	50.5	49.8	3.0	10.0
MW3											
I	Alluvium, Gl. Clay	573.21	573.5	10.7	13.8	15.8	25.8	26.5	25.8	3.1	10.0
D	Gl. Clay	573.22	573.6	20.7	26.0	27.6	32.6	38.0	32.6	5.3	5.0
MW4											
S	Alluvium	572.72	573.1	3.5	5.0	5.5	10.5	10.5	10.5	1.5	5.0
I	Alluvium, Gl. Clay	572.67	573.1	3.8	13.1	13.5	15.5	18.0	15.5	9.3	2.0
MW5											
S	Alluvium	571.01	571.5	3.9	6.0	7.1	12.1	12.8	12.1	2.1	5.0
I	Alluvium, Till	570.38	571.1	16.2	20.0	21.8	31.8	32.5	31.8	3.8	10.0
D	Gl. Clay	570.42	570.9	34.0	37.0	39.0	49.0	50.0	49.0	3.0	10.0
MW6											
I	Alluvium, Gl. Clay	569.92	570.3	6.5	9.4	10.8	20.8	22.0	20.8	2.9	10.0
MW7											
S	Gl. Clay	570.57	570.9	4.0	6.5	7.0	17.0	18.0	17.0	2.5	10.0
MW8											
S	Fill/Soft Sed.	568.83	569.4	3.5	4.9	5.5	10.5	11.0	10.5	1.4	5.0
I	Alluvium	568.54	569.2	11.0	14.0	16.0	21.0	21.2	21.0	3.0	5.0
D	Gl. Clay, Till	569.01	569.2	10.0	24.0	26.0	36.0	36.5	36.0	14.0	10.0
MW9											
S	Fill	568.43	568.7	4.0	5.0	5.5	10.5	10.5	10.5	1.0	5.0
D	Gl. Clay, Till	568.50	568.7	14.0	17.0	19.5	29.5	30.0	29.5	3.0	10.0
MW10											
D	Gl. Clay	572.13	572.6	9.5	12.5	14.5	24.5	26.0	24.5	3.0	10.0
MW11											
S	Alluvium	569.80	569.9	4.0	6.5	7.0	9.0	9.5	9.0	2.5	2.0
I	Alluvium	570.01	570.1	9.4	12.4	12.9	17.2	18.0	17.2	3.0	5.0
MW12											
S	Fill/Gl. Clay	576.05	574.0	1.0	2.0	2.7	8.0	8.4	8.4	1.0	5.3
D	Gl. Clay	572.93	573.2	9.4	12.5	15.0	25.0	26.0	25.0	3.1	10.0
MW13											
S	Fill	578.42	573.2	1.0	2.5	3.4	8.7	9.0	9.0	1.5	5.3
D	Gl. Clay	574.89	575.3	15.0	18.0	20.0	30.0	31.0	30.0	3.0	10.0
MW14											
S	Alluvium	570.37	570.9	3.5	5.5	6.0	11.0	12.0	11.0	2.0	5.0

Well locations shown on Figure 4-1.

TABLE 5-2

FIELD HYDRAULIC CONDUCTIVITIES
Bail Tests - Hvorslev Method

Well	Stratigraphic Unit Screened	Depth of Screened Interval	Horizontal Hydraulic Conductivity cm/sec	ft/day
MW-2S	Fill	6.6' - 11.5'	2.56 x 10 E-1	7.27 x 10 E+2
MW-9S	Fill	5.5' - 10.5'	1.34 x 10 E-3	0.38 x 10 E+1
MW-8S	Fill/Soft Sediment	5.5' - 10.5'	2.64 x 10 E-4	7.48 x 10 E-1
MW-1S	Fill/Alluvium	6.5' - 11.5'	3.39 x 10 E-2	9.61 x 10 E+1
MW-1I	Fill/Alluvium	23.5' - 33.5'	7.45 x 10 E-3	2.11 x 10 E+1
MW-4S	Fill/Alluvium	5.5' - 10.5'	1.56 x 10 E-3	0.44 x 10 E+1
MW-5S	Fill/Alluvium	7.1' - 12.1'	1.92 x 10 E-3	0.54 x 10 E+1
MW-5I	Fill/Alluvium	21.8' - 31.8'	2.37 x 10 E-3	0.67 x 10 E+1
MW-8I	Fill/Alluvium	16.0' - 21.0'	5.56 x 10 E-3	1.58 x 10 E+1
MW-11S	Fill/Alluvium	7.0' - 9.0'	3.07 x 10 E-3	0.87 x 10 E+1
MW-11I	Fill/Alluvium	12.9' - 17.2'	7.40 x 10 E-4	0.21 x 10 E+1
MW-14S	Fill/Alluvium	6.0' - 11.0'	5.13 x 10 E-5	1.45 x 10 E-1
MW-3I	Fill/Alluvium/Glacio-Lacustrine Clay	15.8' - 25.8'	5.13 x 10 E-3	1.46 x 10 E+1
MW-4I	"	13.5' - 15.5'	1.10 x 10 E-4	3.10 x 10 E-1
MW-6I	"	10.8' - 20.8'	1.75 x 10 E-3	0.49 x 10 E+1
MW-3D*	Glacio-Lacustrine Clay	27.6' - 32.6'	6.29 x 10 E-7	1.78 x 10 E-3

Geometric Mean Horizontal Hydraulic Conductivity

Unit	Geometric Mean cm/sec	ft/day
Fill	1.85 x 10 E-2	5.24 x 10 E-1
Fill/Soft Sediment	2.64 x 10 E-4	7.48 x 10 E-1
Fill/Alluvium	2.17 x 10 E-3	6.15 x 10 °
Fill/Alluvium, Glacio-Lacustrine Clay	9.96 x 10 E-4	2.82 x 10 °
Glacio-Lacustrine Clay	6.29 x 10 E-7	1.78 x 10 E-3

* Note: Results for MW-3D are from a slug test.

TABLE 5-3

SUMMARY OF PIEZOMETER MEASUREMENTS

	DATE											
Piezometer	7/12/89	7/12/89	7/13/89	7/24/89	7/25/89	7/25/89	7/26/89	8/2/89	8/2/89	8/3/89	8/3/89	8/4/89
I-21	565.51	565.32	565.46	565.49	565.57	565.45	565.62	565.62	565.94	565.69	565.65	565.65
I-22	565.49	565.32	565.47	565.58	565.58	565.54	565.62	565.60	565.85	565.69	565.66	565.89
I-28	565.59	565.57	565.60	565.61	565.61	565.53	565.69	565.78	565.86	565.75	565.73	565.72
River Staff Gage	565.49	565.23	565.42	565.45	565.63	565.36	565.57	565.62	565.82	565.68	565.61	565.61

	DATE								
Piezometer	8/7/89	8/8/89	8/9/89	8/9/89	8/10/89	8/10/89	8/10/89	8/11/89	8/11/89	**MEAN**
I-21	565.50	565.44	565.54	565.49	565.52	565.51	565.43	565.49	565.46	**565.48**
I-22	565.50	565.45	565.53	565.50	565.49	565.53	565.45	565.49	565.48	**565.53**
I-28	565.55	565.56	565.53	565.58	565.50	565.58	565.54	565.45	565.55	**565.59**
River Staff Gage	565.51	565.41	565.55	565.45	565.56	565.48	565.38	565.55	565.40	**565.51**

Notes:

1. Piezometers were temporary and have been removed.
2. All elevations are MSL.
3. Piezometer locations are shown on Figure 4-1.

TABLE 5-4

SUMMARY OF GROUNDWATER LEVEL MEASUREMENTS

Monitoring Well	WATER ELEVATIONS AND DATE										
	3/27/90	4/4/90	5/7/90	5/15/90	5/24/90	5/30/90	6/5/90	6/18/90	7/18/90	8/6/90	9/13/90
MW-1S	565.05	565.92	565.72	565.50	565.44	565.33	565.52	565.70	565.50	565.41	565.40
MW-1I	565.20	565.96	565.79	565.62	565.58	565.43	565.59	565.74	565.51	565.53	565.42
MW-1D	561.42	563.23	562.03	563.88	564.73	564.97	565.15	565.19	561.12	565.14	565.13
MW-2S	564.97	565.94	565.70	565.46	565.43	565.24	565.51	565.70	565.50	565.39	565.40
MW-2I	565.10	566.00	565.77	565.58	565.52	565.35	565.54	565.71	565.49	565.21	565.41
MW-2D	562.22	564.61	558.17	561.78	563.65	564.34	564.72	565.04	565.05	565.06	565.19
MW-3I	565.50	566.01	565.88	565.86	565.91	565.74	565.77	565.82	565.51	565.44	565.42
MW-3D	565.78	565.85	565.48	565.76	565.87	565.66	565.73	565.74	565.49	565.46	565.47
MW-4S	567.06	566.80	566.91	567.72	567.44	567.04	566.90	566.64	566.19	566.07	566.00
MW-4I	566.69	566.50	566.63	566.90	567.06	566.72	566.64	566.43	566.02	565.91	565.87
MW-5S	565.02	565.90	565.82	565.62	565.51	566.03	565.51	565.69	565.44	565.40	565.46
MW-5I	565.08	565.95	565.82	565.60	565.55	564.77	565.50	565.70	565.41	565.38	565.43
MW-5D	562.85	564.16	561.56	563.84	564.78	565.07	565.25	565.22	565.15	565.25	565.32
MW-6I	564.56	565.97	565.90	565.85	565.90	565.73	565.86	565.81	565.47	565.43	565.42
MW-7S	566.46	566.16	565.52	566.44	566.47	566.30	566.24	565.68	566.05	566.05	566.12
MW-8S	564.94	565.60	565.73	565.52	565.43	565.35	565.51	565.68	565.43	565.40	564.38
MW-8I	564.95	565.96	565.77	565.59	565.43	565.29	565.51	565.66	564.64	565.35	565.38
MW-8D	564.95	564.97	565.12	565.31	565.31	565.23	565.96	565.26	565.86	565.21	565.31
MW-9S	565.15	565.94	565.69	565.62	565.53	565.49	565.56	565.54	565.24	565.25	565.15
MW-9D	565.21	565.32	565.45	565.53	565.57	565.59	565.61	565.51	565.54	565.65	565.76
MW-10D	565.07	565.39	565.01	565.36	565.57	565.75	565.82	565.99	566.16	566.39	566.63
MW-11S	565.03	565.92	565.74	565.56	565.48	565.34	565.51	565.68	565.40	565.36	565.33
MW-11I	565.01	565.82	565.80	565.62	565.48	565.33	565.61	565.68	565.41	565.43	565.35
MW-12S	NA	NA	NA	NA	NA	NA	NA	NA	NA	566.90	<564.45
MW-12D	565.45	565.87	565.43	565.70	565.86	566.01	566.11	566.32	566.42	566.53	566.75
MW-13S	NA	NA	NA	NA	NA	NA	NA	NA	NA	567.49	567.29
MW-13D	566.11	566.16	566.16	566.33	566.49	566.54	566.56	566.51	566.65	566.65	566.76
MW-14S	565.59	566.08	566.02	565.94	566.07	565.70	565.84	565.71	565.29	565.16	565.03
SG-1 INL	565.04	565.98	565.77	565.47	565.42	565.28	565.46	565.71	565.51	565.41	565.46
SG-2 RIV	564.99	565.94	565.79	565.51	565.45	565.35	565.42	565.72	565.52	565.44	565.47
SG-1 INL	564.96	565.93	565.84	NA	565.41	565.30	565.41	565.65	565.40	565.36	565.48
SG-2 RIV	564.94	565.85	565.87	565.57	564.42	565.35	565.42	565.72	565.42	565.42	565.50

Notes:

1. Monitoring well locations are shown on Figure 4-1.
2. Elevations are MSL.
3. NA - Not available.
4. Staff gage (SG) measurements were made at beginning and end of each survey.

TABLE 5-5
HYDRAULIC GRADIENT
VERTICAL COMPONENT

A. S AND I WELLS (Fill/ Alluvium)

Well I.D.	Unit	Well Screen Elevation (A)	(B)	dL (A) - (B)	Well Water Level (A)	(B)	dH (A) - (B)	Gradient dH/dL
MW-1S	Alluvium	564.4		19.6	565.53		-0.06	-0.0031
MW-1I	Alluvium		544.8			565.59		
MW-2S	Fill	564.4		19.6	565.53		0.04	0.0020
MW-2I	Alluvium		544.8			565.49		
MW-4S	Alluvium	565.1		6.5	566.45		0.20	0.0308
MW-4I	Alluv., Gl. Clay		558.6			566.25		
MW-5S	Alluvium	561.9		17.6	565.51		0.01	0.0006
MW-5I	Alluv., Till		544.3			565.50		
MW-8S	Fill/Soft Sed.	561.4		10.7	565.51		0.22	0.0206
MW-8I	Alluvium		550.7			565.29		
MW-11S	Alluvium	561.9		6.8	565.49		-0.04	-0.0059
MW-11I	Alluvium		555.1			565.53		

B. S AND D WELLS (Fill/Alluvium and Clay/Till)

Well I.D.	Unit	Well Screen Elevation (A)	(B)	dL (A) - (B)	Well Water Level (A)	(B)	dH (A) - (B)	Gradient dH/dL
MW-1S	Alluvium	564.4		38.3	565.53		0.38	0.0099
MW-1D	Till		526.1			565.15		
MW-2S	Fill	564.4		35.8	565.53		0.56	0.0156
MW-2D	Till		528.6			564.97		
MW-5S	Alluvium	561.9		35.0	565.51		0.29	0.0083
MW-5D	Gl. Clay		526.9			565.22		
MW-8S	Fill/Soft Sed.	561.4		23.2	565.51		-0.06	-0.0026
MW-8D	Gl. Clay, Till		538.2			565.57		
MW-9S	Fill	560.7		16.5	565.40		-0.18	-0.0109
MW-9D	Gl. Clay, Till		544.2			565.58		

C. I AND D WELLS (Alluvium and Clay/Till)

Well I.D.	Unit	Well Screen Elevation (A)	(B)	dL (A) - (B)	Well Water Level (A)	(B)	dH (A) - (B)	Gradient dH/dL
MW-1I	Alluvium	544.8		18.7	565.59		0.44	0.0235
MW-1D	Till		526.1			565.15		
MW-2I	Alluvium	544.8		16.2	565.49		0.52	0.0321
MW-2D	Till		528.6			564.97		
MW-3I	Alluvium	552.7		9.2	565.64		0.03	0.0033
MW-3D	Gl. Clay		543.5			565.61		
MW-5I	Alluvium	544.3		17.4	565.50		0.28	0.0161
MW-5D	Gl. Clay		526.9			565.22		
MW-8I	Alluvium	550.7		12.5	565.29		-0.28	-0.0224
MW-8D	Gl. Clay, Till		538.2			565.57		

Notes:
1. Screen elevations are mid-screen, ft MSL. All distances in feet.
2. Water levels averaged for 6/5/90 - 8/6/90.
3. Downward gradients are positive.
4. Well locations are shown on Figure 4-1.

TABLE 5-6
GROUNDWATER FLOW RATE CALCULATIONS
FILL/ALLUVIUM AQUIFER

Flow Path	Hydraulic Conductivity K (ft/day)	Horizontal Gradient i (ft/ft) Average June-August 1990	Flow Velocity v (ft/day) Average June-August 1990	Flow Velocity v (ft/year) Average June-August 1990
Fill/Upper Alluvium				
A	1.13 x 10+1	3.23 x 10-3	1.22 x 10-1	4.45 x 10+1
B	1.13 x 10+1	4.00 x 10-3	1.51 x 10-1	5.51 x 10+1
C	1.13 x 10+1	7.75 x 10-3	2.92 x 10-1	1.07 x 10+2
D	7.48 x 10-1	1.88 x 10-2	4.69 x 10-2	1.71 x 10+1
Fill/Alluvium				
E	3.56 x 10+0	6.88 x 10-3	8.16 x 10-2	2.98 x 10+1
F	6.20 x 10+0	5.78 x 10-3	1.19 x 10-1	4.34 x 10+1
Lower Alluvium				
A	10.0 x 10+0	2.88 x 10-3	9.60 x 10-2	3.50 x 10+1
B	10.0 x 10+0	3.37 x 10-3	1.12 x 10-1	4.09 x 10+1

Notes:

1. Flow paths are shown on Figure 5-3S and 5-3I.
2. K for individual flow paths is a geometric mean of selected wells as follows:

S Wells - Paths A, B, C: MW-1S, 2S, 4S, 5S, 11S, 14S.
Path D: MW-8S.
S & I Wells - Path E: MW-8S, 8I, 9S.
Path F: MW-1S, 1I, 4S, 5S, 5I, 8I, 11S, 11I, 14S.
I Wells - Paths A & B: MW-1I, 3I, 5I, 6I.

3. Horizontal gradient component is shown for a short-term average (6/5/90-8/6/90). Use of a long-term average would be preferable, but data are unavailable.
4. Porosity, n, is estimated at 30%.
5. V = Ki/n.

TABLE 6-1

CHRONOLOGY OF CHEMICAL ANALYSES

OCC DUREZ INLET

Soft Sediment		Date	Analytical* Protocols
Vibracore Drilling		Jul 86	1
I-Series Borings	Phase I	Feb-Mar 88	2
	Phase II	Sep 88	2
	Phase III	Jun 89	2
MW-Series Wells	Phase IV	Dec 89 and Feb 90	2
PCF - Series Samples		Nov 90	
Soil		**Date**	
"DR" Series Subsurface Soil Samples		Nov 87	3
I-Series Borings	Phase I	Apr 88	2
	Phase II	Sep 88	2
	Phase III	Jun-Jul 89	2
HA Series Borings		Jul 89	2
IW-Series Borings		Nov 89	2
MW-Series Wells	Phase IV	Nov 89-Feb 90	2
WL-Series Borings		Dec 89 and Jan 90	2
Groundwater		**Date**	
MW-Series Wells	Round 1	Feb-Mar 90	4
	Round 2	Apr 90	4

***References:**

1. DUNN, Nov. 1985
2. DUNN, March 1988a; WOH, March 1988
3. DUNN, Oct. 1988
4. DUNN, Oct. 1989

TABLE 6-2

OBSERVED OR SUSPECTED NAPL

Boring	Unit	Depth to Top, ft	Depth to Bottom, ft	Thickness ft	Elevation of Top, ft MSL	Elevation of Mid-Point, ft MSL	Elevation of Bottom, ft MSL	Remarks
I. POTENTIALLY MOBILE NAPL OBSERVED:								
MW-5I	A	31.0	31.7	0.7	540.1	539.8	539.4	Brown NAPL pool 3.5' deep in well bottom
WL-2	SCF, B	10.8	24.0	13.2	554.6	548.0	541.4	Brown NAPL bailed from boring
WL-3	B	23.3	25.9	2.6	541.0	539.7	538.4	Brown NAPL bailed from boring
WL-5	SCF	11.0	15.0	4.0	556.4	554.4	552.4	Brown NAPL oozed from soil sample
WL-5	B	19.0	19.9	0.9	548.4	548.0	547.5	Brown NAPL oozed from soil sample
II. SMALL BLOBS AND GANGLIA OF NAPL OBSERVED:								
I-23	A	*	*	*	*	*	*	Brown NAPL seen in auger joint and on drill water
I-27	A	14	16.6	2.6	555.5	554.2	552.9	Blk-Brown globules on water in spoon
MW-8D	A	19.6	19.8	0.2	549.6	549.5	549.4	Brown NAPL ganglion in soil pores

Notes:

* Depth and thickness uncertain in I-23.

1. Depths, thicknesses and elevation pertain to soil zone in which NAPL was observed or suspected. Non-aqueous phase liquid (NAPL) may not be continuous in WL-2.
2. "A" - alluvium; "SCF" - silt clay fill; "B" - bedding; "T" - Till.
3. See Figure 6-3 for locations of borings.

17-Dec-90

TABLE 6-2A
INLET NAPL VOLUME ESTIMATE

NAPL ZONE	SOIL TEXTURE; boring(s) (1)	ZONE LENGTH ft (2)	ZONE WIDTH ft (2)	ZONE AREA sf	ZONE THICKNESS ft (3)	SOIL VOLUME cf	TOTAL POROSITY % (4)	EST NAPL CONTENT % (5)	TOTAL NAPL VOL gals (6)
NORTH LOBE ALLUVIUM	gravel & sand; mw-5i	120	30	3,600	0.7	2,520 10.6%	30%	50%	2,827 18.0%
SILT CLAY FILL	silt/clay; wl-2,5	120	12	1,440	9.2	13,248 55.5%	50%	15%	7,432 47.3%
BEDDING	silty sand; wl-2,3,5	250	12	3,000	2.7	8,100 33.9%	30%	30%	5,453 34.7%
TOTAL						23,868			15,712 gals

NOTES

1. Borings listed are those in which potentially mobile (free) non-aqueous phase liquid (NAPL) was reported present in soil samples.
2. See Figure 6-3A for estimated lateral extent of free NAPL. Estimated lateral extent is based on observations in soil borings and stratigraphic considerations.
3. Thickness refers to average length of interval in which free NAPL was observed in soil borings.
4. Porosity is estimated based on soil texture and is consistent with published porosities for similarly textured soils.
5. NAPL content (proportion of pore space saturated with NAPL) is estimated and is an average for the soil volume indicated.
6. Estimate of free NAPL volume is subject to change as additional data become available. Percentages refer to proportion of total NAPL volume represented by that NAPL zone.

TABLE 6-3

RESULTS OF NAPL ANALYSIS

Compound	Percent Composition	Percent of Mass Identified
Benzene	1.4	1.8
Chlorobenzene	32.0	40.7
1,2-Dichlorobenzene	18.0	22.9
1,3-Dichlorobenzene	2.5	3.2
1,4-Dichlorobenzene	13.0	16.5
1,2,4-Trichlorobenzene	3.3	4.2
1,3,5-Trichlorobenzene*	1.7	2.1
1,2,3,4-Tetrachlorobenzene*	1.2	1.5
1,2,3,5-Tetrachlorobenzene*	0.5	0.6
Pentachlorobenzene*	0.8	1.0
Hexachlorobenzene	1.1	1.4
Diphenyl Ether*	1.5	1.9
Hexachlorobutadiene	0.04	0.05
Dibenzofuran	1.7	2.1
Total	78.7	100

* denotes compound identified during National Bureau of Standards Library search.

Sample collected 12/8/89 from boring WL-2, at 14-15 feet.

See Figure 4-1 for location of sample.

TABLE 6-4

PHYSICAL PROPERTIES OF SELECTED CHEMICALS

Chemical Name (1)	Density [g/cc] (*,#)	Vapor Pressure [mm Hg] (#)	Water Solubility [mg/L] (*,#)	Octanol-Water Partition Coefficient [Log Kow]	Soil Partition Coefficient [Koc]
Benzene	0.8787 @ 15 Deg. C (2)	100.0 @ 26.2 Deg. C (2)	1780 @ 20 Deg. C (3)	2.13 (2)	83 (4)
Chlorobenzene	1.1066 (3)	11.5 @ 25 Deg. C (3)	488.0 @ 25 Deg. C (3)	2.84 (4)	330 (4)
1,2-Dichlorobenzene	1.3048 mg/L @ 20 Deg. C (+,2)	1.47 @ 25 Deg. C (2)	137.0 @ 25 Deg. C (2)	3.38 (2)	1700 (4)
1,3-Dichlorobenzene	1.288 @ 20/4 Deg. C (+,3)	NIA	23.0 @ 25 Deg. C (2)	3.38 (3)	1700 (4)
1,4-Dichlorobenzene	1.458 @ 20/4 Deg. C (+,3)	0.6 @ 20 Deg. C (3)	74.0 @ 25 Deg. C (2)	3.60 (4)	1700 (4)
1,2,3-Trichlorobenzene (**)	1.69 (6)	NIA	12.0 @ 22 Deg. C (3)	NIA	7400 (4)
1,2,4-Trichlorobenzene	1.4542 @ 20/4 Deg. C (+,5)	NIA	19.0 @ 22 Deg. C (3)	4.3 (4)	9200 (4)
1,3,5-Trichlorobenzene	NIA	NIA	5.8 @ 20 Deg. C (3)	NIA	NIA
1,2,3,4-Tetrachlorobenzene	NIA	NIA	3.5 @ 22 Deg. C (3)	NIA	18,000 (4)
1,2,3,5-Tetrachlorobenzene	NIA	NIA	2.4 @ 22 Deg. C (3)	NIA	NIA
1,2,4,5-Tetrachlorobenzene (**)	1.858 @ 21/4 Deg. C (+,3)	NIA	0.3 @ 22 Deg. C (3)	4.67 (4)	1600 (4)
Pentachlorobenzene	1.069 (3)	NIA	0.24 @ 22 Deg. C (3)	NIA	13,000 (4)
Hexachlorobenzene	2.044 @ 23 Deg. C (3)	1.089E-05 (3)	0.11 @ 24 Deg. C (3)	6.18 (3)	3900 (4)
Toluene (**)	0.867 @ 20/4 Deg. C (+,3)	22 @ 20 Deg. C (3)	515.0 @ 20 Deg. C (3)	2.69 (3)	300 (4)
2-Chlorotoluene (**)	1.0817 @ 20/4 Deg. C (+,3)	2.7 @ 20 Deg. C (3)	89.0 @ 25 Deg. C (2)	3.42 (3)	1600
Diphenyl Ether	1.073 @ 20 Deg. C (3)	0.02 @ 25 Deg. C (3)	21.0 @ 25 Deg. C (3)	4.20 (3)	NIA
Hexachlorobutadiene	1.675 @ 15.5/15.5 Deg. C (+,3)	22 @ 100 Deg. C (3)	2.0 (3)	4.78 (4)	NIA
Ethylbenzene (**)	0.8670 @ 20/4 Deg. C (+,3)	7.0 @ 20 Deg. C (3)	152 @ 20 Deg. C (3)	3.15 (3)	1100 (4)
Dibenzofuran	1.0886 @ 20/4 Deg. C (+,2)	0.0044 @ 25 Deg. C (2)	10 ppm @ 25 Deg. C (2)	4.12 (2)	4600 (2)

** indicates "chemical not detected in organic phase at Inlet."
* indicates "unless otherwise noted".
# indicates "all temperatures are reported in degrees centigrade unless otherwise noted."
+ indicates "density reported relative to temperature of water as follows: (temperature of liquid)/(temperature of water)."
NIA indicates "no information available".
(1) From: "Results of the Organic Phase, Durez Inlet". OxyChem Memorandum; January 4, 1990.
(2) From: The Hazardous Substance Databank (HSDB), 1989.
(3) From: Vershuren, Karel. "Handbook of Environmental Chemicals,", Second Edition. Van Nostrand Reinhold Company, New York: 1983.
(4) From: U.S. EPA, "Superfund Public Health Evaluation Manual", (EPA 540/1-86/060), October 1986.
(5) From: Weast, Robert, Ph.D., Editor. "CRC Handbook of Environmental Chemistry and Physics, 59th Edition." CRC Press, Inc.; West Palm Beach, Florida: 1978.
(6) From: Hawley, Gessner G., Editor. "The Condensed Chemical Dictionary, 10th Edition." Van Nostrand Reinhold Company; New York: 1981.

TABLE 6-5
Summary of Soft Sediment Chemical Analyses

Compound	Samples 1 (0-6")	1 (6"-2')	2 (0-6")	3 (0-6")	4 (0-6")	4 (2'-5')	5 (0-6")
Benzene	57	1.0	43	760	162	140	2.4
Toluene	18	ND1.0	18	58	4.4	5.4	2.4
Monochlorobenzene	1854	16	2310	128	500	1500	3.9
Styrene	ND1.0	ND1.0	ND1.0	ND1.0	ND1.0	ND1.0	ND1.0
2-Chlorotoluene	1514	66	1100	8650	38	3	ND1.0
1,4-Dichlorobenzene	1119	32	1300	2300	114	300	2.9
1,2-Dichlorobenzene	1432	33	1460	2870	98	430	6
1,2,4-Trichlorobenzene	440	76	645	1700	116	165	3.5
1,2,3-Trichlorobenzene	280	31	230	5600	37	95	1.2
1,2,4,5-Tetrachlorobenzene	230	17	76	260	41	46	1.2
1,2,3,4-Tetrachlorobenzene	270	15	43	200	34	62	1.2
Pentachlorobenzene	98	13	40	180	24	27	1.0
Hexachlorobenzene	75	18	40	160	34	21	1.4
Total (%)	**0.7**	**0.03**	**0.7**	**2.3**	**0.1**	**0.3**	**0.003**

Notes:
(0-6") - Number in ( ) is sample depth
All results are expressed in mg/kg, dry weight (ppm)
NA - Not Available
Samples 1-10 are vibracore samples collected July 1986.
See Figures 4-1 and 4-2 for sample locations.

TABLE 6-5 (continued)
Summary of Soft Sediment Chemical Analyses

Compound	Samples 6 (0-6")	7 (0-6")	7 (6"-2')	8 (0-6")	9 (0-6")	10 (0-6")	10 (6"-2')
Benzene	111	250	155	24	23	182	5.0
Toluene	16	27	239	5.7	8.5	51	5.0
Monochlorobenzene	690	900	3300	260	683	930	136
Styrene	ND1.0	ND1.0	ND1.0	ND1.0	ND1.0	ND1.0	ND1.0
2-Chlorotoluene	180	920	2600	2.9	17	4150	435
1,4-Dichlorobenzene	260	660	3600	59	410	2000	370
1,2-Dichlorobenzene	390	560	3400	52	506	1600	476
1,2,4-Trichlorobenzene	280	410	1100	4.7	450	1100	330
1,2,3-Trichlorobenzene	110	180	510	1.5	58	490	170
1,2,4,5-Tetrachlorobenzene	120	110	330	1.7	46	280	100
1,2,3,4-Tetrachlorobenzene	100	85	300	0.68	51	260	130
Pentachlorobenzene	62	85	210	3.2	63	230	83
Hexachlorobenzene	27	87	190	6.4	88	230	63
Total (%)	**0.2**	**0.4**	**1.6**	**0.04**	**0.2**	**1.2**	**0.2**

Notes; continued:
Adapted from Table 27, Durez Remedial Alternatives Assessment, 1986.
Samples 1-10 are vibracore samples collected July 1986.

TABLE 6-5 (continued)
Summary of Soft Sediment Chemical Analyses

Compound	Samples									
	I-15 (4'-6')	I-15 (6'-8')	I-15 (8'-9.5')	I-24 (2'-2.6')	I-25 (2'-4')	I-27 (4'-6')	I-27 (10'-10.6')	MW-8D (10'-12')	MW-9D (4'-6')	HA-1 (0'-0.8')
Benzene	NA	NA	NA	2.1	0.29	23	76	NA	NA	ND 0.1
Toluene	NA	NA	NA	1.1	ND0.1	0.34	4.9	NA	NA	ND 0.1
Monochlorobenzene	65	450	120	18	270	1400	2600	4.2	2.3	ND 0.1
Styrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chlorotoluene	ND0.1	0.71	ND0.1	1.7	ND0.1	ND0.1	6.1	ND 0.05	ND 0.05	ND 0.1
1,4-Dichlorobenzene	850	8.2	1.2	3.5	29	250	880	1.0	0.98	ND 0.1
1,2-Dichlorobenzene	1000	12	16	2.9	28	220	1200	0.41	1.2	ND 0.1
1,2,4-Trichlorobenzene	38	35	0.17	0.94	6.3	31	180	2.3	2.4	2.3
1,2,3-Trichlorobenzene	24	28	0.13	0.44	4.5	39	110	0.5	1.2	1.2
1,2,4,5-Tetrachlorobenzene	27	24	0.11	0.35	3.9	34	91	0.69	1.2	1.6
1,2,3,4-Tetrachlorobenzene	40	36	0.18	0.56	6.3	46	94	0.65	1.3	4.2
Pentachlorobenzene	32	26	0.16	0.73	5.0	26	52	3.0	1.1	18
Hexachlorobenzene	34	43	0.26	1.7	5.8	41	66	6.9	7.7	43
Total (%)	**0.2**	**0.07**	**0.01**	**0.003**	**0.04**	**0.2**	**0.5**	**0.002**	**0.002**	**0.007**

TABLE 6-5A

PCDD/PCDF CONCENTRATIONS IN SOFT SEDIMENT
(ppb)

Analytes	VIBRACORE - 10	PCF-1	PCF-2	PCF-3
2,3,7,8-TCDD	15	1.1	67	18
Total TCDD	680	42	1,700	440
1,2,3,7,8-PeCDD	-	3.1	270	57
Total PeCDD	-	76	1,900	920
1,2,3,4,7,8-HxCDD	-	4.6	490	94
1,2,3,6,7,8-HxCDD	-	7.2	300	99
1,2,3,7,8,9-HxCDD	-	5.3	220	65
Total HxCDD	-	140	3,500	1,800
1,2,3,4,6,7,8-HpCDD	-	46	2,400	9,100
Total HpCDD	-	82	4,000	1,200
OCDD	-	96	3,900	1,200
2,3,7,8-TCDF	-	<1	<4.4	<1.3
Total TCDF	-	150	8,000	2,600
1,2,3,7,8-PeCDF	-	8.5	520	120
2,3,4,7,8-PeCDF	-	19	670	290
Total PeCDF	-	230	9,000	3,400
1,2,3,4,7,8-HxCDF	-	250	7,100	2,900
1,2,3,6,7,8-HxCDF	-	37	1,300	430
2,3,4,6,7,8-HxCDF	-	9.9	430	130
1,2,3,7,8,9-HxCDF	-	<1	24	4.5
Total HxCDF	-	470	14,000	5,500
1,2,3,4,6,7,8-HpCDF	-	910	19,000	9,100
1,2,3,4,7,8,9-HpCDF	-	-	-	-
Total HpCDF	-	980	21,000	10,000
OCDF	-	1,400	16,000	9,600

TCDD/F - Tetrachlorodibenzo-dioxins/furans
PCDD/F - Pentachlorodibenzo-dioxins/furans
HxCDD/F - Hexachlorodibenzo-dioxins/furans
HpCDD/F - Heptachlorodibenzo-dioxins/furans
OCDD/F - Octachlorodibenzo-dioxins/furans
PCDD - Polychlorinated dibenzodioxins
PCDF - Polychlorinated dibenzofurans

- : not analyzed

Depth for all samples was approximately 0-6".
Sample 10 was collected and analyzed by OCC in 1986.
Samples PCF-1 thru PCF-3 were collected and analyzed by NYS in 1990-91.

TABLE 6-6
SUMMARY OF TOTAL CHLOROBENZENES
INLET COVE - BELOW SOFT SEDIMENT
TASKS 4 & 6

Rank	Boring	Sample	Depth (ft)	Total Chlorobenzenes mg/kg(ppm)	Unit
1	WL-4	S12	25-26.5	7274	B
2*	WL-2	S3/S4	14-18	5010	SCF
3	WL-4	S13	26.5-28	3806	B/T
4*	WL-3	S9	24-26	3387	B
5*	WL-2	S7	22-24	1047	B
6	IW-1	S8	21-23	546.7	A
7	WL-5	S5	19-19.9	398.3	B
8	WL-4	S10/S11	22-25	378.2	SCF/B
9	WL-3	S8B	23.3-24	329.7	B
10	WL-5	S1/S2	11-15	246.3	SCF
11	WL-2	S1/S2	10-14	236.9	SCF
12	WL-5	S3/S4	15-19	217.6	SCF
13	WL-5	S8	25-27	150.5	T
14	WL-2	S8	24-26	112.5	T
15	WL-4	S15	30-31.5	106.0	T
16	WL-2	S5/S6	18-22	90.10	SCF/B
17	IW-5	S7B	24.1-25.1	57.18	B
18	WL-4	S6/S7	16-19	29.02	SCF
19	WL-3	S10	26-28	26.54	T
20	WL-3	S4/S5	14-18	13.50	SCF
21	IW-1	S1	7-9	13.00	SCF
22	WL-3	S12	30-32	12.70	T
23	WL-4	S3/S4	11-14	4.21	SCF
24	IW-4	S2A	5-6.1	4.20	SCF
25	WL-3	S6/S7	18-22	3.70	SCF
26	WL-1A	S9/S10	26-30	2.47	GLC
27	WL-3	S2/S3	10-14	2.18	SCF
28	WL-4	S16	32-34	1.44	T
29	IW-4	S8	17-19	1.20	GLC

Notes:

1. "Total Chlorobenzenes" includes MCBs, DCBs, TCBs, TeCBs, P5CBs, and HCBs.
2. Results are shown for total chlorobenzene values greater than 1 ppm.
3. "Depth" is below ground surface.
4. "Units": F - modern fill; SS - soft sediment; SCF - silt-clay fill (LWL backfill); B - bedding for LWL; A - alluvium; GLC - glacio-lacustrine clay; T - till
5. Asterisk (*) indicates NAPL observed.
6. See Figure 4-1 for locations.

TABLE 6-7
SUMMARY OF TOTAL CHLOROBENZENES
TRANSITION ZONE AND INLET PERIMETER
TASK 3

Rank	Boring	Sample	Depth (ft)	Total Chlorobenzenes mg/kg (ppm)	Unit
TRANSITION ZONE					
1	I-27	S6A	10-10.6	5279	SS
2	I-15	S3	4-6	2110	SS
3	I-27	S3	4-6	2087	SS
4*	MW-8D	S10	18-20	699.4	A
5	I-15	S4	6-8	662.2	SS
6	I-25	S2	2-4	358.8	SS
7	I-15	S5	8-9.5	138.2	SS
8	I-1A	S1	3-5	99.00	F
9	HA-1	- - - - -	0-0.8	70.30	SS
10	I-24	S2A	2-2.6	29.12	SS
11	I-27	S10	18-20	27.52	GLC
12	MW-9D	S7	12-14	25.20	A
13	MW-8D	S6	10-12	19.65	SS
14	MW-9D	S3	4-6	19.38	SS
15	I-27	S9B	16.6-18	14.29	GLC
16	HA-2	- - - - -	0-2	12.75	F
17	I-25	S6B	10.6-12	6.80	SCF
18	I-25	S7	12-14	1.93	SCF
19	MW-9D	S8	14-16	1.86	GLC
20	I-2	S7	12-14	1.24	A
INLET PERIMETER					
1	I-4	S17	32-34	183.6	A
2	I-9	S16	34.5-36	153.0	T
3	I-23	S19B	36.9-38	40.14	GLC
4	I-26	S11	20-22	34.50	GLC
5	I-9	S17	36-38	28.08	T
6	I-8	S13	24-26	27.14	A
7	I-22	S18A	34-34.6	23.47	A
8	I-13	S13	34-35.9	13.80	A
9	I-23	S22	42-44	4.11	T
10	I-22	S2	2-4	3.09	F
11	I-13	S9	16-18	1.69	A

Notes:

1. "Total Chlorobenzenes" includes MCBs, DCBs, TCBs, TeCBs, P5CBs, and HCBs.
2. Results are shown for total chlorobenzene values greater than 1 ppm.
3. "Depth" is below ground surface.
4. "Units":
   F - modern fill
   SS - soft sediment
   SCF - silt-clay fill (LWL backfill)
   B - bedding for LWL
   A - alluvium
   GLC - glacio-lacustrine clay
   T - till
5. See Figure 4-1 for locations.
6. Asterisk (*) indicates NAPL observed.

TABLE 6-8
Summary of Groundwater Chemical Analyses

Monitoring Well	Date Sampled	Screen Depth	Unit Screened	B	T	MCB	OCT	1,2-DCB	1,4-DCB	1,2,3-TCB	1,2,4-TCB
				Analytes mg/L (ppm)							
Quantitation Level				0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MW-1S	2/20/90	6.5-11.5	F/A	ND	ND	ND	ND	ND	ND	ND	ND
	4/18/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-1I	2/20/90	23.5-33.5	A	ND	ND	ND	ND	ND	ND	ND	ND
	4/20/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-1D	3/2/90	42.5-52.5	T	ND	ND	ND	ND	ND	ND	ND	ND
	4/12/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-2S	2/26/90	6.5-11.5	F	ND	ND	ND	ND	ND	ND	ND	ND
	4/18/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-2I	2/27/90	23.8-33.8	A	14.00	0.14	36.00	0.004	3.70	0.30	0.007	0.032
	4/20/90			9.50	ND.30	26.00	ND.30	2.50	1.40	ND.30	ND.30
MW-2D	2/23/90	39.8-49.8	T	0.03	ND	0.13	ND	0.016	0.008	ND	ND
	4/16/90			0.001	ND	0.014	ND	0.005	0.003	ND	ND
MW-3I	2/23/90	15.8-25.8	A/GLC	ND	ND	ND	ND	ND	ND	ND	ND
	4/18/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-3D	2/22/90	27.6-32.6	GLC	ND	ND	ND	ND	ND	ND	ND	ND
	4/16/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-4S	2/23/90	5.5-10.5	F/A	ND	ND	ND	ND	ND	ND	ND	ND
	4/17/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-4I	2/26/90	13.5-15.5	A/GLC	ND	ND	ND	ND	ND	ND	ND	ND
	4/17/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-5S	2/21/90	7.1-12.1	A	0.006	ND	ND	ND	ND	ND	ND	ND
	4/20/90			0.008	ND	0.005	ND	ND	ND	ND	ND
MW-5I	3/2/90	21.8-31.8	A/T	40.00	0.88	150.00	0.76	23.00	18.00	0.38	0.90
	4/19/90			46.00	0.97	170.00	0.82	27.00	20.00	0.50	1.10

TABLE 6-8 (continued)
Summary of Groundwater Chemical Analyses

Monitoring Well	Date Sampled	Screen Depth	Unit Screened	B	T	MCB	OCT	1,2-DCB	1,4-DCB	1,2,3-TCB	1,2,4-TCB
				Analytes mg/L (ppm)							
Quantitation Level				0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MW-5D	4/16/90	39.0-49.0	T	ND	ND	ND	ND	ND	ND	ND	ND
MW-6I	2/27/90	10.8-20.8	A	ND	ND	0.003	ND	0.002	0.001	ND	ND
	4/19/90			ND	ND	0.002	ND	0.001	ND	ND	ND
MW-7S	2/26/90	7.0-17.0	GLC	ND	ND	ND	ND	ND	ND	ND.30	ND.30
	4/17/90			ND	ND	ND	ND	+ND.002	+ND.004	+ND.002	+ND.002
MW-8S	2/28/90	5.5-10.5	F/SS	0.056	ND.005	1.70	ND.005	0.076	0.18	ND.005	0.036
	4/12/90			0.076	ND	1.30	ND.005	0.073	0.17	ND.005	0.032
MW-8I	3/2/90	16.0-21.0	A	ND.30	ND.30	11.0	ND.30	6.40	5.40	ND.50	0.40
	4/19/90			0.27	ND.075	19.00	ND.075	12.00	9.90	0.30	0.84
MW-8D	3/1/90	26.0-36.0	GLC/T	2#	ND	ND	ND	ND	ND	ND	2#
	4/9/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-9S	2/28/90	5.5-10.5	SS	0.01	ND	0.21	ND	0.002	0.006	ND	0.002
	4/11/90			0.008	ND	0.17	ND	0.002	0.005	ND	ND
MW-9D	2/28/90	19.5-29.5	GLC/T	ND	ND	ND	ND	ND	ND	ND	1#
	4/9/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-10D	2/21/90	14.5-24.5	GLC	ND	ND	ND	ND	ND	ND	ND	ND
	4/9/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-11S	2/20/90	7.0-9.0	F/A	ND	ND	ND	ND	ND	ND	ND	ND
	4/10/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-11I	2/21/90	12.9-17.2	A	ND	ND	1#	ND	ND	ND	ND	ND
	4/11/90			ND	ND	ND	ND	ND	ND	ND	ND
MW-12D	2/22/90	15.0-25.0	GLC	ND	ND	ND	ND	ND	ND	ND	ND
	4/10/90			ND	ND	ND	ND	ND	ND	ND	ND

TABLE 6-8 (continued)
Summary of Groundwater Chemical Analyses

Monitoring Well	Date Sampled	Screen Depth	Unit Screened	Analytes mg/L (ppm) B	T	MCB	OCT	1,2-DCB	1,4-DCB	1,2,3-TCB	1,2,4-TCB
Quantitation Level				0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MW-13D	2/21/90	20.0-30.0	GLC	ND	ND	ND	ND	ND	ND	ND	ND
	4/10/90			ND	ND	ND	ND	ND	ND	ND	ND
MW14S	2/22/90	6.0-11.0	A	ND	ND	ND	ND	*	9#	*	*
	4/11/90			ND	ND	ND	ND	+ND.002	+ND.004	+ND.002	+ND.002

NOTES:

Units Screened:
F - Fill
SS - Soft Sediment
A - Alluvium
T - Till

Well locations are shown on Figure 4-1.

Analytes:
B - Benzene
T - Toluene
MCB - Monochlorobenzene
1,2-DCB - 1,2-Dichlorobenzene
1,4-DCB - 1,4-Dichlorobenzene
1,2,3-TCB - 1,2,3-Trichlorobenzene
1,2,4-TCB - 1,2,4-Trichlorobenzene
OCT - Orthochlorotoluene (2-chlorotoluene)

- disqualified
* - Possible hydrocarbon interference.
+ - Resampled on 4/25/90 and analyzed by GC/MS.

FIGURES

LIST OF FIGURES

LIST OF FIGURES cont'd

LEGEND

	Existing Boom
CB	Catch Basin
H/T	Hub & Tack Found
W — W — W	North Tonawanda Water Line
IRF	Iron Rod Found
	Timber Piling
B	Survey Control Points (Disc elevation 571.11 MSL)
SG-1 571.12	Staff Gauge, with elevation
	Lockport Water Line
1+80N / 1+80s	Baselines for Task 2
	Shoreline maximum monthly mean between 1968-1987: Elev. 567.50'
	Property Line (By others)
x — x — x	Fence
P I-17	Test Boring and Designation ("P" if piezometer installed)
BM	Benchmark (elevation 576.91' MSL) (Subtract 1.23 from MSL to convert to IGLD, 1955)
12	Sediment Depth Probes (Task 5)
IPF	Iron Pipe Found
B1	Pump Station Test Boring (By others)
4 X	Soft Sediment Vibracore sample (Approx. location, 1986)
HA-1	Hand Auger Location
DR001	Surface Soil Sample (approx. Location)
WL-1A	Water Line Boring (Task 6)
IW-6	Inlet Water Boring (Task 4)
MW-1S	Monitoring wells S - Shallow - Water table I - Intermediate - Top of Clay D - Deep - Till or Glacio-Lacustrine Clay
	Utility pole
H M	Lockport Water Line Probe H = Hit M = Miss
578.3 x	Spot Elevations
SB-1	Confirmation Soil Borings

NOTES:

1. Contour Interval is 1 Foot
2. Elevations are Feet Above Mean Sea Level (MSL, NGVD)
3. Property Line Survey conducted by STEPHENS S. SIUTA ASSOCIATES Job No. 87777. (9/23/87)
4. Bathymetry of inlet was generated by Dunn Geoscience. Bathymetry of river was supplied by OSI.

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, New York 12205

DUNN GEOSCIENCE CORP

LEGEND AND NOTES FOR INLET SERIES MAPS

OCCIDENTAL CHEMICAL CORPORATION

City of North Tonawanda, Niagara Co., N.Y.

PROJECT NO. 00595-01165 | DATE July 1990 | SCALE NO SCALE | FIGURE NO.

M8044L

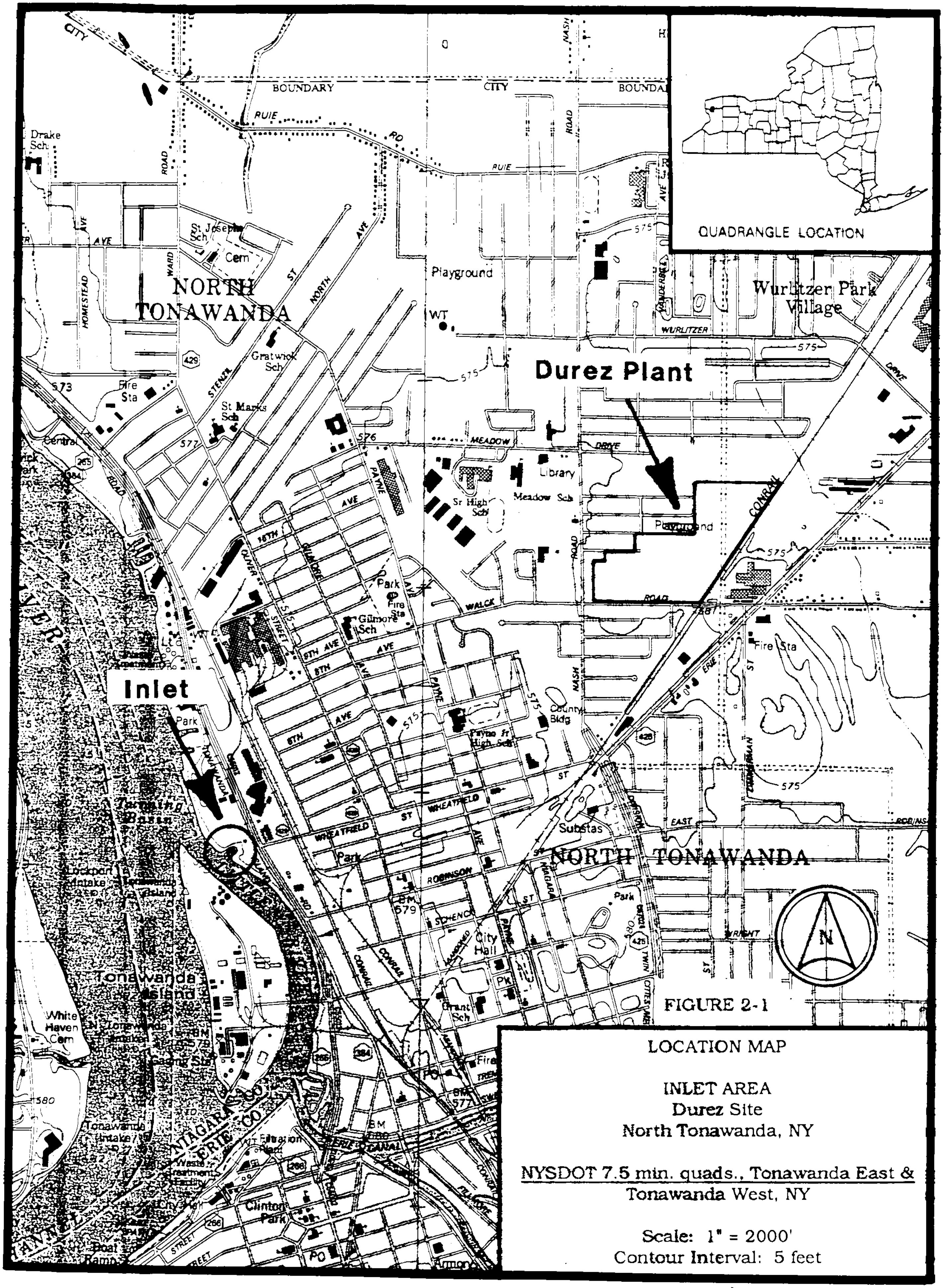


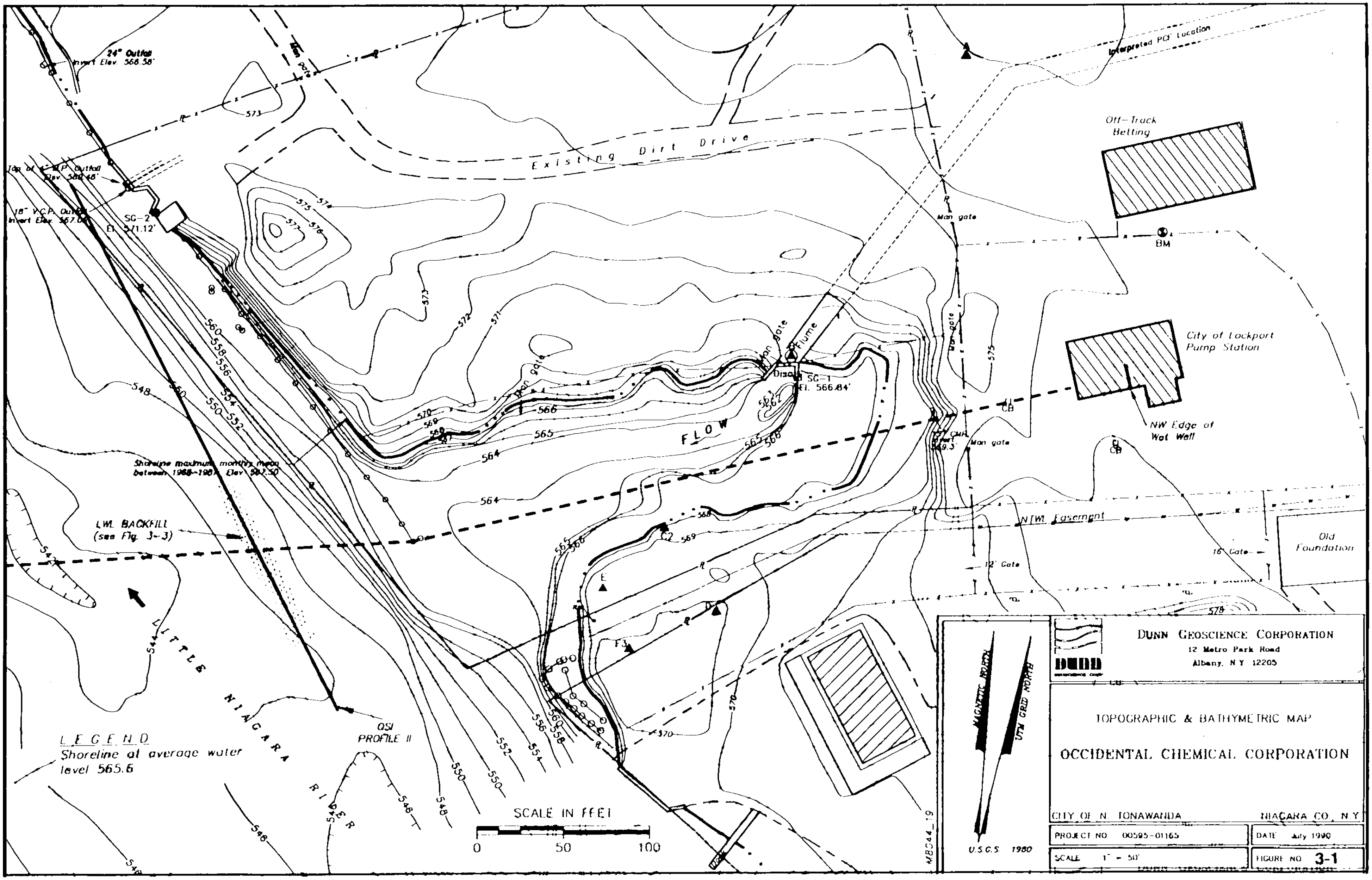
FIGURE 2-1

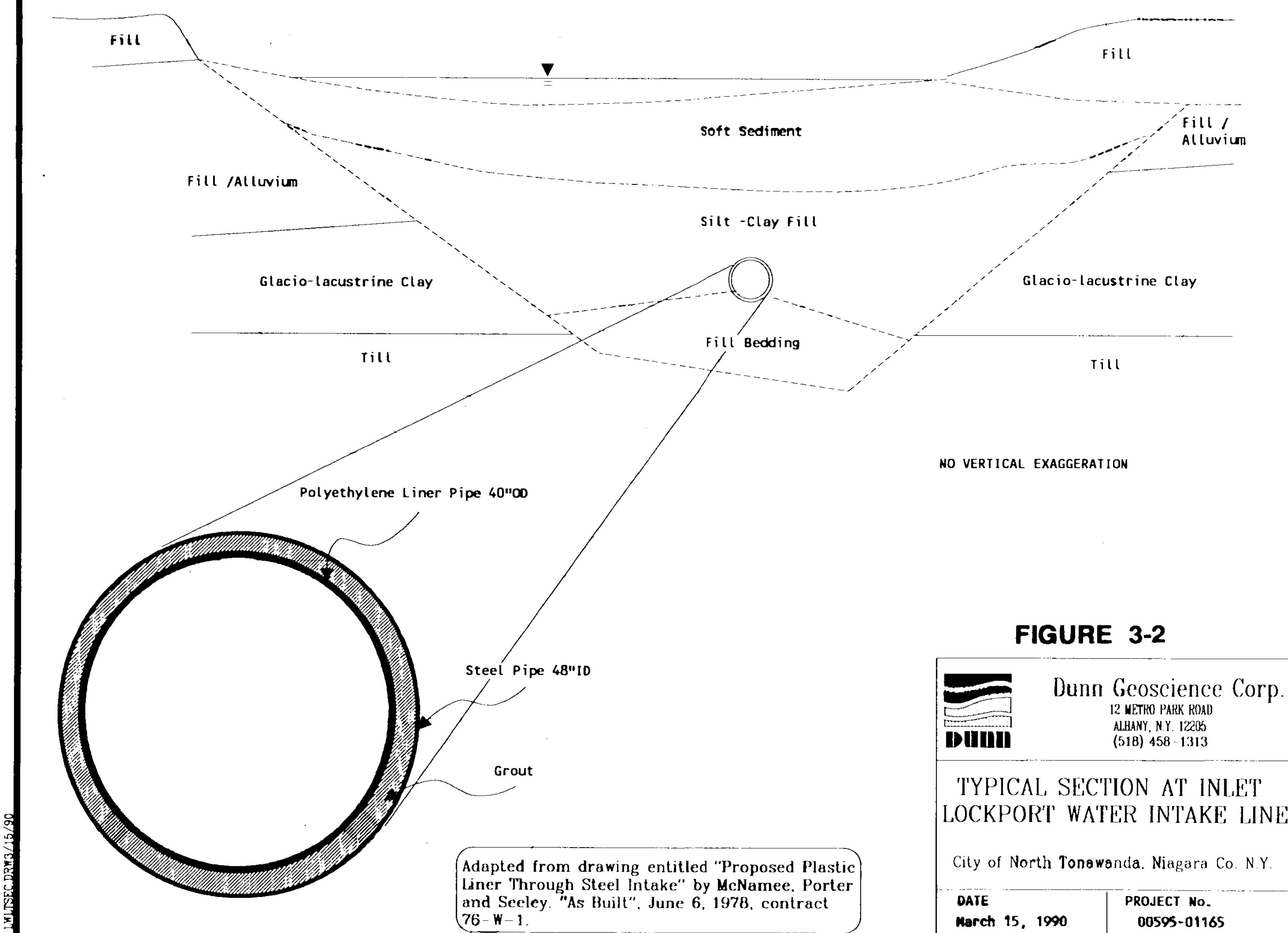
LOCATION MAP

INLET AREA
Durez Site
North Tonawanda, NY

NYSDOT 7.5 min. quads., Tonawanda East & Tonawanda West, NY

Scale: 1" = 2000'
Contour Interval: 5 feet


24" Outfall
Invert Elev. 566.58'
Existing Dirt Drive
Interpreted PCF Location
Off-Track Betting
Man gate
BM
City of Lockport Pump Station
NW Edge of Wet Well
SG-2
El. 571.12'
SG-1
El. 566.84'
Flume
FLOW
Shoreline maximum monthly mean between 1988-1987 Elev. 567.50
L.W. BACKFILL (see Fig. 3-3)
NTWL Easement
Old Foundation
16' Gate
12' Gate
LITTLE NIAGARA RIVER
OSI PROFILE II
LEGEND
Shoreline at average water level 565.6
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
TOPOGRAPHIC & BATHYMETRIC MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE 1" = 50'
FIGURE NO. 3-1



Adapted from drawing entitled "Proposed Plastic Liner Through Steel Intake" by McNamee, Porter and Seeley. "As Built", June 6, 1978, contract 76-W-1.

FIGURE 3-2

Dunn Geoscience Corp.
12 METRO PARK ROAD
ALBANY, N.Y. 12205
(518) 458-1313

TYPICAL SECTION AT INLET
LOCKPORT WATER INTAKE LINE

City of North Tonawanda, Niagara Co. N.Y.

DATE	PROJECT No.
March 15, 1990	00595-01165

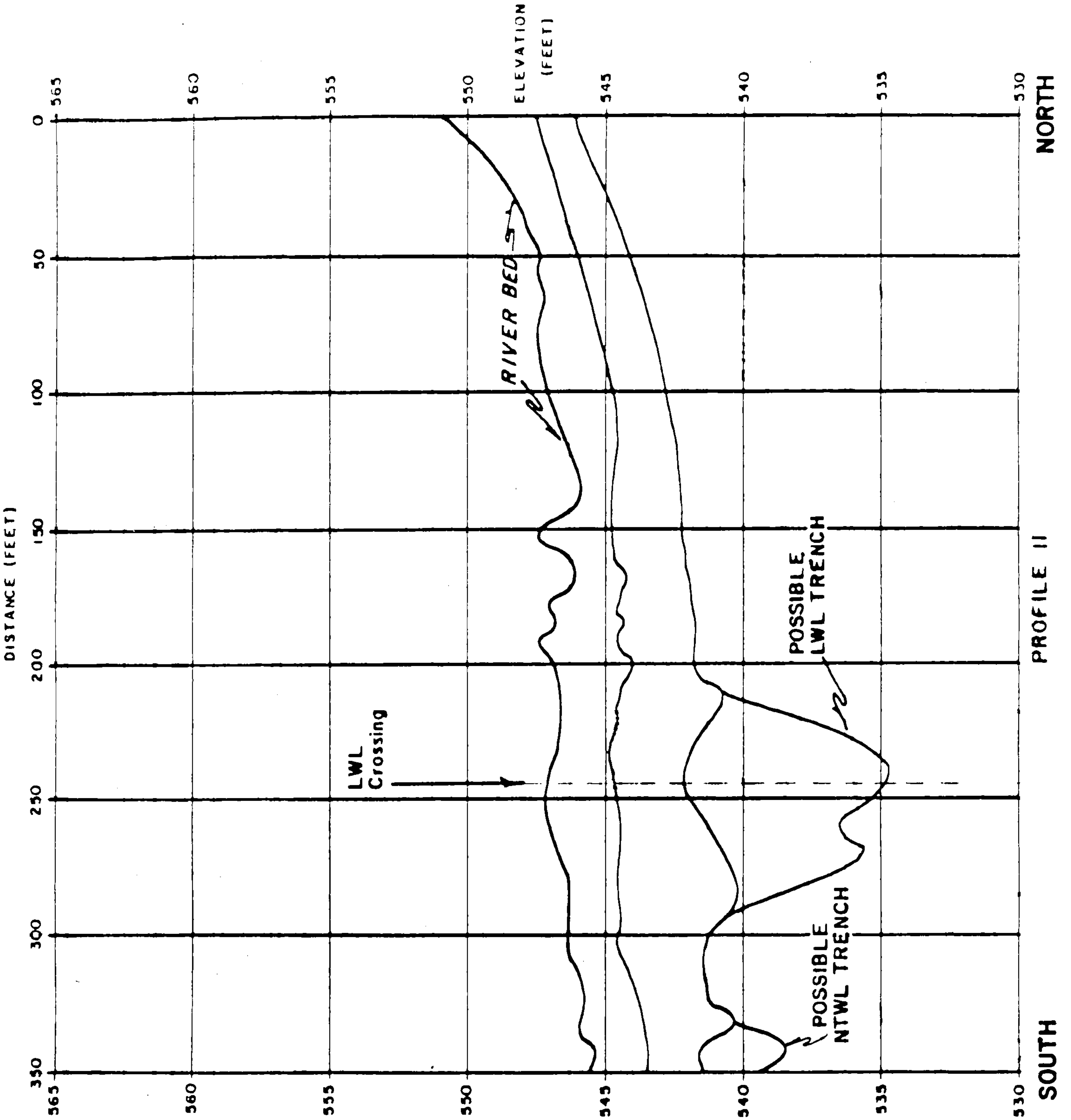


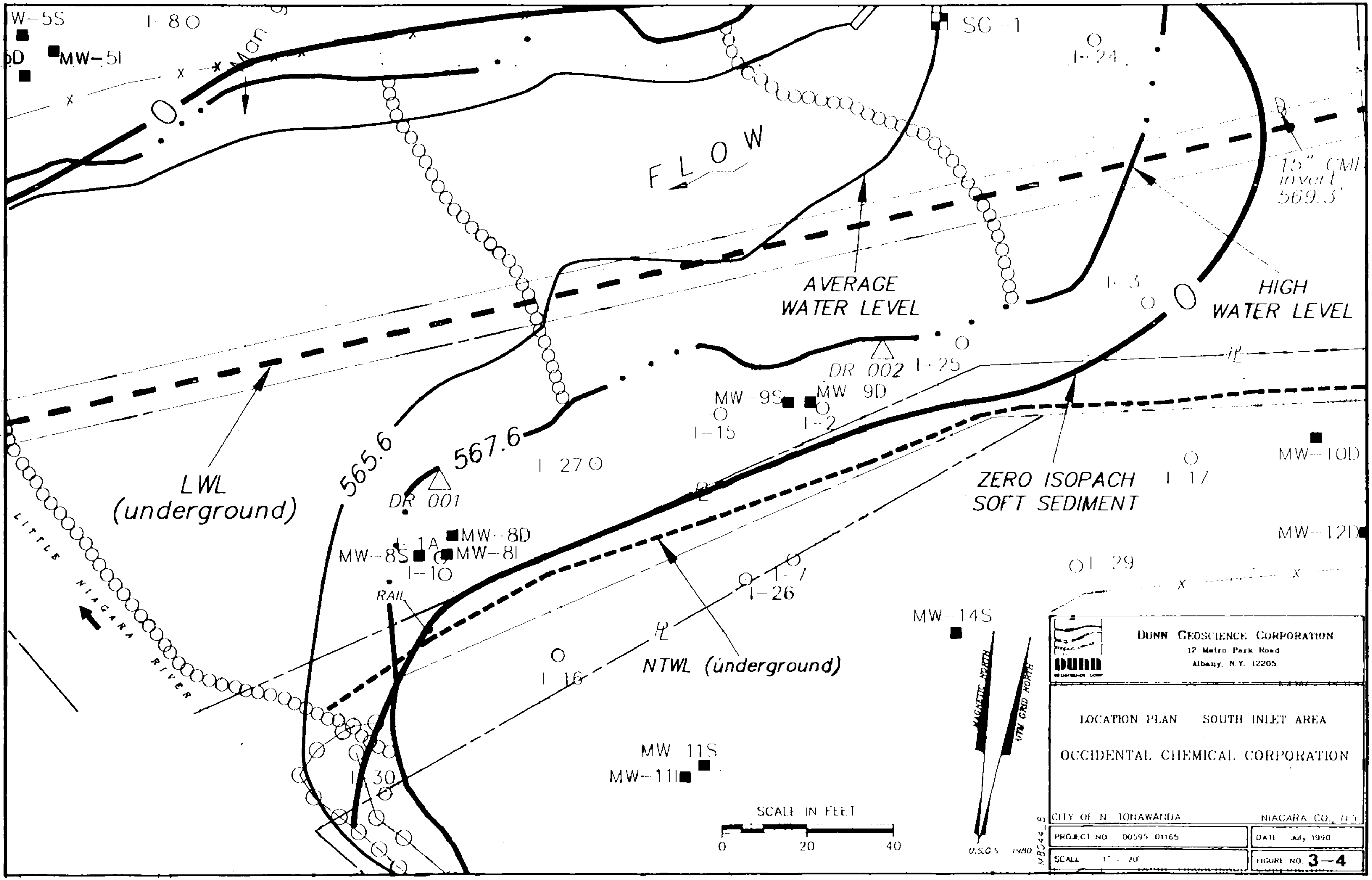
FIGURE 3-3

Dunn Geoscience Corporation
12 Metro Park Road
Albany, N.Y. 12205

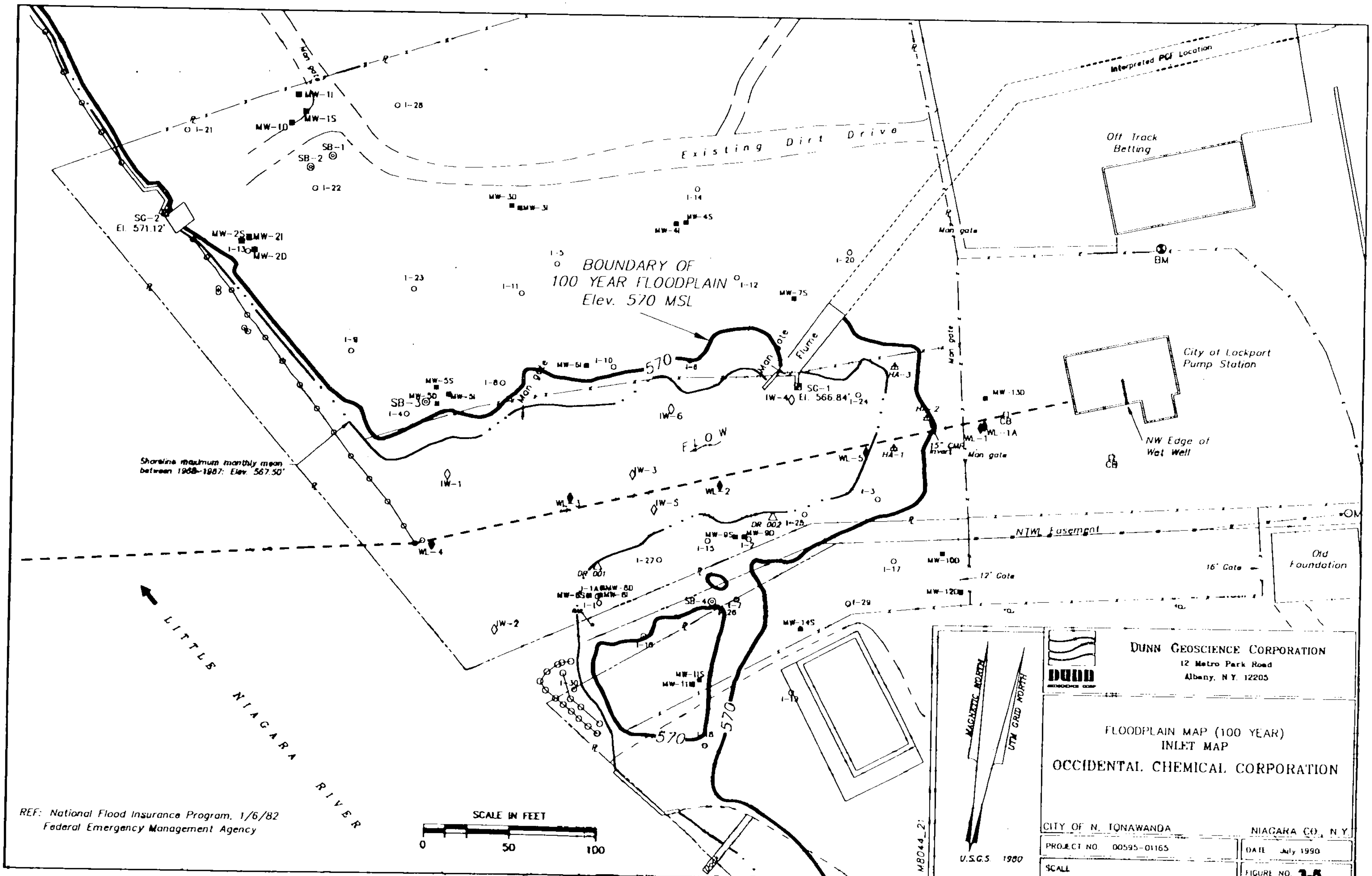
SEISMIC PROFILE
LITTLE NIAGARA RIVER
N. TONAWANDA, NEW YORK

July 27, 1990

OCEAN SURVEYS, INC.
91 SHEFFIELD ST., OLD SAYBROOK, CT 06475



MW-5S
MW-5I
I-8
SG-1
I-24
FLOW
AVERAGE
WATER LEVEL
HIGH
WATER LEVEL
15" CMI
invert
569.3'
I-3
DR 002
I-25
MW-9S
MW-9D
I-15
I-2
565.6
567.6
I-27
LWL
(underground)
DR 001
MW-8D
MW-8S
MW-8I
I-1A
I-10
RAIL
LITTLE NIAGARA RIVER
ZERO ISOPACH
SOFT SEDIMENT
I-17
MW-10D
MW-12D
I-29
I-7
I-26
MW-14S
NTWL (underground)
I-16
I-30
MW-11S
MW-11I
SCALE IN FEET
0
20
40
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
LOCATION PLAN SOUTH INLET AREA
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595 01165
DATE July 1990
FIGURE NO. 3-4



BOUNDARY OF
100 YEAR FLOODPLAIN
Elev. 570 MSL
Existing Dirt Drive
Interpreted PCI Location
Off Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Shoreline maximum monthly mean between 1968-1987: Elev. 567.50'
SG-2 El. 571.12'
SG-1 El. 566.84'
FLOW
NTWL Easement
Old Foundation
16" Gate
12" Gate
Man gate
Flume
LITTLE NIAGARA RIVER
REF: National Flood Insurance Program, 1/6/82
Federal Emergency Management Agency
SCALE IN FEET
0 50 100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
FLOODPLAIN MAP (100 YEAR)
INLET MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE
FIGURE NO. 3-5

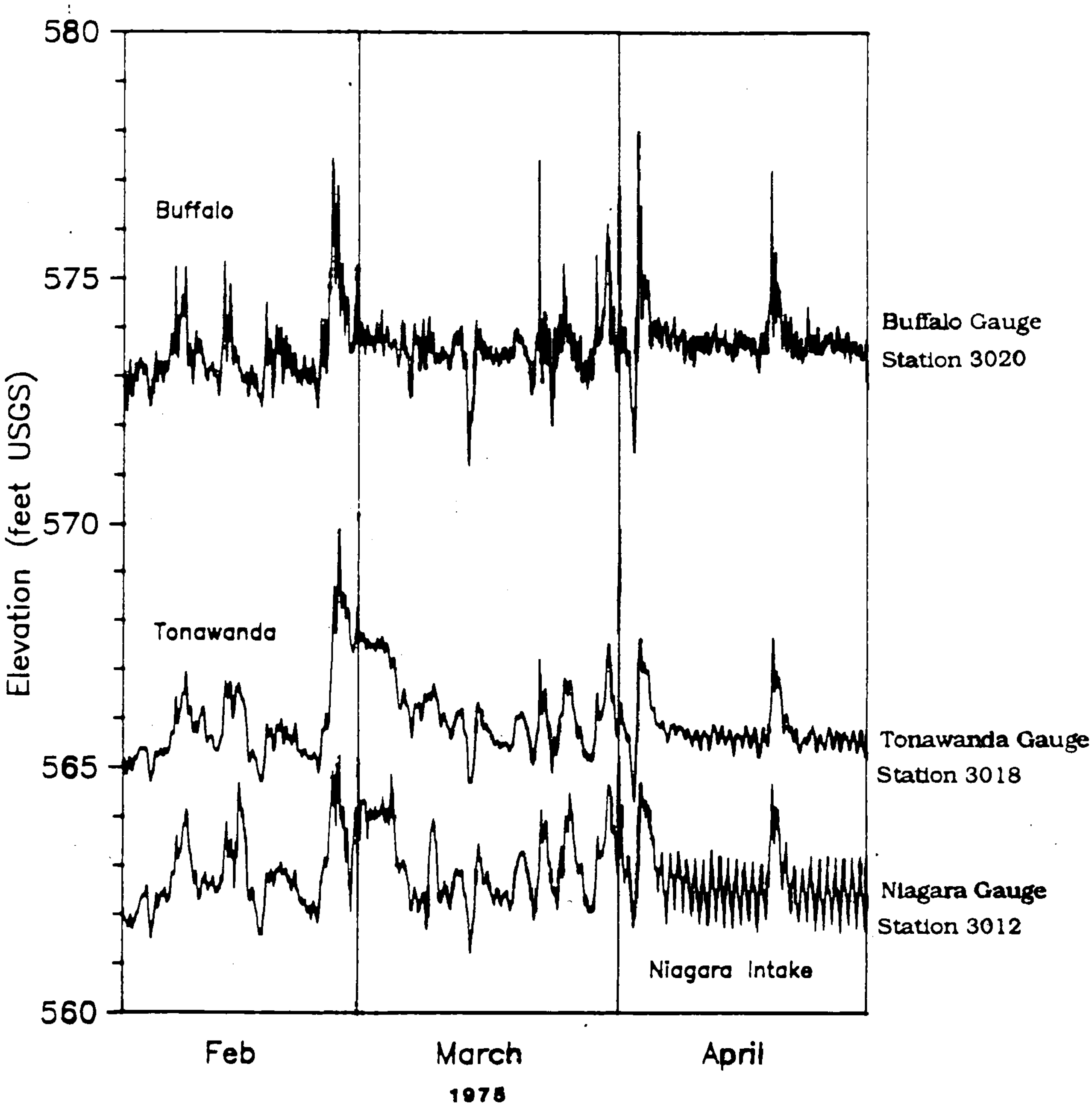


FIGURE 3-6
NIAGARA RIVER HYDROGRAPHS

Data provided by U.S.A. Corps of Engineers
Buffalo District

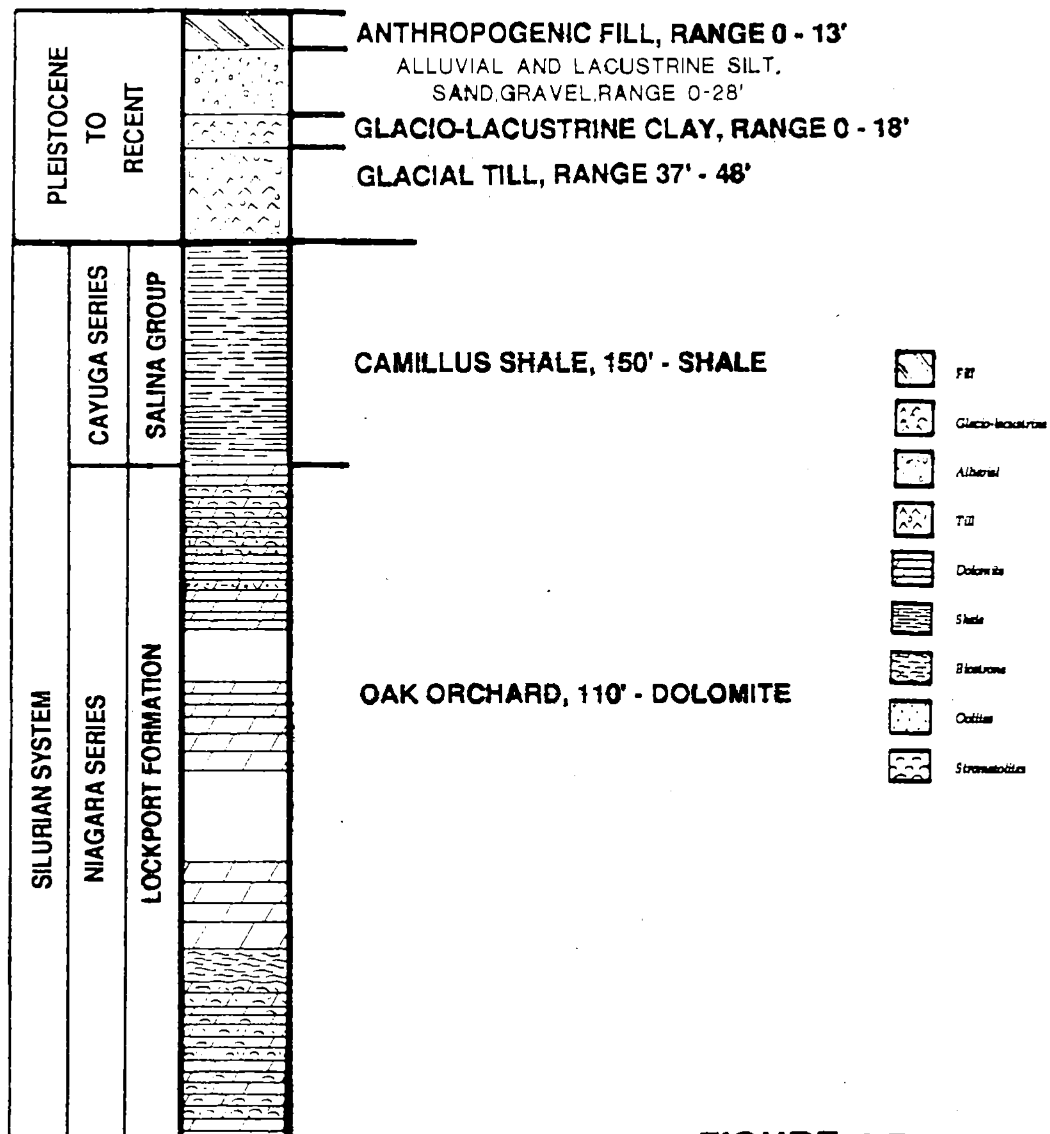


FIGURE 3-7

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205

REGIONAL GEOLOGIC COLUMN

OCCIDENTAL CHEMICAL CORPORATION

CITY OF N. TONAWANDA — NIAGARA CO., N.Y.

PROJECT NO. 595-03-1165	DATE 1990
	FIGURE NO.

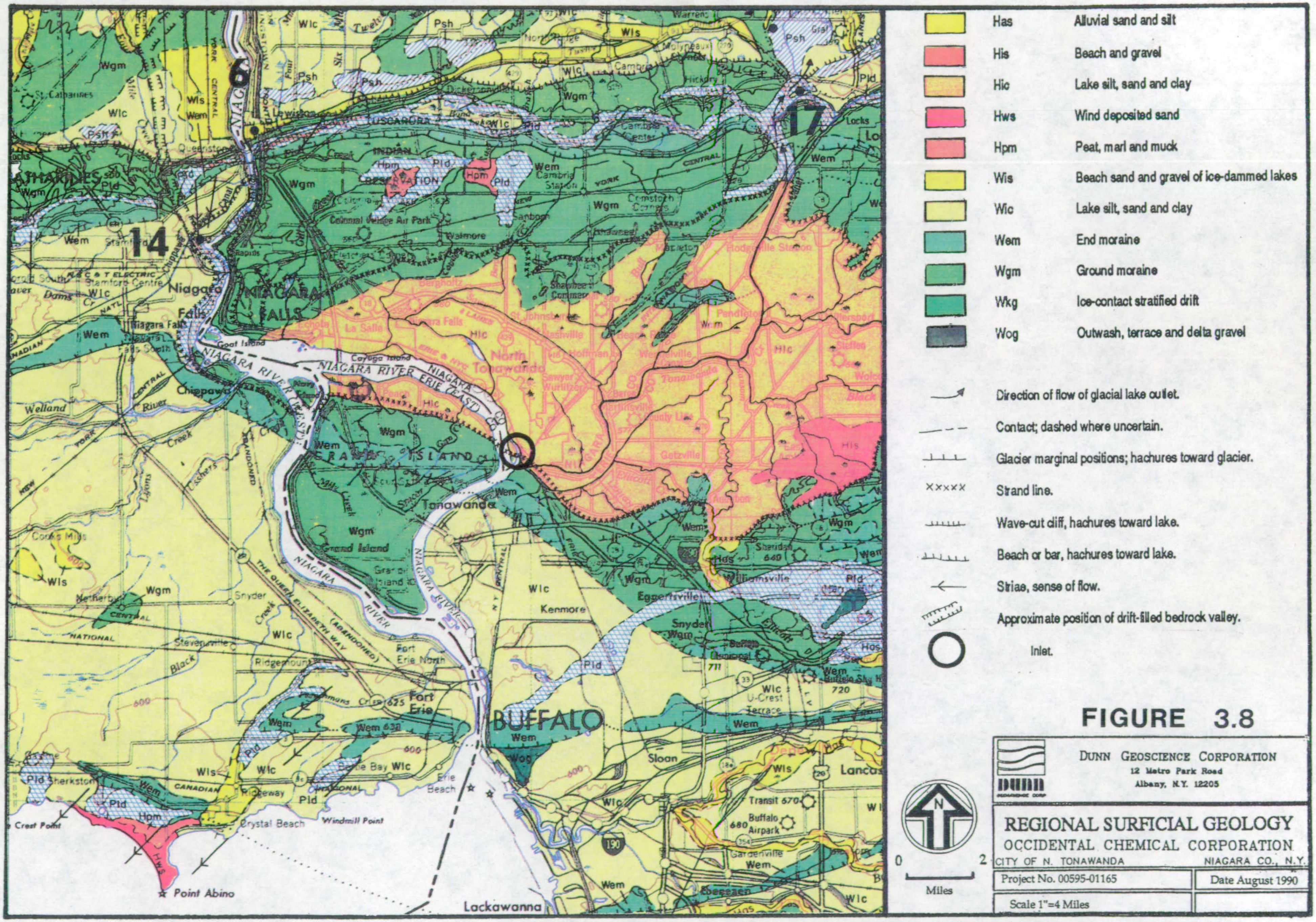


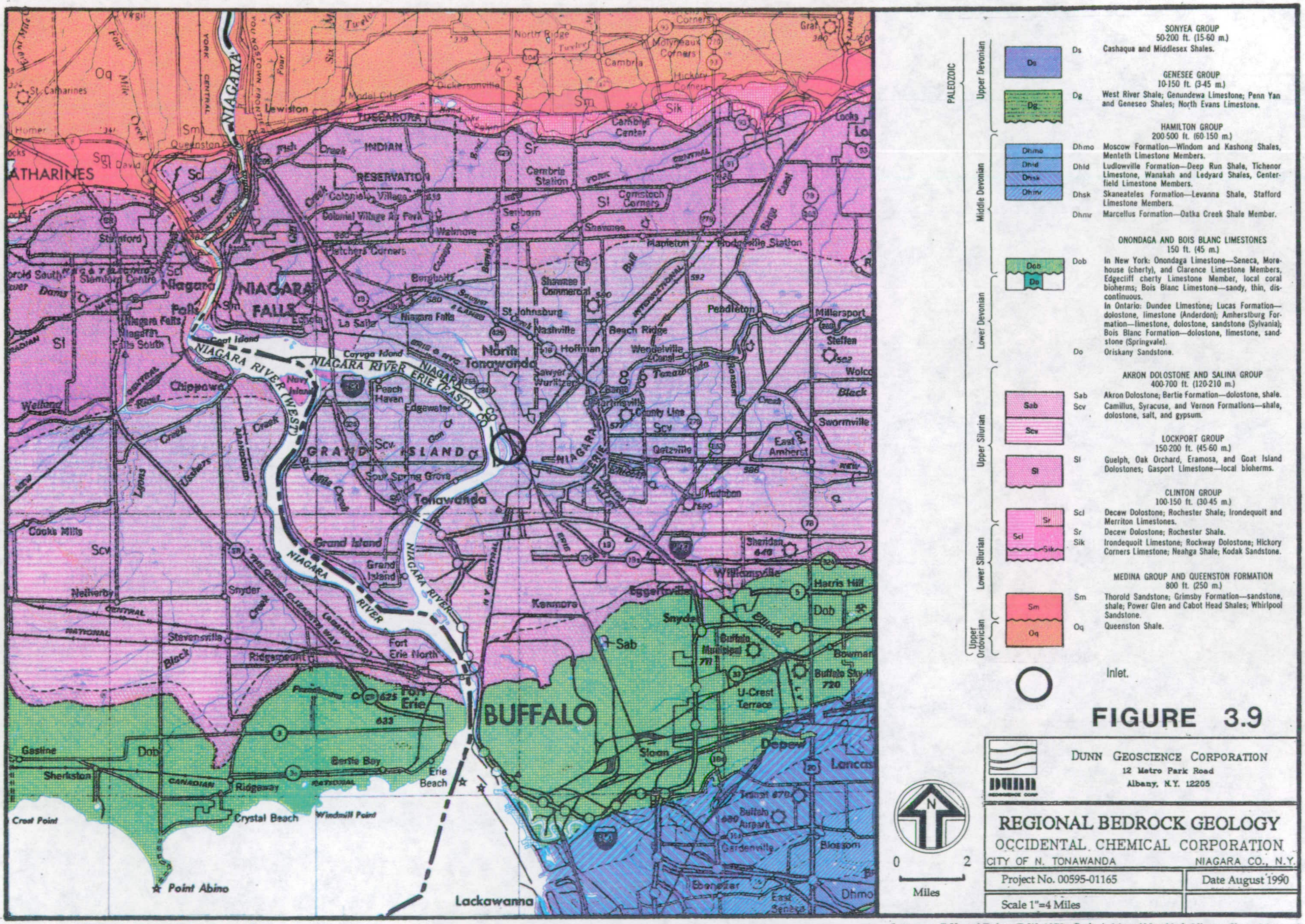
FIGURE 3.8

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205

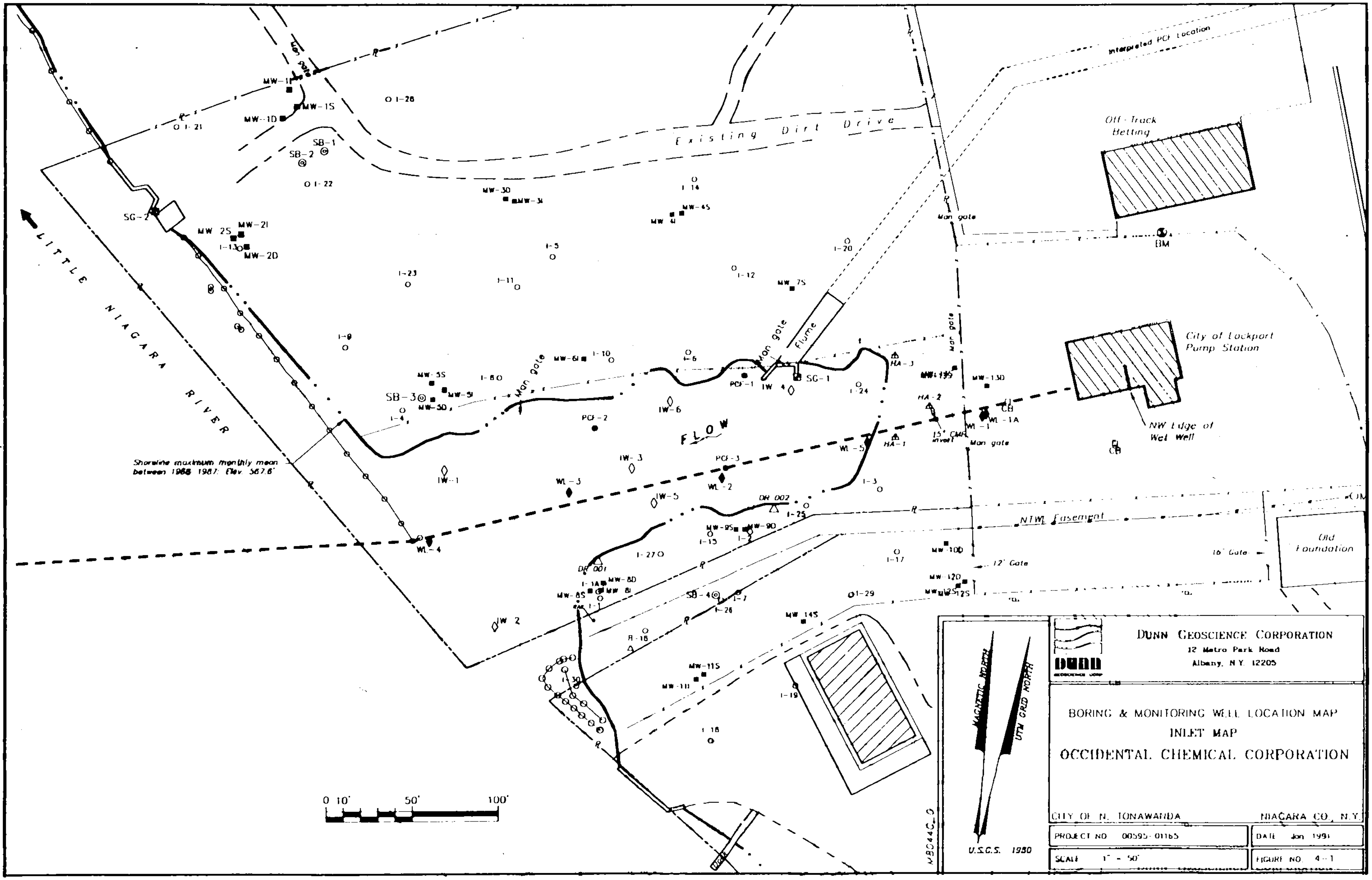
REGIONAL SURFICIAL GEOLOGY
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA NIAGARA CO., N.Y.

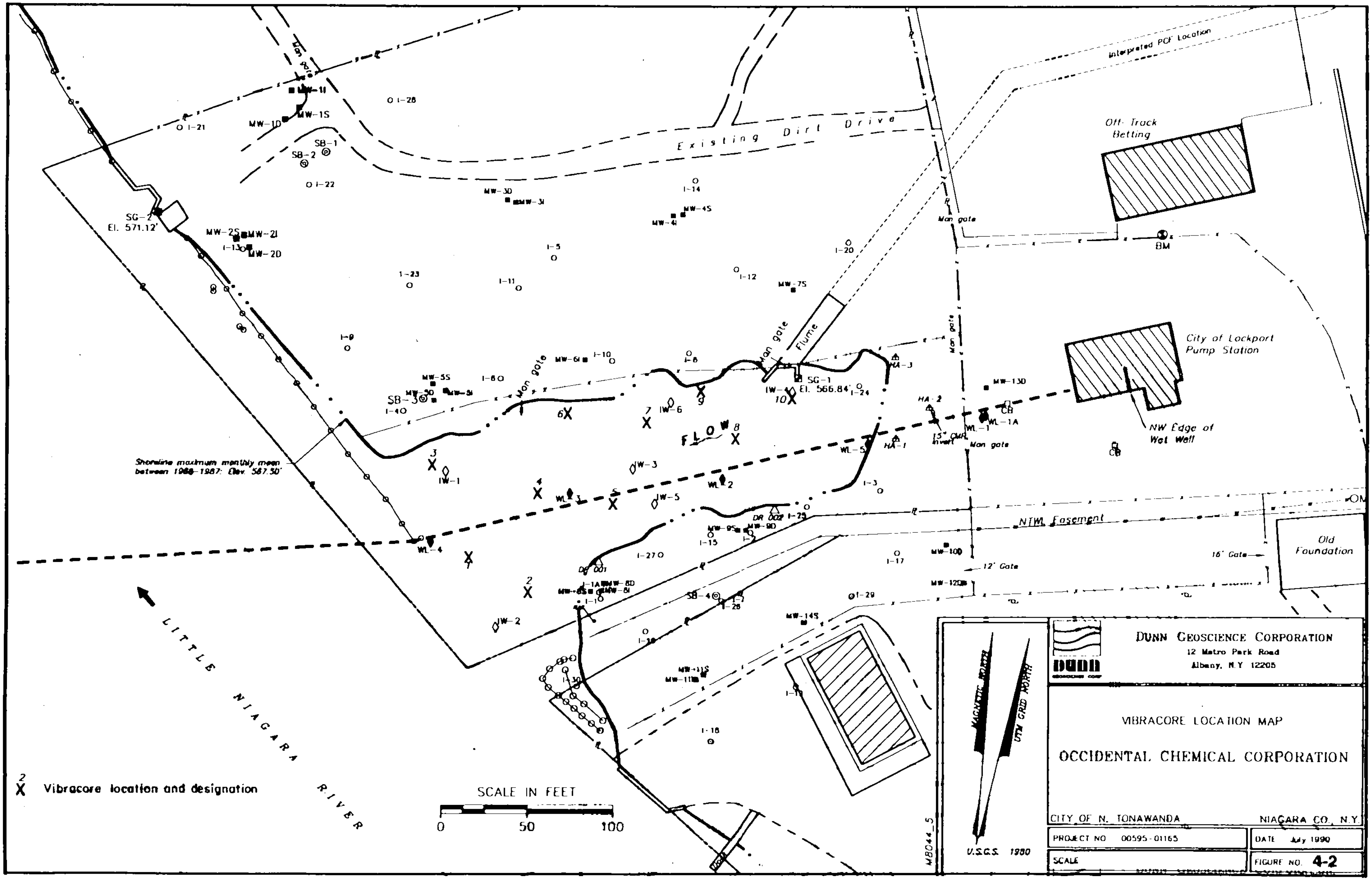
Project No. 00595-01165	Date August 1990
Scale 1"=4 Miles	

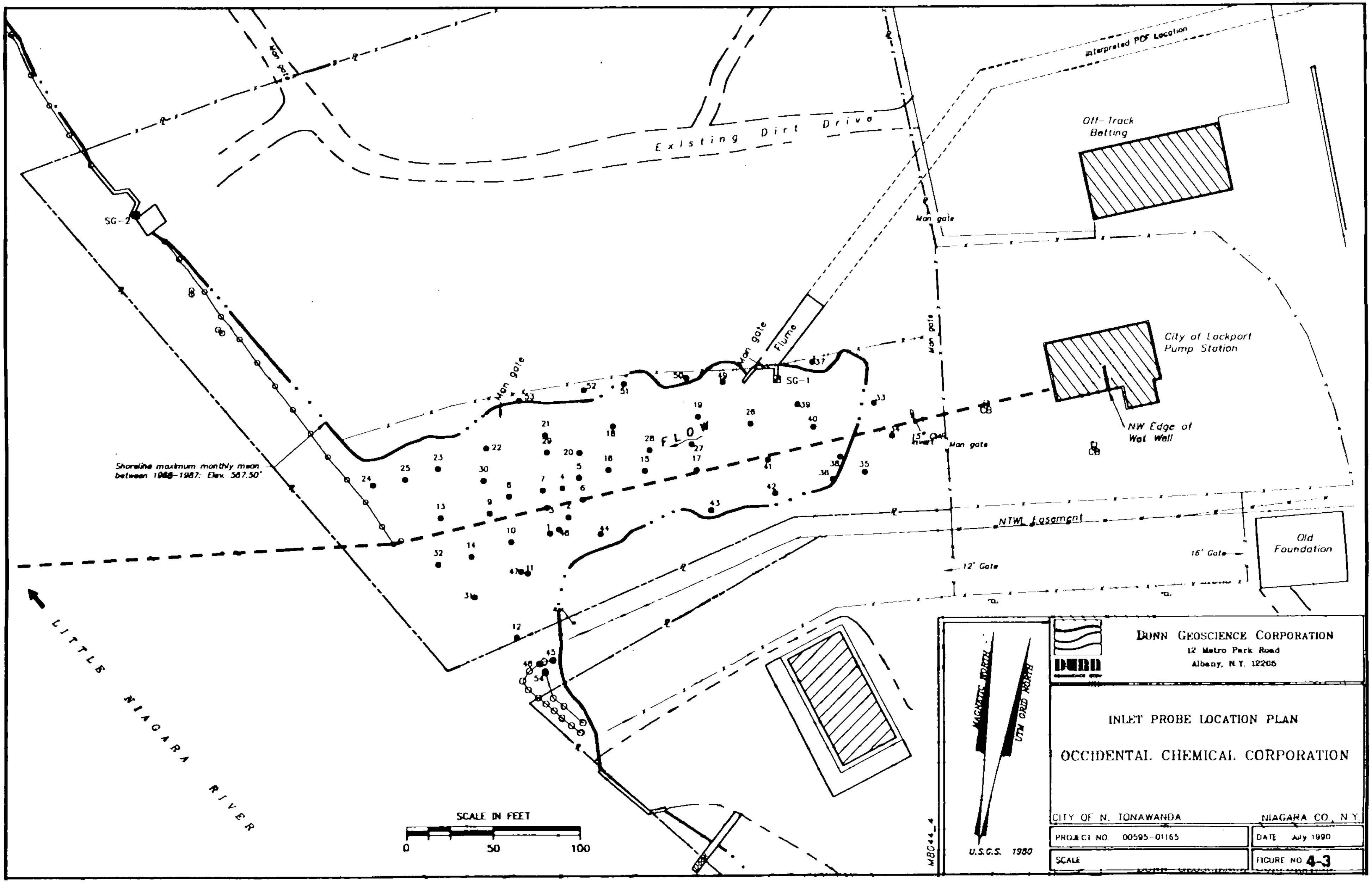
Muller, E.H. 1977. *Quaternary Geology of New York, Niagara Sheet*. Map and Chart Series Number 28: N.Y.S. Education Department/N.Y.S. Museum and Science Service.

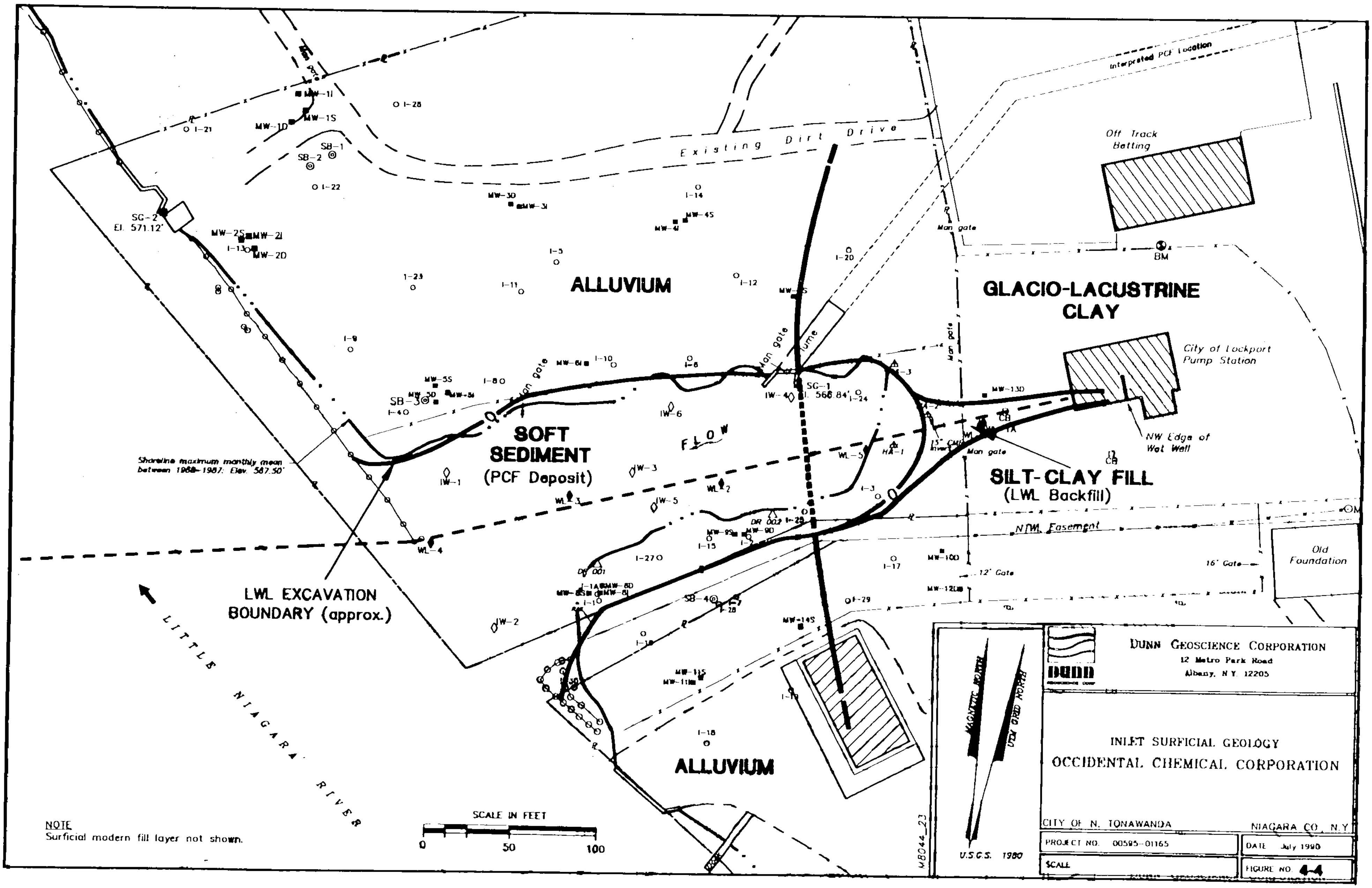


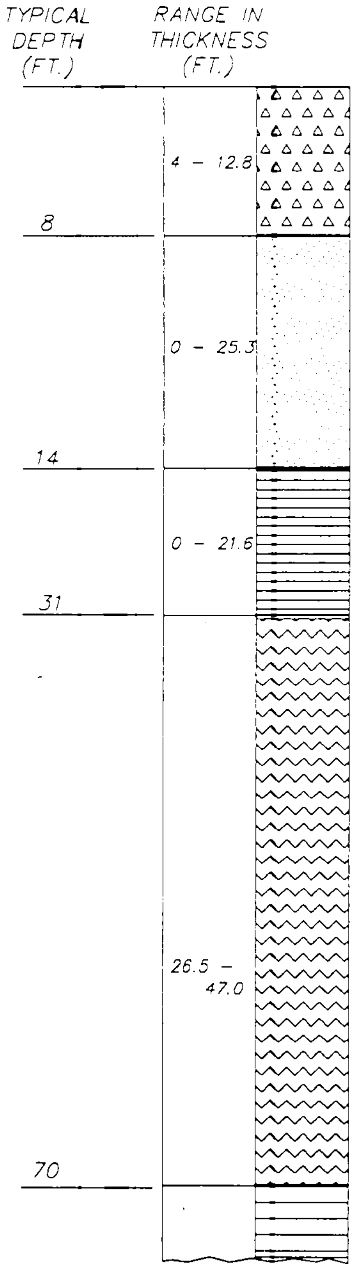
Lawrence, R.V. and Fisher, D.W. 1970. *Geologic Map of New York, Niagara Sheet*. Map and Chart Series Number 15: N.Y.S. Education Department/N.Y.S. Museum and Science


LITTLE NIAGARA RIVER
Existing Dirt Drive
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
FLOW
Flume
Man gate
NTWL Easement
Old Foundation
Shoreline maximum monthly mean between 1988 1987; Elev. 567.6'
Interpreted PCF Location
0 10' 50' 100'
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
BORING & MONITORING WELL LOCATION MAP
INLET MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE Jan 1991
SCALE 1" = 50'
FIGURE NO. 4-1


Existing Dirt Drive
Interpreted PCF Location
Off- Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Old Foundation
NTWL Easement
FLOW
Flume
Man gate
12' Gate
16' Gate
SG-2 El. 571.12'
SG-1 El. 566.84'
Shoreline maximum monthly mean between 1988-1987: Elev. 567.50'
LITTLE NIAGARA RIVER
Vibracore location and designation
SCALE IN FEET
0 50 100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
M8044_5
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
VIBRACORE LOCATION MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO. N.Y.
PROJECT NO 00595-01165
DATE July 1990
SCALE
FIGURE NO. 4-2


Interpreted PCF Location
Existing Dirt Drive
Man gate
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Flume
SG-1
SG-2
FLOW
15" CMP Invert
NTWL Easement
16' Gate
12' Gate
Old Foundation
Shoreline maximum monthly mean between 1988-1987: Elev. 567.50'
LITTLE NIAGARA RIVER
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
INLET PROBE LOCATION PLAN
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE
FIGURE NO. 4-3


ALLUVIUM
GLACIO-LACUSTRINE CLAY
SOFT SEDIMENT
(PCF Deposit)
SILT-CLAY FILL
(LWL Backfill)
ALLUVIUM
LWL EXCAVATION BOUNDARY (approx.)
LITTLE NIAGARA RIVER
FLOW
Existing Dirt Drive
Interpreted PCF Location
Off Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Shoreline maximum monthly mean between 1968-1987. Elev. 567.50'
SG-2 El. 571.12'
SG-1 El. 568.84'
Man gate
Flume
NTWL Easement
Old Foundation
16' Gate
12' Gate
BM
NOTE
Surficial modern fill layer not shown.
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
M8044_23
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
INLET SURFICIAL GEOLOGY
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE
FIGURE NO. 4-4



STRATIGRAPHIC UNIT

FILL – Surficial modern fill materials including slag, bricks, concrete, railroad ballast, sand, gravel, silt and clay.

ALLUVIUM Dark gray silty fine to medium sand in upper part grading to coarse to fine sand with medium to fine gravel in lower part; occasional pockets of gravel; undifferentiated natural alluvium or redeposited dredged river material; shells are commonly present

GLACIO-LACUSTRINE CLAY – Red brown silty clay, highly plastic, varved; locally removed by erosion.

TILL – Red brown silty clay with a little fine sand and fine gravel in the upper part, and silt and clay with a little fine sand and fine gravel in the lower part; lower till is relatively more dense.

BEDROCK – Camillus Shale

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany N.Y., 12205

DUNN GEOSCIENCE CORP

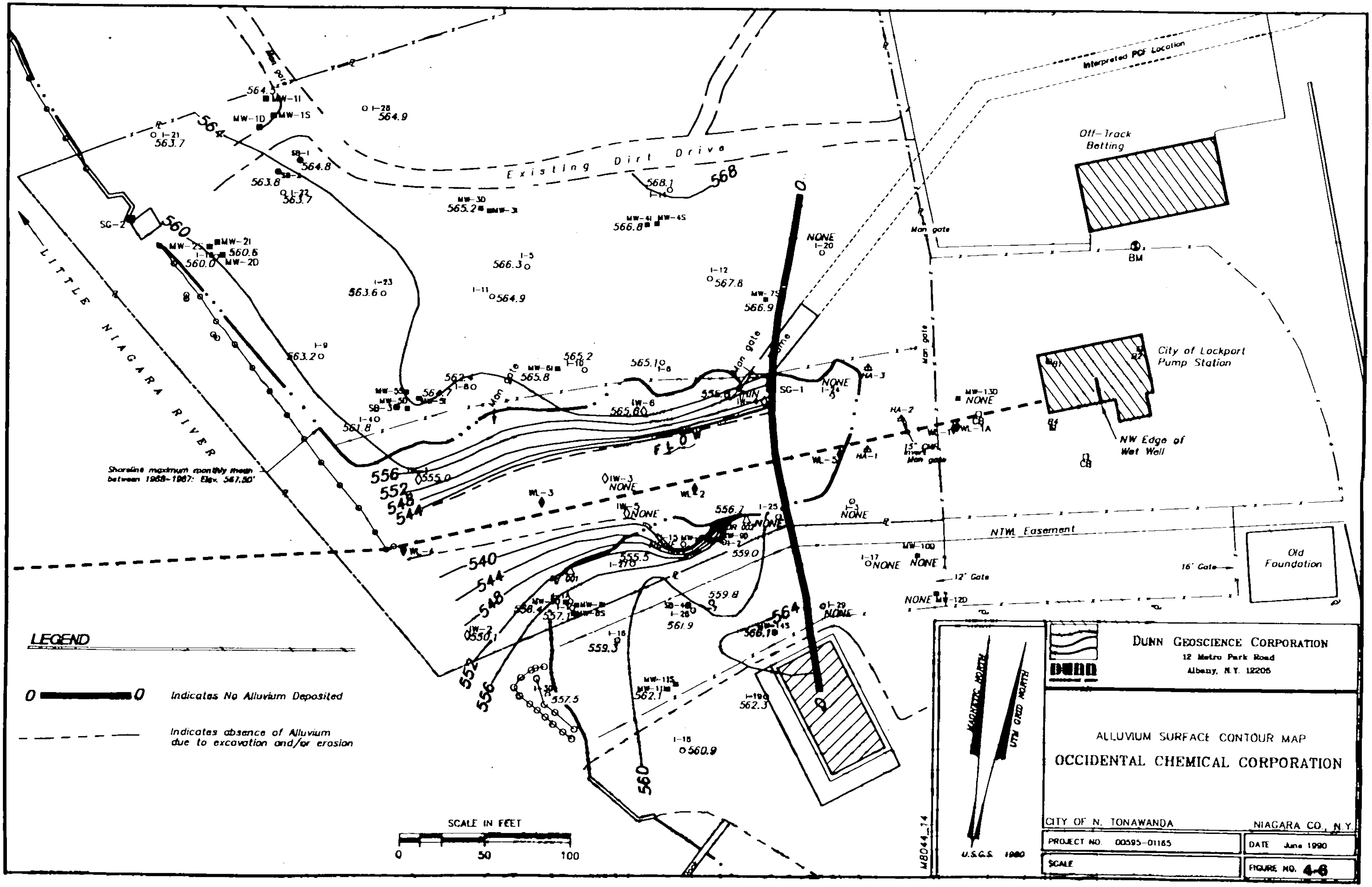
TYPICAL STRATIGRAPHY
INLET PERIMETER AREA

OCCIDENTAL CHEMICAL CORP.

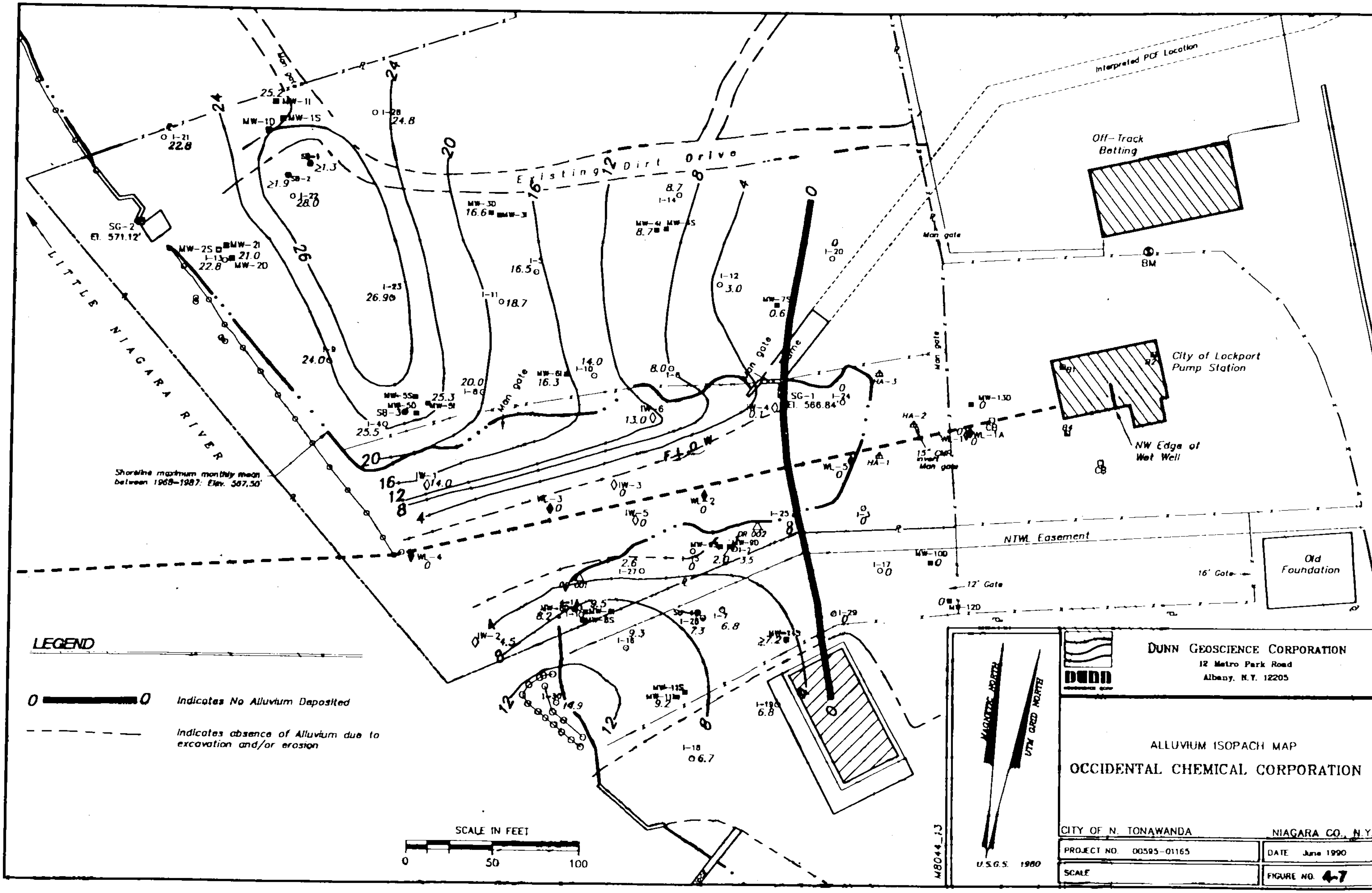
City of North Tonawanda, Niagara Co., N.Y.

C232 – 4/10/90

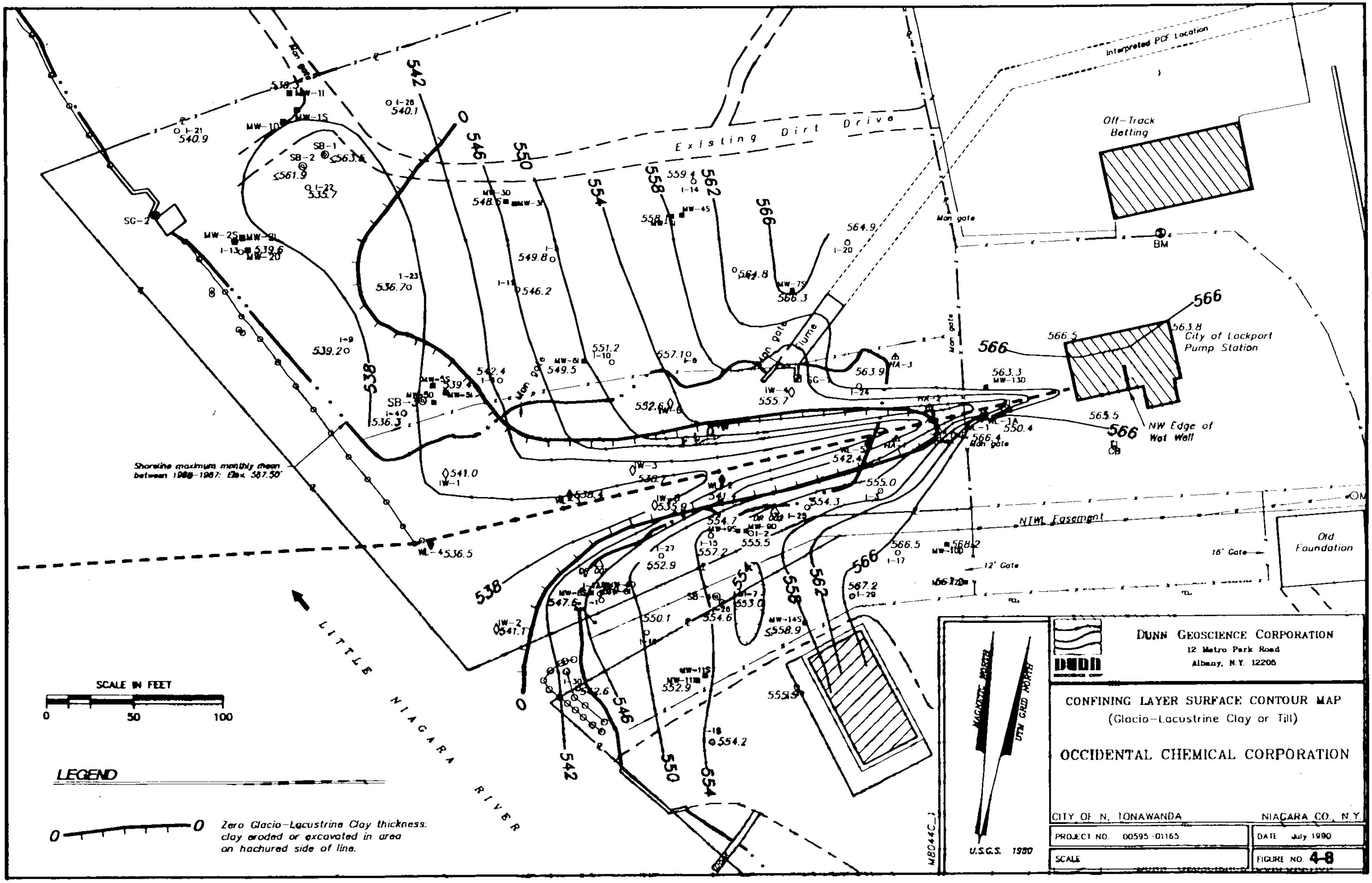
PROJECT NO. 00595-01165	DATE Aug. 1990	SCALE No Scale	FIGURE NO. 4–5



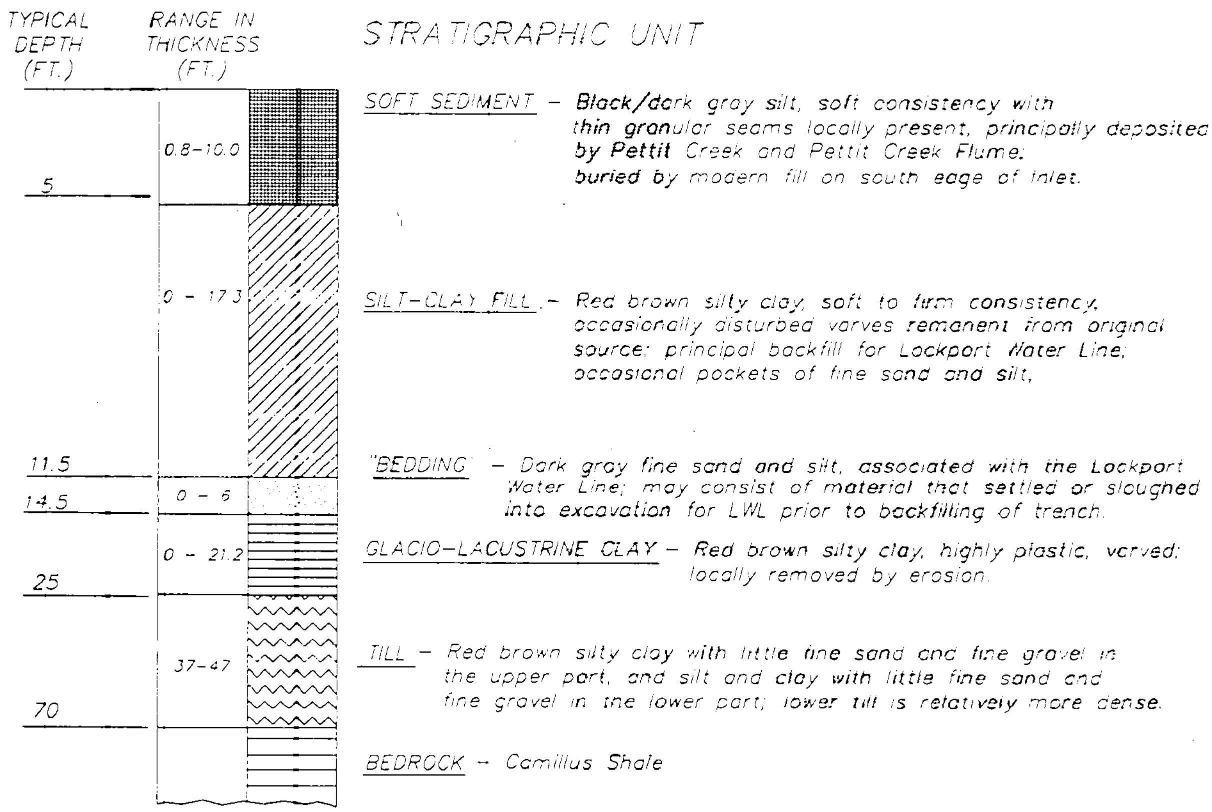
LEGEND
Indicates No Alluvium Deposited
Indicates absence of Alluvium due to excavation and/or erosion
SCALE IN FEET
0 50 100
LITTLE NIAGARA RIVER
Shoreline maximum monthly mean between 1968-1987: Elev. 567.50'
Existing Dirt Drive
Interpreted PCF Location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
NTWL Easement
Old Foundation
16' Gate
12' Gate
Man gate
FLOW
BM
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
ALLUVIUM SURFACE CONTOUR MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE June 1990
SCALE
FIGURE NO. 4-6
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
MB044.14



LEGEND
0 ——— 0 Indicates No Alluvium Deposited
Indicates absence of Alluvium due to excavation and/or erosion
SCALE IN FEET
0 50 100
LITTLE NIAGARA RIVER
Shoreline maximum monthly mean between 1968–1987: Elev. 567.50'
Existing Dirt Drive
FLOW
Interpreted PCF Location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
NTWL Easement
Old Foundation
16' Gate
12' Gate
Man gate
SG-2 El. 571.12'
SG-1 El. 566.84'
BM
U.S.G.S. 1980
MAGNETIC NORTH
UTM GRID NORTH
W8044_13
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
ALLUVIUM ISOPACH MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE June 1990
SCALE
FIGURE NO. 4-7



DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
CONFINING LAYER SURFACE CONTOUR MAP
(Glacio-Lacustrine Clay or Till)
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE
FIGURE NO. 4-8
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
MB044C_1
SCALE IN FEET
0
50
100
LEGEND
Zero Glacio-Lacustrine Clay thickness: clay eroded or excavated in area on hachured side of line.
LITTLE NIAGARA RIVER
Shoreline maximum monthly mean between 1900-1987: Elev. 567.50'
Existing Dirt Drive
Interpreted PCF Location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
NTWL Easement
Old Foundation
16' Gate
12' Gate
Man gate
BM



DUNN GEOSCIENCE CORP

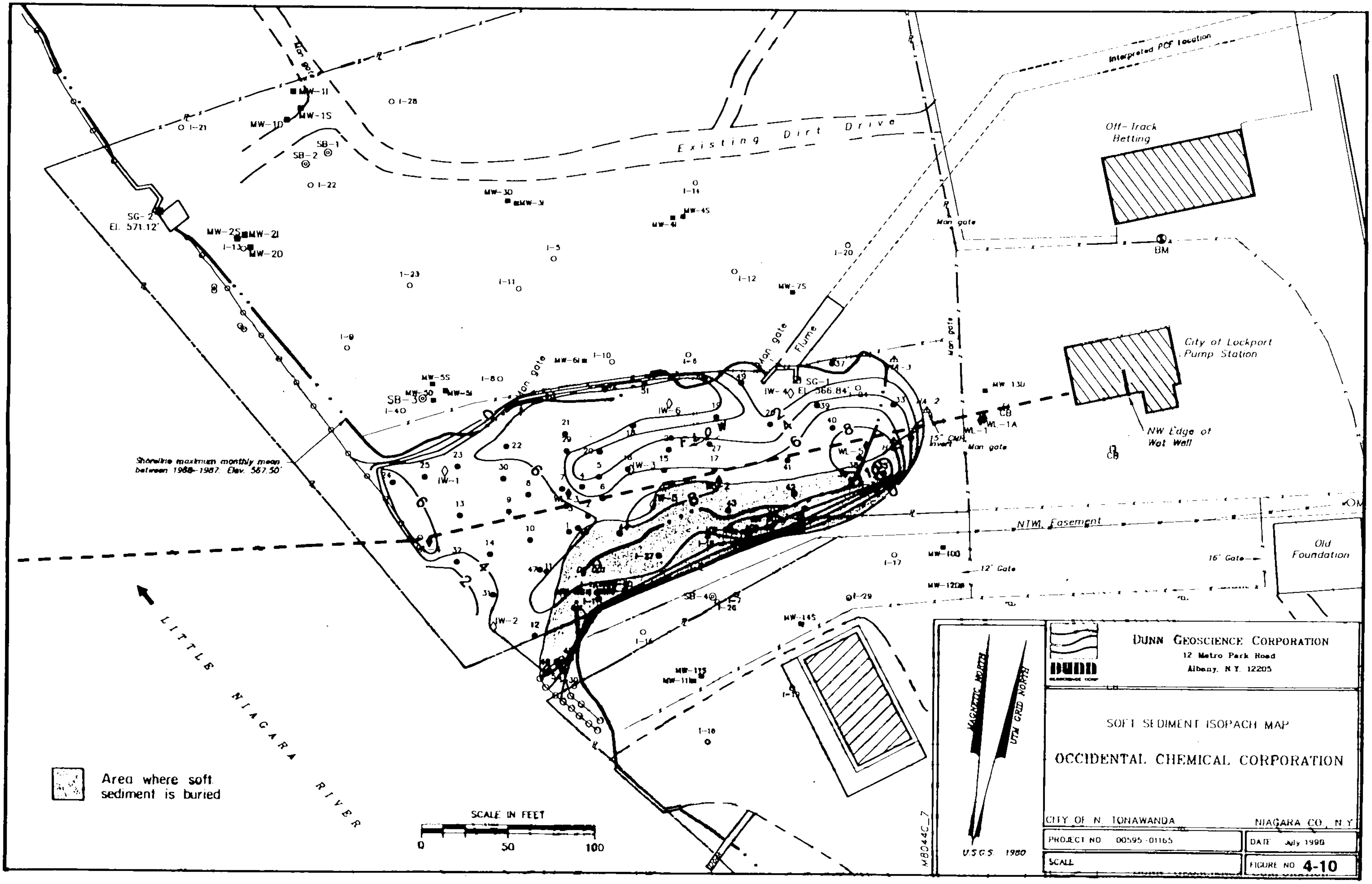
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany N.Y. 12205

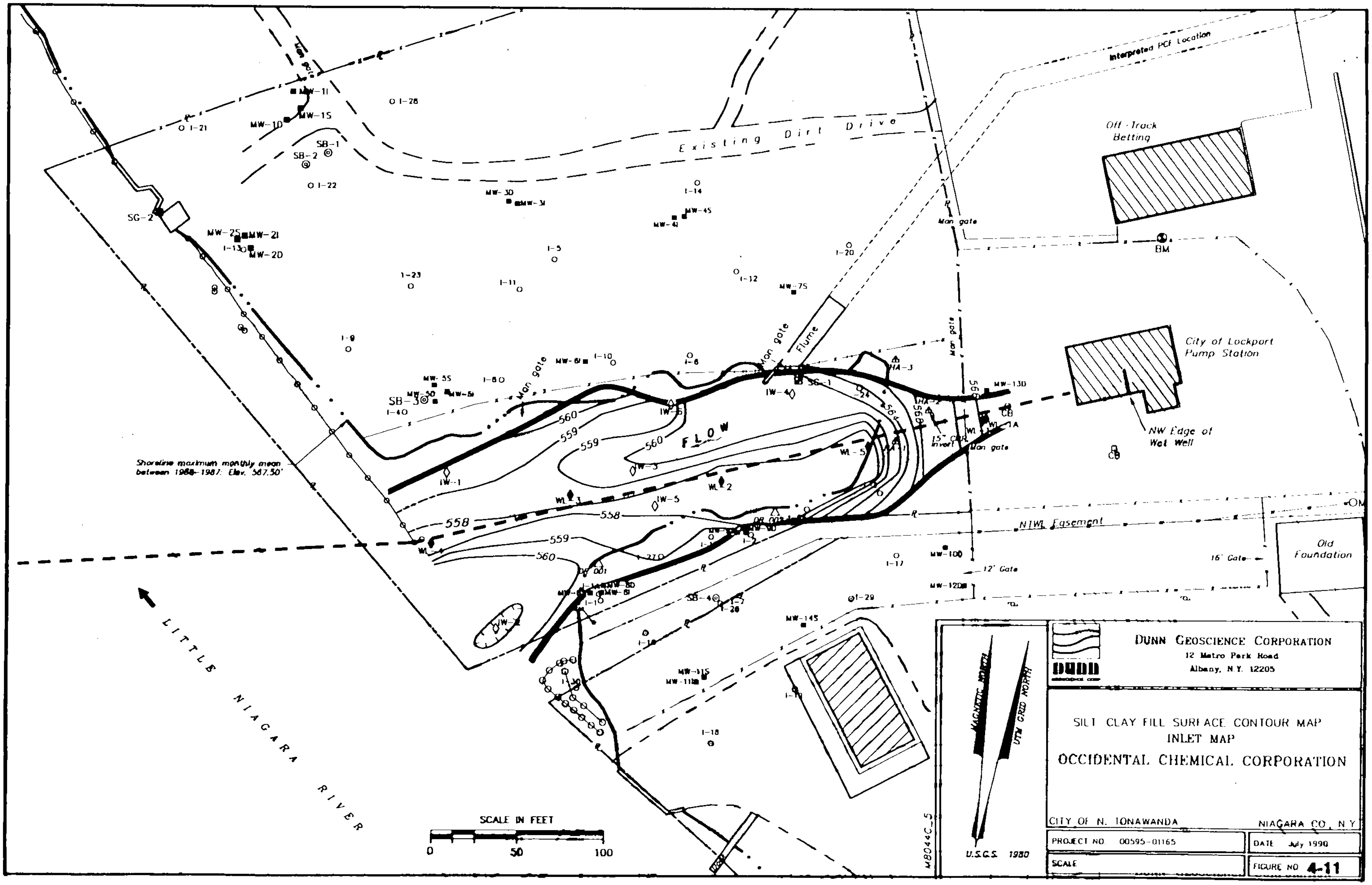
TYPICAL STRATIGRAPHY
INLET/LOCKPORT WATER LINE

OCCIDENTAL CHEMICAL CORP.
City of North Tonawanda, Niagara Co., N.Y.

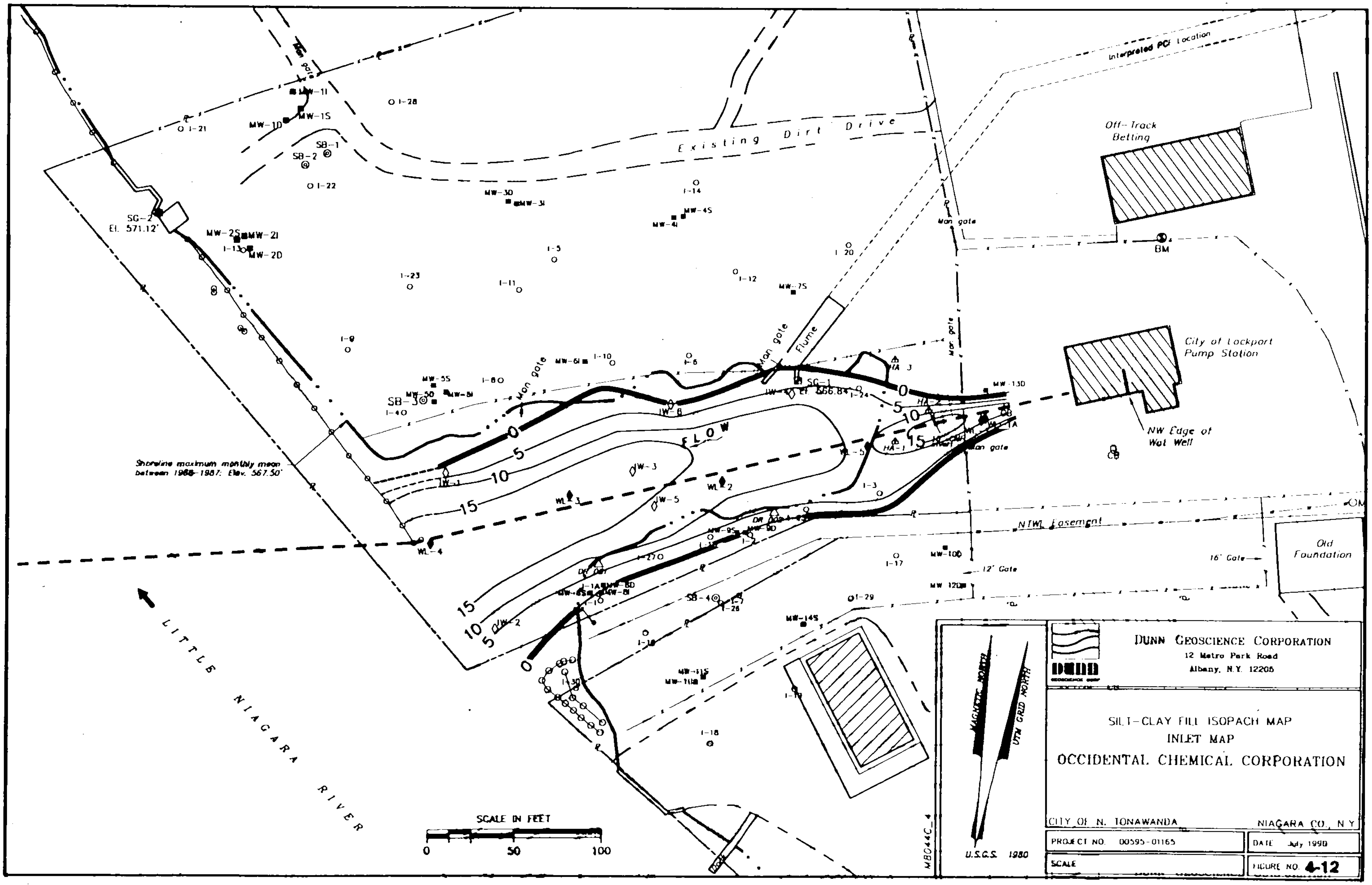
PROJECT NO. 00595-01165	DATE Aug. 1990	SCALE No Scale	FIGURE NO. 4-9

C231 - 4/10/90

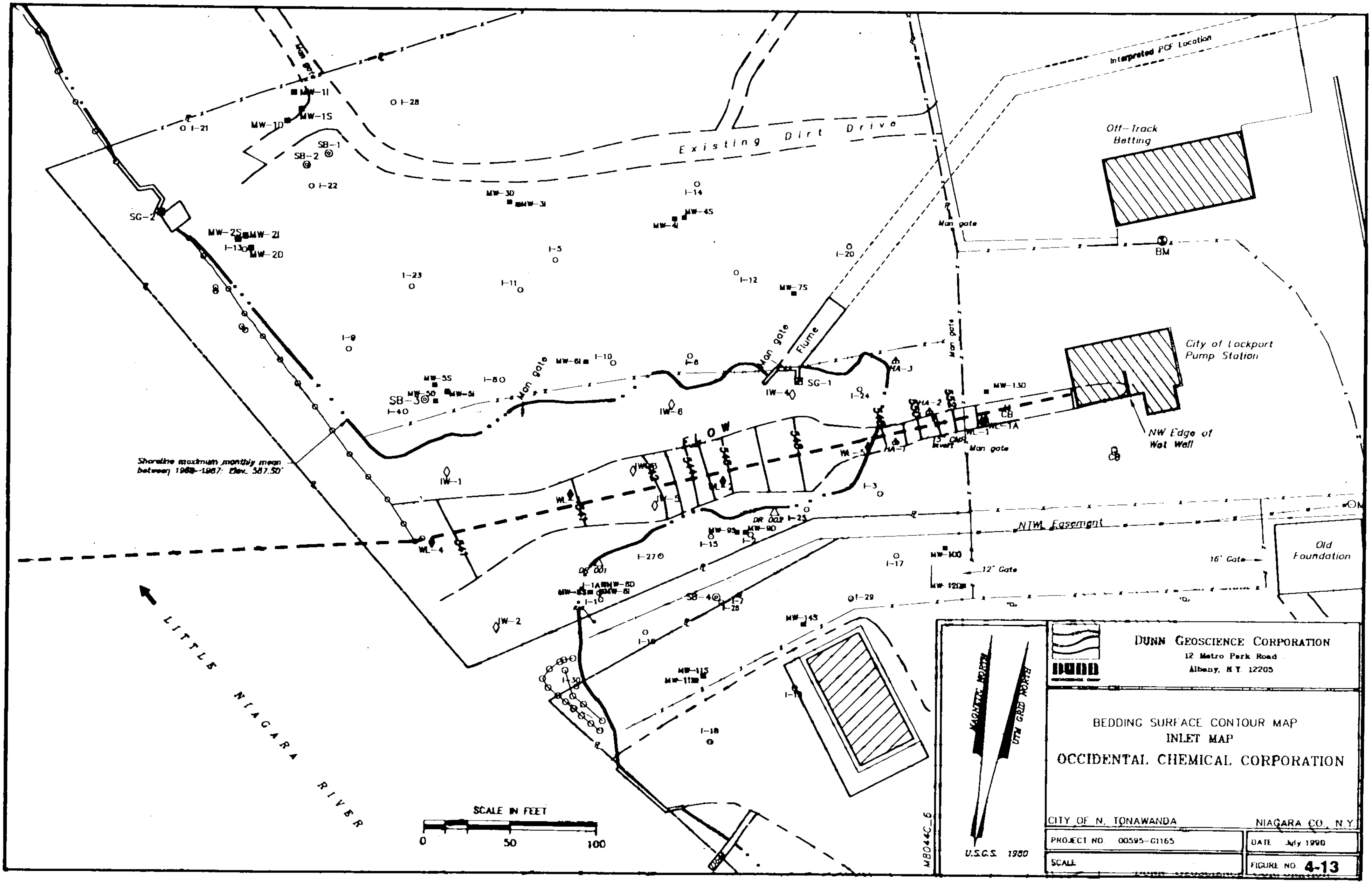

Existing Dirt Drive
Interpreted PCF location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
NTWL Easement
Old Foundation
16' Gate
12' Gate
Man gate
Flume
Shoreline maximum monthly mean between 1968-1987. Elev. 567.50'
LITTLE NIAGARA RIVER
SG-2 El. 571.12'
SG-1 El. 566.84'
Area where soft sediment is buried
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
MB044C_7
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
SOFT SEDIMENT ISOPACH MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE
FIGURE NO. 4-10



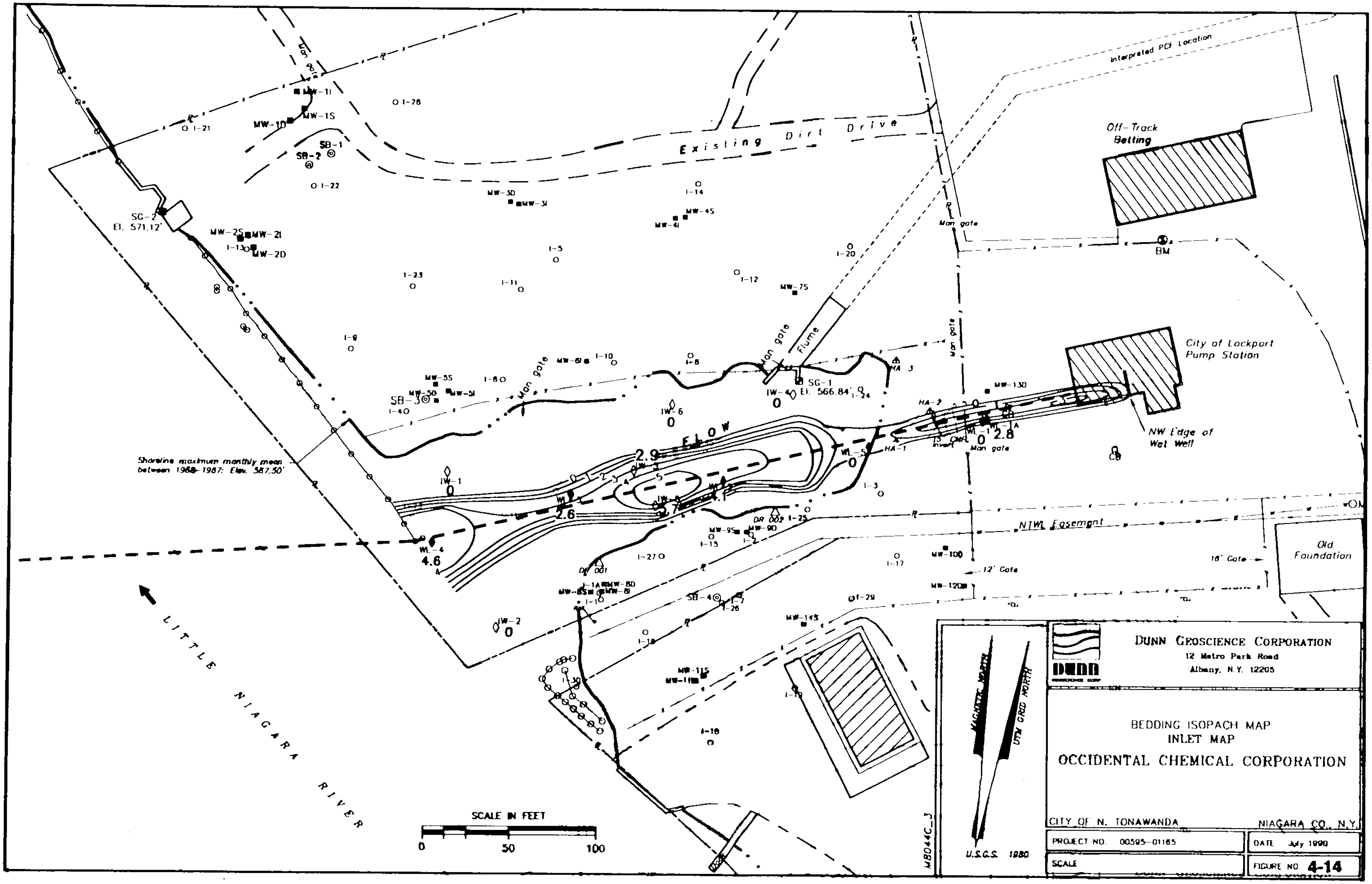
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
SILT CLAY FILL SURFACE CONTOUR MAP
INLET MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE
FIGURE NO. 4-11
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
MB044C_5
SCALE IN FEET
0
50
100
LITTLE NIAGARA RIVER
Shoreline maximum monthly mean between 1988-1987: Elev. 567.50'
Existing Dirt Drive
Interpreted PCF Location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Old Foundation
NIWL Easement
Flume
Man gate
16' Gate
12' Gate
15" CMP Invert
FLOW
BM
CB
558
559
560
564
SG-1
SG-2
SB-1
SB-2
SB-3
SB-4
IW-1
IW-2
IW-3
IW-4
IW-5
IW-6
WL-1
WL-2
WL-3
WL-5
HA-3
MW-1I
MW-1S
MW-1D
MW-2S
MW-2I
MW-2D
MW-3D
MW-3I
MW-4S
MW-4I
MW-5S
MW-5D
MW-6I
MW-7S
MW-10D
MW-12D
MW-13D
MW-14S
MW-11S
I-5
I-6
I-8
I-9
I-10
I-11
I-12
I-14
I-17
I-18
I-20
I-21
I-22
I-23
I-28
I-29



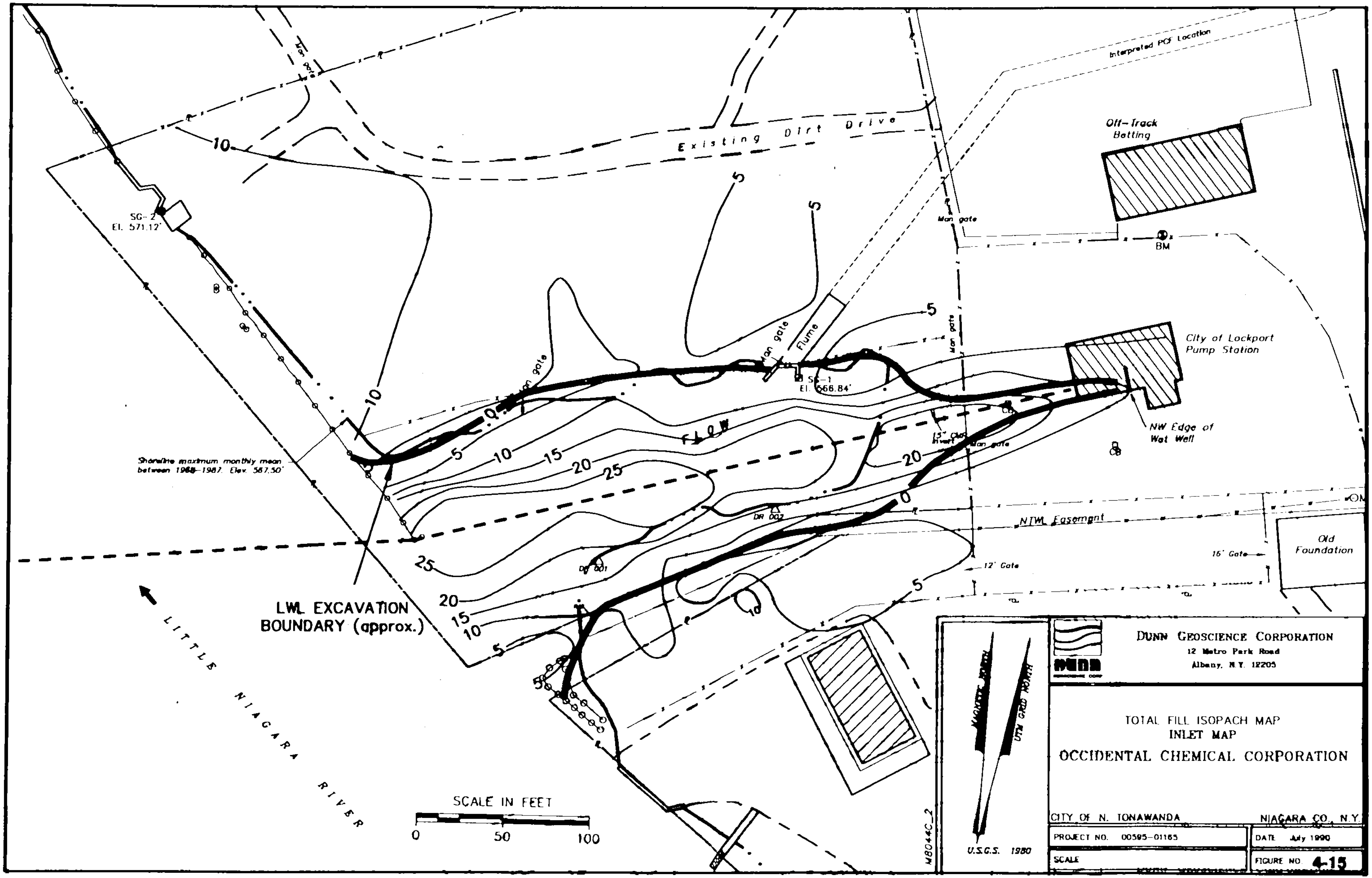
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
SILT-CLAY FILL ISOPACH MAP
INLET MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE
FIGURE NO. 4-12
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
MB044C_4
SCALE IN FEET
0
50
100
LITTLE NIAGARA RIVER
Shoreline maximum monthly mean between 1988-1987; Elev. 567.50'
Existing Dirt Drive
Interpreted PCI Location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Old Foundation
NTWL Easement
Flume
Man gate
12' Gate
16' Gate
FLOW
SG-2
El. 571.12'
SG-1
El. 566.84'
BM
CB
MW-1I
MW-1S
MW-1D
MW-2S
MW-2I
MW-2D
MW-3D
MW-3I
MW-4S
MW-4I
MW-5S
MW-5D
MW-6I
MW-7S
MW-10D
MW-12D
MW-13D
MW-14S
SB-1
SB-2
SB-3
SB-4
WL-1
WL-2
WL-3
WL-4
WL-5
HA-1
HA-3
I-5
I-8
I-9
I-10
I-11
I-12
I-14
I-17
I-18
I-20
I-21
I-22
I-23
I-24
I-26
I-27
I-28
I-29
I-30
I-40



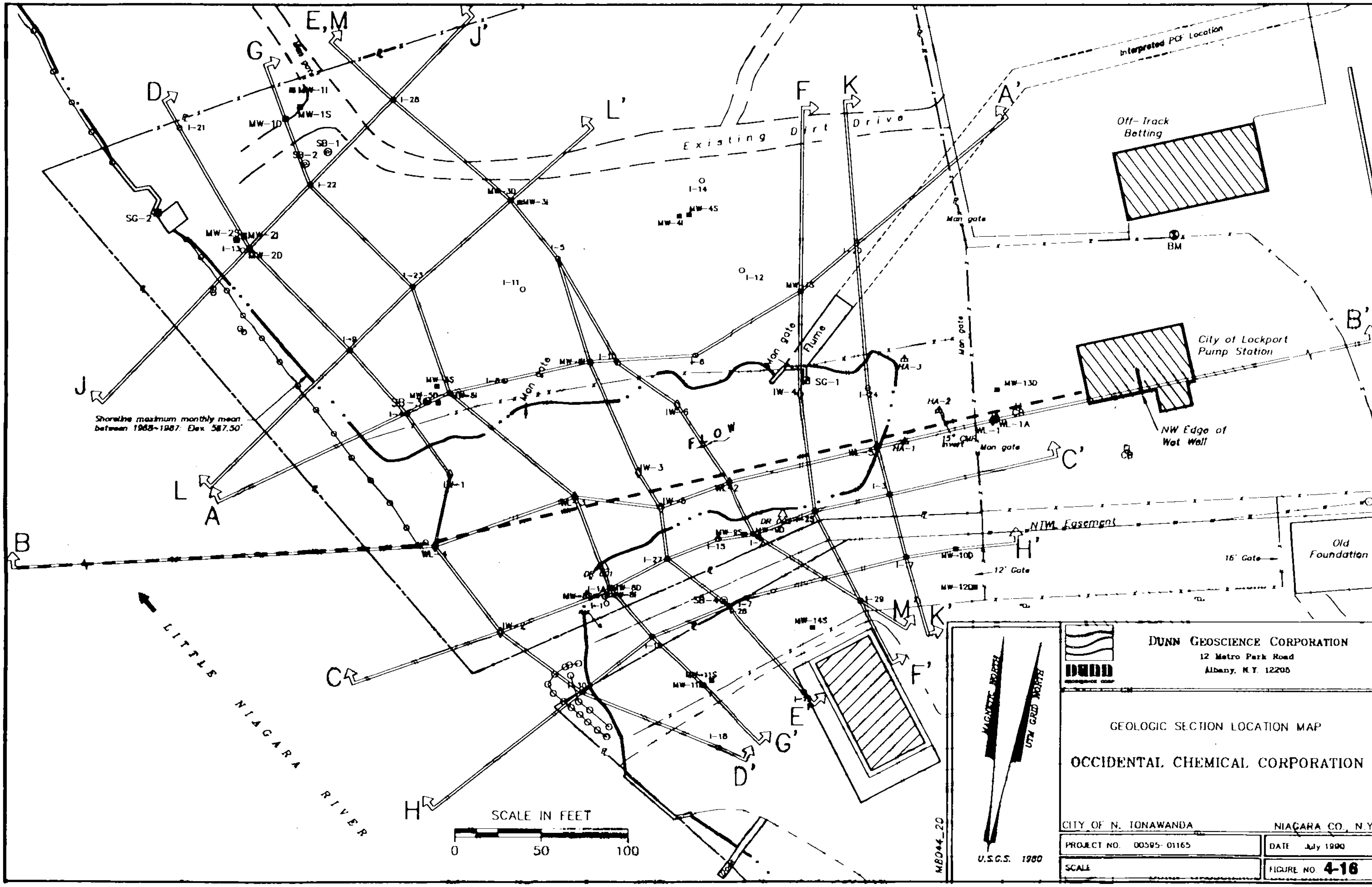
Interpreted PCF Location
Existing Dirt Drive
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Flume
Man gate
FLOW
NIWL Easement
Old Foundation
16' Gate
12" Gate
Shoreline maximum monthly mean between 1960-1987: Elev. 567.50'
LITTLE NIAGARA RIVER
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
MB044C_6
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
BEDDING SURFACE CONTOUR MAP
INLET MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-G1165
DATE July 1990
SCALE
FIGURE NO. 4-13



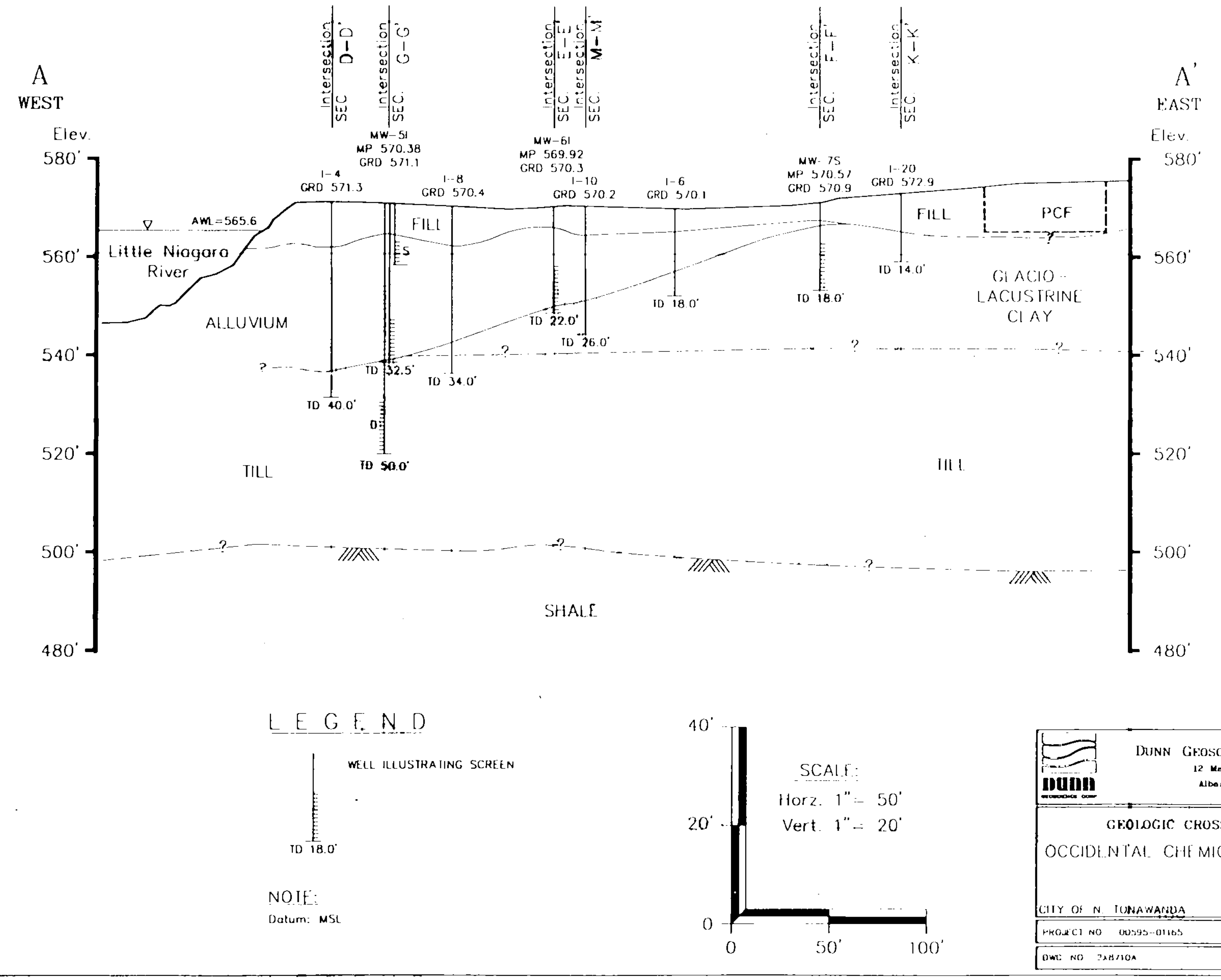
Existing Dirt Drive
Interpreted PCF Location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Shoreline maximum monthly mean between 1988-1987: Elev. 587.50'
LITTLE NIAGARA RIVER
NTWL Easement
Old Foundation
Flume
Man gate
FLOW
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
M8044C_3
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
BEDDING ISOPACH MAP
INLET MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE
FIGURE NO. 4-14



Interpreted PCF Location
Off-Track Betting
Existing Dirt Drive
Man gate
BM
SG-2
El. 571.12'
SG-1
El. 566.84'
Flume
City of Lockport Pump Station
NW Edge of Wet Well
15" CMP Invert
FLOW
Shoreline maximum monthly mean between 1988-1987. Elev. 567.50'
DR 002
DR 001
NTWL Easement
12' Gate
16' Gate
Old Foundation
LWL EXCAVATION BOUNDARY (approx.)
LITTLE NIAGARA RIVER
SCALE IN FEET
0 50 100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
MB044C_2
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
TOTAL FILL ISOPACH MAP
INLET MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00585-01165
DATE July 1990
SCALE
FIGURE NO. 4-15



Interpreted PCF Location
Existing Dirt Drive
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
NTWL Easement
Old Foundation
Flume
Man gate
12' Gate
16' Gate
BM
Flow
Shoreline maximum monthly mean between 1968-1987: Elev. 567.50'
LITTLE NIAGARA RIVER
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
MB044_20
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
GEOLOGIC SECTION LOCATION MAP
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE
FIGURE NO. 4-16



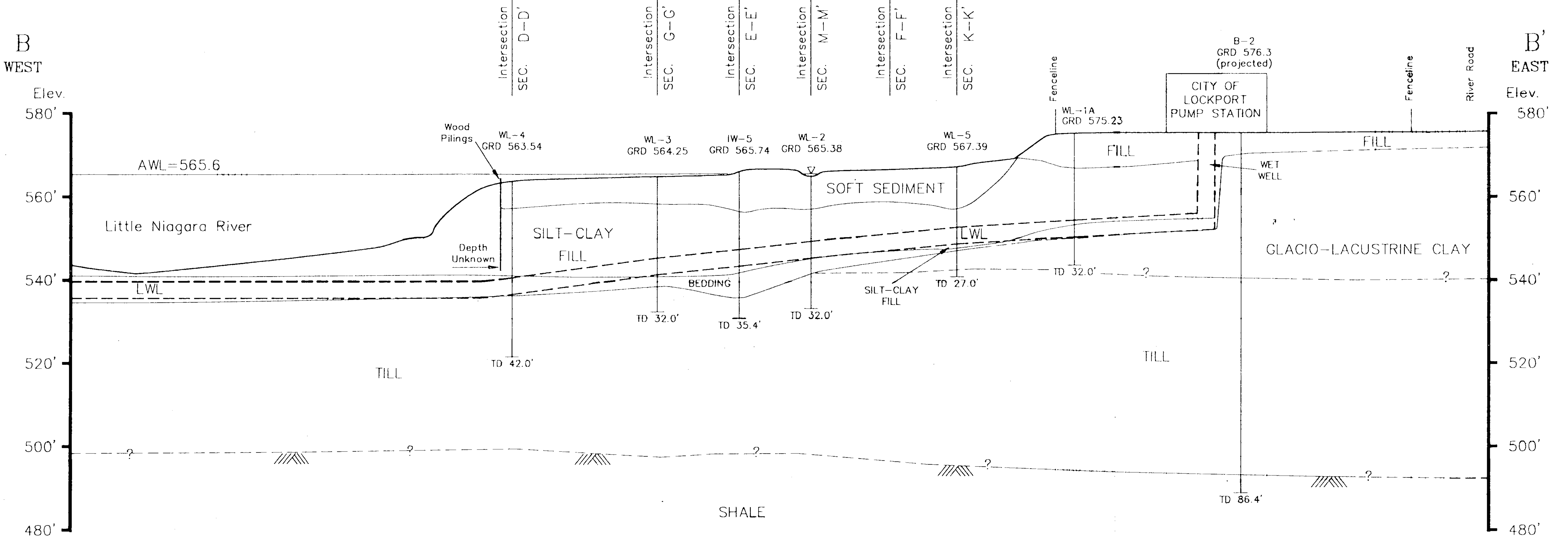
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12206

GEOLOGIC CROSS SECTION A–A'

OCCIDENTAL CHEMICAL CORPORATION

CITY OF N. TONAWANDA — NIAGARA CO., NY

PROJECT NO. 00595–01165	DATE July 1990
DWG NO. 2x8710A	FIGURE NO. 4-16A



L E G E N D

WELL ILLUSTRATING SCREEN

TD 18.0'

NOTE:

Datum: MSL

Subsurface investigation included area east of wood pilings.

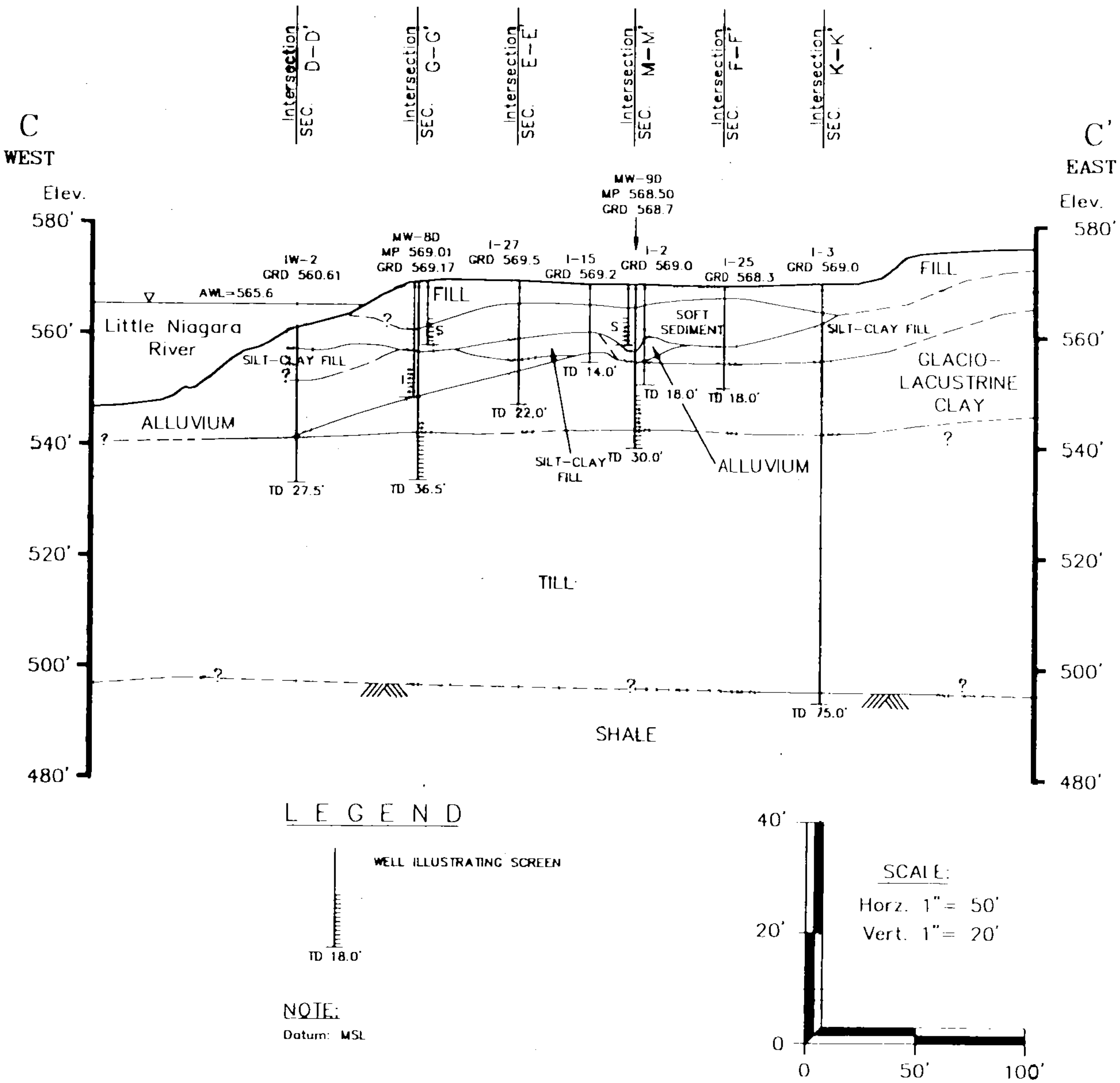
SCALE:
Horz. 1"= 50'
Vert. 1"= 20'

40' 20' 0 — 0 50' 100'

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12205

GEOLOGIC CROSS SECTION B-B'
OCCIDENTAL CHEMICAL CORPORATION
DURAZ DIVISION

CITY OF N. TONAWANDA	NIAGARA CO., NY
PROJECT NO. 00595-01165	DATE July 1990
DWG. NO. 2X8710B	FIGURE NO. 4-16B



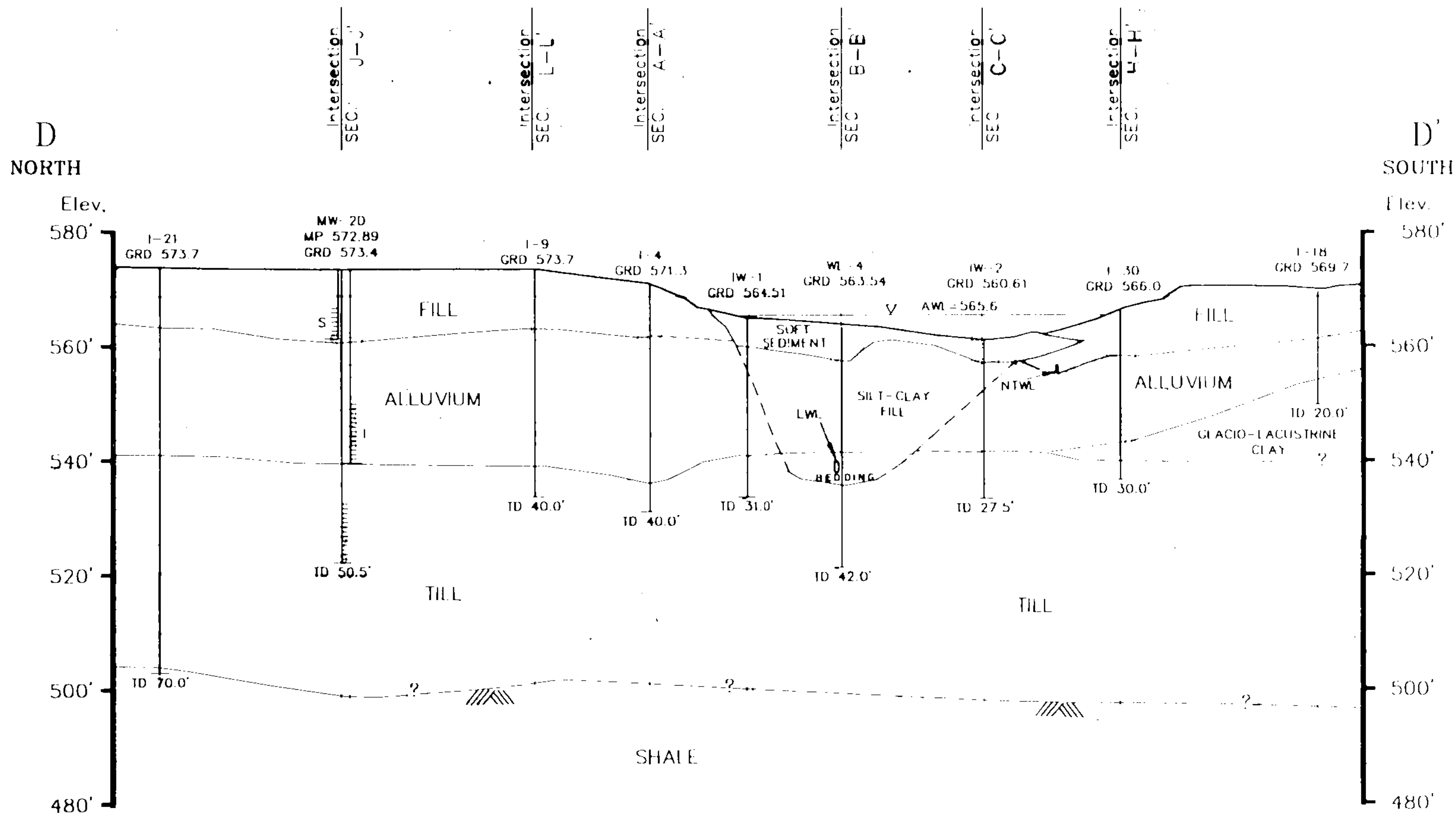
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12206

GEOLOGIC CROSS SECTION C-C'

OCCIDENTAL CHEMICAL CORPORATION

CITY OF N. TONAWANDA NIAGARA CO.,NY

PROJECT NO. 00595-01165	DATE July 1990
DWG NO. 2X8710C	FIGURE NO. 4-16C



LEGEND

WELL ILLUSTRATING SCREEN

TD 18.0'

NOTE:
Datum: MSL

SCALE
Horz. 1" = 50'
Vert. 1" = 20'

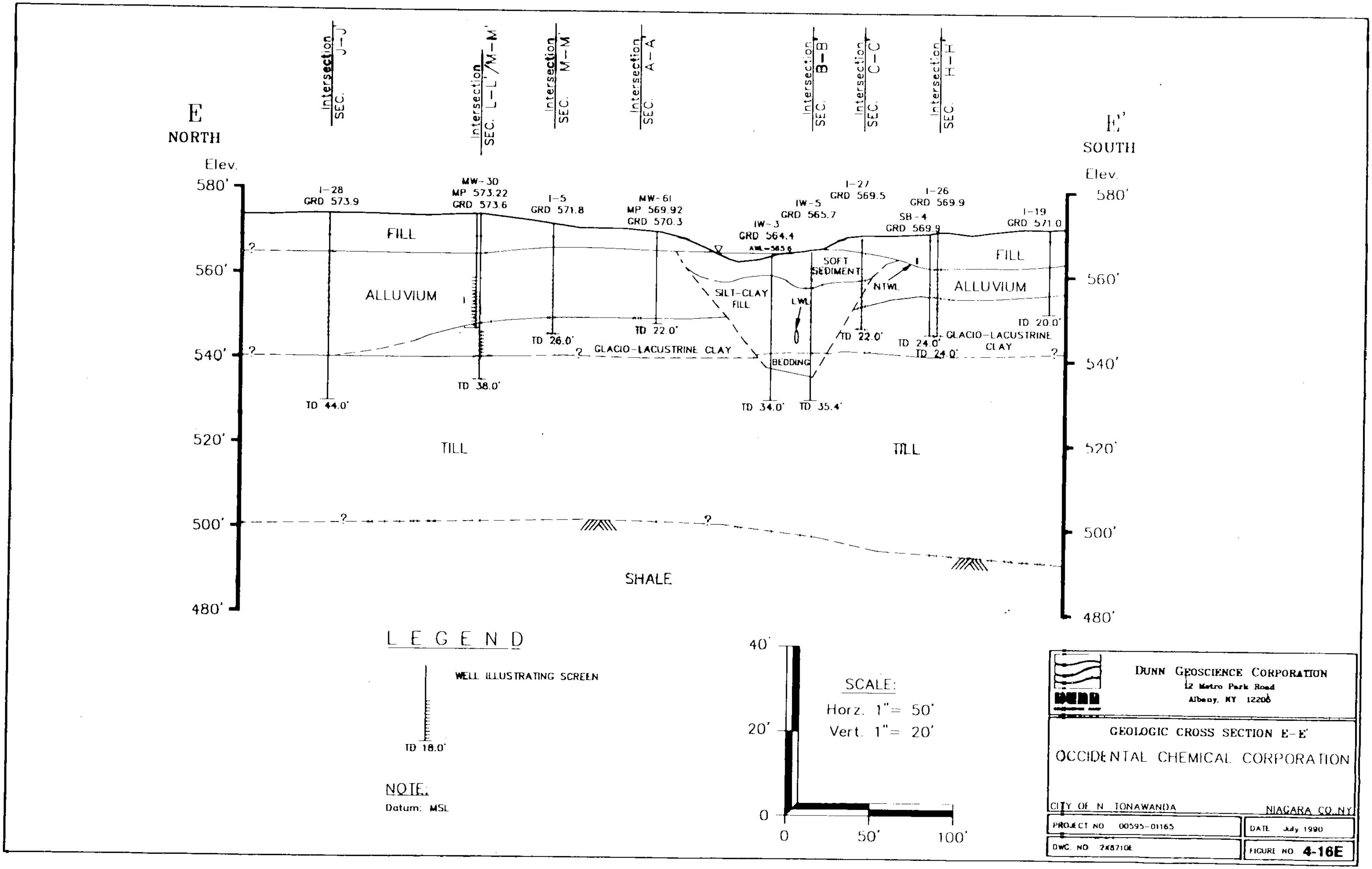
0, 20', 40' / 0, 50', 100'

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12205

GEOLOGIC CROSS SECTION D D'
OCCIDENTAL CHEMICAL CORPORATION

CITY OF N. TONAWANDA — NIAGARA CO. NY

PROJECT NO. 00595 01165	DATE July 1990
DWG NO. 2X87100	FIGURE NO. **4-16D**



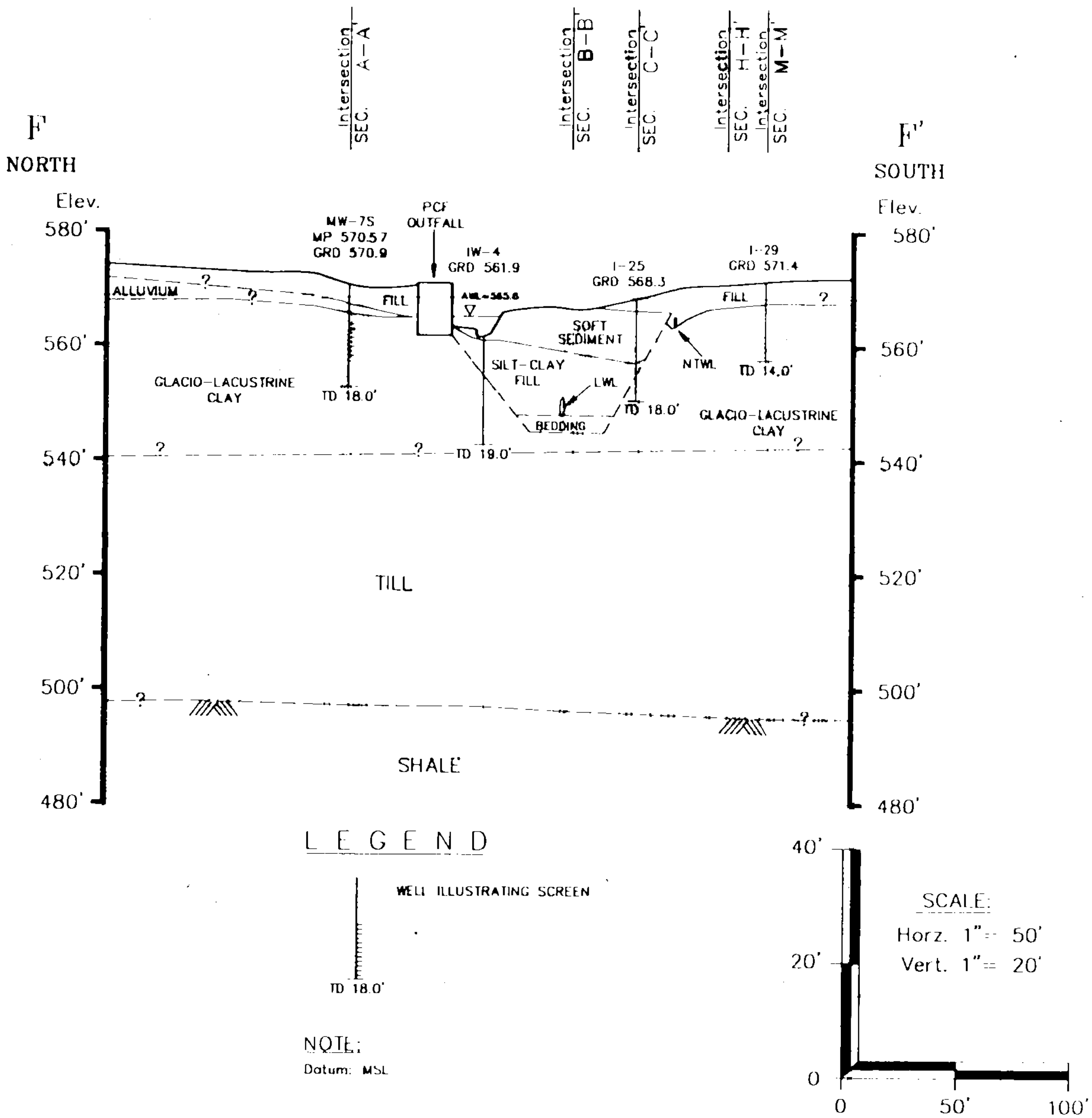
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12205

GEOLOGIC CROSS SECTION E-E'

OCCIDENTAL CHEMICAL CORPORATION

CITY OF N. TONAWANDA — NIAGARA CO. NY

PROJECT NO. 00595-01165	DATE July 1990
DWG. NO. 2X8710E	FIGURE NO. 4-16E



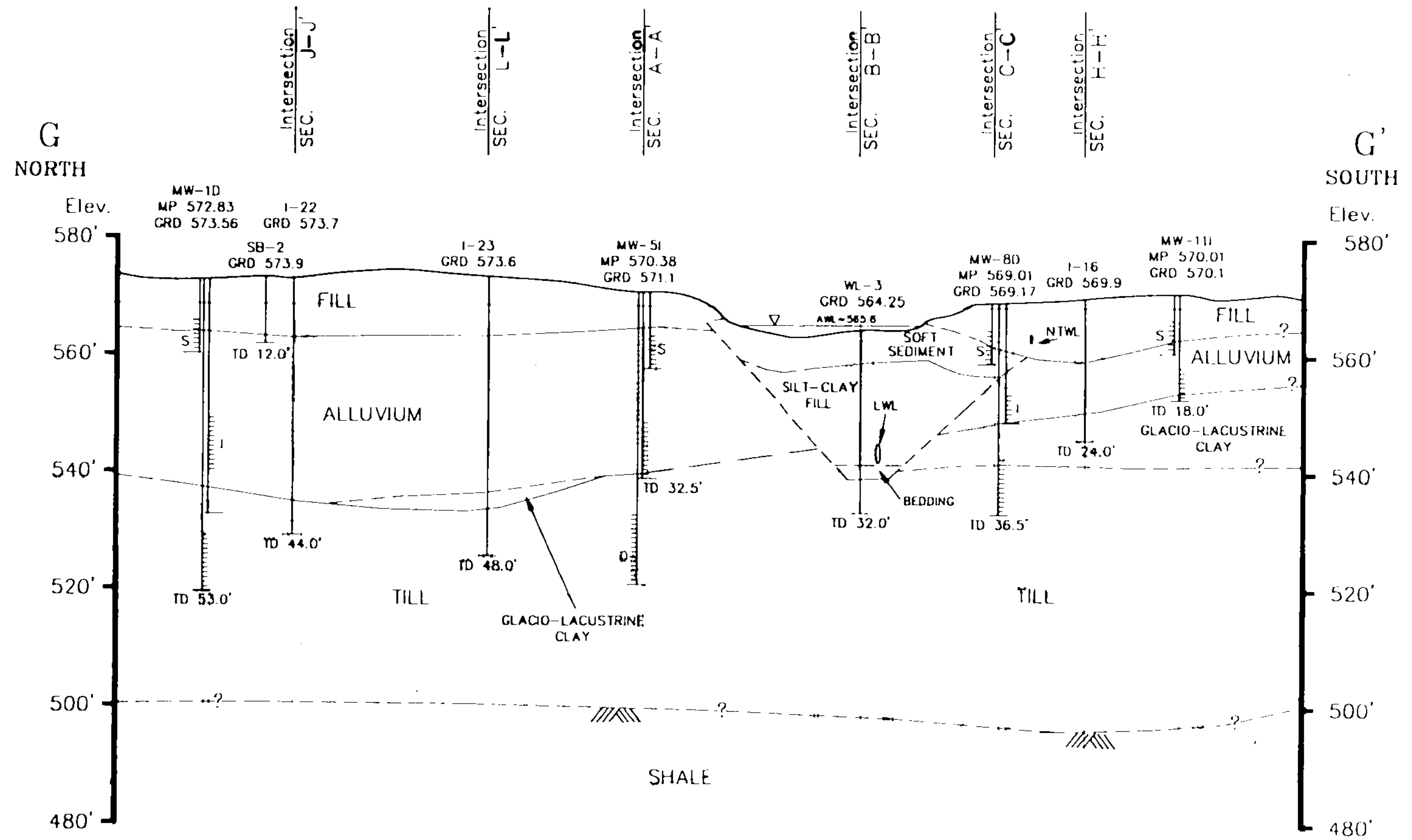
SCALE:
Horz. 1" = 50'
Vert. 1" = 20'

NOTE:
Datum: MSL

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12205

GEOLOGIC CROSS SECTION F-F'
OCCIDENTAL CHEMICAL CORPORATION

CITY OF N. TONAWANDA | NIAGARA CO, NY
PROJECT NO. 00595-01165 | DATE July 1990
DWG NO. 2x8710FF | FIGURE NO. 4-16F

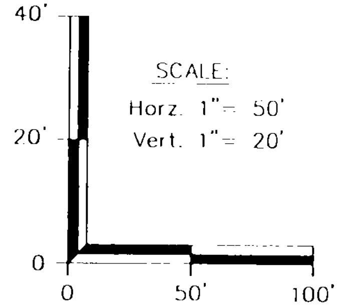


LEGEND

WELL ILLUSTRATING SCREEN

TD 18.0'

NOTE:
Datum: MSL



SCALE:
Horz. 1" = 50'
Vert. 1" = 20'

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12205

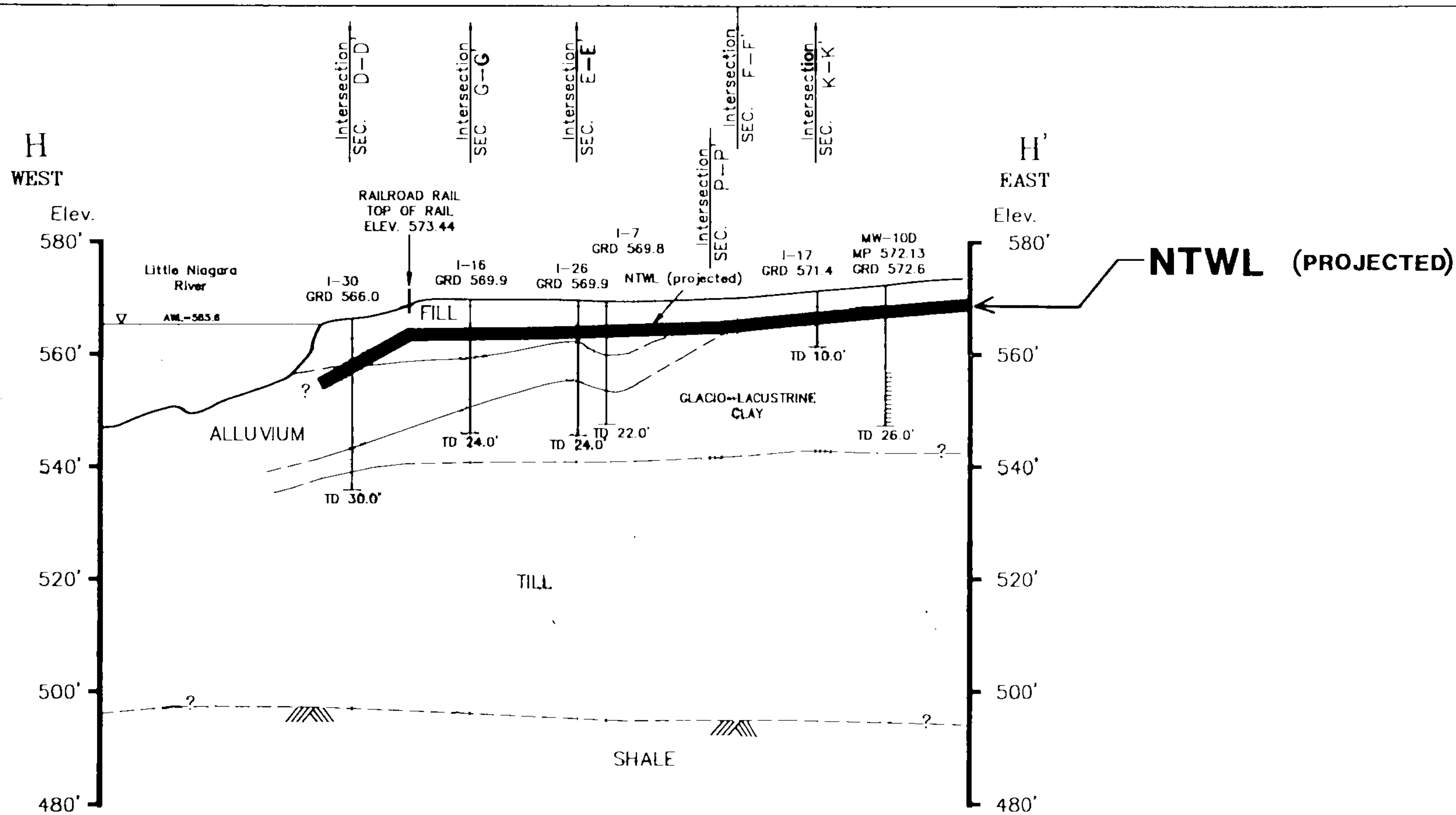
GEOLOGIC CROSS SECTION G-G'

OCCIDENTAL CHEMICAL CORPORATION

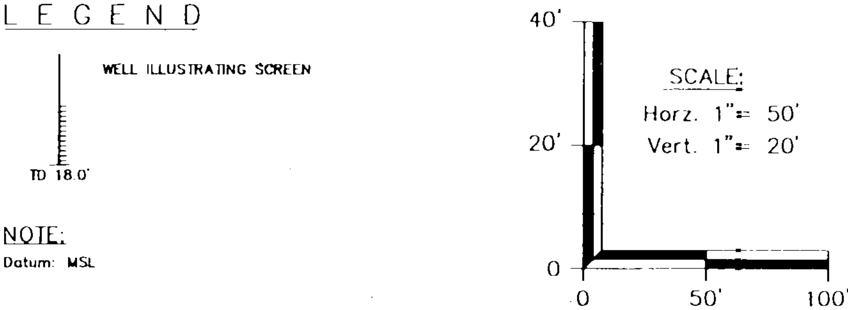
CITY OF N. TONAWANDA — NIAGARA CO., NY

PROJECT NO. 00595-01165 — DATE July 1990

DWG. NO. 2x87100 — FIGURE NO. 4-16G



LEGEND



SCALE:
Horz. 1" = 50'
Vert. 1" = 20'

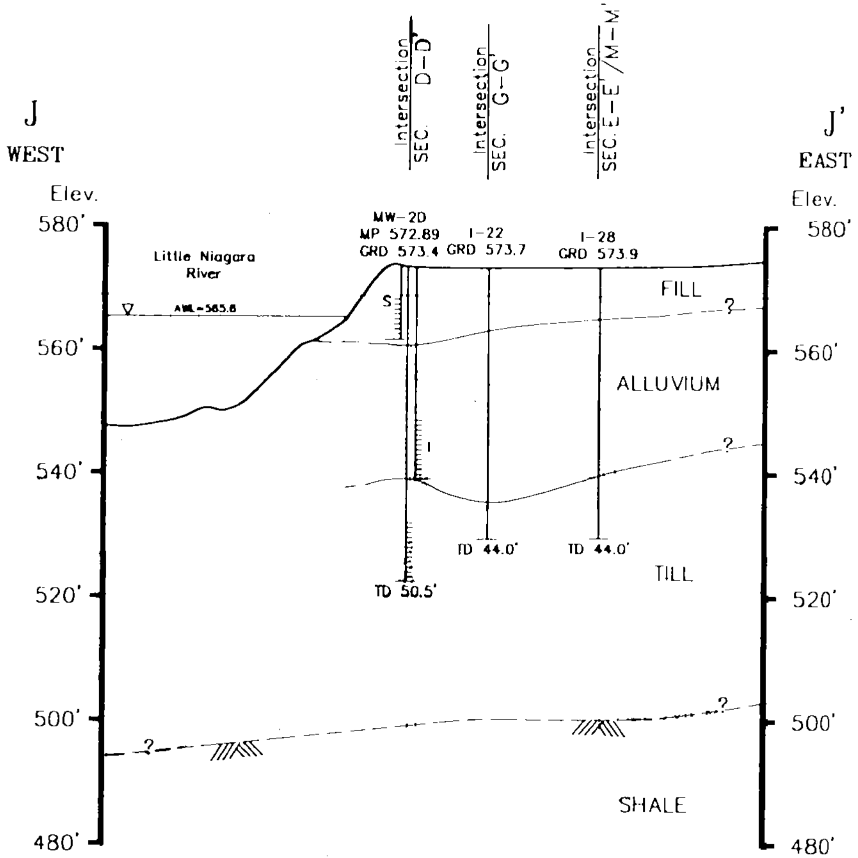
NOTE:
Datum: MSL

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12206

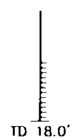
GEOLOGIC CROSS SECTION H-H'
OCCIDENTAL CHEMICAL CORPORATION

CITY OF N. TONAWANDA — NIAGARA CO., NY

PROJECT NO. 00595-01185	DATE July 1990
DWG NO. 2X8710I	FIGURE NO. 4-16H

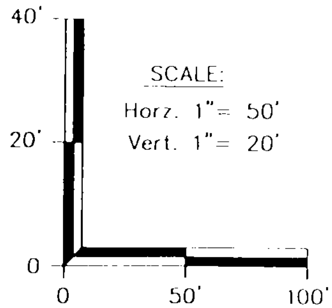


LEGEND



WELL ILLUSTRATING SCREEN

NOTE:
Datum: MSL



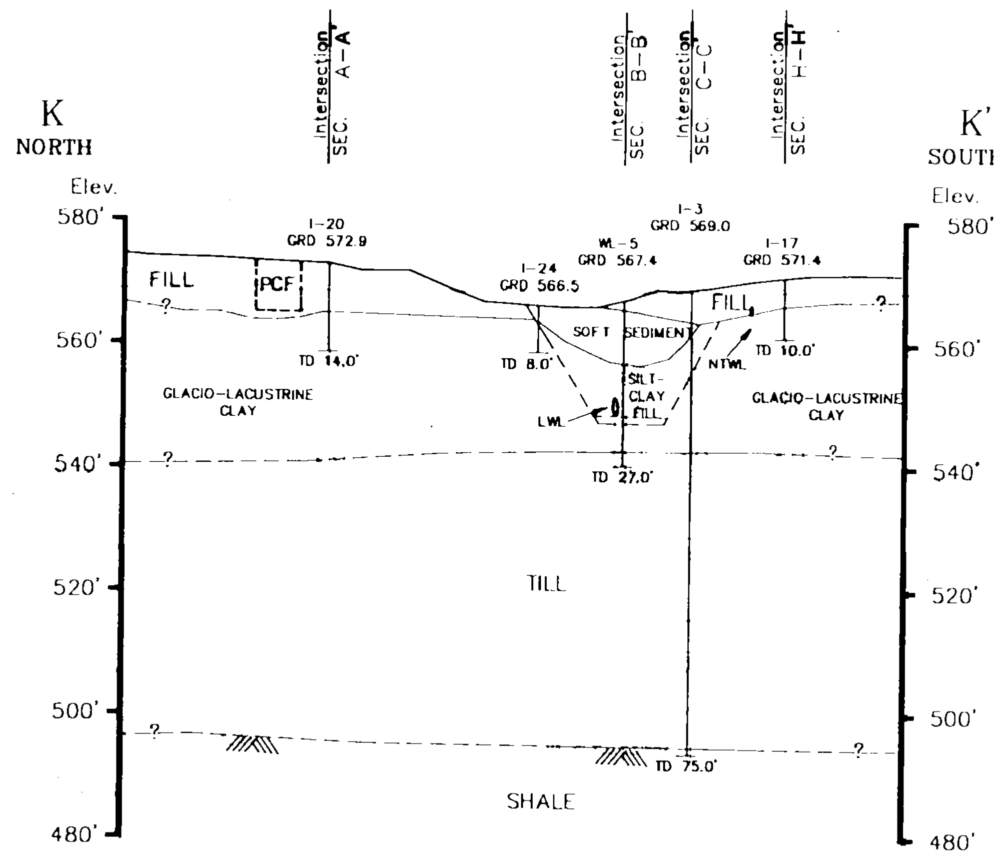
SCALE:
Horz. 1" = 50'
Vert. 1" = 20'

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12205

GEOLOGIC CROSS SECTION J J'
OCCIDENTAL CHEMICAL CORPORATION

CITY OF N. TONAWANDA — NIAGARA CO., NY

PROJECT NO. 00595-01165	DATE July 1990
DWG. NO. 248710L	FIGURE NO. 4-16J

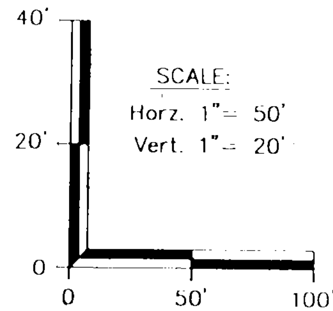


LEGEND

WELL ILLUSTRATING SCREEN

TD 18.0'

NOTE:
Datum: MSL

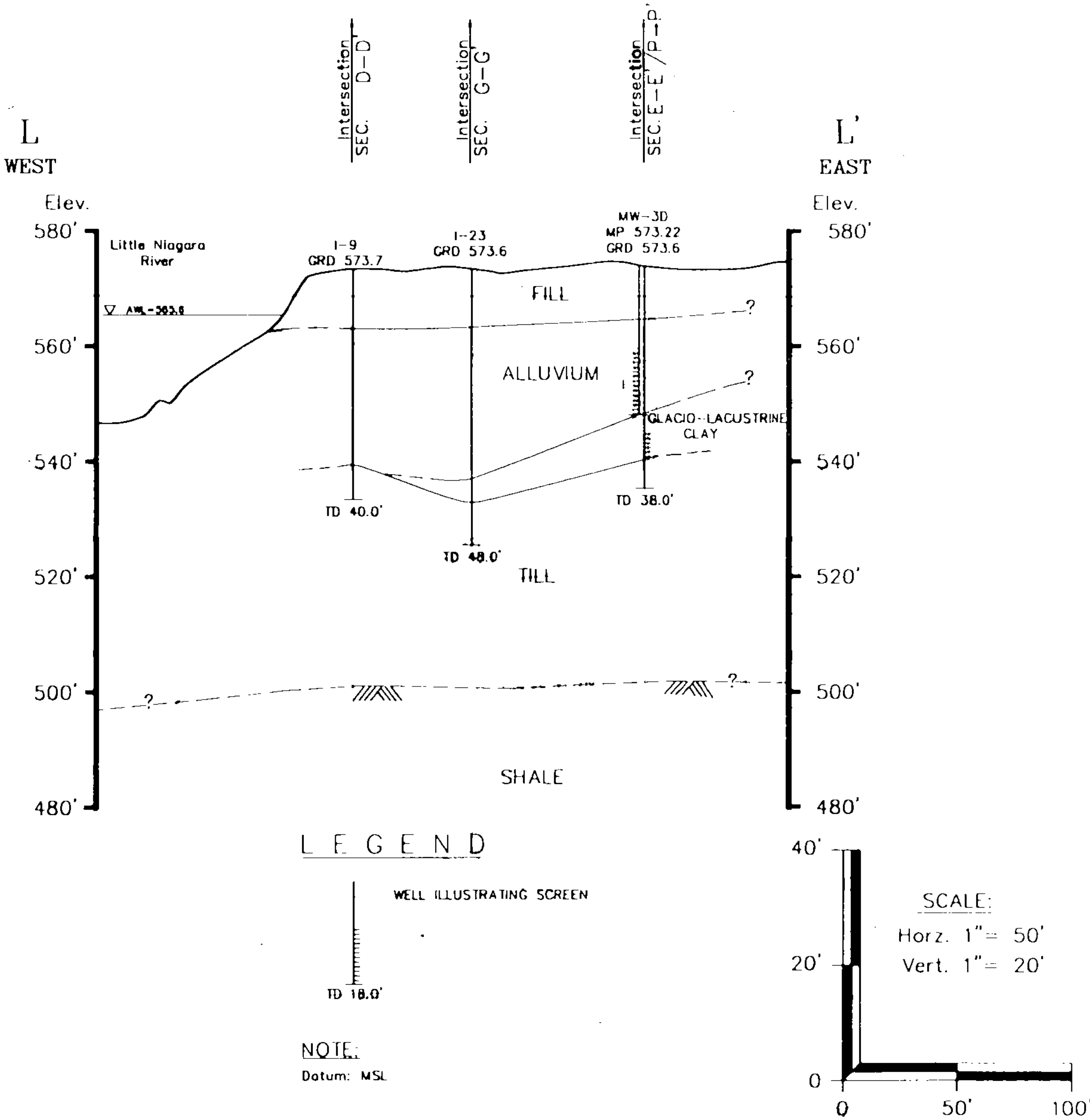


SCALE:
Horz. 1" = 50'
Vert. 1" = 20'

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12205

GEOLOGIC CROSS SECTION K-K'
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA NIAGARA CO. NY

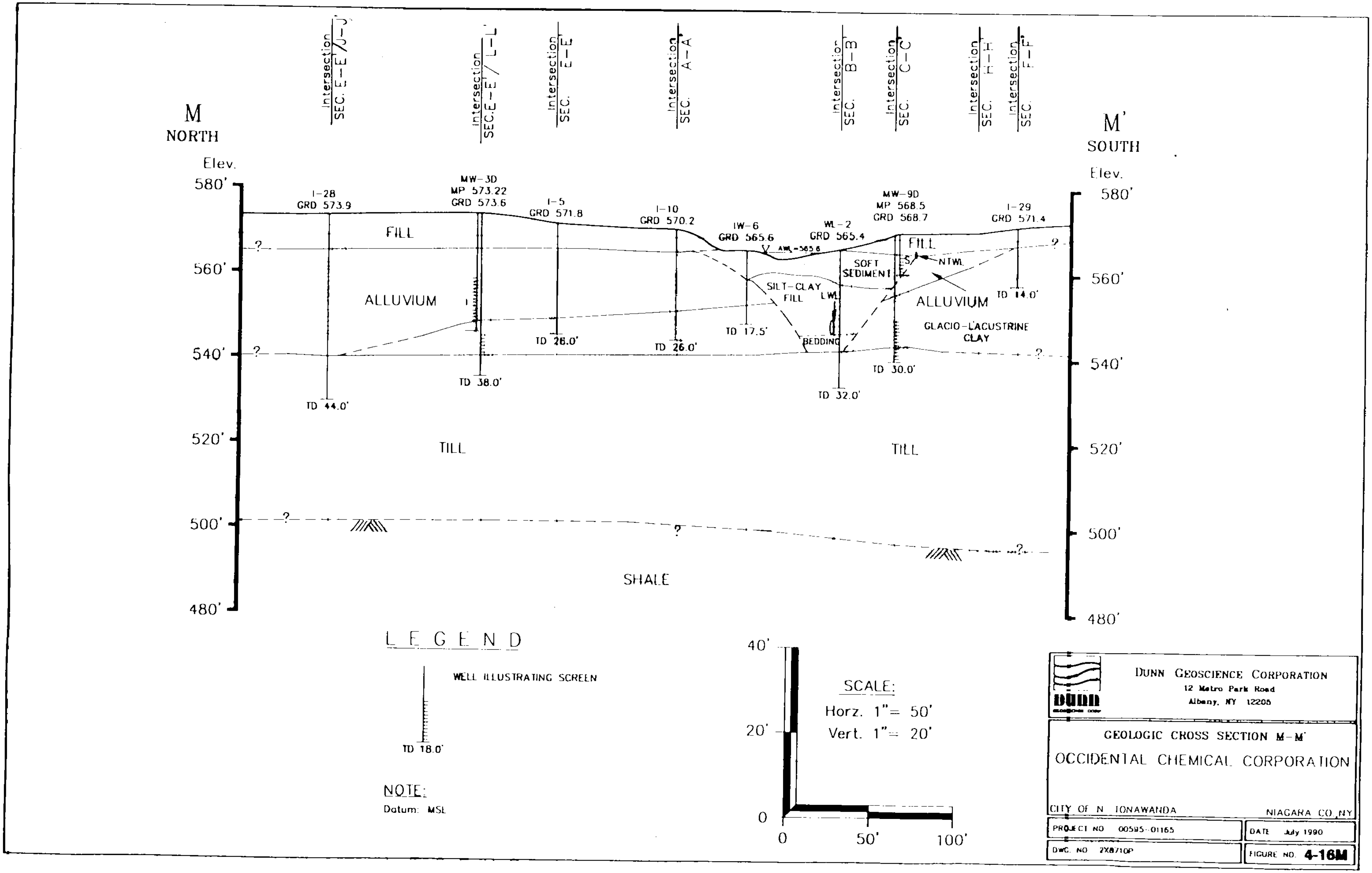
PROJECT NO. 00595-01165	DATE July 1990
DWG. NO. 2X8710M	FIGURE NO. 4-16K



DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12206

GEOLOGIC CROSS SECTION L-L'
OCCIDENTAL CHEMICAL CORPORATION

CITY OF N. TONAWANDA	NIAGARA CO, NY
PROJECT NO. 00595 01165	DATE July 1990
DWG NO. 2X871000	FIGURE NO. 4-16L


M
NORTH
M'
SOUTH
Elev.
580'
560'
540'
520'
500'
480'
Intersection SEC. E-E'/J-J'
Intersection SEC. E-E'/L-L'
Intersection SEC. E-E'
Intersection SEC. A-A'
Intersection SEC. B-B'
Intersection SEC. C-C'
Intersection SEC. H-H'
Intersection SEC. F-F'
I-28 GRD 573.9
MW-3D MP 573.22 GRD 573.6
I-5 GRD 571.8
I-10 GRD 570.2
IW-6 GRD 565.6
WL-2 GRD 565.4
MW-9D MP 568.5 GRD 568.7
I-29 GRD 571.4
FILL
ALLUVIUM
SILT-CLAY FILL
SOFT SEDIMENT
LWL
NTWL
BEDDING
GLACIO-LACUSTRINE CLAY
TILL
SHALE
TD 44.0'
TD 38.0'
TD 28.0'
TD 26.0'
TD 17.5'
TD 32.0'
TD 30.0'
TD 14.0'
LEGEND
WELL ILLUSTRATING SCREEN
TD 18.0'
NOTE:
Datum: MSL
SCALE:
Horz. 1" = 50'
Vert. 1" = 20'
0
50'
100'
40'
20'
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, NY 12205
GEOLOGIC CROSS SECTION M-M'
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., NY
PROJECT NO. 00595-01165
DATE July 1990
DWG. NO. 2X8710P
FIGURE NO. 4-16M

TYPICAL OVERBURDEN MONITORING WELL

DUREZ INLET

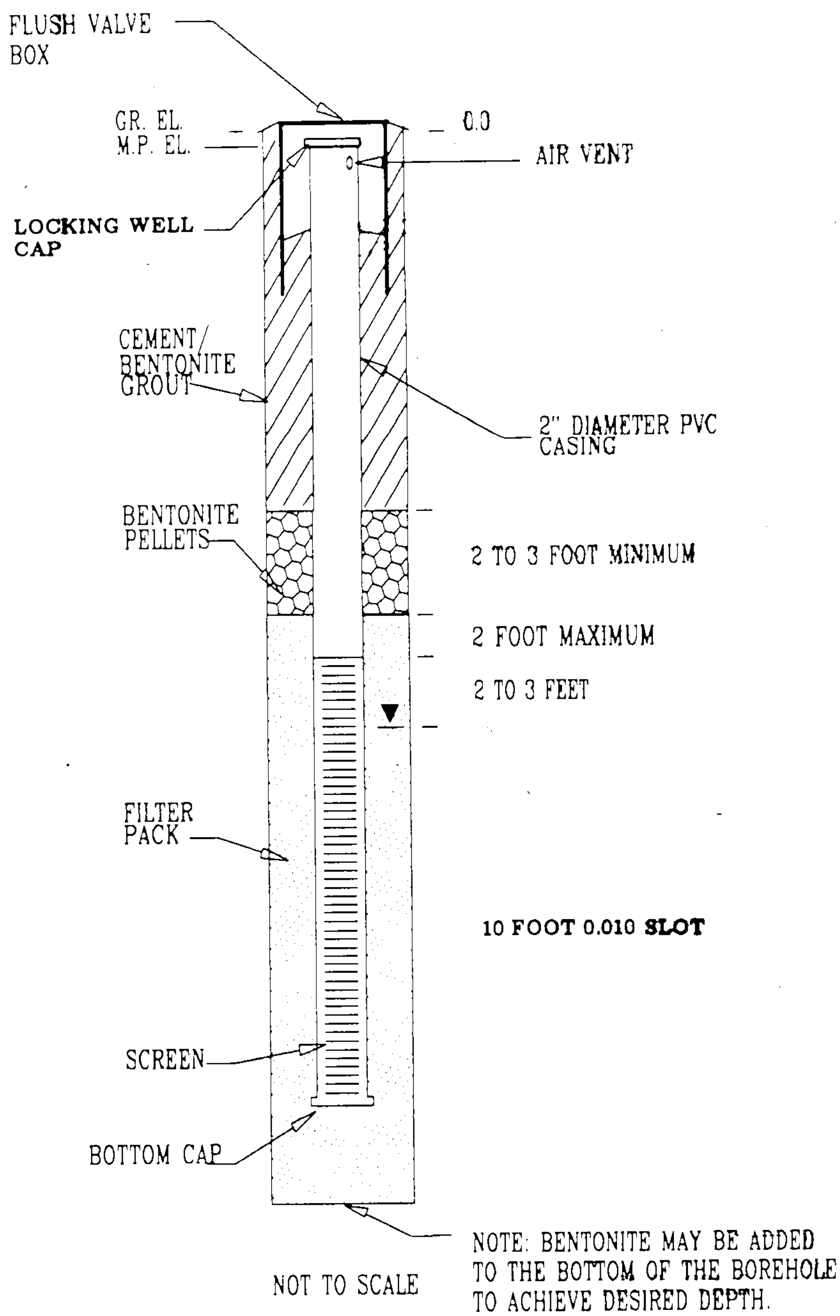
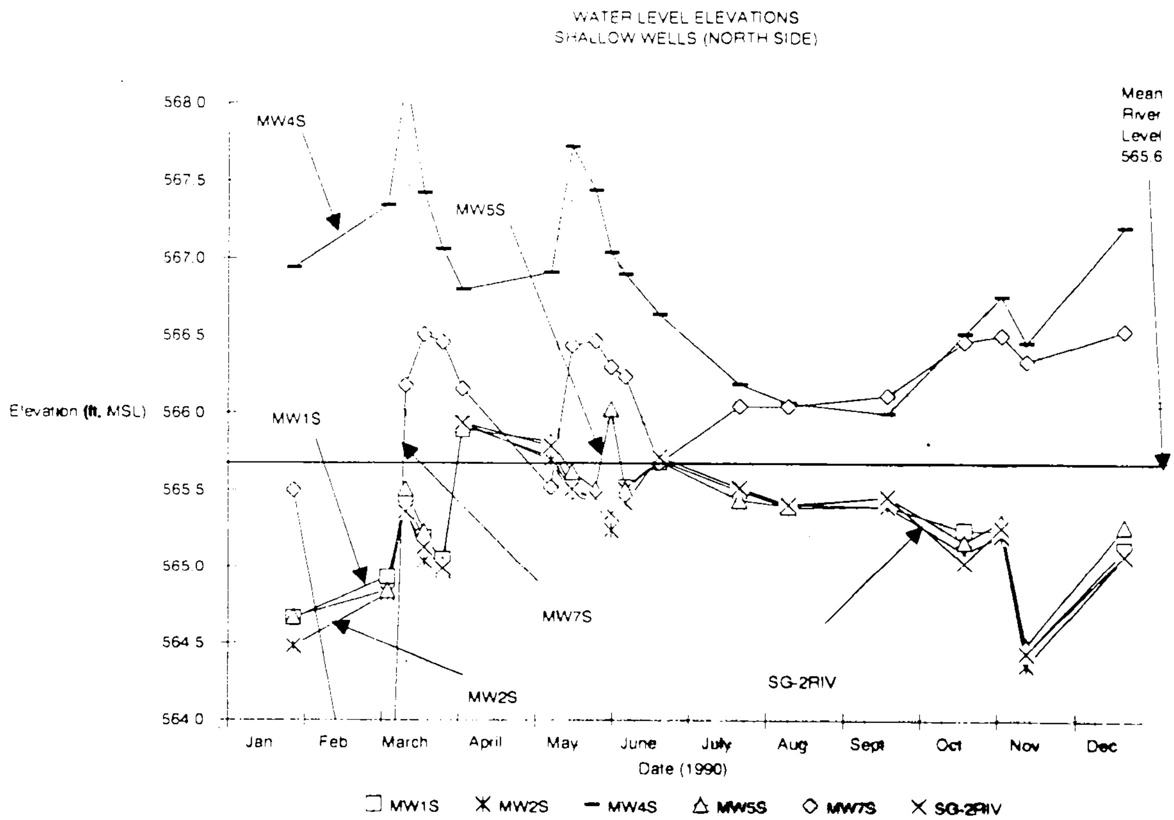


FIGURE 5-1

DUNN



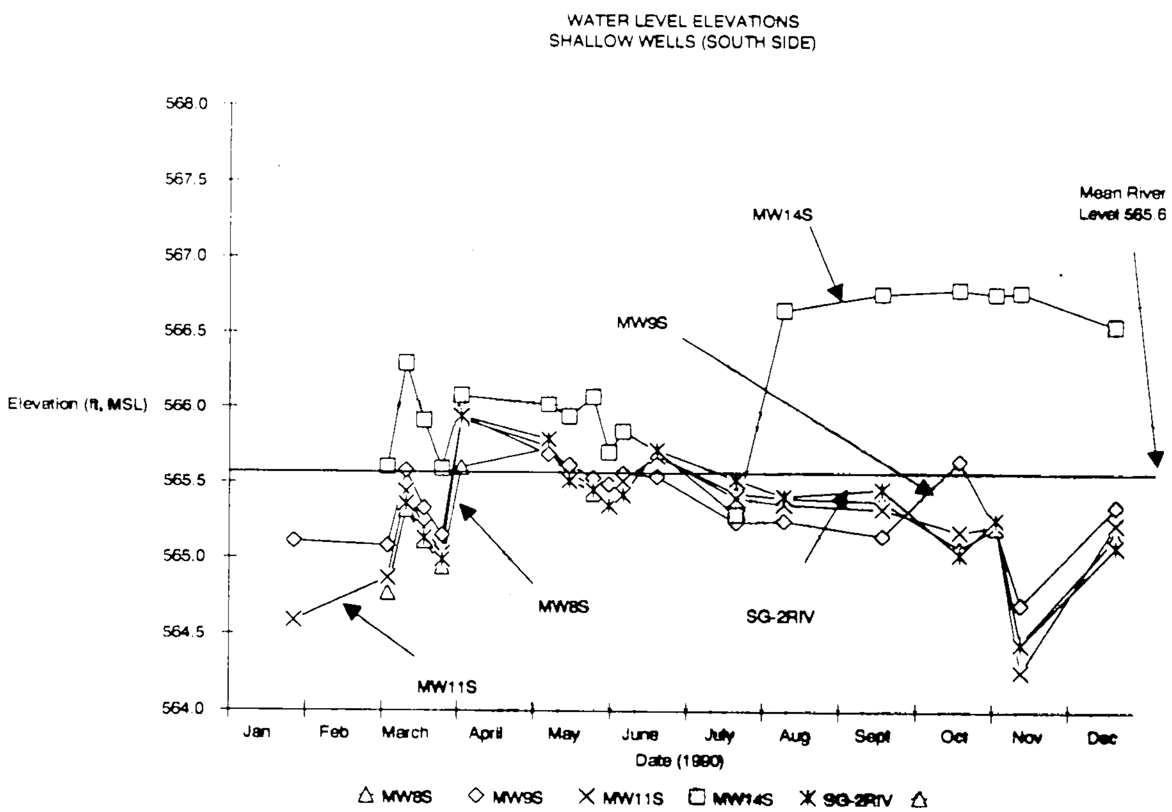
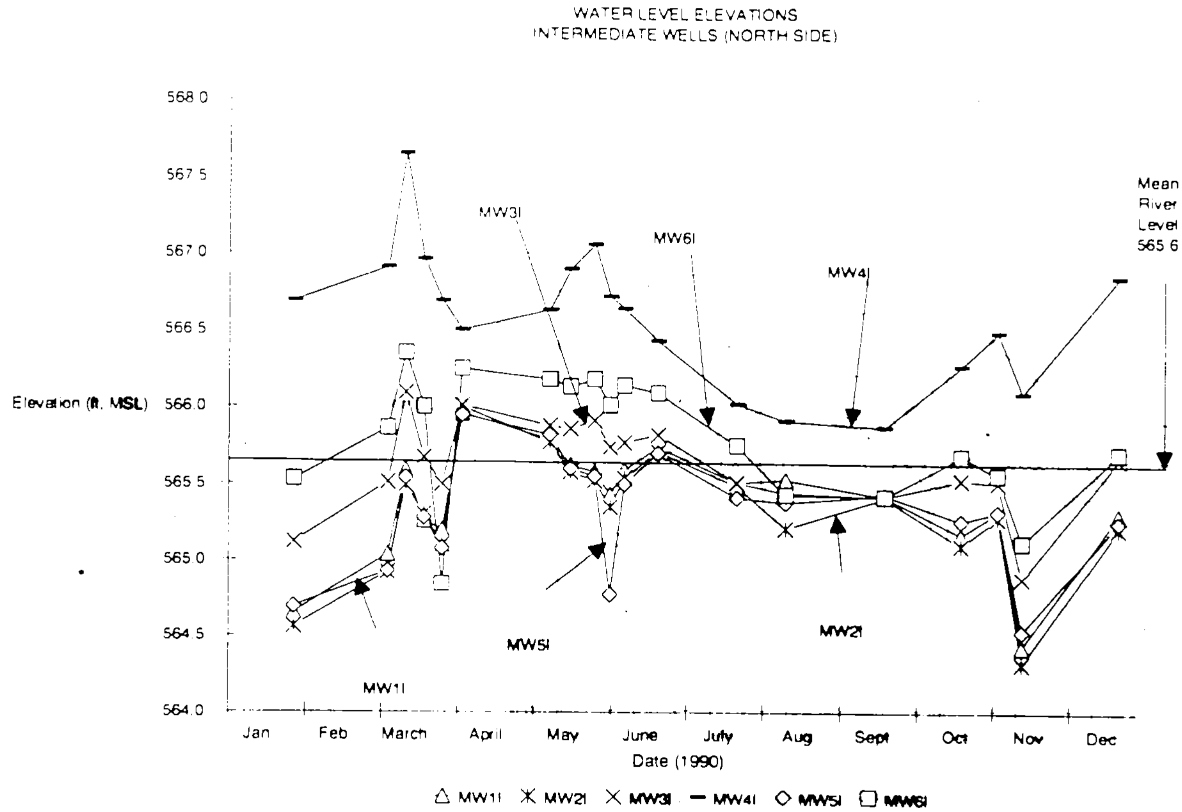


FIGURE 5—2S

GEOSCIENCE CORP


WATER LEVEL ELEVATIONS
INTERMEDIATE WELLS (NORTH SIDE)
568.0
567.5
567.0
566.5
566.0
565.5
565.0
564.5
564.0
Elevation (ft, MSL)
MW3I
MW6I
MW4I
Mean River Level 565.6
MW5I
MW2I
MW1I
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Nov
Dec
Date (1990)
MW1I
MW2I
MW3I
MW4I
MW5I
MW6I

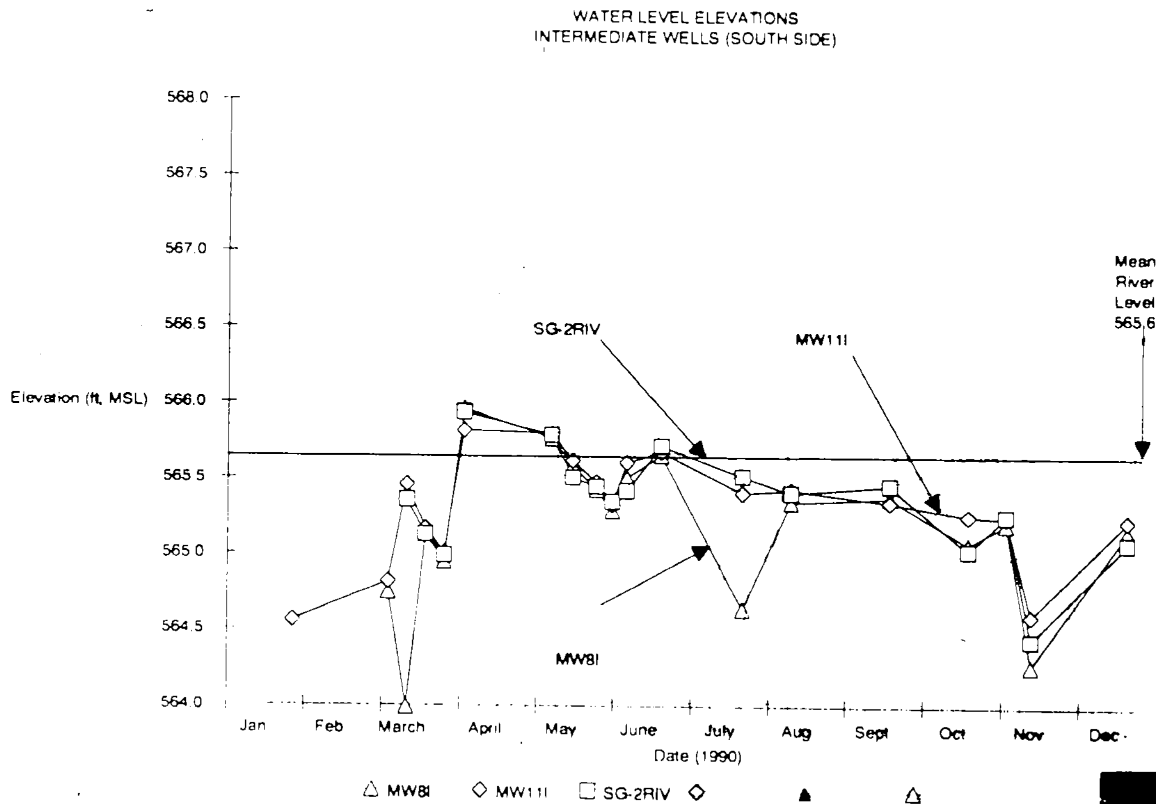
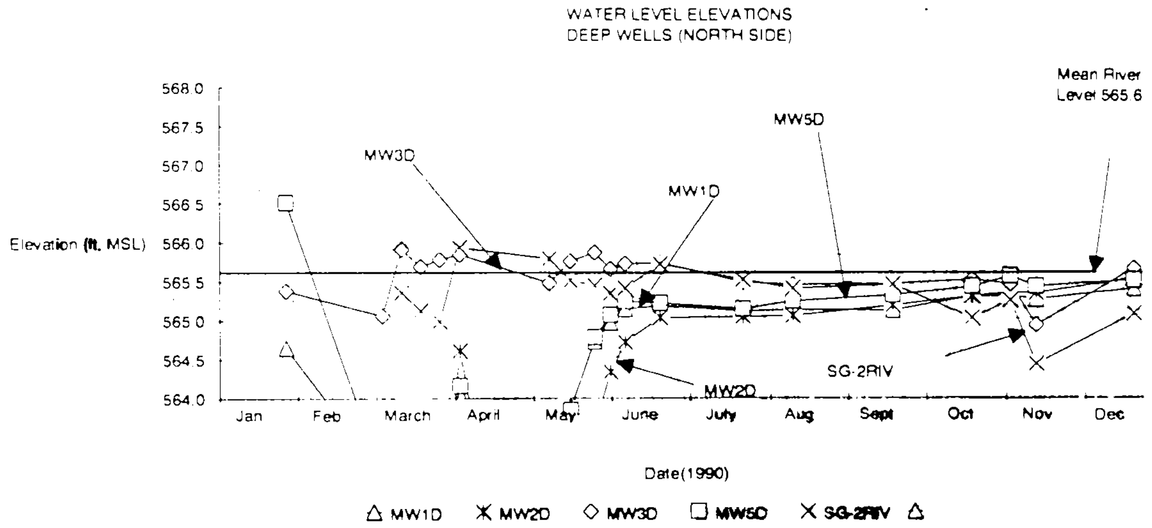

WATER LEVEL ELEVATIONS
INTERMEDIATE WELLS (SOUTH SIDE)
568.0
567.5
567.0
566.5
566.0
565.5
565.0
564.5
564.0
Elevation (ft, MSL)
SG-2RIV
MW11I
Mean River Level 565.6
MW8I
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Nov
Dec
Date (1990)
MW8I
MW11I
SG-2RIV

FIGURE 5-21



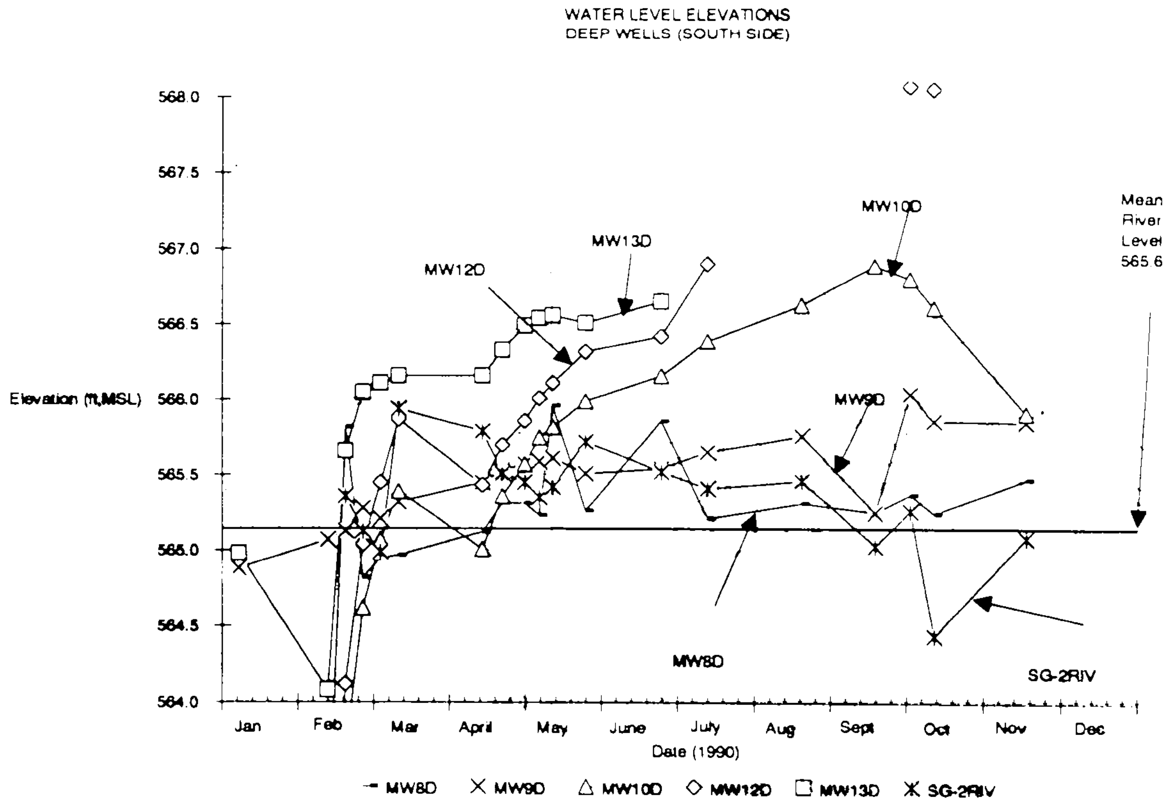
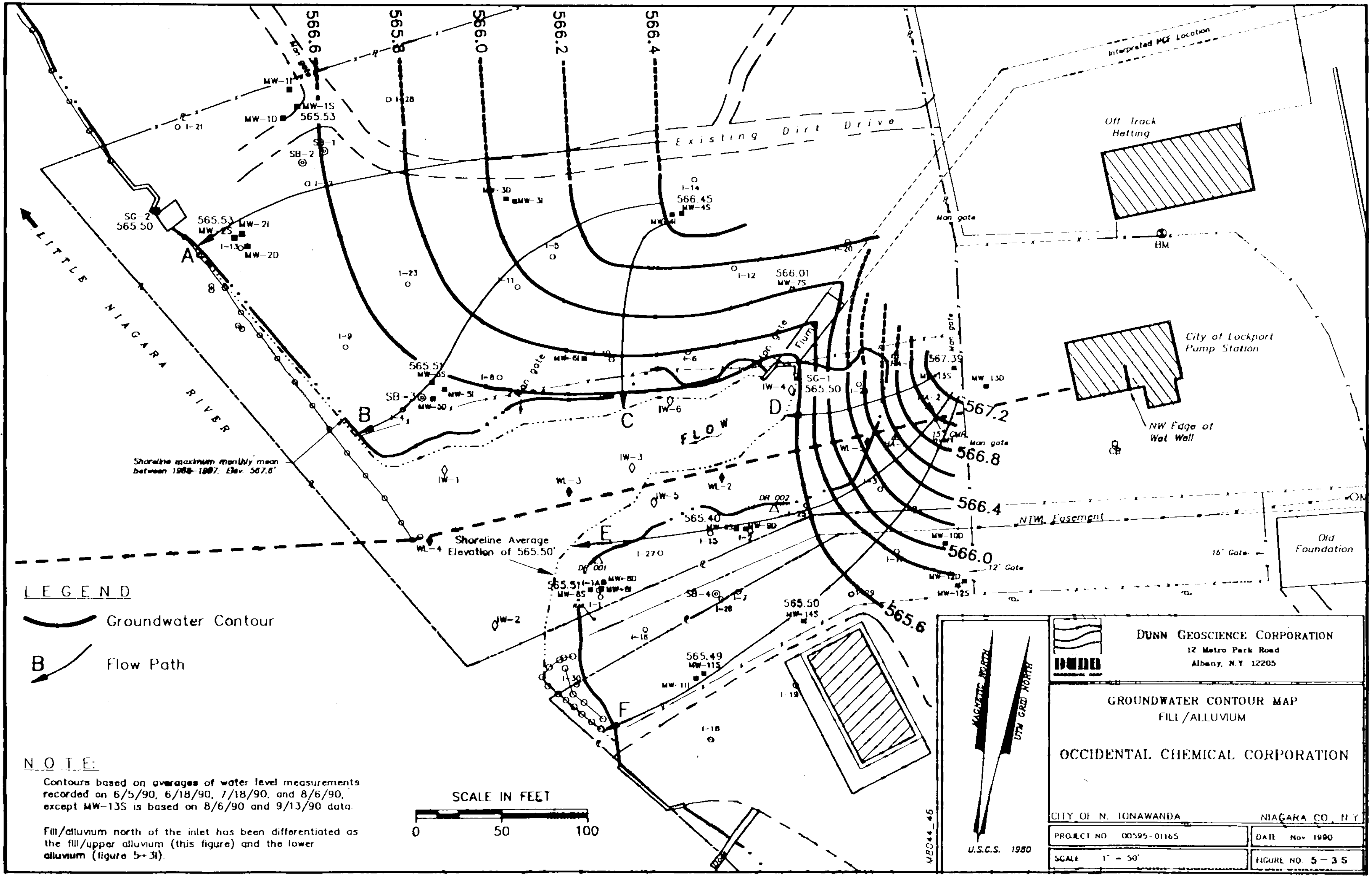
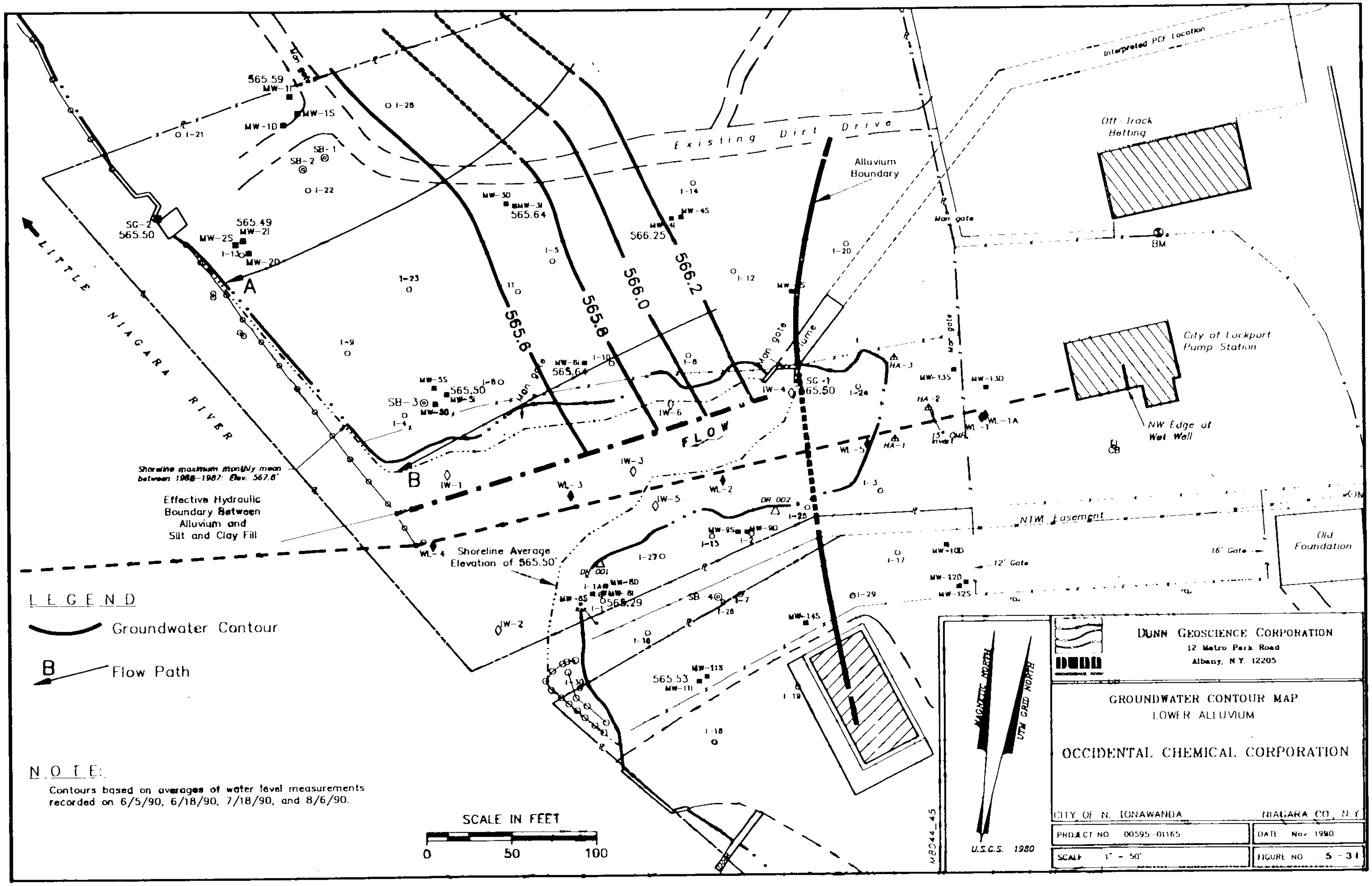


FIGURE 5–2D

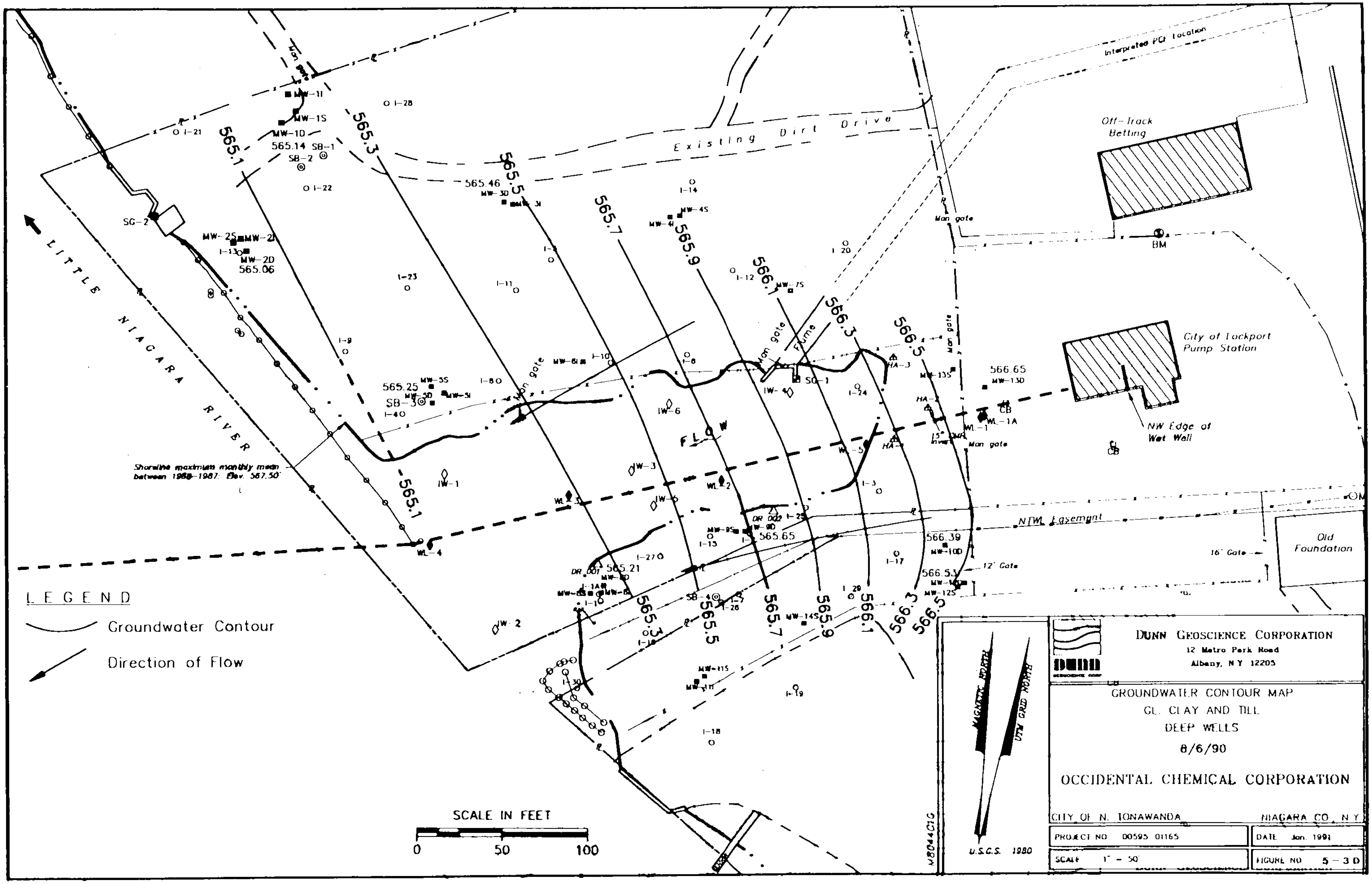
GEOSCIENCE CORP

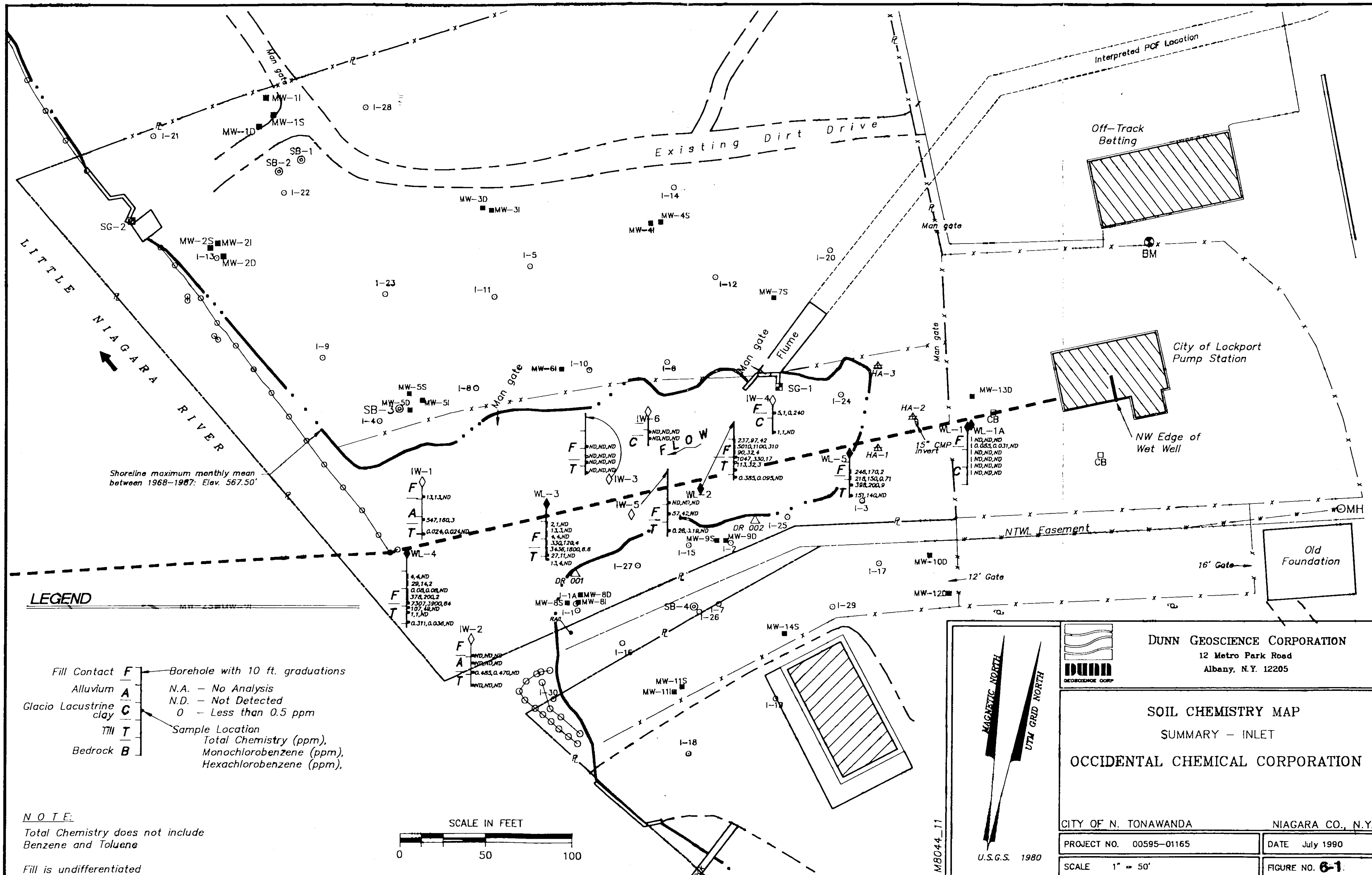


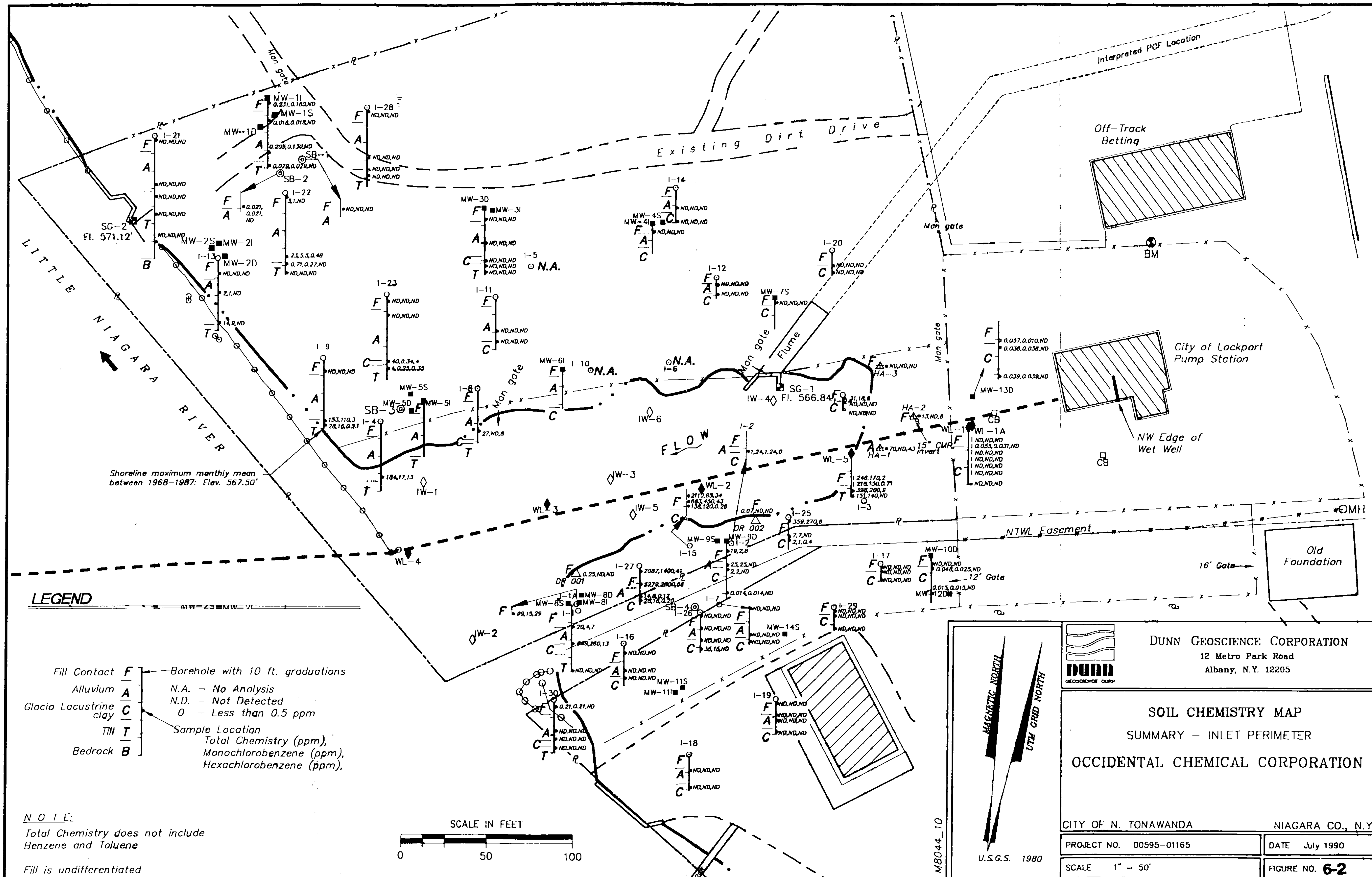
566.6
565.8
566.0
566.2
566.4
Existing Dirt Drive
Interpreted PCF Location
Off Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Old Foundation
LITTLE NIAGARA RIVER
FLOW
Shoreline maximum monthly mean between 1960-1987. Elev. 567.6'
Shoreline Average Elevation of 565.50'
SG-2 565.50
SG-1 565.50
MW-1S 565.53
565.53 MW-2S
566.45 MW-4S
566.01 MW-7S
565.51 MW-3S
567.39 MW-13S
565.40
565.51 MW-8S
565.50 MW-14S
565.49 MW-11S
567.2
566.8
566.4
566.0
565.6
NIW Easement
16' Gate
12' Gate
Man gate
A
B
C
D
E
F
LEGEND
Groundwater Contour
Flow Path
NOTE:
Contours based on averages of water level measurements recorded on 6/5/90, 6/18/90, 7/18/90, and 8/6/90, except MW-13S is based on 8/6/90 and 9/13/90 data.
Fill/alluvium north of the inlet has been differentiated as the fill/upper alluvium (this figure) and the lower alluvium (figure 5-31).
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.C.S. 1980
MB044_46
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
GROUNDWATER CONTOUR MAP
FILL/ALLUVIUM
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE Nov 1990
SCALE 1" = 50'
FIGURE NO. 5-3S



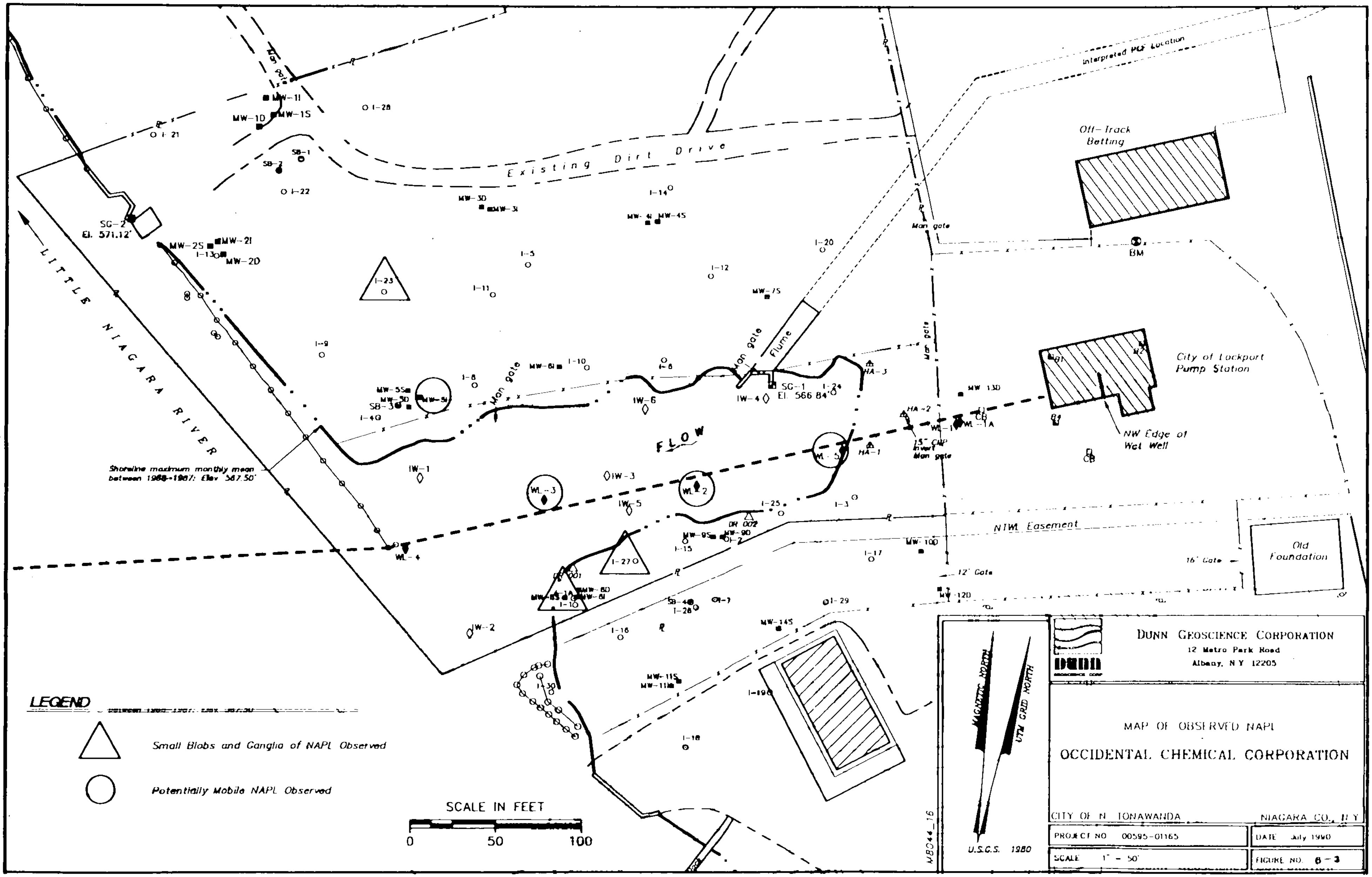
LITTLE NIAGARA RIVER
Existing Dirt Drive
Alluvium Boundary
Interpreted PCF Location
Off Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
NIWI Easement
Old Foundation
FLOW
565.6
565.8
566.0
566.2
Shoreline maximum monthly mean between 1986–1987: Elev. 567.6'
Effective Hydraulic Boundary Between Alluvium and Silt and Clay Fill
Shoreline Average Elevation of 565.50'
LEGEND
Groundwater Contour
Flow Path
NOTE:
Contours based on averages of water level measurements recorded on 6/5/90, 6/18/90, 7/18/90, and 8/6/90.
SCALE IN FEET
0 50 100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
GROUNDWATER CONTOUR MAP
LOWER ALLUVIUM
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO 00595-01165
DATE Nov 1990
SCALE 1" = 50'
FIGURE NO 5-31


LEGEND
Groundwater Contour
Direction of Flow
SCALE IN FEET
0 50 100
LITTLE NIAGARA RIVER
Shoreline maximum monthly mean between 1988-1987: Elev. 567.50'
Existing Dirt Drive
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Interpreted PCF Location
NTWL Easement
Old Foundation
FLOW
565.1
565.3
565.5
565.7
565.9
566.1
566.3
566.5
565.14
565.06
565.46
565.25
565.65
565.21
566.65
566.39
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
GROUNDWATER CONTOUR MAP
GL. CLAY AND TILL
DEEP WELLS
8/6/90
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO 00595 01165
DATE Jan. 1991
SCALE 1" = 50'
FIGURE NO 5-3D
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
N8044C1G

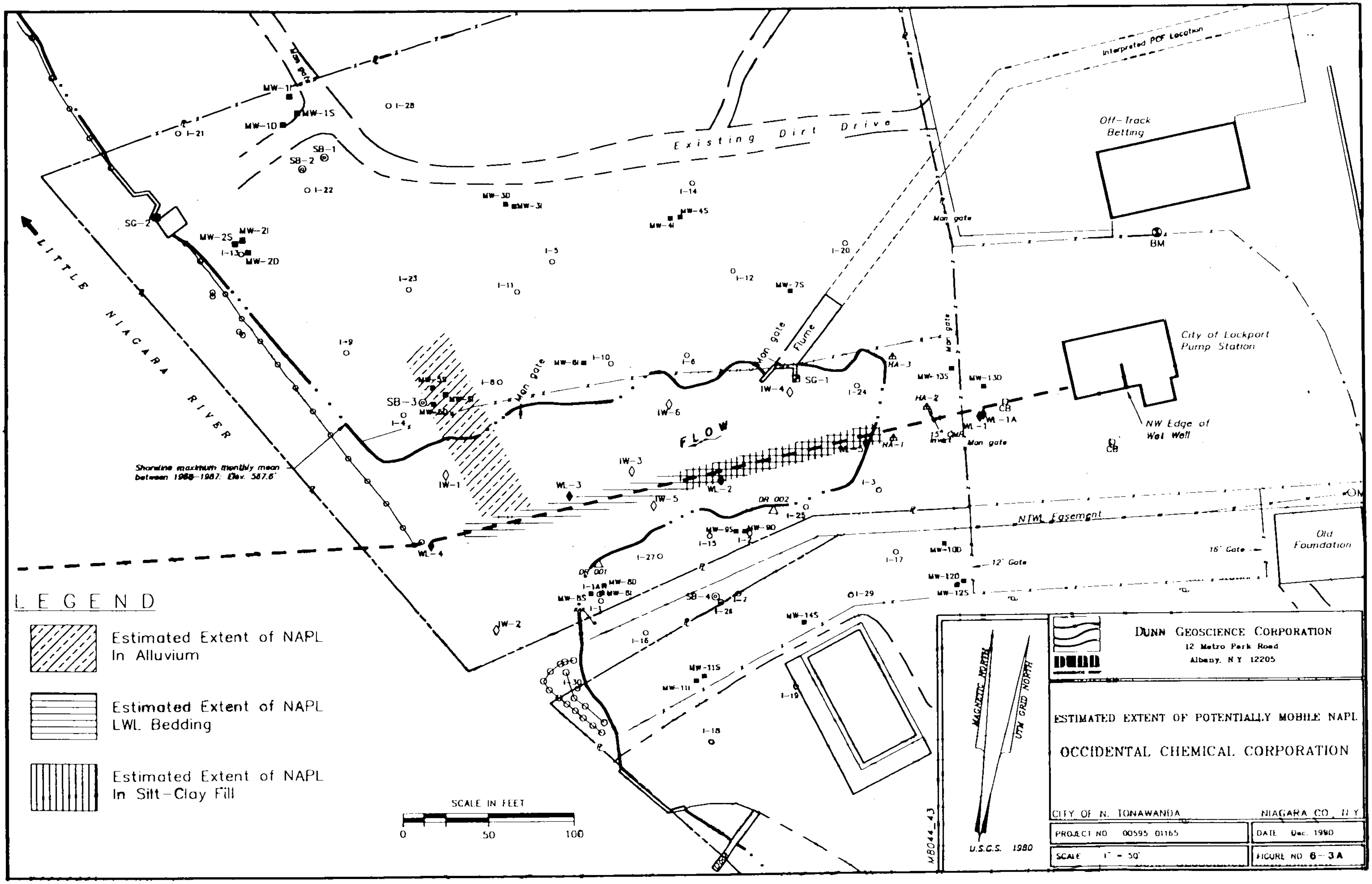

Interpreted PCF Location
Existing Dirt Drive
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
LITTLE NIAGARA RIVER
Shoreline maximum monthly mean between 1968–1987: Elev. 567.50'
FLOW
Flume
Man gate
NTWL Easement
Old Foundation
16' Gate
12' Gate
15" CMP Invert
BM
OMH
CB
SG-1
SG-2
SB-1
SB-2
SB-3
SB-4
MW-1I
MW-1S
MW-1D
MW-2S
MW-2I
MW-2D
MW-3D
MW-3I
MW-4S
MW-4I
MW-5S
MW-5D
MW-5I
MW-6I
MW-7S
MW-8S
MW-8D
MW-8I
MW-9S
MW-9D
MW-10D
MW-11S
MW-11I
MW-12D
MW-13D
MW-14S
IW-1
IW-2
IW-3
IW-4
IW-5
IW-6
WL-1
WL-1A
WL-2
WL-3
WL-4
WL-5
HA-1
HA-2
HA-3
DR 001
DR 002
LEGEND
Fill Contact F
Alluvium A
Glacio Lacustrine clay C
Till T
Bedrock B
Borehole with 10 ft. graduations
N.A. – No Analysis
N.D. – Not Detected
0 – Less than 0.5 ppm
Sample Location
Total Chemistry (ppm),
Monochlorobenzene (ppm),
Hexachlorobenzene (ppm),
NOTE:
Total Chemistry does not include Benzene and Toluene
Fill is undifferentiated
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
M8044_11
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
SOIL CHEMISTRY MAP
SUMMARY – INLET
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595–01165
DATE July 1990
SCALE 1" = 50'
FIGURE NO. 6-1

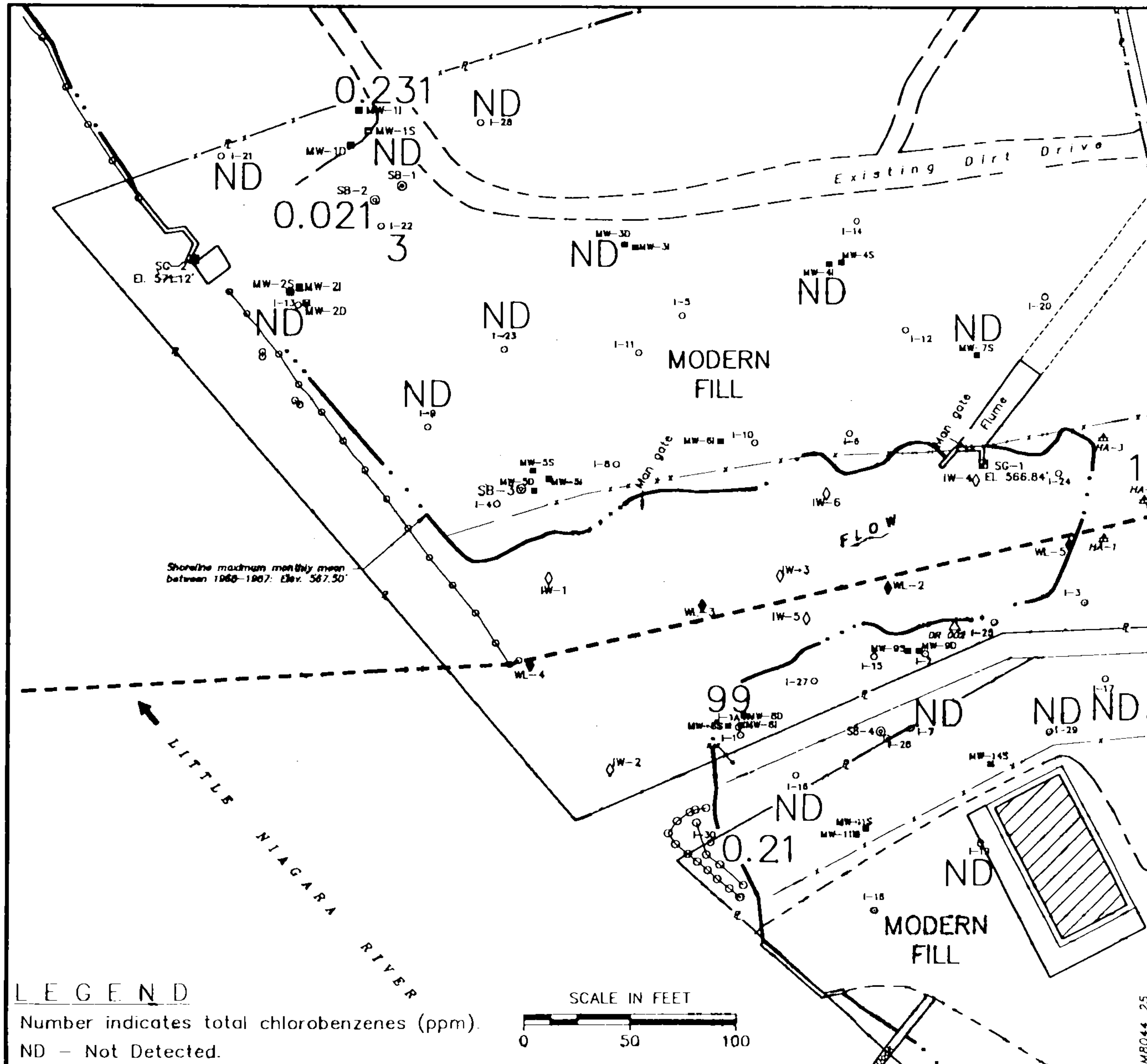


DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
SOIL CHEMISTRY MAP
SUMMARY – INLET PERIMETER
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE 1" = 50'
FIGURE NO. 6-2
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
M8044_10
LEGEND
Fill Contact F
Alluvium A
Glacio Lacustrine clay C
Till T
Bedrock B
Borehole with 10 ft. graduations
N.A. – No Analysis
N.D. – Not Detected
0 – Less than 0.5 ppm
Sample Location
Total Chemistry (ppm),
Monochlorobenzene (ppm),
Hexachlorobenzene (ppm),
NOTE:
Total Chemistry does not include Benzene and Toluene
Fill is undifferentiated
SCALE IN FEET
0
50
100
LITTLE NIAGARA RIVER
Shoreline maximum monthly mean between 1968–1987: Elev. 567.50'
Existing Dirt Drive
Interpreted PCF Location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Old Foundation
NTWL Easement
FLOW
Flume
Man gate
16' Gate
12' Gate
15" CMP Invert
SG–2 El. 571.12'
SG–1 El. 566.84'
BM
CB
OMH



DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
MAP OF OBSERVED NAPL
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE 1" = 50'
FIGURE NO. 6-3
LEGEND
Small Blobs and Ganglia of NAPL Observed
Potentially Mobile NAPL Observed
SCALE IN FEET
0
50
100
LITTLE NIAGARA RIVER
Existing Dirt Drive
FLOW
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Old Foundation
NTWL Easement
Interpreted PCF Location
Flume
Man gate
Shoreline maximum monthly mean between 1988-1987: Elev. 567.50'
SG-2 El. 571.12'
SG-1 El. 566.84'
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
HB044_16


LEGEND
Estimated Extent of NAPL In Alluvium
Estimated Extent of NAPL LWL Bedding
Estimated Extent of NAPL In Silt-Clay Fill
SCALE IN FEET
0 50 100
LITTLE NIAGARA RIVER
Existing Dirt Drive
Interpreted PCF Location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
NTWL Easement
Old Foundation
FLOW
Flume
Man gate
Shoreline maximum monthly mean between 1958-1987: Elev. 567.6'
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
ESTIMATED EXTENT OF POTENTIALLY MOBILE NAPL
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO 00595 01165
DATE Dec. 1990
SCALE 1" = 50'
FIGURE NO 6-3A
MB044_43



LEGEND
Number indicates total chlorobenzenes (ppm).
ND — Not Detected.

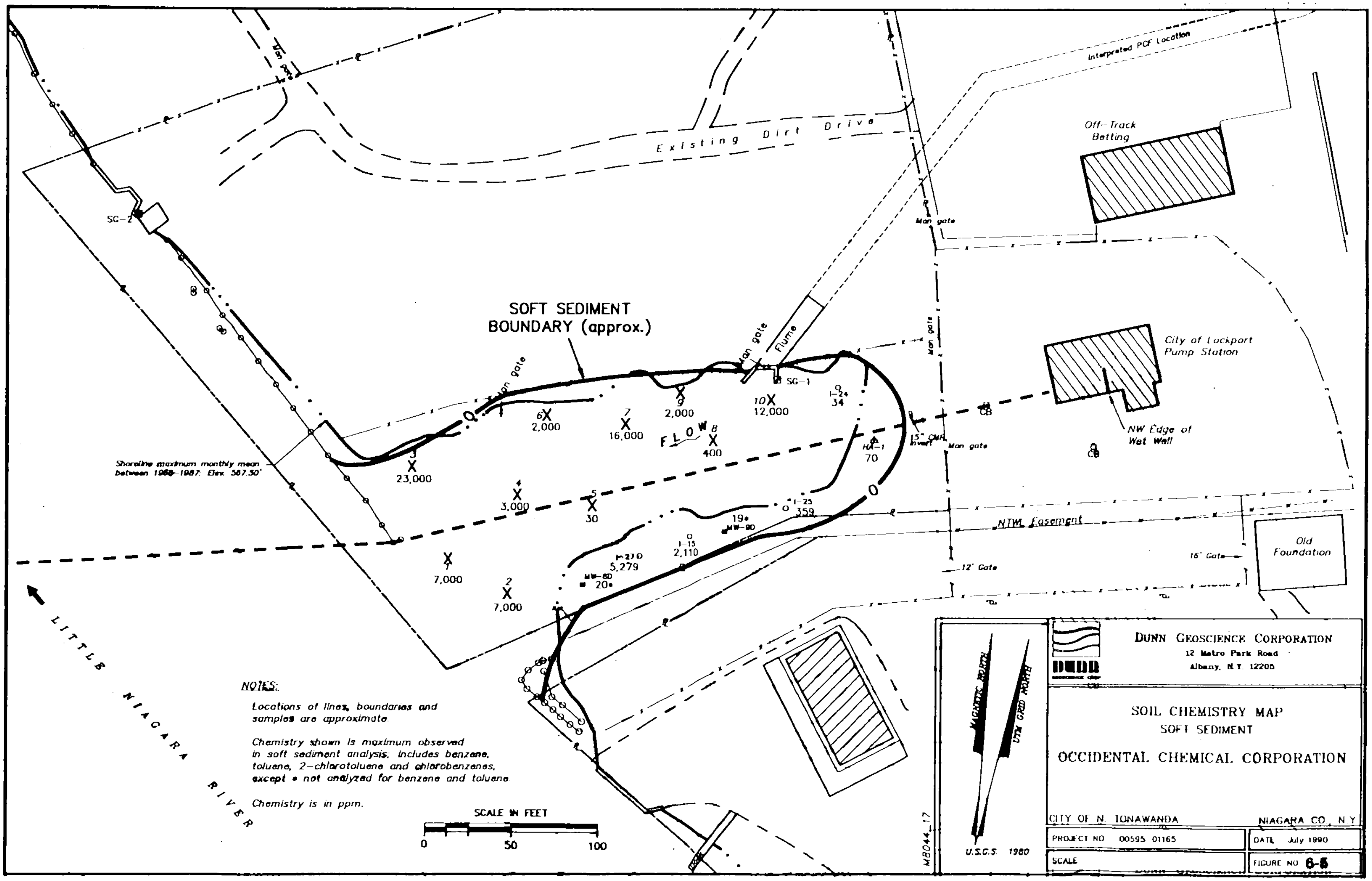
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205

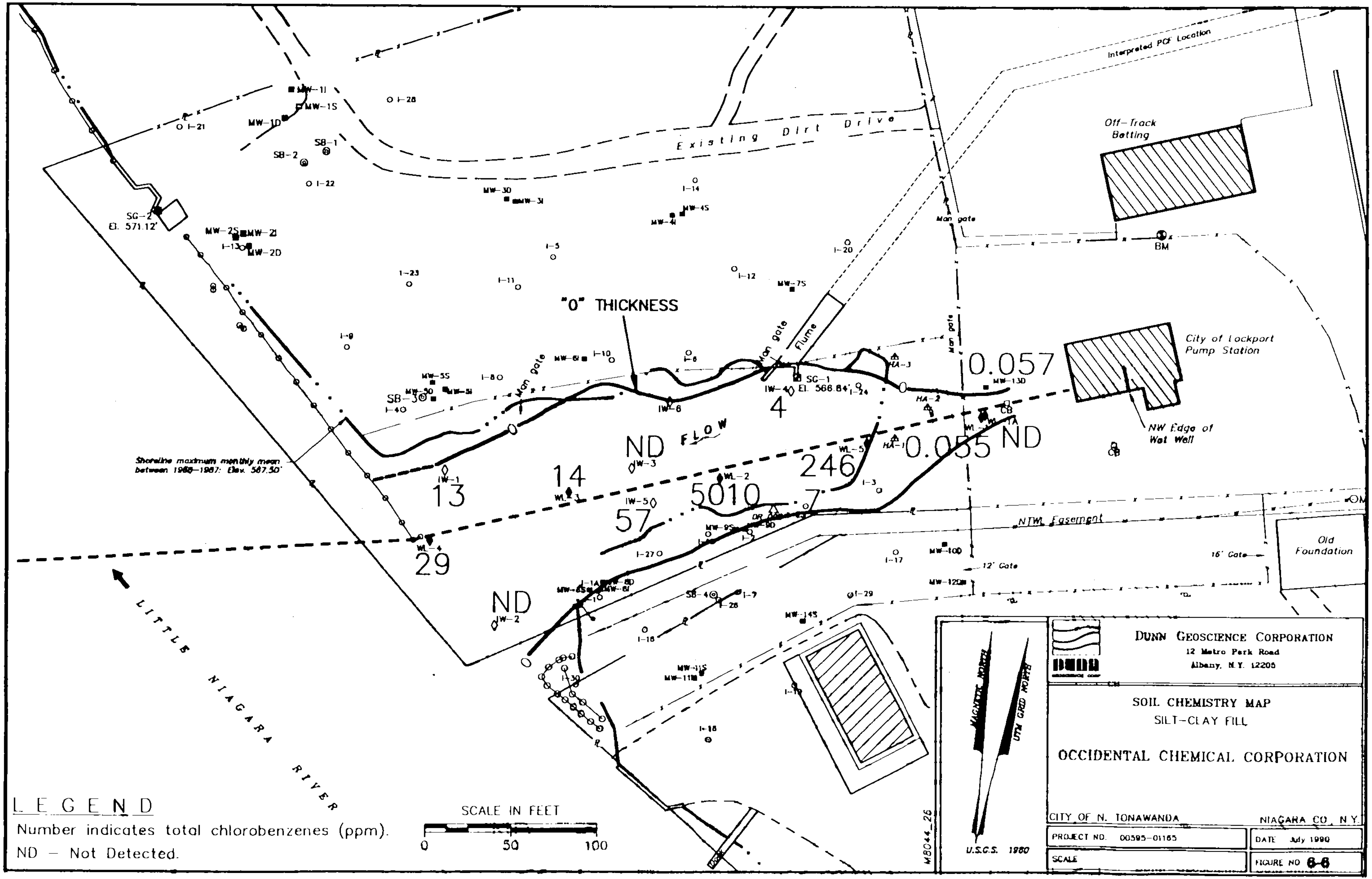
SOIL CHEMISTRY MAP
MODERN FILL

OCCIDENTAL CHEMICAL CORPORATION

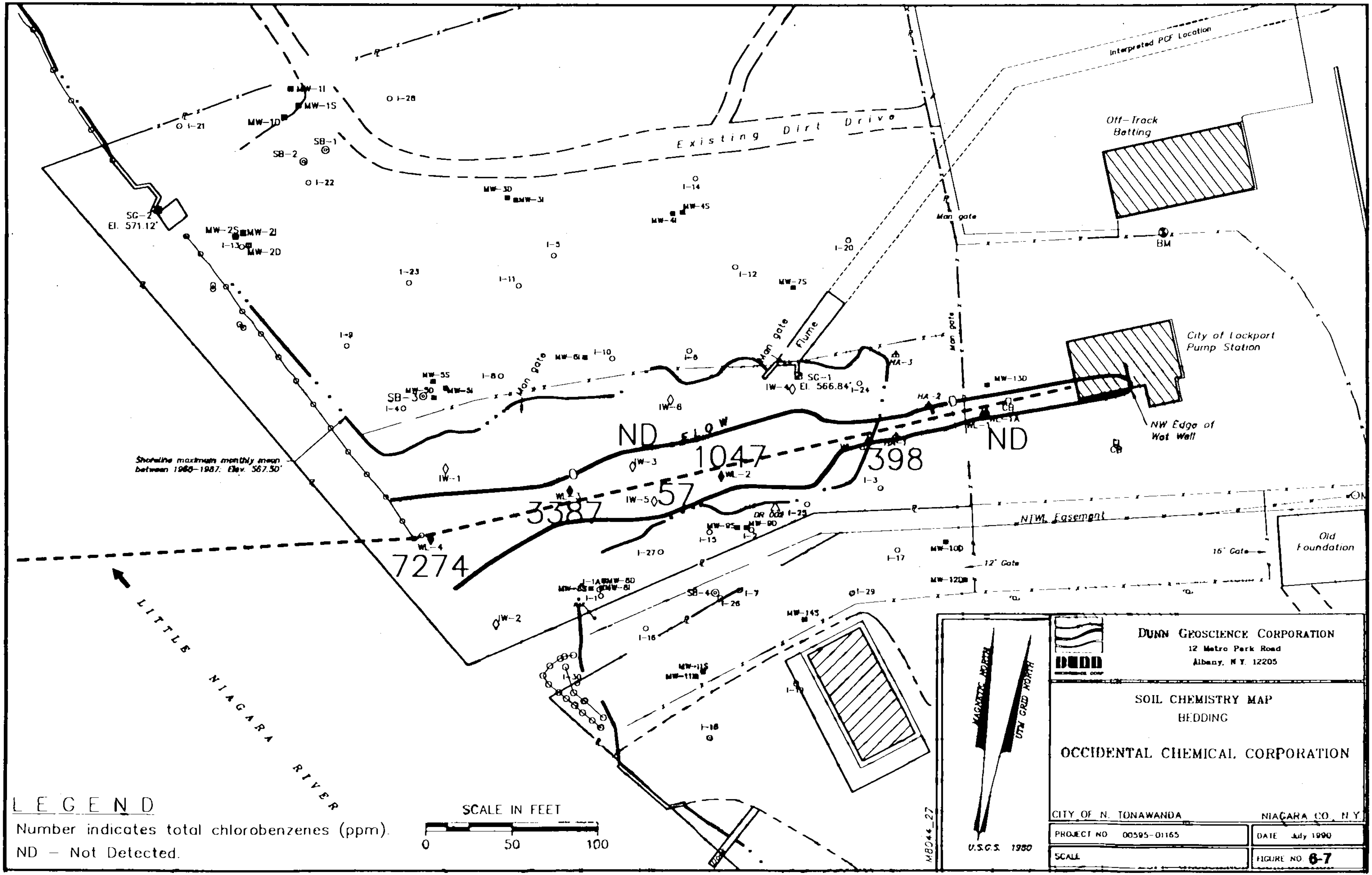
CITY OF N. TONAWANDA NIAGARA CO., N.Y.

PROJECT NO 00595-01165	DATE July 1990
SCALE	FIGURE NO. 6-4

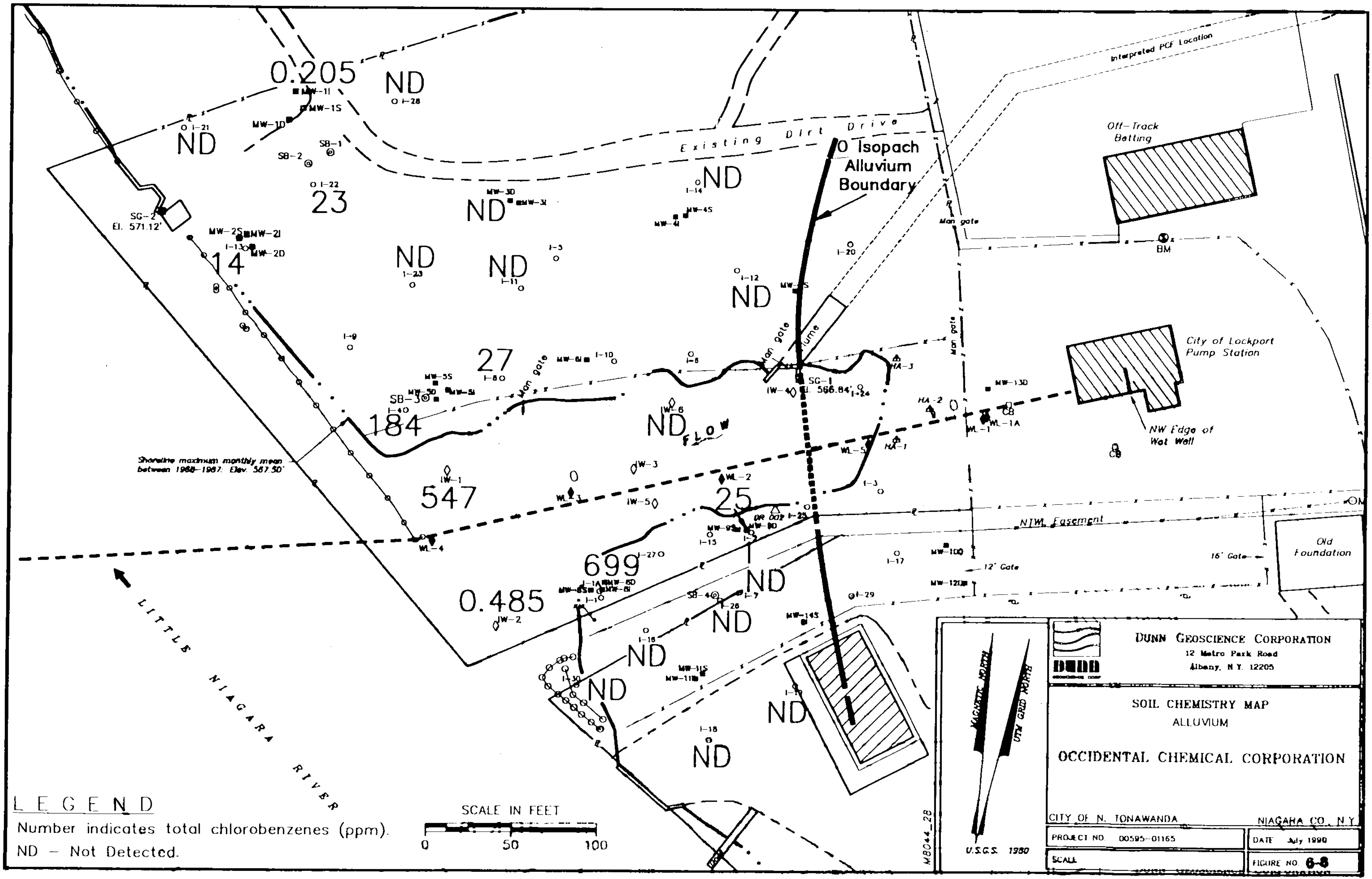

Interpreted PCF Location
Existing Dirt Drive
Off-Track Betting
Man gate
SOFT SEDIMENT BOUNDARY (approx.)
Flume
SG-1
SG-2
City of Lockport Pump Station
NW Edge of Wet Well
CB
15" CMP Invert
FLOW
Shoreline maximum monthly mean between 1980-1987: Elev. 567.50'
3 23,000
6 2,000
7 16,000
9 2,000
10 12,000
8 400
I-24 34
HA-1 70
4 3,000
5 30
I-25 359
19• MW-9D
I-15 2,110
I-27D 5,279
MW-6D 20•
1 7,000
2 7,000
NTW Easement
16' Gate
12' Gate
Old Foundation
LITTLE NIAGARA RIVER
NOTES:
Locations of lines, boundaries and samples are approximate.
Chemistry shown is maximum observed in soft sediment analysis; includes benzene, toluene, 2-chlorotoluene and chlorobenzenes, except • not analyzed for benzene and toluene.
Chemistry is in ppm.
SCALE IN FEET
0 50 100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
MB044_17
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
SOIL CHEMISTRY MAP
SOFT SEDIMENT
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO 00595 01165
DATE July 1990
SCALE
FIGURE NO 6-5



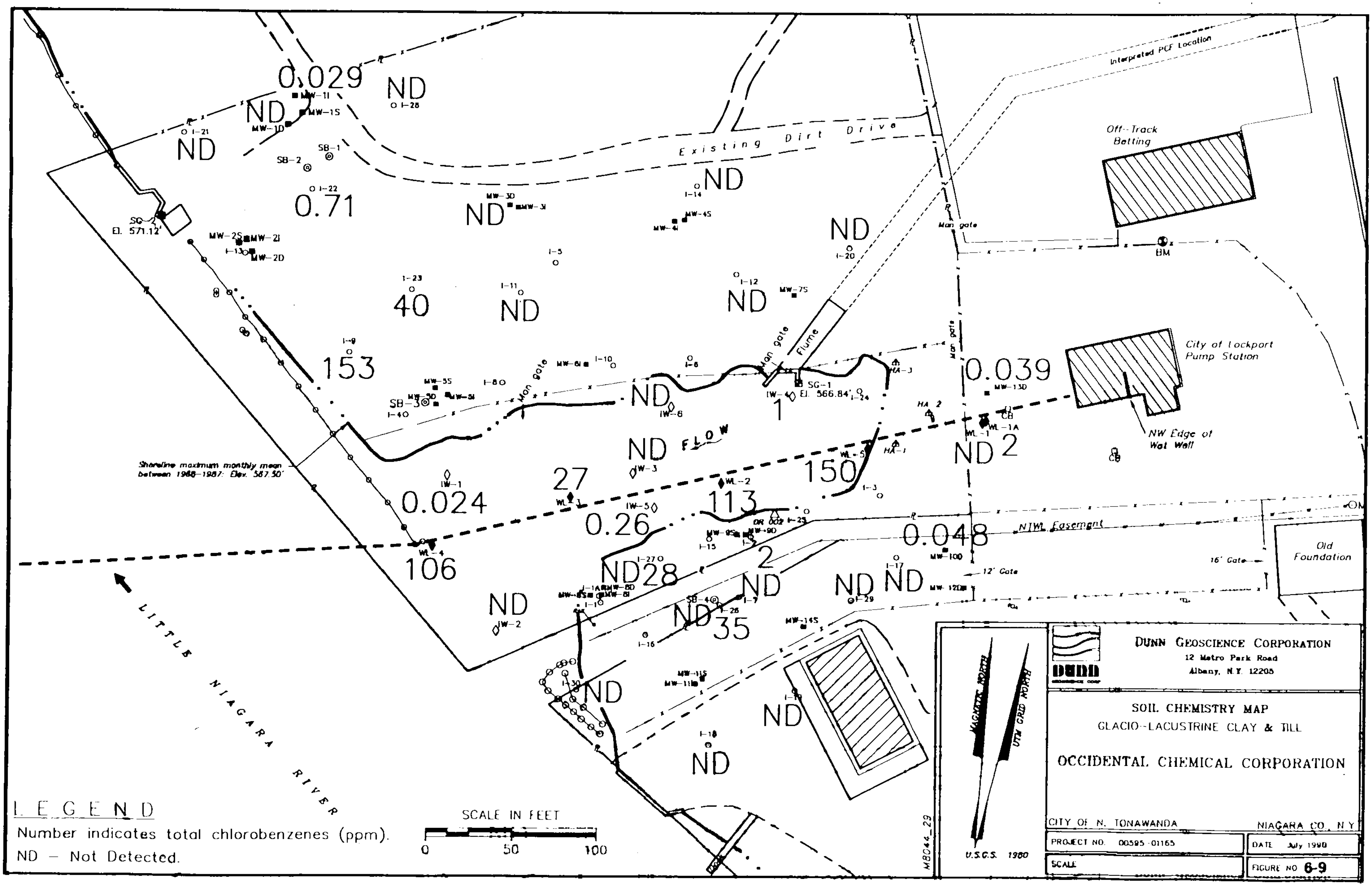
Interpreted PCF Location
Existing Dirt Drive
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Old Foundation
"0" THICKNESS
FLOW
Flume
Man gate
NTWL Easement
12' Gate
16' Gate
Shoreline maximum monthly mean between 1988-1987: Elev. 567.50'
SG-2 El. 571.12'
SG-1 El. 566.84'
BM
CB
LITTLE NIAGARA RIVER
0.057
ND
0.055
246
4
ND
14
13
5010
7
57
29
ND
LEGEND
Number indicates total chlorobenzenes (ppm).
ND – Not Detected.
SCALE IN FEET
0 50 100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
M8044_26
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
SOIL CHEMISTRY MAP
SILT-CLAY FILL
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE
FIGURE NO 6-6

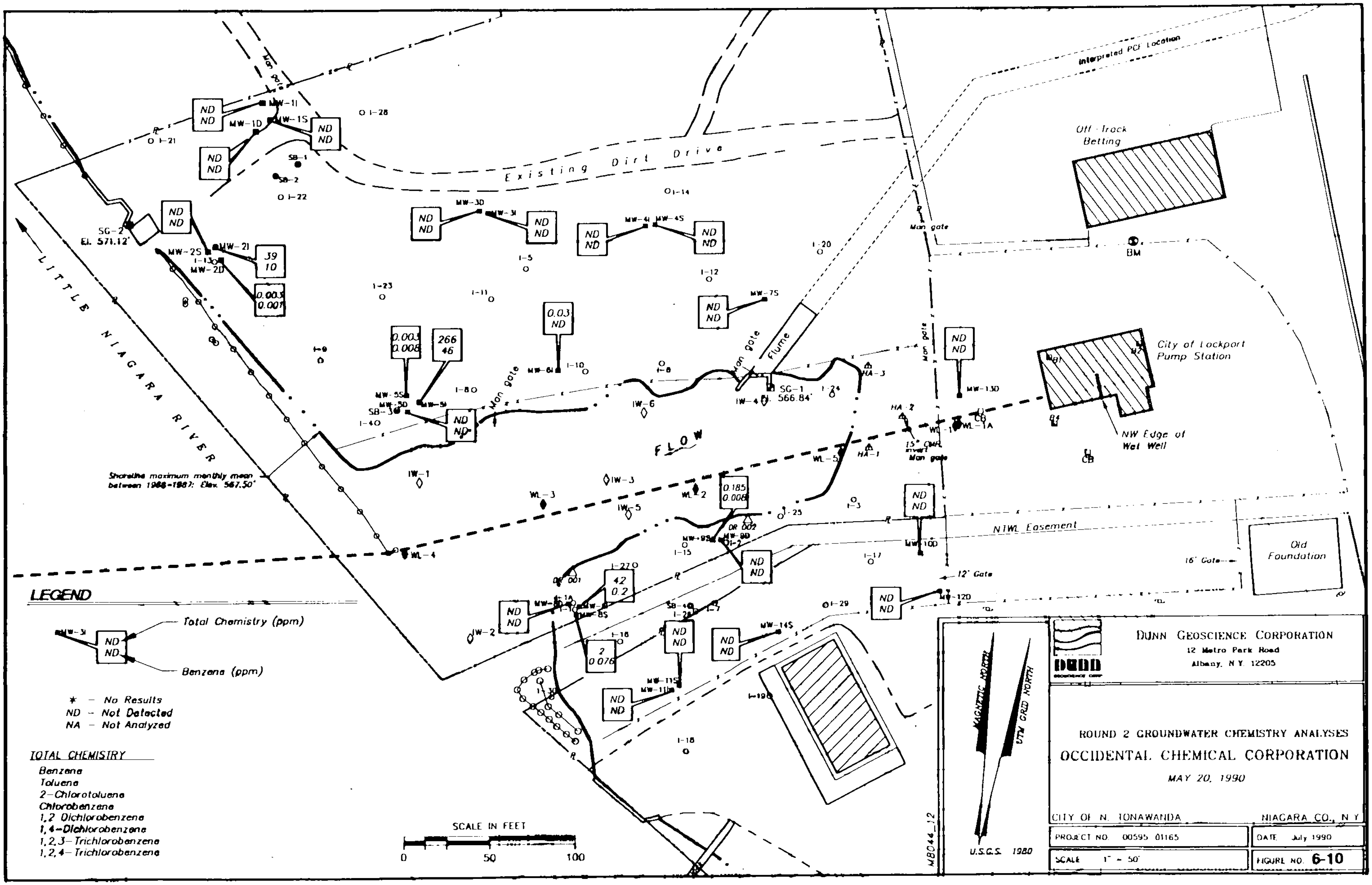


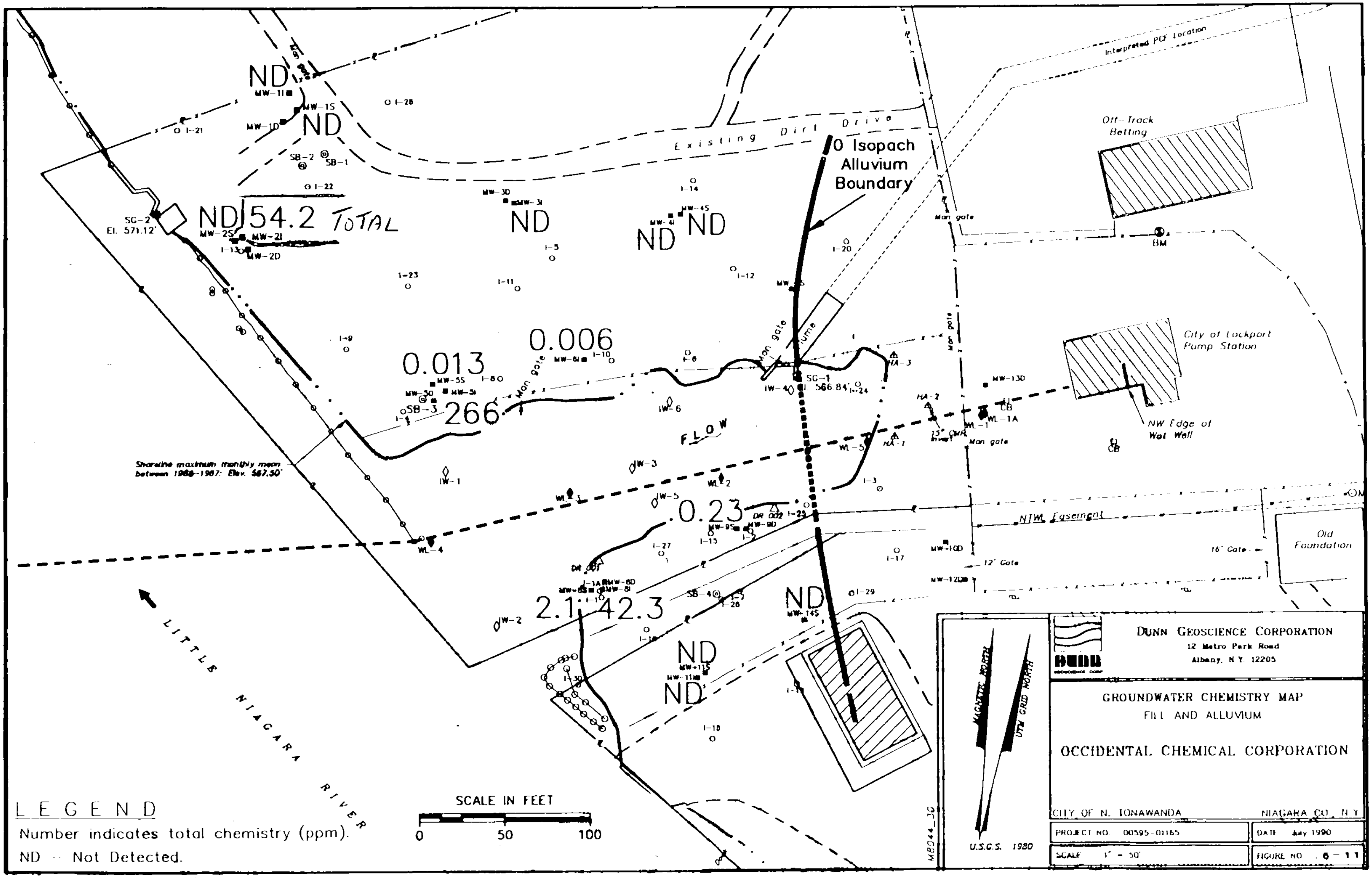
Interpreted PCF Location
Existing Dirt Drive
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Man gate
Flume
FLOW
NTWL Easement
Old Foundation
16' Gate
12' Gate
SC-1 El. 566.84'
SC-2 El. 571.12'
Shoreline maximum monthly mean between 1966-1987: Elev. 567.50'
LITTLE NIAGARA RIVER
ND
1047
398
57
3387
7274
ND
LEGEND
Number indicates total chlorobenzenes (ppm).
ND - Not Detected.
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
SOIL CHEMISTRY MAP
BEDDING
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO 00595-01165
DATE July 1990
SCALE
FIGURE NO. 6-7



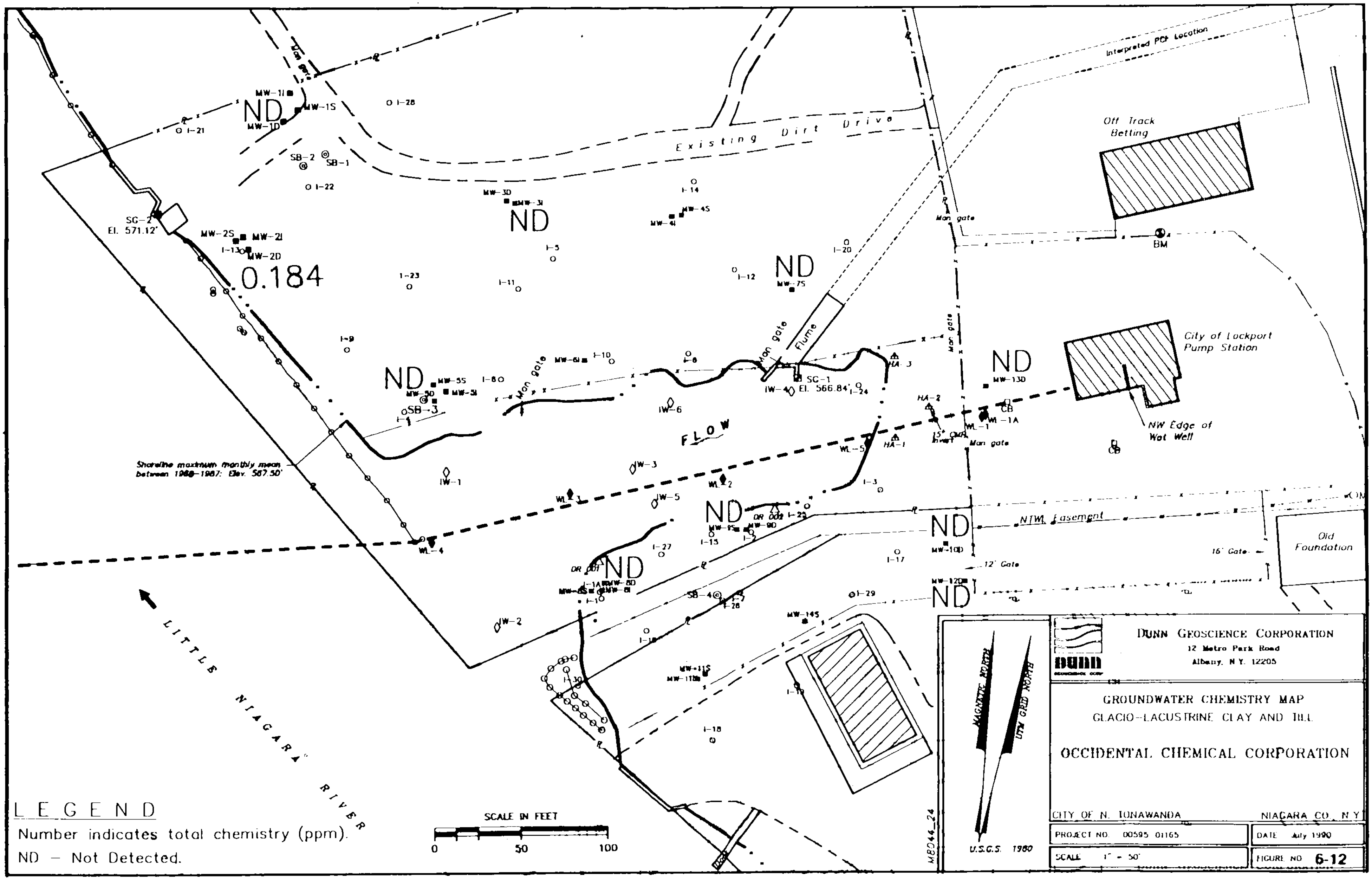
0.205
ND
ND
23
14
ND
ND
ND
ND
27
184
ND
547
0
25
699
0.485
ND
ND
ND
ND
ND
ND
0
Existing Dirt Drive
0 Isopach Alluvium Boundary
Interpreted PCF Location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
BM
FLOW
NIWL Easement
Old Foundation
16' Gate
12' Gate
Man gate
SG-2 El. 571.12'
SG-1 El. 566.84'
Shoreline maximum monthly mean between 1968-1987: Elev. 567.50'
LITTLE NIAGARA RIVER
LEGEND
Number indicates total chlorobenzenes (ppm).
ND – Not Detected.
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
M8044_28
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
SOIL CHEMISTRY MAP
ALLUVIUM
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE
FIGURE NO. 6-8

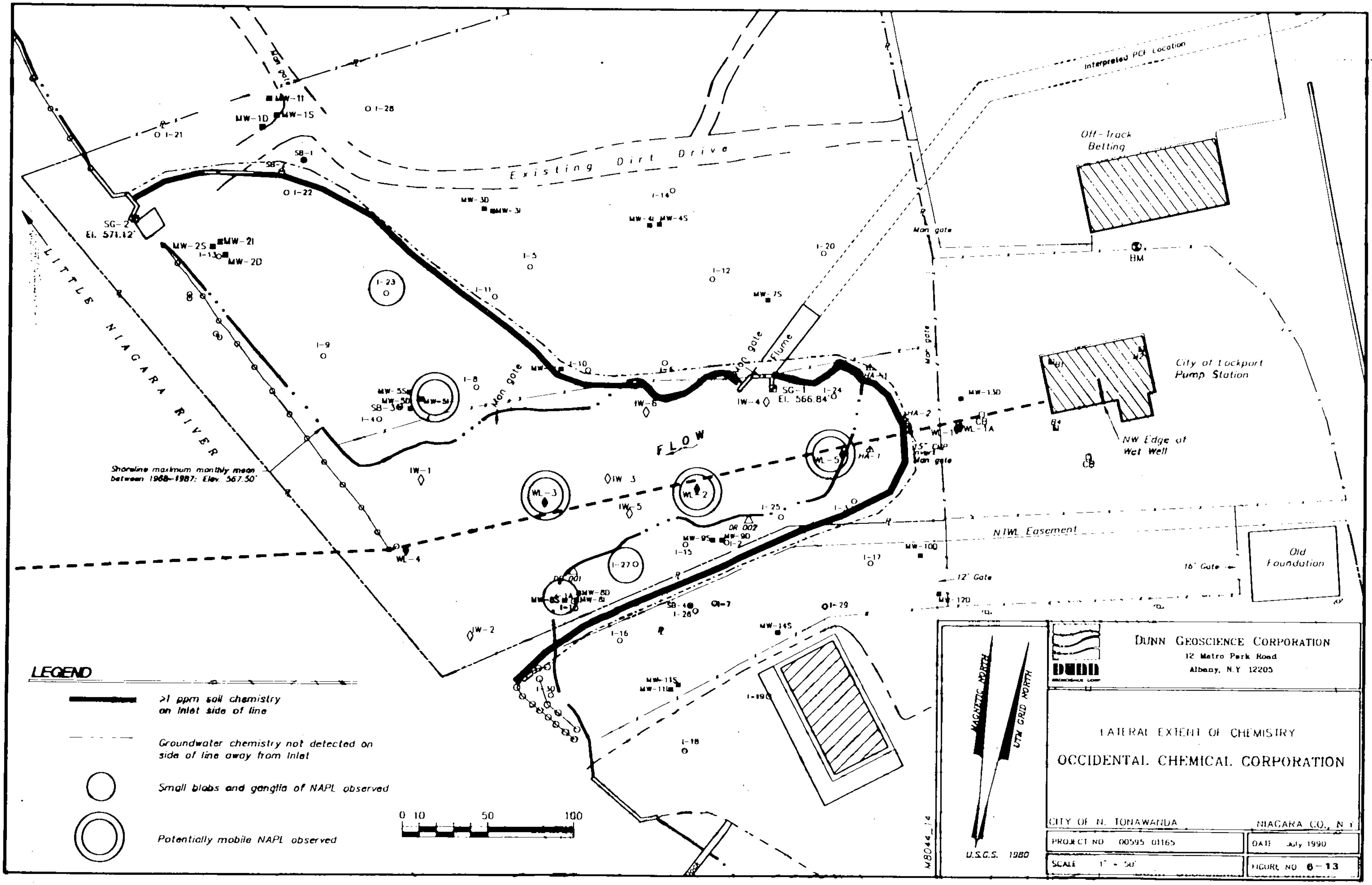

DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
SOIL CHEMISTRY MAP
GLACIO-LACUSTRINE CLAY & TILL
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00585-01165
DATE July 1990
SCALE
FIGURE NO 6-9
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
MBO44_29
LEGEND
Number indicates total chlorobenzenes (ppm).
ND - Not Detected.
SCALE IN FEET
0
50
100
LITTLE NIAGARA RIVER
Shoreline maximum monthly mean between 1968-1987: Elev. 567.50'
Existing Dirt Drive
Interpreted PCF Location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Old Foundation
NIWL Easement
Flume
Man gate
12' Gate
16' Gate
FLOW
SG-1 El. 566.84'
SG-2 El. 571.12'
BM
CB
0.029
ND
0.71
40
153
0.024
106
27
0.26
113
150
0.039
2
0.048
28
35
1


LEGEND
Total Chemistry (ppm)
Benzene (ppm)
* - No Results
ND - Not Detected
NA - Not Analyzed
TOTAL CHEMISTRY
Benzene
Toluene
2-Chlorotoluene
Chlorobenzene
1,2 Dichlorobenzene
1,4-Dichlorobenzene
1,2,3-Trichlorobenzene
1,2,4-Trichlorobenzene
SCALE IN FEET
0
50
100
LITTLE NIAGARA RIVER
Shoreline maximum monthly mean between 1968-1987: Elev. 567.50'
Existing Dirt Drive
FLOW
Flume
Off Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Interpreted PCF Location
NIWL Easement
Old Foundation
16' Gate
12' Gate
Man gate
SG-2 El. 571.12'
SG-1 El. 566.84'
BM
CB
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
ROUND 2 GROUNDWATER CHEMISTRY ANALYSES
OCCIDENTAL CHEMICAL CORPORATION
MAY 20, 1990
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595 01165
DATE July 1990
SCALE 1" = 50'
FIGURE NO. 6-10
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
MB044_12



ND
MW-11
MW-1S
MW-1D
ND
I-28
I-21
Existing Dirt Drive
0 Isopach
Alluvium
Boundary
Interpreted POF Location
Off-Track
Betting
SB-2
SB-1
I-22
MW-3D
MW-3I
I-14
MW-4S
MW-4I
SG-2
El. 571.12'
ND 54.2 TOTAL
MW-2S
MW-2I
I-13
MW-2D
ND
ND ND
Man gate
BM
I-20
I-5
I-23
I-11
I-12
Man gate
City of Lockport
Pump Station
I-9
0.013
0.006
MW-6I
I-10
HA-3
MW-5S
MW-5I
MW-5D
I-8
SG-1
El. 566.84'
IW-4
I-24
MW-13D
SB-3
266
IW-6
HA-2
CB
WL-1
WL-1A
FLOW
NW Edge of
Wet Well
Man gate
Shoreline maximum monthly mean
between 1988-1987: Elev. 567.50'
IW-3
WL-5
HA-1
IW-1
WL-2
I-3
WL-3
IW-5
0.23
I-25
NIWL Easement
MW-9S
MW-9D
I-27
I-15
MW-10D
16' Gate
Old
Foundation
WL-4
12' Gate
I-17
MW-12D
MW-8S
MW-8D
MW-8I
SB-4
I-7
I-26
ND
I-29
MW-14S
IW-2
2.1 42.3
ND
MW-11S
MW-11I
ND
I-30
I-18
LITTLE NIAGARA RIVER
LEGEND
Number indicates total chemistry (ppm).
ND -- Not Detected.
SCALE IN FEET
0
50
100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
GROUNDWATER CHEMISTRY MAP
FILL AND ALLUVIUM
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595-01165
DATE July 1990
SCALE 1" = 50'
FIGURE NO. 6-11


ND
0.184
Existing Dirt Drive
Interpreted PCF Location
Off Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Old Foundation
NTWL Easement
16' Gate
12' Gate
Man gate
Flume
FLOW
BM
SG-2 El. 571.12'
SC-1 El. 566.84'
Shoreline maximum monthly mean between 1960-1987: Elev. 567.50'
LITTLE NIAGARA RIVER
SCALE IN FEET
0
50
100
LEGEND
Number indicates total chemistry (ppm).
ND – Not Detected.
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
GROUNDWATER CHEMISTRY MAP
GLACIO-LACUSTRINE CLAY AND TILL
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO. 00595 01165
DATE July 1990
SCALE 1" = 50'
FIGURE NO 6-12


Existing Dirt Drive
Interpreted PCI Location
Off-Track Betting
City of Lockport Pump Station
NW Edge of Wet Well
Old Foundation
NTWL Easement
16' Gate
12' Gate
Man gate
Flume
FLOW
LITTLE NIAGARA RIVER
Shoreline maximum monthly mean between 1968-1987: Elev. 567.50'
SG-2 El. 571.12'
SG-1 El. 566.84'
BM
WL-1
WL-1A
WL-2
WL-3
WL-4
WL-5
IW-1
IW-2
IW 3
IW-4
IW-5
IW-6
MW-1D
MW-1S
MW-11
MW-2S
MW-21
MW-2D
MW-3D
MW-31
MW-4I
MW-4S
MW-5S
MW-5D
MW-7S
MW-8D
MW-9S
MW-9D
MW-10D
MW-11S
MW-13D
MW-14S
SB-1
SB-3
SB-4
DR 001
DR 002
I-5
I-9
I-12
I-13
I-14
I-15
I-16
I-17
I-18
I-19
I-20
I-21
I-22
I-23
I-24
I-25
I-26
I-27
I-28
I-29
I-30
HA-1
HA-2
LEGEND
>1 ppm soil chemistry on inlet side of line
Groundwater chemistry not detected on side of line away from inlet
Small blobs and ganglia of NAPL observed
Potentially mobile NAPL observed
0 10 50 100
MAGNETIC NORTH
UTM GRID NORTH
U.S.G.S. 1980
DUNN GEOSCIENCE CORPORATION
12 Metro Park Road
Albany, N.Y. 12205
LATERAL EXTENT OF CHEMISTRY
OCCIDENTAL CHEMICAL CORPORATION
CITY OF N. TONAWANDA
NIAGARA CO., N.Y.
PROJECT NO 00595 01165
DATE July 1990
SCALE 1" = 50'
FIGURE NO 6-13