VOLUME I - MAIN REPORT

RCRA FACILITY INVESTIGATION REPORT FOR THE OLIN BUFFALO AVENUE PLANT
RCRA-89-3013-0208

Prepared for:
Olin Chemicals
1186 Lower River Road
Charleston, Tennessee 37310
August 1994

Woodward-Clyde

Woodward-Clyde Consultants, Inc.
15 Hazelwood Drive, Suite 110
Amherst, New York 14228-2229
Project Number 4E02704

Woodward-Clyde

Woodward-Clyde Consultants, Inc.
Engineering & sciences applied to the earth & its environment

August 5, 1994
4E02704

Mr. Michael Bellotti
Olin Chemicals
1186 Lower River Road
Charleston, Tennessee 37310

Subject: RCRA Facility Investigation Report
(RCRA-89-3013-0208)
Olin Buffalo Avenue Plant

Dear Mr. Bellotti:

Woodward-Clyde Consultants (WCC) is pleased to submit this report for the RCRA Facility Investigation (RFI) conducted at Olin's Buffalo Avenue Plant.

This is the Final RFI report prepared as part of the RFI project, and includes a complete summary of analytical data collected to date, a complete set of drilling and boring logs, a complete assessment of contaminant distribution, and a discussion of probable transport mechanisms and pathways. This document represents the completion of work agreed to under the Administrative Order on Consent - Index No. RCRA-89-3013-0208, with the exception of the supplement to this report, which is described below.

Late delivery of the analytical results from the May 1994 sampling round (they have not been received as of the date of this submittal) has made it necessary to plan for the preparation of a supplement to this report. The supplement will present updated analytical data summary tables, and the final data validation packages for the recent sampling rounds.

Earlier submittals for this study have included an Interim Report (February 1992) and the Man-Made Passageways Investigation (November 1992). Information developed in these earlier reports is incorporated into this final report, either by reference or repetition (e.g., all analytical data summaries and drilling logs are included in this document).

Amherst Office
15 Hazelwood Drive, Suite 110 • Amherst, New York 14228-2229
716-691-1777 • Fax 716-691-4560

Woodward-Clyde appreciates the opportunity to be of service to Olin on this project.

Sincerely,

Martin S Leonard

Martin S. Leonard, P.E.
Project Manager

FOR Frank R. Sarbe

Kelly R. McIntosh, P.E., PHGW
Consultant to Woodward-Clyde Consultants

James F Roetzer

James F. Roetzer, Ph.D.
Vice President

KRM/MSL/kjs

The plume of groundwater contamination which appears to derive from Olin sources consists primarily of benzene and chlorinated benzene compounds with lower levels of BHCs, chlorinated phenols and mercury. The presence of these compounds is limited primarily to the area bounded by Gill Creek (and the south-north sanitary sewer), Buffalo Avenue, Adams Avenue, and the Olin Production Well. Elsewhere, observed contaminant levels are either very low or attributable to off-site sources.

The Olin groundwater plume is largely captured by man-made passageways or the Olin Production Well. A-zone groundwater flow west of Gill Creek is intercepted by the Buffalo Avenue sewer. A-zone flow in the vicinity of Gill Creek is bounded and limited by the south-north sanitary sewer line just east of the Creek. Groundwater intercepted by these sewer lines is ultimately collected and treated in the Niagara Falls Wastewater Treatment Plant, except for overflows during high runoff events. B-zone groundwater flow is to the north, toward Buffalo Avenue, or to the Olin Production Well in the western portion of the Plant. The Olin plume in the C- and CD-zones west of Gill Creek is captured by the Olin Production Well. All groundwater intercepted by the Olin Production Well is treated by activated carbon.

The Olin Plant is bordered by two sites which have identified groundwater contamination associated with past activities: the DuPont Niagara Plant to the south and the Solvent Chemicals Site to the east. Potentiometric surface maps developed from coordinated measurements shows that groundwater flow from the DuPont site is generally north toward the Olin property. Migration of groundwater from the DuPont site is the apparent source of chlorinated aliphatic volatile organic compounds observed in groundwater at the Olin Plant. Groundwater flow from the Solvent Chemicals Site is generally to the north to northwest, influencing the portion of the Olin property east of Gill Creek. Migration of contaminated groundwater from the Solvent Chemicals Site has apparently occurred up to and along the Buffalo Avenue sewer line as far west as Gill Creek. Migration of groundwater from the Solvent Chemicals Site is the apparent source of the benzene and chlorinated benzene plume observed east of Gill Creek, including contamination observed in monitoring wells adjacent to the Buffalo Avenue sewer east of Gill Creek.

Airborne transport and direct surface runoff of contaminants from the Olin Plant are inhibited by pavement and gravel cover and are not expected to be significant transport pathways. There is no current use of groundwater in the Plant vicinity as a drinking water supply, and no future use is anticipated due to the high mineral content of the water, and the abundant surface water supply.

Contaminant migration from the Olin Plant to Gill Creek is not expected to be significant. However, Gill Creek will be sampled and analyzed for potential Olin-related chemicals as part of the Gill Creek Remediation Program. Results of this sampling and analysis will be reported to NYSDEC.

1.0

INTRODUCTION

Olin Corporation (Olin) has entered into an Administrative Consent Order (Index No. RCRA-89-3013-0208) with the U.S. Environmental Protection Agency (EPA) which provides for performance of a RCRA Facility Investigation (RFI) of Solid Waste Management Units (SWMUs) at Olin's Buffalo Avenue Plant in Niagara Falls, New York (Figure 1-1). The purpose of the RFI is to assess the nature and extent of releases of hazardous waste or hazardous waste constituents from SWMUs or other source areas at the plant. The Consent Order was issued while Olin was in the process of conducting a voluntary groundwater investigation at the Plant. This groundwater study included installation of 24 groundwater monitoring wells. During discussions with EPA regarding the scope-of-work for the RFI, it was decided that an Interim Report would be prepared based on one round of groundwater analyses and the results of soil sampling and hydraulic monitoring programs conducted pursuant to the Consent Order. These investigations are referred to herein as the Phase I RFI Investigations.

The results of the Phase I RFI Investigations were presented in the Interim Report prepared by Woodward-Clyde Consultants (WCC) dated February 7, 1992. The Interim Report recommended installation and sampling of eight additional groundwater monitoring wells to better characterize groundwater conditions near Gill Creek (2 wells), in the northwestern portion of the plant (3 wells) and in one area north of Buffalo Avenue (3 wells).

Based on their review of the Interim Report, EPA and the New York State Department of Environmental Conservation (NYSDEC) requested additional soil sampling (soil borings) two additional monitoring wells located near the west side of Gill Creek, and three additional monitoring wells in the area north of Buffalo Avenue, east of Gill Creek. Olin agreed to perform the requested investigations.

In addition, Olin installed a total of five additional monitoring wells east of Gill Creek to further investigate the source of contamination found at well cluster OBA-3 during the Phase I RFI Investigations. Olin also obtained samples from DuPont monitoring wells located near the perimeter of the plant to further assess upgradient groundwater conditions. These samples were analyzed for semivolatile organic compounds, pesticides/PCBs and mercury. Volatile organic compound analyses for these samples were provided by DuPont. These additional investigations are referred to herein as the Phase II RFI Investigations.

Woodward-Clyde Consultants was retained by Olin to conduct the Phase II RFI Investigations and to prepare the RFI Report presented herein. The RFI Report presents and integrates the Phase I and Phase II RFI Investigations. Groundwater data from the Solvent Chemicals Site, located to the east of Olin, was provided by NYSDEC and was also incorporated into the RFI. Additional soil and groundwater chemistry data. from investigations conducted by NYSDEC at the Solvent Chemicals Site are expected to be available in September 1994. When this additional data is received, it will be assessed by Olin with respect to contaminant sources and an Addendum to the RFI report presenting Olin's findings will be subsequently issued.

The RFI report is organized in twelve sections. Section 2.0 presents project background information including descriptions of operations history and the facility environmental setting. Section 3.0 describes the work performed for the Phase I and Phase II Investigations. Section 4.0 presents a characterization of regional and site geology. The results of the hydraulic testing program are presented in Section 5.0. The results of soils and groundwater analyses are presented and discussed in Sections 6.0 and 7.0, respectively. Section 8.0 presents an assessment of the potential for contaminant migration including migration along underground utilities. In Section 9.0, potential impacts to human health and the environment resulting from Olin SWMUs are assessed. Conclusions of the RFI are presented in Section 10.0, and limitations of the study are identified in Section 11.0. References are listed in Section 12.0.

2.0
BACKGROUND

2.1 PLANT HISTORY

The Olin Corporation (Olin), under its present name, and earlier as the Olin-Mathieson Chemical Corporation, the Mathieson Chemical Company, and the Castner Electrolytic Company, has manufactured chemical products in Niagara Falls, New York, since 1897. Production has occurred at two plant sites located south of Buffalo Avenue, approximately 1000 feet north of the Upper Niagara River (see Figure 1-1).

A map showing the two plants in more detail is presented as Figure 2-1. The smaller (6-acre) western site (Plant 1) is separated from Plant 2 by Chemical Road and by 300 feet of property owned by E.I. Du Pont de Nemours and Company (Du Pont). Plant 2 (16-acres) is divided into two sections by Alundum Road (private). In this report, Plant 1 and Plant 2 are collectively referred to as the Plant. Only when these facilities are discussed individually are the numeric designations used.

Olin's principal business in Niagara Falls has centered around the electrolytic production of chlorine and caustic soda from rock salt (sodium chloride) using various modifications of the mercury-cell/chlor-alkali process. Mercury cells were once operated on both plant sites, but have been confined to Plant 2 for the past 30 years. Plant 1 has been largely inactive since the shutdown of calcium hypochlorite (HTH™) production in September 1982, and is presently used only for warehousing and groundwater treatment. In 1991, all mercury cell/chlor-alkali operations at the Plant were discontinued and decommissioned.

Despite the historical predominance of inorganic chemical production, several organic chemicals, including trichlorobenzene, trichlorophenol, and BHC (hexachlorocyclohexane), were manufactured in the section of Plant 2 between Alundum Road and Gill Creek (ARGC Area) between 1950 and 1956. Organic chemical production was discontinued in 1956.

2.2 SOLID WASTE MANAGEMENT UNITS (SWMUs)

There are six types of SWMUs at the Olin Plant, including four container storage areas, two land disposal sites, eight wastewater treatment tanks, three land application sites, one injection well and two thermal units. These SWMUs are shown on Figure 2-2.

2.2.1 Container Storage Areas

Four on-site container storage areas are considered SWMUs. They are designated CSA-1, CSA-2, CSA-3 and CSA-4 on Figure 2-2. CSA-1 is an active SWMU and is a building used to store DOT 17C and 17H steel drums. CSA-2, CSA-3, and CSA-4 are inactive. There is no evidence that any release has occurred from these areas.

2.2.2 Land Disposal Areas

The two land disposal areas are designated LD-1 and LD-2 on Figure 2-2. LD-1 is a former elevated and concrete lined waste pile. The waste pile contained brine mud, which contains one hazardous constituent, mercury, at an average concentration of approximately 30 to 50 ppm. Drainage was collected in sump for process recycle. Inspections were performed quarterly from 1984 through the unit's closure in 1989. There is no evidence that any hazardous constituent releases occurred from the unit.

LD-2 was a surface impoundment used for a period of two to three months in 1970 to store cooling water containing traces of mercury. Its dimensions were approximately 100 feet x 100 feet x 4 feet. It is possible that this unit, although only operated for two months, could have caused a release of mercury to the soil.

2.2.3 Wastewater Treatment Units and Tanks

Figure 2-2 shows three active units (WWT-1, WWT-2 and WWT-3), and five inactive units (WWT-4, WWT-5, WWT-6, TK-1 and TK-2) which are listed as SWMUs. Each is discussed below.

WWT-1: WWT-1 is a wastewater treatment unit in which mercury-containing wastewater (D-009) is treated with sodium sulfide to precipitate mercury for removal by filtration.

The unit is vented to a sodium hypochlorite scrubber system. There has been one reported release of wastewater from this tank (in a correspondence to NYSDEC dated March 24, 1988). An estimated 200 gallons were released.

WWT-2: WWT-2 is used to decompose sodium hypochlorite by thermal catalytic reaction prior to POTW discharge. There is no evidence of any releases from this unit.

WWT-3: WWT-3 is used for pH adjustment of wastewater. There is no evidence of any releases from this unit.

WWT-4: WWT-4 was used to remove chlorine from chlorinated wastewater. There is no evidence of any releases from this unit.

WWT-5: This unit was used for decomposition of sodium hypochlorite by thermal catalytic reaction. There is no evidence of any releases from WWT-5.

WWT-6: WWT-6 was used to decompose sodium hypochlorite by thermal catalytic reaction. There is no evidence of any releases from WWT-6.

TK-1: TK-1 was a concrete lined tank used to contain brine sludge (K071). This unit was clean closed in 1989. The results of a semi-annual standing leak test with water in 1987 had indicated possible leakage from this tank. This possible leakage was addressed by soil sampling pursuant to the approved closure plan.

TK-2: TK-2 was a concrete lined tank used to contain waste calcium hypochlorite -- a non-hazardous sludge. There is no evidence of releases of any hazardous constituents from this unit.

2.2.4 Land Application Units

Figure 2-2 shows the locations of the four land application sites. These are locations where brine mud was used for road repair due to its cementitious properties. The material contains a hazardous constituent, mercury, at a concentration of approximately 30 to 50 ppm. When allowed to harden, it is very resistent to leaching. Each of these SWMUs is discussed below.

LA-1, LA-2: An estimated 246 cubic yards of brine mud were used for road repair in the LA-1 area during 19657. Approximately 6 cubic yards were used for road repair in the LA-2 area. Both locations have since been paved.

LA-3: Approximately 12 cubic yards of brine mud were used at location LA-3 for road repair in 1958. The site has since been paved.

LA-4: LA-4 comprises approximately 2,.1 acres on which brine muds were surficially deposited in several small areas to fill potholes.

2.2.5 Disposal Well

A disposal well (UIC-1), located as shown on Figure 2-2, was used at the Olin Plant from 1963 to 1977. The disposal well was 125 feet deep and was used to dispose of approximately 130,000 tons of end liquid (60 to 65 percent water, 30 percent sulfuric acid, 5 to 10 percent sodium chlorate). The well was plugged with concrete in 1977. There is no evidence of off-site environmental impact.

2.2.6 Thermal Treatment Units

There are two active thermal treatment units at the Olin Plant (RT-1 and RT-2). There is no evidence of releases from these SWMUs.

2.3 FACILITY ENVIRONMENTAL SETTING

The Plant is located in an industrial community. Plant 1 is bounded on the west and south by former production facilities owned by Carborundum Corporation. Plant 2 property is bounded on the east by the 3163 Buffalo Avenue Site (also referred to as the Solvent Chemicals Site) a former chemical plant and disposal site currently being investigated by NYSDEC. Adjacent to Plant 2 to the south is the Du Pont Niagara Plant, which has also conducted hydrogeologic investigations and remedial actions pursuant to a NYSDEC Consent Order.

The Remedial Investigation (RI) Report for the Solvent Chemicals Site reports that soil at the site is contaminated with benzene and chlorinated benzene compounds.

Groundwater also was found to contain these chemicals at concentrations up to approximately 500,000 ug/l. Dense non-aqueous phase liquid (DNAPL) has been observed in at least one monitoring well at the site. Sediments in a sewer which apparently historically discharged water from the site to Gill Creek was reported to contain chlorinated benzene compounds at a concentration greater than 3,000,000 ug/kg. This level is sufficiently high to raise a concern of possible past discharge of DNAPL via this sewer.

Based on the RI Report for the Solvent Chemicals Site, NYSDEC has initiated additional environmental investigations including soil sampling and additional groundwater well installations and sampling. This work is planned for completion by the end of 1994. Where available, results of Solvent Chemicals investigations have been included in this RFI (with permission from NYSDEC).

Groundwater at the DuPont Niagara Plant has been found to contain a variety of chlorinated volatile aliphatic compounds, including trichloroethene, tetrachloroethene, chloroform, carbon tetrachloride and other one and two carbon chlorinated volatile organic chemicals. The presence of these chemicals has been attributed by DuPont to past DuPont activities at the site, including manufacture of chlorinated solvents. Groundwater at the Olin Plant is hydraulically downgradient of the DuPont Niagara Plant and has been found to contain high levels of the chlorinated aliphatic volatile organics at some locations. Due to the presence of chlorinated aliphatic volatile organics in its production well water, Olin has treated groundwater withdrawn for non-contact cooling with an activated carbon system since 1984. DuPont, as part of their groundwater remediation program, has agreed with NYSDEC to pump and treat groundwater using the Olin production well. DuPont entered into an agreement with Olin in 1985 under which Olin's production well and treatment system are operated as part of DuPont's groundwater remediation program at an average pumping rate maintained above 600 gpm. The system removes approximately 8 pounds of chlorinated aliphatic volatile organic chemicals per day.

The impacts of the Solvent Chemicals Site and DuPont Niagara Plant on groundwater at the Olin Plant are assessed in Section 7.3

2.4 PREVIOUS INVESTIGATIONS

Investigations conducted by Olin since 1978 have documented the presence of mercury and a variety of organic chemicals at parts-per-billion (ppb) to parts-per-million (ppm) concentrations in soils and shallow groundwater at Plant 2, and in cooling water produced from deeper wells at Plant 1.

In the early 1980s, the EPA commissioned an effort to estimate individual facility chemical contributions to the Niagara River directly, and via groundwater infiltration to the Falls Street Tunnel (Koszalka, et. al., 1985). Both this study and a more recent one conducted for the City of Niagara Falls (O'Brien and Gere, 1987) have claimed a potential for off-site chemical migration in groundwater from the Olin Buffalo Avenue Plant.

These assertions were made based on a very limited review of available data. In 1988, Olin contracted Woodward-Clyde Consultants (WCC) to review all existing data related to soil and groundwater contamination at the Buffalo Avenue Plant and to assess the need for further action on the matter. WCC's findings were presented in the Groundwater Assessment Report (October, 1988). The Groundwater Assessment Report identified the eastern portion of Plant 2, between Alundum Road and Gill Creek, as an area for which additional information was needed to characterize groundwater flow and contaminant transport conditions. Based on this recommendation, Olin Corporation contracted WCC to design and perform a study to further investigate soil and groundwater contamination. The major components of the study included soil sampling near active or former solid waste management units (SWMUs), installation and sampling of groundwater monitoring wells, and hydraulic testing. The elements of this investigation were presented in the Field Operations Plan (FOP) for the project (June, 1989). Monitoring well installations were nearly complete by the time Olin Corporation was notified (in September 1989) of EPA's intention to initiate an RFI pursuant to RCRA Section 3013. These monitoring wells were incorporated into the scope of work for the RFI as described in Section 3.0.

2.5 GILL CREEK INVESTIGATION AND REMEDIATION

Sediment in Gill Creek has historically been impacted by activities at the Olin, DuPont and Solvent Chemical facilities. In 1981, DuPont and Olin undertook voluntary programs to remediate contaminated sediments from portions of Gill Creek which pass through their plant sites. Contaminated sediments were excavated from the Creek and disposed of in a secure landfill. Olin excavated sediment in their reach of Gill Creek to the bedrock surface. The areas of Gill Creek downstream of Olin property which were not remediated during 1981 were later identified as contaminated. These areas were remediated in a joint program by DuPont and Olin in 1992 in accordance with NYSDEC Order on Consent No. B9-0206-90-01 (March 20, 1991). The 1992 Gill Creek Remediation is described in the report prepared by WCC titled "Gill Creek Remediation Project - Final Report" dated December 22, 1993. Post remediation monitoring of Gill Creek will be performed by DuPont/Olin in accordance with the Work Plan prepared by WCC titled "Final Work Plan, Gill Creek Remediation Project Post Remediation Monitoring Plan", dated July 9, 1993.

3.0
WORK PERFORMED

3.1 WORK PLANS

The following Work Plans were submitted to and approved by EPA pursuant to the Consent Order:

Current Conditions Report, 1988 (CCR) (Groundwater Assessment Report)
Project Management Plan, October 1989 (PMP)
Data Management Plan, 1989 (DMP)
Health and Safety Plan, May 1989 (HASP)
Community Relations Plan, 1989 (CRP)
Data Collection Quality Assurance Plan, August 1991 (DCQAP)
RFI Work Plan, February 1990 (WorkPlan)
Addendum to the RFI Work Plan, August 1991 (Addendum)
Final Data Development Plan, April 1994 (FDDP)

All work specified in these Plans has been completed, with the exception of completion of data validation for recent data collection. Due to delays in submittals of complete laboratory packages, data validation could not be performed prior to submittal of this report. The final analytical data reports and the data validation will be submitted as a supplement to this report.

3.2 GROUNDWATER MONITORING WELL INSTALLATION

3.2.1 Phase I Monitoring Wells

The Project Management Plan (PMP) for the Olin RFI describes the technical approach and reasoning for the placement of monitoring wells for the Phase I RFI Investigation. A total of 24 Phase I groundwater monitoring wells were installed at the Buffalo Avenue Plant in the summer of 1989 under the direction of WCC. The wells were installed in clusters of three at eight locations designated OBA-1 through OBA-8, as shown on Figure 3-1.

Five of the Phase I clusters are located in the Plant 2 area west of Gill Creek, two clusters are located on Olin property east of Gill Creek, and one cluster is located along the southern boundary of Plant 1. Each cluster contains a top-of-bedrock well and two deeper bedrock wells to monitor the first three water bearing zones from ground surface to a depth of approximately 50 feet. The top-of-bedrock wells, termed A-zone wells for this study, were installed to evaluate flow conditions and water quality at the interface between the overburden and the fractured bedrock. The deeper bedrock wells were installed to monitor flow conditions and water quality within the two uppermost major water-bearing bedrock fracture zones within the Lockport Formation. The uppermost water-bearing fracture zone is termed the B-zone for this study. Monitoring wells penetrating the lower water-bearing fracture zone are termed C-wells for this study. All drilling and well installation procedures are presented in detail in the Work Plan. The A-zone wells are constructed using a 5 foot length of screen and sandpack with a bentonite and grout annular seal. The B-zone and C-zone wells are completed as open 3-7/8 inch diameter rock holes spanning the water-bearing fracture zone and sealed using a 4-1/2 inch O.D. steel casing and a cement/bentonite grout annular seal. Well completion diagrams are included in Appendix A. Soil boring and rock core descriptive logs are included in Appendix B.

3.2.2 Phase II Monitoring Wells

As described in Section 1.0, a total of 18 Phase II monitoring wells were installed to provide additional data concerning groundwater flow, presence of chemicals and sources of contamination.

The Phase II monitoring wells (with the exceptions of OBA-9A and OBA-10A which were installed in November, 1992) were installed during January through April 1994 at the locations shown on Figure 3-1. Well installation methods and water bearing zone designations are the same as for the Phase I monitoring wells (see Section 3.2.1, above). Well completion diagrams are included in Appendix A. Soil boring and rock core description logs are included in Appendix B.

3.3 GROUNDWATER SAMPLING AND ANALYSIS

The Phase I monitoring wells and the Olin Production well (influent, prior to treatment) were sampled quarterly for four consecutive quarters from fourth quarter 1991 through third quarter 1992. In addition, four quarterly samples were obtained from two wells designated BH-1 and BH-3, which were installed by Olin in 1978 (Harza wells) and were judged by WCC to be capable of yielding representative groundwater samples. The other seven Harza wells installed in 1978 have been damaged and decommissioned except for BH-9. BH-9 was not sampled because it is at approximately the same location as well cluster OBA-5A.

The complete set of Phase II monitoring wells were sampled during May 1994. In addition, three Phase I monitoring wells (OBA-4A, 4B and 4C) were sampled in May 1994. Previously, the OBA-11 and OBA-12 cluster of wells were sampled in January 1994. A second sampling event for the Phase II monitoring wells was conducted during July of 1994.

In addition to the sampling of monitoring wells on the Olin property, eleven wells installed by DuPont near the perimeter of the Olin Plant were sampled. This was a one-time sampling event performed during October 1993. The locations of the DuPont monitoring wells sampled are shown on Figure 3-2.

In addition to the data collected as part of the Olin RFI, data obtained as part of the Solvent Chemical Site RI has been incorporated into this study.

All groundwater samples were collected as described in the Work Plan and Addendum. Groundwater samples were analyzed by Recra Environmental, Inc. of Amherst, New York for the Project Analyte List (PAL). The PAL (Table 3-1) was developed to characterize groundwater contaminants potentially present from on-site and off-site sources. It is a comprehensive list, developed by taking the Contract Laboratory Program (CLP) Target Compound List (TCL) and adding additional chemicals as described in the Work Plan. Groundwater analyses were conducted in accordance with the Data Collection Quality Assurance Plan (DCQAP).

3.4 HYDRAULIC HEAD MONITORING

3.4.1 Phase I Hydraulic Head Monitoring

The Phase I hydraulic head monitoring program was designed to evaluate temporal variations in groundwater elevations and the influence of the Olin Production wells and Gill Creek on local flow conditions. The monitoring program had two separate elements: (1) monthly monitoring well water level measurement, and (2) a continuous (hourly) water level monitoring program in selected monitoring wells, Gill Creek, and the Niagara River.

3.4.1.1 Monthly Measurements

Groundwater hydraulic heads were measured in all Phase I monitoring wells (plus BH-1 and BH-3) monthly for 12 consecutive months (October 1990 through September 1991). Measurements were obtained over a period of less than 4 hours as described in the Work Plan.

3.4.1.2 Continuous (Hourly) Measurements

A 7-day continuous water level monitoring program was conducted in accordance with the Work Plan. Well clusters monitored were OBA-8, OBA-7, OBA-5, and OBA-4. These well clusters are located at increasing distances from the Olin Production Well and on both sides of Gill Creek so that data concerning the relative effects of both hydrologic features could be collected.

At each selected monitoring well cluster, two 2-channel or one 4-channel Hermit™ data logger and three pressure transducers were used to collect and record hourly water level measurements. Each transducer was calibrated and used in accordance with the Work Plan. Water levels were also measured within Gill Creek during the monitoring program using a stilling well and continuous monitoring equipment. Water levels in the Niagara River were obtained from the New York Power Authority monitoring point at the Robert Moses Intakes and from the Ontario Hydro monitoring point at the Canadian Intake. The river water elevations are routinely measured by the power authorities at 60 minute intervals.

Following completion of the 7-day monitoring program, Gill Creek and two top-of-bedrock monitoring wells, OBA-4A and OBA-7A, were selected for 30 days of additional monitoring to evaluate effects of precipitation events. In addition, OBA-4B was continuously monitored to provide data on the interaction between Gill Creek and the upper bedrock fracture zone. During the 30-day period, water levels were continuously monitored at Gill Creek and obtained from the power authorities for the Niagara River.

3.4.2 Phase II Hydraulic Head Monitoring

The Phase II hydraulic head monitoring was more regional in scope and consisted of hydraulic head measurements conducted jointly with the DuPont and Solvent Chemicals investigation teams. Hydraulic heads in all Olin Phase I and Phase II monitoring wells, 139 DuPont monitoring wells and recovery wells, and 27 Solvent Chemicals monitoring Wells were measured on June 10, 1994.

3.5 HYDRAULIC TESTING

The response of the water-bearing zones to hydraulic stress was investigated through single well permeability testing of Phase I monitoring wells and a pumping study using the Olin production well and Phase I monitoring wells. The purpose of the single well tests was to estimate the transmissivity in the vicinity of each monitoring well. The purpose of the pumping study was to evaluate the hydraulic impact of the Olin production well on groundwater flow beneath the Plant in the A-, B-, and C-zones. Single well test results are presented in Section 5.1, and pumping test results are presented in Section 5.2.

3.5.1 Single-Well Permeability Testing

Slug tests were performed on all Phase I monitoring wells. The purpose of these tests was to estimate the transmissivity in the near-well vicinity. The slug tests were performed by inserting (falling head) or withdrawing (rising head) a slug of known volume from the well and monitoring the response of the water level in the well. Both falling and rising head tests were performed.

Water level responses were monitored in the wells using pressure transducers and battery-powered Hermit™ data loggers. The data logger was programmed to take water level measurements in a logarithmic progression (i.e., 10 measurements in the first 10 seconds, 10 measurements in the next 100 seconds, etc.). The following methodology was used to collect the slug test data.

1. Measure depth to water and depth to the bottom of the well. Note the depth of the zone being tested, well construction details, and volume of slug being used.

2. Insert transducer into well and perform initial calibration by raising and lowering transducer a known distance and recording the resultant data logger response. Secure transducer at a depth of approximately 10 feet below the water surface (if possible).

3. Insert or withdraw slug rapidly but smoothly from the water column and begin recording the water level response.

4. Continue monitoring the water level response until 90 percent recovery is observed.

5. Decontaminate all equipment between wells using procedures described in the RFI Work Plans.

3.5.2 Olin Production Well Pumping Study

A pumping study was conducted to determine the areal extent of the hydraulic depression associated with the Olin Production Wells. Groundwater was pumped from the South Production Well and the hydraulic response was monitored at each of the 24 Phase I monitoring wells and in selected Du Pont monitoring wells. The test was conducted in steps as follows:

Pre-test: For approximately 48 hours the pumping rate was maintained at approximately 600 gpm. All monitoring wells were monitored at least twice a day during this period (pre-test monitoring).

Step 1: The pumping test was initiated after the pre-test monitoring by shutting the pump down and monitoring recovery at each observation well for a period of 94 hours (recovery test).

Step 2: After 94 hours of recovery, the South Production Well was pumped at a rate generally between 400 and 500 gpm. The pumping system was somewhat unsteady at this flow rate, which was lower than its normal operating rate. In addition, the pumping rate was in excess of 1000 gpm for a few minutes at the start of the test prior to a buildup of water pressure in the treatment system. The duration of Step 2 was 70 hours.

Step 3: After 70 hours of pumping (Step 2), the pumping rate was increased to approximately 1000 gpm for a period of 118 hours.

Step 4: After pumping at approximately 1000 gpm for 118 hours (Step 3), the pumping rate was increased to the maximum system capacity (pump, piping and water treatment), which ranged between approximately 1300-1500 gpm. The pumping rate was maintained in this range for 48 hours.

The pumping schedule for the test is summarized on Table 3-3. Continuous monitoring devices were used to automatically monitor hydraulic head in 17 monitoring wells (Table 3-3). Figure 3-3 shows a graph of pumping rate versus time for the duration of the test.

3.6 SOIL SAMPLING

3.6.1 Phase I Soil Sampling

Soil sampling was performed as part of the Phase I RFI investigations to assess soil contamination resulting from potential hazardous waste constituents releases at selected Olin SWMUs and other areas of the Plant. Figure 2-2 shows the locations of SWMUs at the Plant. Information regarding potential hazardous waste constituents releases from SWMUs at the Olin Plant is included in the RCRA 3004u questionnaire submitted to USEPA on September 20, 1989. The Olin RFI Workplan and Addendum Letter (dated August 9, 1991) describe the rationale for the placement of Phase I soil sampling locations and analysis parameters for this study. A total of 18 soil borings were advanced and soil sampling performed as shown on Figure 3-4. Figure 3-4 also includes a summary of the particular SWMU or feature being investigated and the depth to refusal for each boring.

All borings were advanced using hollow-stem auger drilling techniques with continuous soil sampling using split-spoon samplers. Borings were advanced and sampling performed until auger refusal was reached. All drilling equipment and split-spoon samplers were decontaminated in accordance with the RFI Work Plan. Soil boring logs are included in Appendix B.

Analyses of soil samples was in accordance with the Work Plan and Addendum. The Phase I soil sampling program is summarized below:

SWMU or Location	Soil Borings	Analyses
LD-2	9	Total and extractable mercury
TK-1	1	Total and extractable mercury
WWT-1	1	Total and extractable mercury
LA-1	1	Total and extractable mercury
LA-2	1	Total and extractable mercury
LA-3	1	Total and extractable mercury
LA-4	1	Total and extractable mercury
North of Building 17	1	Total and extractable mercury
BHC Storage Area	1	Organic analytes on the PAL except methanol
Building 97 Area	1	Inorganic and organic analyses on the PAL except methanol

3.6.2 Phase II Soil Sampling

The Phase II soil sampling consisted of additional soil borings installed at Plant 1 to investigate presence of mercury in soil, and at Plant 2 to investigate presence of BHC in soil. Decontamination methods were as described for the Phase I soil borings. Drilling and soil boring logs are included in Appendix B.

3.6.2.1 Phase II Soil Borings: Plant 1

Fifteen soil borings were advanced in Plant 1 at the areas shown on Figure 3-4. Twelve of these borings were located surrounding the past locations of the mercury cell buildings and three borings were advanced in the former gas holder area. Continuous split spoon samples were obtained from ground surface and examined for traces of elemental mercury. Samples were also screened using a mercury vapor monitor (Jerome Model 431XD). Based on the mercury vapor measurements, three soil borings were selected (based on high readings) to have each split-spoon sample analyzed. Two of three soil borings were located near the former cell buildings and the third was located in the gas holder area.

3.6.2.2 Phase II Soil Borings: Plant 2

Two soil borings were advanced to bedrock near the former location of Building 97 in Plant 2 as shown on Figure 3-4. Continuous split spoon samples were obtained and analyzed for BHCs.

3.7 MAN-MADE PASSAGEWAYS EVALUATION (TASK 6)

Past and present underground man-made passageways at the Olin Plant and in the vicinity were identified based on available utility drawings. The locations and depths of these structures were evaluated with respect to groundwater potentiometric surfaces and the distribution of soil and groundwater contamination. Based on this evaluation, potential preferential pathways for contaminant migration were assessed.

4.0
GEOLOGIC CONDITIONS

4.1 REGIONAL GEOLOGY

A complex sequence of geologic events has resulted in the placement of two sedimentary units of very different ages, origins, and characteristics in direct contact in the Niagara Falls area. A veneer of unconsolidated Pleistocene glacial till and fine-grained lake bottom sediments less than 20,000 years old overlie 80 to 158 feet of dolomite bedrock (Lockport Dolomite) deposited as limestone in the Middle Silurian period (350 million years before present (BP)). Water moves through the glacial deposits at rates determined by the local texture of the unconsolidated sediment matrix. The Lockport Dolomite, however, is of very low permeability except where dissolution channels have developed along horizontal bedding planes or through vertical fractures and joints. A 60-foot thick sequence of impermeable calcareous shale, the Rochester Formation, underlies the Lockport, and separates lower-lying formations from the Lockport Dolomite. Exclusive of man-emplaced fill, the Pleistocene glacial deposits and the Lockport Dolomite are the only two units of potential interest with respect to contaminant migration at the Olin Plant. The thickness, lithology, and hydraulic characteristics of the deposits underlying the Niagara Falls area have been extensively studied by the USGS (Maslia and Johnston, 1982) and through a number of hydrogeologic investigations conducted by Olin, Du Pont, and Occidental Chemical Company, among others, throughout the Niagara Falls region. A more complete discussion of regional geology is presented in the Current Conditions Report (CCR).

4.2 SITE GEOLOGY

4.2.1 Soils

Overburden materials observed during advancement of 36 soil borings and installation of 42 monitoring wells during the Olin RFI can be grouped into two classes: 1) man-emplaced fill materials associated with excavation and construction of the Olin Plant; and 2) pleistocene glacial materials deposited during the most recent Wisconsin glacial advance and subsequent retreat approximately 12,000 years BP. Descriptive logs for the monitoring well installations and soil borings are included in Appendix B. The glacial deposits, where observed, typically consist of a fine-grained silty clay unit related to deposition within ancestral glacial Lake Tonawanda throughout the period of ice margin retreat. However, some coarser-grained glacial till and stratified sand and gravel deposits were observed in limited quantities. The till deposits are generally unsorted, unstratified, glacially transported materials, while the stratified sand and gravel units are associated with the reworking of till materials in glacial outwash streams prior to glacial retreat.

The thickness of unconsolidated overburden materials varies from 3.8 to 14.3 feet across the Plant. As illustrated in the top-of-bedrock elevation contour map and the overburden isopach map (Figures 4-1 and 4-2), the Plant lies above an isolated northwest-southeast trending bedrock ridge. The apex of the ridge appears to be centered beneath the caustic unloading/storage area at Plant 2 and has a N60°W orientation. Regionally, this local bedrock ridge is situated on the western flank of a broad north-south trending buried valley (CCR).

In general, the thickest sequences of natural glacial deposits are found in areas of the Plant furthest radially from the apex of the bedrock ridge (i.e., where overburden thickness is the greatest) and in the northerly portions of the Plant away from the ancestral northern bank of the Upper Niagara River which existed directly south of the Olin Plant prior to reclamation in the last century. As is illustrated in a glacial deposits isopach map (Figure 4-3), the most significant accumulation of glacial deposits (greater than 3 feet) are found at well clusters located in the contractor's laydown area and the northern portions of the DuPont leased parking lot between Gill Creek and the Solvent Chemicals Site. Another area of significant glacial deposits accumulation is the western part of Plant 1.

All unconsolidated sediments have been classified, in order of occurrence from ground surface, into four material types: 1) fill; 2) alluvium; 3) glaciolacustrine; and 4) till. As discussed earlier, the man-emplaced fill and to a lesser extent the glaciolacustrine sediments volumetrically dominate the overburden materials observed at the Plant.

Fill materials encountered across the Plant are quite variable in thickness and nature. These include gray shot rock, cinder, mixtures of reworked sand, silt and clay, brick debris, slag, and lesser amounts of brine mud, fly ash, and lime sludge. Fill materials were most prevalent at: 1) the most southerly portions of the Plant where reclamation of low lying marsh areas near the ancestral northern bank of the Upper Niagara River has occurred (i.e., cluster OBA-5); 2) areas where bedrock is closest to the surface (i.e., the bedrock ridge apex/axis); 3) Plant process areas where intense excavation, construction and infilling have occurred (i.e., most recent cell room area, process areas situated between Alundum Road and Gill Creek); and 4) areas adjacent to Gill Creek (i.e., remediation areas, past channel modification).

Alluvium deposits, believed to have been emplaced during late stage evolution of glacial Lake Tonawanda, typically consist of a fine silty sand sometimes with interspersed wood and peat stringers. A thin layer of alluvium was observed only at cluster OBA-8, suggesting it is very limited in volume and areal extent beneath the Plant. Alluvium deposits would most likely be observed only in areas where the overburden is relatively thick and further toward the Niagara Falls sewage treatment plant, approximately 1000 feet west of the Plant, where the unit was first described (Calkin and Brett, 1978).

The glaciolacustrine deposits generally consist of a mottled brown/red/gray clay and silty clay with a small sand component. The clay is typically very firm, cohesive, relatively impermeable and has high plasticity. Subrounded rock clasts are usually present and increase in abundance close to the bedrock interface. The lacustrine clay was observed in varying thicknesses at well clusters OBA-1, OBA-2, OBA-3, OBA-6, OBA-8, OBA-11, OBA-13, OBA-14, and in soil borings OSB-3, OSB-5, OSB-6, OSB-18, NSB-1, NSB-2, NSB-11, NSB-12, NSB-13, NSB-14, and NSB-16.

Glacial till, composed of brown to gray silty clay with abundant rock fragments and sand was most often observed in the area around the former contractors laydown yard at the northeastern most part of Plant 2. Well clusters OBA-3, OBA-13, OBA-14, and OBA-15 exhibited varying thickness of till. The till often resembles the lacustrine clay with a larger component of rock clasts and sand.

The only natural material encountered at cluster OBA-5 was a thin bed of black, organic rich, marsh deposits. This occurrence again illustrates the fact that the former north bank of the Upper Niagara River was situated just south of Olin Plant, very close to OBA-5 cluster location.

4.2.2 Bedrock

The Olin Niagara Plant is underlain by the Lockport Formation of Middle Silurian Age (320-350 million years old). Lithologically the Lockport Formation is a dolomite and is generally brown-gray in color, medium-grained, displays medium to massive bedding, carbonaceous partings, vugs, and stylolites and is fossiliferous in sections. The approximately 200-foot section of the Lockport Formation in the Niagara Falls vicinity is divided into five members: 1) the Oak Orchard; 2) Eramosa; 3) Goat Island; 4) Gasport; and 5) Decew. The portion of the Lockport Formation which immediately underlies the Plant is the Oak Orchard member.

As discussed earlier, the Olin Plant lies above a northwest-southeast trending bedrock ridge. This isolated bedrock ridge appears to be located on the western flank of a longer regional north-south trending buried valley (CCR).

The Lockport Dolomite supplies non-contact cooling water for the Olin Plant but is not used for potable water supply due to naturally high levels of dissolved solids. Groundwater movement in the Lockport Dolomite occurs through near horizontal bedding plane fractures, vertical joints and solution cavities. As described below, bedding plane fractures, further enhanced by groundwater solutioning, are the primary route of groundwater transport. The most significant bedding plane fracture frequency occurs within the upper 25 to 30 feet of the formation, as it has been subjected to weathering and flexure during tectonic events and glacial rebound. Distinct water-bearing fracture zones in the Lockport have been identified and intensively examined in the past few decades by numerous investigators. At a given location, distinct water-bearing zones appear to be locally laterally continuous and occur at fairly uniform depths.

Numerous vertical joints have also been observed within the Lockport Dolomite in exposed rock faces but were originally described as tight and do not appear to transmit water readily. However, since vertical joints provide vertical pathways for contaminants and cross-communication between water-bearing zones they must be considered significant. This is a consideration for the Plant area as it has been suggested that exceptional well yields from the Olin production wells may be a result of an enhanced east-northeasterly set of vertical joints related to deep basin faulting (Yager and Kappel, 1987).

Descriptive rock logs for the Phase I and Phase II monitoring wells are included in Appendix B.

4.3 GROUNDWATER HYDROLOGY

4.3.1 Water-Bearing Zones

As discussed above, the overburden at the Olin Plant is relatively thin, in general less than 10 feet in thickness. Saturated conditions (i.e., the water table) were generally encountered during drilling within the lower 2 feet of soil above the top-of-bedrock. The upper most water-bearing zone is therefore defined as the lower 2 feet of overburden and the weathered bedrock surface. This will be referred to as the A-zone. Groundwater flow in the A-zone is influenced to a large extent by the slope of the bedrock surface.

The water-bearing properties of the Lockport Dolomite have been extensively studied at the adjacent Du Pont Niagara Plant and the Solvent Chemicals Site, and elsewhere in the vicinity. These studies have shown that groundwater flow within the bedrock occurs primarily within dissolution channels which have developed along horizontal bedding planes and through vertical fractures and joints. The horizontal bedding plane fracture zones can be considered to be leaky confined water-bearing zones, with vertical leakage occurring through vertical fractures and joints.

During drilling for well installation, water-bearing fracture zones are identified by drilling water loss to the formation, core inspection and sudden changes in the drilling mechanics (such as a drill rod dropping or vibration). Two major water-bearing fracture zones were encountered at the Plant. Using terminology consistent with that used for the hydrogeologic assessments performed at the adjacent Du Pont facility, these zones are referred to as the B- and CD-zones. A less widespread water-bearing fracture zone was encountered during the drilling of five wells (OBA-1C, OBA-7C, OBA-4C, OBA-14C and OBA-15B). This minor water-bearing zone corresponds to the C-zone identified in the Du Pont studies and is located between the B- and CD-zones. The B-zone is located between 16 and 21 feet below ground surface. The CD-zone is located between 45 and

50 feet below the ground surface. When present, the C-zone was encountered between 25 and 35 feet below ground surface.

4.3.2 Groundwater Flow

4.3.2.1 Regional Influences on Groundwater Flow

Major regional influences on groundwater flow in the region near the Olin Plant are the Niagara River and Niagara Gorge, the water diversion structures of the Niagara Power Project, and the Falls Street Tunnel. Figure 4-4 shows the approximate locations of these features.

The Niagara Power Project was constructed in the early 1960s and is operated by the New York Power Authority (NYPA). The NYPA diversion structures potentially affecting groundwater flow at the Olin Plant are the twin buried conduits which carry water from the upper Niagara River north to the Robert Moses Power Plant, and the Forebay Canal, an L-shaped excavation in the bedrock linking the conduits with the Robert Moses Power Plant. The Olin Plant is located approximately 2000 feet west of the twin buried conduits and approximately 4 miles southeast of the Forebay Canal. The upper Niagara River is located approximately 1000 feet south of the Olin Plant.

For a detailed account of the effect of the Niagara Power Project on groundwater flow within the Lockport Dolomite in the Niagara Falls area, refer to U.S. Geological Survey Water-Resources Investigations Report 86-4130. Very briefly, the present understanding of the hydraulic impact of these structures is as follows. The unlined Forebay Canal is cut directly into and entirely through the Lockport Dolomite. The Forebay Canal is in hydraulic communication with the twin buried conduits and with the drain system along the outside of the conduits. The communication is via gently southward dipping water-bearing bedding plane fractures that are exposed in the walls of the Forebay Canal. The conduit drain system has been described as being highly efficient at transmitting hydraulic pressure charges from the Forebay Canal southward (Miller and Kappel, 1986).

The water level in the Forebay Canal is a hydraulic low point. Since there is close hydraulic connection between the Forebay Canal and the conduit drain system, the hydraulic head in the drains is lower than that in the surrounding upper Lockport

Formation and groundwater discharges to the drains. The conduit drains therefore act as a line sink for groundwater discharge.

Forebay Canal water levels typically vary over a 24-hour cycle, with highs occurring in the morning and lows occurring in the evening. The magnitude of these fluctuations is greatest during the tourist season, which begins on April 1, when less water is diverted to the power project during daylight hours. After November 1, however, levels are typically lower and the magnitude of the fluctuations is less.

The Falls Street Tunnel (FST) is an unlined 7-foot by 9-foot tunnel within the upper Lockport. The FST carries stormwater from east to west beneath Falls Street, approximately 1500 feet north of the Olin Plant. The FST likely receives groundwater infiltration throughout its length, however the location where it crosses above the conduits (approximately 3.6 miles south of the Forebay Canal) is known to be a major infiltration point into the FST due to leakage from the conduit drain system.

Groundwater infiltration at the FST/conduit crossing contributes to head loss in the conduit drain system. The high rate of infiltration apparently is a contributing factor causing the conduit system to be a consistent discharge boundary. In 1989, the City of Niagara Falls undertook a project to seal the FST at the conduit crossing. Although seepage was substantially reduced, the general location remains an area of major groundwater infiltration (W. Kappel, USGS, Personal Communication). The Niagara River flows from east to west approximately 1000 feet south of the Plant. The river level in the vicinity of the plant is also affected by the NYPA diversions. NYPA regulates the flow of diverted water in part by closing a gated structure in the Niagara River downstream of the Olin Plant, which partially obstructs flow in the river and increases the diversion flow. Therefore, the river level rises during periods of high rates of diverted flow and falls during periods of low rates of diverted flow. The change in river level is approximately 1.5 feet.

4.3.2.2 A-Zone Groundwater Flow

The discussions of groundwater flow presented in this and the following three subsections are based on monthly hydraulic head measures obtained from the Phase I monitoring wells.

Figures 4-5 through 4-16 present potentiometric surface maps constructed for the A-zone based on the monthly measurements from October 1990 through September 1991. These maps show that the A-zone potentiometric surface mimics the top-of-bedrock surface (see Figure 4-1) with radial flow occurring in all directions from the bedrock high located in the western part of Plant 2. A-zone groundwater flowing to the north may be seeping into the Buffalo Avenue Diversion Sewer, which is a 48-inch sewer excavated into the bedrock (invert elevation north of the Plant is approximately 555 feet).

Some A-zone groundwater flowing toward the east may seep into Gill Creek. Projected hydraulic heads to near the creek suggest that the Gill Creek water level and A-zone hydraulic head are approximately the same. East of Gill Creek (OBA-4A) the hydraulic head is substantially less than Gill Creek. The low hydraulic head at OBA-4A may be caused by leakage into a DuPont sanitary sewer running south to north along the east side of Gill Creek (passing between Gill Creek and OBA-4A). This sewer is constructed below the top of bedrock at this location and would tend to intercept A-zone groundwater creating an hydraulic barrier to groundwater flow. Some A-zone groundwater discharge to Gill Creek may occur from the west.

A-zone flow westward and southward from the bedrock high could eventually discharge to the Niagara River or Gill Creek. However, it is more likely that the primary direction of groundwater flow is downward to the more transmissive bedding plane fracture zones. Two factors, consistently observed for each of the 12 monthly measurement rounds, suggest downward leakage is occurring. First, the low hydraulic head at OBA-8A suggests that the Olin production well cone-of-depression has induced leakage downward from the overlying A-zone. Second, the elevated A-zone hydraulic heads associated with the bedrock high cause an impressed area of high hydraulic head in the B-zone bedding plane fracture zone (as described below).

4.3.2.3 B-Zone Groundwater Flow

The production well water level is incorporated into the potentiometric surface maps for the bedrock water-bearing zones. Prior to February 1991 no direct measurements were obtained from the production well. Access to the well for hydraulic head measurements was obtained for the pumping study (and later measurements). To estimate production well water levels for earlier months, measurements obtained subsequent to February

1991 were plotted versus the pumping rate at the time of measurement (Figure 4-17). The resulting plot fits a straight line over the range of measurements. For the months prior to the installation of the access hole, the best fit line shown on Figure 4-17 was used to estimate the water level in the production well based on the measured pumping rate.

Monthly potentiometric surface maps for the B-zone are presented in Figures 4-18 through 4-29. Although the production wells are not open directly to the B-zone interval, a cone-of-depression resulting from induced leakage downward to the C- and/or CD-zones appears to extend throughout the Plant 1 area to near the center of Plant 2, where there is a radial flow component due to the impressed hydraulic head from the overlying A-zone hydraulic mound (at the bedrock high). Leakage from Gill Creek may also be causing a hydraulic mound in the underlying B-zone. Only to the east of Gill Creek does there appear to be a north or northeasterly component to groundwater flow, possibly toward the NYPA Conduits or Falls Street Tunnel. Vertical gradients between the A- and B-zones are without exception downward and represent a substantial driving force for downward vertical groundwater flow from the A-zone. Horizontal hydraulic gradients between Chemical Road and Gill Creek are extremely low.

4.3.2.4 C-Zone Groundwater Flow

The potentiometric surface maps for the C-zone are presented in Figures 4-30 through 4-41. The Olin production wells are open directly to the C-zone interval. The cone-of-depression appears to extend approximately to Gill Creek for each of the monthly measurement rounds. The effects of the production wells are further discussed in Section 5.0.

4.3.2.5 CD-Zone Groundwater Flow

Figures 4-42 through 4-53 present the potentiometric surface maps for the CD-zone. The Olin production wells are open directly to the CD-zone interval. The cones-of-depression appear to extend throughout the Plant approximately to Gill Creek. The effects of the production wells are further discussed in Section 5.0.

4.3.2.6 Deeper Water-Bearing Fracture Zones

Hydrogeologic studies at the adjacent Du Pont facility and at the 3163 Buffalo Avenue Site provide ample evidence that an upward vertical hydraulic gradient exists between deeper water-bearing bedding plane fracture zones in the Lockport Dolomite and the overlying C- and CD-zones. Du Pont has installed monitoring well clusters including deeper bedrock (termed D- and F-zones by Du Pont) wells at locations both south and north of the Olin Plant. These well clusters (14, 15, 19 and 22) show a consistent upward vertical gradient between the D- or F-zones and the C/CD-zone. Du Pont studies also indicate substantial cones-of-depression in the D- and F-zones as a result of pumping from the Olin production well.

4.3.3 Results of Continuous Monitoring Study

4.3.3.1 Seven-Day Study

Hydraulic head versus time plots were prepared based on the 7-day continuous monitoring at well clusters OBA-4, OBA-5, OBA-7, OBA-8 and the Niagara River. The Gill Creek stilling well was also continuously monitored. The 7-day continuous monitoring at well cluster OBA-4 began approximately 3 days after the other wells due to a data logger malfunction. Figure 4-54 shows the Gill Creek and Niagara River stage throughout the monitoring period. Figure 4-55 shows hydraulic head versus time plots for A-zone wells. A-zone hydraulic heads varied less than approximately 0.3 feet during the period, showing little direct hydraulic communication with the river. Hydraulic head versus time plots are presented on Figure 4-56 for the B-zone wells monitored. As with the A-zone wells, the B-zone shows little variation in hydraulic head (less than a few tenths of a foot). C- and CD-zone water levels (Figure 4-57) show more variation in general, and appear to show an increase in hydraulic head (of 0.3 to 0.5 feet) nearly concurrent with the approximate one foot increase in Niagara River level that occurred on January 31, 1991. Monitoring at OBA-4C was not begun in time to monitor this change, but OBA-4C showed little or no variation in hydraulic head during the days it was monitored. For OBA-5C, OBA-7C and OBA-8C, the rise in hydraulic head associated with the river stage increases occurred over approximately the same time period in each well (i.e., there was no substantial lag time between the well responses on one side of the Plant versus the other). The fluctuations measured in OBA-8C on

January 30 and February 6 were apparently a result of surges in the production well pumping system, which have been noted to occur occasionally. Monitoring well OBA-8C responds almost immediately to changes in the production well pumping rate.

Daily precipitation records obtained from the Niagara Falls Airport Weather Station during the 7-day study indicate only trace levels of daily precipitation (0.1 inch or less), and 2 inches of snowmelt during the study period. Therefore, there were no substantial precipitation effects on groundwater during the 7-day study.

4.3.3.2 Thirty-Day Study

The Gill Creek stilling well and monitoring wells OBA-7A, OBA-4A and OBA-4B were continuously (hourly measurements) monitored for a period of 30 days. Substantial precipitation events occurred twice during the 30-day monitoring period. Between March 2 and March 7, a total of approximately 2.7 inches of precipitation (including snowmelt) occurred. Later in the month, on March 18, 0.63 inches of rainfall were recorded. Gill Creek stage elevations versus time are plotted on Figure 4-58.

Figures 4-59 and 4-60 show each of the two precipitation events and their corresponding Gill Creek stage hydrographs. The Niagara Falls International Airport Weather Station records total precipitation every 6 hours. Therefore, the precipitation histogram time intervals are 6 hours. Hydraulic head versus time curves for the three monitoring wells continuously monitored are presented on Figures 4-61 through 4-63. Each of the monitoring wells responded rather quickly to precipitation indicating that some recharge is occurring near these wells. The monitoring well hydrographs show a shorter lag-to-peak hydraulic head than the Gill Creek hydrograph. This suggests that the hydraulic head increase is due to recharge rather than the increase in stage in Gill Creek.

4.3.4 Results of Phase II Hydraulic Head Monitoring

The Phase II hydraulic head monitoring program was a cooperative effort involving Olin, DuPont and NYSDEC. On June 10, 1994, hydraulic heads were measured by Olin and DuPont for their respective groundwater monitoring networks and by NYSDEC's contractor for the Solvent Chemicals Site monitoring network. All measurements were converted to the USGS datum.

Olin and DuPont use the same terminology for water bearing zones and have used similar well installation methods designed to monitor the individual water-bearing zones. Solvent Chemicals A-zone wells are screened only in the overburden. Investigations using paired monitoring wells at DuPont have indicated up to two feet of head difference between wells screened solely in the overburden and those penetrating the top of rock zone. Therefore, Solvent Chemicals A-zone monitoring wells are not hydraulically representative of the top of rock zone and are therefore not included in the A-zone potentiometric surface maps covering the three sites.

Figures 4-64, 4-65, 4-66 and 4-67 present potentiometric surface maps developed from the coordinated round of hydraulic head measurements. These maps are used to assess groundwater flow on a more regional scale. Figure 4-64 shows the A-zone regional potentiometric surface map. This map indicates that groundwater flow from DuPont property south of the ARGC area is generally toward the east. However, comparison of measured hydraulic heads at DuPont wells WPT-8, 14A and WPT-7 with the level at Olin well OBA-5A suggests that some groundwater flow northwest from the DuPont Site to the Olin plant is occurring. In the area east of Gill Creek, the direction of A-zone groundwater flow appears to be structurally controlled by the bedrock surface. Groundwater flows toward a depression in the bedrock surface located in the vicinity of well clusters OBA-3C and OBA-4 (see Figure 4-1). The hydraulic gradient in the A-zone is toward this depression from areas to the southwest, south, southeast and east. Therefore, A-zone groundwater from the Solvent Chemical Site apparently flows northwesterly toward OBA-3A. The sanitary sewer and/or installation trench along Buffalo Avenue appears to be receiving groundwater discharge from the A-zone (See Section 8.0). This man-made passageway is sloped to carry water to the west. Therefore, for conditions when the system is receiving groundwater infiltration, groundwater would tend to the flow to the west as it approaches the sewer installation trench. The potential for contaminant migration along man-made passageways is discussed in detail in Section 8.0.

Solvent Chemicals overburden potentiometric surface data is plotted separately on Figure 4-68 along with some nearby DuPont "overburden only" monitoring wells. Based on Figure 4-68, groundwater in the overburden at the Solvent Chemicals Site flows from the southwestern portion of the site toward south, west and north. A major flow component exists from the Site toward the depression in the bedrock surface near OBA-

3A. Comparison of Figure 4-68 with Figure 4-64 shows a downward vertical gradient between the overburden wells and the A-zone wells, suggesting flow from the overburden to the A-zone.

Figure 4-65 presents the regional potentiometric surface map for the B-zone. Groundwater flow from the portion of the DuPont Plant east of Chemical Road, appears to be primarily to the northeast. The potentiometric surface map also indicates that B-zone groundwater in the northwest portion of the Solvent Chemical Site flows toward Olin monitoring well OBA-3B.

Figure 4-66 presents the C-zone regional potentiometric surface map. Groundwater flow in the C-zone is toward the Olin production well from areas west of Gill Creek. Hydraulic gradients in the C-zone at the Solvent Chemicals Site are toward an apparent hydraulic depression located in the northwestern corner of the property.

The CD-zone regional potentiometric surface (Figure 4-67) is similar to the C-zone with hydraulic gradients toward the Olin production well in most areas west of Gill Creek. The apparent hydraulic depression located in the northeast corner of the Solvent Chemicals Site, which was observed in the C-zone, is more pronounced in the CD-zone. This depression, measured in Solvent Chemicals well MW-5CD, was not assessed in the Solvent Chemical RI. Based on data from Solvent Chemicals monitoring well MW-5F, located adjacent to MW-5CD, the head loss at MW-5CD is not likely due to a vertical fracture causing a direct connection with a deeper water bearing zone with a lower hydraulic head. MW-5F has a measured water level of 8.49 feet higher than the level measured in MW-5CD, indicating an upward, rather than a downward vertical gradient. Based on a measurement obtained during a slug test conducted, approximately 3 months after MW-5CD was installed, the total depth of MW-5CD was 8.6 feet less than the drilled depth. This suggests that MW-5CD could have been cross-grouted during installation of MW-5F. However, this does not explain the head loss observed in the MW-5CD well since the slug test result indicated the well was water bearing and, therefore, should equilibrate to the hydraulic head in the surrounding media.

4.3.5 Summary of Groundwater Flow Conditions

In summary, A-zone groundwater beneath the Olin Plant appears to flow radially from a bedrock high located in Plant 2. A sanitary sewer running south to north along the east bank of Gill Creek likely intercepts A-zone groundwater flow. The A-zone near Buffalo Avenue, west of Gill Creek is dry. Some groundwater may be flowing from the former chlorinated solvent manufacturing locations at the DuPont Plant toward the southern portion of the Olin Plant ARGC Area. Regional potentiometric surface maps indicate groundwater flow in both the overburden and A-zone (which includes the top-of-rock zone) occurs from the Solvent Chemicals Site toward Olin monitoring well OBA-3A. Groundwater flow in the B-zone generally flows from the DuPont Plant northerly across Olin property toward the Buffalo Avenue sewers and the Olin production well. The influence of the Olin production well on B-zone groundwater flow extends to the central portion of Plant 2. At the Solvent Chemicals Site, B-zone groundwater flows both northwesterly toward Olin monitoring well OBA-3B and northeasterly toward an apparent hydraulic depression located in the vicinity of the east corner of the Solvent Chemicals Site.

C-and CD-zone groundwater west of Gill Creek flows toward the Olin Production well from both the DuPont and Olin Plants at the Solvent Chemicals Site, C- and CD-zone groundwater flow appears to be toward the hydraulic depression in the northeast corner of the Site. The hydraulic head at this depression (measured at Solvent Chemicals well MW-5CD) is the lowest of any location measured during the coordinated hydraulic head monitoring (including the Olin Production well and Dupont wells monitoring the contact between the Lockport Dolomite and the underlying Rochester shale. The cause of this depression at the Solvent Chemical Site has not been ascertained by WCC.

5.0
HYDRAULIC TESTING

5.1 SLUG TESTS

5.1.1 Solution Methods

Transmissivity or hydraulic conductivity was estimated from the slug tests of Phase I monitoring wells using the methods of Cooper et. al. (1967), and Bower and Rice (1976), respectively. The Bower and Rice solution is applicable to unconfined aquifers and was used to interpret the test data from A-zone monitoring wells. The parameter estimated for unconfined conditions is hydraulic conductivity(k). The solution is as follows:

$$\ln S_o - \ln S_t = \frac{2 K L t}{r_c^2 \ln(r_e/r_w)}$$

where:

S_o = initial drawdown in well due to instantaneous removal of water from well, dimensions of length [L]

S_t = drawdown in well at time t [L]

L = length of well screen [L]

r_c = radius of well casing [L]

$\ln(r_e/r_w)$ = empirical "shape factor" determined from tables provided in Bower and Rice (1976)

r_e = equivalent radius over which head loss occurs [L]

K = hydraulic conductivity [Lt^{-1}]

r_w = radius of well (including gravel pack) [L]

H = static height of water in well [L]

b = saturated thickness of aquifer [L]

This equation is solved through use of semilog plots of impressed head or drawdown (logscale) versus time (arithmetic scale). Hydraulic conductivity is estimated by fitting a straight line to the semilog plot, calculating the slope, and solving for K.

The Cooper et. al. (1967) method is applicable for confined aquifers and was used to estimate transmissivities(T) from the B-zone and C-zone test data. Cooper et. al. have developed a family of type curves based on solution of the partial differential equation for drawdown in a well using the Laplace Transform. The type curves are semilog plots of H/H_o versus time, where H is the hydraulic head at time t and H_o is the initial head in the well due to slug injection or extraction. By matching the field data to the type curve, transmissivity can be estimated.

WCC used the software package AQTESOLV to reduce the slug test data using the appropriate solution technique.

5.1.2 Slug Test Results

Table 5-1 presents the results of the slug tests conducted on A-zone monitoring wells. Since in all A-zone wells the static water level was below the depth of the top of the sandpack, the hydraulic conductivity of the sandpack is likely to significantly impact resulting hydraulic conductivity estimates. Therefore, when evaluating the hydraulic conductivity of the A-zone, the slug test results should be considered together with the response of the wells to purging and the soil texture characteristics observed during well installation. Slug test results for the A-zone wells are presented graphically for each well tested in Appendix C of the Interim Report (1992).

Table 5-2 presents the results of slug tests conducted on the B-zone and C-zone wells. Estimated transmissivity values for B-zone wells ranged from 4.9×10^{-4} ft^2/min to 2.9 ft^2/min, with a logarithmic mean of 2.1×10^{-1} ft^2/min. Estimated transmissivity values for the C-zone wells ranged from 6.6×10^{-3} ft^2/min to 86.5 ft^2/min, with a logarithmic mean of 1.2×10^{-1} ft^2/min. Since the B-zone and C-zone monitoring wells are completed as open holes, the results of the slug tests are not impacted by sandpack. However, use of the estimated transmissivity values is limited by the basic assumption of porous media flow conditions required to use either solution method. Therefore, some of the slug test curves do not match the standard type curves well. All hydraulic conductivity and transmissivity estimates should be considered of order-of-magnitude accuracy.

5.2 PUMPING STUDY RESULTS

The pumping study presented in this subsection was conducted during February 1991 using the Phase I monitoring wells and selected DuPont monitoring wells as observation wells.

5.2.1 Pre-Test Monitoring

The pre-test hydraulic head monitoring showed that A-zone and B-zone hydraulic heads varied less than approximately 0.3 feet (except for an 0.38 foot variation at OBA-7B) and C- and CD-zone hydraulic heads fluctuated less than 0.4 feet during the 48 hours prior to the initiation of the pumping study. Potentiometric surface maps prepared from data collected near the end of the pre-test monitoring period are presented on Figures 5-1 through 5-4.

5.2.2 Recovery Test: Unstressed (No Pumping) Conditions

Hydraulic head measurements were obtained from all observation wells toward the end of the recovery test (Step 1). At the time of measurement, the pump had been off for approximately 90 hours. Figures 5-5 through 5-8 present the potentiometric surface maps prepared from these measurements for each water-bearing zone. The maps show potentiometric surfaces under conditions where no pumping of groundwater occurs. The A-zone potentiometric surface shows a groundwater high near the center of Plant 2, with outward radial groundwater flow. This groundwater high appears to be approximately coincident with the bedrock high described in Section 4.0. The relatively low water level at OBA-8A suggests that the hydraulic regime had not completely recovered from drawdown due to induced leakage downward under pumping conditions even though the pump had been off for nearly 4 days. This finding suggests that in this area the A-zone is behaving as an unconfined, low hydraulic conductivity unit and/or it is not well connected to the bedrock water-bearing zones (i.e., vertical hydraulic conductivity is low compared to horizontal hydraulic conductivity in the bedrock). As described in Section 4.0, some A-zone groundwater may be discharging to Gill Creek from the west. ....

The B-zone hydraulic regime (Figure 5-6), under conditions of no pumping, is characterized by extremely low hydraulic gradients. The groundwater flow direction appears to be primarily northward. Although less pronounced than observed in the A-zone, the B-zone exhibits a hydraulic low near cluster OBA-8, suggesting a residual drawdown due to induced leakage during pumping conditions. Gill Creek does not appear to be substantially impacting groundwater flow in the B-zone, although the marginally elevated level at OBA-4B could be caused by leakage of Gill Creek water through the crushed stone stream bed which directly overlies the bedrock in this area. West of Gill Creek, hydraulic heads in the B-zone were generally 4 to 8 feet lower than in the A-zone indicating strong downward vertical hydraulic gradients. East of Gill Creek, hydraulic heads in the B-zone were less than two feet lower than in the A-zone.

The C-zone potentiometric surface, under conditions of no pumping, is characterized by extremely low horizontal hydraulic gradients (Figure 5-7). The gradient is so small that groundwater flow direction is unclear from the hydraulic head measurements. Hydraulic heads in the C-zone were approximately one foot lower than in the B-zone.

Similar to the other bedrock water-bearing zones, the CD-zone potentiometric surface (Figure 5-8), under conditions of no pumping, is characterized by extremely low horizontal hydraulic gradients. The one exception is the rather low hydraulic head (about 1.5 feet less than elsewhere) measured in well OBA-2C. The cause of this hydraulic low has not been determined, however, the low slug test result (6.1×10^{-3} ft^2/min) and lack of fractures encountered in this well suggest that it may be slower to respond to pumping changes than other C/CD-zone wells. Except at cluster OBA-2, hydraulic heads measured in the CD-zone were less than 2 feet lower than in the B-zone.

5.2.3 500 GPM Pumping Step

Figures 5-9 through 5-12 present potentiometric surface maps based on measurements taken after approximately 70 hours of pumping at approximately 500 gpm. Figure 5-9 shows that the A-zone at this time was not substantially impacted by the pumping. As evidenced by the residual drawdown observed at OBA-8A after 90 hours of recovery, any pumping impacts caused by induced downward leakage would be manifested very slowly and would not be discernable during the timeframe of this pumping study.

As shown on Figure 5-10, the cone-of-depression in the B-zone due to downward leakage extends to the center of Plant 2 (near well cluster OBA-7B). Figure 5-11 presents the potentiometric surface map for the C-zone, showing a cone-of-depression extending easterly throughout Plant 2 to the vicinity of Gill Creek. The CD-zone potentiometric surface shows a similar cone-of-depression (Figure 5-12) which extends easterly to Gill Creek.

5.2.4 1000 GPM Pumping Step

Figures 5-13 through 5-16 present potentiometric surface maps prepared from measurements taken after approximately 100 hours of pumping at approximately 1000 gpm. Figure 5-13 shows that the A-zone had not yet been impacted by the pumping. The B-zone potentiometric surface map (Figure 5-14) shows a more pronounced cone-of-depression (compared to 500 gpm), due to induced leakage near the production well but no discernable increase in the radius of influence. The C-zone and CD-zone potentiometric surface maps for this step (Figures 5-15 and 5-16) both show increased hydraulic gradients toward the production well. The radius of influence to the east slightly increased, but still extends to Gill Creek.

5.2.5 1500 GPM Pumping Step

Figures 5-17 through 5-20 present potentiometric surface maps prepared from measurements taken after approximately 48 hours of pumping at approximately 1300 to 1500 gpm. As shown on Figure 5-17, the A-zone potentiometric surface still showed little or no response to pumping. In the B-zone, the increase in the pumping rate did not result in a significant increase in the radius of influence east of the production well

(Figure 5-18). The C-zone and CD-zone potentiometric surface, shown on Figures 5-19 and 5-20, again shows an increase in hydraulic gradient toward the production well within the cone-of-depression, but no significant increase in the radius of influence toward the east.

6.0
SOIL CONTAMINATION

The soil sampling and analytical program for the Olin RFI is described in Section 3.6. A summary of all laboratory analytical data is included in Appendix C. Analytical results are discussed below.

6.1 MERCURY

Tabulated analytical results from total mercury and TCLP mercury analyses conducted on soil samples collected during the Phase I and Phase II investigations are presented in Table 6-1. These results are plotted on Figures 6-1 and 6-2. Phase I soil borings are designated by the prefix OSB-, and Phase II soil borings are designated by the prefix NSB-. Mercury presence in soil is relatively widespread at the Plant. Low concentrations of 2.3 mg/kg or less were reported for OSB-3 located north of Buffalo Avenue in an area where brine mud was used for pothole repair. Concentrations reported for OSB-2, also a location of brine mud deposition, were 6.5 mg/kg or less. Total mercury concentrations in soil were in the range of 1 to 100 mg/kg at OSB-4, OSB-5, OSB-6, OSB-7, OSB-8, OSB-12, OSB-16, and NSB-14. Levels of total mercury exceeding 100 mg/kg were reported for OSB-1, OSB-9, OSB-10, OSB-13, OSB-14, OSB-15, NSB-1 and NSB-4.

Total mercury concentrations were generally highest in the upper 4 feet of soil with the notable exception of OSB-1 in which the 8 to 10-foot interval showed the highest total mercury levels. Small beads of elemental mercury were noted in the sample obtained from the bottom of the 6 to 8-foot interval in this boring and the analyzed total mercury concentrations from the 6 to 8-foot and 8 to 10-foot intervals were the highest levels reported in any of the Phase I soil borings. The TCLP extract concentration was 8.6 ug/L, indicating low potential to leach.

One purpose of the Phase II soil borings was to examine soil samples for elemental mercury. No elemental mercury was observed in any of the Phase II soil borings.

Soil samples were also analyzed for mercury using the Toxicity Characteristic Leaching

Procedure (TCLP). All TCLP mercury results were less than the regulatory level of 200 ug/L, except for samples for the Phase II soil boring NSB-1, located near the north side of a former cell building in Plant 1. Reported TCLP results were 254 ug/L for the sample from 2 to 4 feet BGS and 577 ug/L for the sample from 4 to 6 feet BGS. The highest TCLP mercury result in any other Phase I or Phase II analyses was 31.7 ug/L from the 0 to 2 foot interval in boring OSB-11. Other soil borings with samples yielding TCLP mercury concentrations higher than 10 ug/L were OSB-10, OSB-11, and OSB-12. TCLP mercury results for all soil samples from the remaining soil borings were less than 10 ug/L.

6.2 ORGANIC CHEMICALS

Soil samples obtained from Phase I soil borings OSB-17 and OSB-18 were analyzed for the organic chemicals on the Project Analyte List (PAL). Table 6-2 presents the results of soil analyses for the PAL organic chemicals (see Section 3.6). Figure 3-4 shows the locations of OSB-17 and OSB-18.

Soil samples obtained from Phase II soil borings NSB-16 and NSB-17 were analyzed for BHC isomers. Table 6-3 presents the analytical results for these samples.

Analytical results for organic chemicals in soil samples are summarized below.

6.2.1 Volatile Organic Chemicals

The following volatile organic chemicals were detected in soil samples from OSB-17 and OSB-18:

Methylene chloride
Acetone
Chloroform
Trichloroethene
Benzene
Tetrachloroethene
Toluene
Chlorobenzene
Total xylenes

These chemicals were generally detected at trace levels. A few results were in the 0.010

mg/kg range and no reported concentrations exceeded 0.050 mg/kg. The results are tabulated in Table 6-2.

6.2.2 Semivolatile Organic Chemicals

Analytical results for all semivolatile organic chemicals detected in soil samples from OSB-17 and OSB-18 are tabulated in Table 6-2. A total of 35 semivolatile compounds were detected in at least one of the soil samples. Neither chlorinated benzene compounds nor chlorinated phenol compounds were measured above 10 mg/kg in samples from OSB-17. 4-Methylphenol was quantified in one sample from OSB-17 (6 to 8 feet) at 25 mg/kg. The semivolatiles present at the highest concentrations in soil samples from OSB-17 were the polyaromatic hydrocarbon compounds (PAHs). Individual PAH compounds were measured at levels ranged up to 59 mg/kg in the intervals between 0 and 6 feet. In the lowermost interval of soil (6 to 8 feet) PAH concentrations were much higher. Nine PAH compounds were measured in this interval at levels exceeding 1,000 mg/kg. The elevated PAH levels in OSB-17 apparently are related to the type of fill used in the area. The lowermost split-spoon sample obtained from OSB-17 was noted to contain a black granular fill. This material could possibly contain flyash or weathered asphalt.

In soil boring OSB-18, dichlorobenzene compounds were measured above 10 mg/kg in one sample (4 to 6 feet interval). The levels were 17 mg/kg for 1,3-dichlorobenzene and 24 mg/kg for 1,2-dichlorobenzene. 2,4,5-Trichlorobenzene was present in all four samples from OSB-18 at levels ranging from 210 mg/kg to 1,900 mg/kg. Hexachlorobenzene was present in two samples from OSB-18 at 5.8 mg/kg (2 to 4 feet) and 25 mg/kg (0 to 2 feet). No other semivolatile compounds were quantified above 10 ppm in soil samples from OSB-18.

6.2.3 Pesticides/PCB

Results for all chemicals detected in the pesticide/PCB analyses of soil samples from OSB-17 and OSB-18 are tabulated in Table 6-2. No PCB compounds were detected. Of the 15 pesticides detected in at least one sample, only alpha-BHC, beta-BHC and gamma-BHC were quantified above 10 mg/kg. The maximum pesticide concentration in samples from OSB-17 was 44 mg/kg for beta-BHC (2 to 4 feet). The maximum pesticide concentration for OSB-18 was 23 mg/kg of alpha-BHC (4 to 6 feet).

Results for BHC analyses of samples from NSB-16 and NSB-17 are presented in Table 6-3. Samples from NSB-16 were reported to contain elevated levels of alpha-BHC and beta-BHC. The highest concentrations were in the 1 to 3 foot interval (110 mg/kg and 57 mg/kg for alpha-BHC and beta-BHC, respectively) and in the 5 to 7 foot interval (54 mg/kg and 50 mg/kg). No BHCs were detected above 10 mg/kg in samples for NSB-17.

7.0
GROUNDWATER CONTAMINATION

Table 7-1 summarizes the groundwater sampling and analyses conducted for the Olin RFI. The results of the four quarterly sampling events for the original 28 wells used in the Phase I RFI were presented in the following reports previously submitted to EPA and NYSDEC:

> Woodward-Clyde Consultants (WCC). 1992a. Interim Report for the Olin Buffalo Plant RFI. February 1992.
>
> Woodward-Clyde Consultants (WCC). 1992b. Analytical Data Validation. March 1992 Groundwater Sampling Round. August 1992.
>
> Woodward-Clyde Consultants (WCC). 1992c. Analytical Data Validation. June 1992 Groundwater Sampling Round. November 1992.
>
> Woodward-Clyde Consultants (WCC). 1993a. Analytical Data Validation. September and November 1992 Groundwater Sampling Round. March 1993.

The results of these quarterly sampling events are tabulated in Appendix C.

The Phase II monitoring wells were sampled as follows:

Well	**Sampling Event**
OBA-3A, OBA-3B, OBA-3C	July 1994
OBA-4A, OBA-4B, OBA-4C, OBA-9A, OBA-10A	May 1994
OBA-11B, OBA-11C, OBA-12B, OBA-12C	January 1994, May 1994

OBA-13A, OBA-13B, OBA-13C, OBA-14A, OBA-14B, OBA-14C, OBA-15A, OBA-15B, OBA-16A, OBA-16B	May 1994, July 1994

Due to delays at the contracted laboratory, only partial results of the May 1994 (second quarter) sampling event were available at the time of this RFI report submittal. Therefore, Olin proceeded with the planned followup sampling of Phase II monitoring wells in July 1994 (third quarter) and arranged an accelerated turnaround time so that preliminary analytical results for samples from the Phase II monitoring wells could be included in this report. Sampling and preliminary data reporting was accomplished; however, the complete laboratory data packages were not received in time for the data to be validated in accordance with the DCQAPP prior to preparation of this report. Therefore, a Data Validation Report, covering all Phase II groundwater sampling, will be issued as a supplement to the RFI Report. This supplement will include any revisions to the RFI data summary tables resulting from the data validation. The preliminary analytical results for the July 1994 sampling event, and the partial results from the May event, are tabulated in Appendix D. In addition, as noted in Section 1.0, additional groundwater chemistry results are pending from NYSDEC's current investigations at the Solvent Chemicals Site. Per NYSDEC's request, these data will also be included and assessed in the Corrective Measures Study (CMS) with respect to the interpretations presented in the RFI Report.

To facilitate review and interpretation of groundwater chemistry data, isoconcentration contour maps have been prepared. These maps were developed using the following data:

1. The most recent analytical data for each Olin monitoring well.
2. Groundwater analytical data from the Solvent Chemicals RI Report (sampling was conducted by Ecology & Environment, Inc. in February, 1990).
3. Split samples obtained from selected DuPont monitoring wells and analyzed by Olin for SVOCs, pesticides/PCBs and mercury and by DuPont for VOCs.

Solvent Chemicals overburden wells and results from two shallow groundwater samples collected by hydropunch were included on the A-zone isoconcentration maps and the C-and CD-zones data were combined on single C/CD-zone isoconcentration map. The isoconcentration maps were prepared for the following chemicals or chemical groups:

Mercury
Benzene
Chlorinated Benzene Compounds
Chlorinated Phenol Compounds
Chlorinated Volatile Aliphatic Compounds
BHCs
Methanol

Based on review of plant operating history, the Olin plant used or produced mercury, benzene, chlorinated benzenes, chlorinated phenols, BHCs, and methanol in substantial quantities. However, while there may have been some incidental usage, there was no substantial use of chlorinated volatile aliphatic compounds at the Olin Plant.

The DuPont Niagara Plant, which adjoins the Olin property to the south, manufactured chlorinated volatile aliphatic compounds from mid-1940s to mid-1950s.

Chlorinated benzenes and benzene are known to have been used or produced at the Solvent Chemicals Site located on the adjoining property to the east of the Olin Plant. The Solvent Chemicals RI Report presents no information relative to other chemicals which were used or manufactured at the site.

The following subsections describe the presence and distribution of chemicals detected in the groundwater.

7.1 MERCURY

The isoconcentration map for mercury in A-zone groundwater based on the most recent analyses is presented in Figure 7-1. Two areas of elevated mercury concentrations are evident: one in the southwestern portion of the ARGC Area and the other encompassing most of the western portion of the Solvent Chemicals Site. The maximum concentration in the A-zone on Olin property was 77.9 ug/l in OBA-5A. The maximum concentration within the A-zone mercury plume on the Solvent Chemicals Site was 216 ug/l (at MW-1A). Mercury at the Solvent Chemicals Site appears to be migrating in the direction of groundwater flow (from MW-1A toward the north and west).

Figure 7-2 presents the isoconcentration map for mercury developed from the most recent B-zone groundwater samples. Again, the plumes of elevated mercury concentrations are evident, one encompassing most of the area of Olin's Plant 1, with the highest level measured in the southeast portion of the ARGC area (133 ug/l at BH-3). In comparison, the mercury plume in the B-zone at the Solvent Chemicals Site is less concentrated and less extensive, centered beneath the most elevated A-zone concentrations (MW-1). The maximum B-zone mercury concentration at the Solvent Chemicals Site was 11.9 ug/l in MW-1B.

Figure 7-3 presents the isoconcentration map for mercury in the C- and CD-zones. There is only one CD-zone monitoring well at the Solvent Chemicals Site for which data are currently available. Mercury was measured in three C-/CD-zone wells on the Olin property at concentrations above 1 ug/l: 9.4 ug/l in OBA-7C, 1.9 ug/l in OBA-4C and 1.8 ug/l in OBA-11C.

7.2 ORGANIC CHEMICALS

7.2.1 Non-Aqueous Phase Liquid

In 1992, a denser than water non-aqueous phase liquid (DNAPL) was observed in groundwater samples from the base of water column in Well OBA-2C, located near Buffalo Avenue. The DNAPL was sampled and analyzed for the PAL. Compounds detected were chlorinated aliphatic volatile compounds (total of 29.8 percent), semivolatile organic chemicals (total of 4.7 percent) and pesticides (total of 0.06 percent). Concentrations of compounds quantified in the DNAPL sample are listed in Table 7-2. The predominance of chlorinated volatile aliphatic organic compounds, which have not been used at the Plant in substantial quantities and were not found at high levels in soil samples, suggests an off-site source. The DNAPL was evacuated from OBA-2C in 1992, and as of July 1994, no additional DNAPL has accumulated in the well.

In May 1994, DNAPL was observed in OBA-10A. This well is screened within a sewer trench excavated approximately six feet below the top of bedrock. This trench contains a DuPont sanitary sewer which runs from its origin at DuPont north to its connection with the Buffalo Avenue Sewer. The path of the sewer is along the east bank of Gill Creek. OBA-10A is constructed within the installation trench. OBA-4A is located approximately 10 feet east of this sewer line. OBA-15A is located approximately 50 feet east of this sewer line. Olin monitoring wells OBA-9A and OBA-9AR are located directly across Gill Creek from OBA-10A and are between any potential Olin source area and OBA-10A. These wells were checked for DNAPL in May 1994 and no DNAPL was observed. This suggests that the Olin Plant is not the source of the observed DNAPL in OBA-10A.

OBA-10A is located near the point where a former sewer line from the Solvent Chemicals Site crosses over the DuPont sewer prior to its outfall into Gill Creek. During the Solvent Chemicals RI, sediments in this sewer pipe were found to contain high concentrations of chlorinated benzene compounds (greater than 3,000,000 ug/kg total chlorinated benzenes. This suggests that the sewer formerly discharged chlorobenzenes to Gill Creek. Under these circumstances, the route of DNAPL migration to the DuPont sewer installation trench may have been via the Solvent Chemical sewer. DNAPL has been observed in Solvent Chemicals monitoring wells MW-1B and MW-2B, which are located near this sewer at the southwest portion of the Solvent Chemicals site. Migration of contamination in sewers is further discussed in Section 8.0.

DNAPL from OBA-10A was sampled and submitted for chemical analyses. Due to laboratory delays, the results are not available at the time of this RFI report submittal. The results of the OBA-10A DNAPL analysis will be included in the supplement to the RFI Report.

7.2.2 Aqueous Contamination

7.2.2.1 Chlorinated Aliphatic Volatile Organic Chemicals

Concentrations of volatile organic chemicals detected in any groundwater sample are tabulated in Appendices C and D. In general, the contaminants present at the highest concentrations in groundwater beneath the Olin Plant are the volatile organics,

VOLUME I - MAIN REPORT

RCRA FACILITY INVESTIGATION REPORT FOR THE OLIN BUFFALO AVENUE PLANT

RCRA-89-3013-0208

Prepared for:
Olin Chemicals
1186 Lower River Road
Charleston, Tennessee 37310
August 1994

Woodward-Clyde Consultants, Inc.
15 Hazelwood Drive, Suite 110
Amherst, New York 14228-2229
Project Number 4E02704

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EXECUTIVE SUMMARY

Olin Corporation (Olin) has entered in an Administrative Consent Order (Index No. RCRA-89-3013-0208) with the U.S. Environmental Protection Agency (EPA) which provides for performance of a RCRA Facility Investigation (RFI) at Olin's Buffalo Avenue Plant in Niagara Falls, New York (Figure 1-1). The Consent Order was issued while Olin was in the process of conducting a voluntary groundwater investigation at the plant.

The purpose of the Olin Buffalo Avenue Plant RFI was to assess the nature and extent of releases of hazardous waste or hazardous waste constituents from SWMUs or other potential source areas at the plant. The RFI included extensive sampling and analyses of soil and groundwater and integration of results with the results of groundwater investigations performed at two sites adjacent to the Olin Plant (the DuPont Niagara Plant and the Solvent Chemicals Site). This report presents a summary of data collected to complete the RFI in accordance with the approved Work Plans. A supplement to this report, consisting of data reports and the data validation, will be submitted subsequent to receipt of complete data packages from the laboratories. The conclusions of the RFI are summarized below.

Mercury was detected in soil borings advanced in areas throughout the plant. Total mercury concentrations in soil ranged from < 1 to 15,600 mg/kg. The distribution of mercury in soil did not indicate a specific source area. Because small beads of elemental mercury were observed in one soil sample collected from the 6 to 8 foot depth interval in a boring located in Plant 1, supplemental (Phase II) soil borings were advanced throughout Plant 1 to further determine the presence or absence of elemental mercury. Elemental mercury was not observed in these or any other soil samples obtained during the RFI.

Elevated concentrations of BHCs (ranging from < 1 to 171 mg/kg total BHCs) were measured near the former BHC production area in Plant 2.

In general, the distribution of mercury and BHC in soils at the Plant do not correlate with the locations of SWMUs. This suggests that the sources of mercury and BHC were handling losses during plant operations rather than releases from specific SWMUs.

Because the site is predominantly covered by pavement and gravel, surface water runoff and airborne particulate transport are not significant potential contaminant transport pathways for soil contaminants. Potential migration in groundwater was addressed by the extensive groundwater monitoring program conducted as part of the RFI.

The four uppermost water bearing units beneath the Olin Plant were investigated during the RFI. The uppermost water bearing unit, referred to as the A-zone, consists of the lower 2 feet of overburden and upper 3 feet of weathered bedrock (Lockport Dolomite). Underlying the A-zone are the deeper bedding plane fracture zones of the Lockport Dolomite: the B-zone (16 to 21 feet BGS), the C-zone (25 to 35 feet BGS), and the CD-zone (45 to 50 feet BGS).

Groundwater flow patterns at the Olin Plant are strongly influenced by man-made passageways and the Olin Production Well.

In the A-zone groundwater flows radially from a bedrock high located beneath Plant 2. Some minor discharge to Gill Creek occurs from the A-zone, with the remaining flow intercepted by a deep sanitary sewer running south to north along the east bank. In the portion of the Olin Plant west of Gill Creek, A-zone groundwater flow to the north is intercepted by the Buffalo Avenue sewer line. (The A-zone is dewatered near the deep sewers running along Buffalo Avenue.) East of Gill Creek, the Buffalo Avenue sewer line has apparently produced localized migration of A-zone groundwater from east to west along Buffalo Avenue as far as Gill Creek, where the sewer line trench has been plugged. A-zone groundwater also leaks downward to the B-zone.

Hydraulic head monitoring of B-zone wells indicate that groundwater flow from the Olin Plant is toward Buffalo Avenue or to the Olin Production Wells. In the C- and CD-zones, groundwater flow is toward the Olin Production Well from areas west of Gill Creek. East of Gill Creek, C- and CD-zone groundwater flow appears to be generally in a northeasterly direction.

particularly the chlorinated aliphatic (i.e., non-aromatic) hydrocarbons. These chemicals have not been produced, or used to any substantial extent in production, at the Olin Plant. These chemicals have been detected in high concentrations in groundwater at the DuPont Plant adjacent to, and upgradient of, the Olin Plant. DuPont is currently remediating groundwater contamination on its plant site.

Figure 7-4 presents the isoconcentration map for chlorinated aliphatic volatile organic compounds in A-zone groundwater. The highest concentration occurs at the DuPont Plant at PW-19 (greater than 200,000 ug/l). Concentrations in the A-zone decrease with distance from the former production area except that concentrations show an increase along Buffalo Avenue, east of Gill Creek. This is discussed in more detail in Section 8.0. Significant sources of chlorinated aliphatic volatile organic compounds are not evident at either the Olin Plant or Solvent Chemicals Site.

Figure 7-5 presents the chlorinated aliphatic volatile organic compound isoconcentration map for the B-zone. The highest concentrations in the B-zone was measured at Olin Well OBA-5B, located near the DuPont property line. There are no B-zone groundwater monitoring wells in the vicinity of its boundary with the Olin Plant; however, an upgradient source is indicated by groundwater flow directions and the distribution of contamination observed in the A-zone. As with the A-zone, B-zone concentrations increase near Buffalo Avenue east of Gill Creek.

Figure 7-6 presents the isoconcentration maps for the C-/CD-zone. The highest concentrations of chlorinated aliphatic volatile organic compounds (greater than 100,000 ug/l) occur near Buffalo Avenue, west of Gill Creek. This suggests that the chlorinated aliphatic contamination is migrating vertically (due to vertical hydraulic gradients and or density driven DNAPL flow) as well as horizontally. The highest levels therefore occur, as expected, in deeper horizons with increased horizontal distance from the apparent upgradient source areas.

7.2.2.2 Benzene

Figure 7-7 presents the isoconcentration map for benzene in A-zone groundwater. Most of the benzene contamination is present at the Solvent Chemicals Site. The Solvent Chemicals plume extends northwesterly to Buffalo Avenue, then appears to follow the

Buffalo Avenue sewer installation trench westward. The highest concentration (540,000 ug/l) was detected in the southwest portion of the Solvent Chemicals Site, which appears to be the source area for this plume.

Lower levels of benzene were detected in three A-zone wells in Olin's former production area (west of Gill Creek). Concentrations were 79 ug/l in OBA-5A, 19 ug/l in OBA-9A and 2 ug/l in OBA-6A.

Figure 7-8 presents the isoconcentration map for benzene in B-zone groundwater. As with the A-zone, two benzene plumes are evident - a highly concentrated plume from the Solvent Chemicals Site and a lesser concentration plume in the southern portion of the ARGC area on Olin property. The maximum concentration in the B-zone at the Solvent Chemicals Site was 310,000 ug/l at MW-1B. The maximum concentration on Olin property was 31,000 at BH-3.

Figure 7-9 presents the isoconcentration maps for benzene in C-/CD-zone groundwater. The highest concentrations (1,000 ug/l to 5,000 ug/l) occur near Buffalo Avenue west of Gill Creek. However, the concentration distribution depicted in Figure 7-9 is influenced by a lack of data at the Solvent Chemicals Site. There is only one CD-zone well at the site, and it is located on the east side of the property near Buffalo Avenue. Additional CD-zone data is expected from the 1994 NYSDEC investigations of the Solvent Chemicals Site. These data will be included and discussed in the CMS. CD-zone benzene concentrations within the former operating areas of the Olin Plant were less than 1,000 ug/l.

7.2.2.3 Chlorinated Benzene Compounds

The isoconcentration map for total chlorinated benzene compounds also show two distinct plumes of groundwater contamination. Figure 7-10 presents the isoconcentration map for chlorinated benzenes in A-zone groundwater. The concentration distribution is similar to that observed for benzene. The highest concentrations were measured in wells located within the southwestern portion of the Solvent Chemicals Site (172,000 to 230,000 ug/l). Northerly migration appears to be occurring from this source area as evidenced by concentrations from 44,160 to 97,300 ug/l within the northwest portion of the property. Chlorinated benzenes appear to be migrating westerly from this area along the Buffalo Avenue sewer as evidenced by concentrations from 16,380 ug/l to 26,200 ug/l along Buffalo Avenue between the Solvent Chemicals Site and Gill Creek. This migration pattern is consistent with groundwater flow directions (see Section 4.0). In the former operating area of the Olin Plant, chlorobenzene concentrations were elevated in two monitoring wells: 6,420 ug/l in OBA-5A and 855 ug/l in OBA-9A. The maximum A-zone concentration in the former Olin operating area was approximately 35 times less than the maximum A-zone concentration at the Solvent Chemicals Site.

Figure 7-11 presents the isoconcentration map for total chlorinated benzene compounds in B-zone groundwater. Groundwater plumes are generally consistent with those observed in the A-zone. The Solvent Chemicals plume is again more concentrated (maximum concentration of 305,000 ug/l compared to 16,700 ug/l at the Olin Plant).

Figure 7-12 presents the isoconcentration map for total chlorinated benzene compounds in C-/CD-zone groundwater. Concentrations are highest (16,310 ug/l to 17,680 ug/l) near Buffalo Avenue between the Solvent Chemicals Site and Gill Creek. Again, this depicted distribution is influenced by a lack of C-/CD-zone data for the south of the Buffalo Avenue at the Solvent Chemicals Site. Additional data from 1994 NYSDEC investigations at the Solvent Chemicals Site will be included in the CMS. The maximum total chlorinated benzene concentration within the former operating areas of the Olin Plant was 3,054 ug/l at OBA-2C.

7.2.2.4 Chlorinated Phenols

Figure 7-13 presents the isoconcentration maps for total chlorinated phenol concentrations in A-zone groundwater. There was one detection of chlorinated phenols in the former operating area of the Olin Plant (293 ug/l at OBA-1A). A similar concentration was measured in the southwestern portion of the Solvent Chemicals Site (312 ug/l at MW-1A). North and northwesterly migration from this area is indicated.

Figure 7-14 shows two distinct low level chlorinated phenol plumes in the B-zone: one in the ARGC area on the eastern portion of Olin's property, and the other in the western portion of the Solvent Chemicals Site. The concentration and the extent of the two plumes are similar with a maximum concentration of 395 ug/l reported for Olin (OBA-16B) and 303 ug/l reported for the Solvent Chemicals Site (MW-1B).

Chlorinated phenols were not detected in the one CD-zone monitoring well at the Solvent Chemicals Site. Chlorinated phenols were detected at concentrations up to 878 ug/l (OBA-6C) in areas between the ARGC area and the Olin Production Well.

7.2.2.5 Pesticides/PCBs

No PCB compounds were detected in any Olin groundwater sample, except for one low level detection at OBA-5A (1.4 ug/l of Aroclor-1260). BHC compounds were the only pesticide or PCB compounds consistently detected in groundwater at the Olin Plant. Figure 7-16 presents the isoconcentration map for total BHCs in A-zone groundwater. The maximum concentration was 152.4 ug/l at OBA-5A.

The isoconcentration map for total BHC concentrations in B-zone groundwater is presented in Figure 7-17. The maximum reported concentration was 1,820 ug/l in BH-3. Concentrations of total BHC in the C-/CD-zone did not exceed 100 ug/l.

7.2.2.6 Methanol

Methanol was used at the Olin plant from 1941 until 1990. Isoconcentration maps are presented in Figures 7-19, 7-20, and 7-21 for the A-, B-, and C-/CD-zones. Concentrations exceeding 10 mg/l were limited to monitoring wells OBA-6A (52 mg/l), OBA-5B (62 mg/l), and OBA-6B (410 mg/l).

Potential contaminant source areas and migration pathways, including the influence of man-made passageways (e.g., sewer lines) on migration pathways, are discussed in detail in the following section.

8.0
CONTAMINANT MIGRATION

This section discusses the potential pathways of transport of contaminants from source areas. In general, groundwater transport represents the predominant contaminant migration pathway, and man-made passageways (e.g., sewer lines and bedding materials), appear to substantially affect groundwater flow patterns at the site.

8.1 AIRBORNE TRANSPORT

Airborne transport is not considered a significant potential contamination pathway at the site. The site is generally covered (approximately 90%) by pavement or gravel, which effectively inhibit fugitive dust generation and airborne particulate transport. Volatile organic emissions are also limited by the existing cover at the site, and because there have been no recent releases of volatile organics, no significant residual near-surface volatile organic concentrations will remain.

8.2 SURFACE WATER TRANSPORT

Surface water runoff is not considered a significant contaminant migration pathway. Existing cover at the site (pavement and gravel) minimizes the potential for generation of contaminated runoff by minimizing contact with subsurface materials. Runoff that is generated generally is captured by storm sewer lines on the plant site which flow to the Buffalo Avenue sewer and ultimately to the Niagara Falls Wastewater Treatment Plant. Surface water runoff from a limited area of the plant, consisting of the creek bank and the immediately adjacent area (10 to 15 feet to the west and five feet to the east) may drain directly to the creek. Potential transport of groundwater to surface water is discussed in Section 8.3.4.

8.3 GROUNDWATER TRANSPORT

In Section 7.2, three distinct plumes of groundwater contamination were identified in the Study Area. These plumes will be referred to as the Olin plume, the Solvent Chemical plume and the DuPont plume, depending on their source locations.

8.3.1 Olin Plume

Groundwater contamination attributable to activities at the Olin plant include the following chemical constituents:

Mercury
Benzene
Chlorinated Benzene Compounds
Chlorinated Phenol Compounds
BHCs

Benzene, chlorinated benzenes, chlorinated phenols and BHCs were used or produced over a period of six years in the area of Plant 2 between Gill Creek and Alundum Road (ARGC area). Levels of these chemicals in the A-zone are relatively low in the ARGC area, but generally exhibit order-of-magnitude increases in the B-zone samples. This distribution likely occurs because the contaminant releases occurred over a short period of time (ie, during the company's seven year period of production of organic chemicals (BHCs) from 1950 to 1956). Under these conditions, the bulk of the contamination may have migrated to the B-zone during the last 40 years, leaving only residual concentrations in the A-zone.

The isoconcentration maps presented in Section 7.2 suggest that there are no large residual sources of benzene, chlorinated benzene, chlorinated phenols or BHC contamination present in the A-zone. The majority of the elevated concentration levels associated with the Olin plume occur in the B-zone.

The Interim Report identified the Buffalo Avenue Sanitary Sewer and the Buffalo Avenue Diversion Sewer as potential interceptors of groundwater flow and contaminant migration from the A-zone and B-zone at the Olin Plant. Figure 8-1 shows the location of these sewers in plan view and Figures 8-2 and 8-3 show the sewers in cross-section. Figures 8-2 and 8-3 are from a study conducted in 1989 by O'Brien & Gere Engineers for the City of Niagara Falls. These cross sections depict areas of poor quality (cracked and broken sewer pipes) in both sewer lines north of the Olin Plant. Considering the depth of these sewers, which are excavated 10 or more feet below the top of bedrock, and the poor quality of the sewer pipe, the sewers likely intercept A-zone and B-zone groundwater flow from the Olin Plant. In fact, the A-zone is completely dewatered (OBA-2A, OBA-12A) west of Gill Creek in the vicinity of the point where the Diversion Sewer first reaches Buffalo Avenue (at Packard Road).

During the Phase II RFI Investigations, a DuPont sanitary sewer running from the south toward Buffalo Avenue along the east side of Gill Creek was found. Based on the depth of the sewer trenches (excavated into bedrock and below the bottom of Gill Creek), this sewer likely intercepts A-zone groundwater flow from the Olin Plant. The isoconcentration contour maps presented in Section 7.2 show that the Olin plumes in the A- and B-zone are primarily limited to the area bounded by Buffalo Avenue to the north and the DuPont Sanitary Sewer to the east. Olin related A- and B-zone contamination is limited primarily to the ARGC area. In the CD-zone, the Olin plume has become more disperse as the groundwater flows toward the Olin production well located at Plant 1.

8.3.2 Solvent Chemicals Plume

As discussed in Section 6.0, groundwater piezometric surfaces generally indicate groundwater flow to the north, northwest, or northeast. However, the influence of man-made passageways (sewer lines and bedding) has had substantial localized effects on contaminant transport. As discussed below, the Buffalo Avenue sewer has a substantial effect on contaminant transport between the Solvent Chemicals Site and Gill Creek. In addition, former discharges in the sewer line running from the southwest corner of the Solvent Chemicals site to Gill Creek have affected the distribution of contaminants in the southern portion of the Olin property east of Gill Creek (see Section 7.2.1).

Groundwater contamination apparently emanating from the Solvent Chemicals Site includes the following constituents:

Benzene
Chlorinated Benzene Compounds
Chlorinated Phenol Compounds
Chlorinated Aliphatic Volatile Organic Compounds
Mercury

The major constituents in terms of concentration are benzene and chlorinated benzene compounds. The source areas for these chemicals appear to be located within the southwestern portion of the Site (see Figure 7-7 and 7-10). Migration in the A-zone is from this area toward the north, in the direction of the hydraulic gradient (see Figures 4-64 and Figure 4-68).

In the vicinity of Buffalo Avenue, the contamination appears to follow the Buffalo Avenue sewer and installation trench which is sloped to carry flow toward the west. This same distribution of contamination occurs in the B-zone. The elevated concentrations abruptly end at the Gill Creek crossing of the sewer. Concentrations of benzene and chlorinated benzenes near Buffalo Avenue east of Gill Creek exceed 10,000 $\mu g/L$ in both the A- and B-zone. However, west of Gill Creek, the A-zone is dry and the B-zone concentrations were less than 2 $\mu g/L$ for benzene and less than 250 $\mu g/L$ for chlorinated benzenes. This apparent incongruity may be a consequence of the construction of the Buffalo Avenue Sanitary Sewer and its crossing beneath Gill Creek. The Buffalo Avenue Sanitary Sewer between Gill Creek and the Solvent Chemicals Site is shown in plan view on Figure 8-1 and in cross section on Figure 8-3. The invert elevation of this sewer is below the top of bedrock elevation west of Gill Creek, indicating that the A-zone groundwater is physically intercepted in this area. East of Gill Creek, the invert elevation is above the top of bedrock, but below the groundwater elevation, again indicating that it would capture A-zone groundwater.

Based on a 1914 drawing of the sewer, the installation trench is backfilled with loose stone and boulders, suggesting it could act as a preferential pathway for groundwater flow. In August 1951, the section of the sewer crossing beneath Gill Creek was uncovered. All joints were sealed and the sewer under the creek was encased in concrete. This likely resulted in an impermeable plug in the installation trench beneath the creek. Therefore, contaminated groundwater migrating within the trench from the east will back up at the plug beneath Gill Creek and leak into the sewer pipe itself or leak out in the surrounding media. This could account for the presence of contamination found in wells located east of Gill Creek along both sides of Buffalo Avenue.

In a 1989 study conducted by O'Brien & Gere Engineers for the City of Niagara Falls, the Buffalo Avenue sanitary sewer pipe between Gill Creek and the Solvent Chemicals

Site was found to be in poor condition. This is shown as the dark shaded area on Figure 8-3. The specific problem in this section was reported as being "much cracked at crown". Therefore, leakage of groundwater into the pipe in this area is likely. However, because the cracking is primarily at the crown, DNAPL or highly concentrated aqueous contamination in the lower portion of the sewer trench bedding is less likely to leak into the sewer line. This material would tend to migrate west, in the direction of the slope of the trench. The flow of this material would be impeded by the plug beneath Gill Creek. Thus, DNAPL or other highly concentrated groundwater originating from the Solvent Chemicals Site (or any other source east of Olin), once it entered the trench, would migrate to the west (downslope) in the bedding until it reached Gill Creek, where it would tend to pool and accumulate. Very high contaminant concentrations could tend to persist in and near the trench in this area even after the contamination levels close to the original source have been depleted. (This phenomenon may explain the levels of chlorinated aliphatic volatile organic compounds which tend to be higher near Buffalo Avenue than close to the apparent source area discussed below.)

8.3.3 DuPont Niagara Plant Plume

Groundwater contamination emanating from the DuPont Niagara Plant is primarily comprised of chlorinated aliphatic volatile organic compounds. These compounds have been found in groundwater throughout the study area. Within the Olin operating plant areas (i.e., west of Gill Creek), the potentially Olin-derived chemical contamination in groundwater is generally small relative to the chlorinated aliphatic VOC contamination.

The chlorinated aliphatic volatile organic chemical plume appears to be migrating from DuPont north toward Buffalo Avenue and northwest toward the Olin production wells. Elevated levels near Buffalo Avenue may be a result of historic DNAPL migration which may have reached the Buffalo Avenue sewer line. The high concentrations observed east of Gill Creek could be due to the presence of residual DNAPL or concentrated aqueous contamination accumulating in the excavation trench of the Buffalo Avenue Sanitary Sewer as described in Section 8.2.2

8.3.4 Transport of Groundwater to Surface Water

Chemicals present in groundwater could reach surface water through direct seepage to

Gill Creek or through seepage to the deep sewers (or installation trenches) identified above which subsequently carry water to the Niagara Falls Wastewater Treatment Plant. Since the sewers are part of a combined sewer overflow system, during sustained or intense precipitation events, some of this water bypasses the treatment plant and is discharged directly to the Niagara River. However, at all other times, the water in these sewers is treated with state of the practice secondary treatment followed by activated carbon treatment prior to discharge to the Niagara River.

During these sustained or intense precipitation events, the hydraulic head on the sewer pipes would increase (possibly to overpressured conditions) which would tend to inhibit groundwater infiltration. The sewer may leak out to the groundwater during these conditions. Since groundwater infiltration is inhibited during precipitation events, and since the infiltrating groundwater is treated at other times prior to discharge, the transport to surface water via underground sewers does not represent a significant contaminant transport pathway.

Direct seepage of groundwater to Gill Creek may occur from Olin Property along the western creek bank. Based on the depth of the DuPont sanitary sewer running south to north along the east bank of the creek (it is excavated approximately 6 feet into bedrock), it appears that A-zone groundwater may flow beneath Gill Creek and discharge to the sewer. The bottom of Gill Creek is approximately 6 feet higher in elevation then the bottom of the sewer trench. Therefore, transport to Gill Creek via direct seepage is expected to be minimal. A-zone groundwater in this area contains relatively low levels of contaminants. Thus, any seepage entering the Creek would be diluted by the creek flow. Water samples from Gill Creek will be analyzed for potential Olin-related chemicals as part of the Performance Monitoring Program being conducted by DuPont and Olin as a follow-up to the Gill Creek Remediation Project. The first round of post remediation sampling is scheduled for Fall 1994. These data will be routinely submitted to NYSDEC.

8.4 SUMMARY

Airborne transport and direct surface runoff of contaminants from the Olin Plant are inhibited by pavement and gravel cover and are not expected to be significant transport pathways.

Three district plumes of groundwater contamination were identified during the Phase I and Phase II RFI. Only one of these plumes is of concern to the RFI (the plume identified as the Olin Plume). This groundwater contamination is apparently associated with past Olin activities and consists primarily of benzene and chlorinated benzene compounds in an area bounded by Adams Avenue, Gill Creek, Buffalo Avenue and the Olin production well. Lower levels of mercury, BHCs and chlorinated phenols also occur in this area and are also apparently related to past Olin activities at the plant.

Contaminant migration from the Olin Plant to Gill Creek is not expected to be significant. However, Gill Creek will be sampled and analyzed for potential Olin-related chemicals as part of the Gill Creek Remediation Program (sampling is scheduled for Fall 1994). The following section, which addresses the potential for impacts on human health and environment is focused solely on the Olin groundwater plume.

9.0
POTENTIAL IMPACTS ON HUMAN HEALTH AND THE ENVIRONMENT

Potential impacts on human health and the environment can occur through any of four exposure pathways:

- direct contact with soils
- airborne transport
- groundwater transport
- surface water transport

Each of these potential exposure pathways was considered for the Olin Plant.

9.1 DIRECT CONTACT

Direct contact with soils is not a significant potential exposure pathway. The site represents an industrial property, predominantly covered by pavement and gravel, limiting the potential for direct contact with potentially contaminated subsurface soils.

9.2 AIRBORNE TRANSPORT

As described in Section 8.1, the potential for airborne migration of contaminants found in soil at the Olin Plant is not likely to be significant.

9.3 GROUNDWATER TRANSPORT

Section 8.3 shows that groundwater could be a potential pathway for off-site migration of contamination at the Olin Plant. However, there are no domestic users of groundwater within one mile of the Plant (Niagara County DOH, 1986). Furthermore, the natural hardness and high mineral content of water within the Lockport Dolomite render it unsatisfactory for potable use without treatment. Since the Niagara River provides an abundant supply of drinking water, future use of groundwater in the area for domestic supply is not anticipated. Thus, direct exposure to drinking water is not a significant potential exposure route.

9.4 SURFACE WATER TRANSPORT

As discussed in Section 8.2, surface water runoff does not represent a significant potential exposure pathway. However, potential discharge of groundwater to surface water represents a potentially complete exposure pathway (see Section 8.3.4). Groundwater beneath the site is generally captured, either by the Olin Production Well, or by sewer lines on and adjacent to the site. Water collected by the sewer lines is ultimately discharged to and treated by the Niagara Falls Wastewater Treatment Plant, except during overflow events caused by high rainfall. Groundwater captured by the Olin Production Well is treated by activated carbon. Some direct seepage of groundwater to Gill Creek may also occur, although it is expected that A-zone groundwater flow toward Gill Creek will be primarily captured by the former DuPont sewer line on the eastern side of the Creek. Because the bottom of Gill Creek is approximately six feet higher than the bottom of the sewer trench, direct seepage to Gill Creek is expected to be minimal.

In summary, some groundwater discharge to Gill Creek, or to the Niagara River during storm events, is possible. In neither case are these discharges expected to have a significant effect on surface water quality. Water quality in Gill Creek will be monitored as part of the performance monitoring being conducted by DuPont and Olin as a follow-up to the Gill Creek Project. Results of this monitoriong will be submittaed to NYSDEC.

9.5 POTENTIAL GROUNDWATER PROTECTION STANDARDS

The consent order specifies that the RFI Report must include the following information:

For regulated units, the Respondent shall provide information to support the Agency's selection/development of Ground Water Production Standards for all of the constituents of concern found in the ground water during the Facility Investigation and determined not to originate from sources other than the facility (Task IV).

1. The Ground Water Protection Standards shall consist of:

   a. For any constituents listed in Table 1 of 40 CFR 264.94, the respective value given in that table (Maximum Contaminant Levels or MCLs) if the background level of the constituent is below the given value in Table 1; or

b. The background level of that constituent in the ground water; or
c. An EPA approved Alternate Concentration Limit (ACL).

The following constituents, when present in groundwater in the ARGC area, may have originated from Olin activities at the Plant:

Mercury
Benzene
Chlorinated Benzene Compounds
Chlorinated Phenol Compounds
BHCs
Methanol

MCLs have been developed for only two of the potential chemicals of concern, mercury and gamma-BHC (lindane). Due to the urban/industrial character of the plant area, and the presence of groundwater plumes originating from off-site sources, cleanup to background levels may not be practical. Thus it may be appropriate to consider ACLs for Groundwater Protection Standards.

10.0
SUMMARY AND CONCLUSIONS

The purpose of the Olin Buffalo Avenue Plant RFI was to assess the nature and extent of releases of hazardous waste or hazardous waste constituents from SWMUs or other potential source areas at the plant. The RFI included extensive sampling and analyses of soil and groundwater and integration of results with the results of groundwater investigations performed at two sites adjacent to the Olin Plant (the DuPont Niagara Plant and the Solvent Chemicals Site). This report presents a summary of data collected to complete the RFI in accordance with the approved Work Plans. A supplement to this report, consisting of data reports and the data validation, will be submitted subsequent to receipt of complete data packages from the laboratories. The conclusions of the RFI are summarized below.

10.1 SOIL

Mercury was detected in soil borings advanced in areas throughout the plant. Total mercury concentrations in soil ranged from < 1 to 15,600 mg/kg. The distribution of mercury in soil did not indicate a specific source area. Because small beads of elemental mercury were observed in one soil sample collected from the 6 to 8 foot depth interval in a boring located in Plant 1, supplemental (Phase II) soil borings were advanced throughout Plant 1 to further determine the presence or absence of elemental mercury. Elemental mercury was not observed in these or any other soil samples obtained during the RFI.

Elevated concentrations of BHCs (ranging from < 1 to 171 mg/kg total BHCs) were measured near the former BHC production area in Plant 2.

In general, the distribution of mercury and BHC in soils at the Plant do not correlate with the locations of SWMUs. This suggests that the sources of mercury and BHC were handling losses during plant operations rather than releases from specific SWMUs.

Because the site is predominantly covered by pavement and gravel, surface water runoff and airborne particulate transport are not significant potential contaminant transport pathways for soil contaminants. Potential migration in groundwater was addressed by the extensive groundwater monitoring program conducted as part of the RFI.

10.2 GROUNDWATER

The four uppermost water bearing units beneath the Olin Plant were investigated during the RFI. The uppermost water bearing unit, referred to as the A-zone, consists of the lower 2 feet of overburden and upper 3 feet of weathered bedrock (Lockport Dolomite). Underlying the A-zone are the deeper bedding plane fracture zones of the Lockport Dolomite: the B-zone (16 to 21 feet BGS), the C-zone (25 to 35 feet BGS), and the CD-zone (45 to 50 feet BGS).

10.2.1 Hydrogeology

Groundwater flow patterns at the Olin Plant are strongly influenced by man-made passageways and the Olin Production Well.

In the A-zone groundwater flows radially from a bedrock high located beneath Plant 2. Some minor discharge to Gill Creek occurs from the A-zone, with the remaining flow intercepted by a deep sanitary sewer running south to north along the east bank. In the portion of the Olin Plant west of Gill Creek, A-zone groundwater flow to the north is intercepted by the Buffalo Avenue sewer line. (The A-zone is dewatered near the deep sewers running along Buffalo Avenue.) East of Gill Creek, the Buffalo Avenue sewer line has apparently produced localized migration of A-zone groundwater from east to west along Buffalo Avenue as far as Gill Creek, where the sewer line trench has been plugged. A-zone groundwater also leaks downward to the B-zone.

Hydraulic head monitoring of B-zone wells indicate that groundwater flow from the Olin Plant is toward Buffalo Avenue or to the Olin Production Wells. In the C- and CD-zones, groundwater flow is toward the Olin Production Well from areas west of Gill Creek. East of Gill Creek, C- and CD-zone groundwater flow appears to be generally in a northeasterly direction.

10.2.2 Olin-Related Contaminant Sources and Transport

The plume of groundwater contamination which appears to derive from Olin sources consists primarily of benzene and chlorinated benzene compounds with lower levels of BHCs, chlorinated phenols and mercury. The presence of these compounds is limited primarily to the area bounded by Gill Creek (and the south-north sanitary sewer), Buffalo Avenue, Adams Avenue, and the Olin Production Well. Elsewhere, observed contaminant levels are either very low or attributable to off-site sources.

The Olin groundwater plume is largely captured by man-made passageways or the Olin Production Well. A-zone groundwater flow west of Gill Creek is intercepted by the Buffalo Avenue sewer. A-zone flow in the vicinity of Gill Creek is bounded and limited by the south-north sanitary sewer line just east of the Creek. Groundwater intercepted by these sewer lines is ultimately collected and treated in the Niagara Falls Wastewater Treatment Plant, except for overflows during high runoff events. B-zone groundwater flow is to the north, toward Buffalo Avenue, or to the Olin Production Well in the western portion of the Plant. The Olin plume in the C- and CD-zones west of Gill Creek is captured by the Olin Production Well. All groundwater intercepted by the Olin Production Well is treated by activated carbon.

10.2.3 Off-Site Contaminant Sources and Transport

The Olin Plant is bordered by two sites which have identified groundwater contamination associated with past activities: the DuPont Niagara Plant to the south and the Solvent Chemicals Site to the east. Potentiometric surface maps developed from coordinated measurements shows that groundwater flow from the DuPont site is generally north toward the Olin property. Migration of groundwater from the DuPont site is the apparent source of chlorinated aliphatic volatile organic compounds observed in groundwater at the Olin Plant. Groundwater flow from the Solvent Chemicals Site is generally to the north to northwest, influencing the portion of the Olin property east of Gill Creek. Migration of contaminated groundwater from the Solvent Chemicals Site has apparently occurred up to and along the Buffalo Avenue sewer line as far west as Gill Creek. Migration of groundwater from the Solvent Chemicals Site is the apparent source of the benzene and chlorinated benzene plume observed east of Gill Creek, including contamination observed in monitoring wells adjacent to the Buffalo Avenue sewer east of Gill Creek.

10.3 POTENTIAL CONTAMINANT TRANSPORT PATHWAYS

Airborne transport and direct surface runoff of contaminants from the Olin Plant are inhibited by pavement and gravel cover and are not expected to be significant transport pathways. There is no current use of groundwater in the Plant vicinity as a drinking water supply, and no future use is anticipated due to the high mineral content of the water, and the abundant surface water supply.

Contaminant migration from the Olin Plant to Gill Creek is not expected to be significant. However, Gill Creek will be sampled and analyzed for potential Olin-related chemicals as part of the Gill Creek Remediation Program. Results of this sampling and analysis will be reported to NYSDEC.

11.0

LIMITATIONS

WCC's work is in accordance with our understanding of professional practice and environmental standards existing at the time the work was performed. Professional judgements presented are based on our evaluation of technical information gathered and on our understanding of site conditions and site history. Our analyses, interpretations, and judgements rendered are consistent with professional standards of care and skill ordinarily exercised by the consulting community and reflect the degree of conservatism WCC deems proper for this project at this time. Methods are constantly changing and it is recognized that standards may subsequently change because of improvements in the state of the practice.

The information used for this investigation is presented in this report and includes boring logs, water level elevations, and soil and water quality analyses. Boring logs reflect subsurface conditions at the indicated locations. WCC has endeavored to collect soil and water samples which are representative of site conditions. Soil and water quality samples, however, can only represent a small portion of the subsurface conditions in the area, both in volume and through time. The interpretations made in this report are based on the assumption that subsurface conditions do not deviate appreciably from those found during our field investigations.

12.0

REFERENCES

Bouwer, H., and C. Rice, 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells. Water Resources Research 12(3), 423-428.

Calkin, P.E., and C.E. Brett, 1978. Ancestral Niagara River drainage: stratigraphic and paleontologic setting. Geol. Soc. Am. Bull. 89: 1140-1154.

Cooper, H.H., Bredehoeft, J.D. and I.S. Papadopulos, 1967. Response of a Finite Diameter Well to an Instantaneous Charge of Water. Water Resources Research 3(1), 263-269.

Ecology & Environment, Inc., 1990. Remedial Investigation Report for the 3163 Buffalo Avenue Site, Niagara Falls, New York. Prepared for the New York State Department of Environmental Conservation. November 1990.

Koszalka, E.J., Paschal, J.E., Jr., Miller, T.S., and P.B. Duran, 1985. Preliminary Evaluation of Chemical Migration to Groundwater and the Niagara River from Selected Waste Disposal Sites. Environmental Protection Agency Report, Great Lakes National Program Office, Chicago. EPA-905/4-85-001. 425 p.

Maslia, M.L. and R.H. Johnston, 1982. Simulation of groundwater flow in the vicinity of the Hyde Park landfill, Niagara Falls, New York. U.S. Geol. Survey Open-File Rept. 82-159. 19 p.

Miller, T.S., and W.M. Kappel, 1986. Effect of Niagara Power Project on groundwater flow in the upper part of the Lockport Dolomite, Niagara Falls area, New York. U.S. Geol. Survey Water RES. Invest. Rept. 86-4130. 31 p.

Niagara County Department of Health. 1986. Personal Communication from Mike Hopkins, Assistant Public Health Engineering, Niagara County D.O.H. to Woodward-Clyde Consultants.

O'Brien and Gere Engineers, 1989. Buffalo Avenue Utilities Examination. Prepared for the City of Niagara Falls, New York. September, 1989.

O'Brien and Gere Engineers, 1987. Phase I Falls Street Tunnel Study. Prepared for the City of Niagara Falls, New York. October 1987.

Woodward-Clyde Consultants (WCC). 1988. Groundwater Assessment Report, Olin Chemicals, Buffalo Avenue Plants, Niagara Falls, New York. ("Current Conditions Report"). October, 1988.

Woodward-Clyde Consultants (WCC). 1989. Field Operations Plan, Olin Plant Site Study. June 1989.

Woodward-Clyde Consultants (WCC). 1989. Health and Safety Plan, Olin Plant Site Study, Niagara Falls, New York. (Attachment II of the Field Operations Plan.) June 1989.

Woodward-Clyde Consultants (WCC). 1989. Project Management Plan for the Olin Buffalo Avenue Plant RFI. October 1989.

Woodward-Clyde Consultants (WCC). 1989. Data Management Plan for the Olin Buffalo Avenue Plant RFI. November 1989.

Woodward-Clyde Consultants (WCC). 1989. Community Relations Plan for the Olin Buffalo Avenue Plant RFI. November 1989.

Woodward-Clyde Consultants (WCC). 1990. Work Plan for Olin Buffalo Avenue Plants RFI, Niagara Falls, New York. February 1990.

Woodward-Clyde Consultants (WCC). 1991. Addendum to the Olin Buffalo Avenue Plant RFI Work Plan. August 1991.

Woodward-Clyde Consultants (WCC). 1991. Data Collection Quality Assurance Plan (Appendix A of Work Plan for the Olin Buffalo Avenue Plants RFI). August 1991.

Woodward-Clyde Consultants (WCC). 1992. Interim Report for the Olin Buffalo Avenue Plant RCRA Facility Investigation (RCRA-89-3013-0208). February 1992.

Woodward-Clyde Consultants (WCC). 1992. Analytical Data Validation. March 1992 Groundwater Sampling Round. August 1992.

Woodward-Clyde Consultants (WCC). 1992. Analytical Data Validation. June 1992 Groundwater Sampling Round. November 1992.

Woodward-Clyde Consultants (WCC). 1992. Man-Made Passageways Investigation for the Olin Buffalo Avenue Plant. November 1992.

Woodward-Clyde Consultants (WCC). 1993. Analytical Data Validation, September and November 1992 Groundwater Sampling Round. March 1993.

Woodward-Clyde Consultants (WCC). 1993. Final Work Plan, Gill Creek Remediation Project Post Remediation Monitoring Plan. July 1993.

Woodward-Clyde Consultants (WCC). 1993. Gill Creek Remediation Project - Final Report. December 1993.

Woodward-Clyde Consultants (WCC). 1994. Final Data Development Plan for the Olin Buffalo Avenue Plant RFI. April 1994.

Yager, R.M. and Kappel, W.M., 1987. Characterization of Fractures in the Lockport Dolomite, Niagara County, New York. In Proc. Third Groundwater Technology Conference. September 1987. City University of New York, New York. 1987.

Tables

TABLE 3-1

PROJECT ANALYTE LIST

TCL VOLATILES

Chloromethane
Bromomethane
Vinyl Chloride
Chloroethane
Methylene Chloride
Acetone
Carbon Disulfide
1,1-Dichloroethene
1,1-Dichloroethane
1,2-Dichloroethene
Chloroform
1,2-Dichloroethane
2-Butanone
1,1,1-Trichloroethane
Carbon Tetrachloride
Vinyl Acetate
Bromodichloromethane
1,2-Dichloropropane
cis-1,3-Dichloropropene
Trichloroethene
Dibromochloromethane
1,1,2-Trichloroethane
Benzene
trans-1,3-Dichloropropene
Bromoform
4-Methyl-2-pentanone
2-Hexanone
Tetrachloroethene
Toluene
1,1,2,2-Tetrachloroethane
Chlorobenzene
Ethyl Benzene
Styrene
Xylenes

TABLE 3-1 (continued)

PROJECT ANALYTE LIST

NON-TCL VOLATILES

Methanol

TCL SEMI-VOLATILES

Phenol
bis(2-Chloroethyl)ether
2-Chlorophenol
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Benzyl alcohol
1,2-Dichlorobenzene
2-Methylphenol
bis(2-Chloroisopropyl)ether
4-Methylphenol
N-Nitroso-di-n-propylamine
Hexachloroethane
Nitrobenzene
Isophorone
2-Nitrophenol
2,4-Dimethylphenol
Benzoic acid
bis(2-Chloroethoxy)methane
2,4-Dichlorophenol
1,2,4-Trichlorobenzene
Naphthalene
4-Chloroaniline
Hexachlorobutadiene
4-Chloro-3-methylphenol(para-chloro-meta-cresol)
2-Methylnaphthalene
Hexachlorocyclopentadiene
2,4,6-Trichlorophenol
2,4,5-Trichlorophenol
2-Chloronaphthalene
2-Nitroaniline
Dimethylphthalate

TABLE 3-1 (continued)

PROJECT ANALYTE LIST

TCL SEMI-VOLATILES (continued)

Acenaphthylene
2,6-Dinitrotoluene
3-Nitroaniline
Acenaphthene
2,4-Dinitrophenol
4-Nitrophenol
Dibenzofuran
2,4-Dinitrotoluene
Diethylphthalate
4-Chlorophenyl-phenyl ether
Fluorene
4-Nitroaniline
4,6-Dinitro-2-methylphenol
N-nitrosodiphenylamine
4-Bromophenyl-phenylether
Hexachlorobenzene
Pentachlorophenol
Phenanthrene
Anthracene
Di-n-butylphthalate
Fluoranthene
Pyrene
Butylbenzylphthalate
3,3'-Dichlorobenzidine
Benzo(a)anthracene
Chrysene
bis(2-Ethylhexyl)phthalate
Di-n-octylphthalate
Benzo(b)fluoranthene

TABLE 3-1 (continued)

PROJECT ANALYTE LIST

NON-TCL SEMI-VOLATILES

Benzo(k)fluoranthene
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenz(a,h)anthracene
Benzo(g,h,i)perylene
3-Chlorophenol
4-Chlorophenol
2,3-Dichlorophenol
2,5-Dichlorophenol
3,4-Dichlorophenol
3,5-Dichlorophenol
2,3,4-Trichlorophenol
2,3,5-Trichlorophenol
2,3,6-Trichlorophenol
3,4,5-Trichlorophenol
2,3,4,5-Tetrachlorophenol
2,3,5,6-Tetrachlorophenol
2,3,4,6-Tetrachlorophenol

PESTICIDES/PCBs

alpha-BHC
beta-BHC
delta-BHC
gamma-BHC (Lindane)
Heptachlor
Aldrin
Heptachlor epoxide
Endosulfan I
Dieldrin
4,4'-DDE
Endrin
Endosulfan II
4,4'-DDD
Endosulfan sulfate
4,4'-DDT

TABLE 3-1 (continued)

PROJECT ANALYTE LIST

PESTICIDES/PCBs (continued)

Methoxychlor
Endrin ketone
alpha-Chlordane
gamma-Chlordane
Toxaphene
Aroclor-1016
Aroclor-1221
Aroclor-1232
Aroclor-1242
Aroclor-1248
Aroclor-1254
Aroclor-1260

TAL INORGANICS

Mercury

TABLE 3-2

SUMMARY OF PUMPING RATES: PRODUCTION WELL PUMPING STUDY OLIN NIAGARA FALLS PLANT RFI

Step	Date/Time Started	Date/Time Ended	Approximate Pumping Rate
Step 1	2/7/91 1:00PM	2/11/91 11:36AM	0 gpm (Recovery)
Step 2	2/11/91 11:36AM	2/14/91 1:00PM	400-500 gpm
Step 3	2/14/91 1:00PM	2/19/91 11:00AM	1000 gpm
Step 4	2/19/91 11:00AM	2/21/91 11:00AM	1300-1600 gpm

TABLE 3-3

PRODUCTION WELL PUMP TEST: OBSERVATION WELLS
OLIN NIAGARA FALLS PLANT RFI

Observation Well	Measurement Method
OBA-1A	Manual
OBA-2A	Manual
OBA-3A	Manual
OBA-4A	Manual
OBA-5A	Manual
OBA-6A	Manual
OBA-7A	Manual
OBA-8A	Manual
OBA-1B	Continuous
OBA-2B	Manual
OBA-3B	Manual
OBA-4B	Manual
OBA-5B	Manual
OBA-6B	Manual
OBA-7B	Continuous
OBA-8B	Continuous
OBA-1C	Continuous
OBA-2C	Manual
OBA-3C	Manual
OBA-4C	Manual
OBA-5C	Manual
OBA-6C	Manual
OBA-7C	Continuous
OBA-8C	Continuous
BH-1	Manual

TABLE 3-3 (continued)

PRODUCTION WELL PUMP TEST: OBSERVATION WELLS OLIN NIAGARA FALLS PLANT RFI

Observation Well	Measurement Method
BH-3	Manual
Gill Creek	Continuous
North Well	Continuous
South Well	Manual
OBA-14A	Continuous
OBA-14C	Continuous
OBA-15A	Continuous
OBA-15C	Continuous
OBA-15CD	Continuous
OBA-19A	Continuous
OBA-19B	Continuous
OBA-19C	Continuous
OBA-19CD1	Continuous
OBA-19CD2	Manual
OBA-20A	Manual
OBA-20B	Continuous
OBA-22A	Manual
OBA-22B	Manual
OBA-22C	Manual
OBA-26C	Manual/Continuous
OBA-26CD	Manual/Continuous

TABLE 5-1

RESULTS OF SLUG TESTS: A-ZONE MONITORING WELLS OLIN NIAGARA FALLS PLANT RFI

Well	Date Tested	Estimated Hydraulic Conductivity (ft/min)(1) Falling Head Test	Rising Head Test
OBA-1A	1/22/91	$5.9\text{x}10^{-5}$ (2)	$1.4\text{x}10^{-4}$ (2)
OBA-2A	(3)	-----	-----
OBA-3A	1/25/91	$2.3\text{x}10^{-2}$	$2.6\text{x}10^{-2}$
OBA-4A	(3)	-----	-----
OBA-5A	1/24/91	$1.3\text{x}10^{-2}$	$1.2\text{x}10^{-2}$
OBA-6A	1/23/91	$2.3\text{x}10^{-4}$ (2)	$1.9\text{x}10^{-4}$ (2)
OBA-7A	1/24/91	$9.7\text{x}10^{-4}$ (2)	$8.4\text{x}10^{-4}$ (2)
OBA-8A	1/22/91	$2.0\text{x}10^{-5}$ (2)	$5.0\text{x}10^{-5}$ (2)

(1) - Method of Bower and Rice (1976) used to estimate hydraulic conductivity
(2) - Test results likely impacted by sandpack
(3) - Insufficient volume of water in well to perform slug test

TABLE 5-2

RESULTS OF SLUG TESTS: B-ZONE AND C-ZONE MONITORING WELLS OLIN NIAGARA FALLS PLANT RFI

Well	Date Tested	Estimated Transmissivity (ft^2/min)(1)	
		Falling Head Test	Rising Head Test
OBA-1B	1/22/91	8.5x10^{-1}	8.3x10^{-1}
OBA-2B	1/24/91	2.9	-----(2)
OBA-3B	1/25/91	1.6x10^{-3}	4.9x10^{-4}
OBA-4B	1/23/91	1.1x10^{-2}	1.3x10^{-2}
OBA-5B	1/24/91	3.2x10^{-1}	4.7x10^{-1}
OBA-6B	1/23/91	5.7x10^{-1}	9.7x10^{-1}
OBA-7B	1/24/91	1.6x10^{-1}	4.3x10^{-1}
OBA-8B	1/22/91	1.1	1.6
OBA-1C	1/22/91	1.2x10^{-1}	1.0x10^{-1}
OBA-2C	1/24/91	6.6x10^{-3}	6.1x10^{-3}
OBA-3C	1/25/91	1.8x10^{-2}	1.6x10^{-2}
OBA-4C	1/23/91	86.5	-----(2)
OBA-5C	1/24/91	3.1x10^{-1}	5.2x10^{-2}
OBA-6C	1/23/91	3.8x10^{-3}	3.4x10^{-3}
OBA-7C	1/24/91	4.6x10^{-1}	1.6
OBA-8C	1/22/91	6.0	1.1

(1) - Method of Cooper et. al. (1967) used to estimate transmissivity
(2) - Response too rapid for accurate measurement

TABLE 6-1

OLIN NIAGARA PLANT RFI
SUBSURFACE SOIL INVESTIGATION
MERCURY RESULTS

BORING ID		TOTAL Hg(mg/kg)	TCLP Hg (ug/L)
OSB-1	0’-2’	0.40	ND0.2
	2’-4’	458	1.6
	4’-6’	167	0.6
	6’-8’	624	8.6
	8’-10’	1210	2.9
OSB-2	0’-2’	6.5	ND0.2
	4’-6’	0.41	0.2
OSB-3	0’-2’	2.3	0.2
	2’-4’	0.77	ND0.2
	4’-6’	0.44	ND0.2
Dup	4’-6’	0.98	ND0.2
	6’-8’	ND0.10	ND0.2
OSB-4	0’-2’	56.9	0.4
	2’-4’	2.9	2.4
OSB-5	0’-2’	11.4	0.2
	2’-4’	35.4	0.9
	4’-6’	1.3	ND0.2
OSB-6	0’-2’	78.6	3.7
Dup	0’-2’	65.6	3.2
	3’-5’	55.0	6.6
	5’-7’	6.5	ND0.2
	7’-9’	1.7	0.8
OSB-7	0’-2’	21.1J	1.3J
	2’-4’	7.8J	ND0.2
OSB-8	0’-2’	29.8J	1.3J
	2’-4’	18.5J	0.3J
OSB-9	0’-2’	23.7J	ND0.2
	2’-4’	112J	4.6J
OSB-10	0’-2’	250J	13.2J
	2’-4’	626J	14.2J
Dup	2’-4’	1920J	10.7J
OSB-11	0’-2’	588J	31.7J
	2’-4’	165J	2.5J
OSB-12	0’-2’	50	3.2
	2’-4’	63	16.3
OSB-13	0’-2’	418	8.6
	2’-4’	95.4	1.5
OSB-14	0’-2’	113	1.1
	2’-4’	95.2	1.4

TABLE 6-1 (continued)

OLIN NIAGARA PLANT RFI
SUBSURFACE SOIL INVESTIGATION
MERCURY RESULTS

BORING ID		TOTAL Hg(mg/kg)	TCLP Hg (ug/L)
OSB-15	0'-2'	27.5	1.2
	2'-4'	104	0.3
OSB-16	0'-2'	8.3	ND0.2
	2'-4'	5.2	0.2
Dup	2'-4'	4.0	ND0.2
	4'-6'	15.7	ND0.2
	6'-8'	No Result[1]	ND0.2
OSB-17	0'-2'	Not Analyzed[2]	Not Analyzed[2]
	2'-4'	Not Analyzed	Not Analyzed
	4'-6'	Not Analyzed	Not Analyzed
	6'-8'	Not Analyzed	Not Analyzed
OSB-18	0'-2'	404	4.0
Dup	0'-2'	464	6.5
	2'-4'	161	5.1
	4'-6'	1.7	0.5
	6'-8'	11.9	1.3
NSB-1	0'-2'	13000J	21.4
	2'-4'	15600J	254
	4'-6'	186J	577
	6'-8'	6.9J	2.0
	8'-10'	8.2J	2.3
NSB-4	0'-2'	NS	NS
	2'-4'	217	1.3
	4'-6'	158	3.0
	6'-8'	0.38	ND 0.2
NSB-14	0'-1'	NS	NS
	1'-3'	20.1	1.7
	3'-5'	0.13	0.56
	5'-7'	0.53	ND 0.2
	7'-9'	ND 0.1	ND 0.2

Rinsate Blanks	Total Hg(ug/L)
RB-1	0.2
RB-2	57.7
RB-3	ND0.2
RB-4	0.7
RB-5	ND0.2

NS - Not sampled
ND - Not detected, applicable detection limit listed
J - Indicates an estimated value due to outlying QC criteria and/or indicates detection above the method detection limit (MDL) but less than the practical quantitation limit (PQL).
E - Compound whose concentration exceeds the calibration range of the GC/MS instrument but was diluted below the instrument detection limit on subsequent dilution runs.

TABLE 6-1 (continued)

OLIN NIAGARA PLANT RFI
SUBSURFACE SOIL INVESTIGATION
MERCURY RESULTS

R - Data found to be unusable as a result of outlying QC criteria.
U - The material was analyzed for but was not detected. The numerical value is the sample quantitation limit and has been adjusted to reflect contamination from laboratory or field activities.
UJ - Estimated quantitation limit

Notes:

(1) - Total mercury analysis not performed due to laboratory error
(2) - Total and TCLP mercury analysis not performed as per RFI Work Plan

TABLE 6-2

SUMMARY OF DETECTED COMPOUNDS
OLIN RFI SOIL SAMPLES
NIAGARA FALLS, NEW YORK

Sample ID	OSB-17	OSB-17	OSB-17	OSB-17	OSB-18	Dup OSB-18	OSB-18	OSB-18
	0'-2'	2'-4'	4'-6'	6'-8'	0'-2'	0'-2'	2'-4'	4'-6'
Sample Date	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Compounds								
TCL - VOAS								
Methylene chloride	0.002J	0.0005J	0.001J	0.001J	ND0.006	ND0.006	ND0.006	ND0.006
Acetone	ND0.011	ND0.010	0.008J	0.012J	0.016J	0.034J	0.034J	0.045J
Chloroform	0.006	0.007	0.004J	0.009	0.016	0.017	0.008	0.001
1,2-dichloropropane	ND0.006	ND0.005	ND0.006	ND0.006	ND0.006	ND0.006	ND0.006	ND0.006
Trichloroethene	0.002J	0.002J	0.0007J	0.002J	0.0009J	0.001J	0.0009J	ND0.006
Benzene	0.003J	0.002J	ND0.006	0.003J	0.003	0.003J	0.003J	0.002J
Tetrachloroethene	0.002J	0.002J	0.002J	0.003J	0.008	0.007	0.015	0.009
Toluene	0.0005J	ND0.005	ND0.006	0.0006J	0.001J	ND0.006	ND0.006	ND0.006
Chlorobenzene	0.003J	0.002J	0.002J	0.003J	0.002J	ND0.006	0.020	22
Total xylenes	ND0.006	ND0.005	ND0.006	ND0.006	ND0.006	ND0.006	ND0.006	ND0.006

TABLE 6-2 (continued)

SUMMARY OF DETECTED COMPOUNDS
OLIN RFI SOIL SAMPLES
NIAGARA FALLS, NEW YORK

Sample ID	OSB-18 6'-8'	RB-5 Rinsate
Sample Date	10/18/91	10/18/91
Units	mg/kg	ug/L
Compounds **TCL - VOAS**		
Methylene chloride	ND0.006	ND5
Acetone	ND0.012	ND10
Chloroform	0.003J	ND5
1,2-dichloropropane	ND0.006	3J
Trichloroethene	ND0.006	ND5
Benzene	0.002J	ND5
Tetrachloroethene	0.009	ND5
Toluene	0.001J	ND5
Chlorobenzene	0.015J	4J
Total xylenes	0.003J	ND5

NS -	Not sampled
ND -	Not detected, applicable detection limit listed
J -	Indicates an estimated value due to outlying QC criteria and/or indicates detection above the method detection limit (MDL) but less than the practical quantitation limit (PQL).
E -	Compound whose concentration exceeds the calibration range of the GC/MS instrument but was diluted below the instrument detection limit on subsequent dilution runs.
R -	Data found to be unusable as a result of outlying QC criteria.
U -	The material was analyzed for but was not detected. The numerical value is the sample quantitation limit and has been adjusted to reflect contamination from laboratory or field activities.
UJ -	Estimated quantitation limit

TABLE 6-2 (continued)

SUMMARY OF DETECTED COMPOUNDS
OLIN RFI SOIL SAMPLES
NIAGARA FALLS, NEW YORK

Sample ID	OSB-17	OSB-17	OSB-17	OSB-17	OSB-18	Dup OSB-18	OSB-18	OSB-18
	0'-2'	2'-4'	4'-6'	6'-8'	0'-2'	0'-2'	2'-4'	4'-6'
Sample Date	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Compounds								
<u>Semi-Volatiles</u>								
1,3-dichlorobenzene	0.36J	0.52J	0.077J	ND24	1.7	2.3	1.1	17E
1,4-dichlorobenzene	1.0	1.7	ND0.75	ND24	ND0.80	ND0.79	0.69J	2.0
1,2-dichlorobenzene	0.57J	0.85	0.15J	ND24	0.89	1.3	3.4	24
2-methylphenol	ND0.71	ND0.73	ND0.75	7.5J	ND0.80	ND0.79	ND0.80	ND0.82
4-methylphenol	ND0.71	0.13J	ND0.75	25	ND0.80	ND0.79	ND0.80	ND0.82
2,4-dimethylphenol	ND0.71	ND0.73	ND0.75	5.9J	ND0.80	ND0.79	ND0.80	ND0.82
2,4-dichlorophenol	ND0.71	ND0.73	ND0.75	ND24	ND0.80	ND0.79	0.15J	ND0.82
1,2,4-trichlorobenzene	4.4	6.4	1.1	ND24	330	270	210	1,900
Naphthalene	2.0	2.4	1.4	1,400	ND0.80	ND0.79	ND0.80	ND0.82
2-methylnaphthalene	0.38J	0.57J	0.46J	140J	0.46J	0.44J	0.19J	ND0.82UJ
2,4,6-trichlorophenol	0.085J	0.15J	ND0.75	ND24	ND0.80	ND0.79	ND0.80	ND0.82
2,4,5-trichlorophenol	0.42J	0.43J	ND3.6	ND110	1.7J	2.2J	ND3.9	6.5
Acenaphthylene	0.93	0.82	ND0.75	ND24	ND0.80	ND0.79	0.17J	ND0.82
Acenaphthene	ND0.71	2.4	2.7	1,000	ND0.80	ND0.79	0.14J	ND0.82
Dibenzofuran	2.0	1.7	2.1	650	0.31J	0.36J	0.14J	ND0.82
Fluorene	2.4	3.1	3.8	920	ND0.80	ND0.79	0.13J	ND0.82
Hexachlorobenzene	0.14J	0.15J	ND0.75	ND24	25	29J	5.8	ND0.82
Phenanthrene	26	47	59	4,600	1.6	1.8	1.8	0.28J
Anthracene	3.8	6.5	5.7	1,300	ND0.80	ND0.79	0.29J	ND0.82
Fluoranthene	43	50	51	3,500	2.5	2.9	3.9	0.39J
Pyrene	25	33	31	2,800	1.7	1.9	4.7	0.30
Benzo(a)anthracene	18	24	20	1,600	0.83	0.97	1.4	0.17J
Chrysene	18	25	23	1,400	1.6	1.8	1.8	0.20J
Bis(2-ethylhexyl)phthalate	0.91	0.91	0.85	ND24	1.4	1.7	1.5	0.35J
Benzo(b)fluoranthene	18	29	25	1.4	2.1	2.6	3.1	0.21J
Benzo(k)fluoranthene	6.1	7.6	6.0	260	0.76J	0.98	1.4	0.11J
Benzo(a)pyrene	12E	23	10	1,200	0.18J	0.21J	1.8	0.13J
Indeno(1,2,3-cd)pyrene	0.063J	5.8	ND0.75	310	0.83	0.87	1.3	0.12J

TABLE 6-2 (continued)

SUMMARY OF DETECTED COMPOUNDS
OLIN RFI SOIL SAMPLES
NIAGARA FALLS, NEW YORK

Sample ID	OSB-17	OSB-17	OSB-17	OSB-17	OSB-18	Dup OSB-18	OSB-18	OSB-18
	0'-2'	2'-4'	4'-6'	6'-8'	0'-2'	0'-2'	2'-4'	4'-6'
Sample Date	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Compounds								
Semi-Volatiles								
Dibenzo(a,h)anthracene	1.3	1.2	0.33J	65	ND0.80	ND0.79	ND0.80	ND0.82
Benzo(g,h,i)perylene	0.062J	1.1	2.3	82	0.59J	0.59J	0.87	0.10J
3,4-dichlorophenol	ND0.71	ND0.73	ND0.75	ND24	ND0.80	ND0.79	0.13J	ND0.82
2,3,6-trichlorophenol	ND0.71	ND0.73	ND0.75	ND24	ND0.80	ND0.79	2.6	ND0.82
3,4,5-trichlorophenol	ND0.71	ND0.73	ND0.75	ND24	0.31J	0.57J	ND0.80	ND0.82
2,3,4,5-tetrachlorophenol	ND0.71UJ	ND0.73UJ	ND0.75UJ	ND24UJ	0.16J	0.45J	0.46J	ND0.82
2,3,4,6-tetrachlorophenol	ND0.71R	ND0.73R	ND0.75R	ND24R	0.096J	ND0.79R	ND0.80R	0.31J

TABLE 6-2 (continued)

SUMMARY OF DETECTED COMPOUNDS
OLIN RFI SOIL SAMPLES
NIAGARA FALLS, NEW YORK

Sample ID	OSB-18 6'-8'	RB-5 Rinsate
Sample Date	10/18/91	10/18/91
Units	mg/kg	ug/L
Compounds **Semi-Volatiles**		
1,3-dichlorobenzene	2.3	ND10
1,4-dichlorobenzene	0.42J	ND10
1,2-dichlorobenzene	4.3	ND10
2-methylphenol	ND0.73	ND10
4-methylphenol	ND0.73	ND10
2,4-dimethylphenol	ND0.73	ND10
2,4-dichlorophenol	ND0.73	ND10
1,2,4-trichlorobenzene	340	ND10
Naphthalene	ND0.73	ND10
2-methylnaphthalene	ND0.73UJ	ND10
2,4,6-trichlorophenol	ND0.73	ND10
2,4,5-trichlorophenol	2.9J	ND50
Acenaphthylene	ND0.73	ND10
Acenaphthene	ND0.73	ND10
Dibenzofuran	ND0.73	ND10
Fluorene	ND0.73	ND10
Hexachlorobenzene	ND0.73	ND10
Phenanthrene	0.18J	ND10
Anthracene	ND0.73	ND10
Fluoranthene	0.28J	ND10
Pyrene	0.22J	ND10
Benzo(a)anthracene	0.12J	ND10
Chrysene	0.17J	ND10
Bis(2-ethylhexyl)phthalate	3.7	ND10
Benzo(b)fluoranthene	0.21J	ND10
Benzo(k)fluoranthene	0.079J	ND10
Benzo(a)pyrene	0.072J	ND10
Indeno(1,2,3-cd)pyrene	0.11J	ND10

TABLE 6-2 (continued)

SUMMARY OF DETECTED COMPOUNDS
OLIN RFI SOIL SAMPLES
NIAGARA FALLS, NEW YORK

Sample ID	OSB-18	RB-5
	6'-8'	Rinsate
Sample Date	10/18/91	10/18/91
Units	mg/kg	ug/L
Compounds		
Semi-Volatiles		
Dibenzo(a,h)anthracene	0.036J	ND10
Benzo(g,h,i)perylene	0.11J	ND10
3,4-dichlorophenol	ND0.73	ND10
2,3,6-trichlorophenol	ND0.73	ND10
3,4,5-trichlorophenol	ND0.73	ND10
2,3,4,5-tetrachlorophenol	ND0.73	ND10
2,3,4,6-tetrachlorophenol	ND0.73R	ND10R

NS - Not sampled
ND - Not detected, applicable detection limit listed
J - Indicates an estimated value due to outlying QC criteria and/or indicates detection above the method detection limit (MDL) but less than the practical quantitation limit (PQL).
E - Compound whose concentration exceeds the calibration range of the GC/MS instrument but was diluted below the instrument detection limit on subsequent dilution runs.
R - Data found to be unusable as a result of outlying QC criteria.
U - The material was analyzed for but was not detected. The numerical value is the sample quantitation limit and has been adjusted to reflect contamination from laboratory or field activities.
UJ - Estimated quantitation limit

TABLE 6-2 (continued)

SUMMARY OF DETECTED COMPOUNDS
OLIN RFI SOIL SAMPLES
NIAGARA FALLS, NEW YORK

Sample ID	OSB-17	OSB-17	OSB-17	OSB-17	OSB-18	Dup OSB-18	OSB-18	OSB-18
	0'-2'	2'-4'	4'-6'	6'-8'	0'-2'	0'-2'	2'-4'	4'-6'
Sample Date	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91	10/18/91
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Compounds								
Pesticides								
alpha-BHC	10	18	2.6	1.6	1.0J	1.6	18	23
beta-BHC	27	44	3.5	0.56	19	30	9.5	0.94
delta-BHC	5.5	9.8	0.94	0.58	ND0.19	ND0.19	0.16J	0.19J
gamma-BHC	8.3	13	1.0	0.46	ND0.19	ND0.19	0.35J	0.39J
Heptachlor	ND0.34	ND0.70	0.051	0.0057	ND0.19	ND0.19	ND0.39	ND0.40
Aldrin	ND0.34	ND0.70	ND0.036	0.096	ND0.19	ND0.19	ND0.39	ND0.40
Heptachlor epoxide	ND0.34	ND0.70	ND0.036	ND0.037	ND0.19	0.03J	ND0.39	ND0.40
Dieldrin	ND0.69	ND1.4	0.083	1.1	ND0.39	ND0.38	ND0.78	ND0.81
Endrin	ND0.69	ND1.4	ND0.072	1.3	ND0.39	ND0.38	ND0.78	ND0.81
Endosulfan II	ND0.69	ND1.4	0.015J	0.01J	ND0.39	0.05J	ND0.78	ND0.81
4,4'-DDD	ND0.69	ND1.4	ND0.072	0.029J	ND0.39	ND0.38	ND0.78	ND0.81
4,4'-DDT	ND0.69	ND1.4	0.085	0.0087J	ND0.39	ND0.38	ND0.78	ND0.81
Methoxychlor	ND3.4	ND7.0	ND0.36	0.17J	ND1.9	ND1.9	ND3.9	ND4.0
Alpha-chlordane	ND3.4	ND7.0	0.36U	0.37U	ND1.9	ND1.9	ND3.9	ND4.0
Gamma-chlordane	ND3.4	ND7.0	ND0.36	ND0.37	ND1.9	0.065J	ND3.9	ND4.0

TABLE 6-2 (continued)

SUMMARY OF DETECTED COMPOUNDS
OLIN RFI SOIL SAMPLES
NIAGARA FALLS, NEW YORK

Sample ID	OSB-18 6'-8'	RB-5 Rinsate
Sample Date	10/18/91	10/18/91
Units	mg/kg	ug/L
Compounds		
Pesticides		
alpha-BHC	5.0	0.14
beta-BHC	1.6	0.063
delta-BHC	ND0.088	0.12
gamma-BHC	0.091	0.041
Heptachlor	ND0.088	ND0.062
Aldrin	ND0.088	ND0.062
Heptachlor epoxide	ND0.088	ND0.062
Dieldrin	ND0.18	ND0.12
Endrin	ND0.18	ND0.12
Endosulfan II	ND0.18	ND0.12
4,4'-DDD	ND0.18	ND0.12
4,4'-DDT	ND0.18	ND0.12
Methoxychlor	ND0.88	ND0.62
Alpha-chlordane	ND0.88	ND0.62
Gamma-chlordane	ND0.88	ND0.62

NS - Not sampled

ND - Not detected, applicable detection limit listed

J - Indicates an estimated value due to outlying QC criteria and/or indicates detection above the method detection limit (MDL) but less than the practical quantitation limit (PQL).

E - Compound whose concentration exceeds the calibration range of the GC/MS instrument but was diluted below the instrument detection limit on subsequent dilution runs.

R - Data found to be unusable as a result of outlying QC criteria.

U - The material was analyzed for but was not detected. The numerical value is the sample quantitation limit and has been adjusted to reflect contamination from laboratory or field activities.

UJ - Estimated quantitation limit

TABLE 6-3
OLIN NIAGARA PLANT RFI
SUMMARY OF BHC ANALYSIS
PHASE II SOIL BORINGS NSB-16 AND NSB-17

Boring ID		TCL Pesticides (ug/kg)			
		alpha-BHC	beta-BHC	delta-BHC	gamma-BHC
NSB-16	1'-3'	110000 CE	57000 CE	2600 C	4000 C
	3'-5'	1800 CE	5400 CE	110 J	71 J
	5'-7'	54000 CE	50000 CE	1500 CJ	1500 CJ
	7'-9'	4800 CE	9400 CE	150	1500
NSB-17	1'-3'	290 J	1300 E	25	140
	3'-5'	190	450 E	12 J	52
	5'-7'	2100 E	3100 E	220	1000
	7'-9'	60	66	4.5 J	15 J

J - Indicates an estimated value due to outlying QC results and/or indicates detection above the mean detection limit (MDL), but less than the practical quantitation limit (PQL)

C - Compound confirmation by GC/MS

E - Sample result reported from a secondary dilution

TABLE 7-1
Groundwater Sampling and Analyses Summary
Olin Buffalo Avenue Plant RFI
Niagara Falls, New York

Sampling Round	Wells Sampled	Analyses
September/October 1991	Olin Production Well, OBA-1A, OBA-1B, OBA-1C, OBA-2B, OBA-2C, OBA-3A, OBA-3B, OBA-3C, OBA-4A, OBA-4B, OBA-4C, OBA-5A, OBA-5B, OBA-5C, OBA-6A, OBA-6B, OBA-6C, OBA-7A, OBA-7B, OBA-7C, OBA-8A, OBA-8B, OBA-8C, BH-1, BH-3	All wells sampled for Olin Project Analyte List*
March 1992	Olin Production Well, OBA-1A, OBA-1B, OBA-1C, OBA-2B, OBA-2C, OBA-3A, OBA-3B, OBA-3C, OBA-4A, OBA-4B, OBA-4C, OBA-5A, OBA-5B, OBA-5C, OBA-6A, OBA-6B, OBA-6C, OBA-7A, OBA-7B, OBA-7C, OBA-8A, OBA-8B, OBA-8C, BH-1, BH-3	All wells sampled for Olin Project Analyte List*
June 1992	Olin Production Well, OBA-1A, OBA-1B, OBA-1C, OBA-2B, OBA-2C, OBA-3A, OBA-3B, OBA-3C, OBA-4A, OBA-4B, OBA-4C, OBA-5A, OBA-5B, OBA-5C, OBA-6A, OBA-6B, OBA-6C, OBA-7A, OBA-7B, OBA-7C, OBA-8A, OBA-8B, OBA-8C, BH-1, BH-3	All wells sampled for Olin Project Analyte List*
September 1992	Olin Production Well, OBA-1A, OBA-1B, OBA-1C, OBA-2B, OBA-2C, OBA-3A, OBA-3B, OBA-3C, OBA-4A, OBA-4B, OBA-4C, OBA-5A, OBA-5B, OBA-5C, OBA-6A, OBA-6B, OBA-6C, OBA-7A, OBA-7B, OBA-7C, OBA-8A, OBA-8B, OBA-8C, BH-1, BH-3	All wells sampled for Olin Project Analyte List*
November 1992	OBA-9A, OBA-10A	All wells sampled for Olin Project Analyte List*
October 1993	MW-15A, MW-15CD, MW-19A, MW-19B, MW-19CD-1, MW-20B, MW-22B, MW-22C, MW-22D, MW-22F, MW-26CD	All wells sampled for Dupont Niagara Plant Indicator Parameter List** for Volatile Organic Compounds, Olin Project Analyte List* for Semi-Volatile Organic Compounds, Pesticides/PCBs, and Mercury
January 1994	OBA-11B, OBA-11C, OBA-12B, OBA-12C	All wells sampled for Olin Project Analyte List*
May 1994	OBA-4A, OBA-4B, OBA-4C, OBA-9A, OBA-10A, OBA-11B, OBA-11C, OBA-12B, OBA-12C, OBA-13A, OBA-13B, OBA-13C, OBA-14A, OBA-14B, OBA-14C,	All wells sampled for Olin Project Analyte List*

TABLE 7-1
Groundwater Sampling and Analyses Summary
Olin Buffalo Avenue Plant RFI
Niagara Falls, New York

Sampling Round	Wells Sampled	Analyses
May 1994 (continued)	OBA-15A, OBA-15B, OBA-16A, OBA-16C	As Above
July 1994	OBA-3A, OBA-3B, OBA-3C, OBA-13A, OBA-13B, OBA-13C, OBA-14A, OBA-14B, OBA-14C, OBA-15A OBA-15B, OBA-16A, OBA-16B	All wells sampled for Olin Project Analyte List* (1)

Notes:

(1) Semi-volatile organic compounds analyses did not include chlorinated phenolics.

* Olin Project Analyte List = TCL-Volatile Organic Compounds + Methanol, TCL-Semi-Volatile Organic Compounds + chlorinated phenolics, TCL-Pesticides/PCBs, and Total Mercury

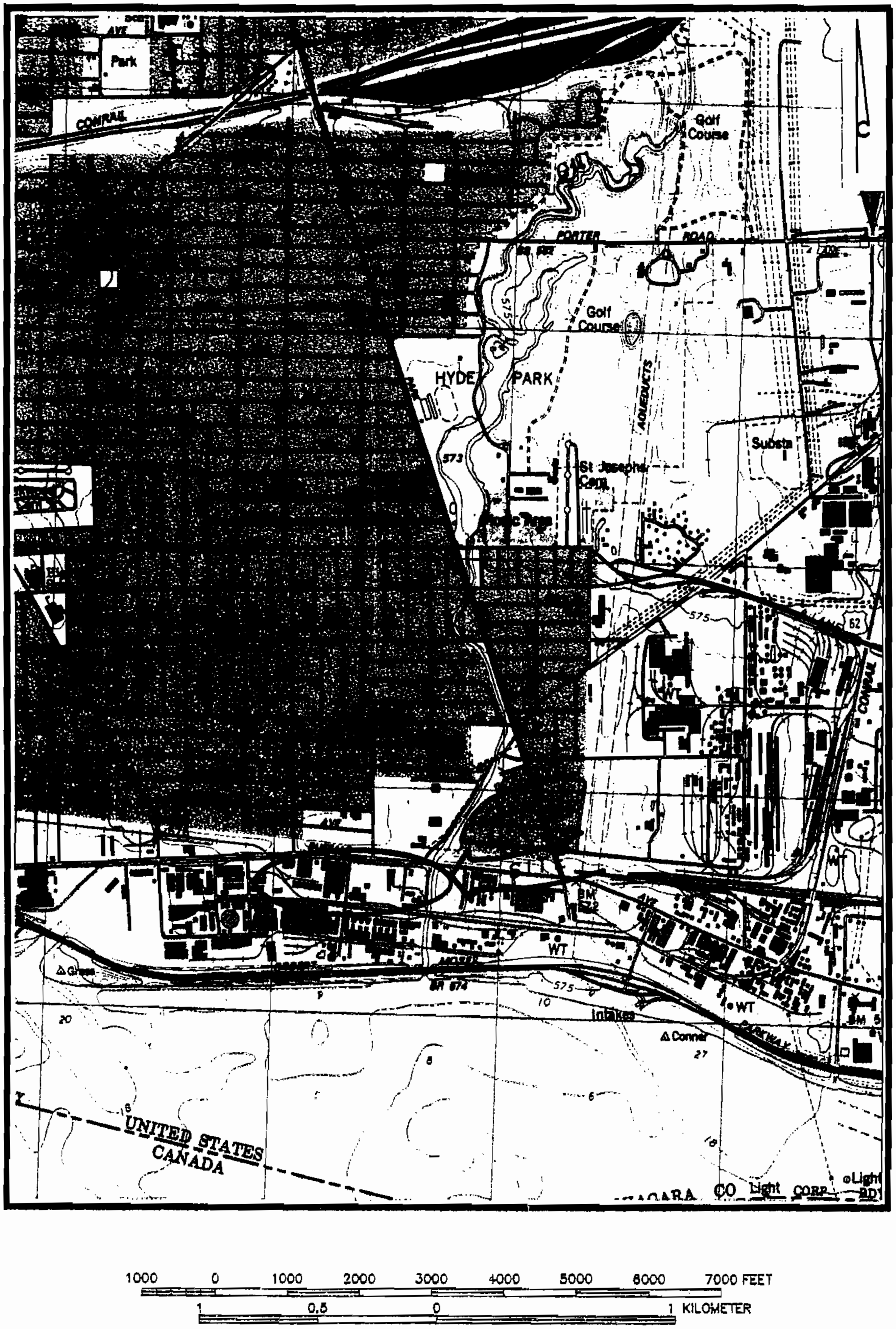
** Dupont Niagara Plant Indicator Parameter List Volatile Organic Compounds = Method 8010/8020 Volatile Organic Compounds

TABLE 7-2

DETECTED CHEMICALS IN WELL OBA-2C DNAPL
OLIN BUFFALO AVENUE PLANT RFI

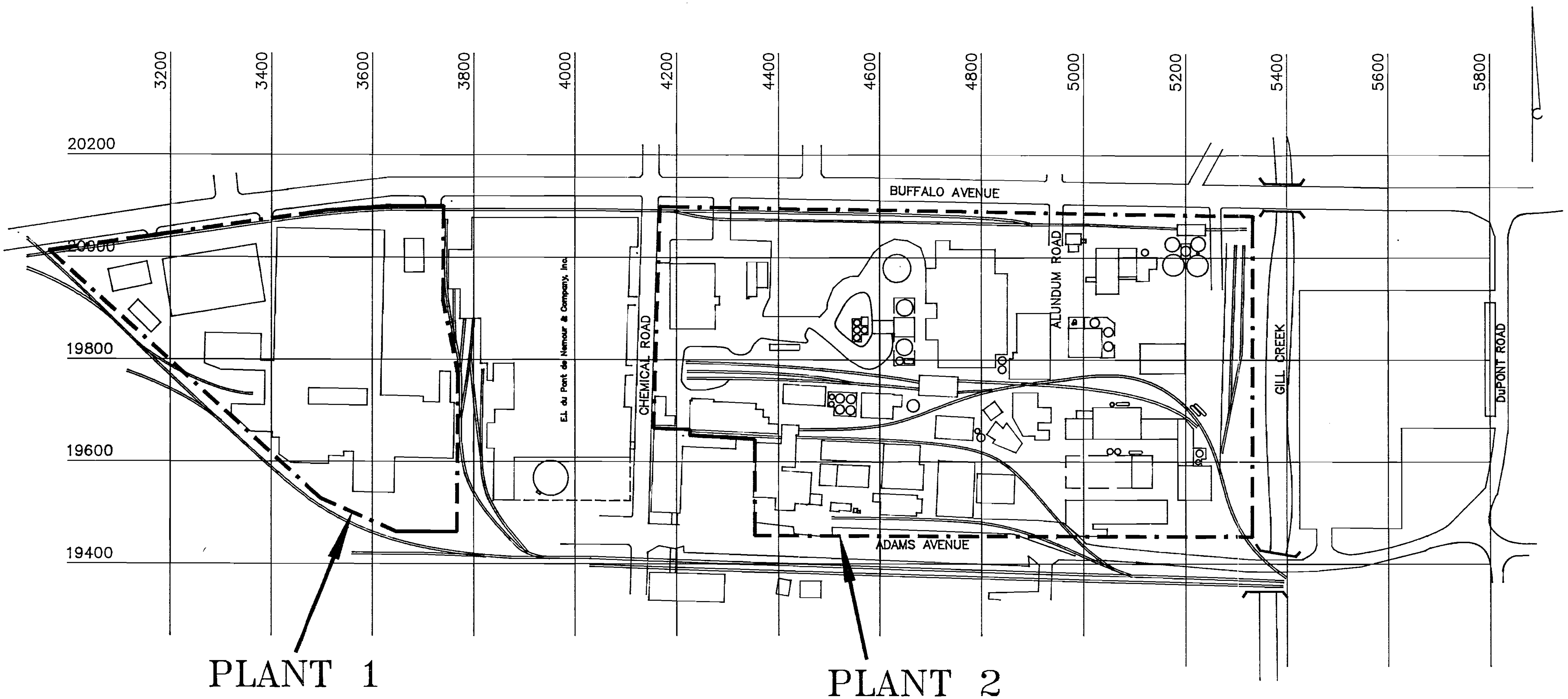
Chemical	Concentration (mg/kg)
Volatile Organic Compounds	
1,2-Dichloroethene (total)	380
Chloroform	600
Carbon tetrachloride	2,300
Trichloroethene	130,000
Tetrachloroethene	130,000
1,1,2,2-Tetrachloroethane	35,000
	Subtotal: 298,280 mg/kg (29.8%)
Semivolatile Organic Compounds	
1,3-Dichlorobenzene	410
1,4-Dichlorobenzene	1,200
1,2-Dichlorobenzene	6,000
1,2,4-Trichlorobenzene	2,800
Hexachlorobutadiene	9,600
Hexachlorobenzene	360
bis(2-Ethylhexyl)phthalate	2,100
Hexachloroethane	25,000
	Subtotal: 47,470 mg/kg (4.7%)
Pesticide/PCB	
alpha-BHC	70
beta-BHC	71
delta-BHC	130
gamma-BHC	50
Heptachlor	7.6
Heptachlor epoxide	5.2
Endrin	130
Endosulfan sulfate	130
alpha-Chlordane	1.8
gamma-Chlordane	3.9
4,4′-DDE	9.0
	Subtotal: 608.5 mg/kg (0.06%)

Figures



REGIONAL LOCATION PLAN

Figure 1–1

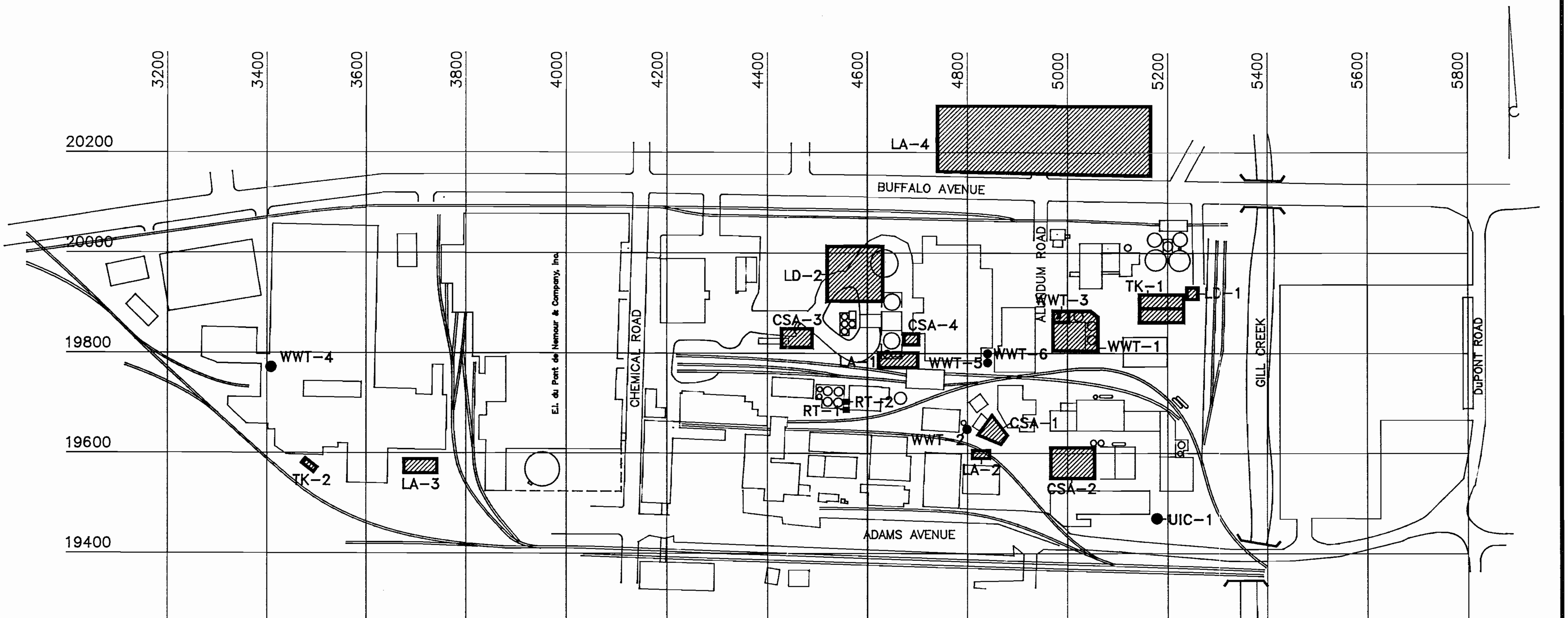


OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

SITE LOCATION PLAN

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 2–1
Scale: 0 200 Feet		



UNIT	USAGE	STATUS (as of 2/90)	UNIT	USAGE	STATUS (as of 2/90)
CSA-1	Drum Storage Area	Active	WWT-6	Treatment Tank: Sodium Hypochlorite Decomposition	Inactive
CSA-2	Drum Storage Area	Inactive	TK-1	Concrete Lined Brine Mud Treatment Tank	Inactive (RCRA Closure)
CSA-3	Drum Storage Area	Inactive (RCRA Closure)	TK-2	Concrete Lined Waste Calcium Hypochlorite Settling Tank	Inactive (RCRA Closure)
CSA-4	Drum Storage Area	Inactive	LA-1	Brine Mud Application for Road Repairs	Inactive
LD-1	Brine Mud Waste Pile	Inactive (RCRA Closure)	LA-2	Brine Mud Application for Road Repairs	Inactive
LD-2	Cooling Water Surface Impoundment	Inactive	LA-3	Brine Mud Application to Fill Topographic Low Area	Inactive
WWT-1	Treatment Tank: Hg Removal from Wastewater	Active	LA-4	Brine Mud Application for Road Repairs	Inactive
WWT-2	Treatment Tank: Sodium Hypochlorite Decomposition	Active	UIC-1	Bedrock Injection Well	Inactive
WWT-3	Treatment Tank: pH Adjustment of Wastewater	Active	RT-1	Thermal Treatment of Mercury Sludge	Active
WWT-4	Treatment Tank: Chlorine Removal from Wastewater	Inactive	RT-2	Thermal Treatment of Mercury Sludge (Backup for RT-1)	Active
WWT-5	Treatment Tank: Sodium Hypochlorite Decomposition	Inactive			

OLIN CHEMICALS NIAGARA PLANT
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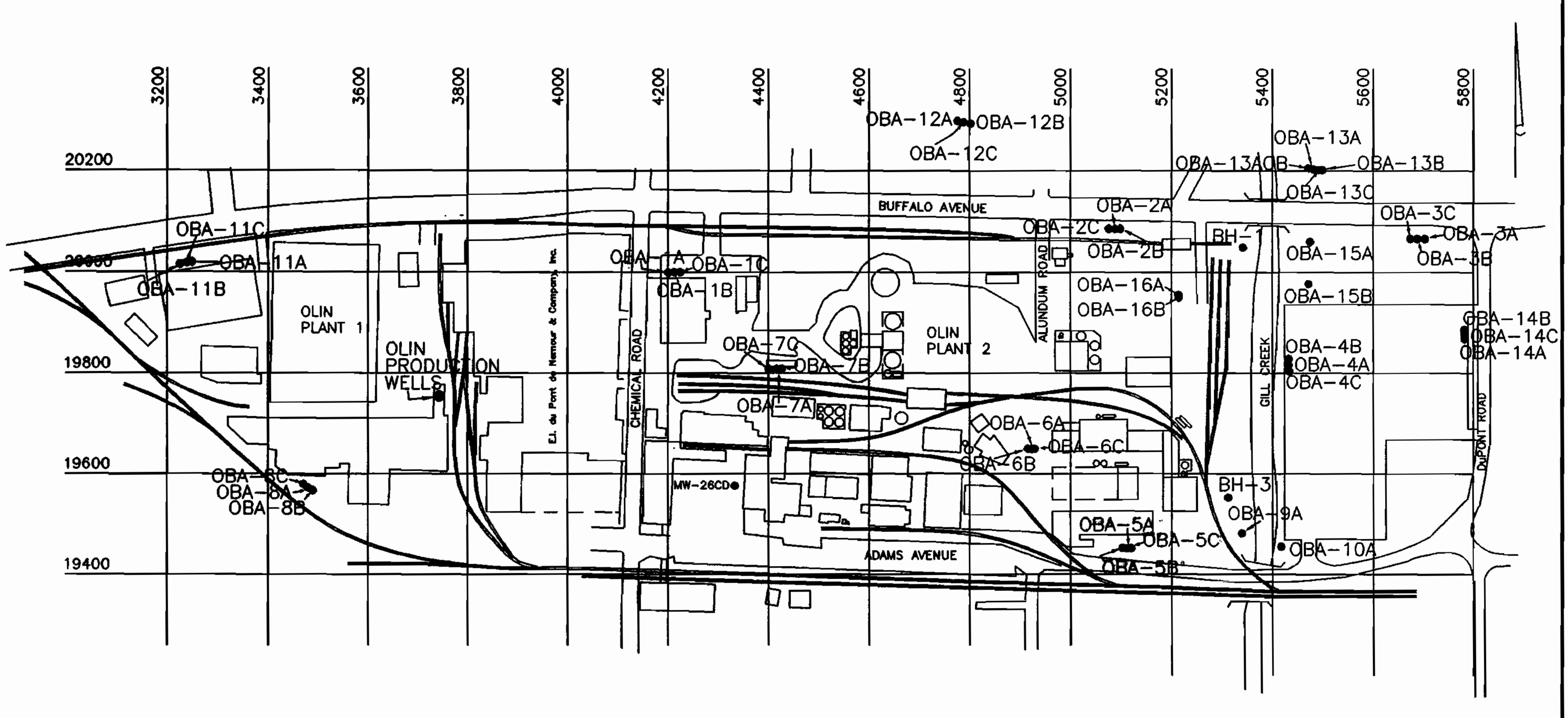
OLIN SOLID WASTE MANAGEMENT
UNITS (SWMUs)

Job No.: 88C2346-12
Drawing No.
Date:
Checked by: KRM
Rev. No.:
Scale: 0 200 Feet

FIGURE 2-2



LEGEND:

OBA-5A ● OLIN MONITORING WELL

OLIN CHEMICALS NIAGARA PLANT
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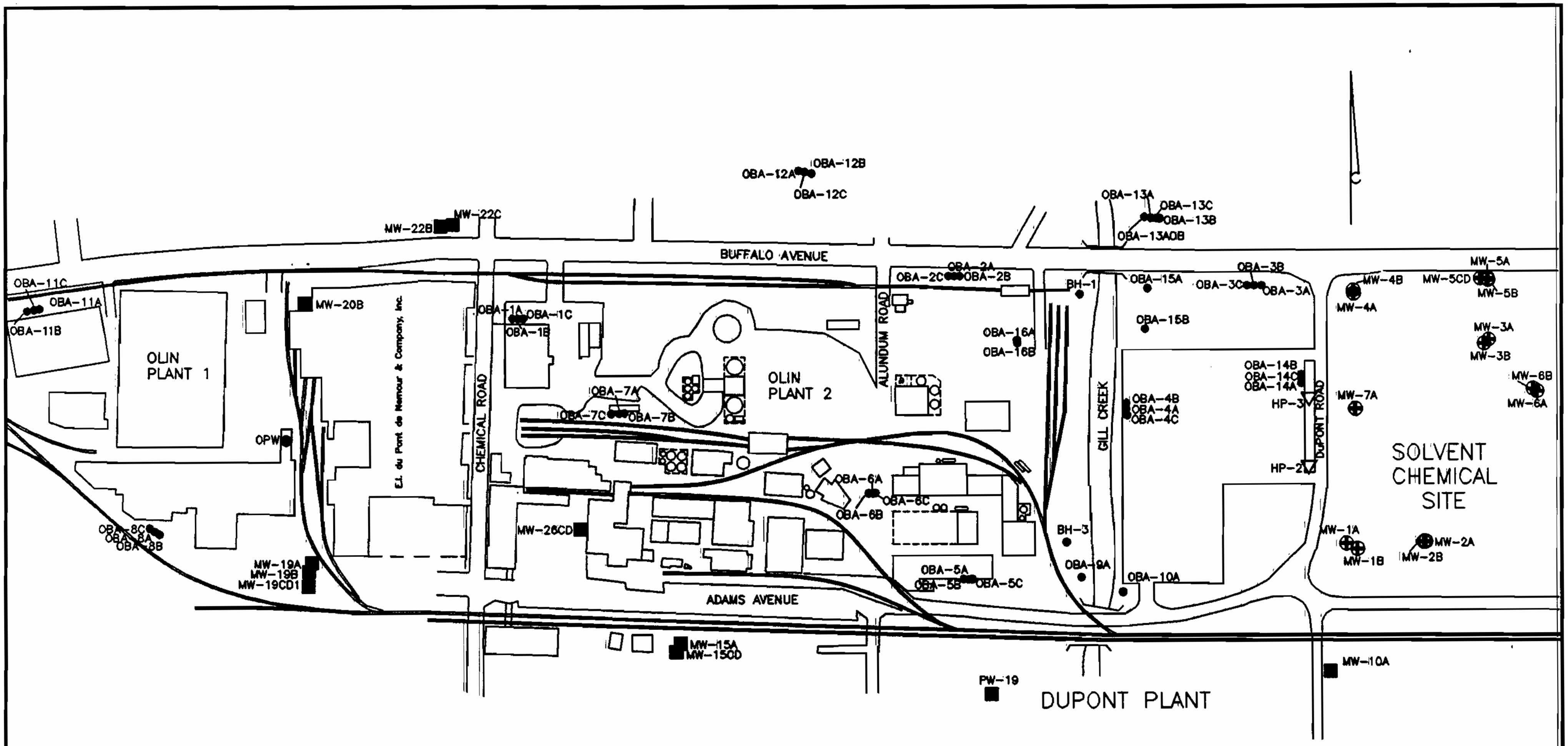
OLIN GROUNDWATER MONITORING WELLS

Job No.: 4E02704	Drawing No. OLINWELL	Date: 7-29-94
Checked by: KRM	Rev. No.:	FIGURE 3-1
Scale: 0 200 Feet		



NOTE:
OPW – OLIN PRODUCTION WELL(S)

LEGEND:

OBA-8A	●	OLIN MONITORING WELL
MW-19A	■	DUPONT MONITORING WELL
MW-6A	⊕	SOLVENT CHEMICAL SITE MONITORING WELL
HP-3	▽	SOLVENT CHEMICAL SITE HYDROPUNCH SAMPLING LOCATION

OLIN CHEMICALS NIAGARA PLANT
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REGIONAL WELLS USED IN
PREPARATION OF CHEMICAL
ISOCONCENTRATION CONTOUR MAPS

Job No.: 4E02704	Drawing No. ALLWELLS	Date: 7-29-94
Checked by: KRM	Rev. No.:	FIGURE 3-2
Scale: 0 200 Feet		

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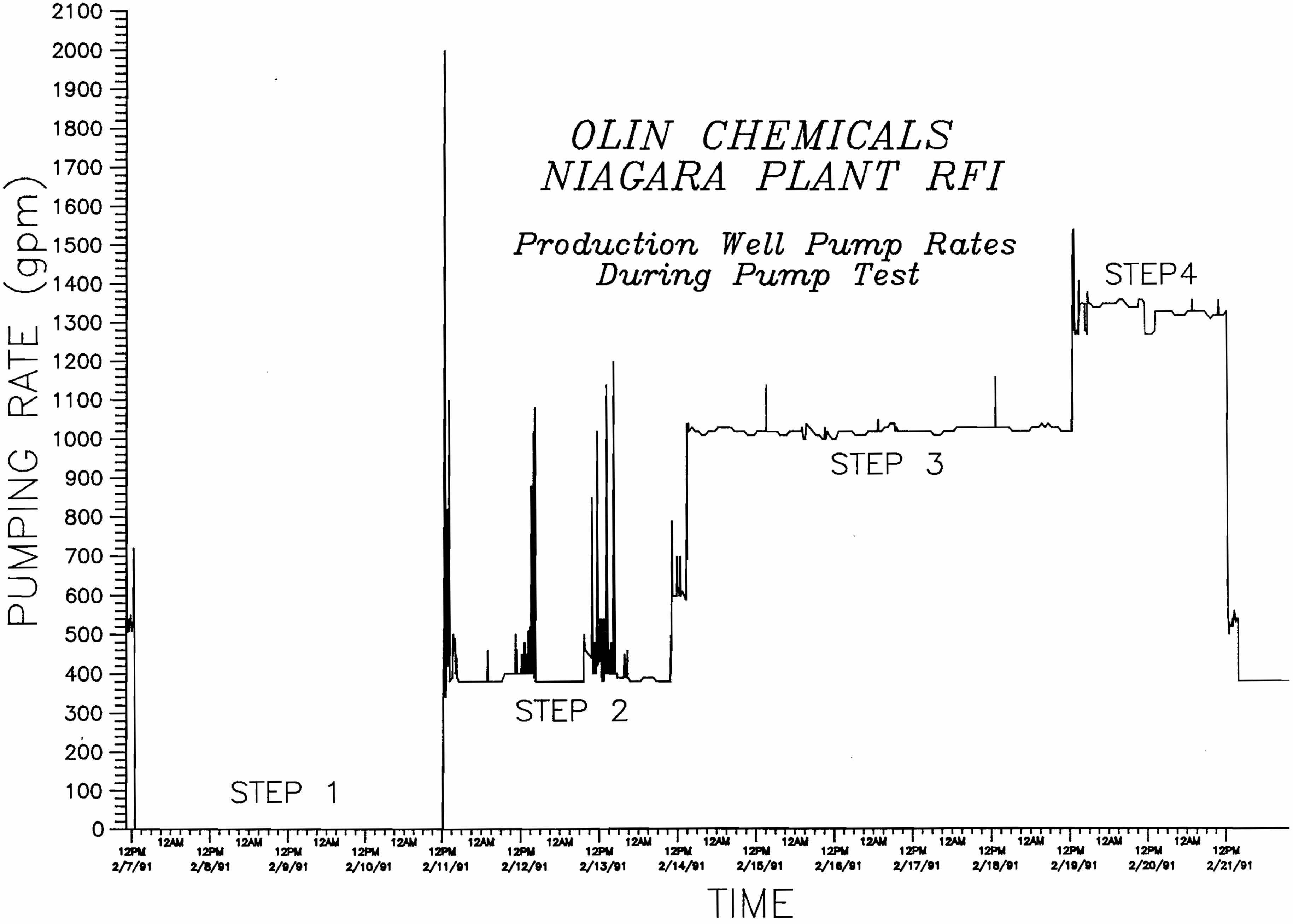
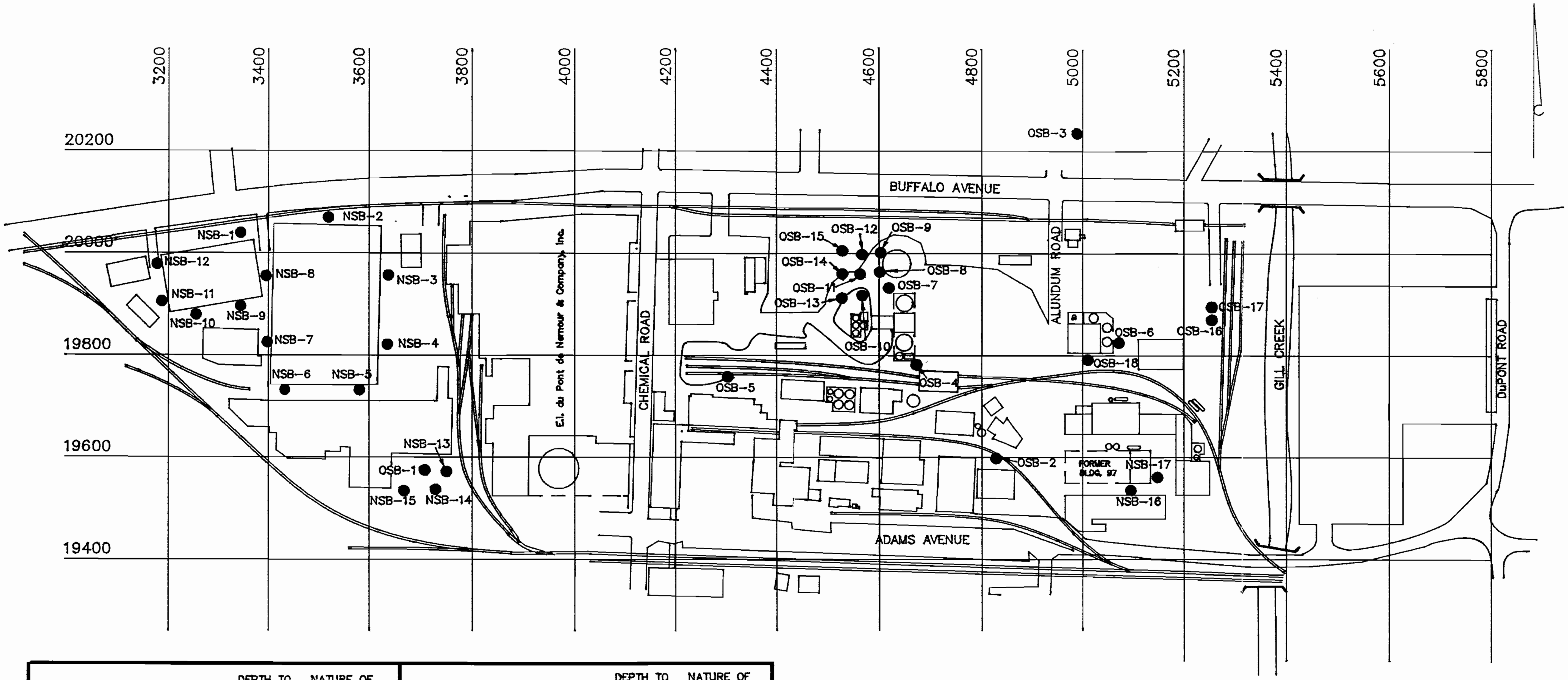


OLIN CHEMICALS
NIAGARA PLANT RFI

Production Well Pump Rates
During Pump Test

FIGURE 3-3



BORING	SWMU INVESTIGATED	DEPTH TO REFUSAL	NATURE OF REFUSAL
OSB-1	LA-3	9.1'	Bedrock
OSB-2	LA-2	4.6'	Bedrock
OSB-3	LA-4	6.9'	Bedrock
OSB-4	LA-1	2.5'	Old Foundation
OSB-5	North of Building 17	6.5'	Bedrock
OSB-6	WWT-1	8.2'	Bedrock
OSB-7	LD-2	5.3'	Bedrock
OSB-8	LD-2	3.2'	Old Foundation
OSB-9	LD-2	3.2'	Old Foundation
OSB-10	LD-2	4'	Old Foundation
OSB-11	LD-2	2.5'	Old Foundation
OSB-12	LD-2	3'	Old Foundation
OSB-13	LD-2	3.4'	Old Foundation
OSB-14	LD-2	2.8'	Old Foundation
OSB-15	LD-2	2.8'	Old Foundation
OSB-16	TK-1	6.7'	Bedrock
OSB-17	BHC Storage Pile	7'	Bedrock
OSB-18	Building 97	6.7'	Bedrock

BORING	SWMU INVESTIGATED	DEPTH TO REFUSAL	NATURE OF REFUSAL
NSB-1	Former Hg cell perimeter	8.3'	Bedrock
NSB-2	Former Hg cell perimeter	5.9'	Bedrock
NSB-3	Former Hg cell perimeter	7.2'	Bedrock
NSB-4	Former Hg cell perimeter	7.2'	Bedrock
NSB-5	Former Hg cell perimeter	7.5'	Bedrock
NSB-6	Former Hg cell perimeter	7.9'	Bedrock
NSB-7	Former Hg cell perimeter	9.0'	Bedrock
NSB-8	Former Hg cell perimeter	10.6'	Bedrock
NSB-9	Former Hg cell perimeter	9.3'	Bedrock
NSB-10	Former Hg cell perimeter	8.7'	Bedrock
NSB-11	Former Hg cell perimeter	8.5'	Bedrock
NSB-12	Former Hg cell perimeter	8.9'	Bedrock
NSB-13	LA-3	7.7'	Bedrock
NSB-14	LA-3	7.7'	Bedrock
NSB-15	LA-3	7.8'	Bedrock
NSB-16	Former Building 97	8.9'	Bedrock
NSB-17	Former Building 97	8.7'	Bedrock

NOTES:

PHASE I: OSB SOIL BORINGS DRILLED IN OCTOBER, 1991

PHASE II: NSB SOIL BORINGS DRILLED IN DECEMBER, 1993

OLIN CHEMICALS NIAGARA PLANT
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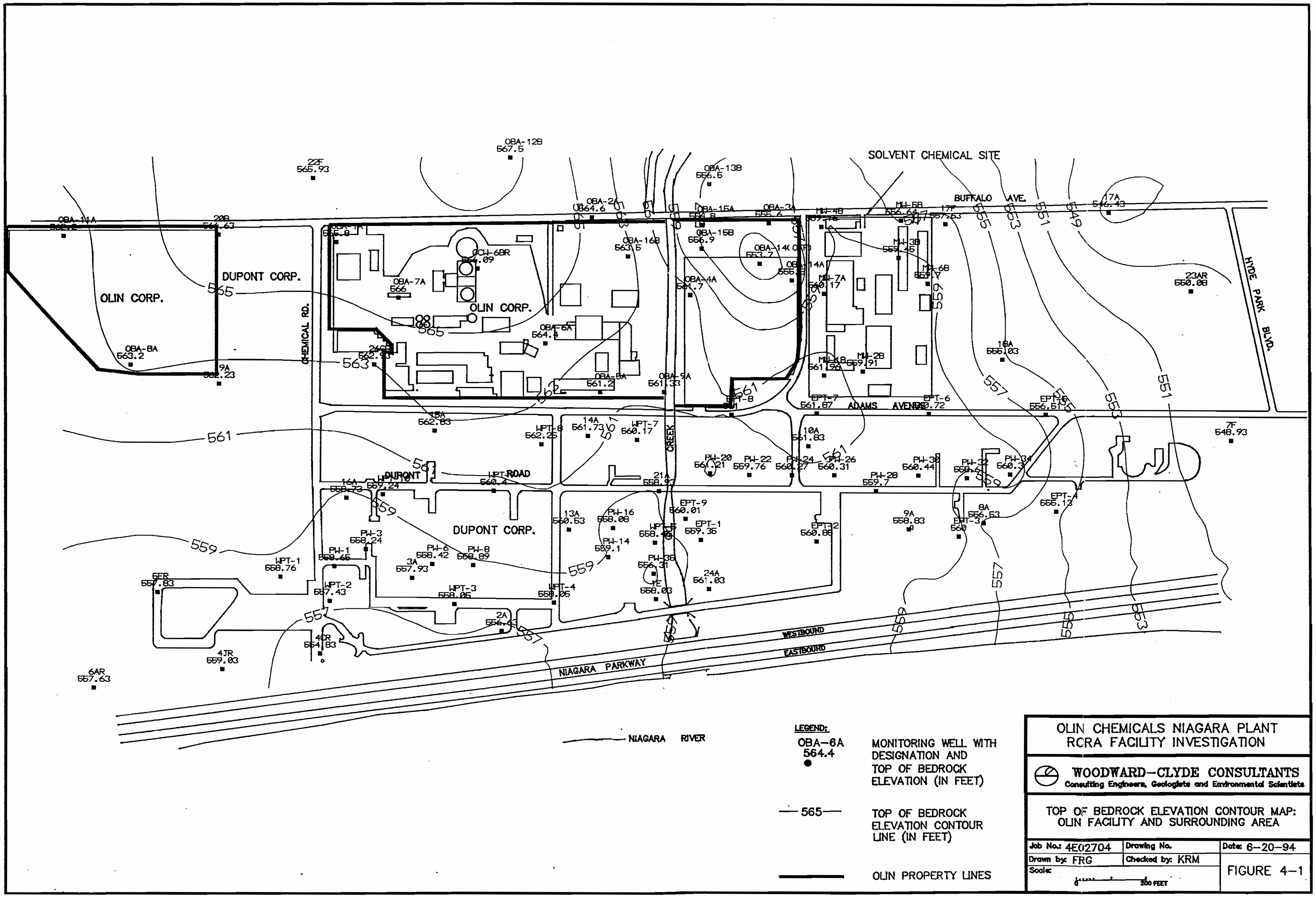
PHASE I & PHASE II SOIL BORING LOCATIONS

Job No.: 4E02704	Drawing No. OLINBASE	Date: 6-26-94
Checked by: KRM	Rev. No.:	
Scale: 0 — 200 Feet		FIGURE 3-4



LEGEND:

OBA-6A
564.4
● MONITORING WELL WITH DESIGNATION AND TOP OF BEDROCK ELEVATION (IN FEET)

—565— TOP OF BEDROCK ELEVATION CONTOUR LINE (IN FEET)

▬ OLIN PROPERTY LINES

OLIN CHEMICALS NIAGARA PLANT
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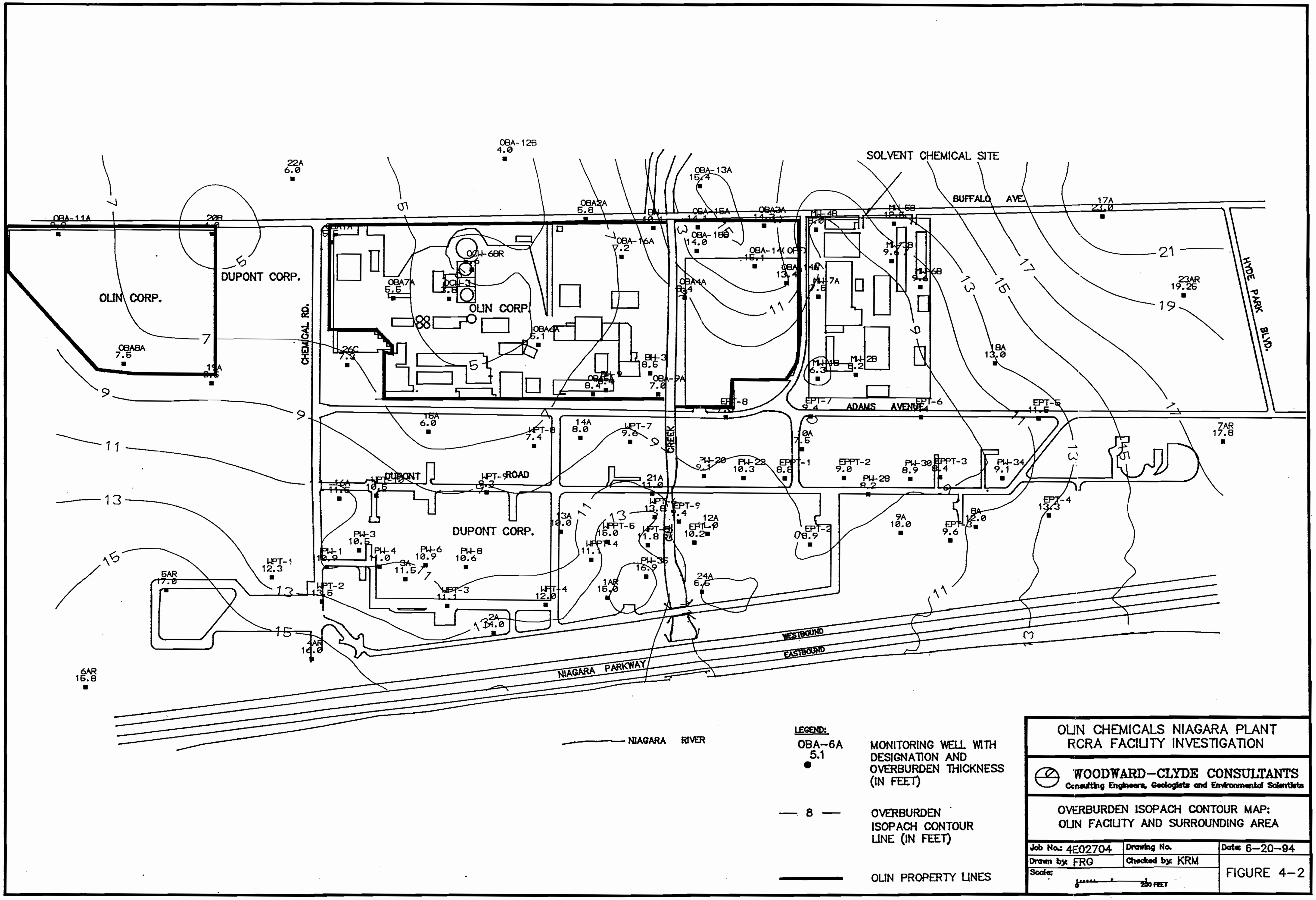
TOP OF BEDROCK ELEVATION CONTOUR MAP:
OLIN FACILITY AND SURROUNDING AREA

Job No.: 4E02704	Drawing No.	Date: 6-20-94
Drawn by: FRG	Checked by: KRM	FIGURE 4-1
Scale: 0 — 200 FEET		



OLIN CHEMICALS NIAGARA PLANT
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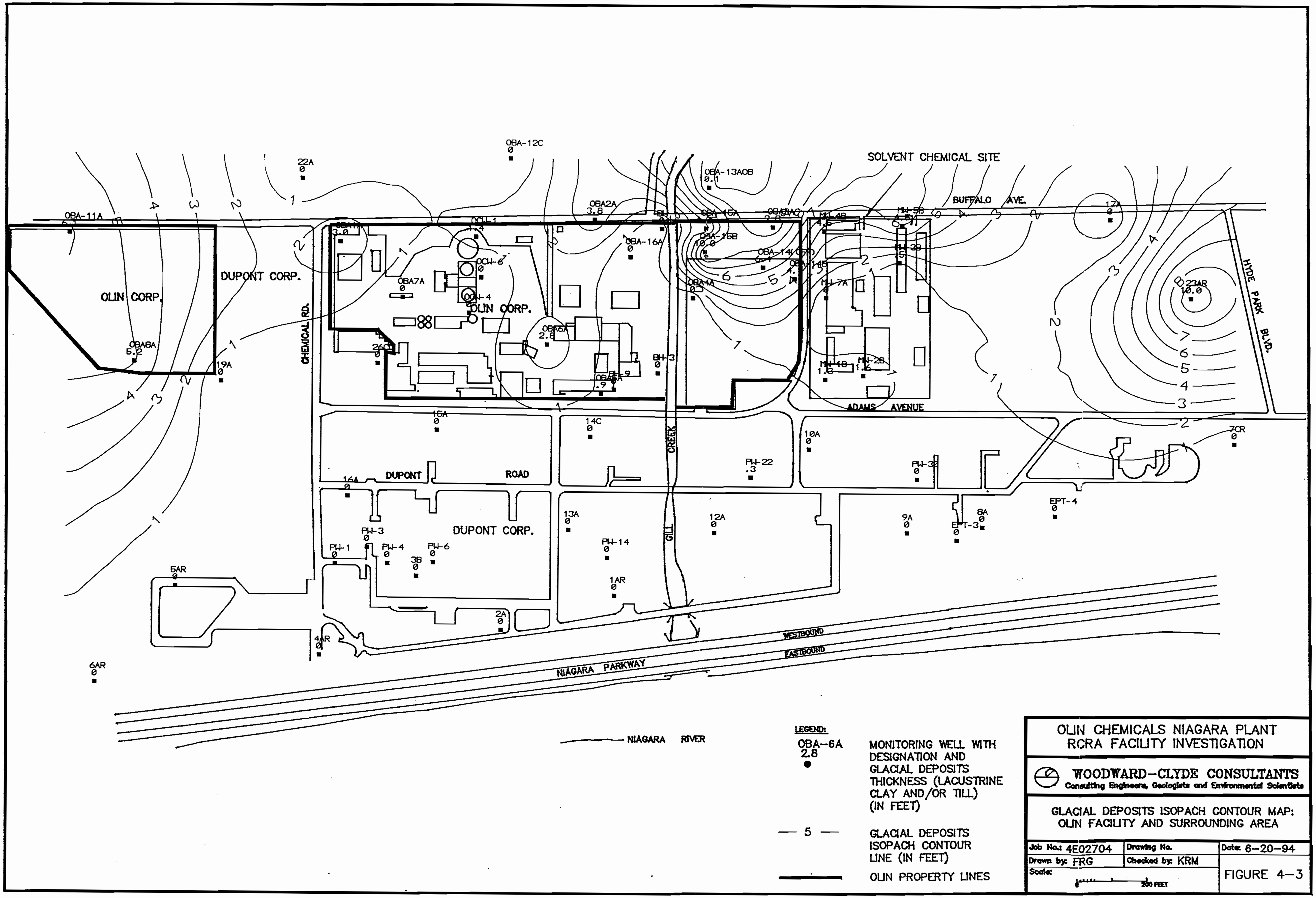
OVERBURDEN ISOPACH CONTOUR MAP:
OLIN FACILITY AND SURROUNDING AREA

Job No.: 4E02704	Drawing No.	Date: 6-20-94
Drawn by: FRG	Checked by: KRM	FIGURE 4-2
Scale:		



LEGEND:

OBA-6A 2.8 ● MONITORING WELL WITH DESIGNATION AND GLACIAL DEPOSITS THICKNESS (LACUSTRINE CLAY AND/OR TILL) (IN FEET)

— 5 — GLACIAL DEPOSITS ISOPACH CONTOUR LINE (IN FEET)

▬ OLIN PROPERTY LINES

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

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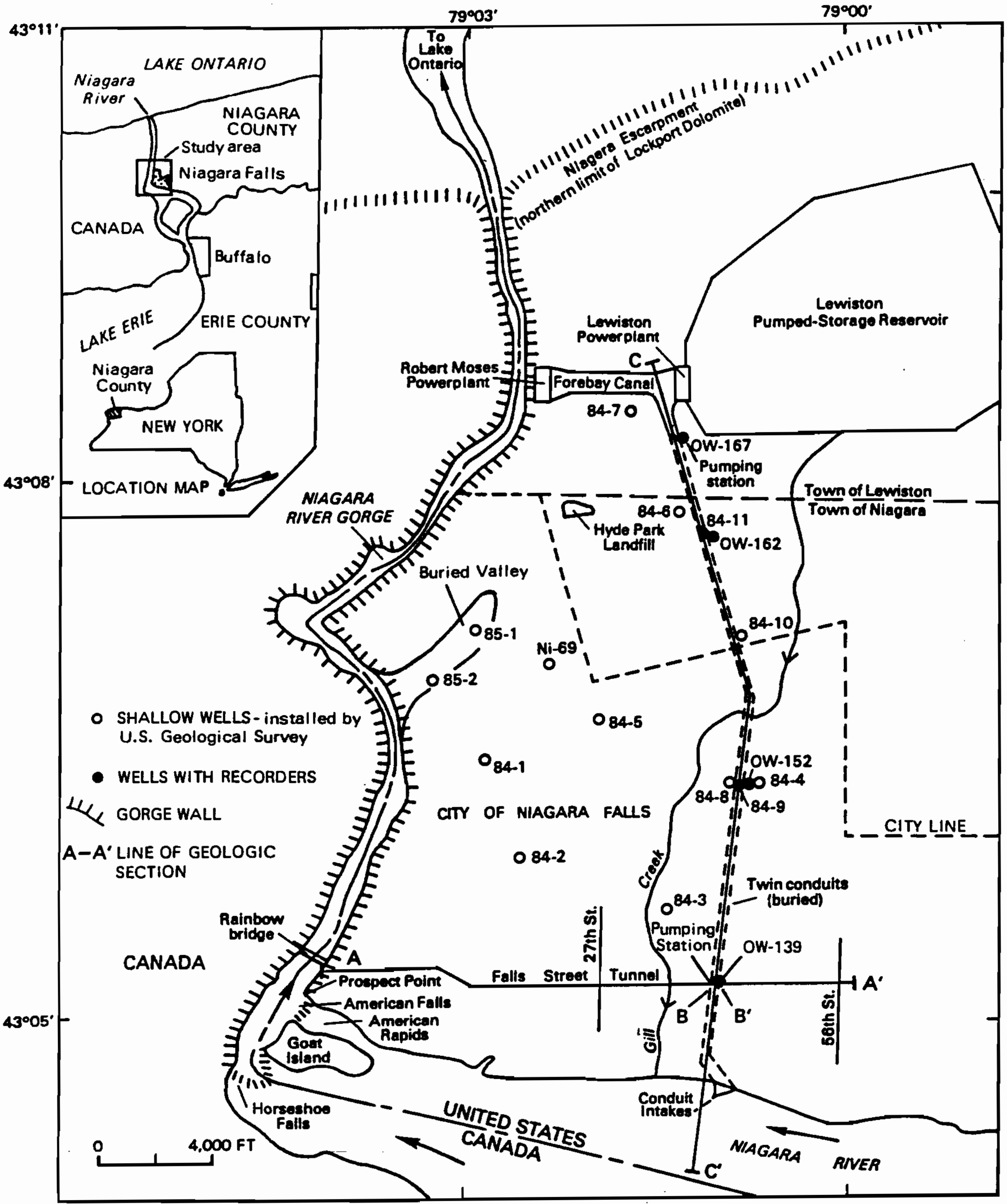
GLACIAL DEPOSITS ISOPACH CONTOUR MAP:
OLIN FACILITY AND SURROUNDING AREA

Job No.: 4E02704	Drawing No.	Date: 6-20-94
Drawn by: FRG	Checked by: KRM	FIGURE 4-3
Scale: 0 200 FEET		



Base from U.S. Geological Survey
Lewiston, 1965, and Niagara Falls, 1965, 1:24,000

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

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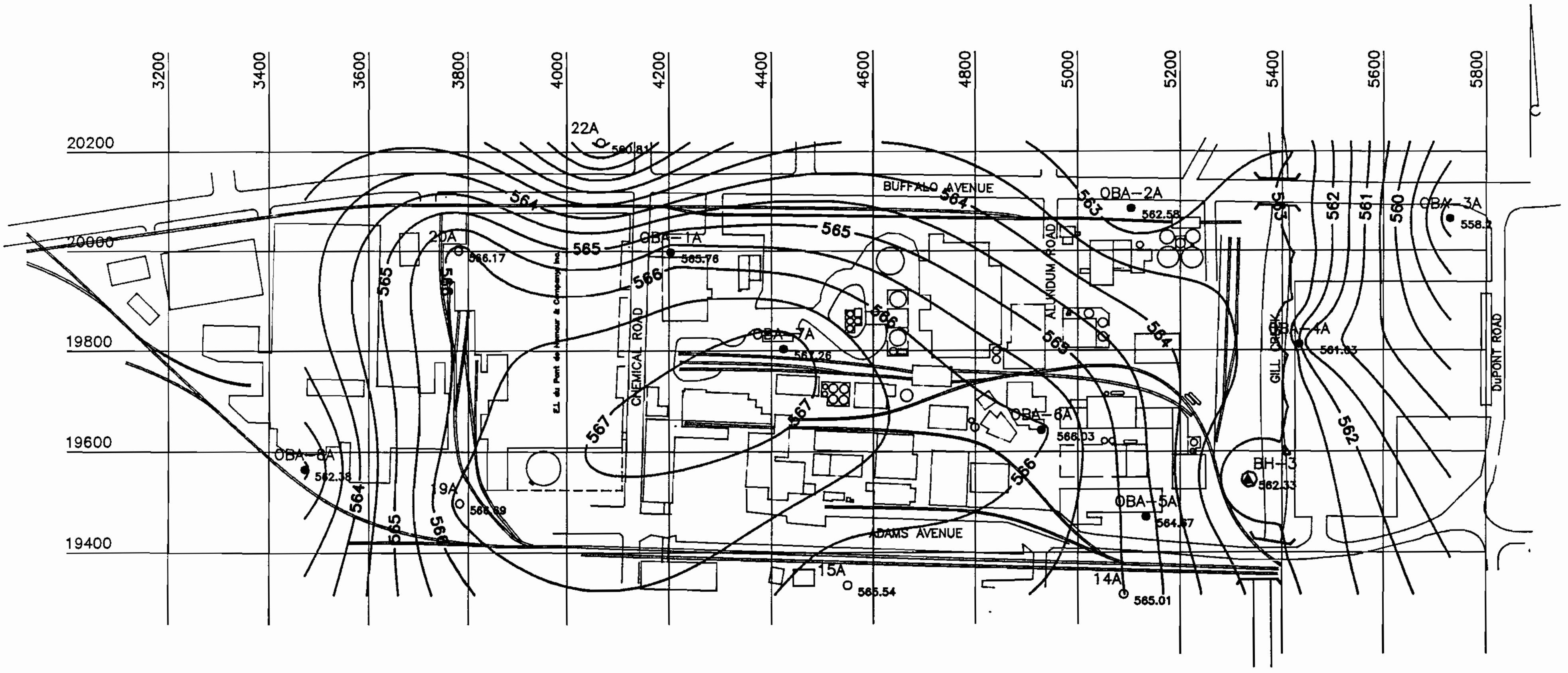
REGIONAL INFLUENCES ON
GROUNDWATER FLOW
NIAGARA FALLS, NEW YORK

Job No.: 88C2346–12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4–4
Scale:		



STATIC WATER LEVEL AT GILL CREEK: 563.00

DATE OF MEASUREMENT: 10/25/90

OLIN CHEMICALS NIAGARA PLANT
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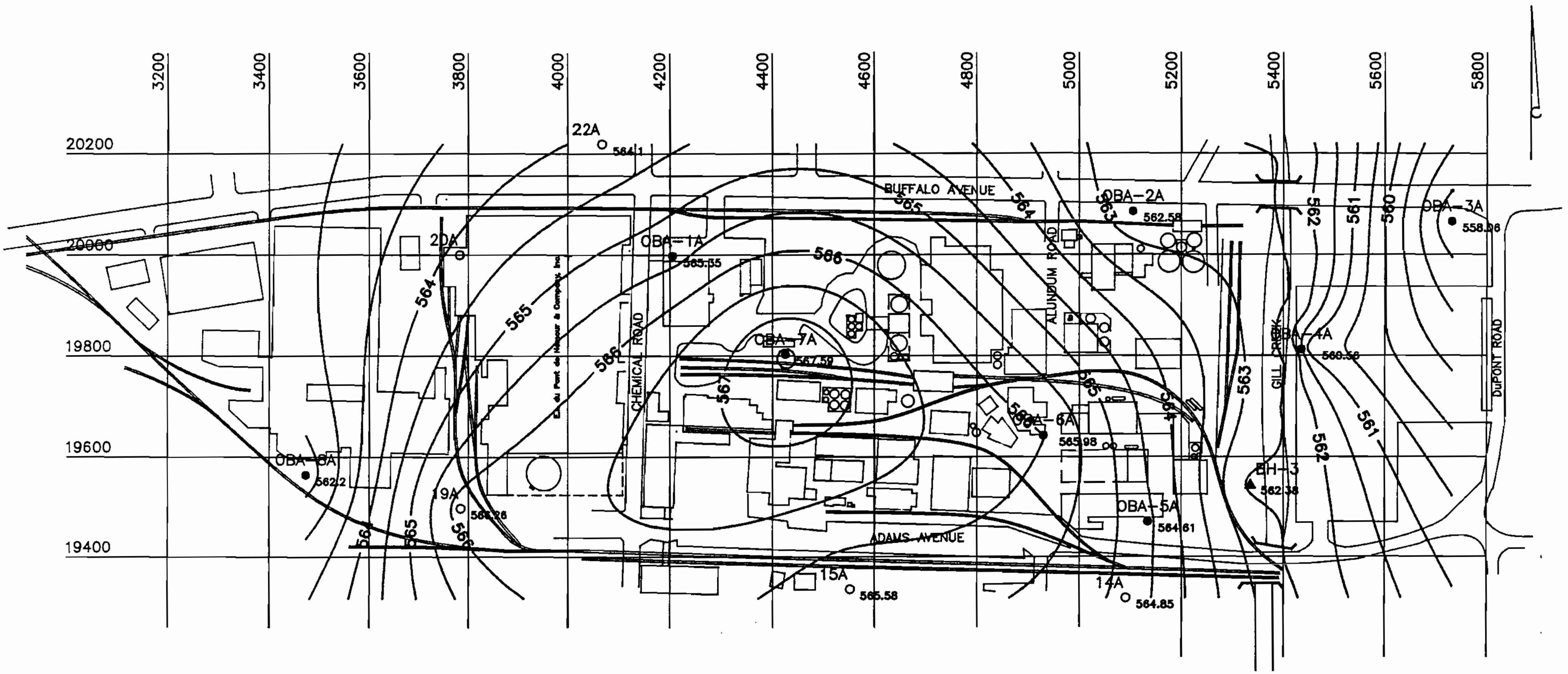
POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
OCTOBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-5
Scale: 0 200 Feet		



STATIC WATER LEVEL AT GILL CREEK: 562.44

DATE OF MEASUREMENT: 11/27/90

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
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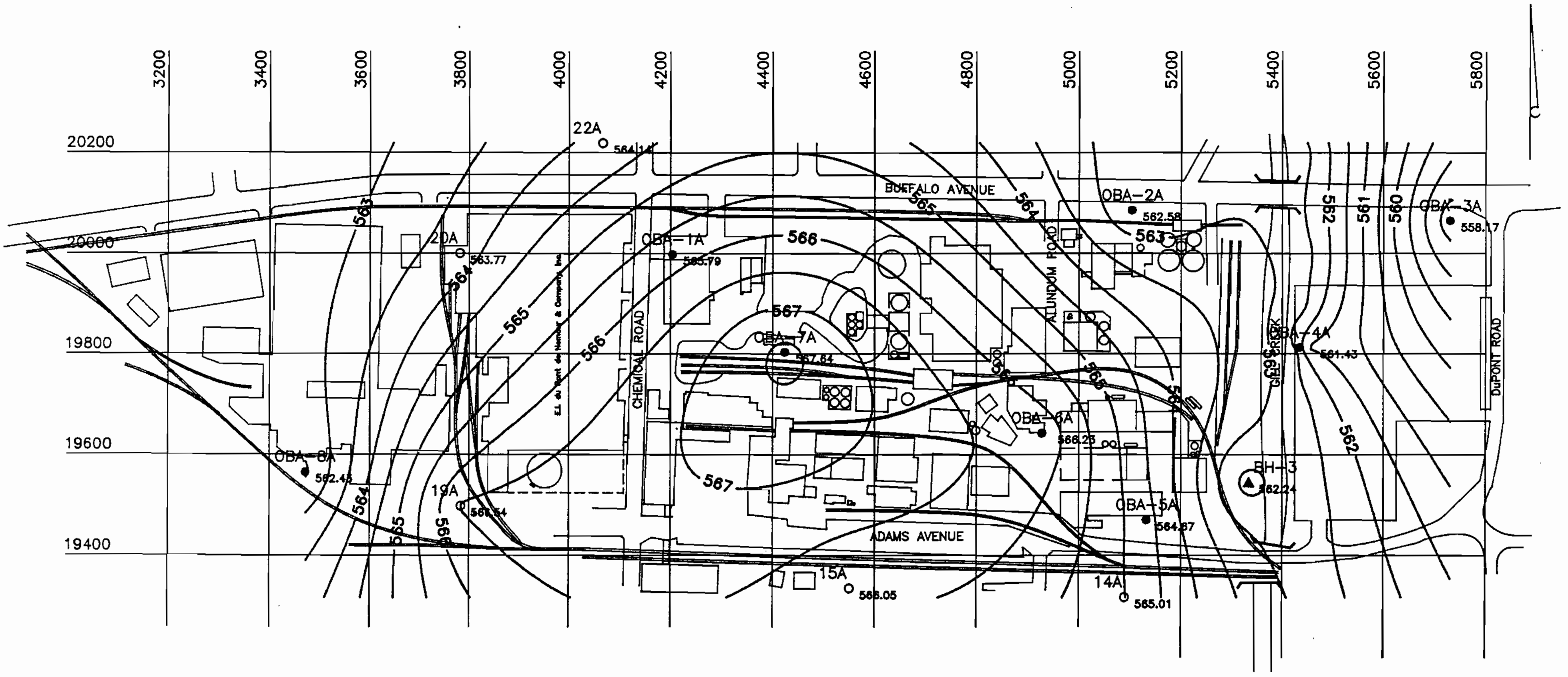
POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
NOVEMBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-6
Scale: 0 200 Feet		



STATIC WATER LEVEL AT GILL CREEK: 562.85

DATE OF MEASUREMENT: 12/7/90

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

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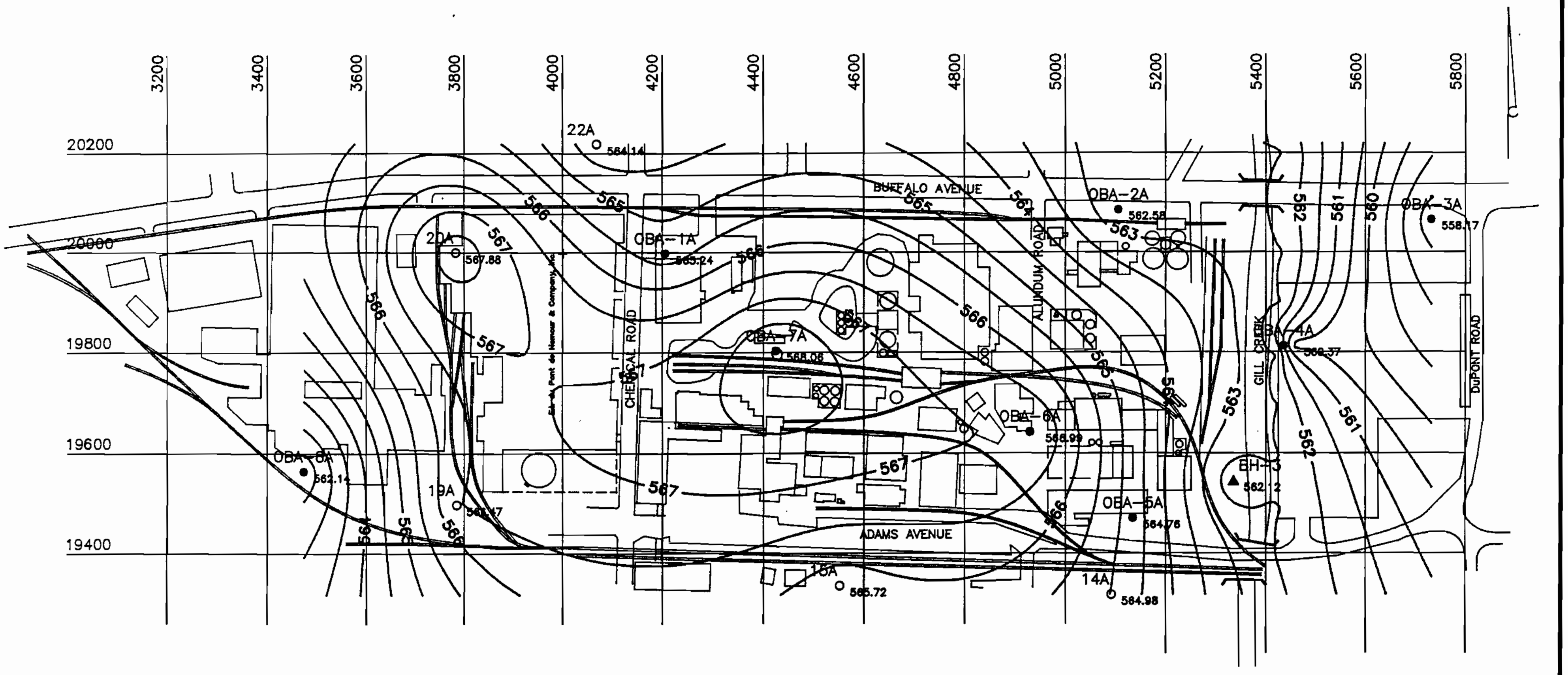
POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
DECEMBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-7
Scale: 0 200 Feet		



STATIC WATER LEVEL AT GILL CREEK: 562.53

DATE OF MEASUREMENT: 1/16/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
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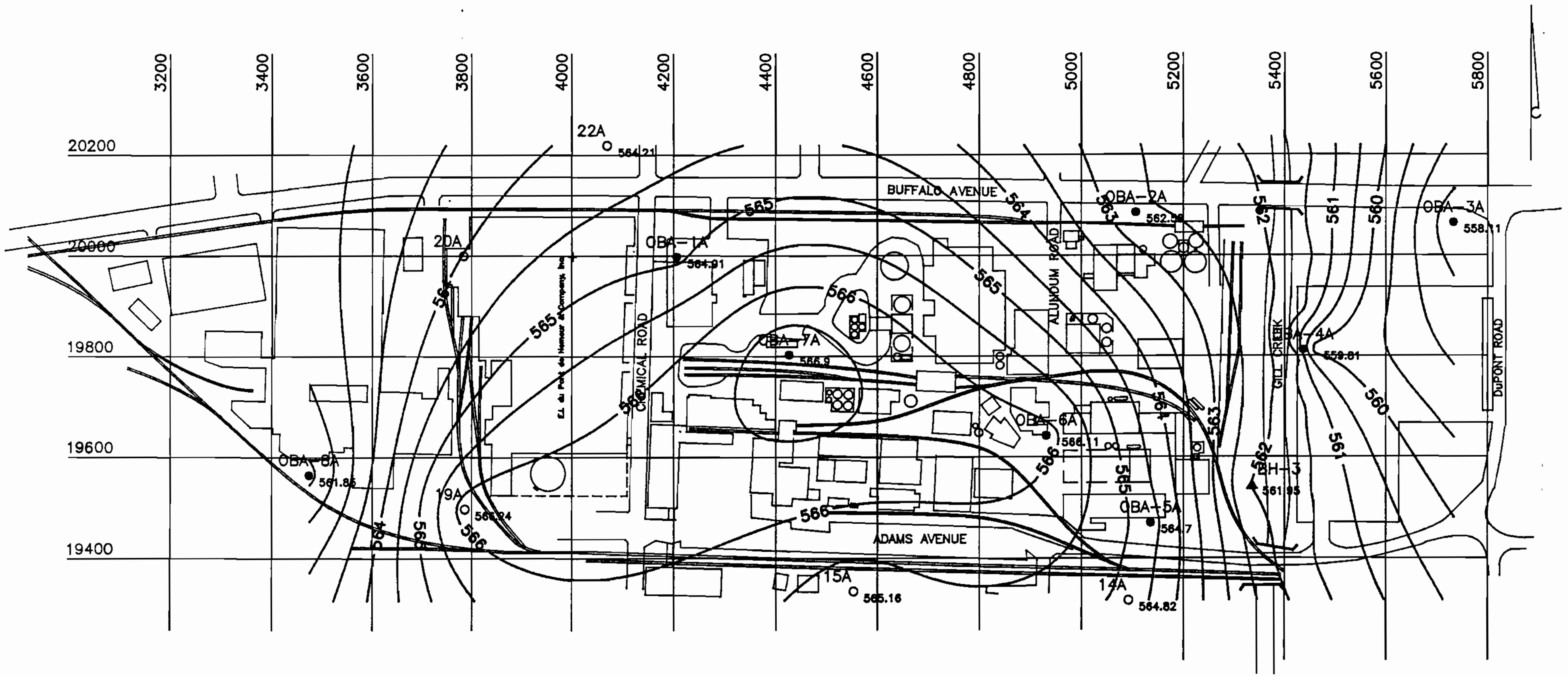
POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
JANUARY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-8
Scale: 0 200 Feet		



STATIC WATER LEVEL AT GILL CREEK: 561.73

DATE OF MEASUREMENT: 2/6/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

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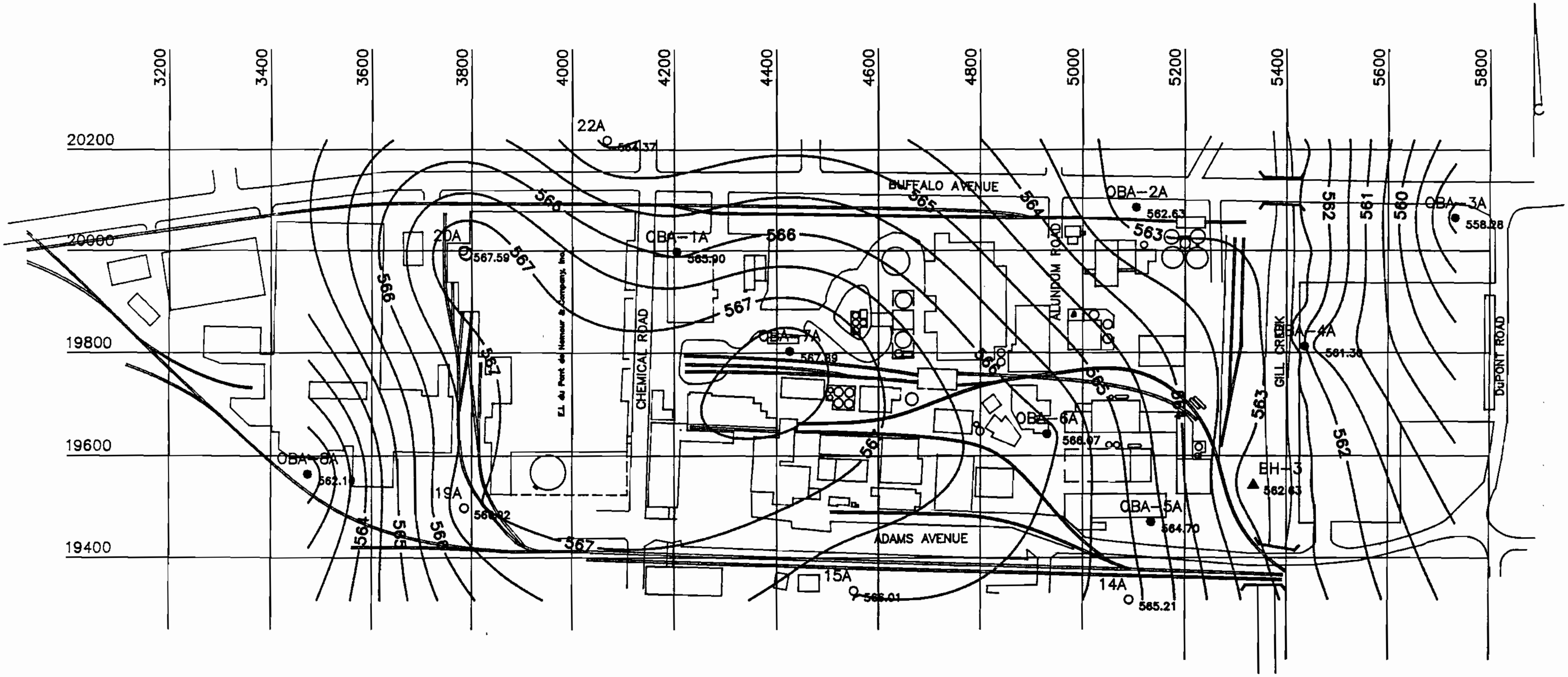
POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
FEBRUARY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-9
Scale: 0 200 Feet		



STATIC WATER LEVEL AT GILL CREEK: 562.68

DATE OF MEASUREMENT: 3/25/91

OLIN CHEMICALS NIAGARA PLANT
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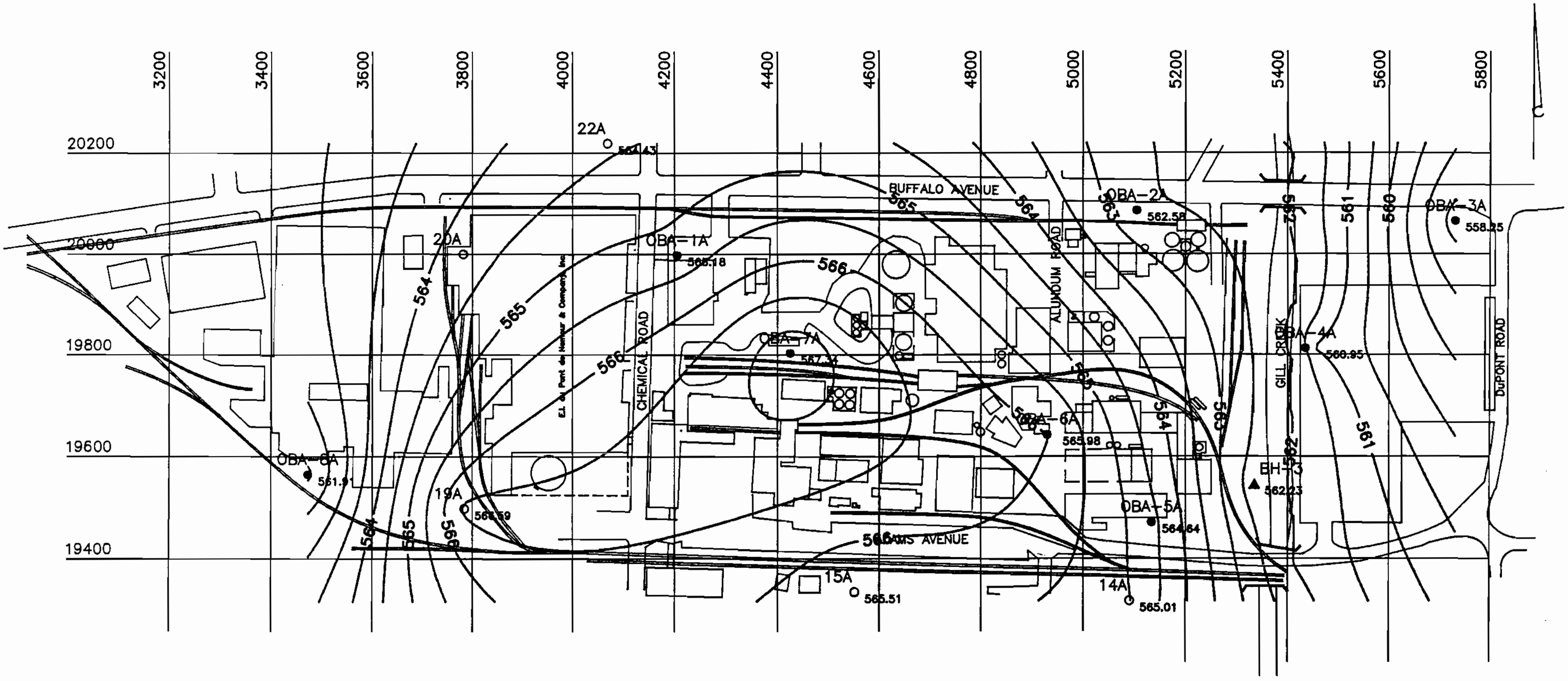
POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
MARCH, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-10
Scale: 0 200 Feet		



STATIC WATER LEVEL AT GILL CREEK: 561.99

DATE OF MEASUREMENT: 4/8/91

OLIN CHEMICALS NIAGARA PLANT
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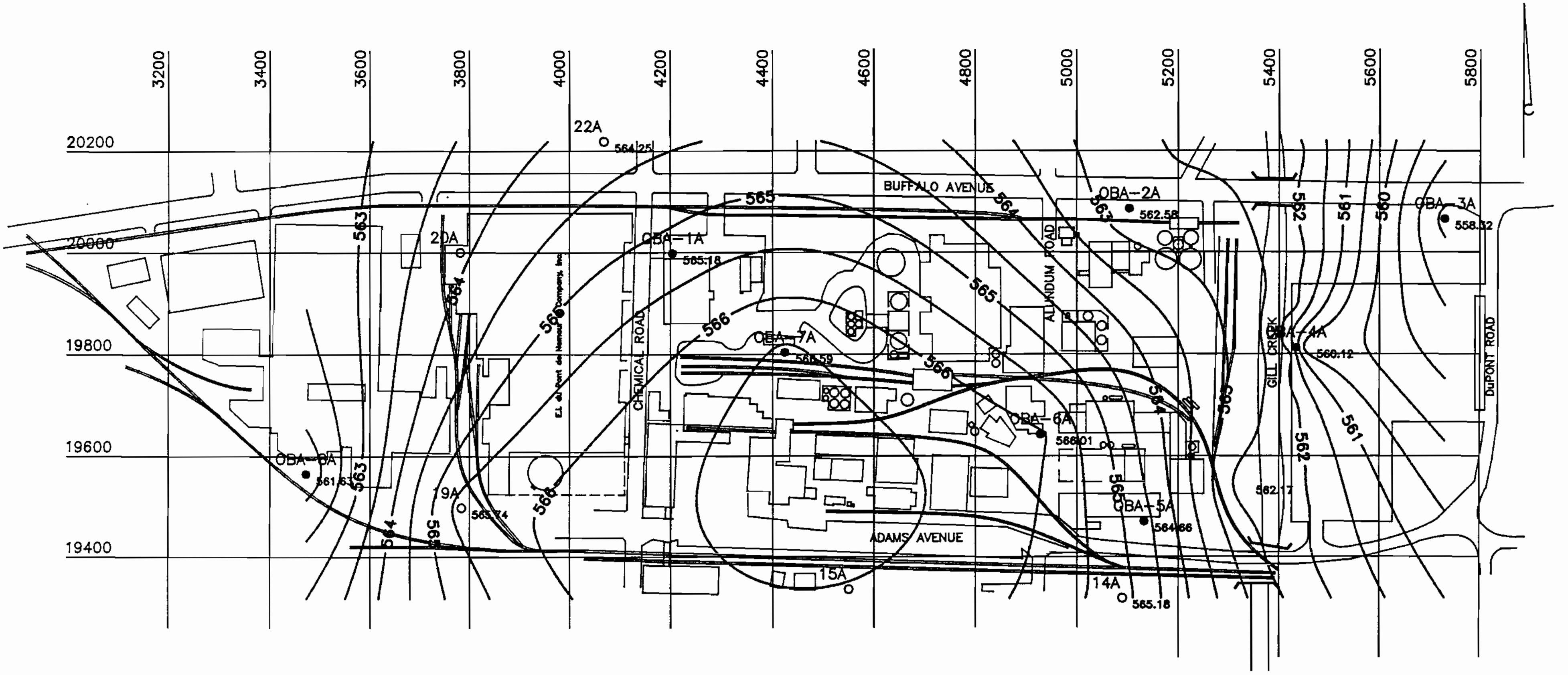
POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
APRIL, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-11
Scale: 0 200 Feet		



STATIC WATER LEVEL AT GILL CREEK: 562.24

DATE OF MEASUREMENT: 5/13/91

OLIN CHEMICALS NIAGARA PLANT
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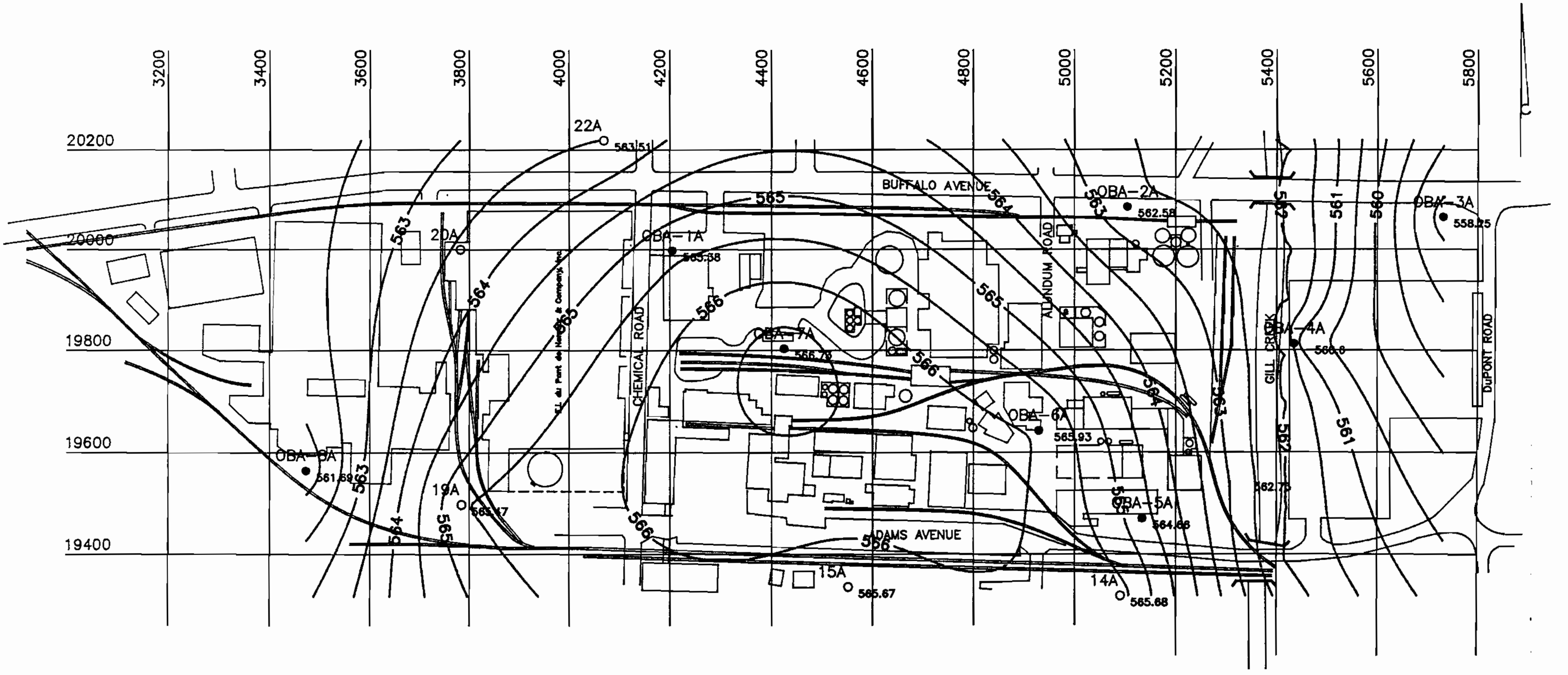
POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
MAY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-12
Scale: 0 — 200 Feet		



STATIC WATER LEVEL AT GILL CREEK: 562.01

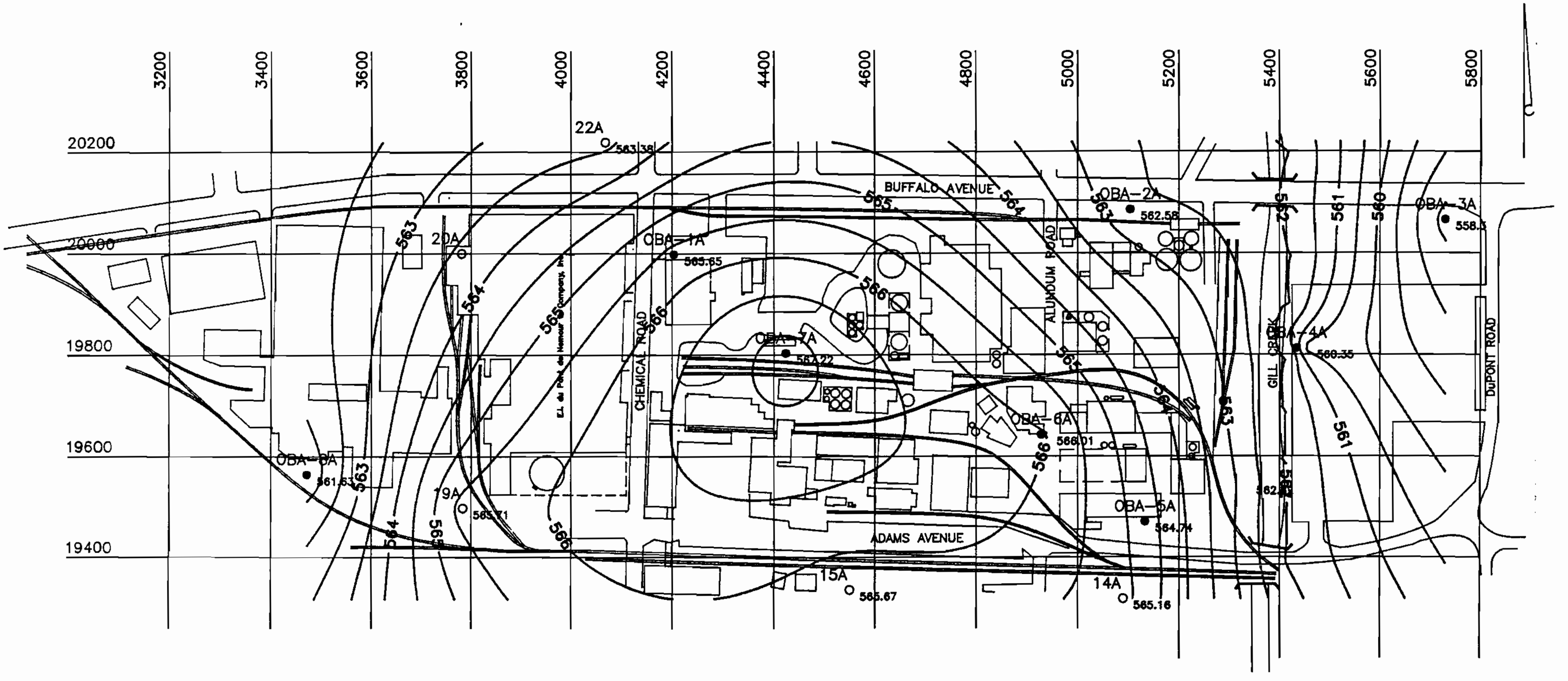
DATE OF MEASUREMENT: 6/6/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
JUNE, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-13
Scale: 0 — 200 Feet		



STATIC WATER LEVEL AT GILL CREEK: 562.00

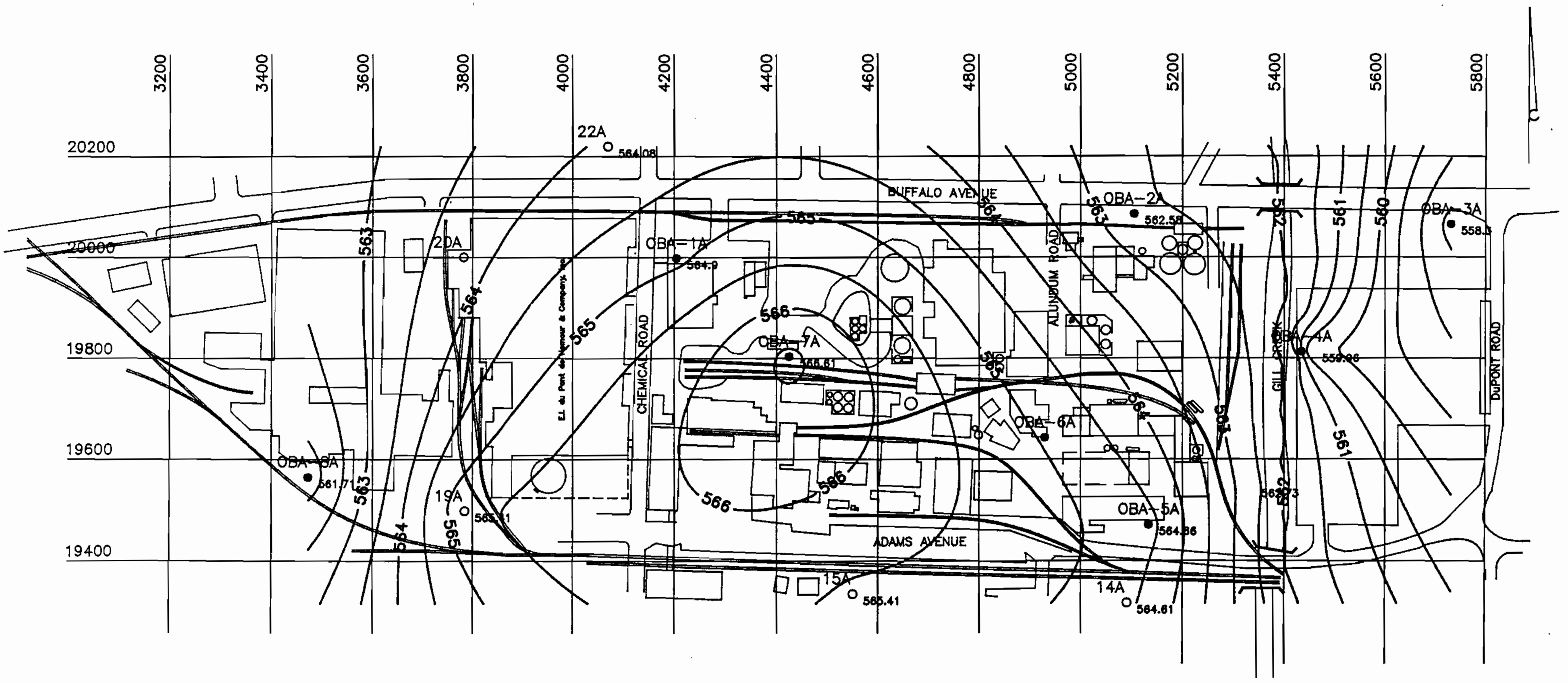
DATE OF MEASUREMENT: 7/9/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
JULY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-14
Scale: 0 — 200 Feet		



STATIC WATER LEVEL AT GILL CREEK: 561.91

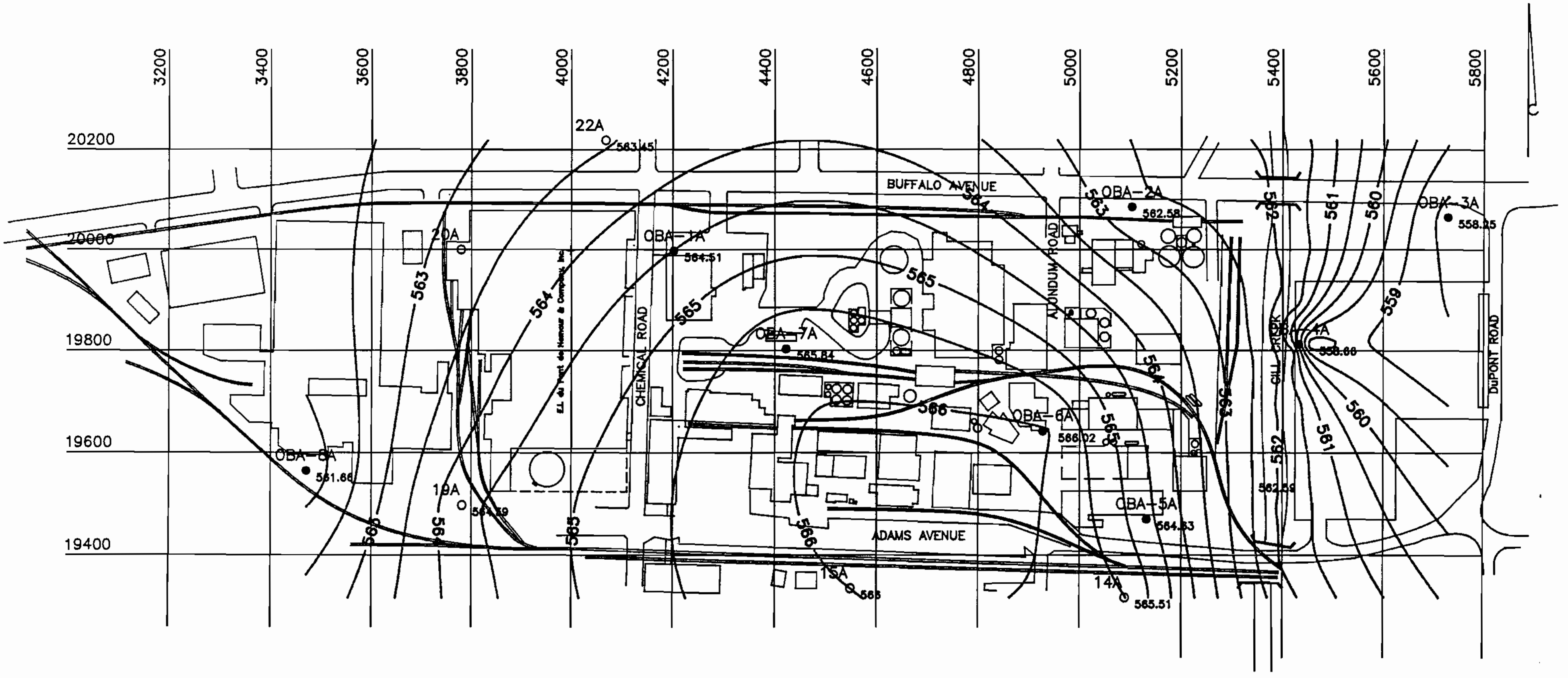
DATE OF MEASUREMENT: 8/19/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
AUGUST, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-15
Scale: 0 200 Feet		



STATIC WATER LEVEL AT GILL CREEK: 561.83

DATE OF MEASUREMENT: 9/4/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

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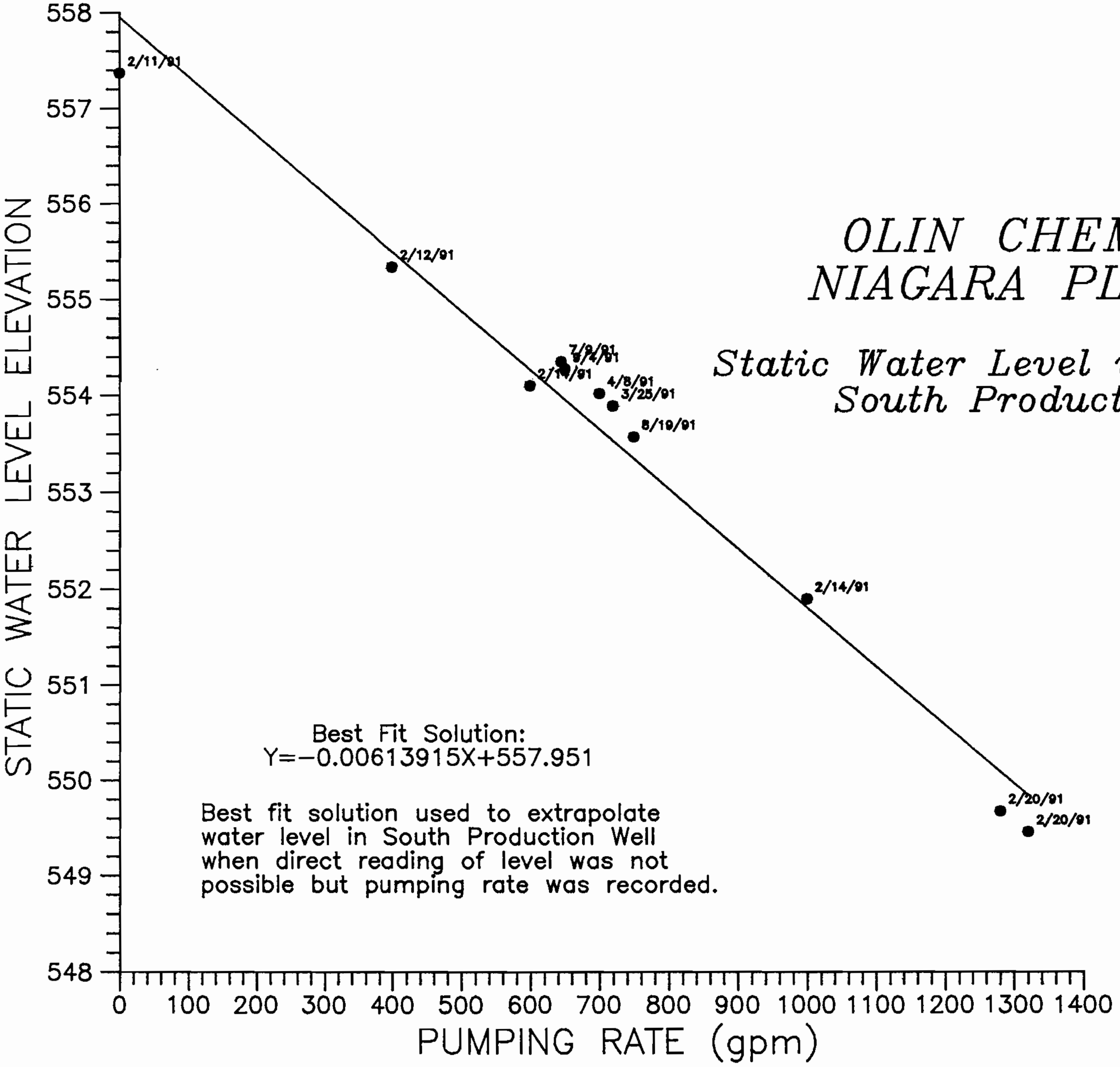
POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
SEPTEMBER, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-16
Scale: 0 200 Feet		

OLIN CHEMICALS
NIAGARA PLANT RFI

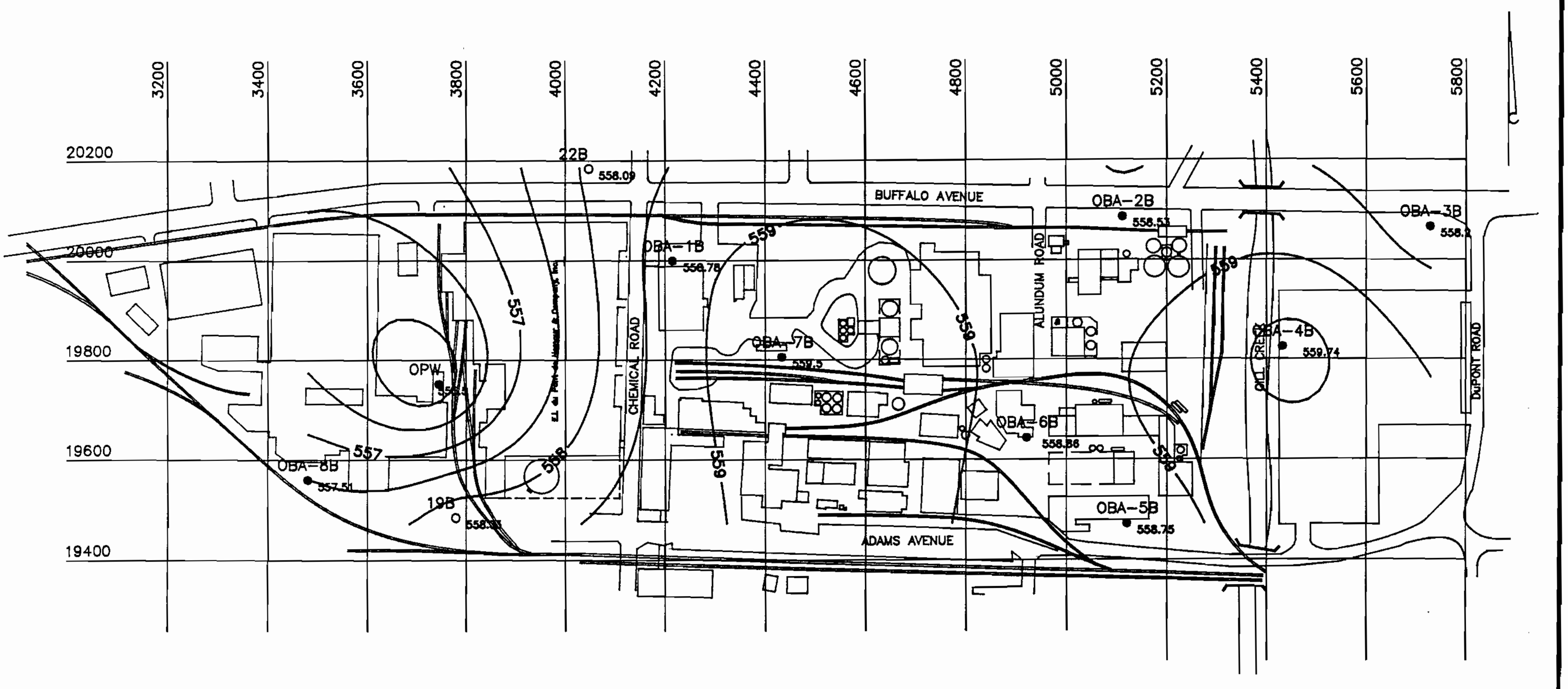
Static Water Level vs Pumping Rate
South Production Well



Best Fit Solution:
Y=-0.00613915X+557.951

Best fit solution used to extrapolate
water level in South Production Well
when direct reading of level was not
possible but pumping rate was recorded.

Figure 4-17



PRODUCTION WELL PUMPING RATE: 370 gpm

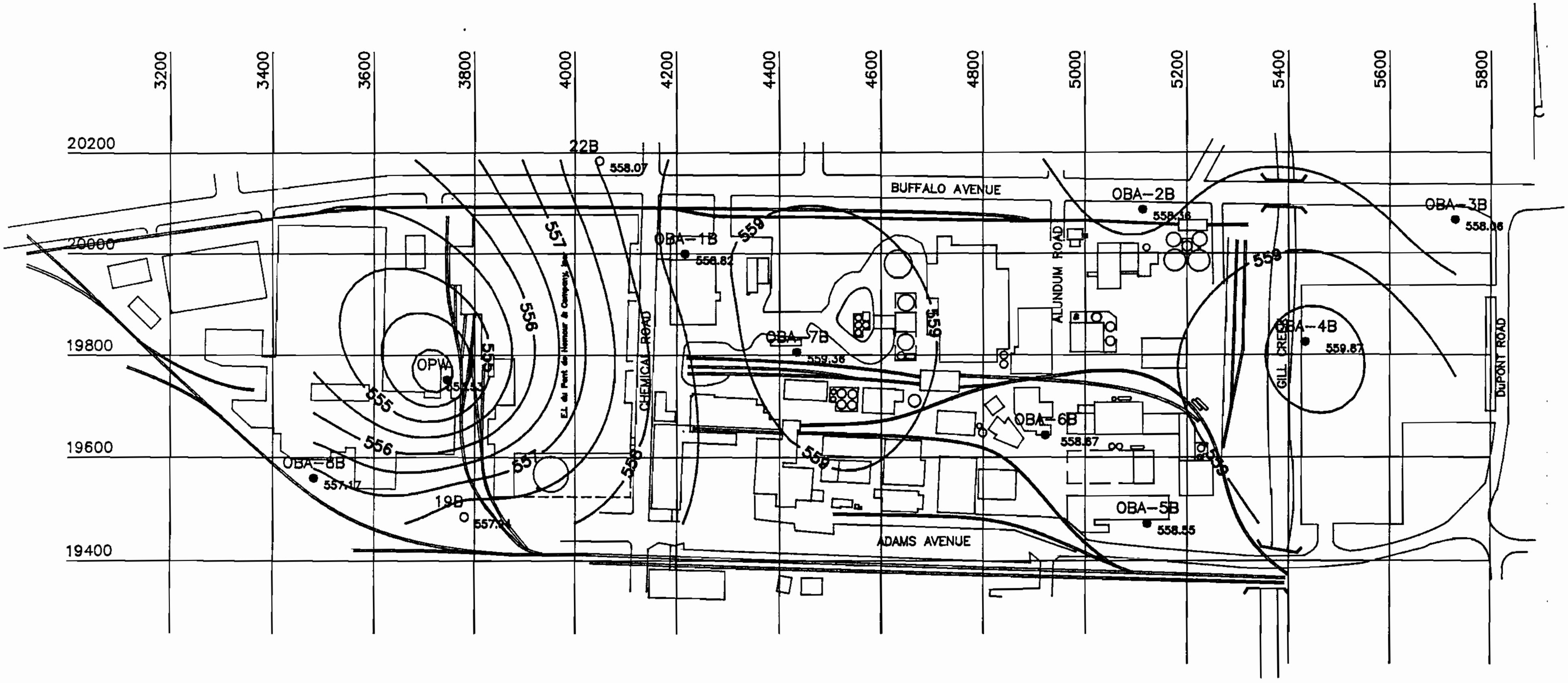
DATE OF MEASUREMENT: 10/25/90

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
OCTOBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-18
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 720 gpm

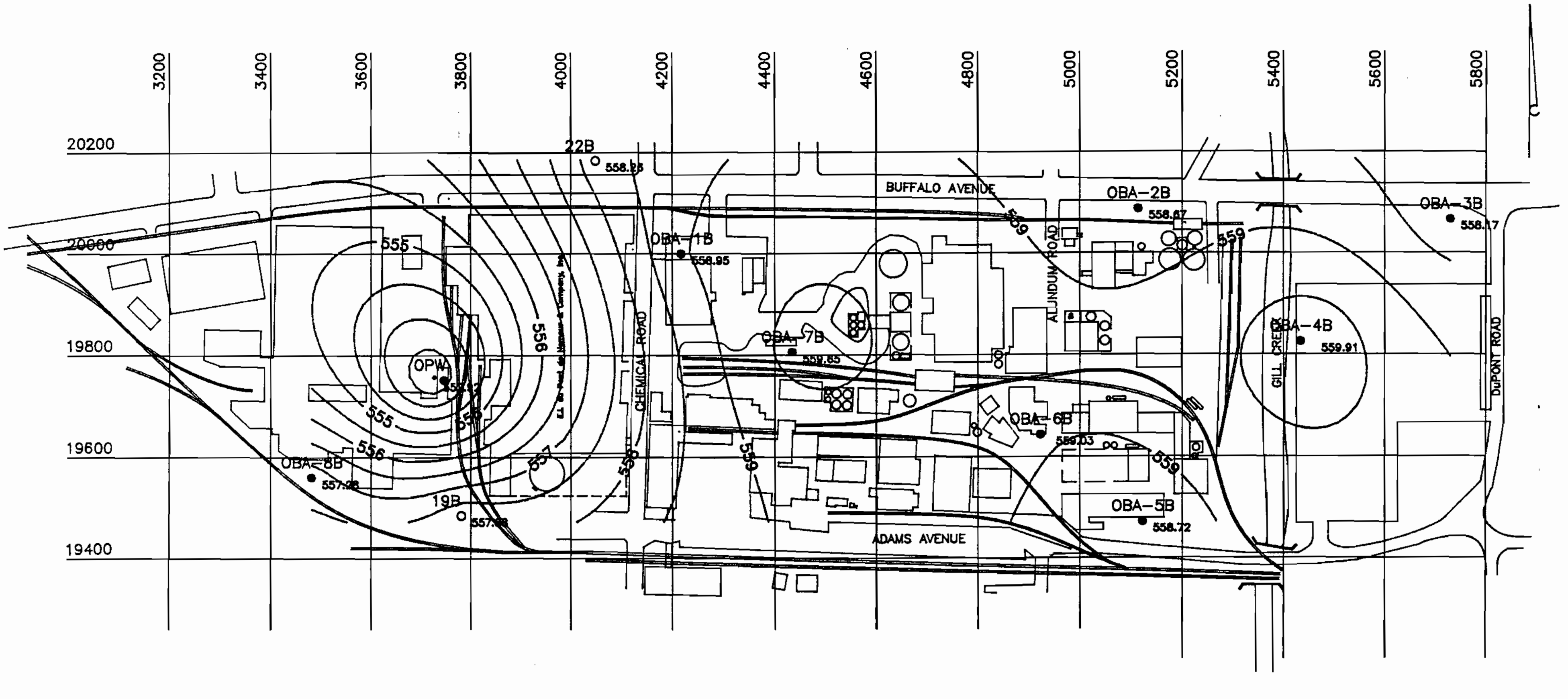
DATE OF MEASUREMENT: 11/27/90

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
NOVEMBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-19
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 820 gpm

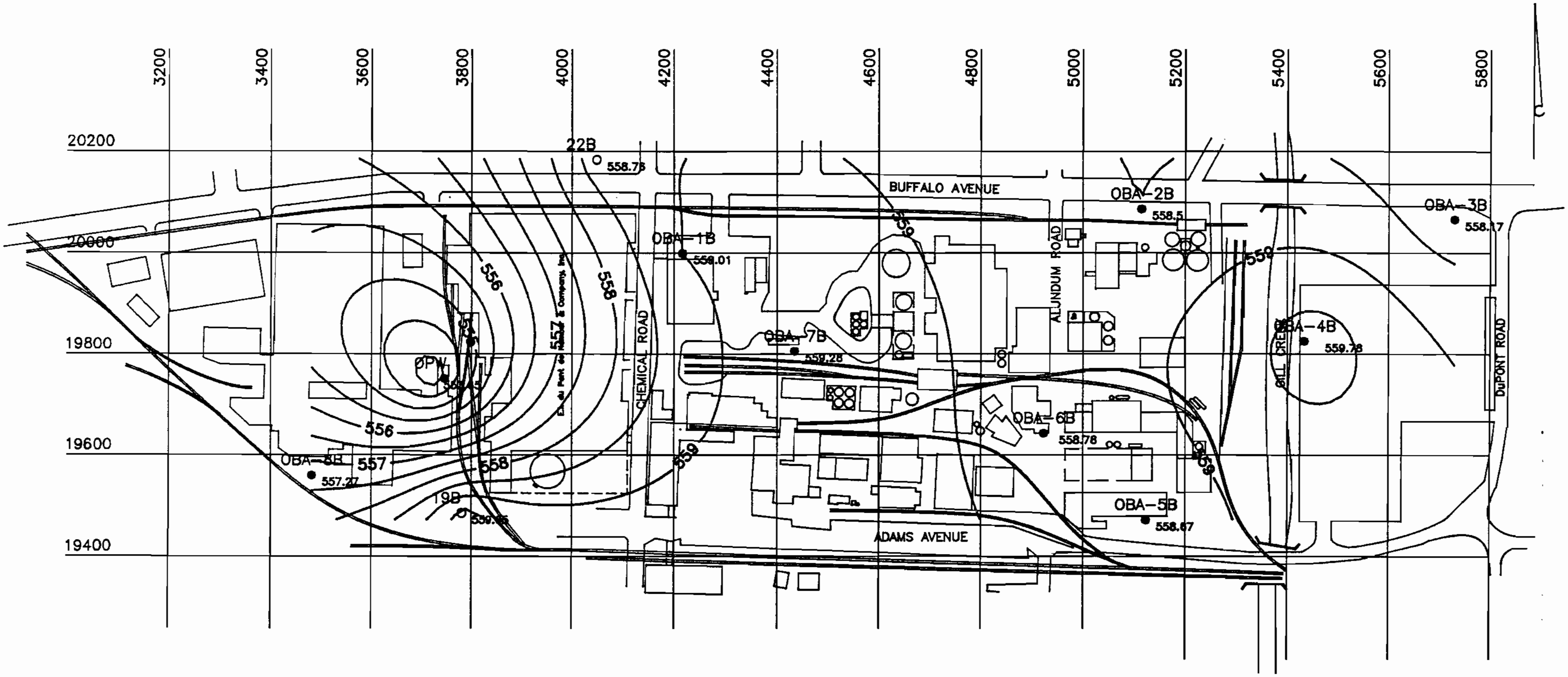
DATE OF MEASUREMENT: 12/7/90

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
DECEMBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-20
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 700 gpm

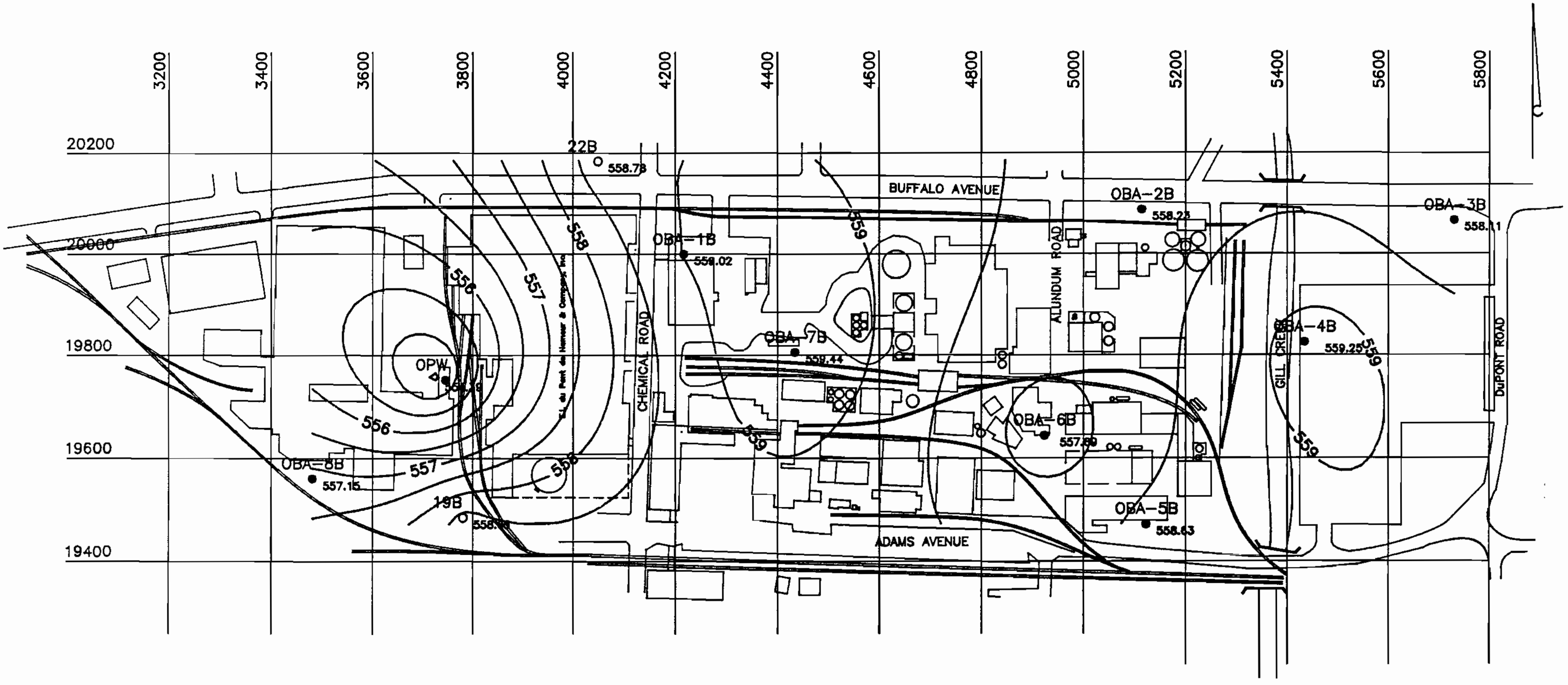
DATE OF MEASUREMENT: 1/16/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
JANUARY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-21
Scale: 0 — 200 Feet		



PRODUCTION WELL PUMPING RATE: 580 gpm

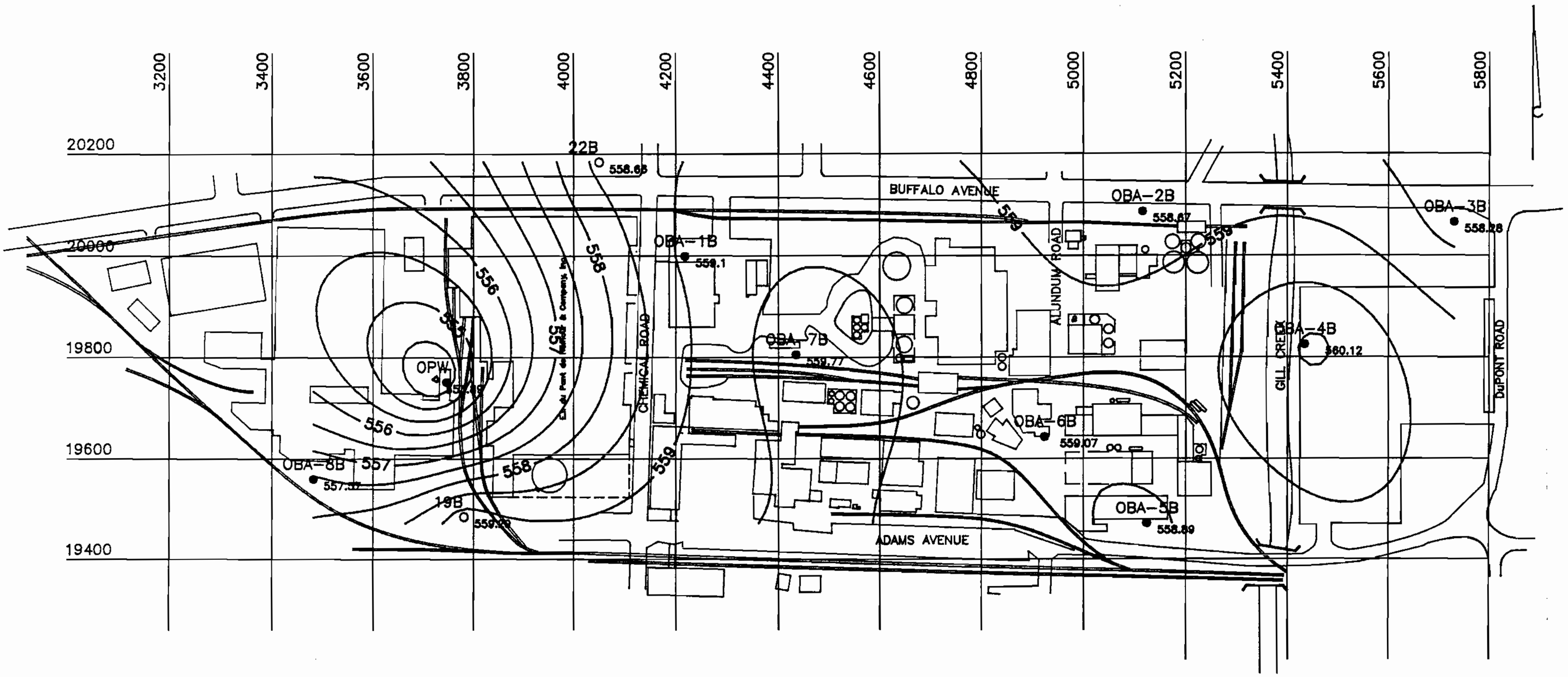
DATE OF MEASUREMENT: 2/6/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
FEBRUARY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-22
Scale: 0 — 200 Feet		



PRODUCTION WELL PUMPING RATE: 720 gpm

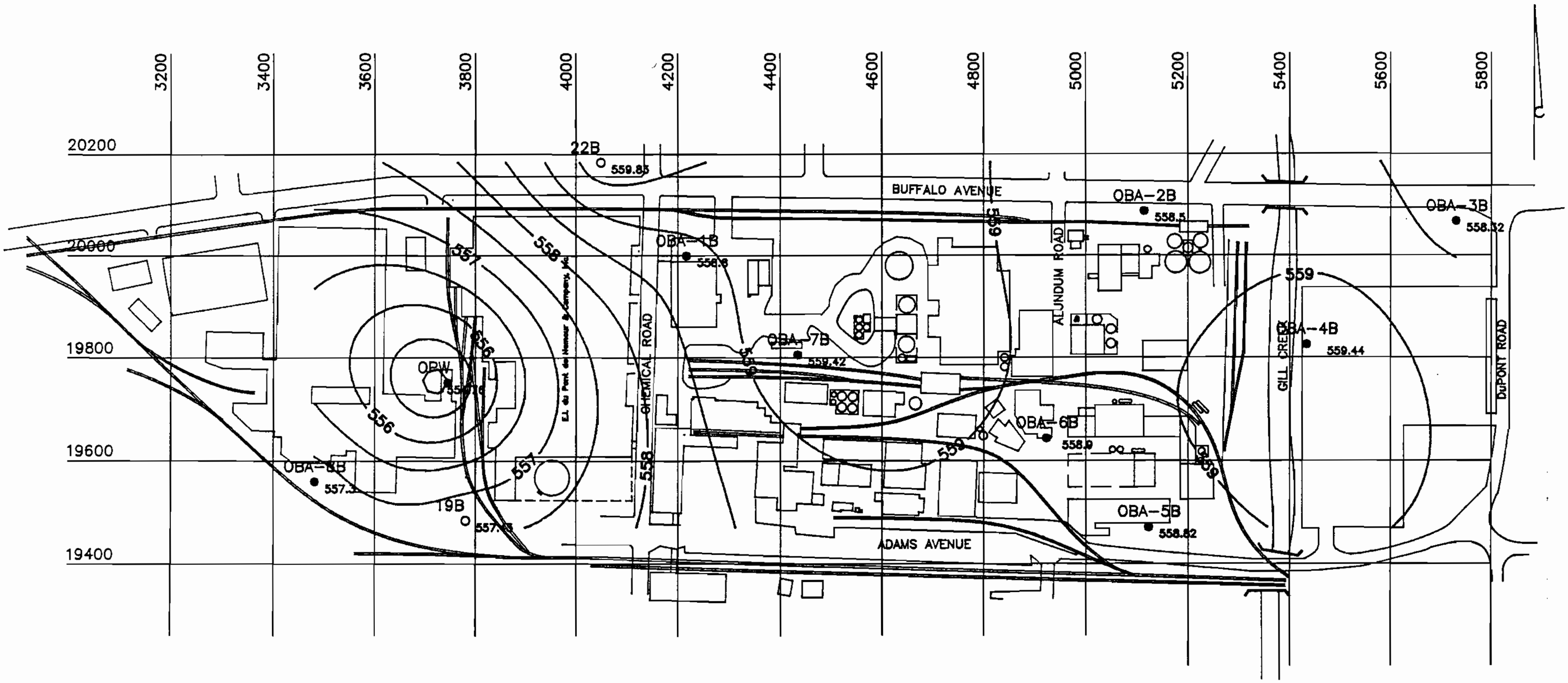
DATE OF MEASUREMENT: 3/25/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
MARCH, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-23
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 520 gpm

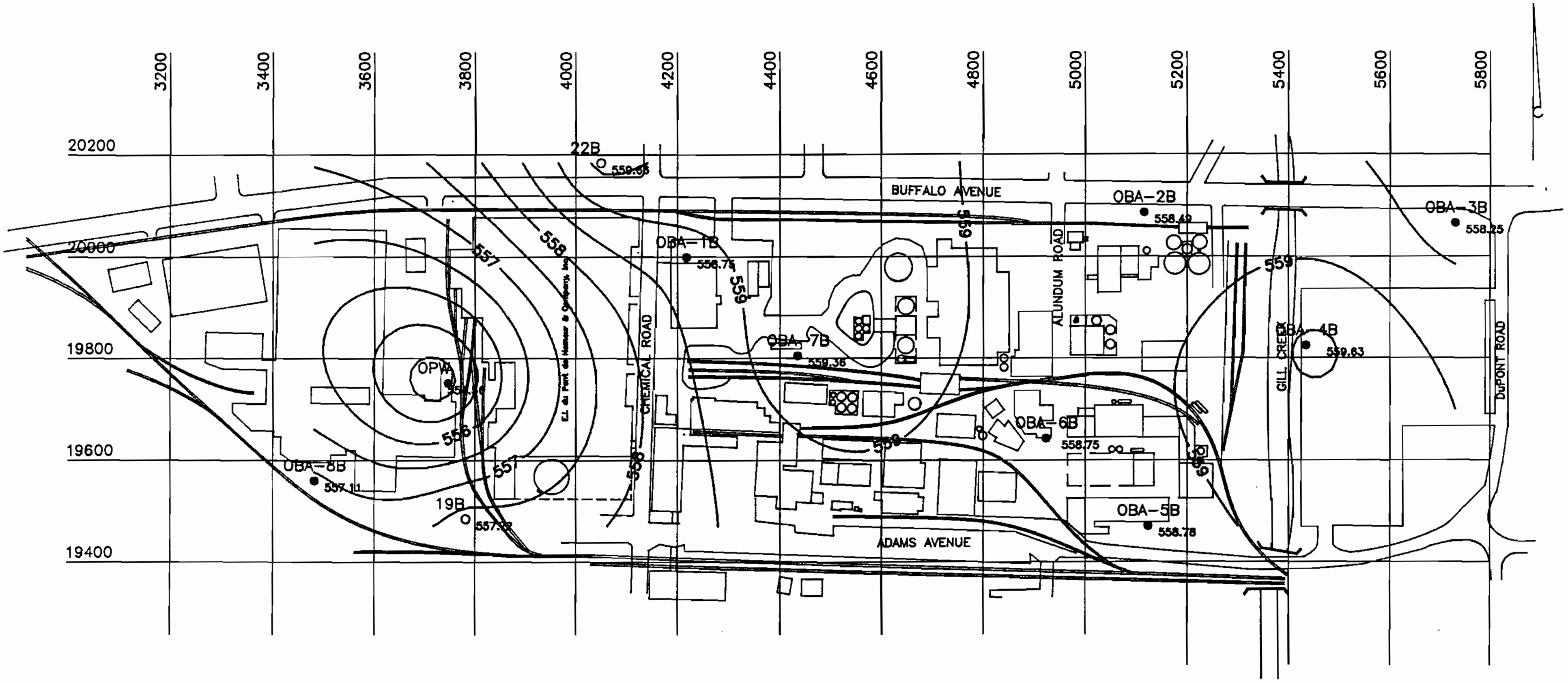
DATE OF MEASUREMENT: 5/13/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
MAY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-25
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 600 gpm (average)

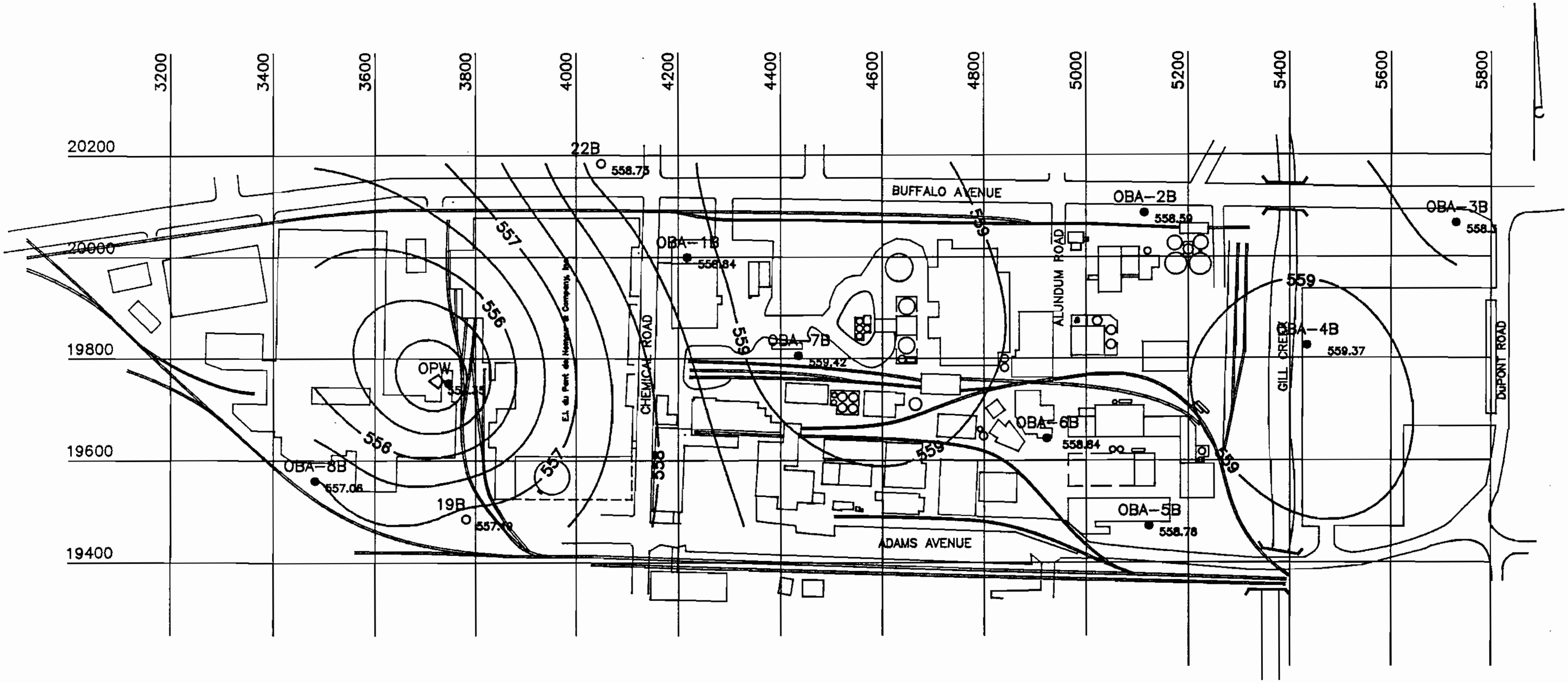
DATE OF MEASUREMENT: 6/6/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
JUNE, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-26
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 645 gpm

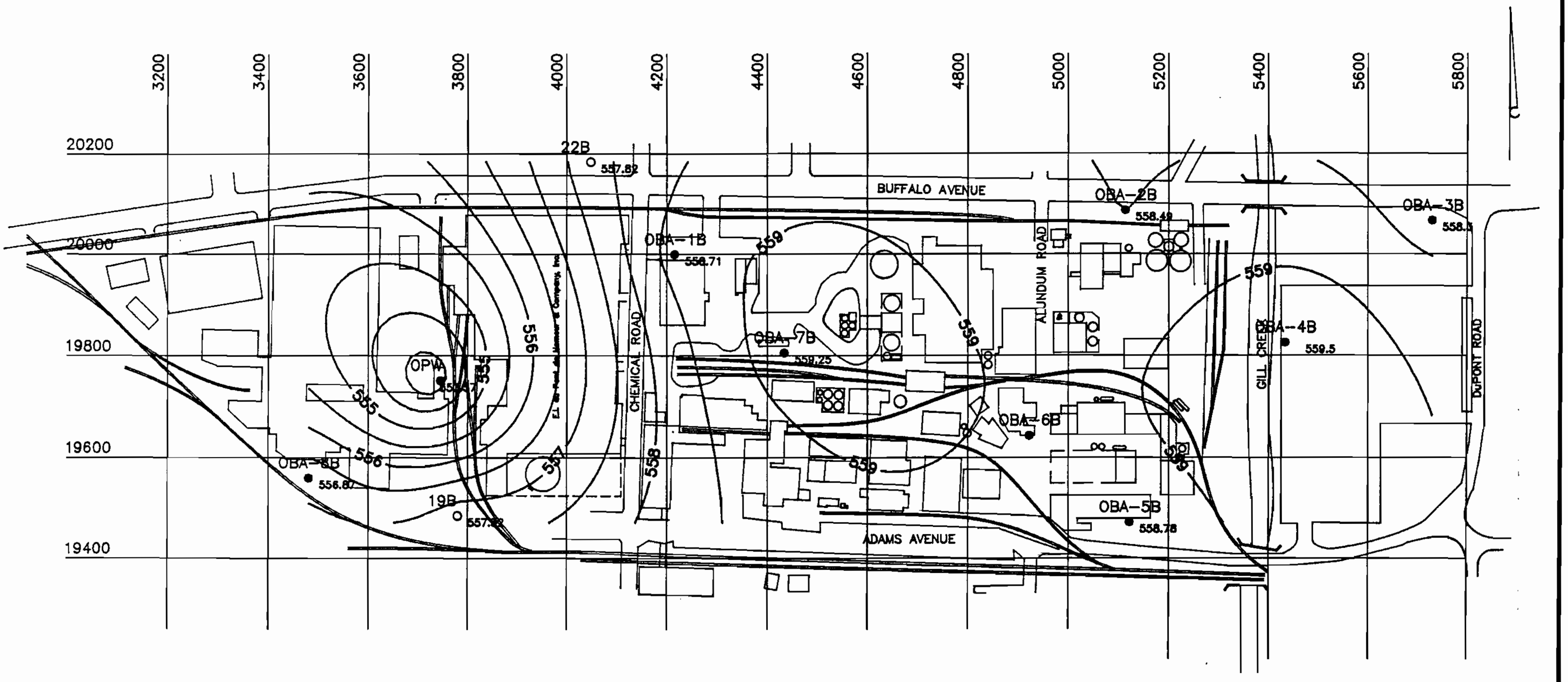
DATE OF MEASUREMENT: 7/9/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
JULY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-27
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 750 gpm

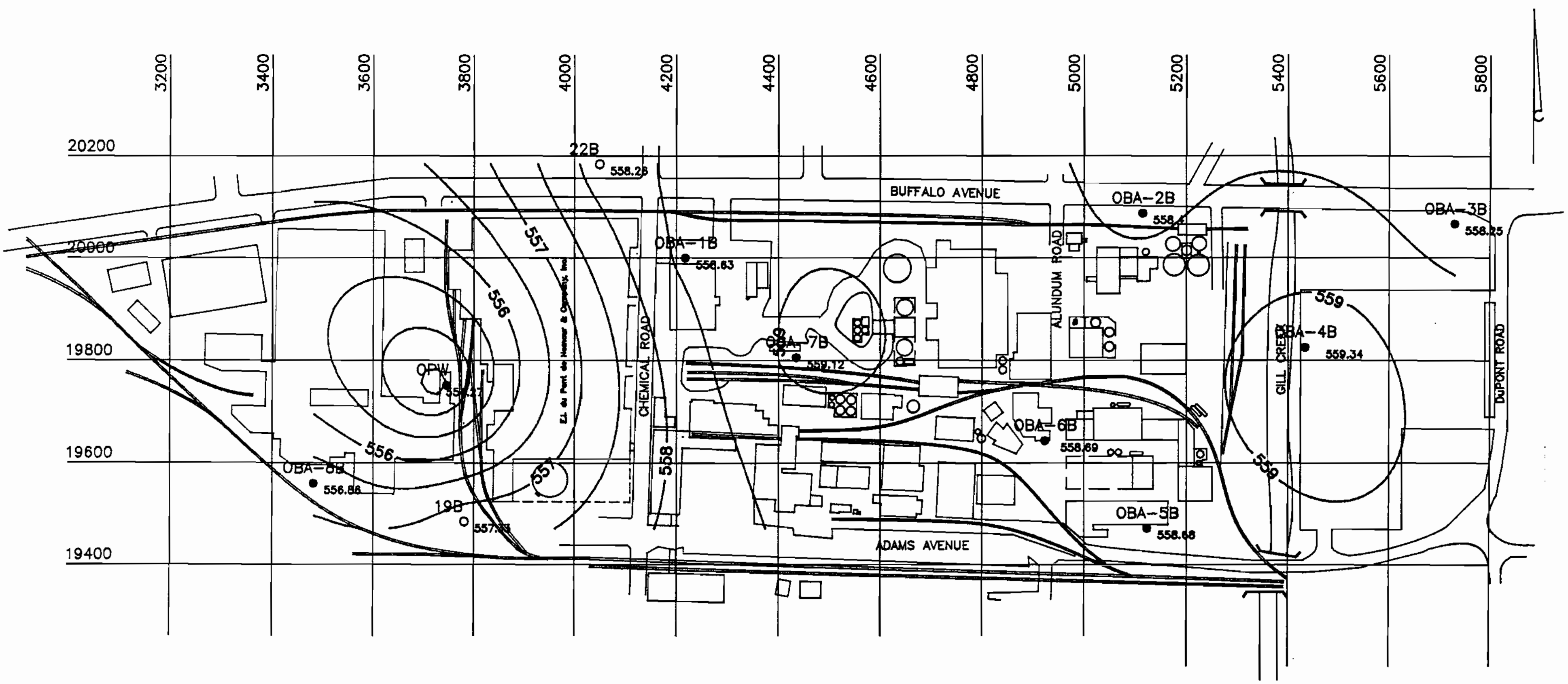
DATE OF MEASUREMENT: 8/19/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
AUGUST, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-28
Scale: 0 — 200 Feet		



PRODUCTION WELL PUMPING RATE: 650 gpm

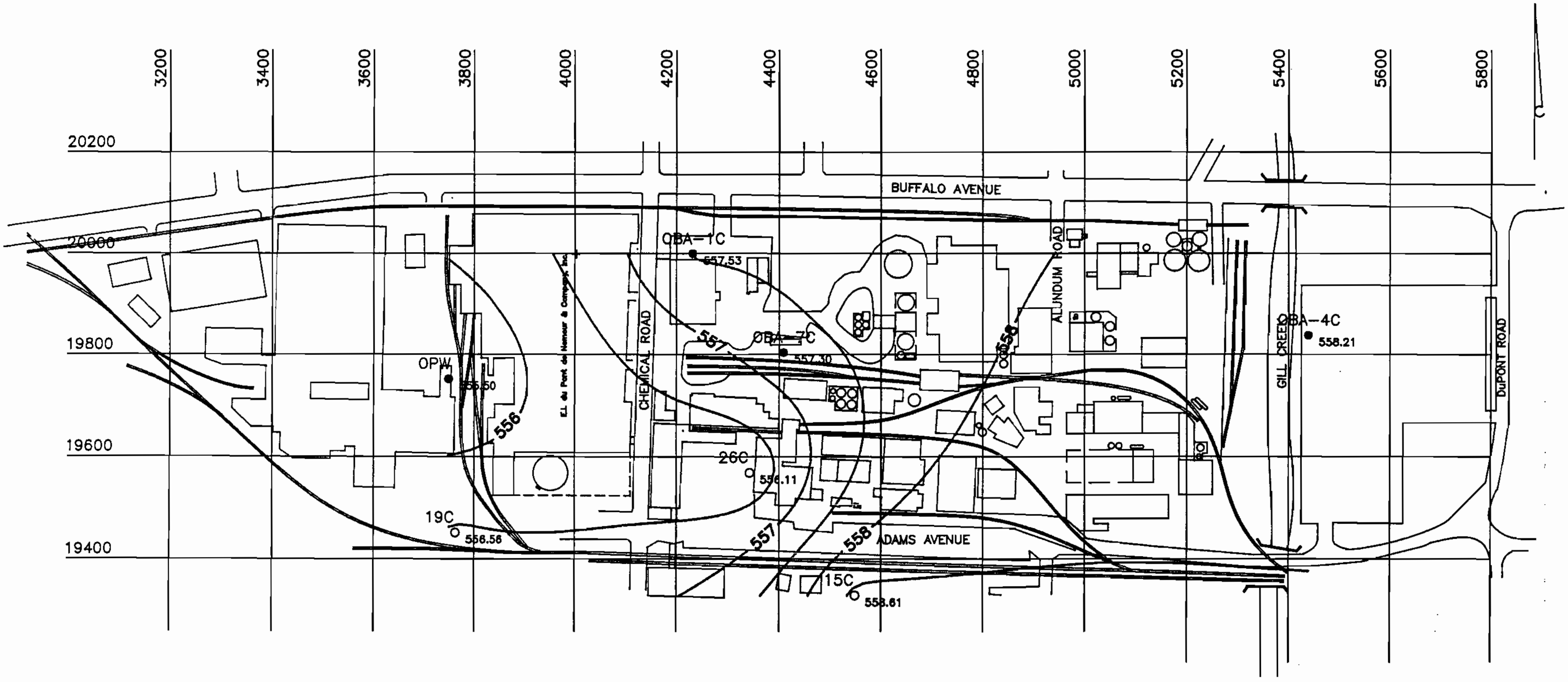
DATE OF MEASUREMENT: 9/4/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
SEPTEMBER, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-29
Scale: 0 — 200 Feet		



PRODUCTION WELL PUMPING RATE: 370 gpm

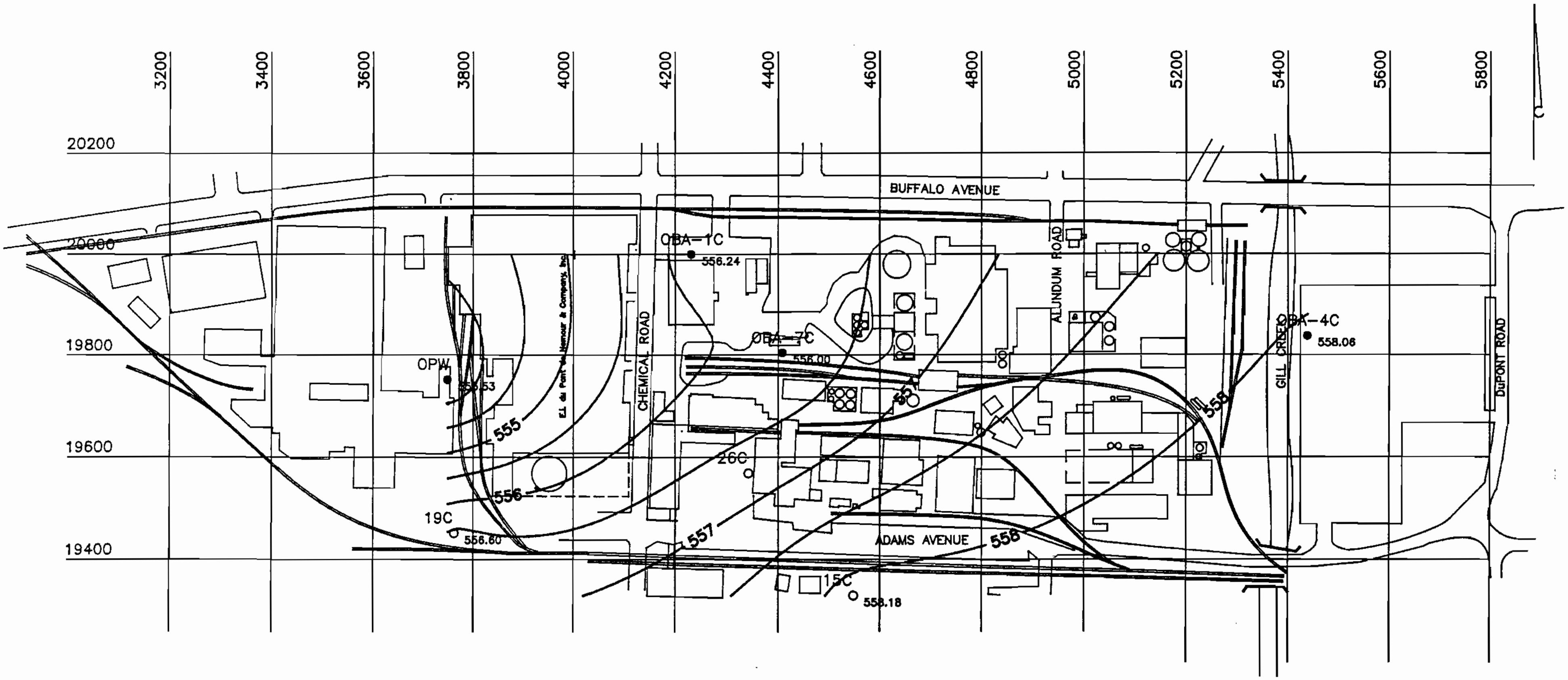
DATE OF MEASUREMENT: 10/25/90

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
OCTOBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-30
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 720 gpm

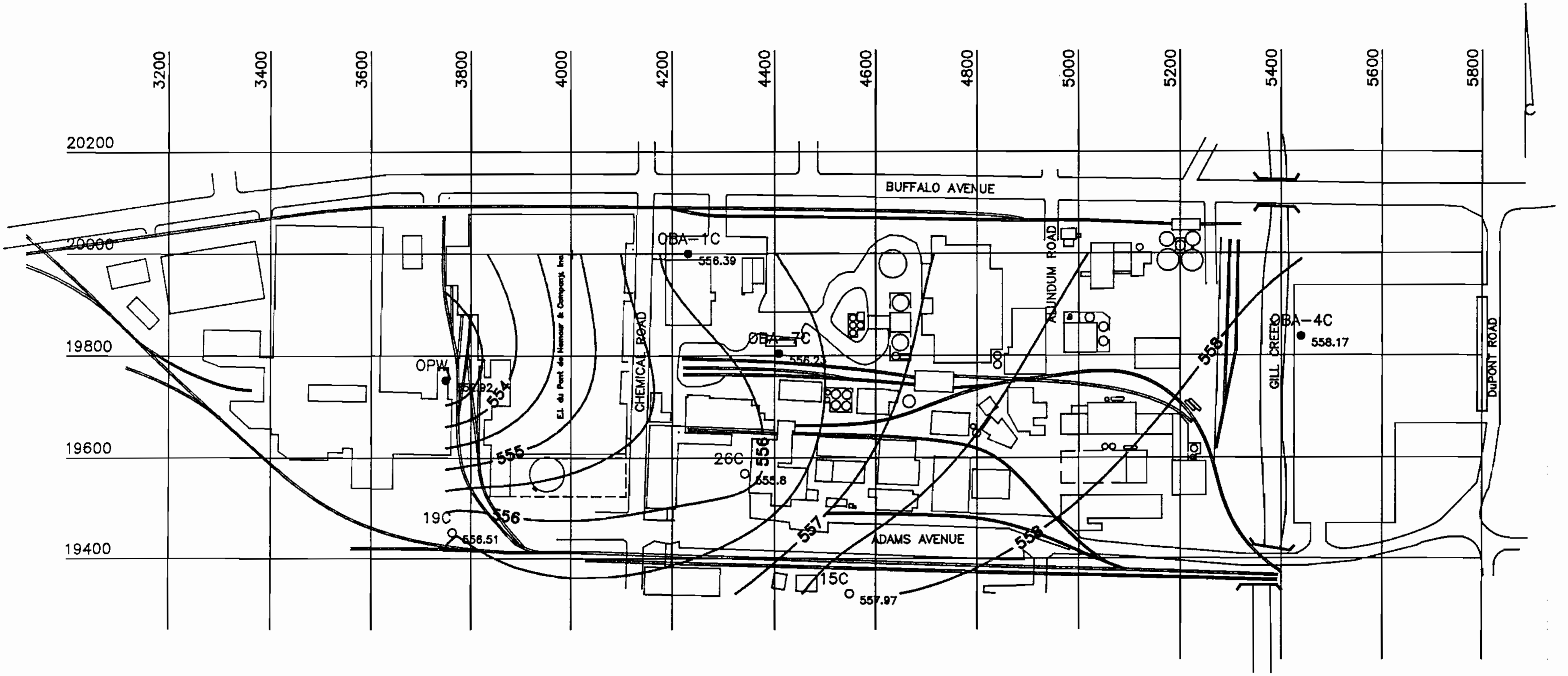
DATE OF MEASUREMENT: 11/27/90

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
NOVEMBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-31
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 820 gpm

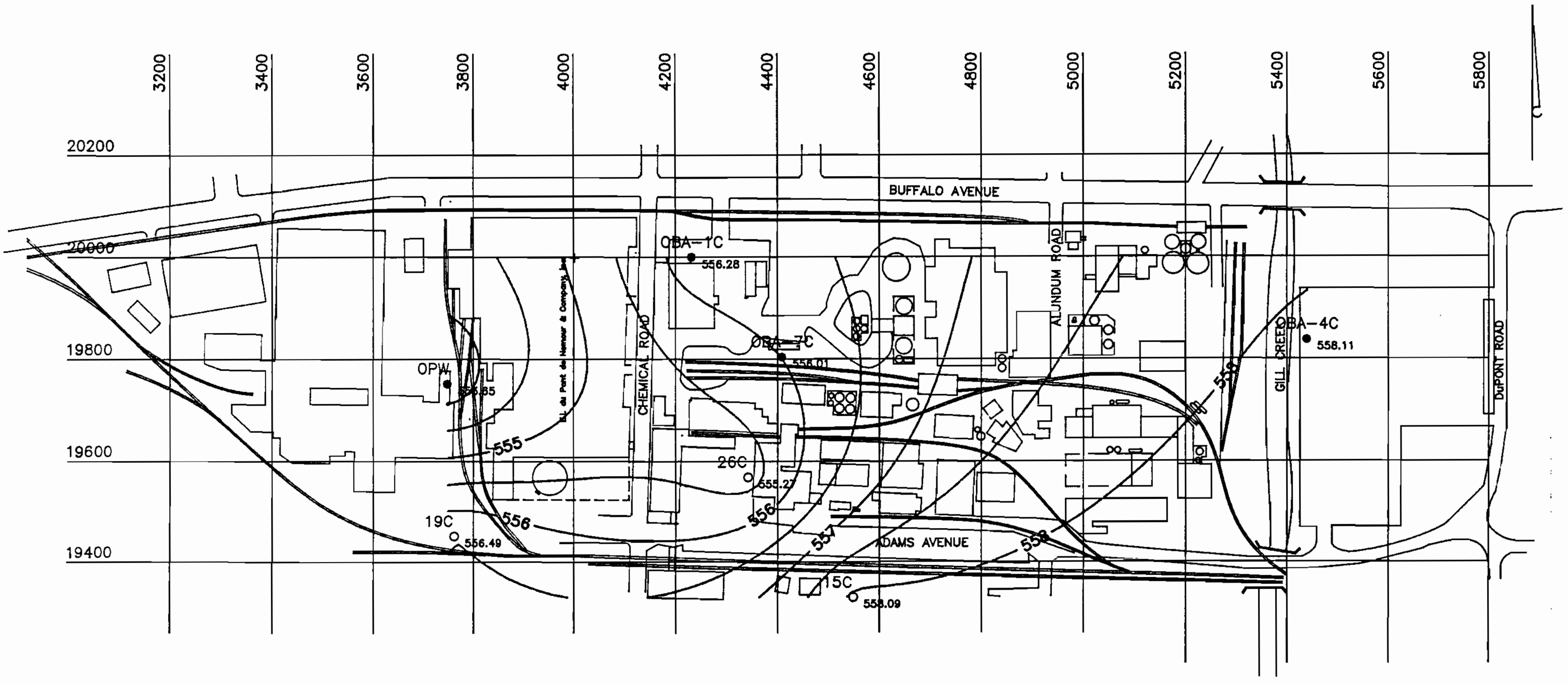
DATE OF MEASUREMENT: 12/7/90

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
DECEMBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-32
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 700 gpm

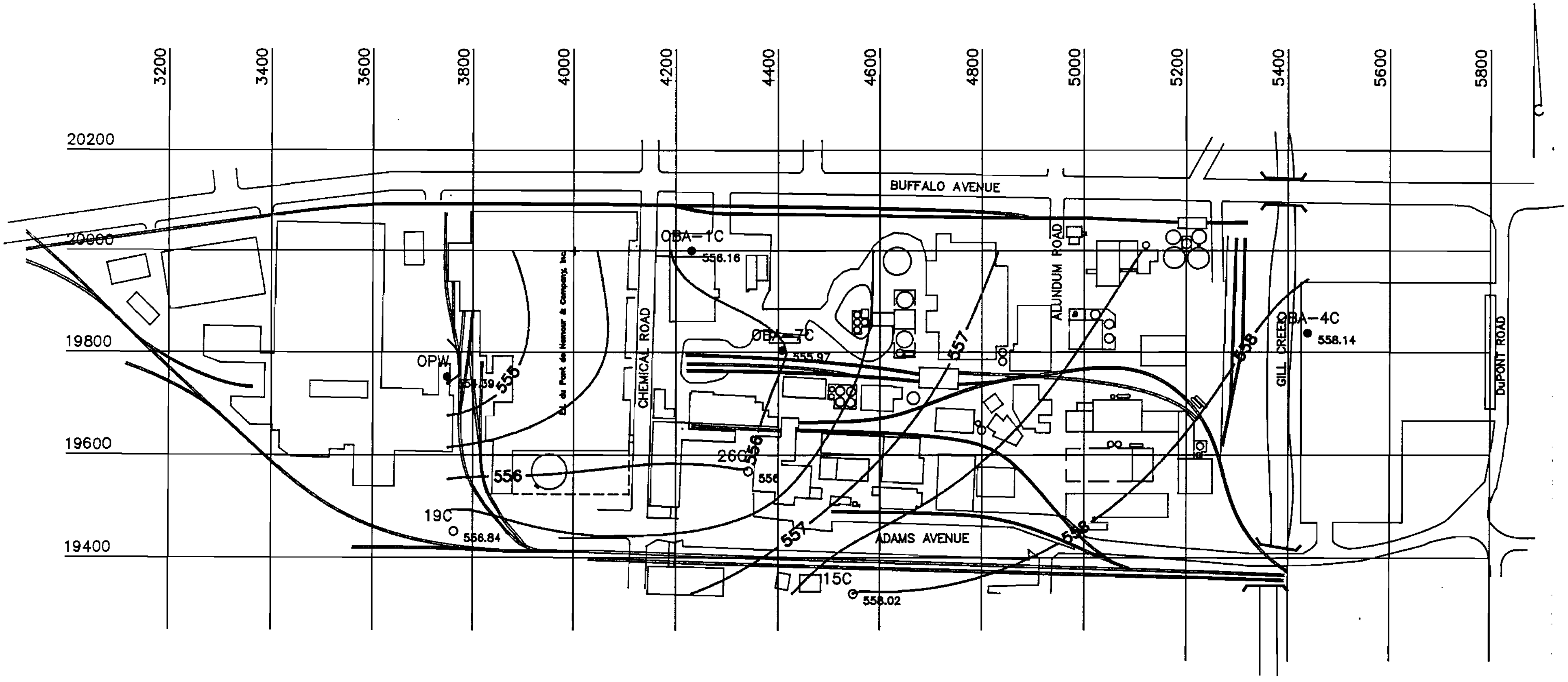
DATE OF MEASUREMENT: 1/16/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
JANUARY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-33
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 580 gpm

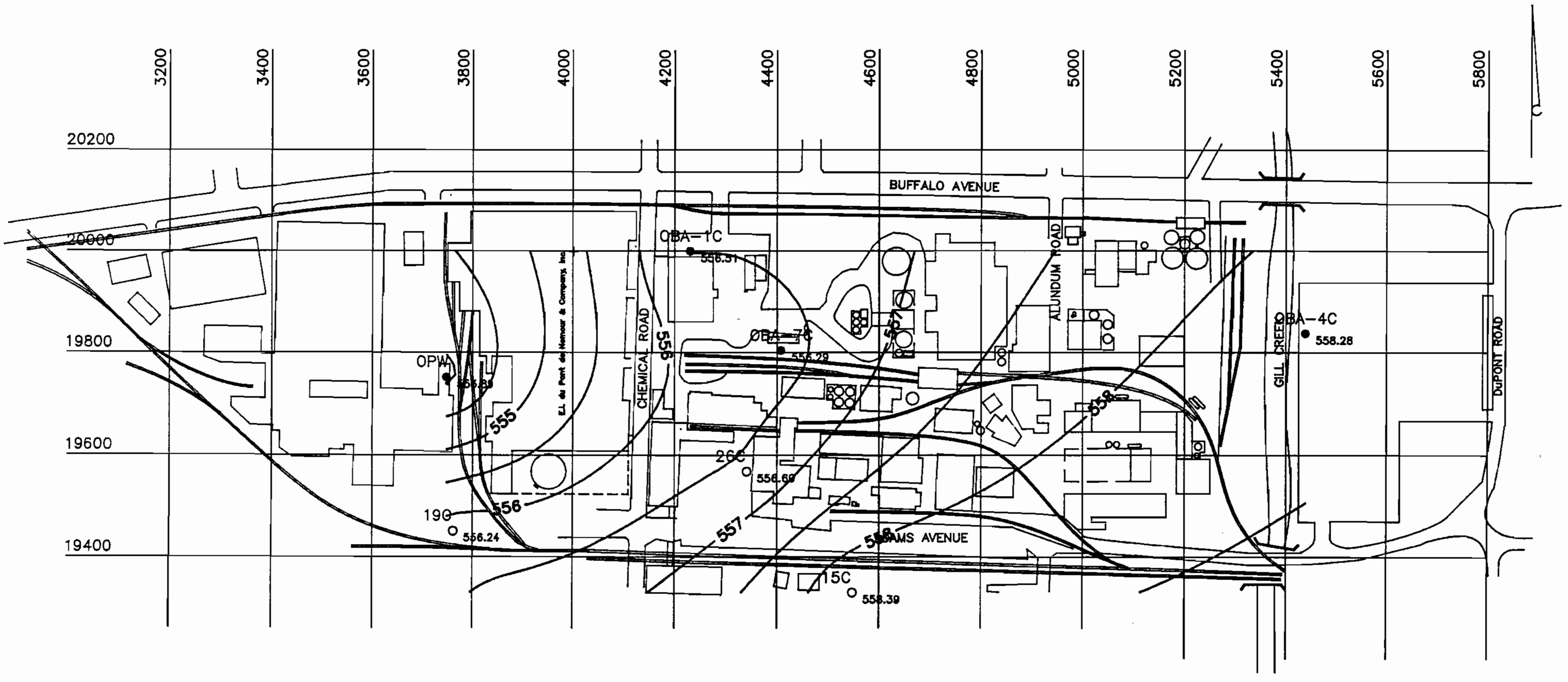
DATE OF MEASUREMENT: 2/6/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
FEBRUARY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-34
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 720 gpm

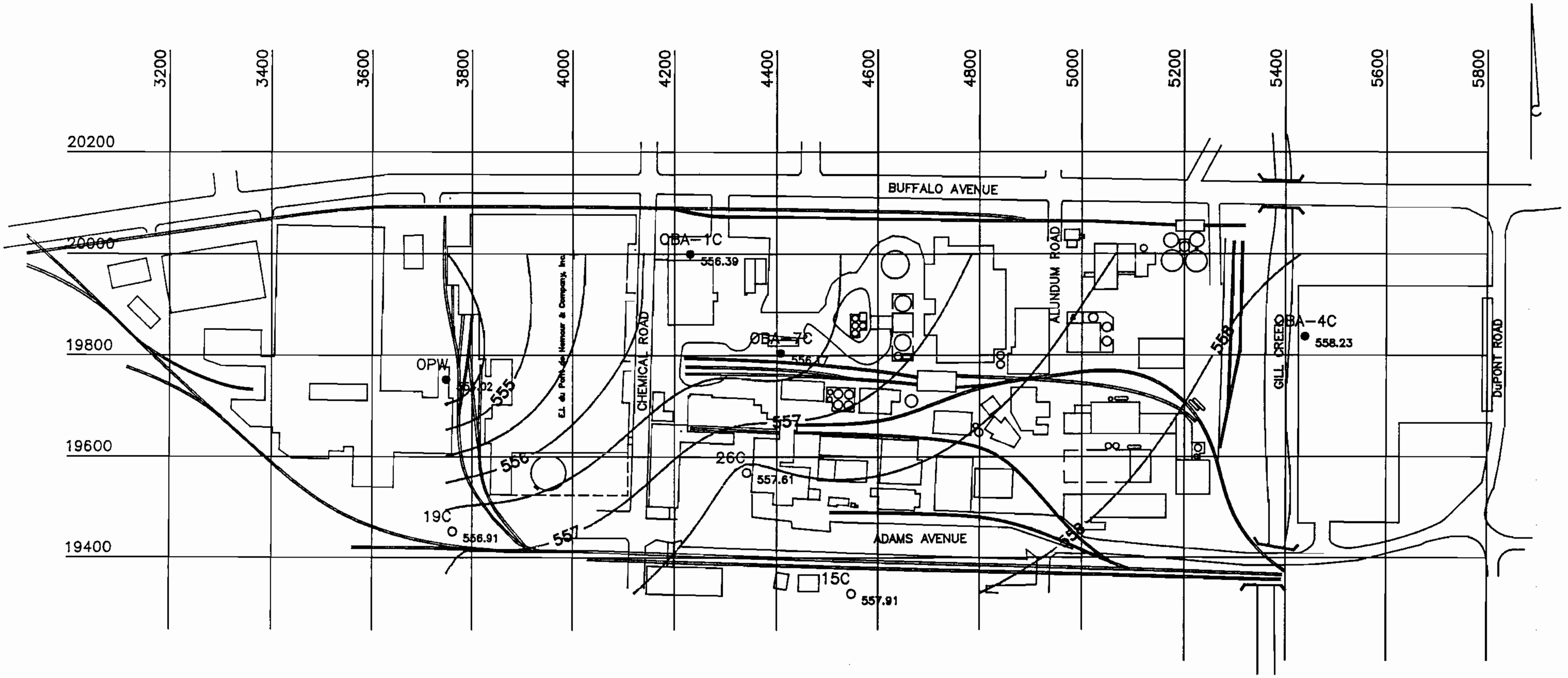
DATE OF MEASUREMENT: 3/25/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
MARCH, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-35
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 700 gpm

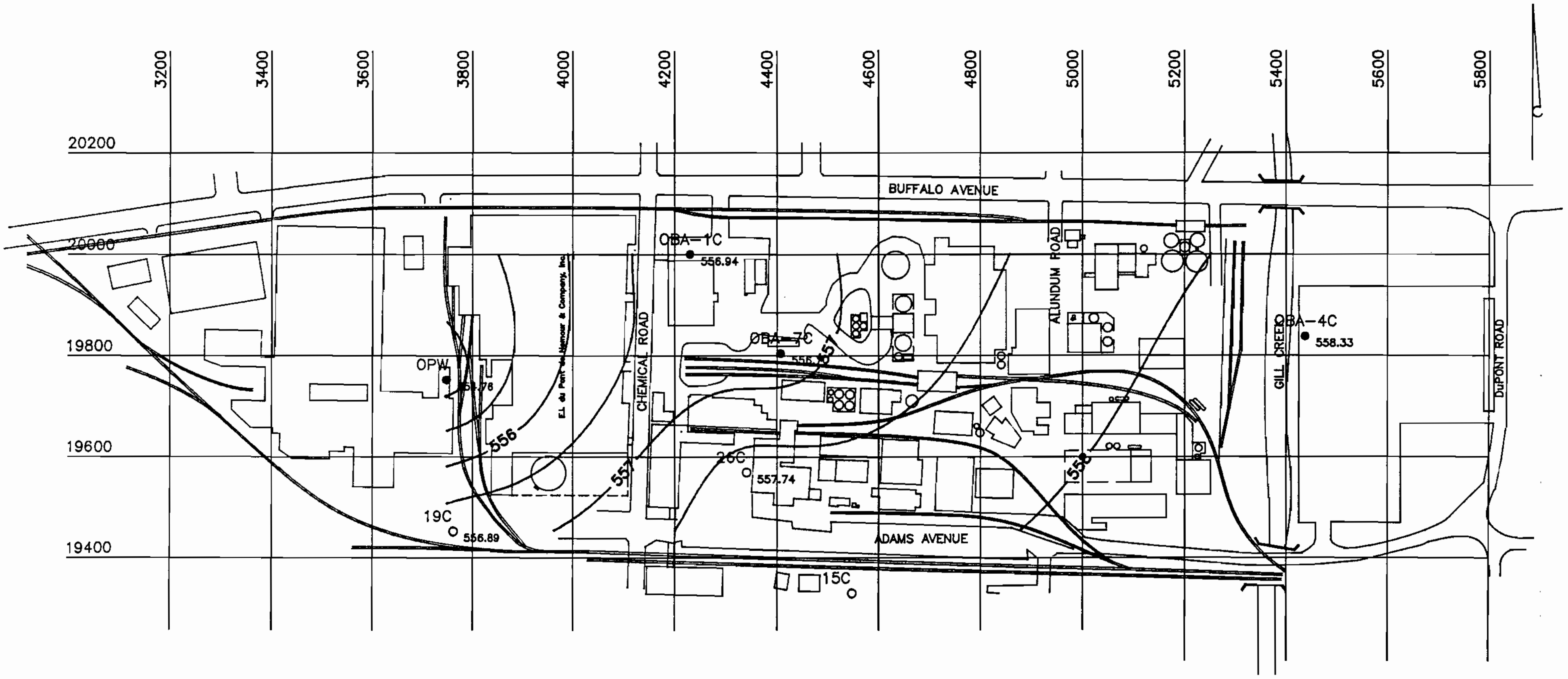
DATE OF MEASUREMENT: 4/8/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
APRIL, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-36
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 520 gpm

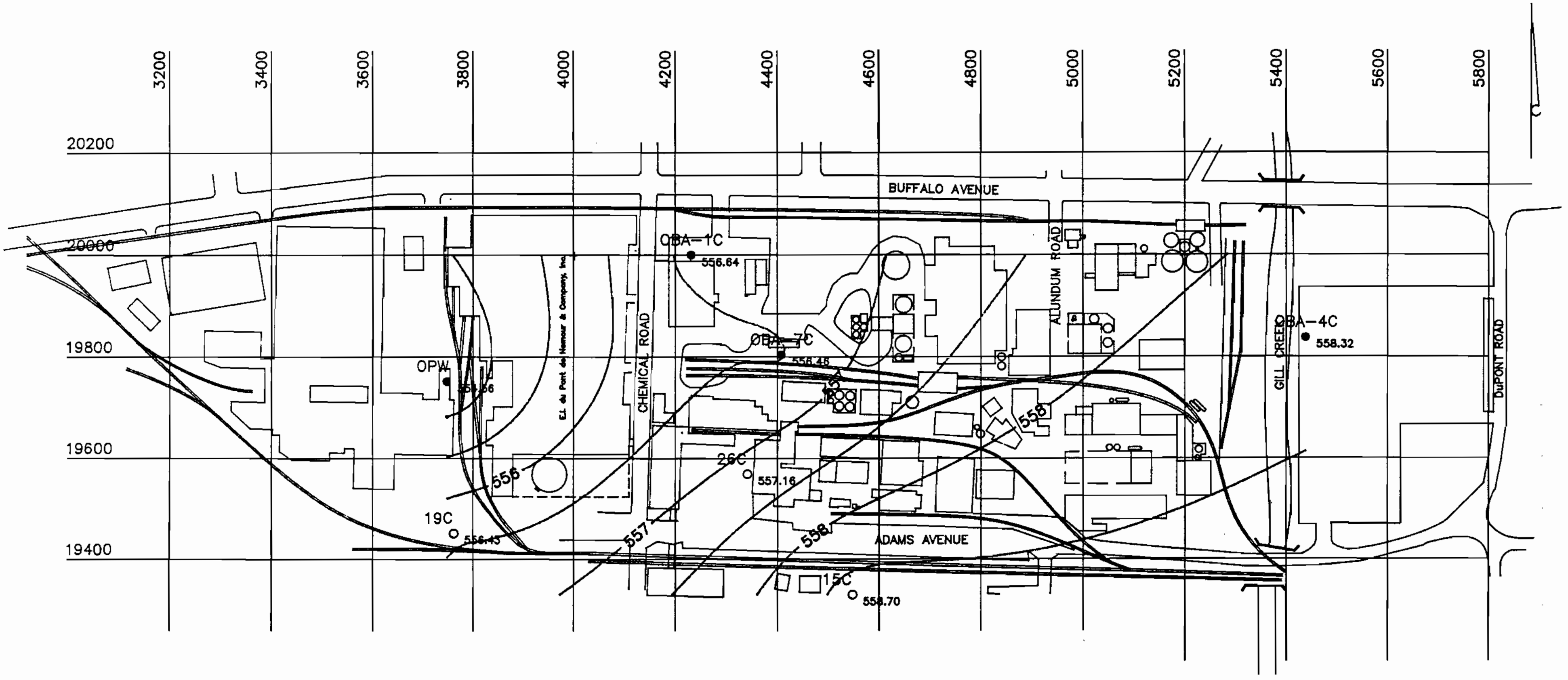
DATE OF MEASUREMENT: 5/13/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
MAY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-37
Scale: 0 — 200 Feet		



PRODUCTION WELL PUMPING RATE: 600 gpm (average)

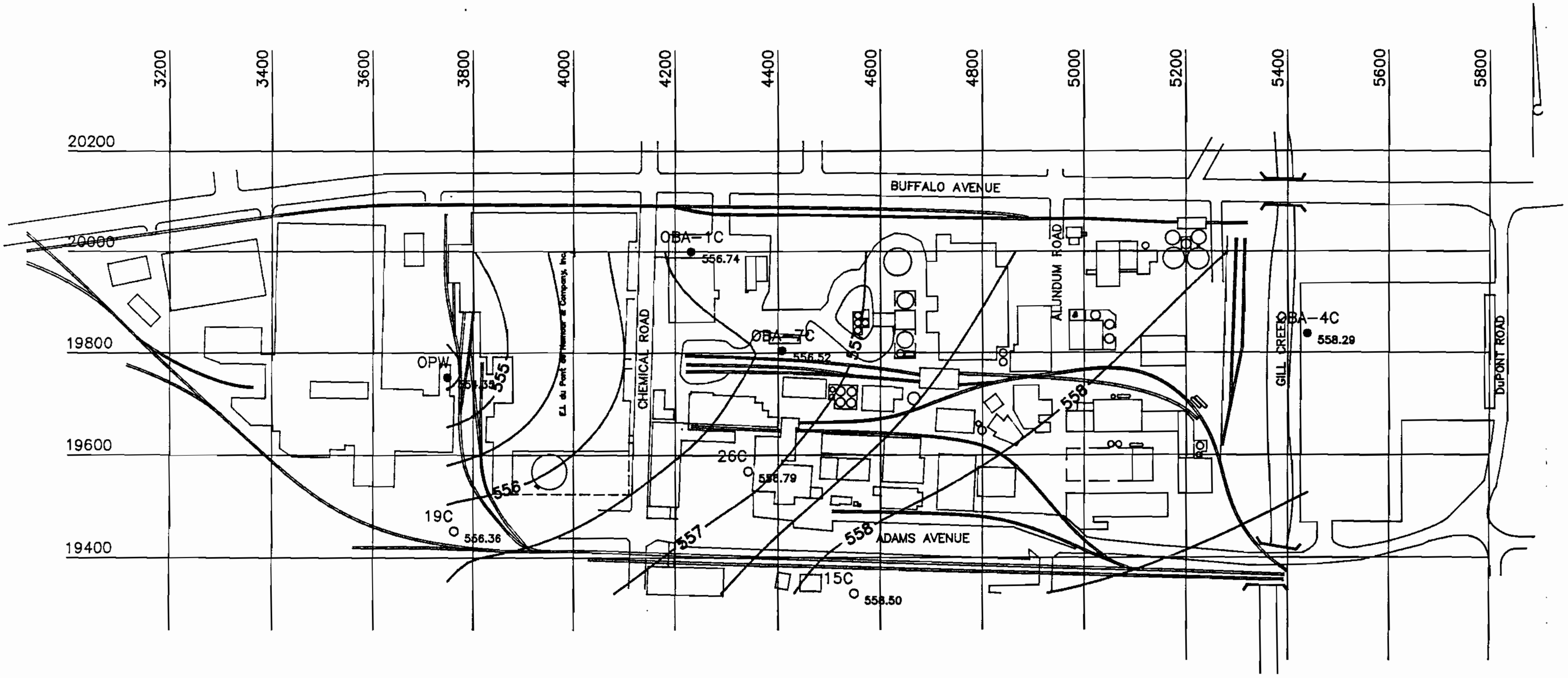
DATE OF MEASUREMENT: 6/6/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
JUNE, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-38
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 645 gpm

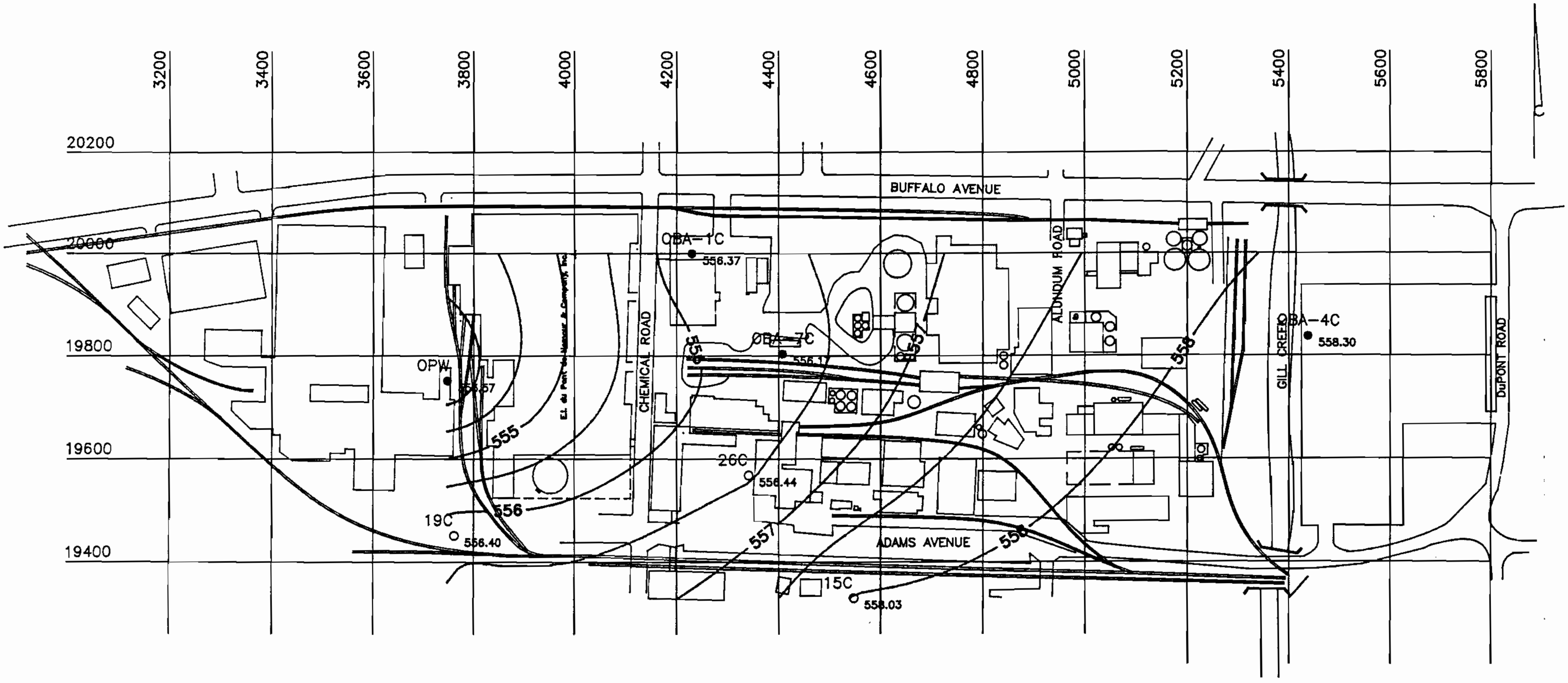
DATE OF MEASUREMENT: 7/9/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
JULY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-39
Scale: 0 — 200 Feet		



PRODUCTION WELL PUMPING RATE: 750 gpm

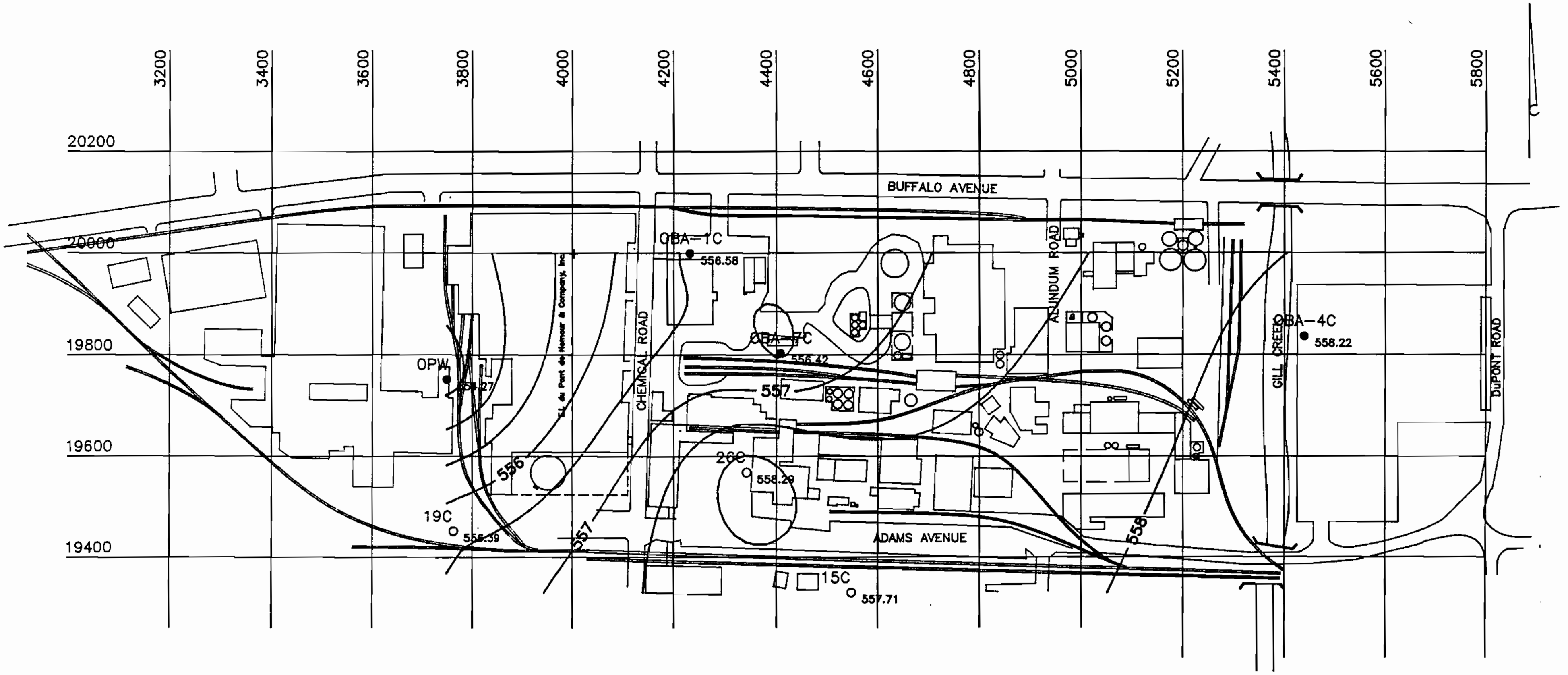
DATE OF MEASUREMENT: 8/19/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
AUGUST, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-40
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 650 gpm

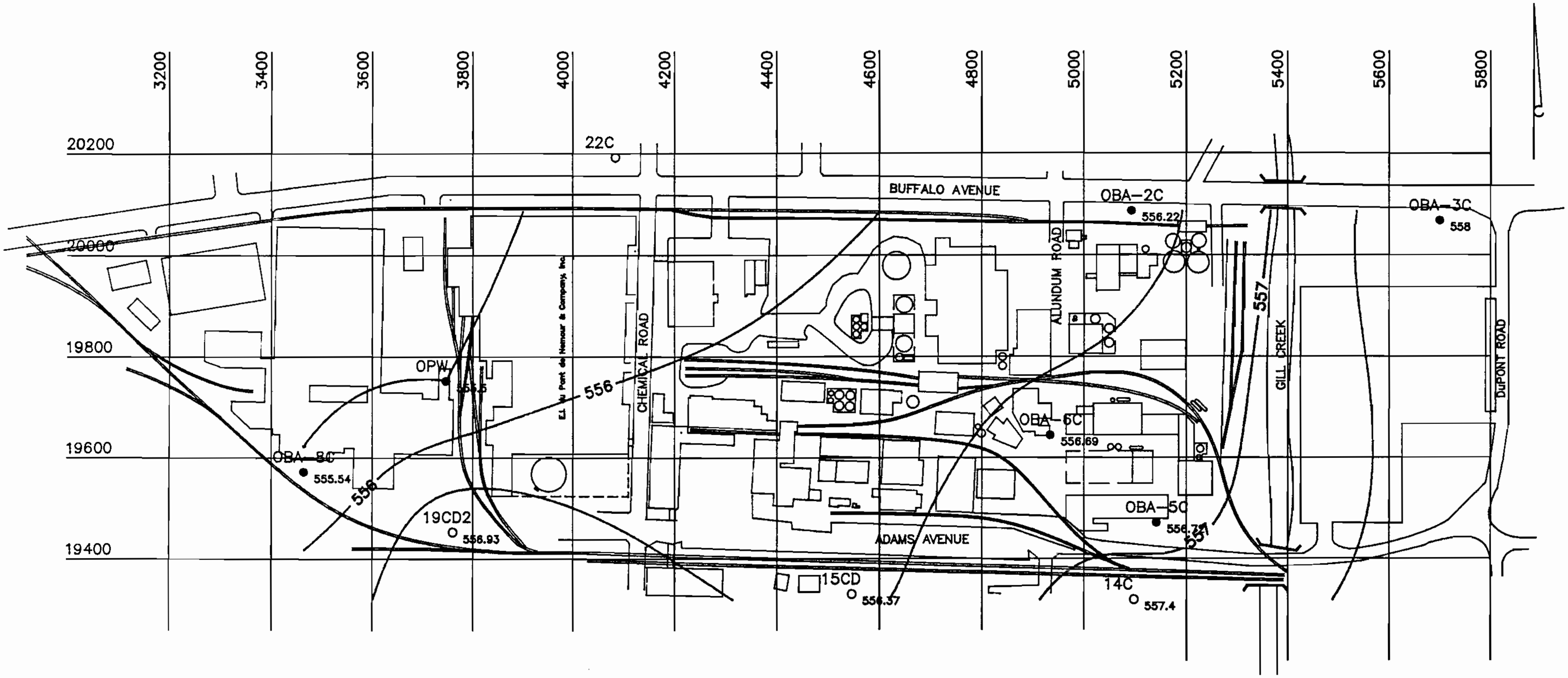
DATE OF MEASUREMENT: 9/4/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
SEPTEMBER, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-41
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 370 gpm

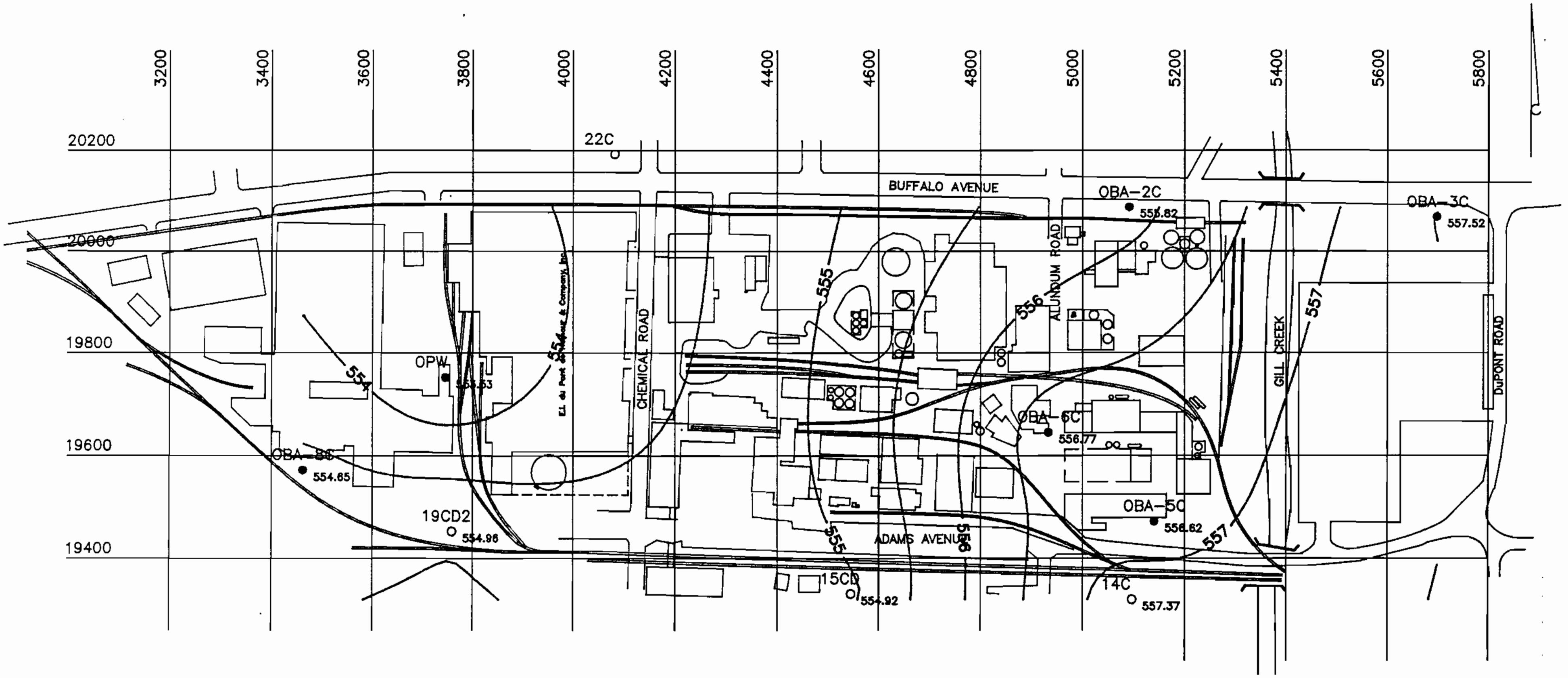
DATE OF MEASUREMENT: 10/25/90

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
OCTOBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-42
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 720 gpm

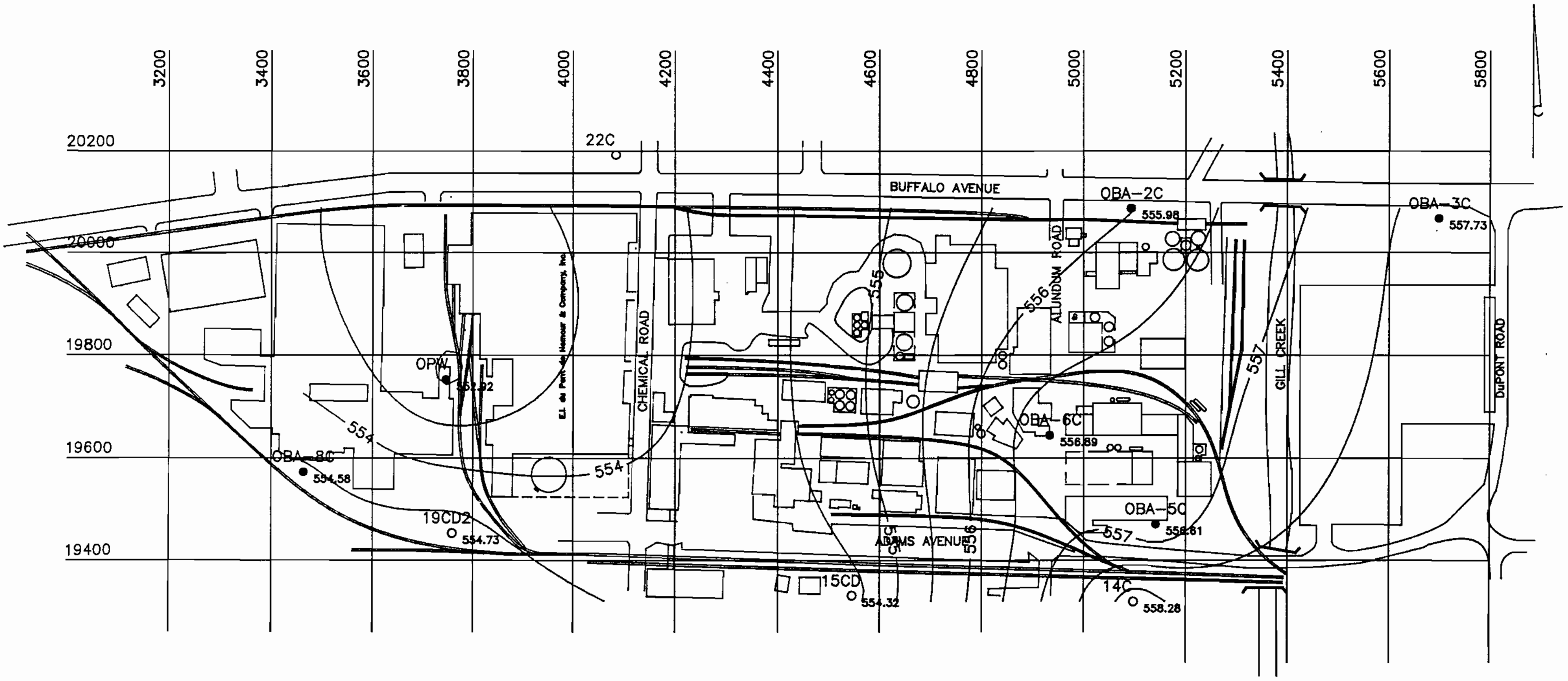
DATE OF MEASUREMENT: 11/27/90

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
NOVEMBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-43
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 820 gpm

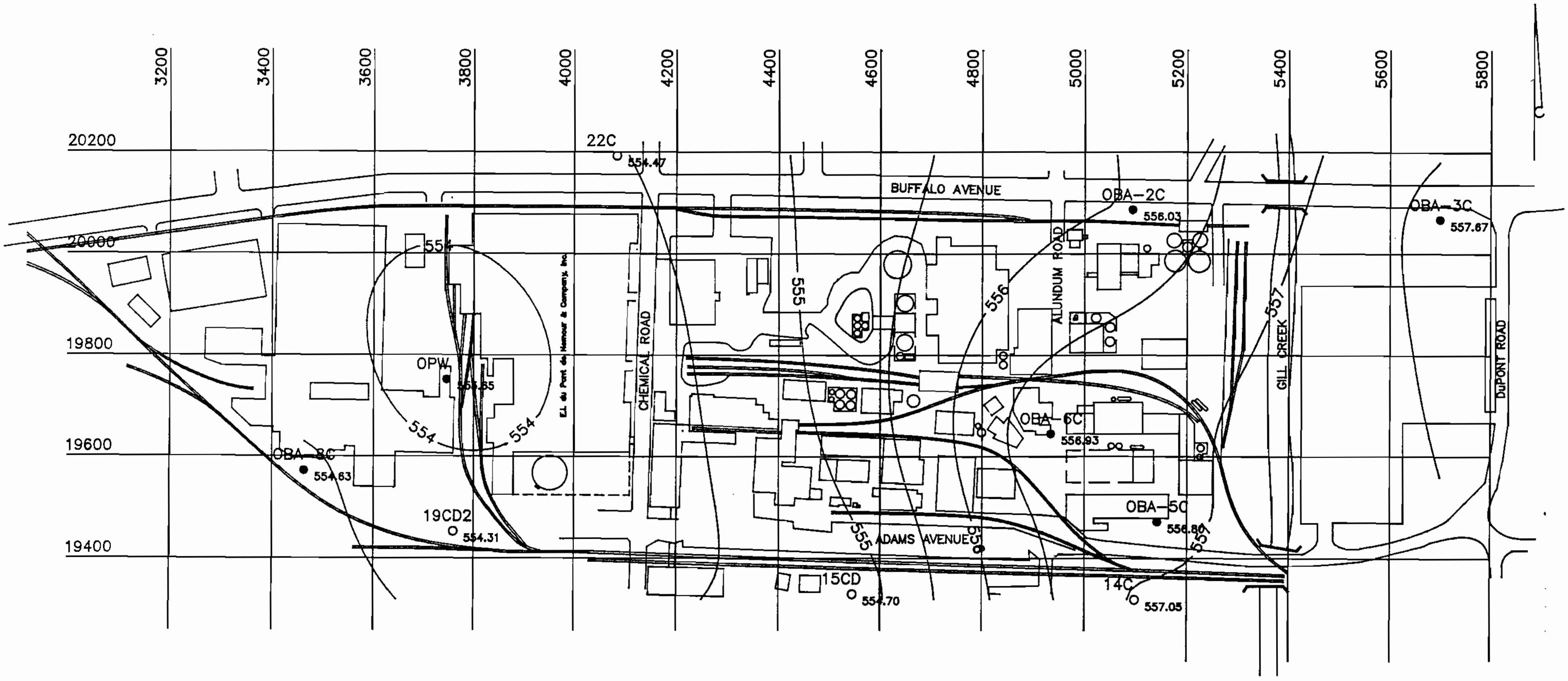
DATE OF MEASUREMENT: 12/7/90

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
DECEMBER, 1990

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-44
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 700 gpm

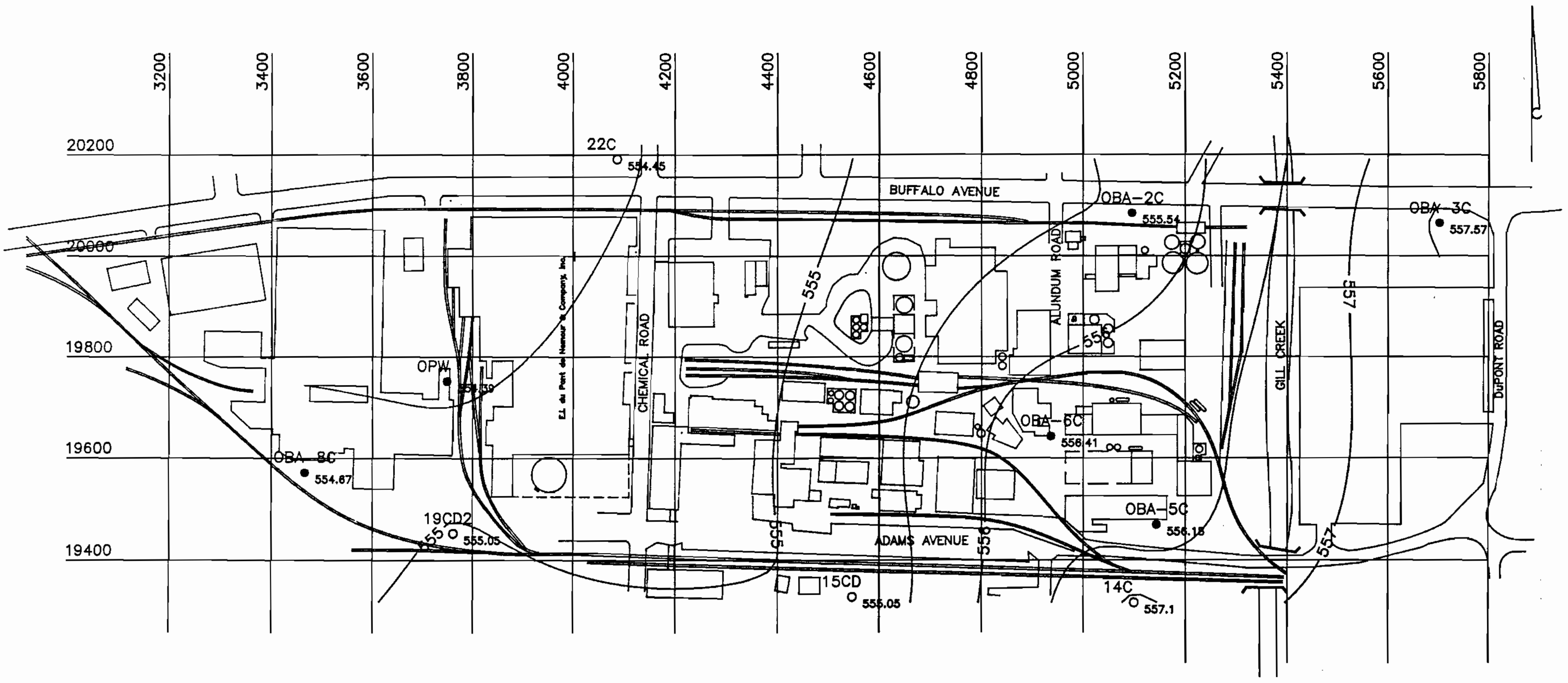
DATE OF MEASUREMENT: 1/16/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
JANUARY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-45
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 580 gpm

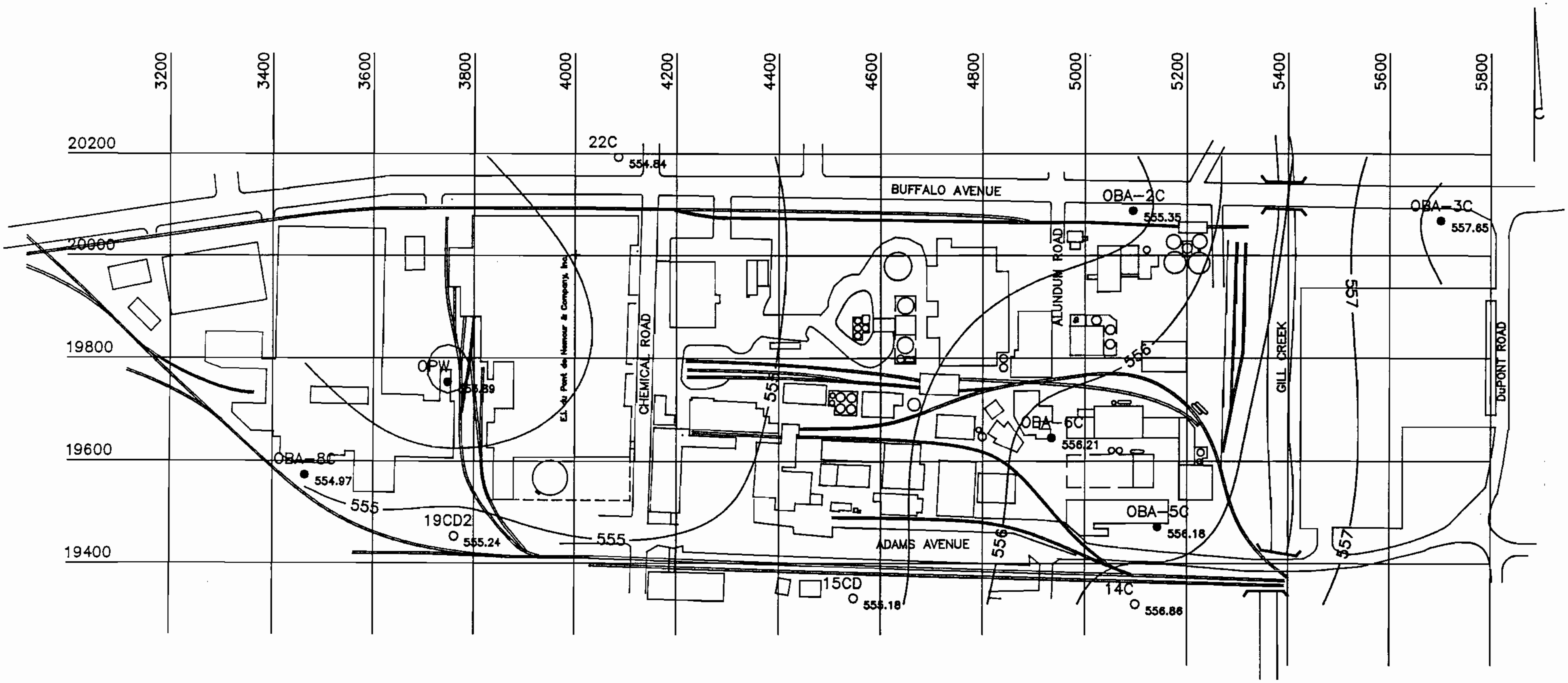
DATE OF MEASUREMENT: 2/6/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
FEBRUARY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-46
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 720 gpm

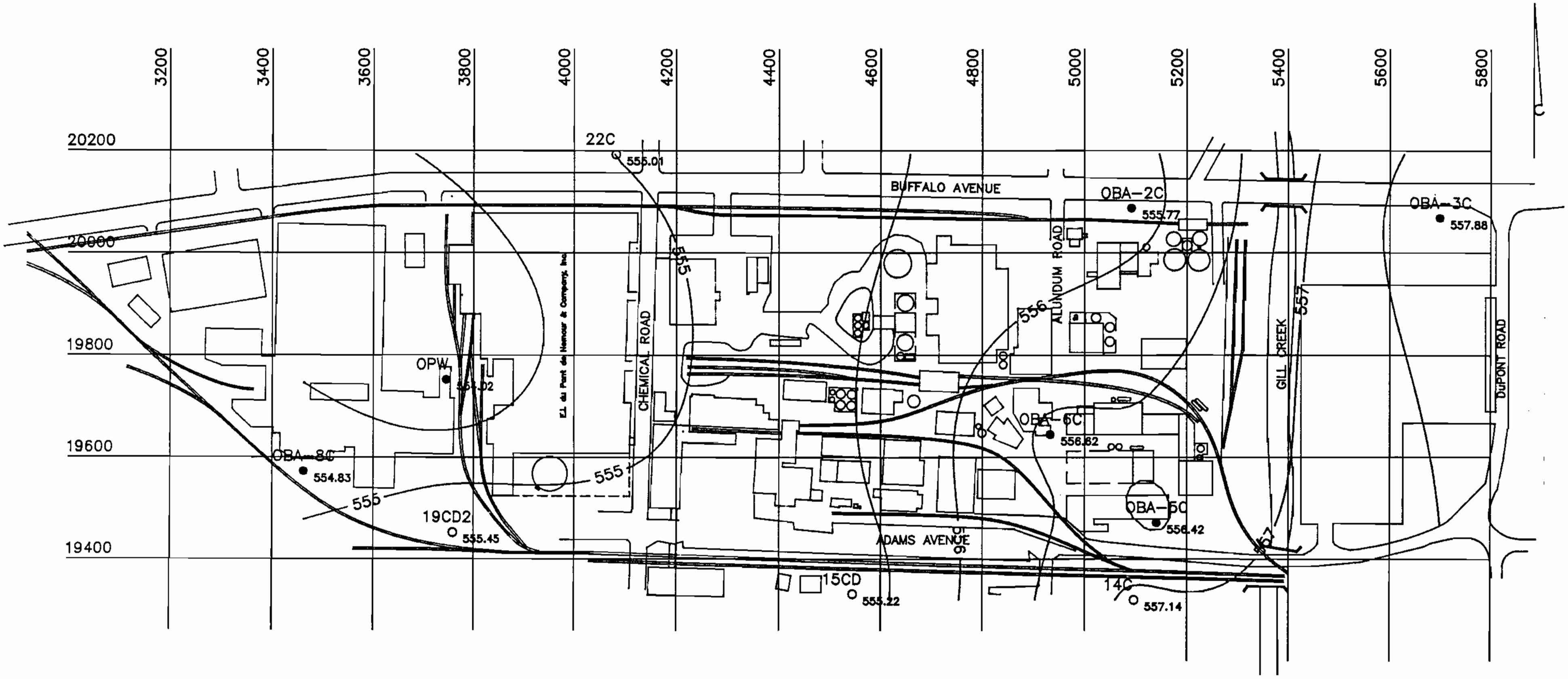
DATE OF MEASUREMENT: 3/25/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
MARCH, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-47
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 700 gpm

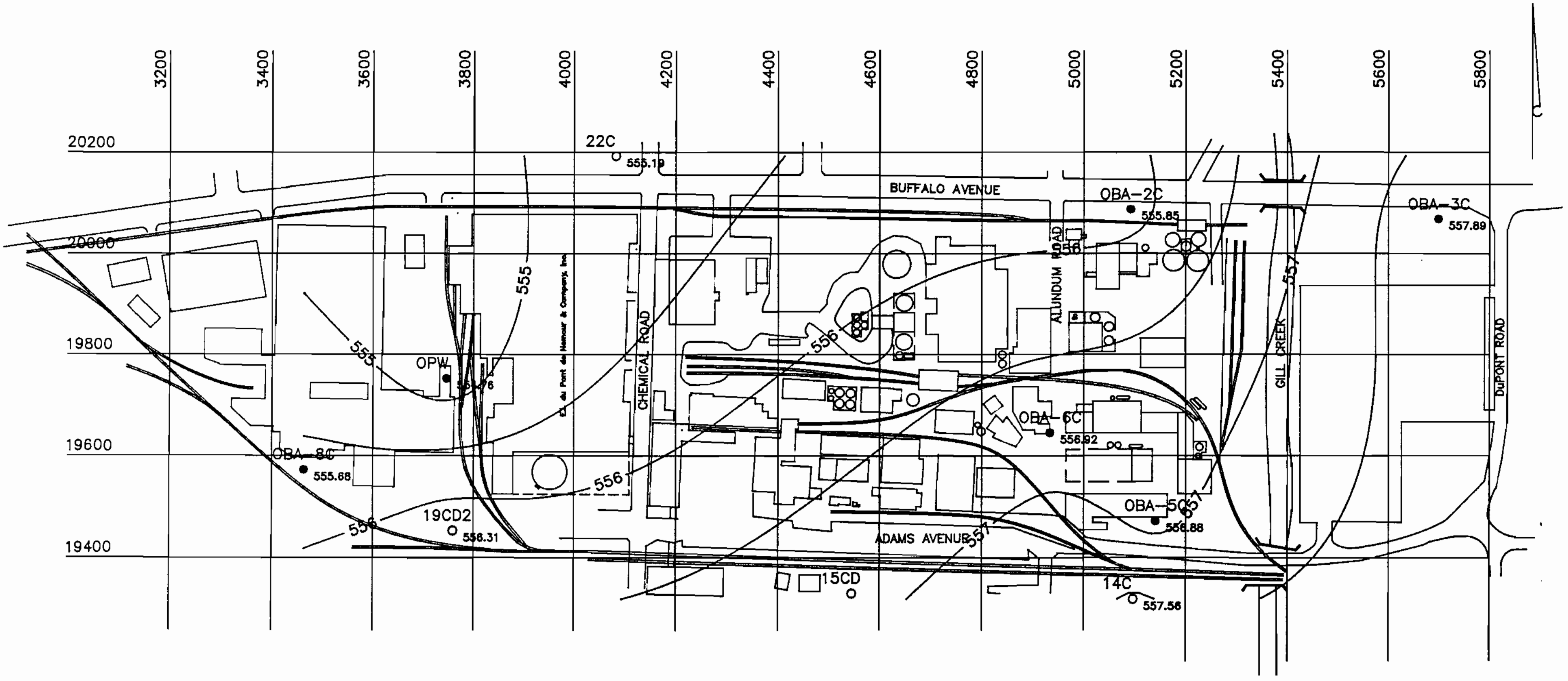
DATE OF MEASUREMENT: 4/8/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD–CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD–ZONE
APRIL, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4–48
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 520 gpm

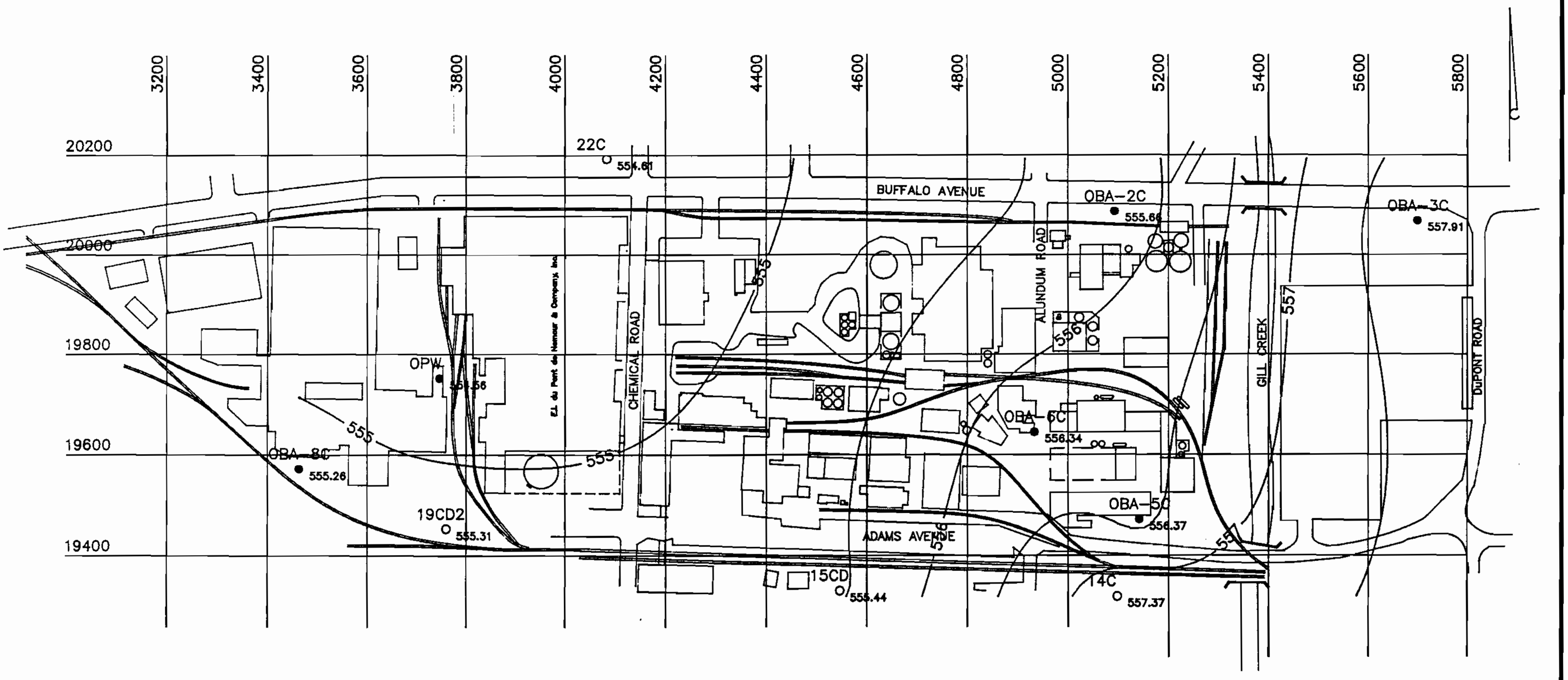
DATE OF MEASUREMENT: 5/13/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
MAY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-49
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 600 gpm (average)

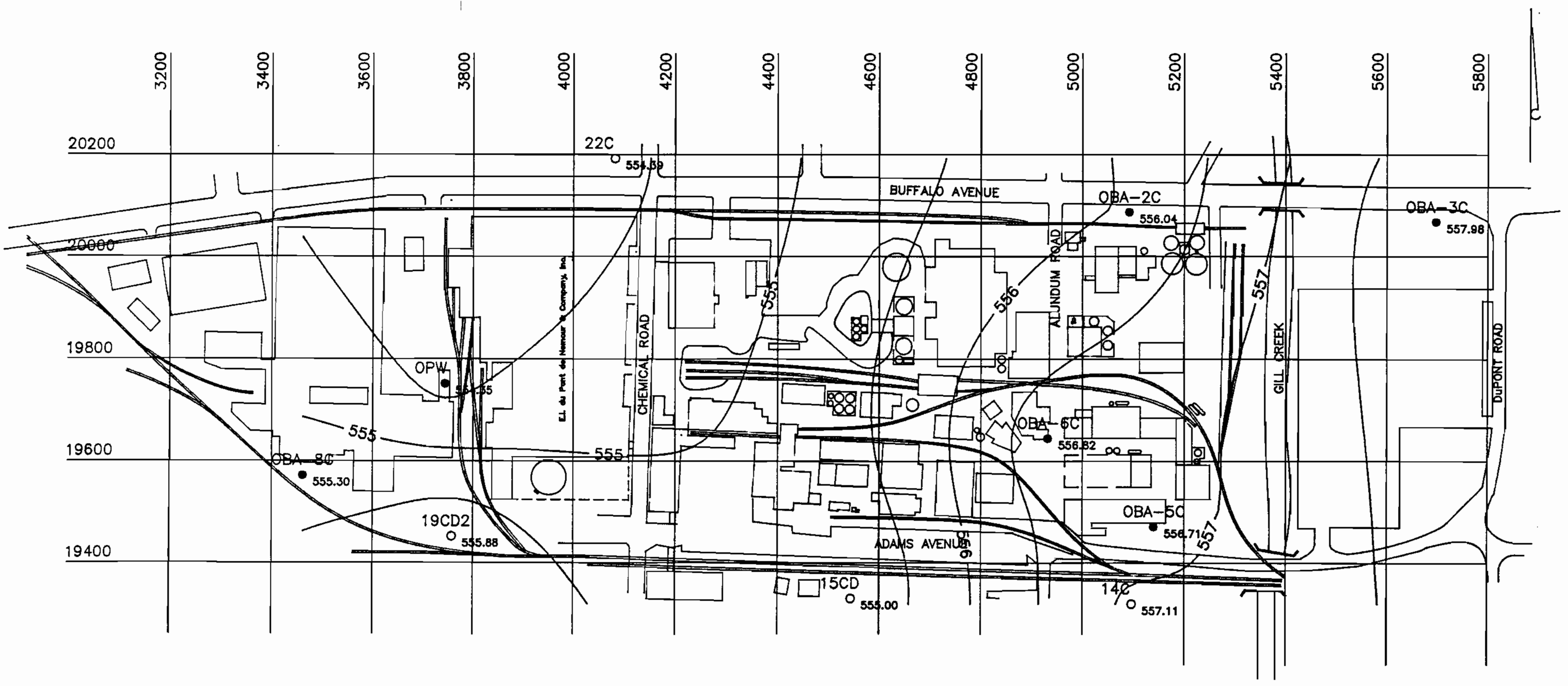
DATE OF MEASUREMENT: 6/6/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
JUNE, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-50
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 645 gpm

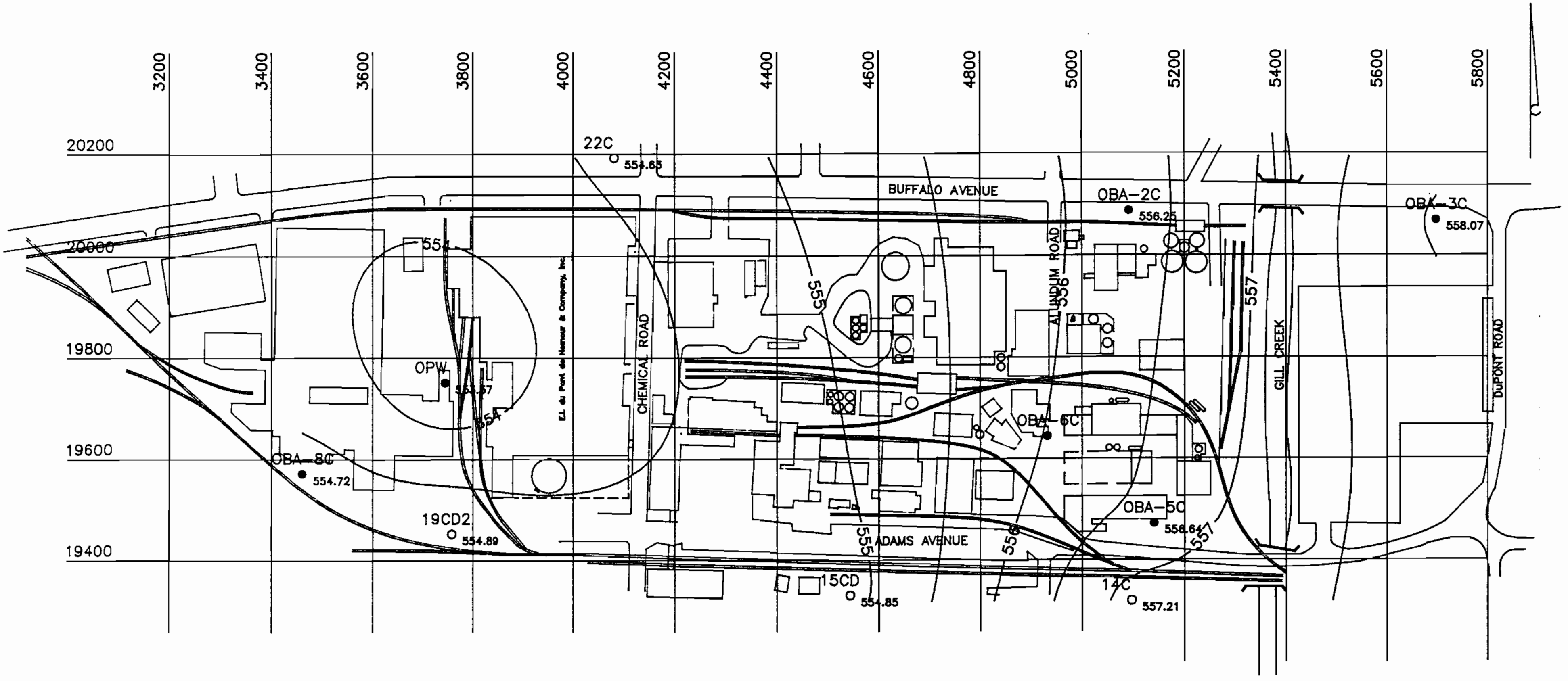
DATE OF MEASUREMENT: 7/9/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
JULY, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-51
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 750 gpm

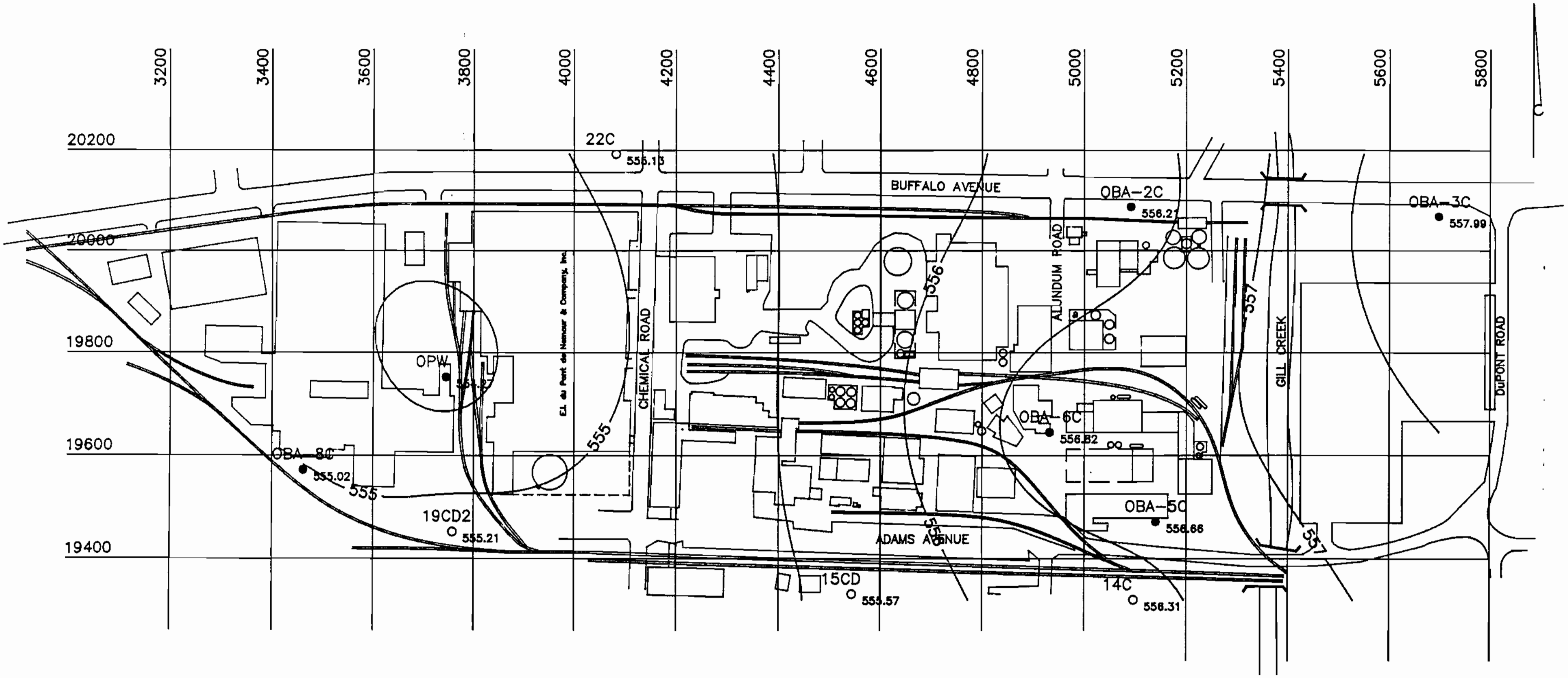
DATE OF MEASUREMENT: 8/19/91

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
AUGUST, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-52
Scale: 0 200 Feet		



PRODUCTION WELL PUMPING RATE: 650 gpm

DATE OF MEASUREMENT: 9/4/91

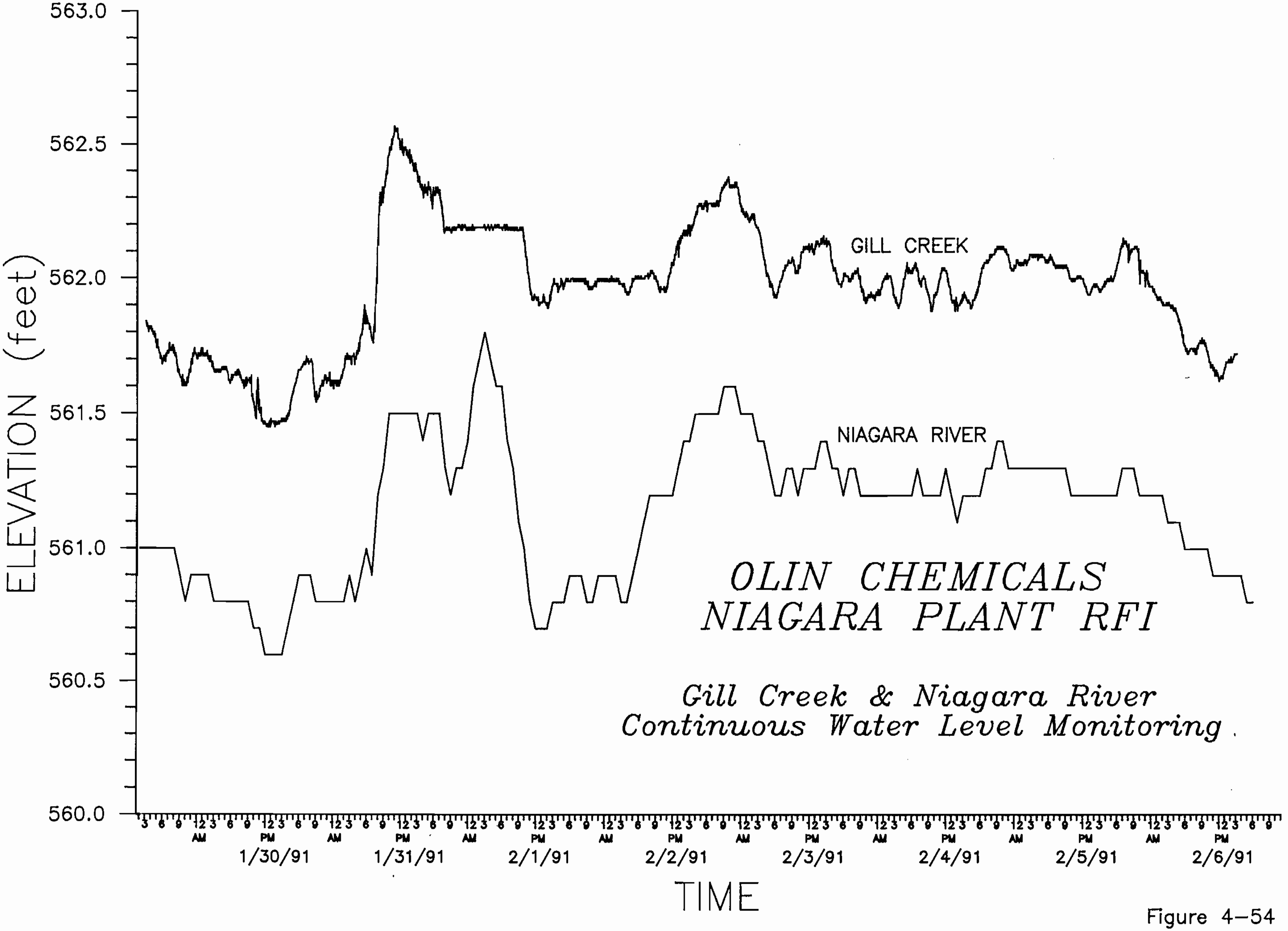
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
SEPTEMBER, 1991

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 4-53
Scale: 0 200 Feet		

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists



OLIN CHEMICALS
NIAGARA PLANT RFI

Gill Creek & Niagara River
Continuous Water Level Monitoring

Figure 4–54

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

OLIN CHEMICALS NIAGARA PLANT RFI

A-Zone Well Hydrographs Continuous Water Level Monitoring

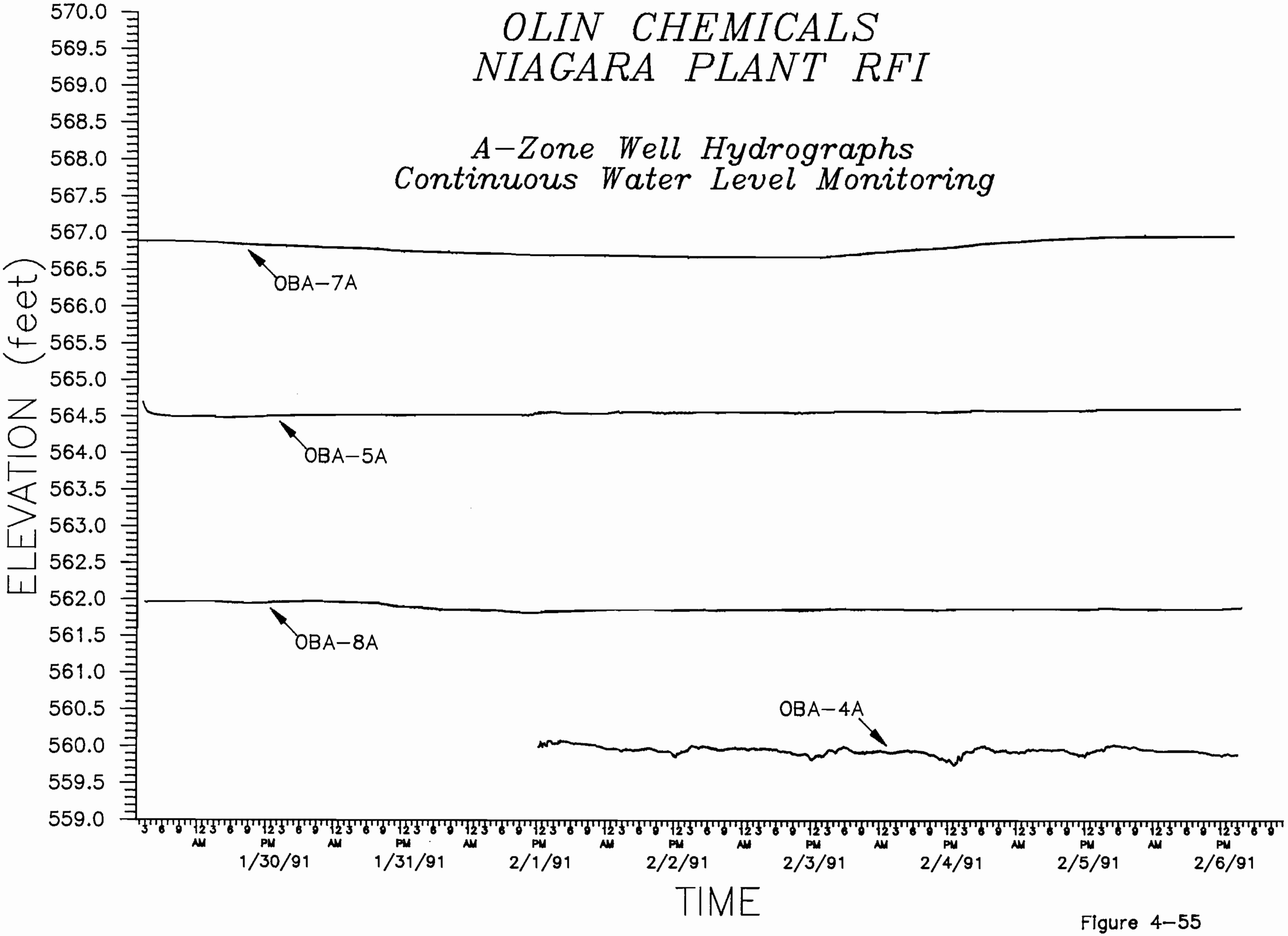
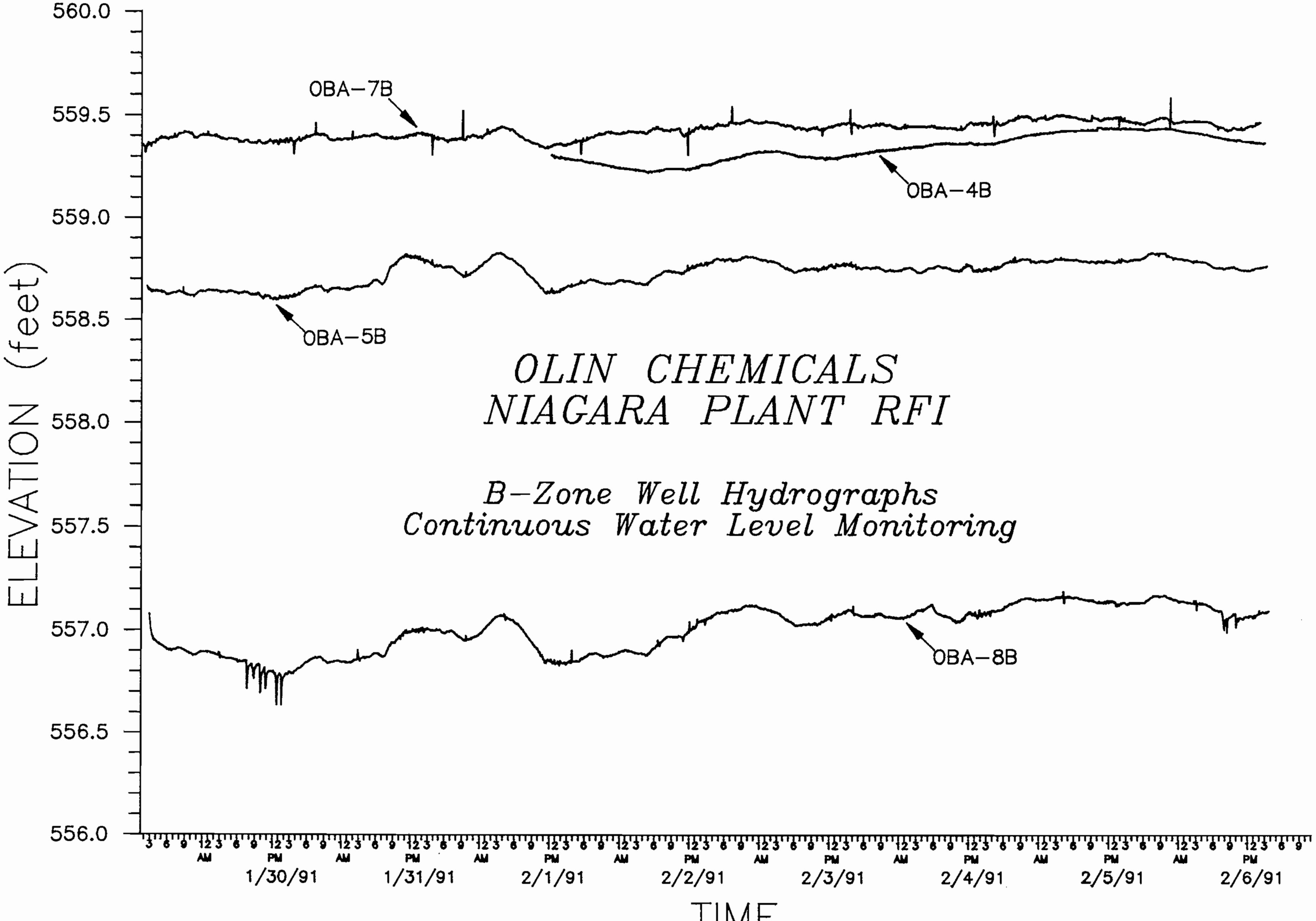


Figure 4-55

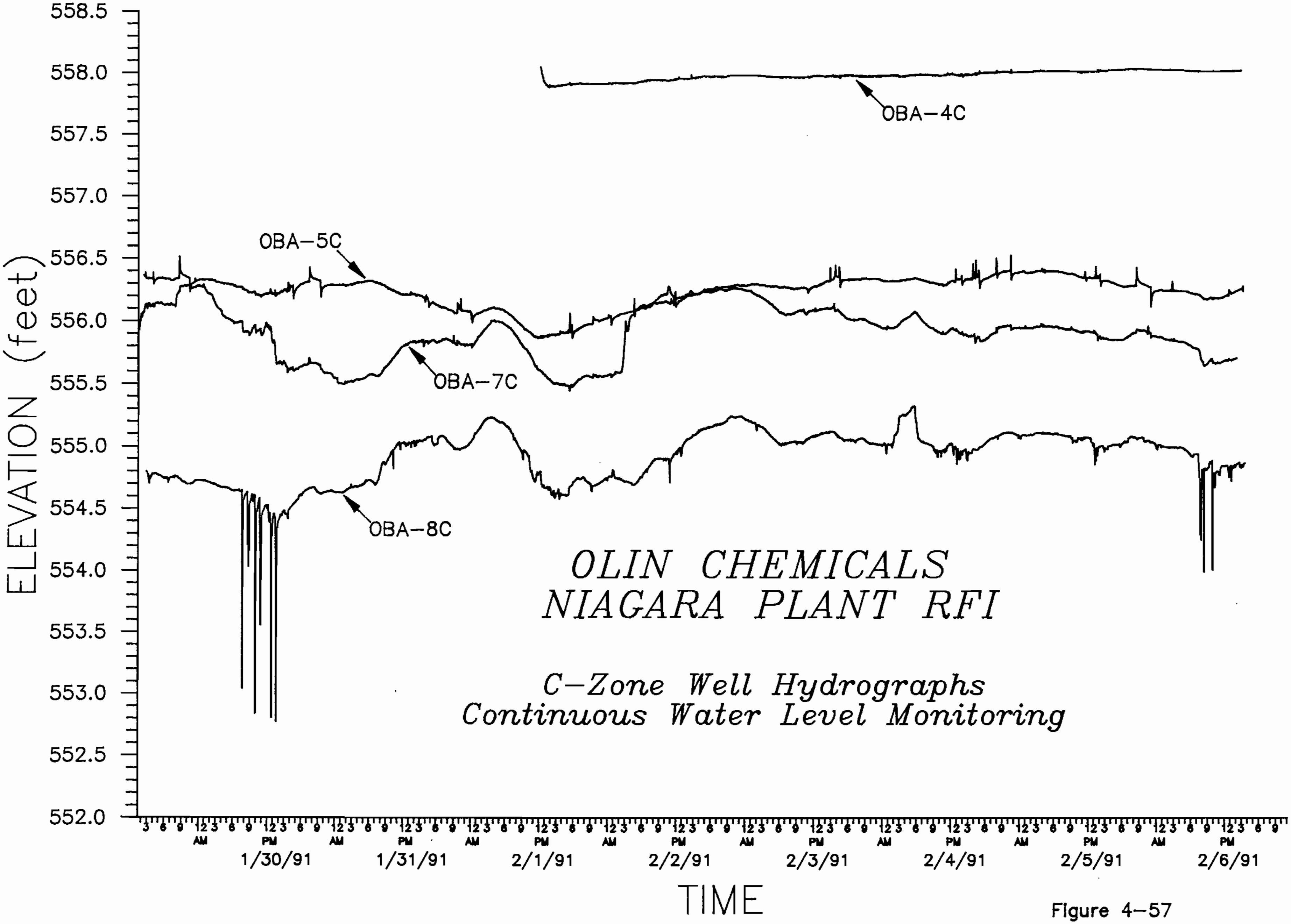
WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists



OLIN CHEMICALS
NIAGARA PLANT RFI

B-Zone Well Hydrographs
Continuous Water Level Monitoring

Figure 4-56

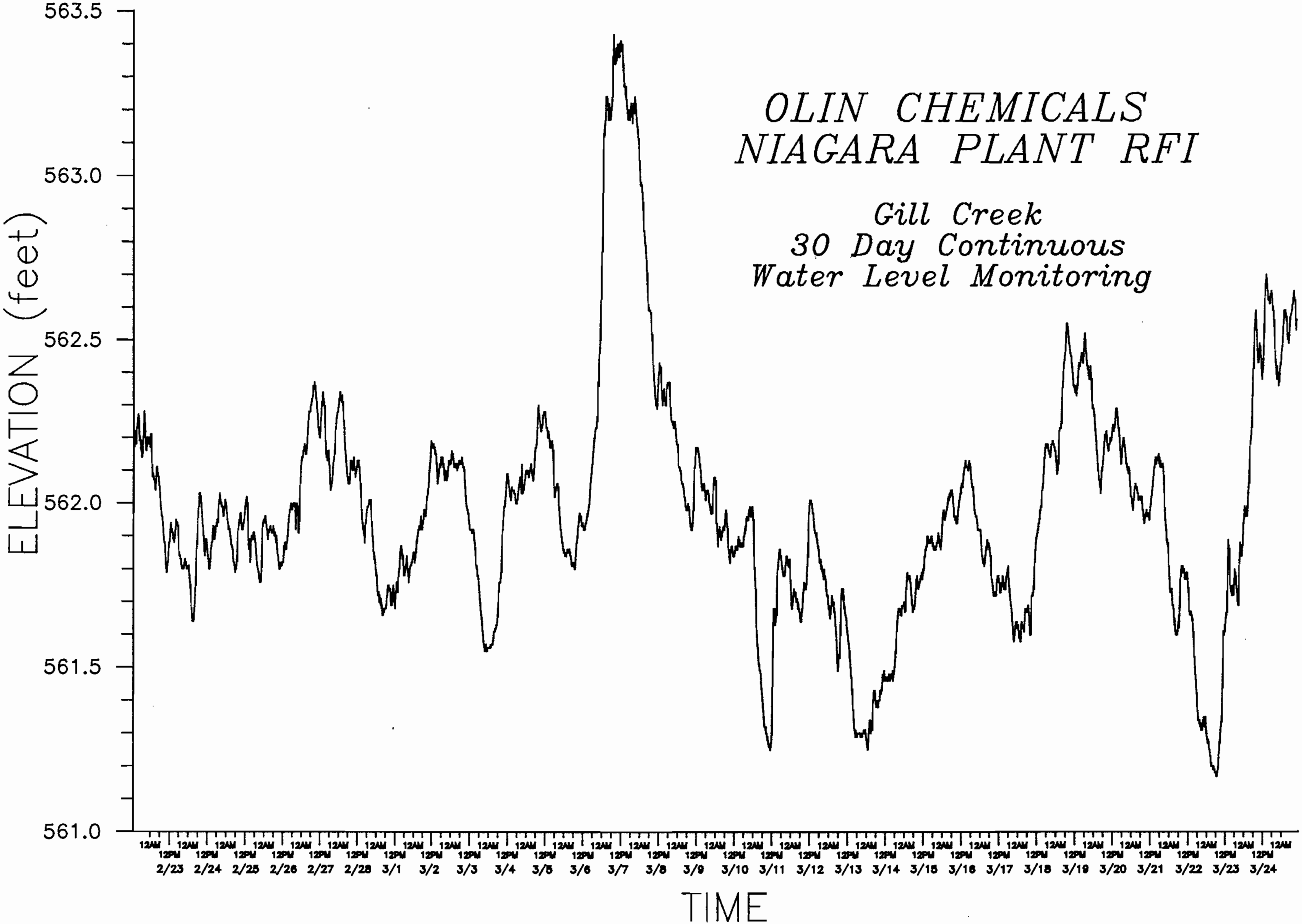


OLIN CHEMICALS
NIAGARA PLANT RFI

C-Zone Well Hydrographs
Continuous Water Level Monitoring

Figure 4-57

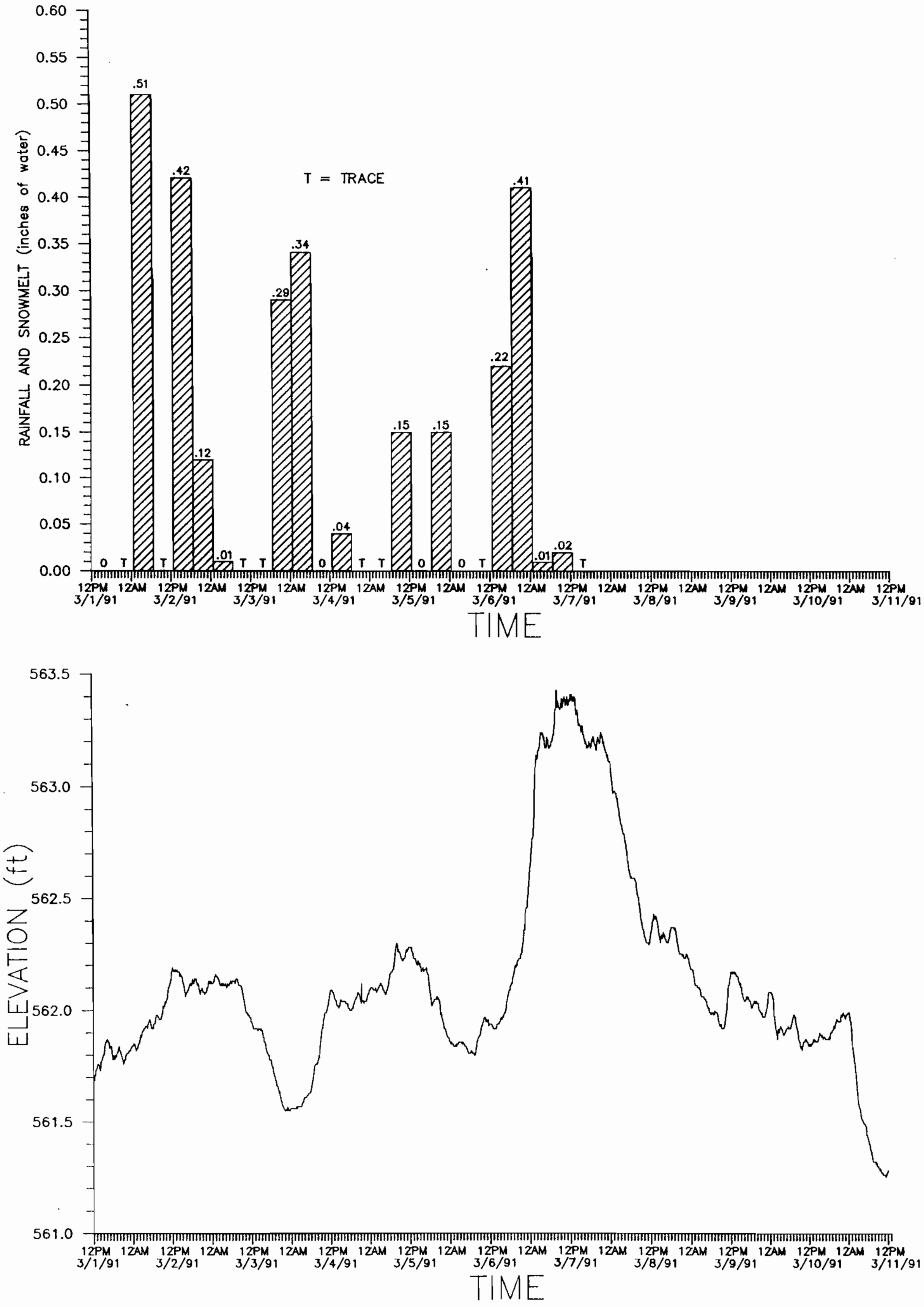
WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists



OLIN CHEMICALS
NIAGARA PLANT RFI

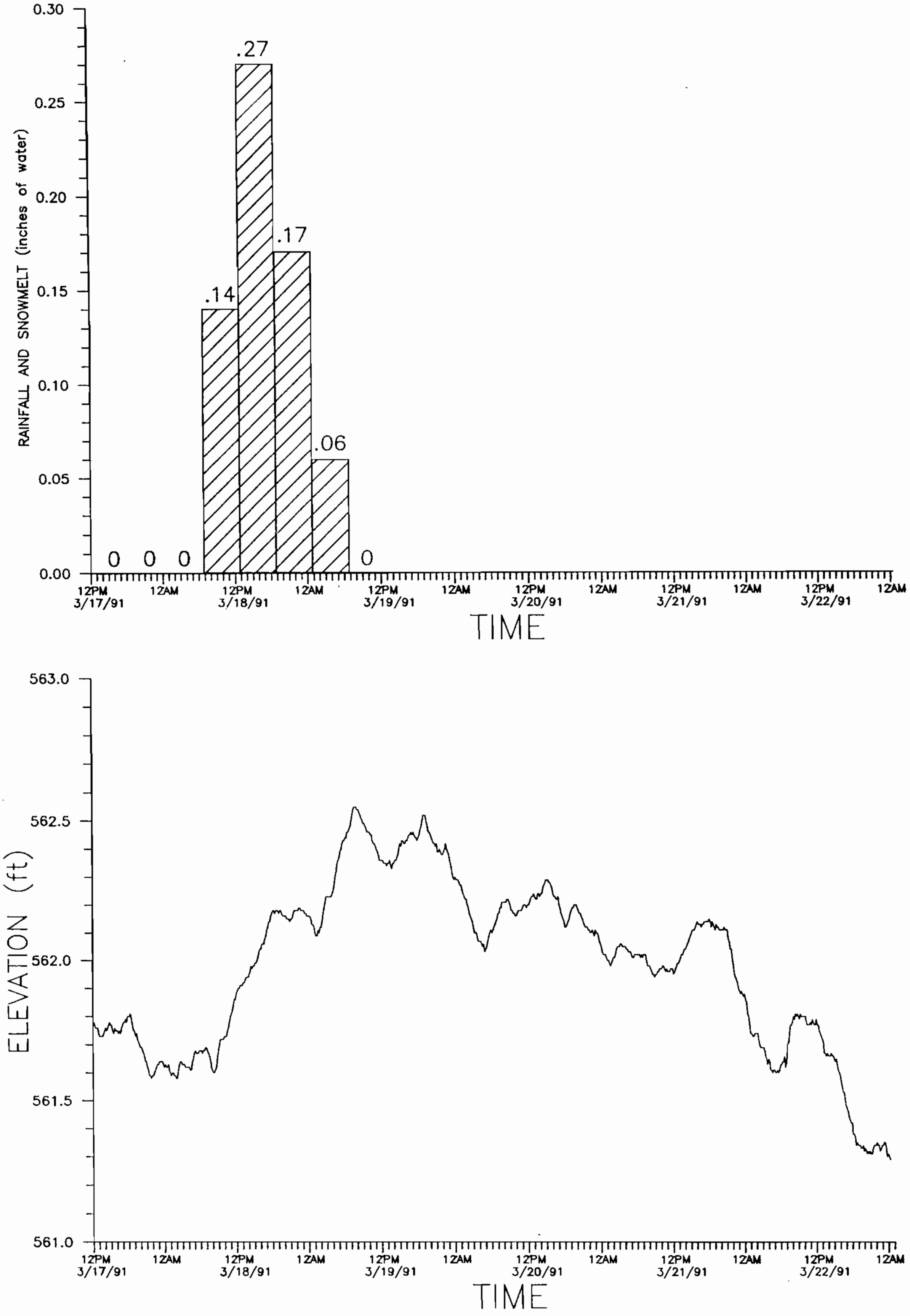
Gill Creek
30 Day Continuous
Water Level Monitoring

Figure 4-58



Gill Creek Stage Hydrograph:
March 1 through March 11, 1991

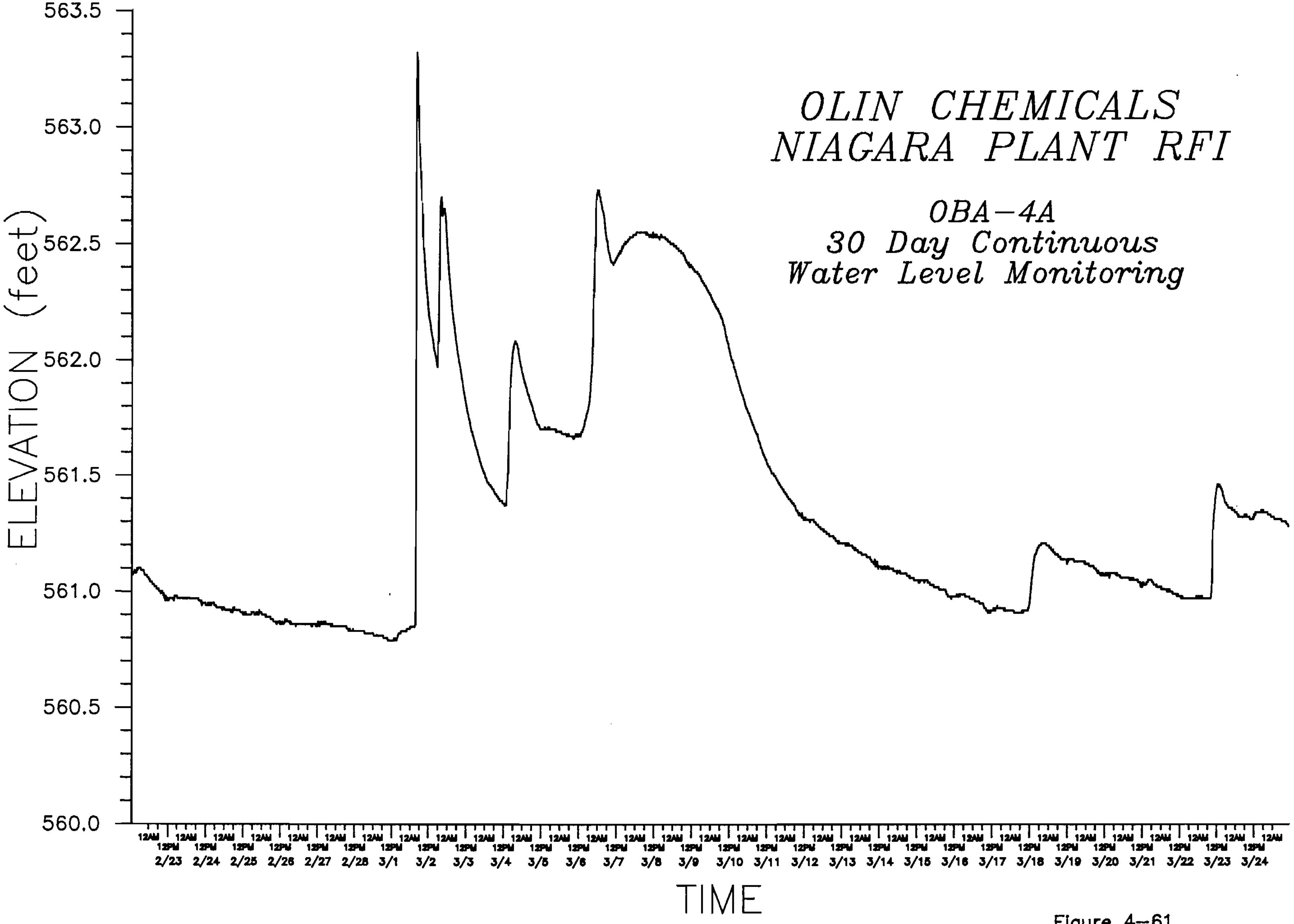
Figure 4-59



Gill Creek Stage Hydrograph:
March 17 through March 22, 1991

Figure 4-60

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists



OLIN CHEMICALS
NIAGARA PLANT RFI

OBA-4A
30 Day Continuous
Water Level Monitoring

Figure 4-61

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

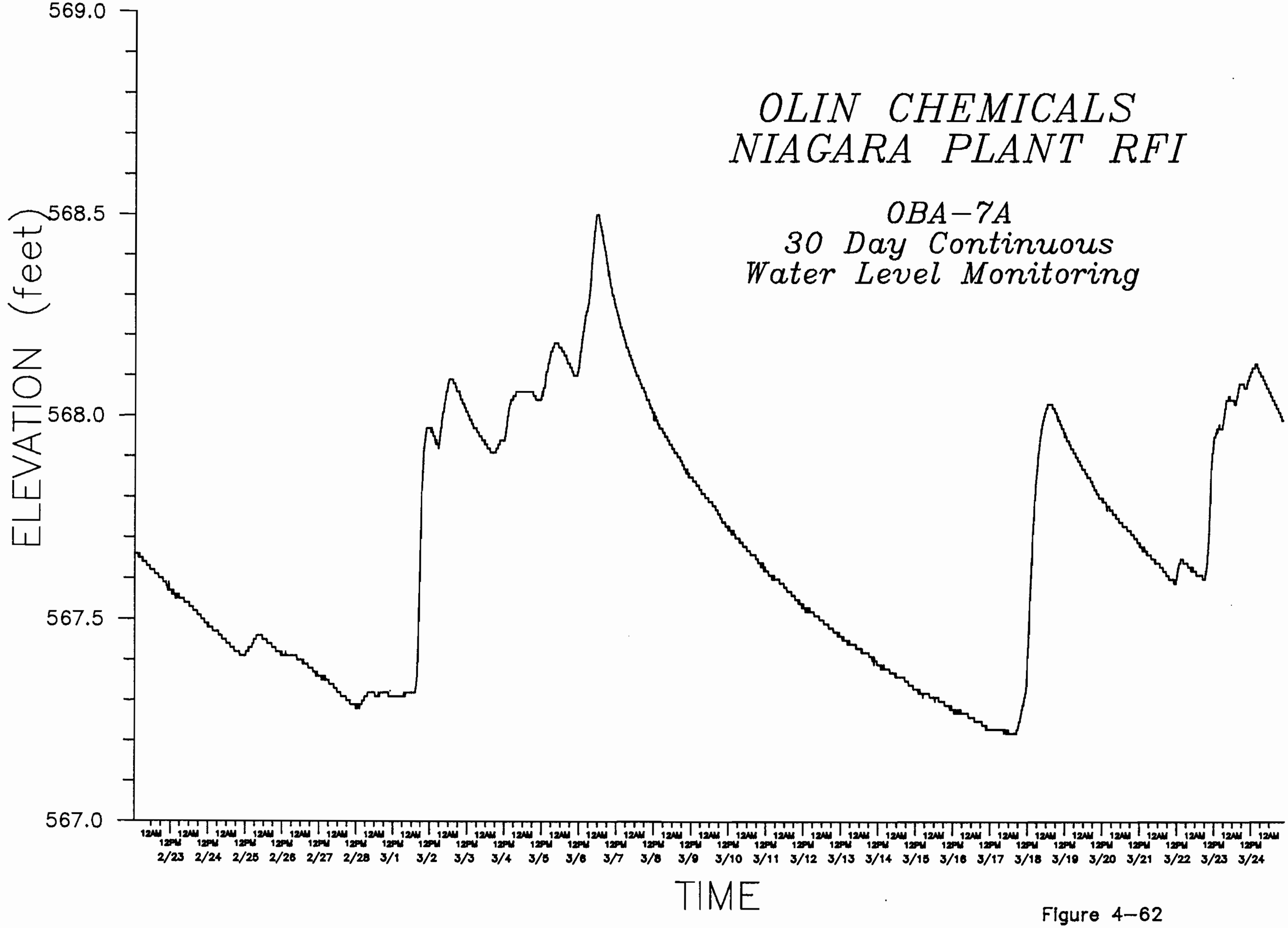


Figure 4-62

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

OLIN CHEMICALS
NIAGARA PLANT RFI

OBA-4B
30 Day Continuous Water Level Monitoring

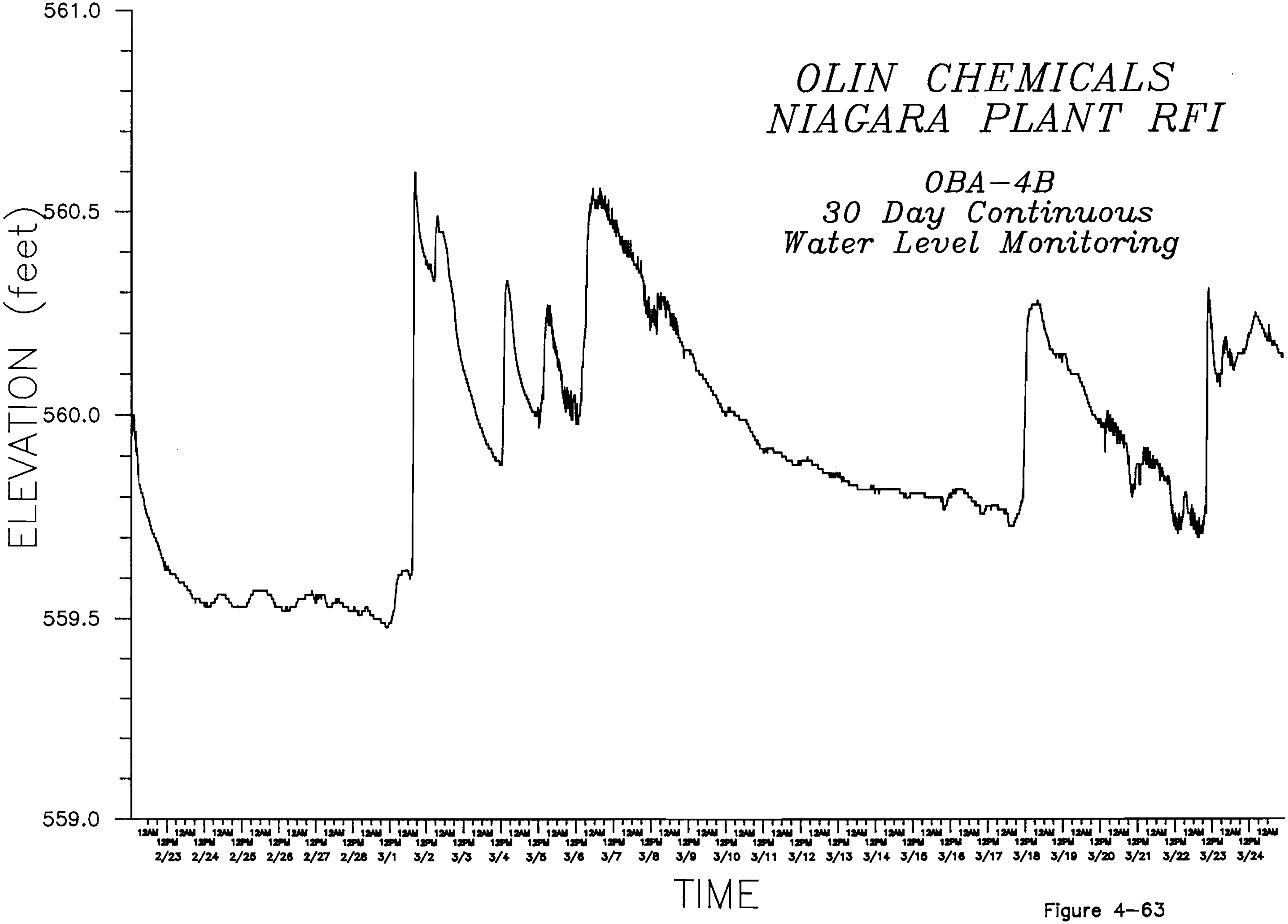
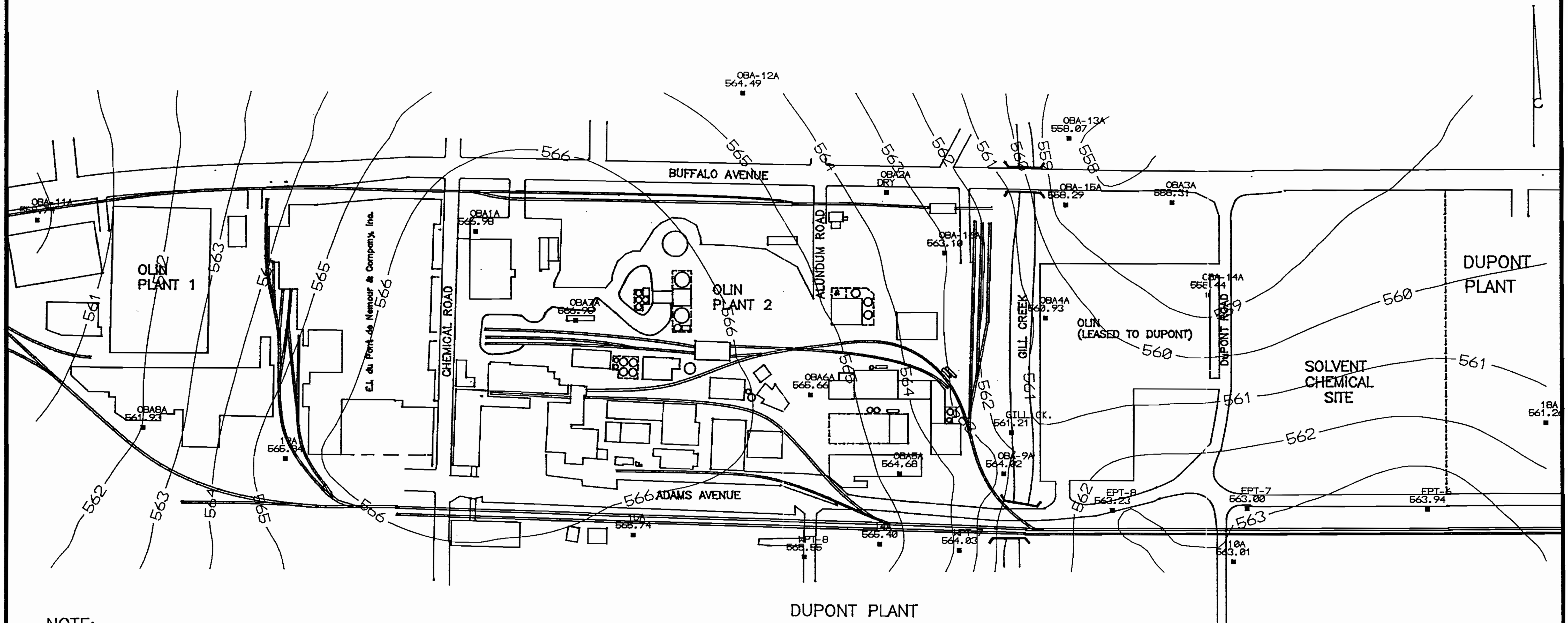


Figure 4-63



NOTE:
ALL GROUNDWATER ELEVATIONS DERIVED FROM WATER LEVEL MEASUREMENTS OBTAINED ON JUNE 10, 1994 DURING THE COORDINATED HYDRAULIC HEAD MONITORING EVENT.

LEGEND:

OBA–8A ⟵ WELL ID
●
561.93 ⟵ GROUNDWATER ELEVATION (IN FEET)

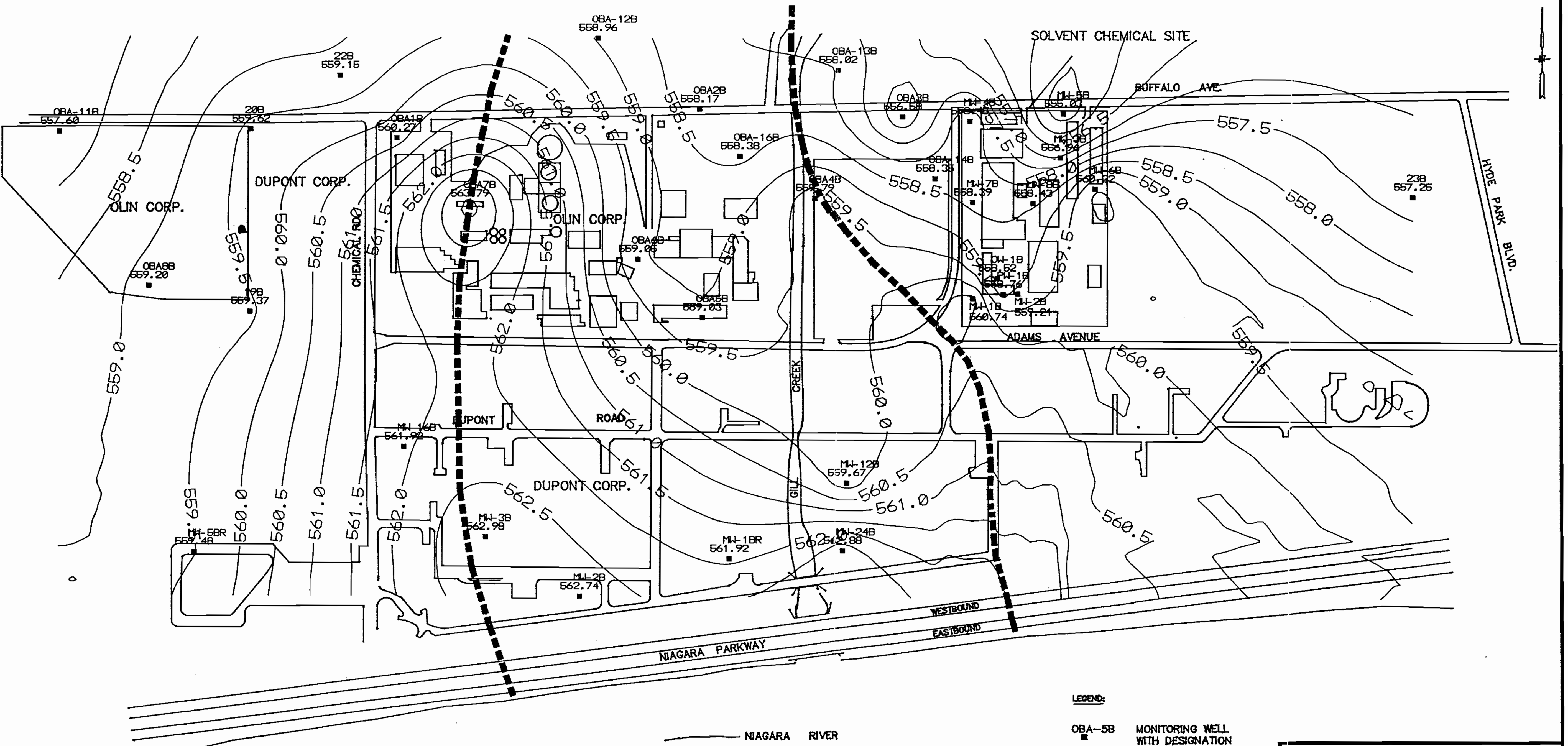
—— 561 —— POTENTIOMETRIC SURFACE CONTOUR LINE (IN FEET)

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD–CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

A–ZONE POTENTIOMETRIC SURFACE CONTOUR MAP: OLIN FACILITY AND SURROUNDING AREA

Job No.: 4E02704	Drawing No. AZFINAL	Date: 07–27–94
Checked by: KRM	Rev. No.:	FIGURE 4–64
Scale: 0 — 200 Feet		



LEGEND:

OBA–5B ■ 559.03 — MONITORING WELL WITH DESIGNATION AND GROUNDWATER ELEVATION (IN FEET)

—562— POTENTIOMETRIC SURFACE CONTOUR LINE (IN FEET)

■■■■■ FLOW DIVIDE LINE

NOTE: ALL GROUNDWATER ELEVATIONS DERIVED FROM WATER LEVEL MEASUREMENTS OBTAINED ON JUNE 10, 1994 DURING THE COORDINATED HYDRAULIC HEAD MONITORING EVENT.

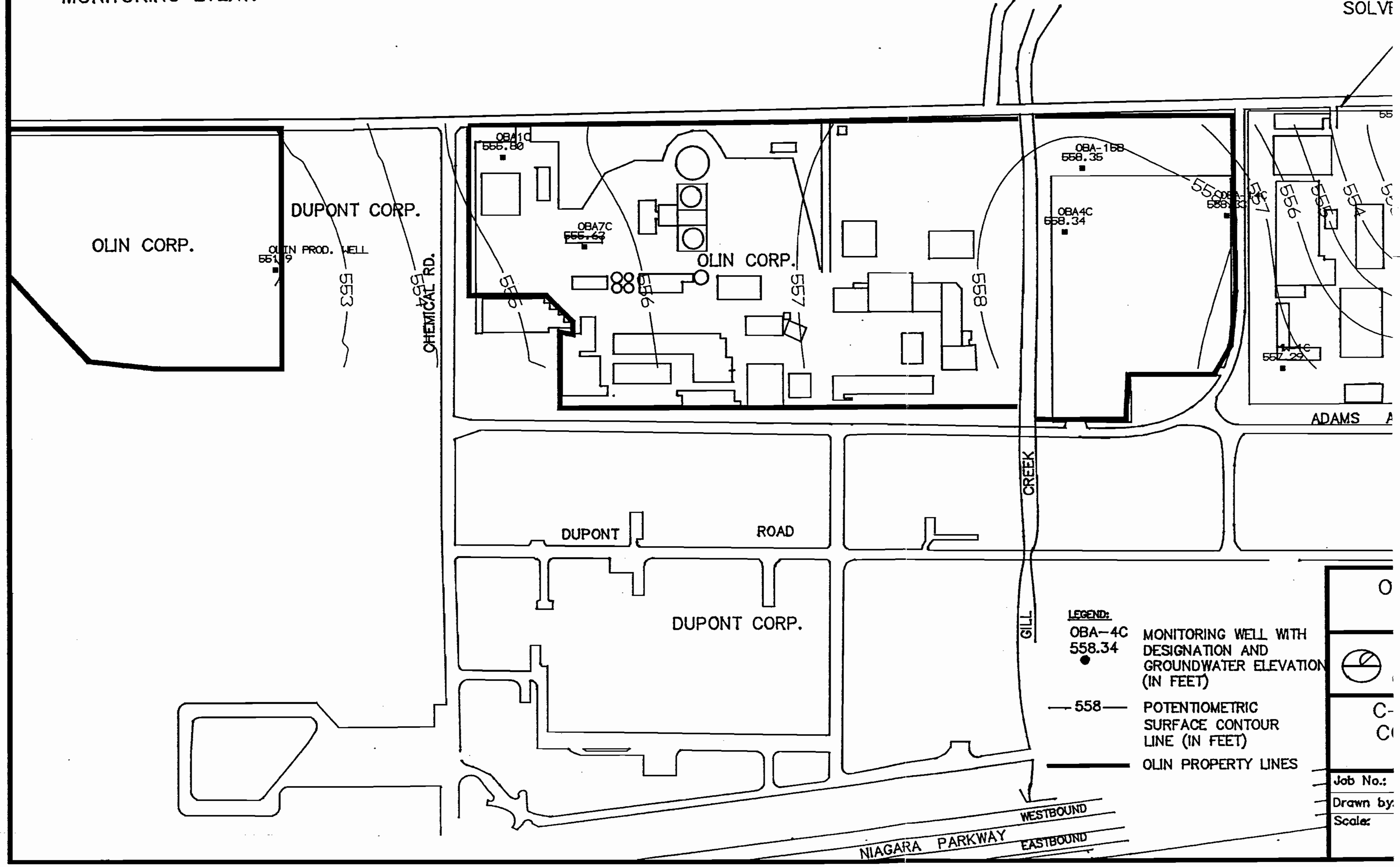
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

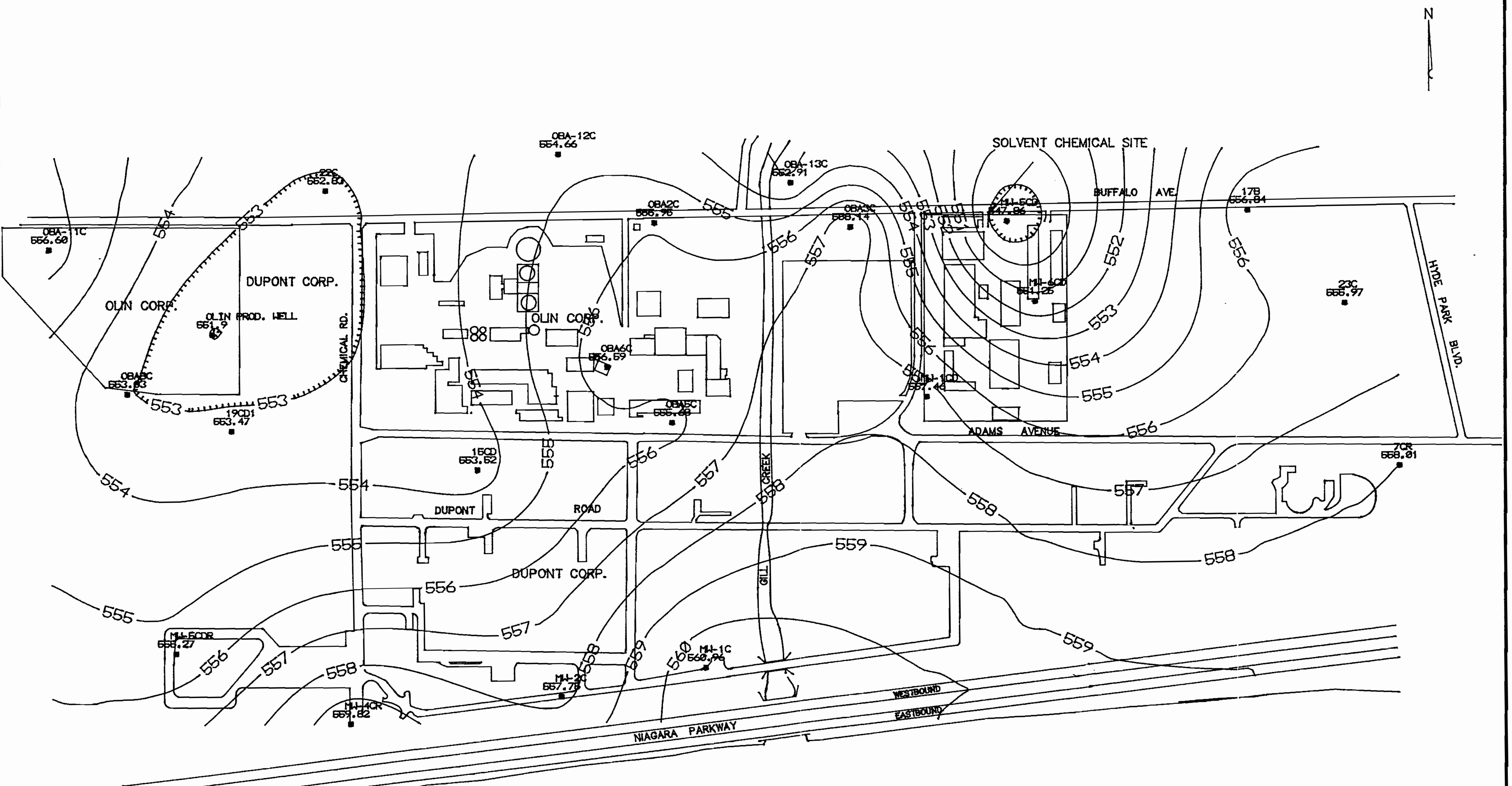
WOODWARD–CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

B–ZONE POTENTIOMETRIC SURFACE
CONTOUR MAP: OLIN FACILITY AND
SURROUNDING AREA

Job No.: 4E02704	Drawing No. BZFINAL	Date: 7/28/94
Drawn by: FRG	Checked by: KRM	FIGURE 4–65
Scale: 0 — 300 FEET		

NOTE:
ALL GROUNDWATER ELEVATIONS DERIVED FROM WATER LEVEL MEASUREMENTS OBTAINED ON JUNE 10, 1994 DURING THE COORDINATED HYDRAULIC HEAD MONITORING EVENT.





LEGEND:

OBA-12C
554.66
● MONITORING WELL WITH DESIGNATION AND GROUND-WATER ELEVATION (IN FEET)

—— 562 —— POTENTIOMETRIC SURFACE CONTOUR LINE

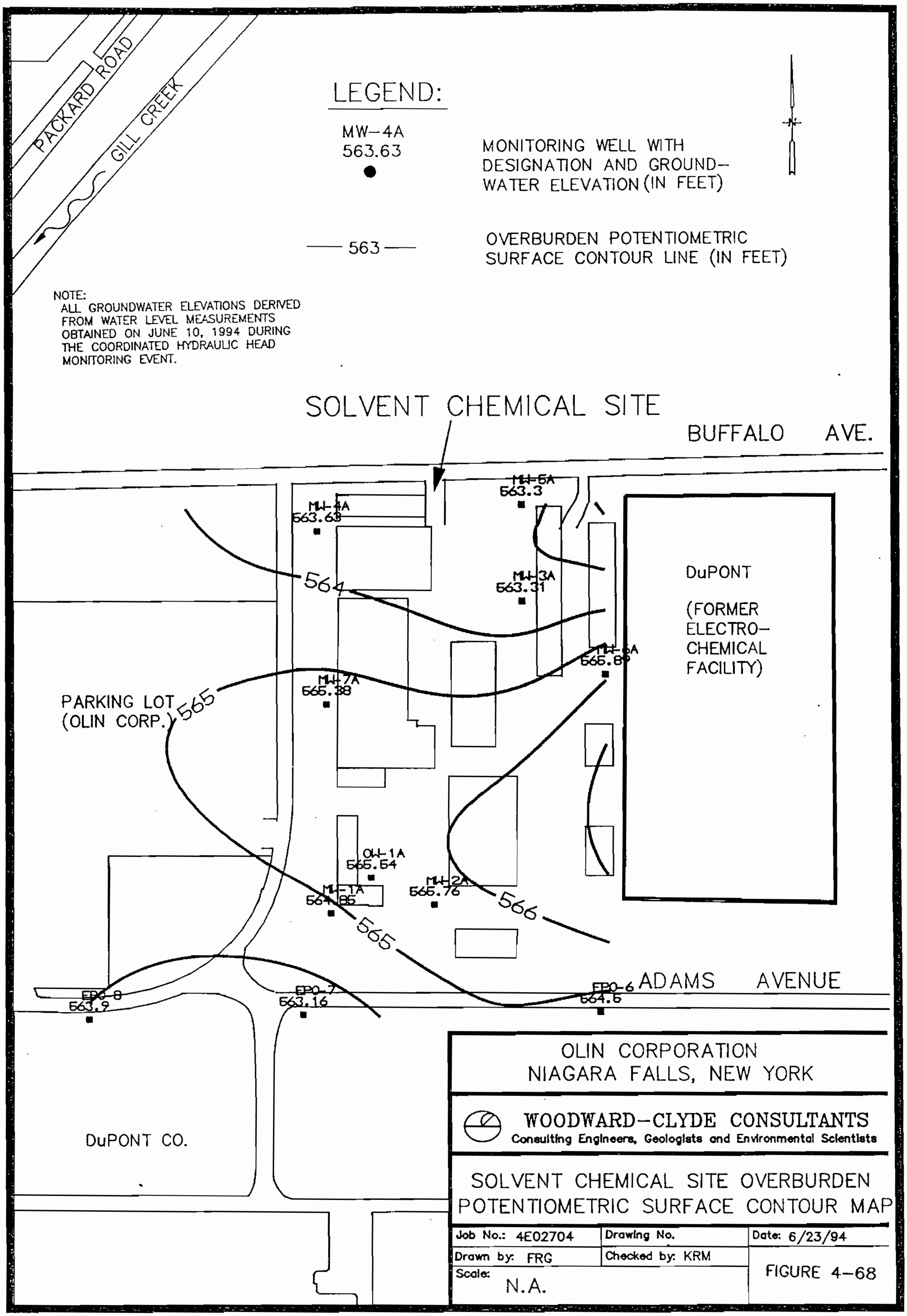
NOTE:
ALL GROUNDWATER ELEVATIONS DERIVED FROM WATER LEVEL MEASUREMENTS OBTAINED ON JUNE 10, 1994 DURING THE COORDINATED HYDRAULIC HEAD MONITORING EVENT.

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

CD-ZONE POTENTIOMETRIC SURFACE CONTOUR MAP:
OLIN FACILITY AND SURROUNDING AREA

Job No.: 4E02704	Drawing No.	Date: 6-20-94
Drawn by: FRG	Checked by: KRM	FIGURE 4-67
Scale: 0 200 FEET		



LEGEND:

MW-4A 563.63 ●	MONITORING WELL WITH DESIGNATION AND GROUND-WATER ELEVATION (IN FEET)
—— 563 ——	OVERBURDEN POTENTIOMETRIC SURFACE CONTOUR LINE (IN FEET)

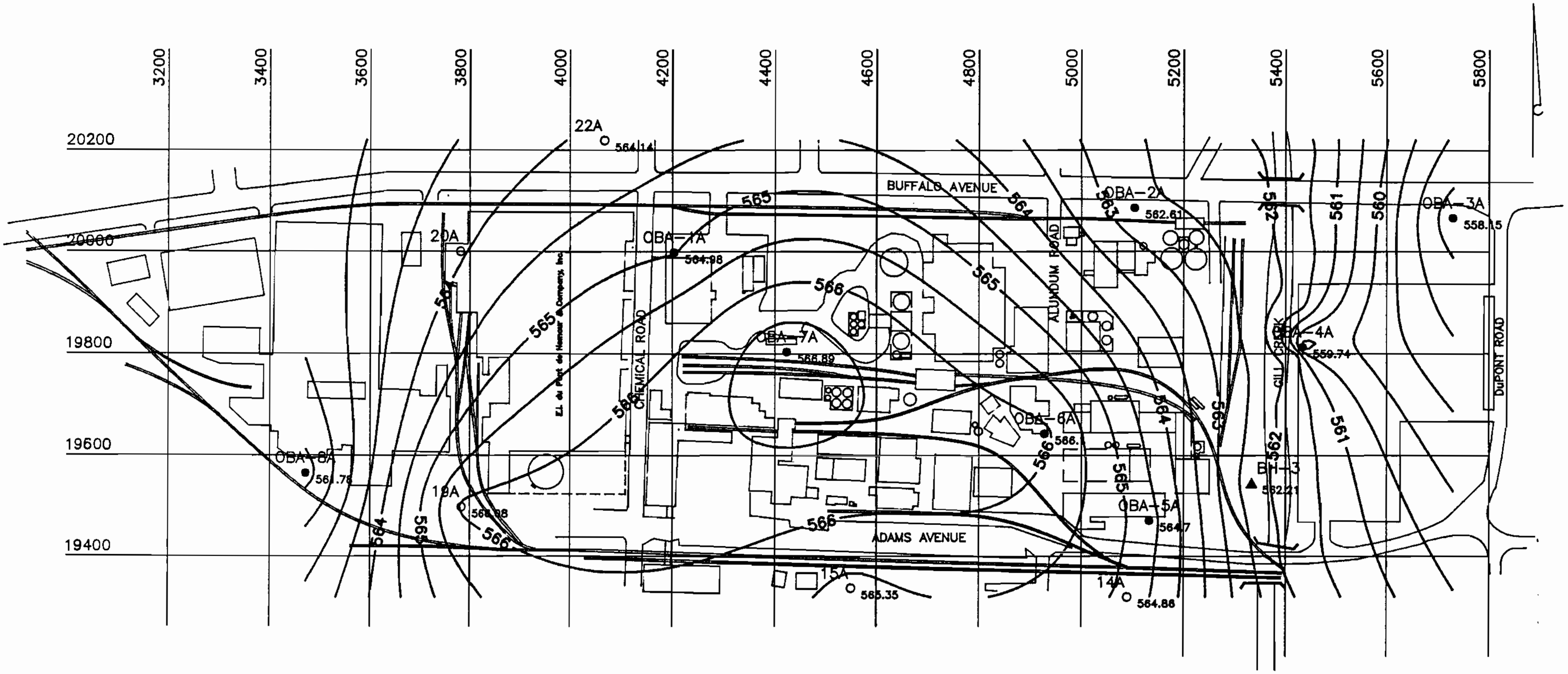
NOTE:
ALL GROUNDWATER ELEVATIONS DERIVED FROM WATER LEVEL MEASUREMENTS OBTAINED ON JUNE 10, 1994 DURING THE COORDINATED HYDRAULIC HEAD MONITORING EVENT.

OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

SOLVENT CHEMICAL SITE OVERBURDEN
POTENTIOMETRIC SURFACE CONTOUR MAP

Job No.: 4E02704	Drawing No.	Date: 6/23/94
Drawn by: FRG	Checked by: KRM	FIGURE 4-68
Scale: N.A.		



DATE/TIME OF MEASUREMENT: 2/6/91, 1500 hours

ELAPSED TIME FROM START OF PUMP TEST: Not applicable

STATIC WATER LEVEL AT GILL CREEK: 561.82

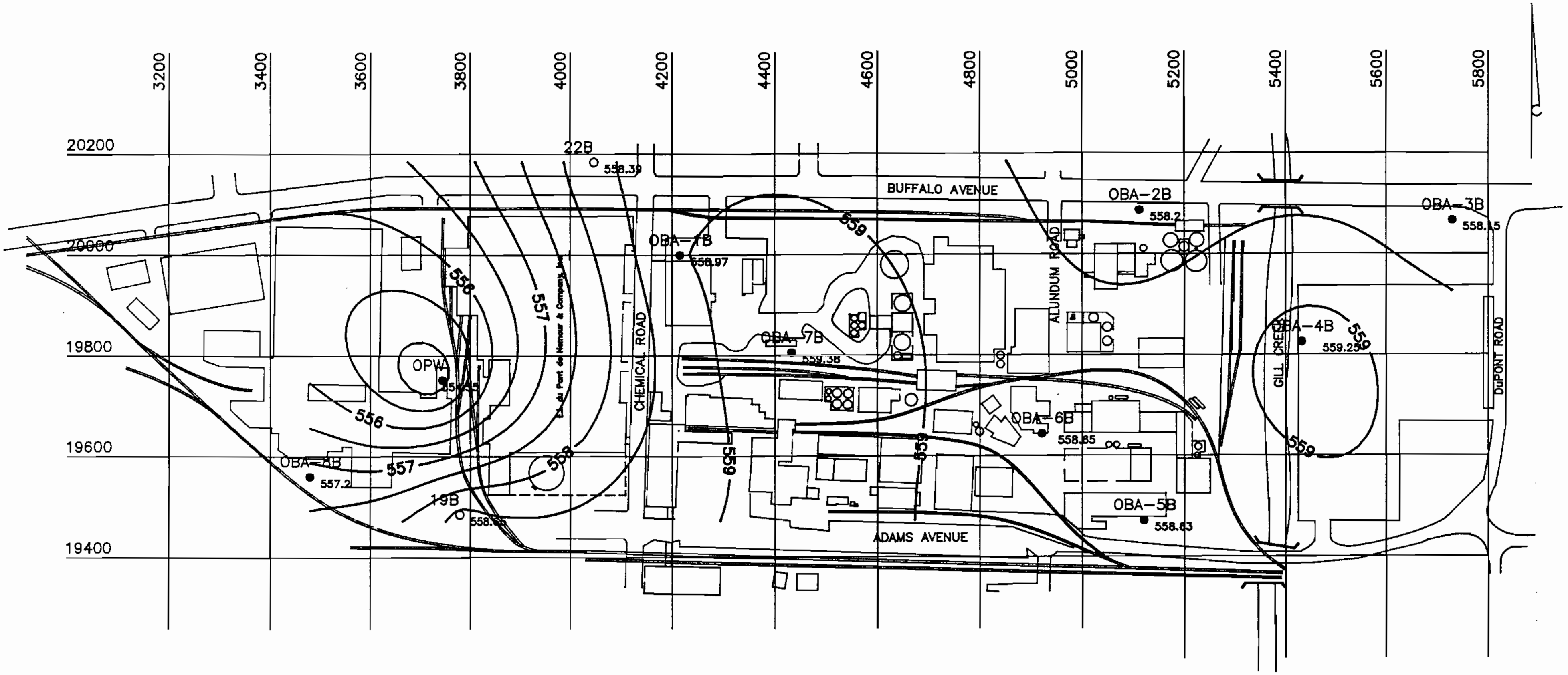
PRODUCTION WELL PUMPING RATE: 570 gpm

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
PRE-PUMP TEST MONITORING

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-1
Scale: 0 200 Feet		



DATE/TIME OF MEASUREMENT: 2/6/91, 1500 hours

ELAPSED TIME FROM START OF PUMP TEST: Not applicable

STATIC WATER LEVEL AT GILL CREEK: 561.82

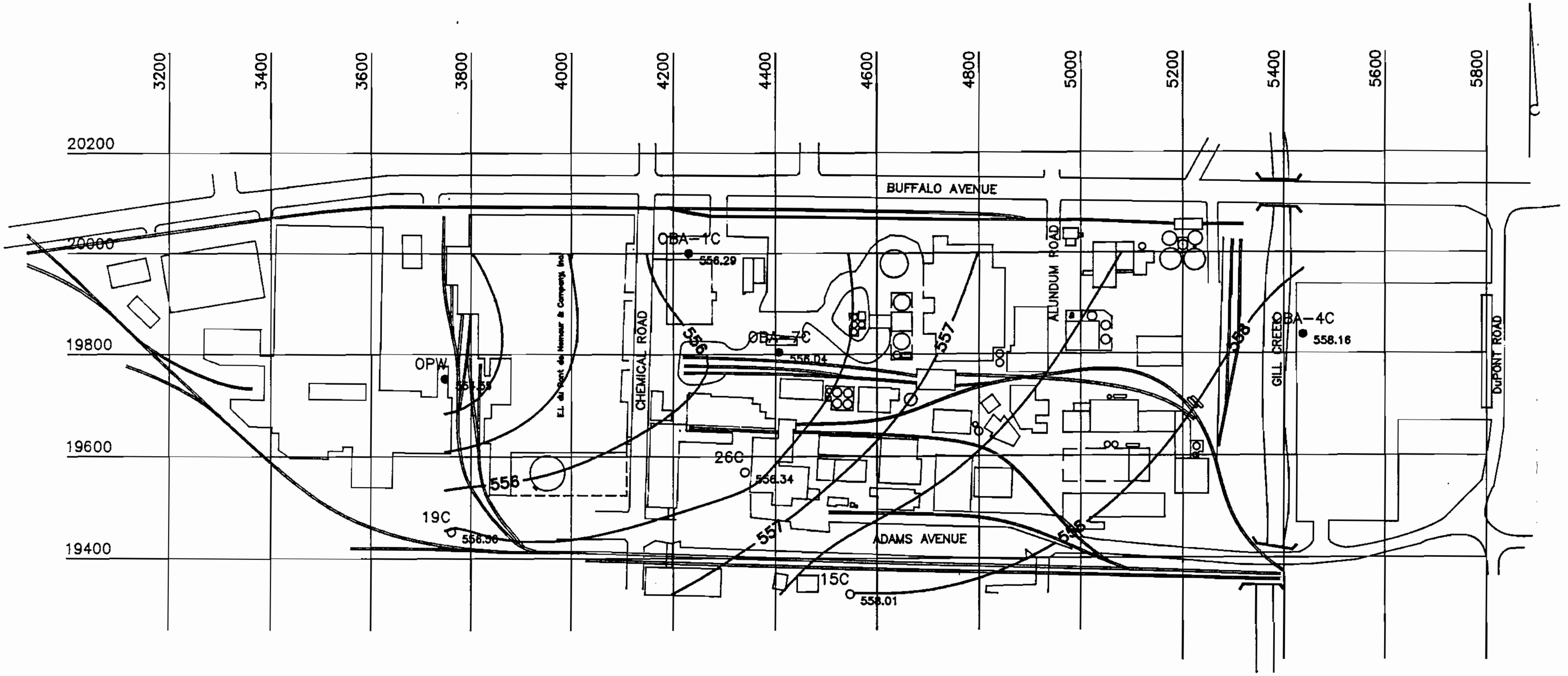
PRODUCTION WELL PUMPING RATE: 570 gpm

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
PRE-PUMP TEST MONITORING

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-2
Scale: 0 — 200 Feet		



DATE/TIME OF MEASUREMENT: 2/6/91, 1500 hours

ELAPSED TIME FROM START OF PUMP TEST: Not applicable

STATIC WATER LEVEL AT GILL CREEK: 561.82

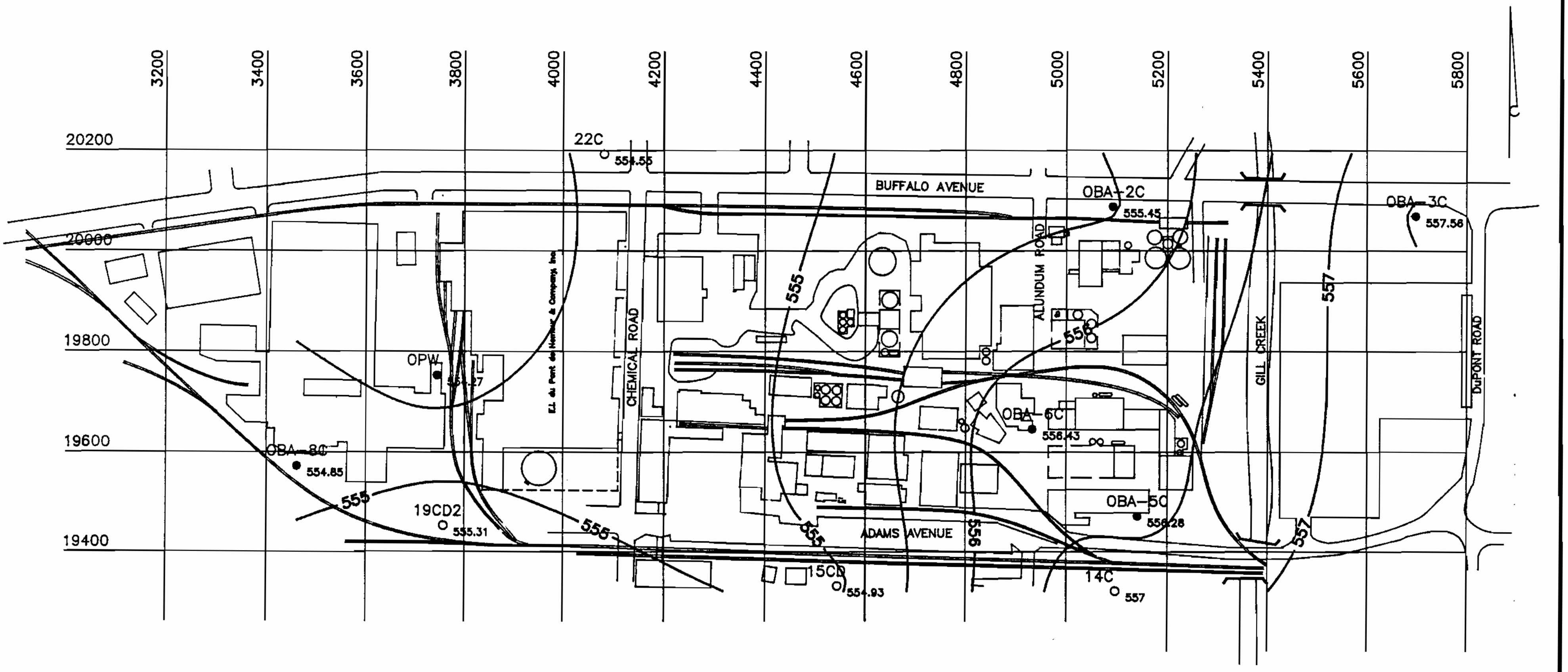
PRODUCTION WELL PUMPING RATE: 570 gpm

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
PRE-PUMP TEST MONITORING

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-3
Scale: 0 — 200 Feet		



DATE/TIME OF MEASUREMENT: 2/6/91, 1500 hours

ELAPSED TIME FROM START OF PUMP TEST: Not applicable

STATIC WATER LEVEL AT GILL CREEK: 561.82

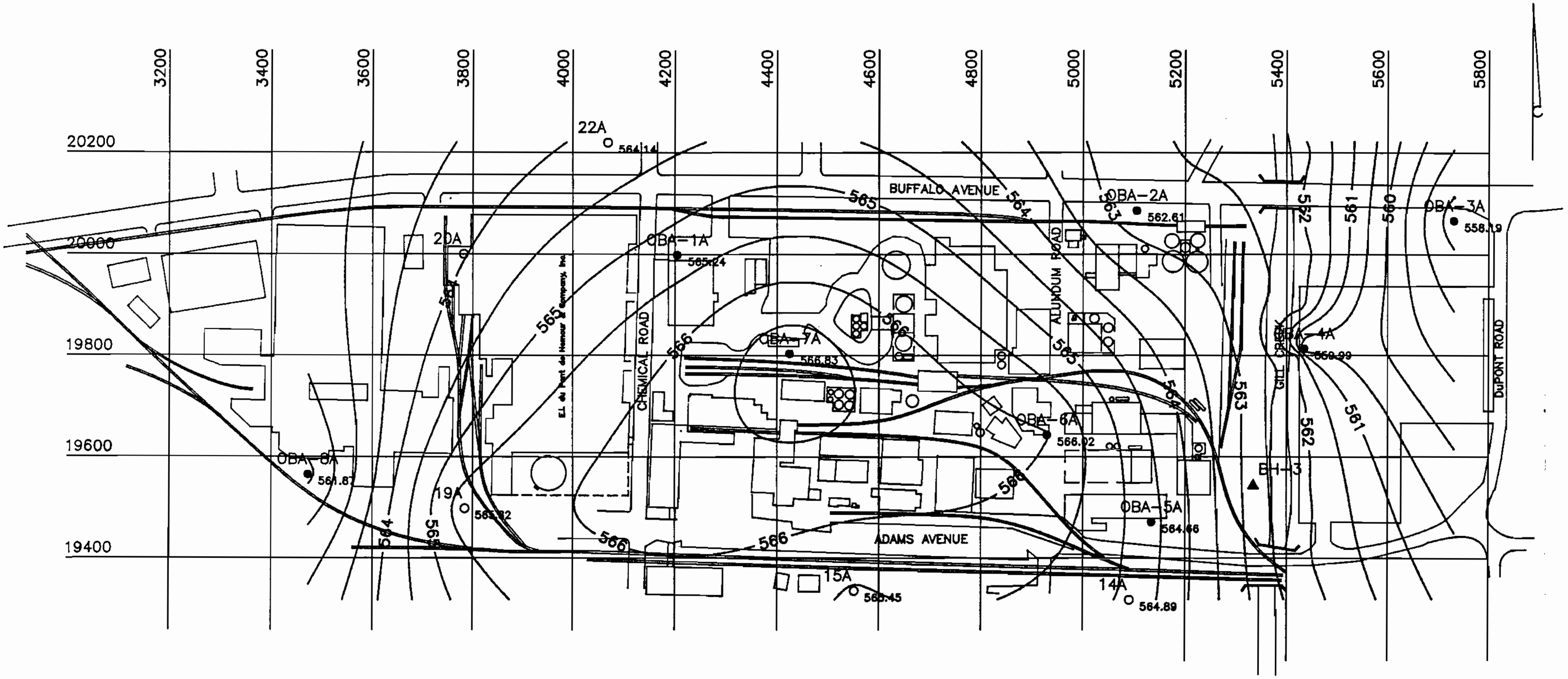
PRODUCTION WELL PUMPING RATE: 570 gpm

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
PRE-PUMP TEST MONITORING

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-4
Scale: 0 200 Feet		



DATE/TIME OF MEASUREMENT: 2/11/91, 1030 hours

ELAPSED TIME FROM START OF PUMP TEST: 93.5 hours

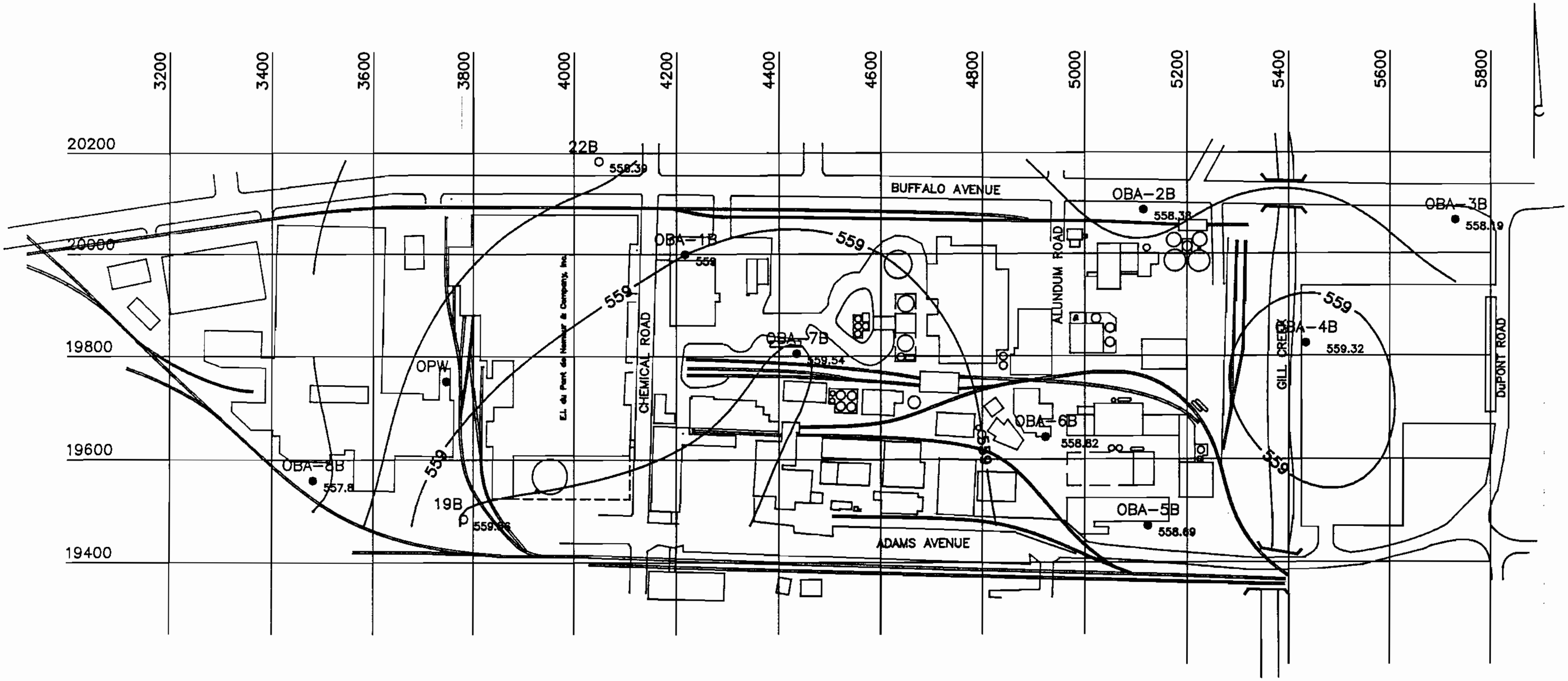
STATIC WATER LEVEL AT GILL CREEK: 562.20

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
RECOVERY STEP (UNSTRESSED CONDITIONS)

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-5
Scale: 0 200 Feet		



DATE/TIME OF MEASUREMENT: 2/11/91, 1030 hours

ELAPSED TIME FROM START OF PUMP TEST: 93.5 hours

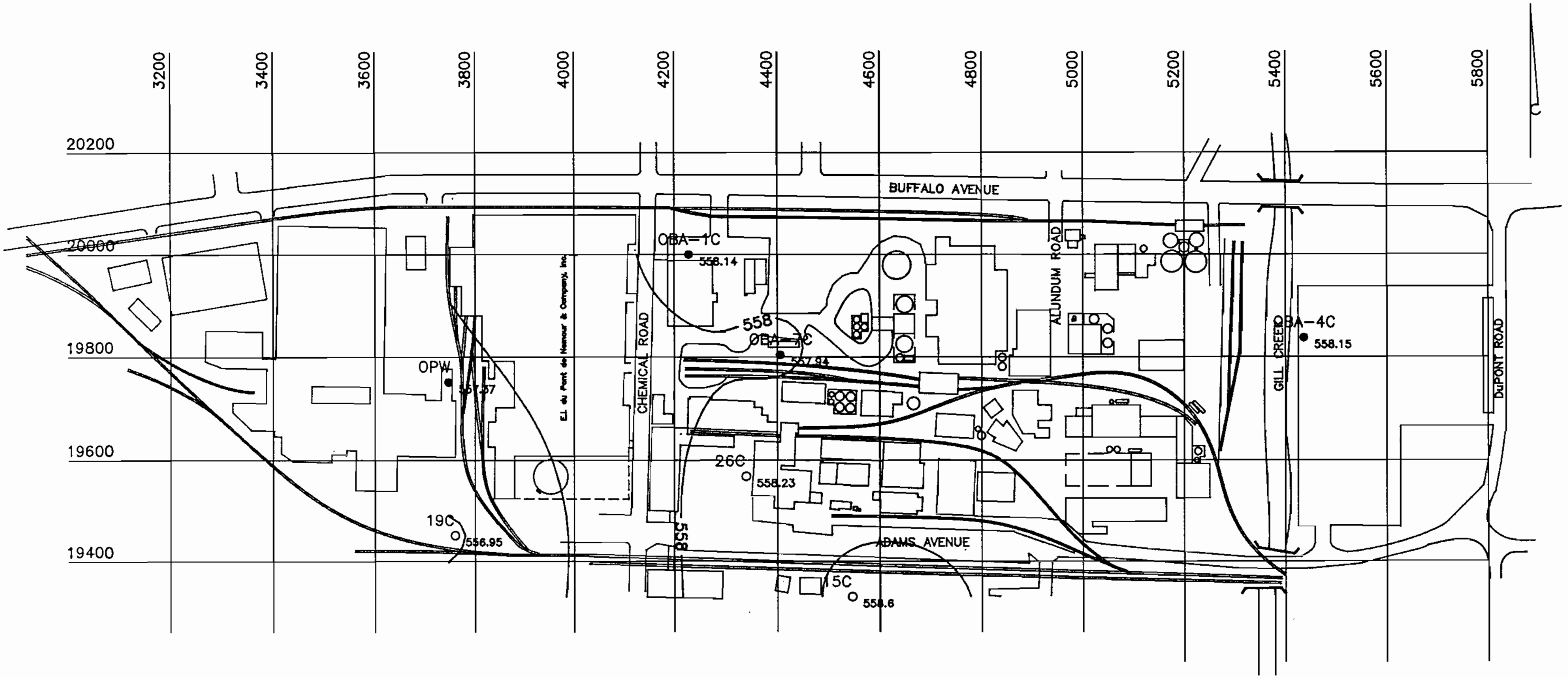
STATIC WATER LEVEL AT GILL CREEK: 562.20

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
RECOVERY STEP (UNSTRESSED CONDITIONS)

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-6
Scale: 0 — 200 Feet		



DATE/TIME OF MEASUREMENT: 2/11/91, 1030 hours

ELAPSED TIME FROM START OF PUMP TEST: 93.5 hours

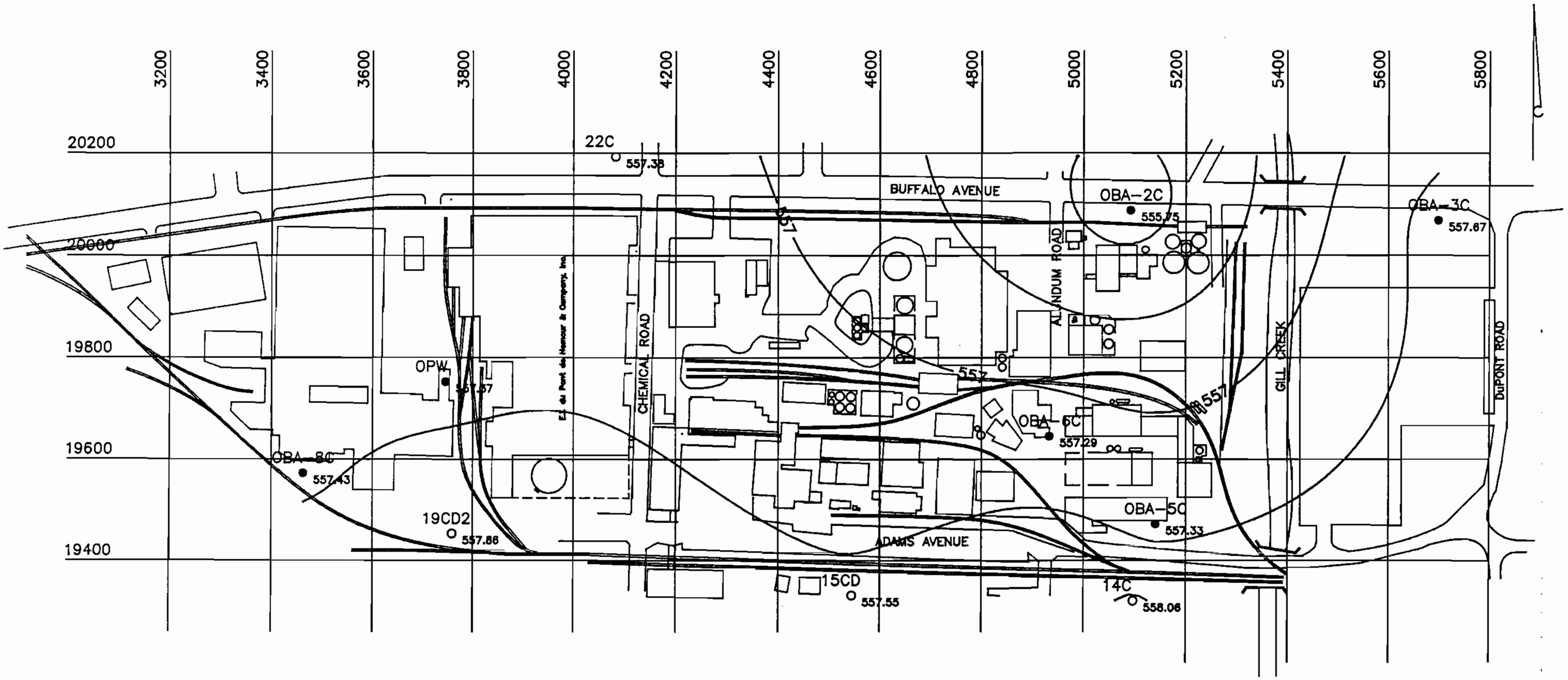
STATIC WATER LEVEL AT GILL CREEK: 562.20

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
RECOVERY STEP (UNSTRESSED CONDITIONS)

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-7
Scale: 0 — 200 Feet		



DATE/TIME OF MEASUREMENT: 2/11/91, 1030 hours

ELAPSED TIME FROM START OF PUMP TEST: 93.5 hours

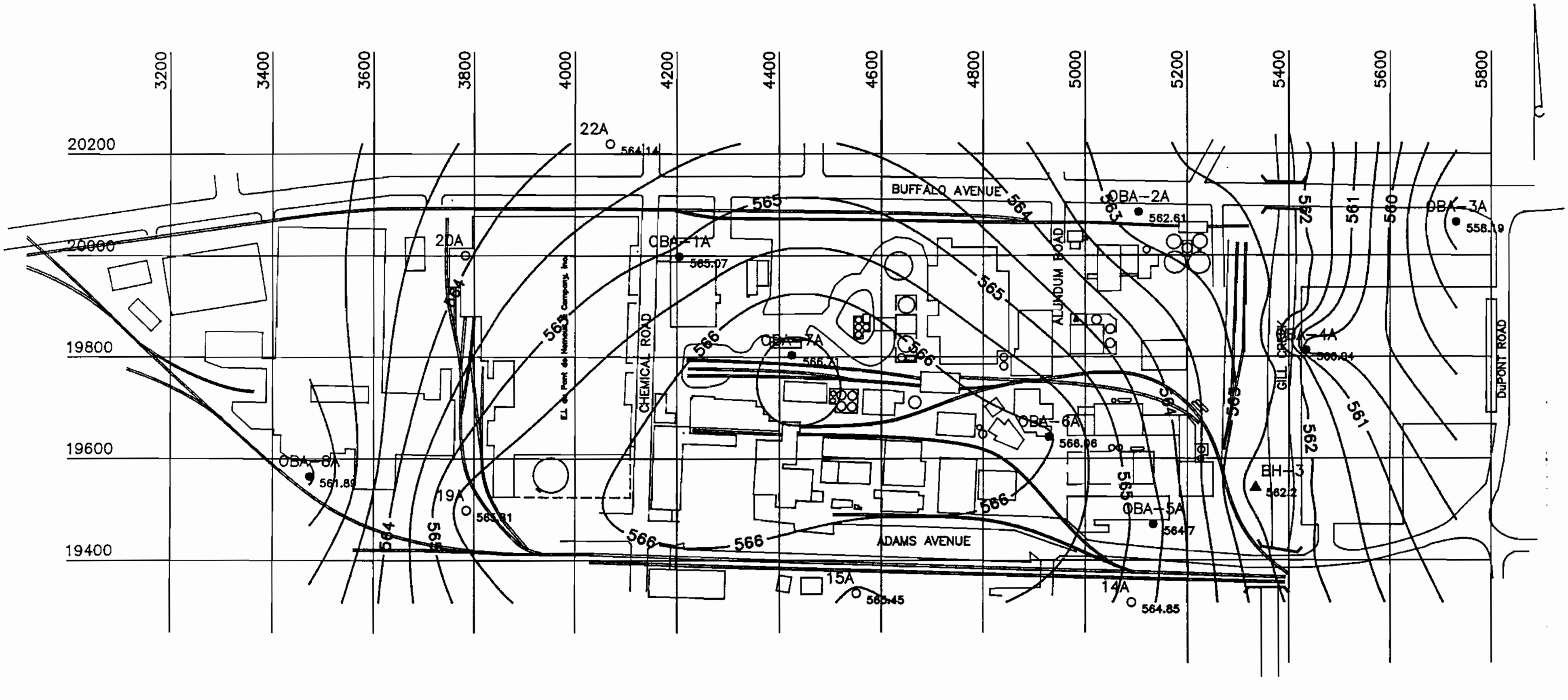
STATIC WATER LEVEL AT GILL CREEK: 562.20

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
RECOVERY STEP (UNSTRESSED CONDITIONS)

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-8
Scale: 0 200 Feet		



DATE/TIME OF MEASUREMENT: 2/14/91, 1130 hours

ELAPSED TIME FROM START OF PUMP TEST: 166.5 hours

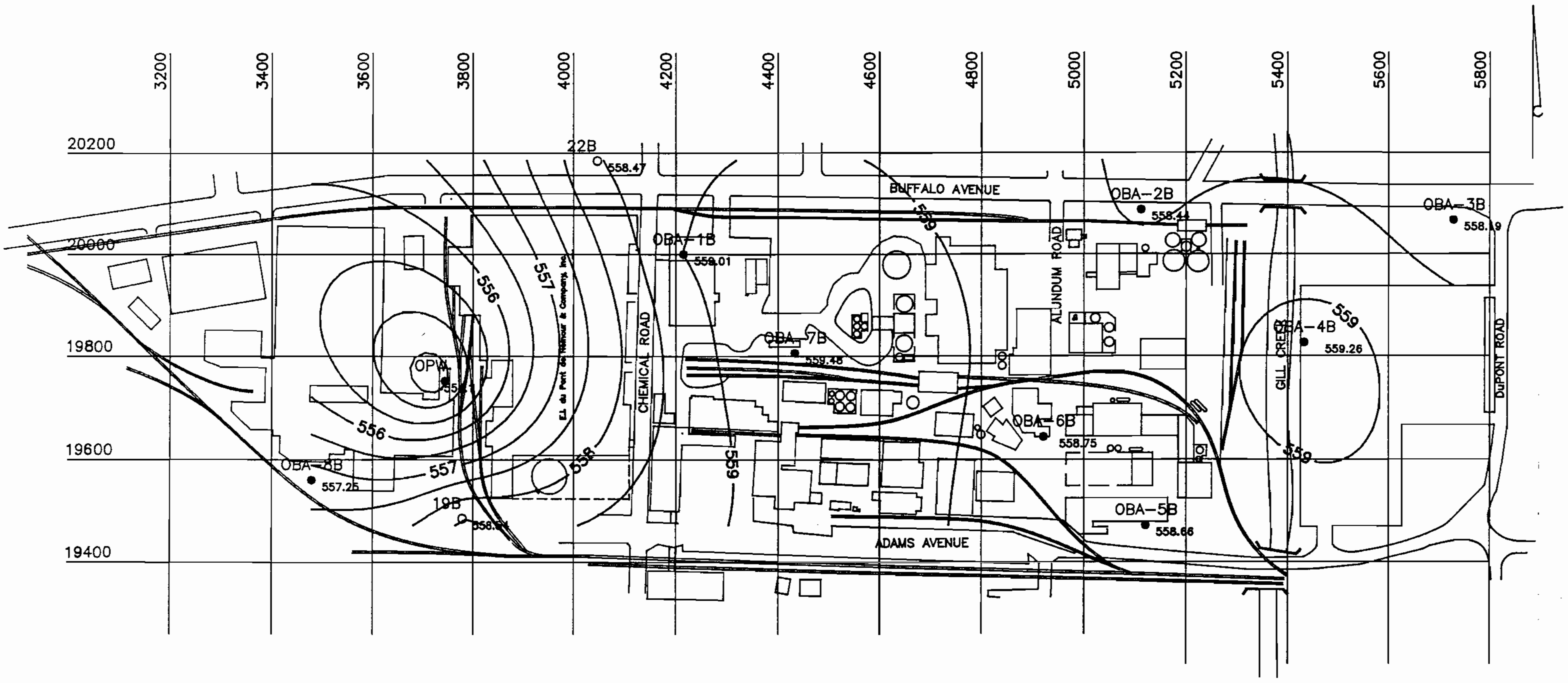
STATIC WATER LEVEL AT GILL CREEK: 562.18

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
500 GPM PUMPING STEP: STEP2

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-9
Scale: 0 — 200 Feet		



DATE/TIME OF MEASUREMENT: 2/14/91, 1130 hours

ELAPSED TIME FROM START OF PUMP TEST: 166.5 hours

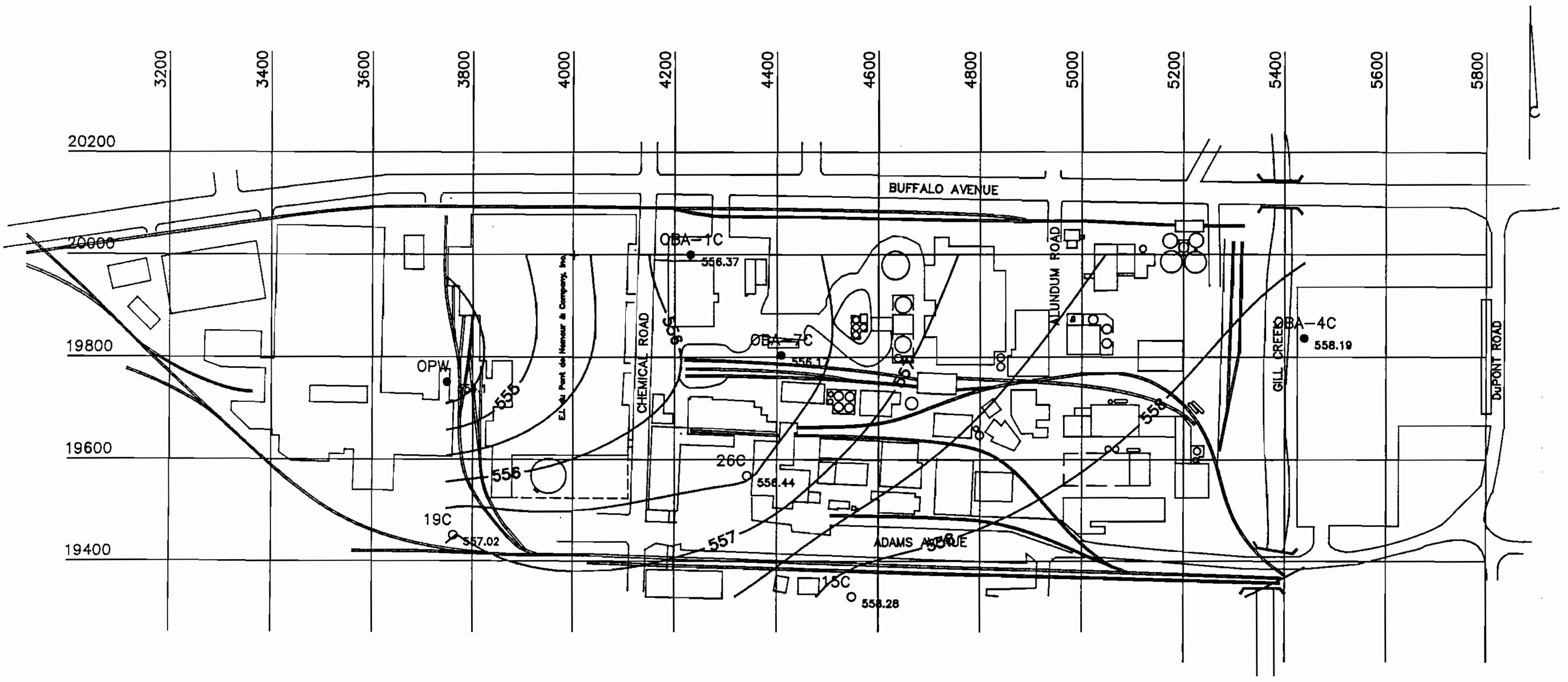
STATIC WATER LEVEL AT GILL CREEK: 562.18

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
500 GPM PUMPING STEP: STEP2

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-10
Scale: 0 200 Feet		



DATE/TIME OF MEASUREMENT: 2/14/91, 1130 hours

ELAPSED TIME FROM START OF PUMP TEST: 166.5 hours

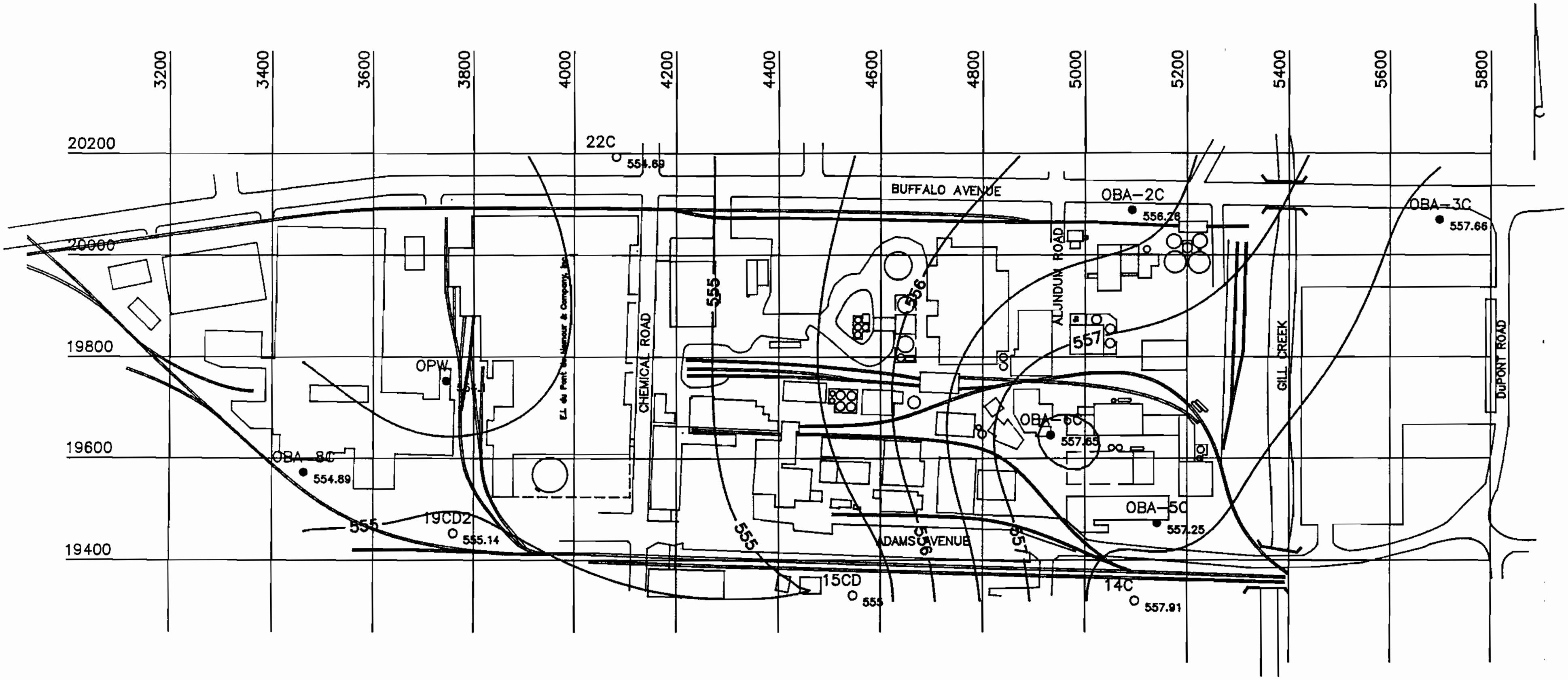
STATIC WATER LEVEL AT GILL CREEK: 562.18

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
500 GPM PUMPING STEP: STEP2

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-11
Scale: 0 — 200 Feet		



DATE/TIME OF MEASUREMENT: 2/14/91, 1130 hours

ELAPSED TIME FROM START OF PUMP TEST: 166.5 hours

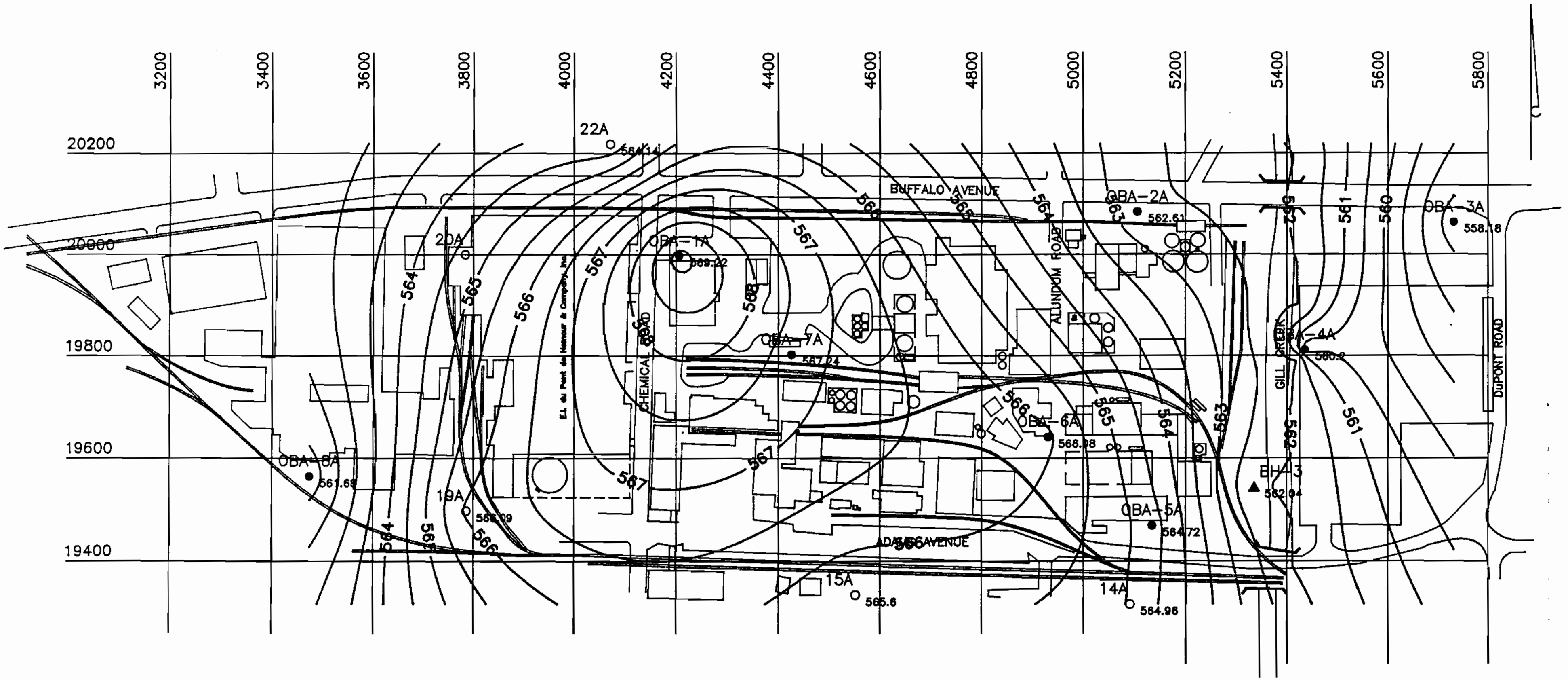
STATIC WATER LEVEL AT GILL CREEK: 562.18

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
500 GPM PUMPING STEP: STEP2

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-12
Scale: 0 200 Feet		



DATE/TIME OF MEASUREMENT: 2/19/91, 1000 hours

ELAPSED TIME FROM START OF PUMP TEST: 285 hours

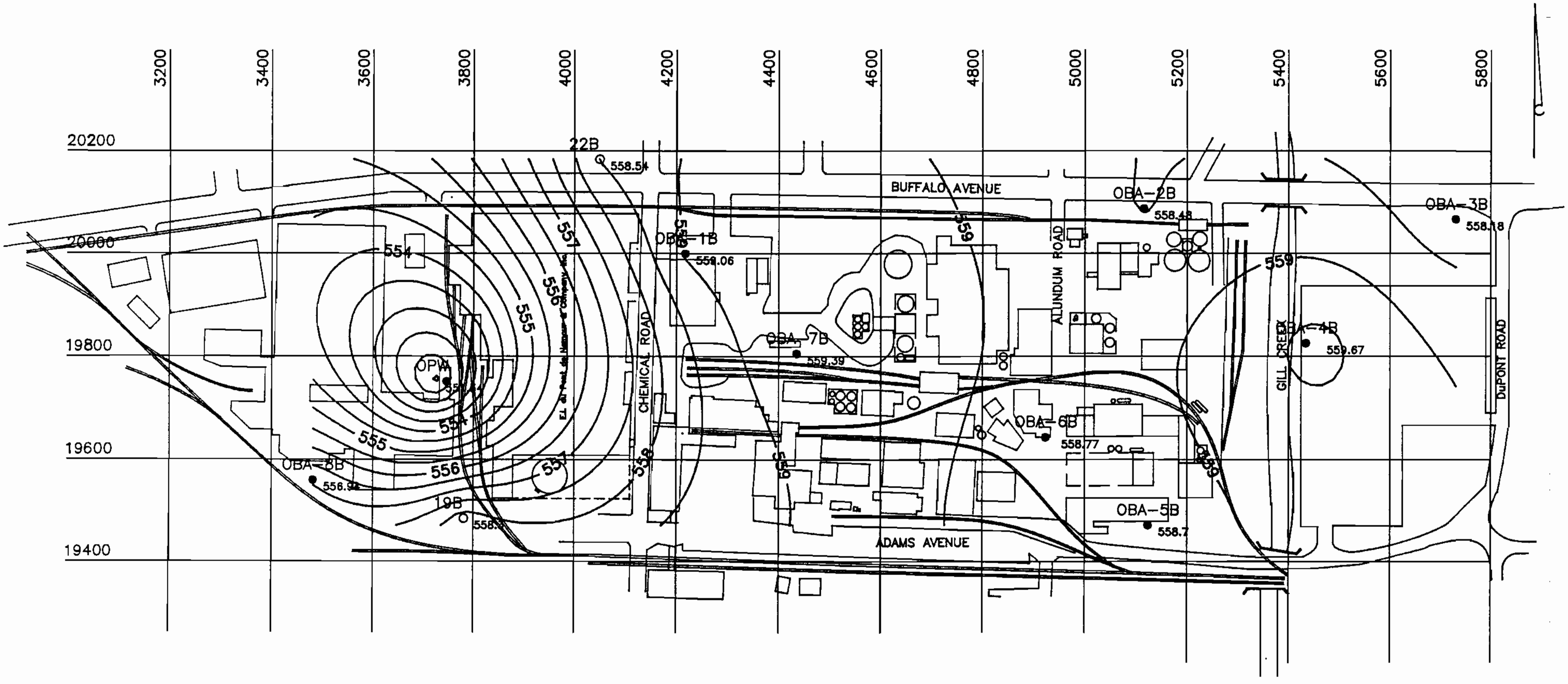
STATIC WATER LEVEL AT GILL CREEK: 561.99

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
1000 GPM PUMPING STEP: STEP 3

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-13
Scale: 0 200 Feet		



DATE/TIME OF MEASUREMENT: 2/19/91, 1000 hours

ELAPSED TIME FROM START OF PUMP TEST: 285 hours

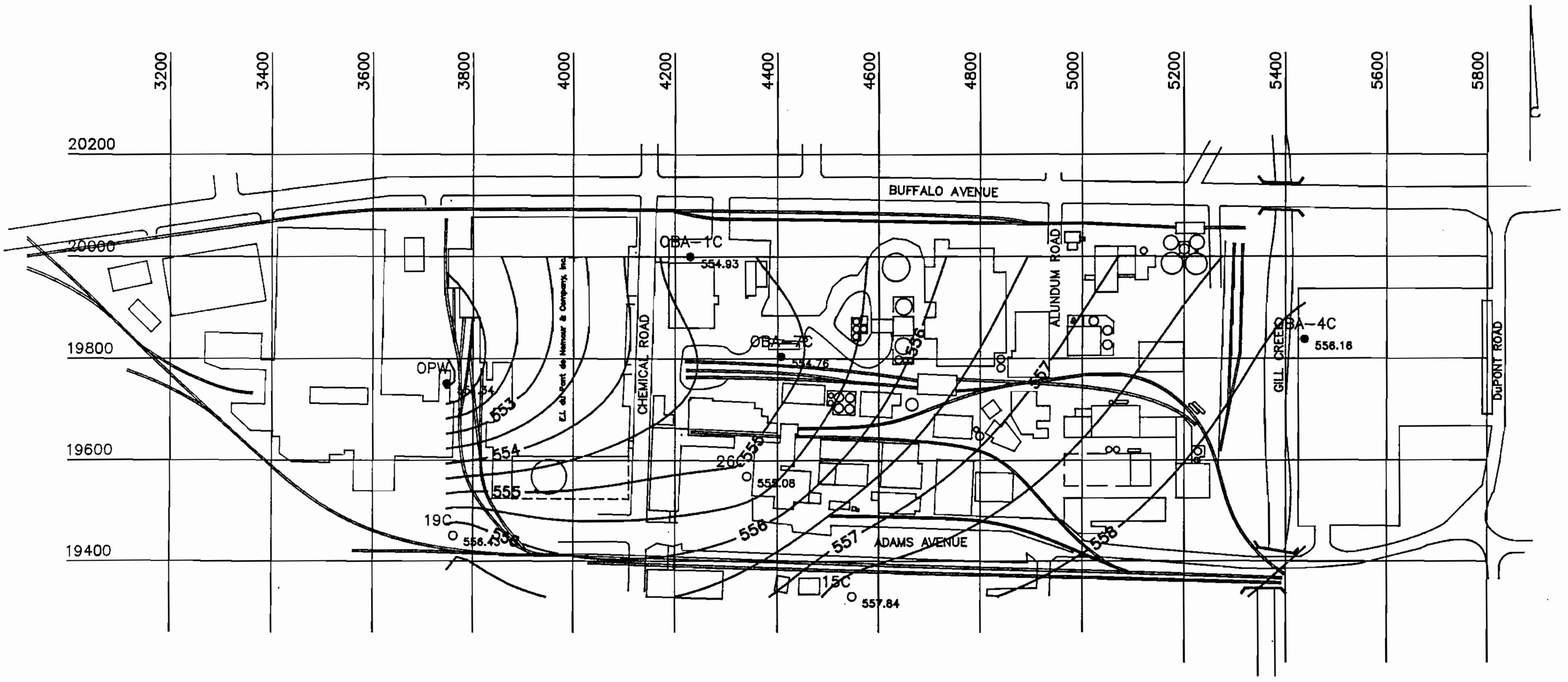
STATIC WATER LEVEL AT GILL CREEK: 561.99

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
1000 GPM PUMPING STEP: STEP 3

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-14
Scale: 0 — 200 Feet		



DATE/TIME OF MEASUREMENT: 2/19/91, 1000 hours

ELAPSED TIME FROM START OF PUMP TEST: 285 hours

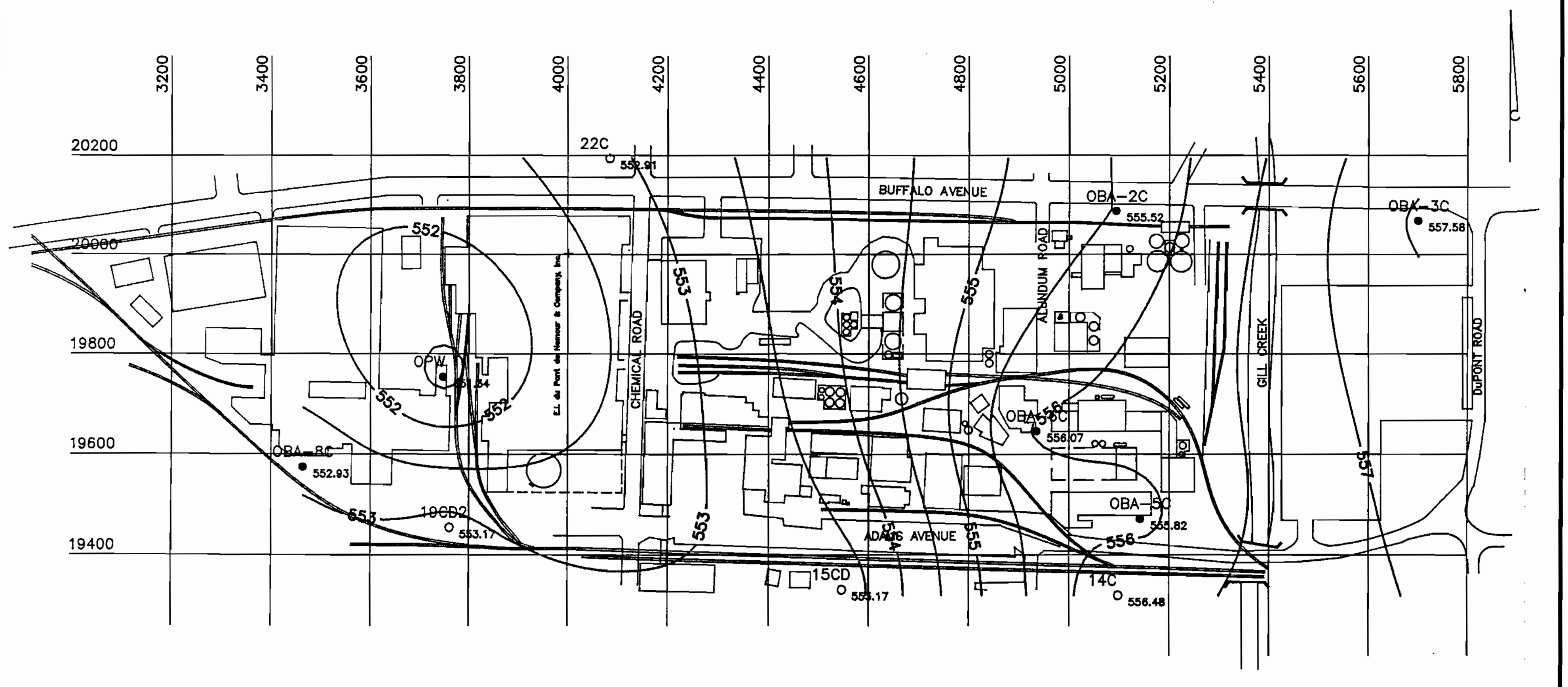
STATIC WATER LEVEL AT GILL CREEK: 561.99

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
1000 GPM PUMPING STEP: STEP 3

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-15
Scale: 0 200 Feet		



DATE/TIME OF MEASUREMENT: 2/19/91, 1000 hours

ELAPSED TIME FROM START OF PUMP TEST: 285 hours

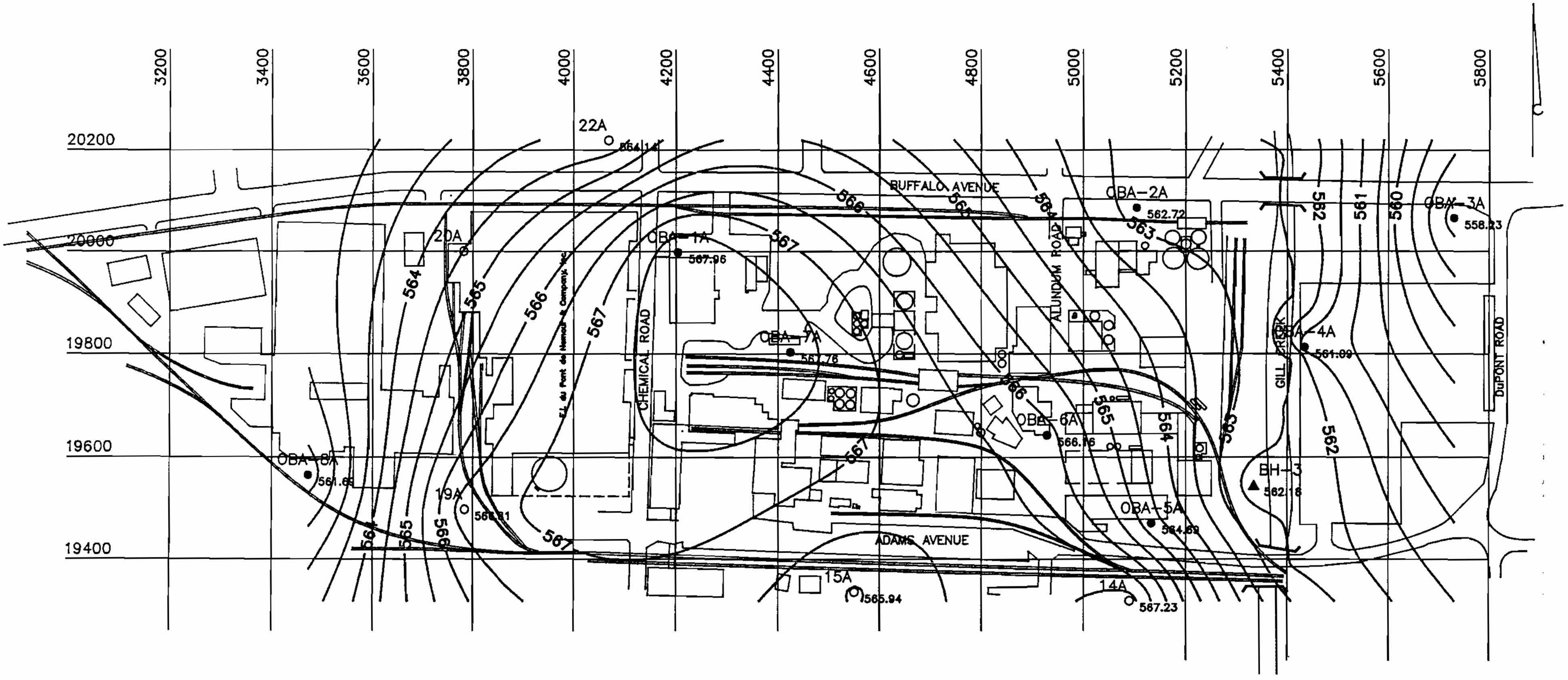
STATIC WATER LEVEL AT GILL CREEK: 561.99

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
1000 GPM PUMPING STEP: STEP 3

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-16
Scale: 0 — 200 Feet		



DATE/TIME OF MEASUREMENT: 2/21/91, 1030 hours

ELAPSED TIME FROM START OF PUMP TEST: 333.5 hours

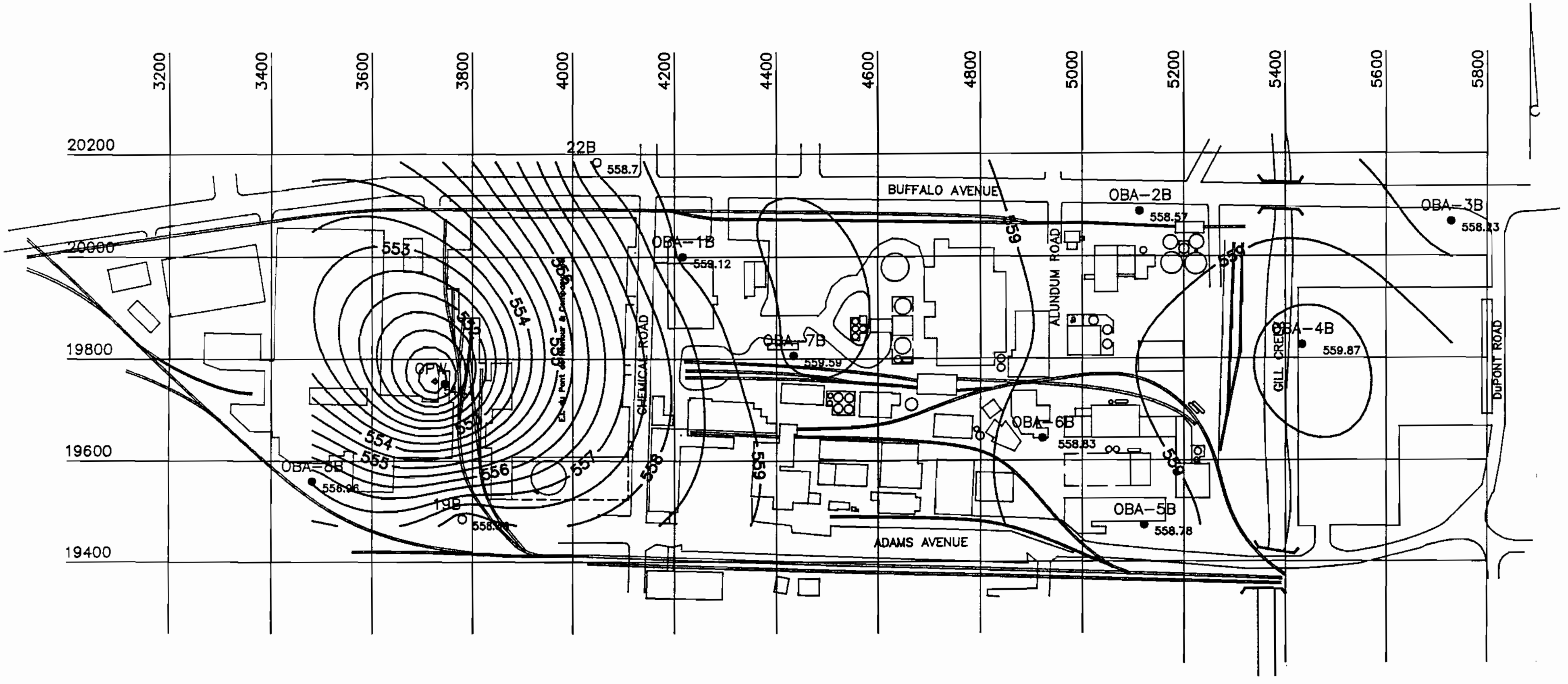
STATIC WATER LEVEL AT GILL CREEK: 562.45

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
A-ZONE
1500 GPM PUMPING STEP: STEP 4

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-17
Scale: 0 200 Feet		



DATE/TIME OF MEASUREMENT: 2/21/91, 1030 hours

ELAPSED TIME FROM START OF PUMP TEST: 333.5 hours

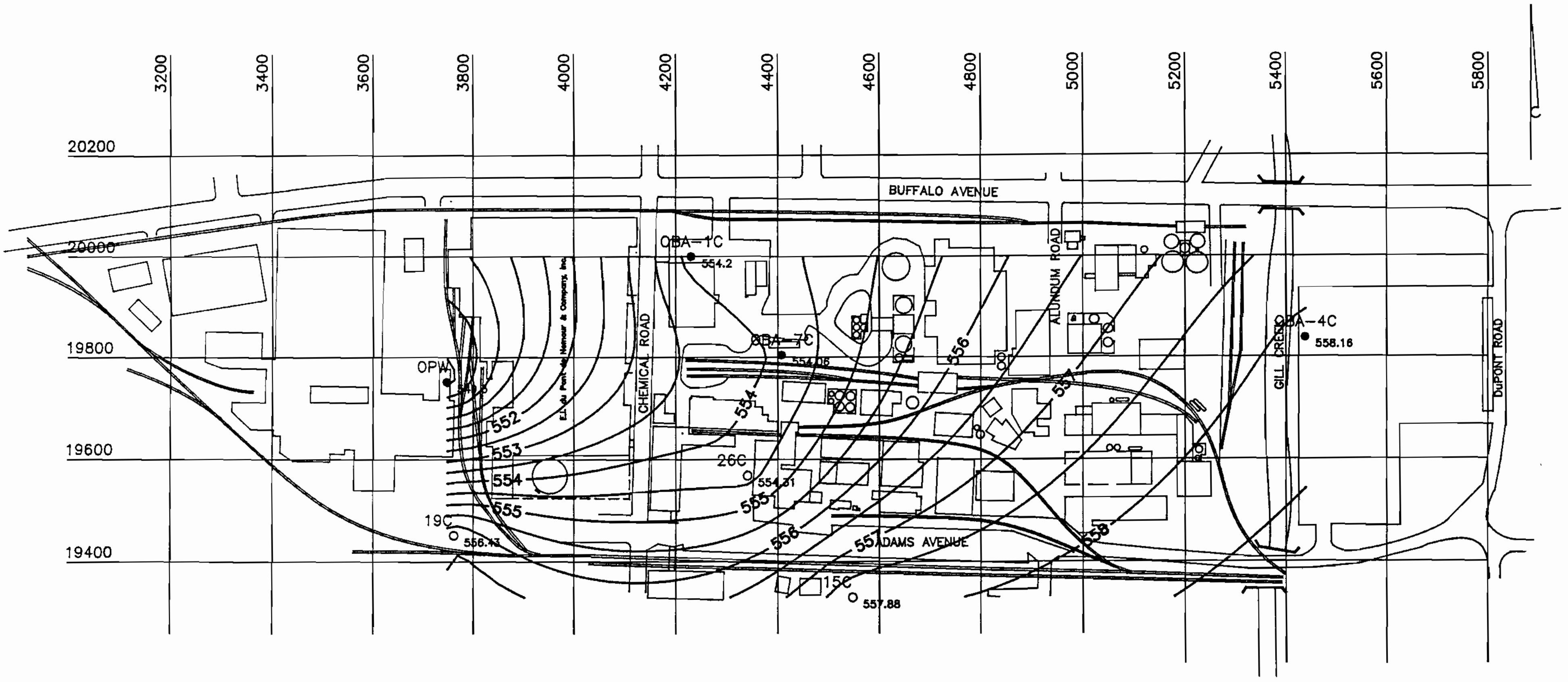
STATIC WATER LEVEL AT GILL CREEK: 562.45

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
B-ZONE
1500 GPM PUMPING STEP: STEP 4

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-18
Scale: 0 200 Feet		



DATE/TIME OF MEASUREMENT: 2/21/91, 1030 hours

ELAPSED TIME FROM START OF PUMP TEST: 333.5 hours

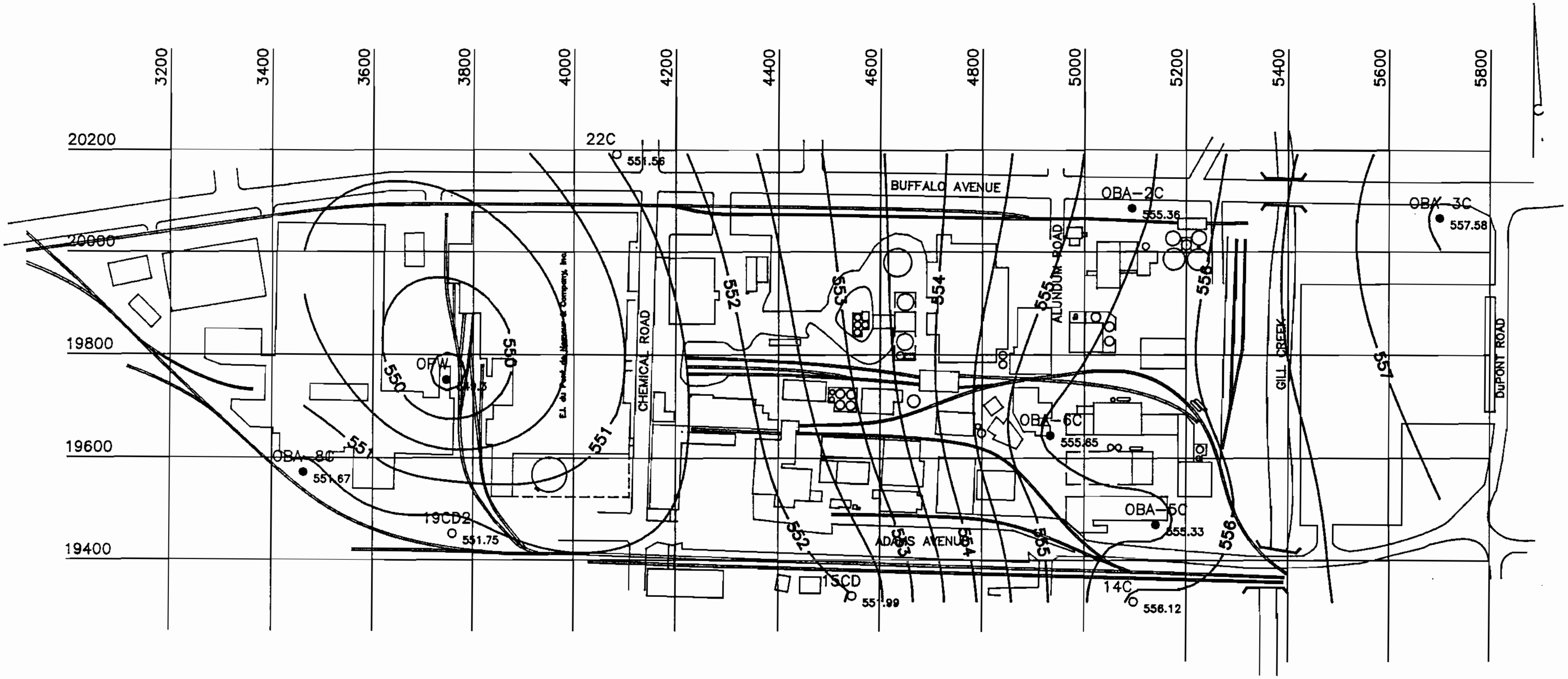
STATIC WATER LEVEL AT GILL CREEK: 562.45

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
C-ZONE
1500 GPM PUMPING STEP: STEP 4

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-19
Scale: 0 — 200 Feet		



DATE/TIME OF MEASUREMENT: 2/21/91, 1030 hours

ELAPSED TIME FROM START OF PUMP TEST: 333.5 hours

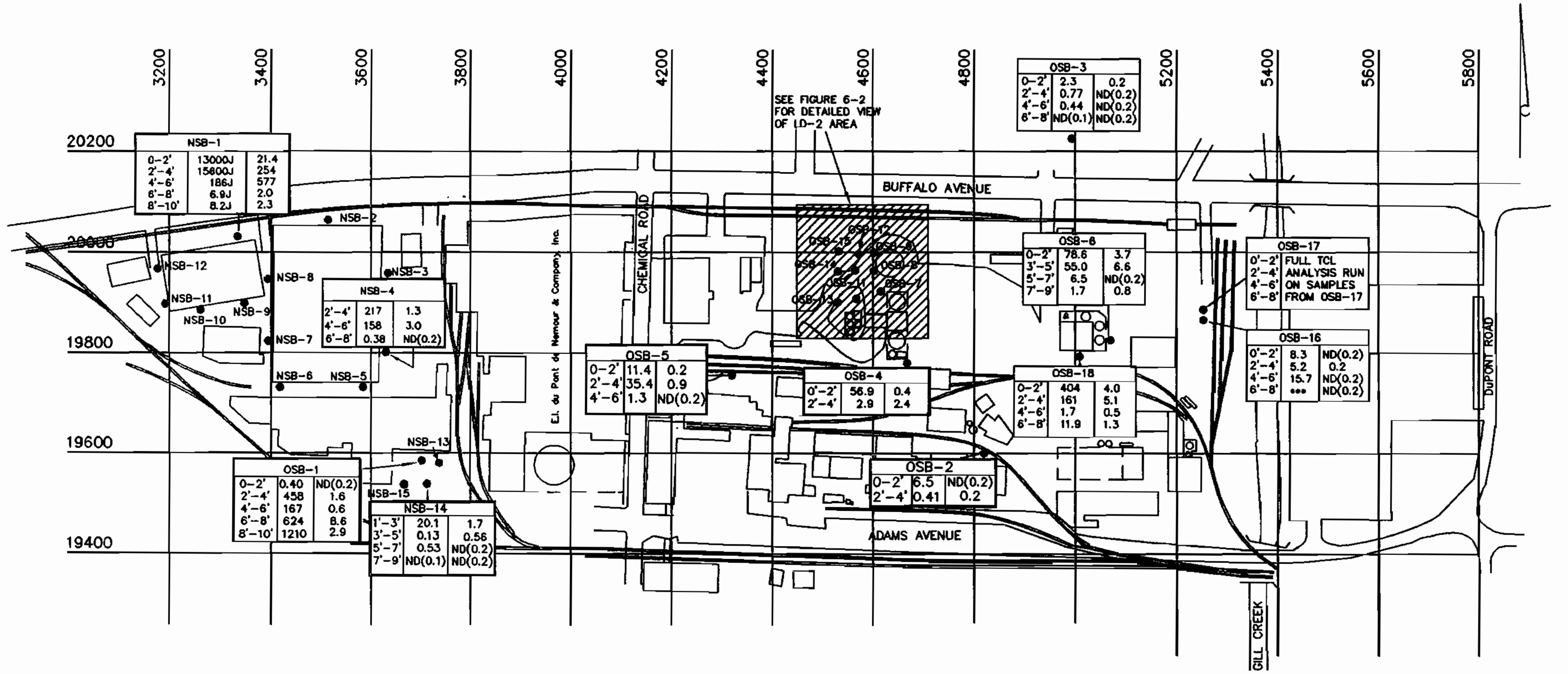
STATIC WATER LEVEL AT GILL CREEK: 562.45

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

POTENTIOMETRIC SURFACE CONTOUR MAP
CD-ZONE
1500 GPM PUMPING STEP: STEP 4

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 5-20
Scale: 0 — 200 Feet		



LEGEND:

SOIL BORING ID		
SAMPLE DEPTH	TOTAL Hg CONCENTRATION (mg/kg)	TCLP Hg CONCENTRATION (ug/L)

QUALIFIERS: ND - NON DETECT (APPLICABLE DETECTION LIMIT SHOWN)
J - ESTIMATED VALUE

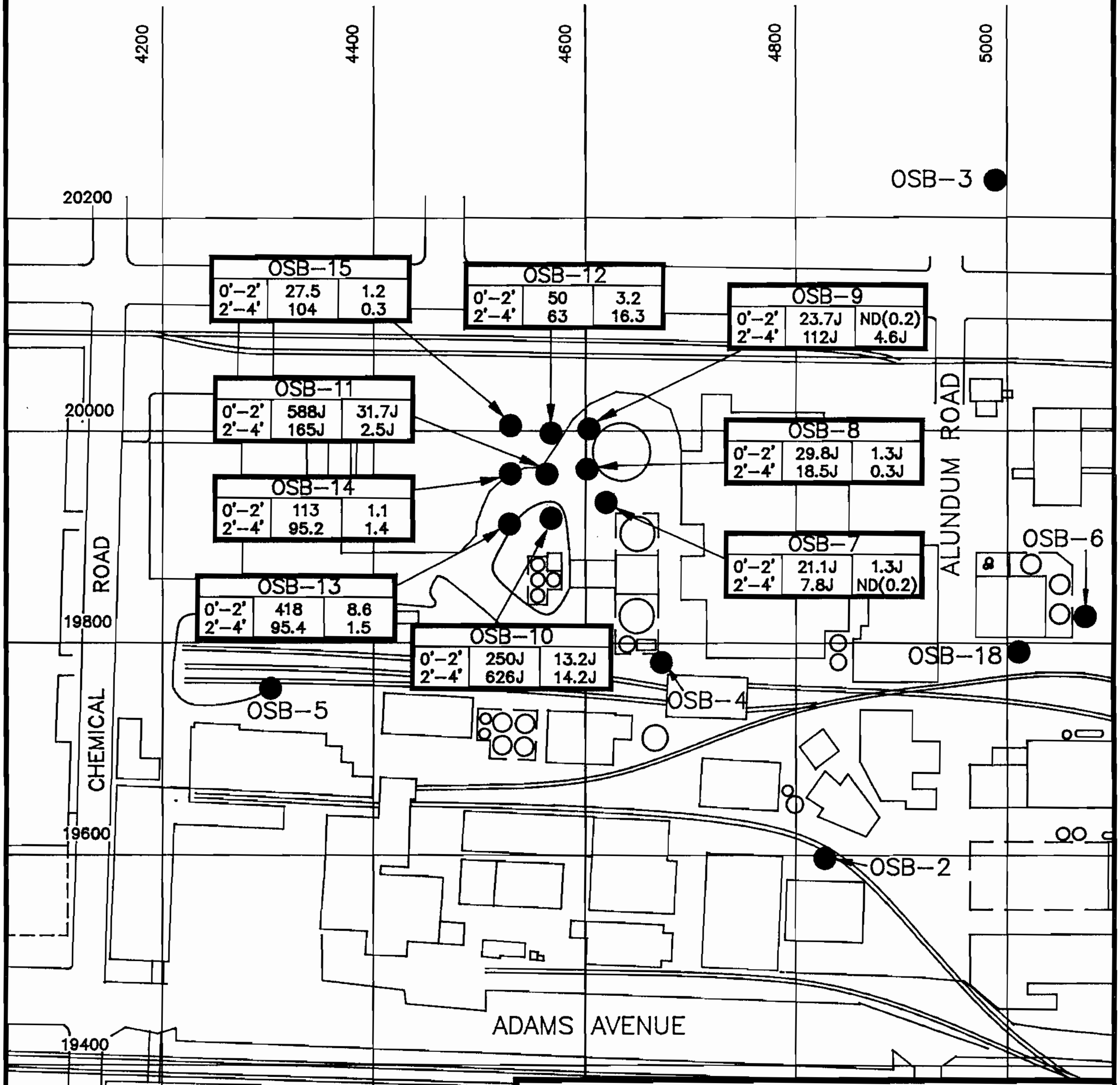
*** - SOIL SAMPLE OSB-16 6'-8' NOT ANALYZED FOR TOTAL MERCURY DUE TO LABORATORY ERROR

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL AND TCLP MERCURY IN SOIL

Job No.: 4E02704	Drawing No. SOILCHEM	Date: 6-26-94
Checked by: DPF	Rev. No.:	FIGURE 6-1
Scale: 0 — 200 Feet		



OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

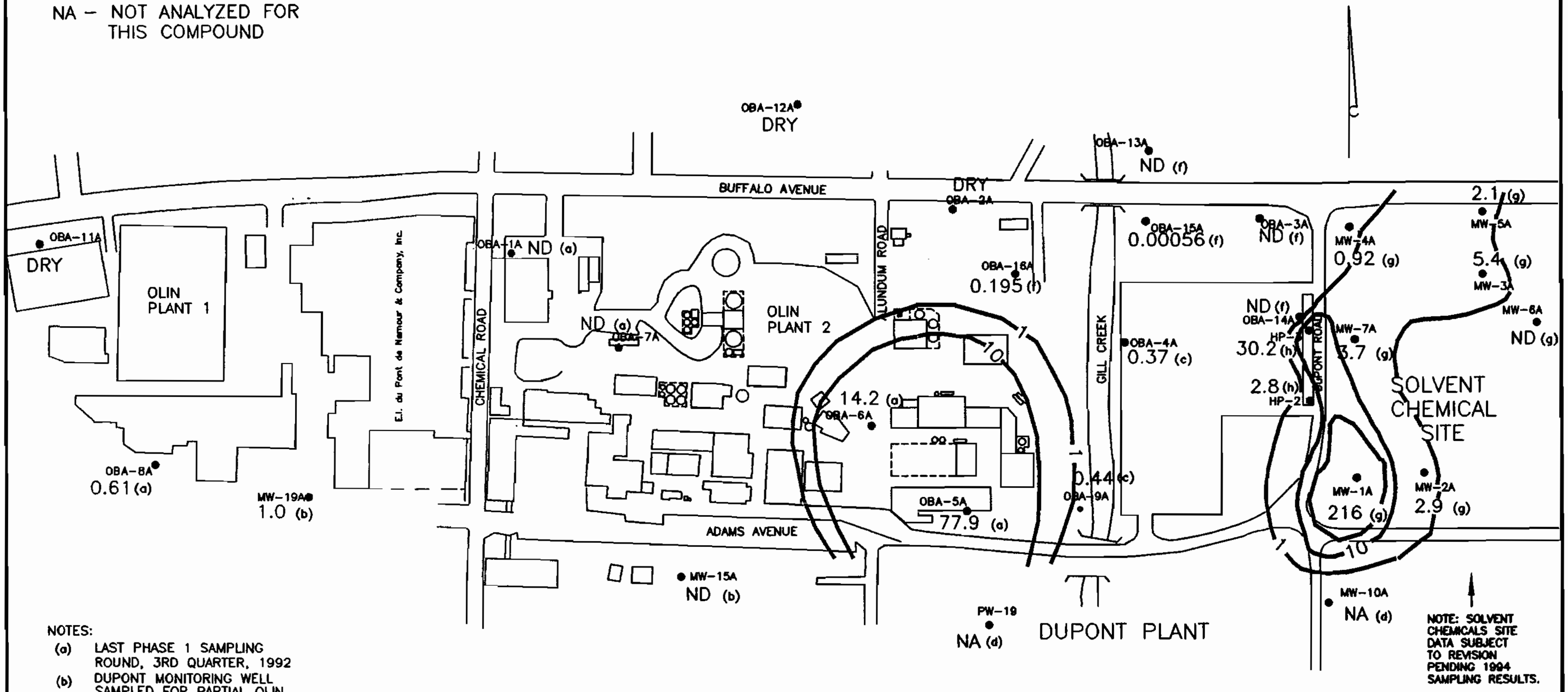
TOTAL AND TCLP MERCURY
CONCENTRATIONS IN SOIL
EXPANDED VIEW OF LD-2 AREA

Job No.: 88C2346-12	Drawing No.	Date:
Checked by: KRM	Rev. No.:	Figure 6-2
Scale: NOT TO SCALE		

LEGEND:

Soil Boring ID		
Sample Depth	Total Hg Conc. (mg/kg)	TCLP Hg Conc. (ug/L)

ND - NOT DETECTED
NA - NOT ANALYZED FOR THIS COMPOUND



NOTES:

(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990
(h) SOLVENT CHEMICAL SITE (HYDROPUNCH) ANALYSIS, FEBRUARY, 1994

LEGEND:

OBA-8A —— WELL ID
●
0.61 —— MERCURY CONCENTRATION (ug/L)

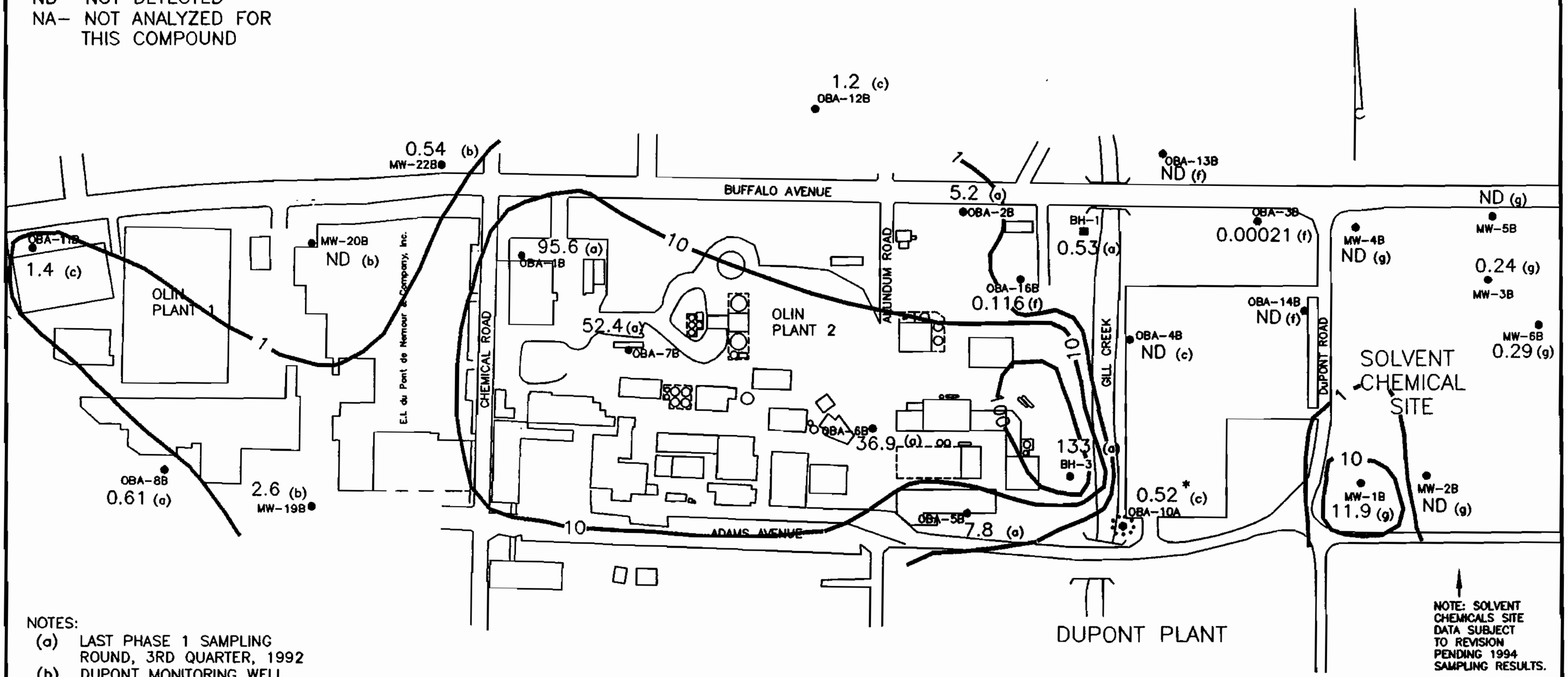
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

MERCURY CONCENTRATION
IN GROUNDWATER:
A-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-7-94
Checked by: KRM	Rev. No.:	FIGURE 7-1
Scale: 0 — 200 Feet		

ND- NOT DETECTED
NA- NOT ANALYZED FOR THIS COMPOUND



NOTES:
(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THR 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990

* OBA-10A INSTALLED IN SEWER TRENCH CUT INTO ROCK, NOT USED IN GROUNDWATER ISOCONCENTRATION MAPS

LEGEND:
OBA-8B ● —— WELL ID
0.61 —— MERCURY CONCENTRATION (ug/L)

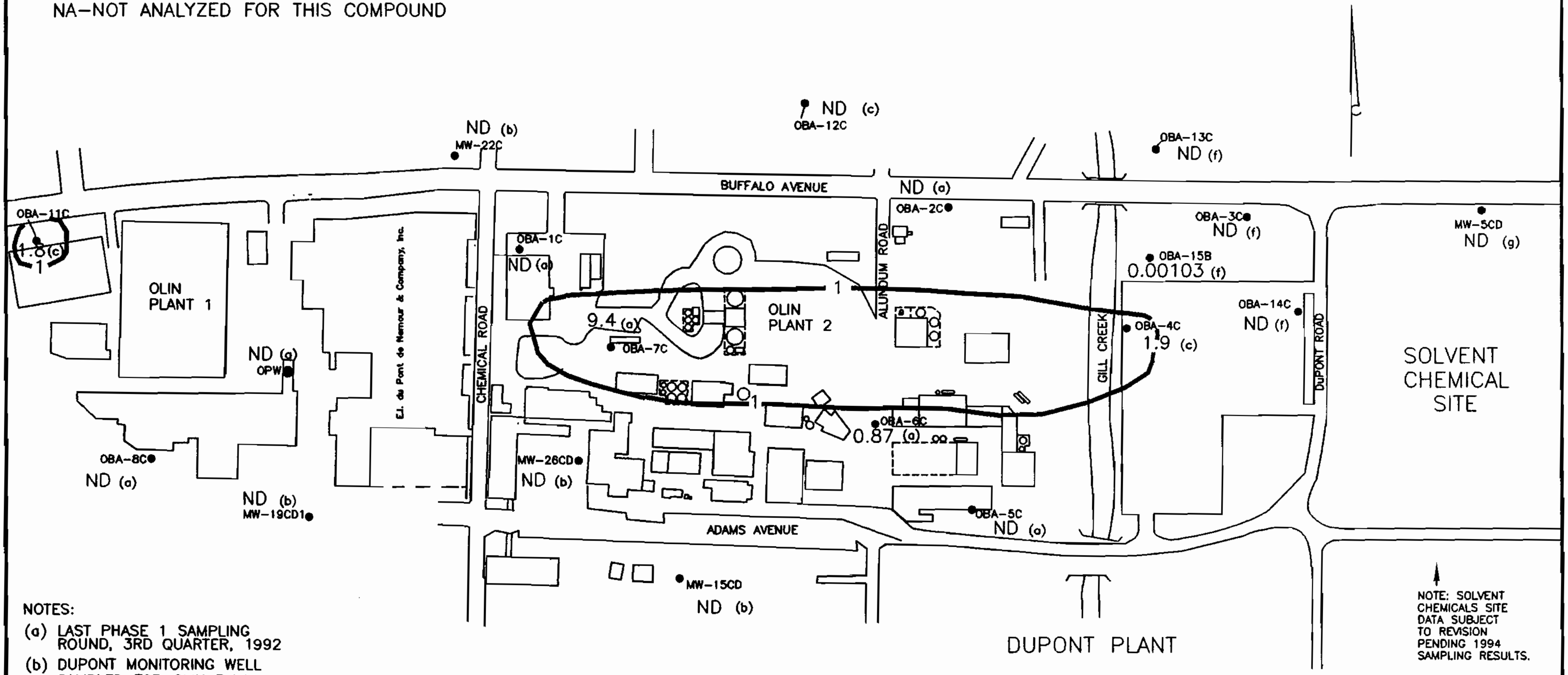
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

MERCURY CONCENTRATION
IN GROUNDWATER
B-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-8-94
Checked by: KRM	Rev. No.:	FIGURE 7-2
Scale: 0 200 Feet		

ND–NOT DETECTED
NA–NOT ANALYZED FOR THIS COMPOUND



NOTES:

(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR OLIN P.A.L.–OCTOBER, 1993
(c) PHASE II SAMPLING ROUND–MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS–OCTOBER, 1993
(e) PHASE II SAMPLING ROUND–JANUARY, 1994
(f) PHASE II SAMPLING ROUND–JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT,INC., NOV. 1990

LEGEND:

OBA-8C ← WELL ID
●
ND ← MERCURY CONCENTRATION (ug/L)

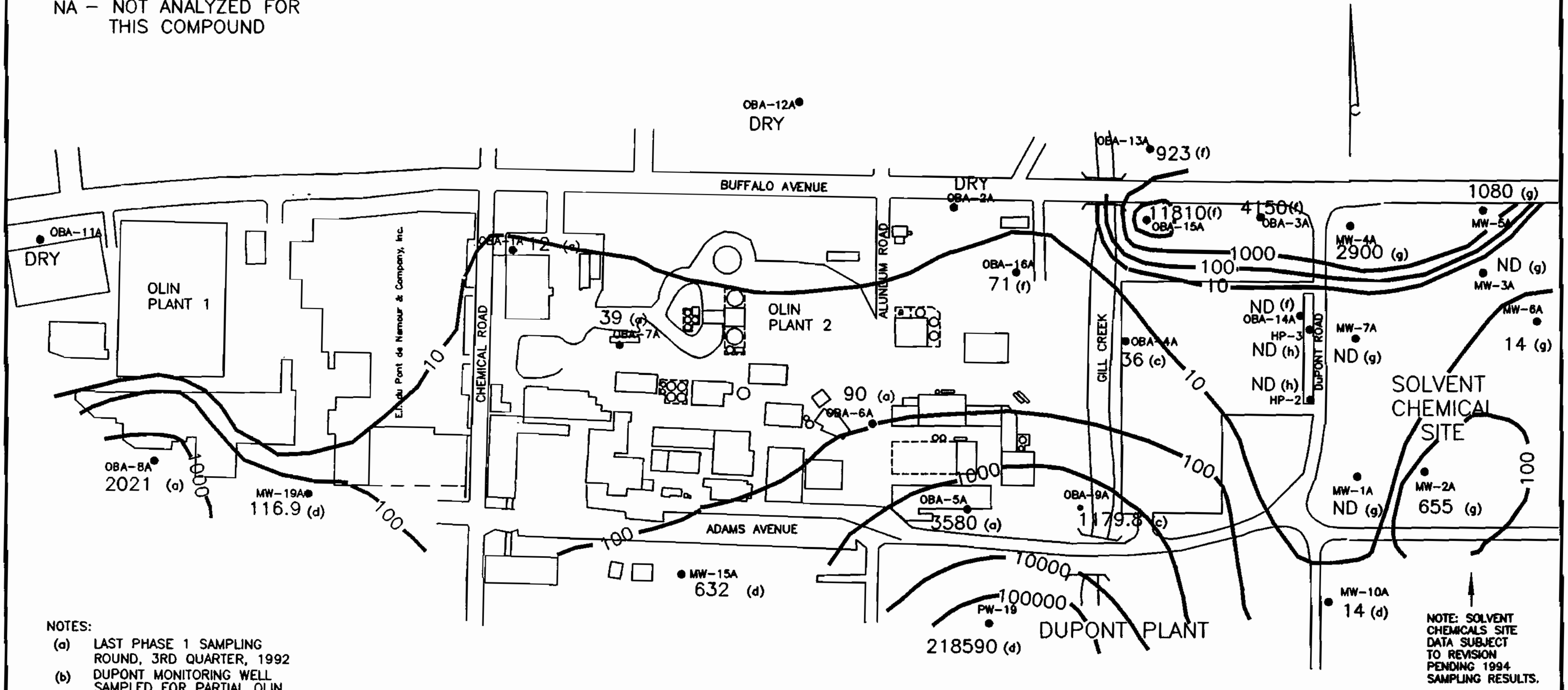
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

MERCURY CONCENTRATIONS
IN GROUNDWATER
C/CD-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-11-94
Checked by: KRM	Rev. No.:	FIGURE 7-3
Scale: 0 — 200 Feet		

ND - NOT DETECTED
NA - NOT ANALYZED FOR THIS COMPOUND



NOTE: SOLVENT CHEMICALS SITE DATA SUBJECT TO REVISION PENDING 1994 SAMPLING RESULTS.

NOTES:

(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990
(h) SOLVENT CHEMICAL SITE (HYDROPUNCH) ANALYSIS, FEBRUARY, 1994

LEGEND:

OBA-8A —— WELL ID
•
2021 —— TOTAL CHLORINATED ALIPHATIC VOLATILE ORGANIC COMPOUND CONCENTRATION (ug/L)

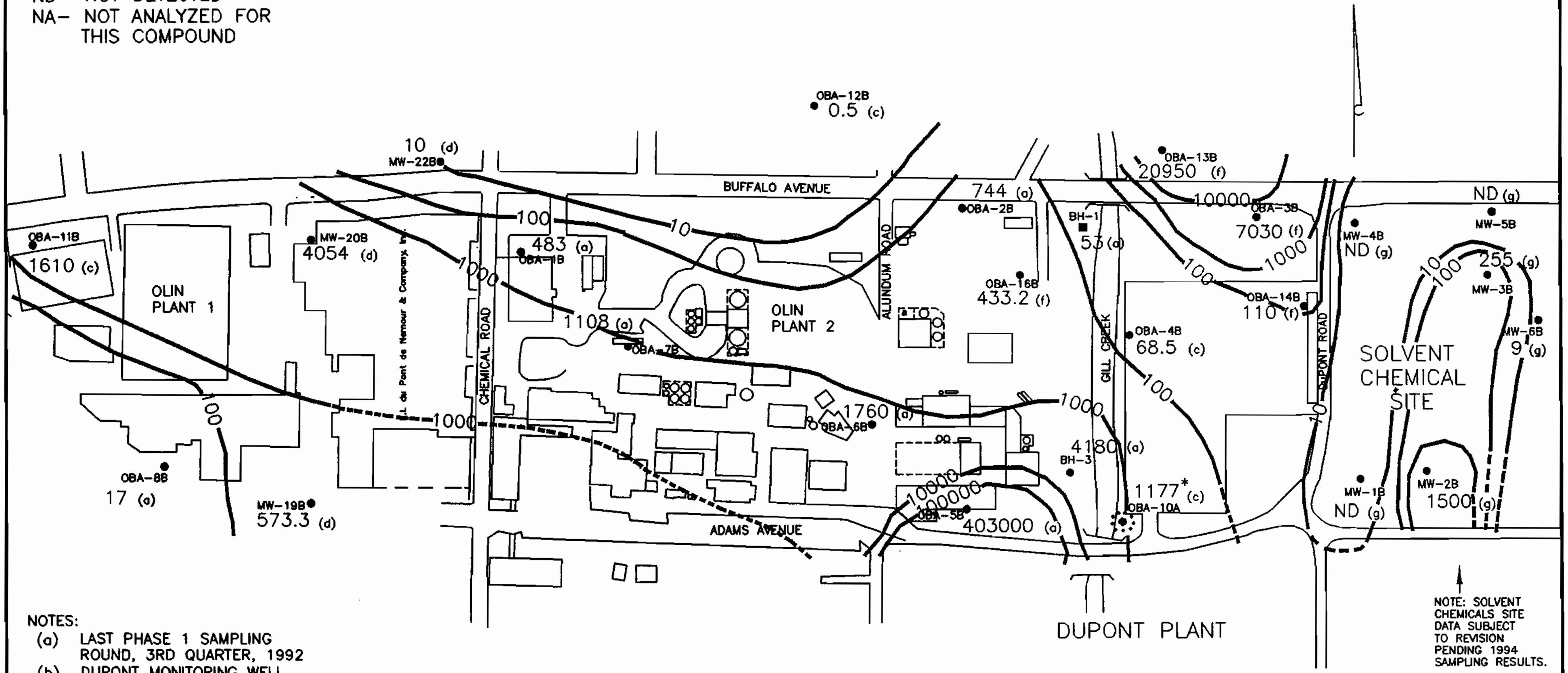
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL CHLORINATED ALIPHATIC VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN GROUNDWATER A-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-7-94
Checked by: KRM	Rev. No.:	FIGURE 7-4
Scale: 0 — 200 Feet		

ND- NOT DETECTED
NA- NOT ANALYZED FOR
THIS COMPOUND



NOTES:
(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THR 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990

* OBA-10A INSTALLED IN SEWER TRENCH CUT INTO ROCK, NOT USED IN GROUNDWATER ISOCONCENTRATION MAPS

LEGEND:
OBA-8B ●—WELL ID
17 —TOTAL CHLORINATED ALIPHATIC ORGANIC COMPOUND CONCENTRATION (ug/L)

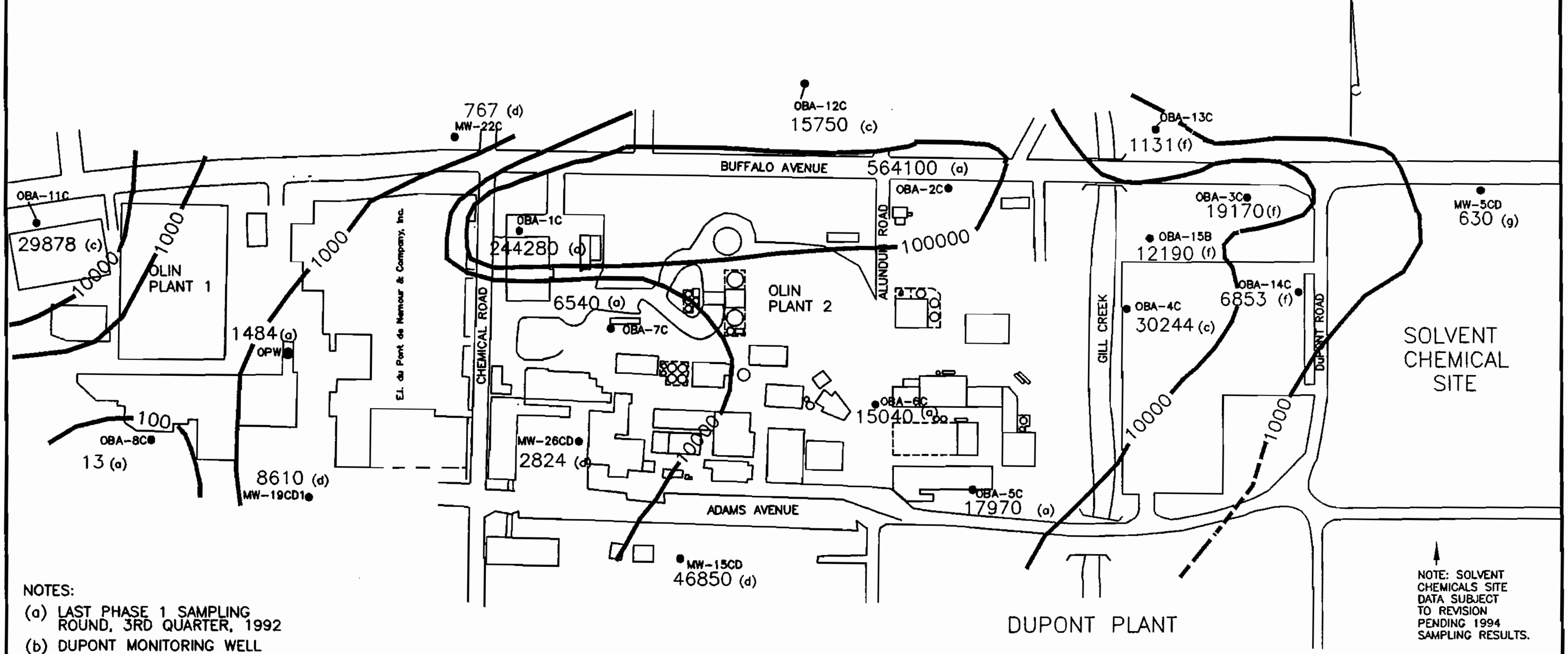
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL CHLORINATED ALIPHATIC VOLATILE ORGANIC COMPOUND CONCENTRATION IN GROUNDWATER: B-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-8-94
Checked by: KRM	Rev. No.:	FIGURE 7-5
Scale: 0 — 200 Feet		

ND–NOT DETECTED
NA–NOT ANALYZED FOR THIS COMPOUND



NOTE: SOLVENT CHEMICALS SITE DATA SUBJECT TO REVISION PENDING 1994 SAMPLING RESULTS.

NOTES:

(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR OLIN P.A.L.– OCTOBER, 1993
(c) PHASE II SAMPLING ROUND– MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS–OCTOBER, 1993
(e) PHASE II SAMPLING ROUND– JANUARY, 1994
(f) PHASE II SAMPLING ROUND–JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV. 1990

LEGEND:

OBA-8C ●	← WELL ID
13	← TOTAL CHLORINATED ALIPHATIC VOLATILE ORGANIC COMPOUND CONCENTRATION (ug/L)

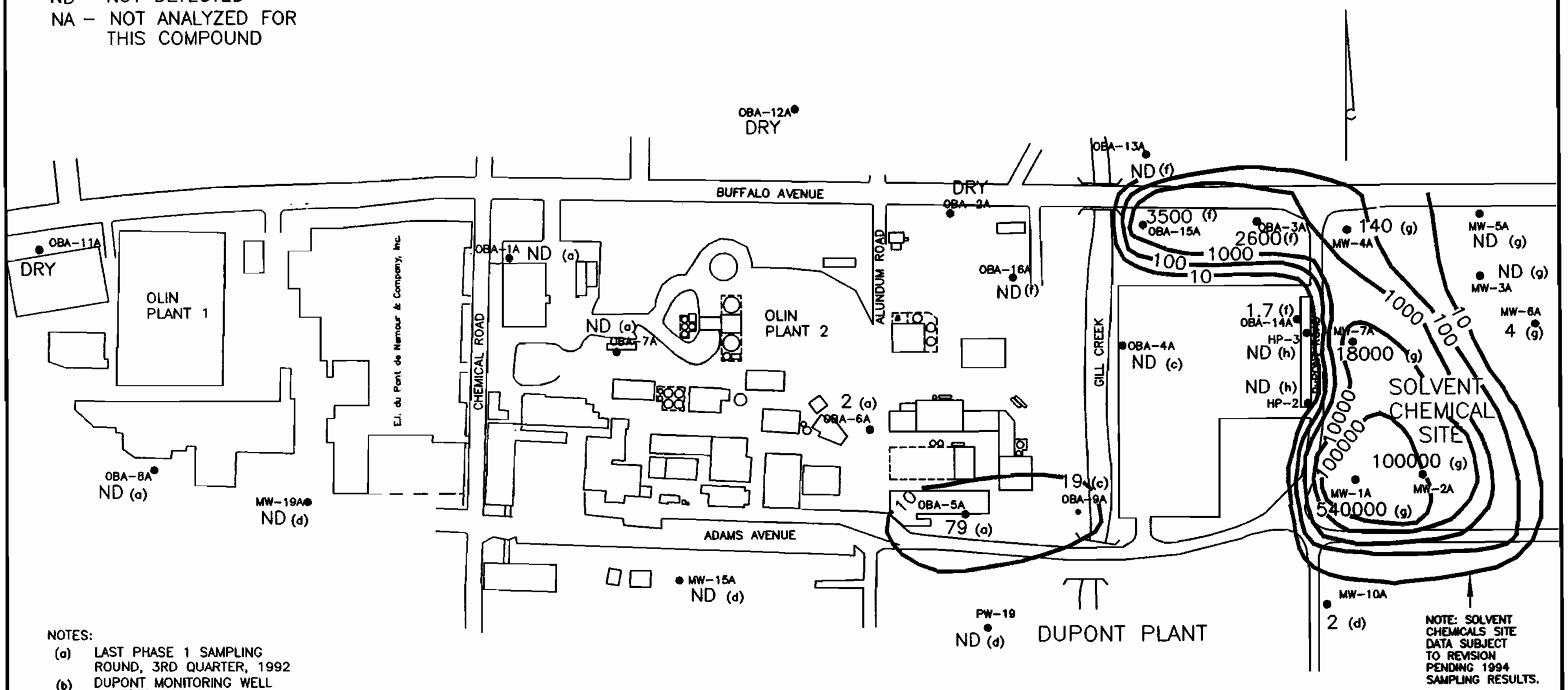
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD–CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL CHLORINATED ALIPHATIC VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN GROUNDWATER C/CD–ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-11-94
Checked by: KRM	Rev. No.:	FIGURE 7-6
Scale: 0 — 200 Feet		

ND - NOT DETECTED
NA - NOT ANALYZED FOR THIS COMPOUND



NOTES:

(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990
(h) SOLVENT CHEMICAL SITE (HYDROPUNCH) ANALYSIS, FEBRUARY, 1994

LEGEND:

OBA-8A ● —— WELL ID
ND —— BENZENE CONCENTRATION (ug/L)

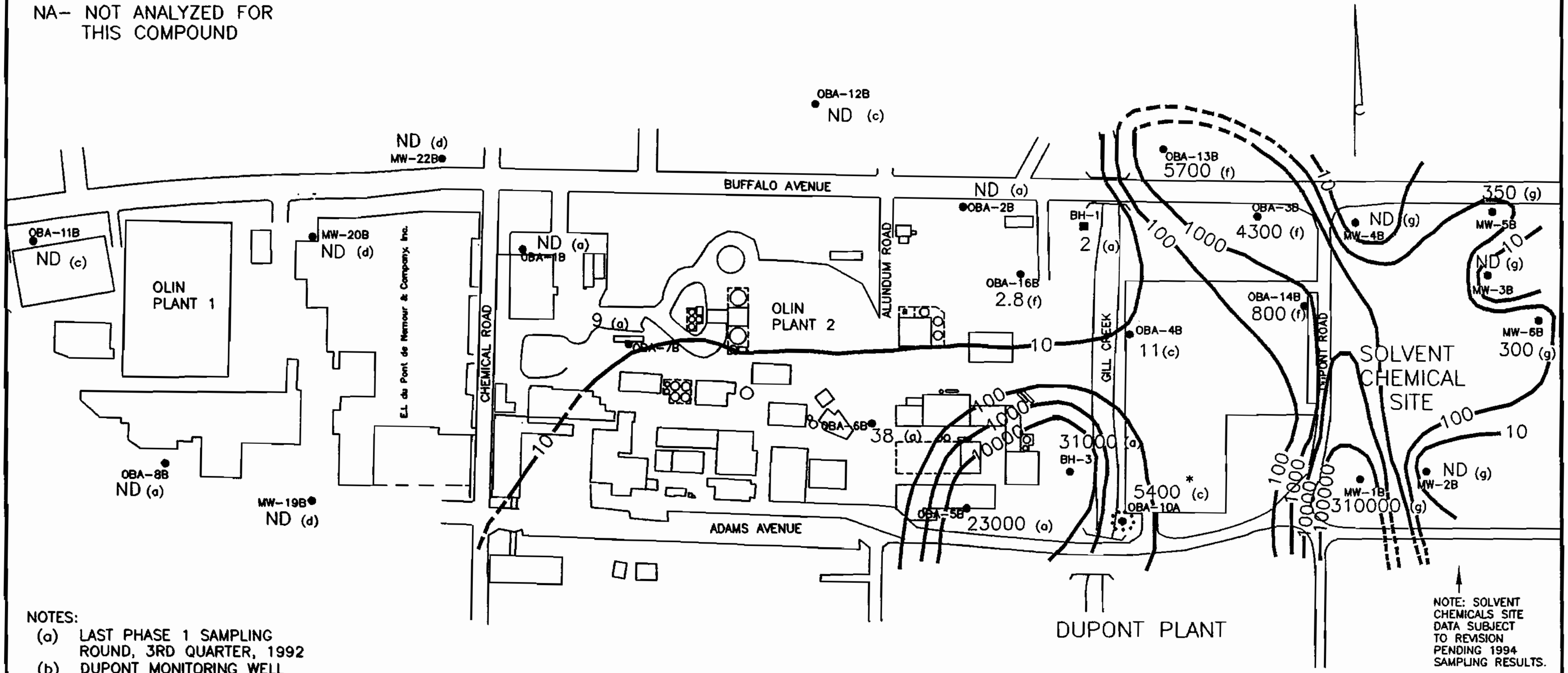
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

BENZENE CONCENTRATIONS
IN GROUNDWATER:
A-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-7-94
Checked by: KRM	Rev. No.:	FIGURE 7-7
Scale: 0 200 Feet		

ND- NOT DETECTED
NA- NOT ANALYZED FOR
THIS COMPOUND



NOTES:
- (a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
- (b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
- (c) PHASE II SAMPLING ROUND-MAY, 1994
- (d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
- (e) PHASE II SAMPLING ROUND-JANUARY, 1994
- (f) PHASE II SAMPLING ROUND-JULY, 1994
- (g) FROM "REMEDIAL INVESTIGATION REPORT FOR THR 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990

* OBA-10A INSTALLED IN SEWER TRENCH CUT INTO ROCK, NOT USED IN GROUNDWATER ISOCONCENTRATION MAPS

LEGEND:

OBA-8B ● —— WELL ID

ND —— BENZENE CONCENTRATION (ug/L)

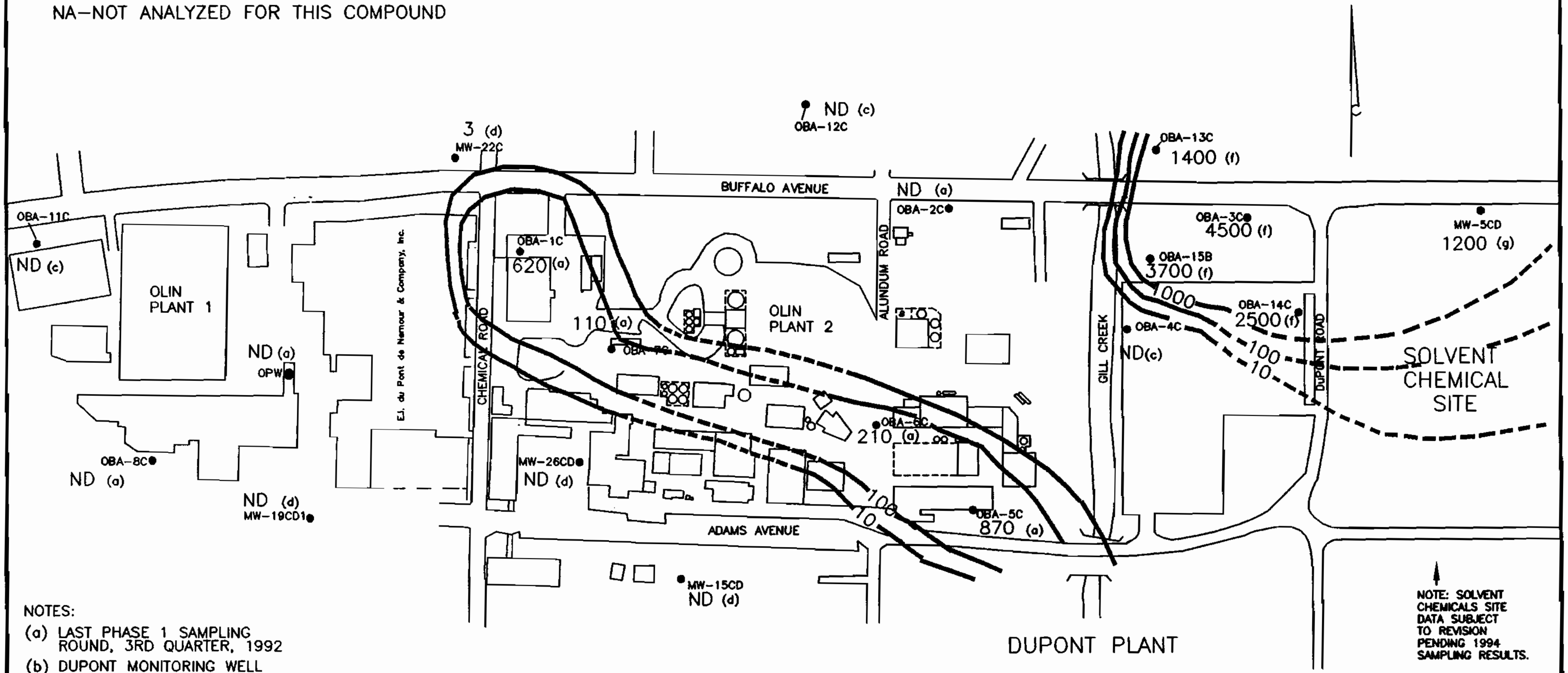
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

BENZENE CONCENTRATIONS
IN GROUNDWATER
B-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-8-94
Checked by: KRM	Rev. No.:	FIGURE 7-8
Scale: 0 — 200 Feet		

ND–NOT DETECTED
NA–NOT ANALYZED FOR THIS COMPOUND



NOTES:
(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR OLIN P.A.L.– OCTOBER, 1993
(c) PHASE II SAMPLING ROUND– MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS–OCTOBER, 1993
(e) PHASE II SAMPLING ROUND– JANUARY, 1994
(f) PHASE II SAMPLING ROUND–JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT,INC., NOV. 1990

LEGEND:
OBA-8C ← WELL ID
●
ND ← BENZENE CONCENTRATION (ug/L)

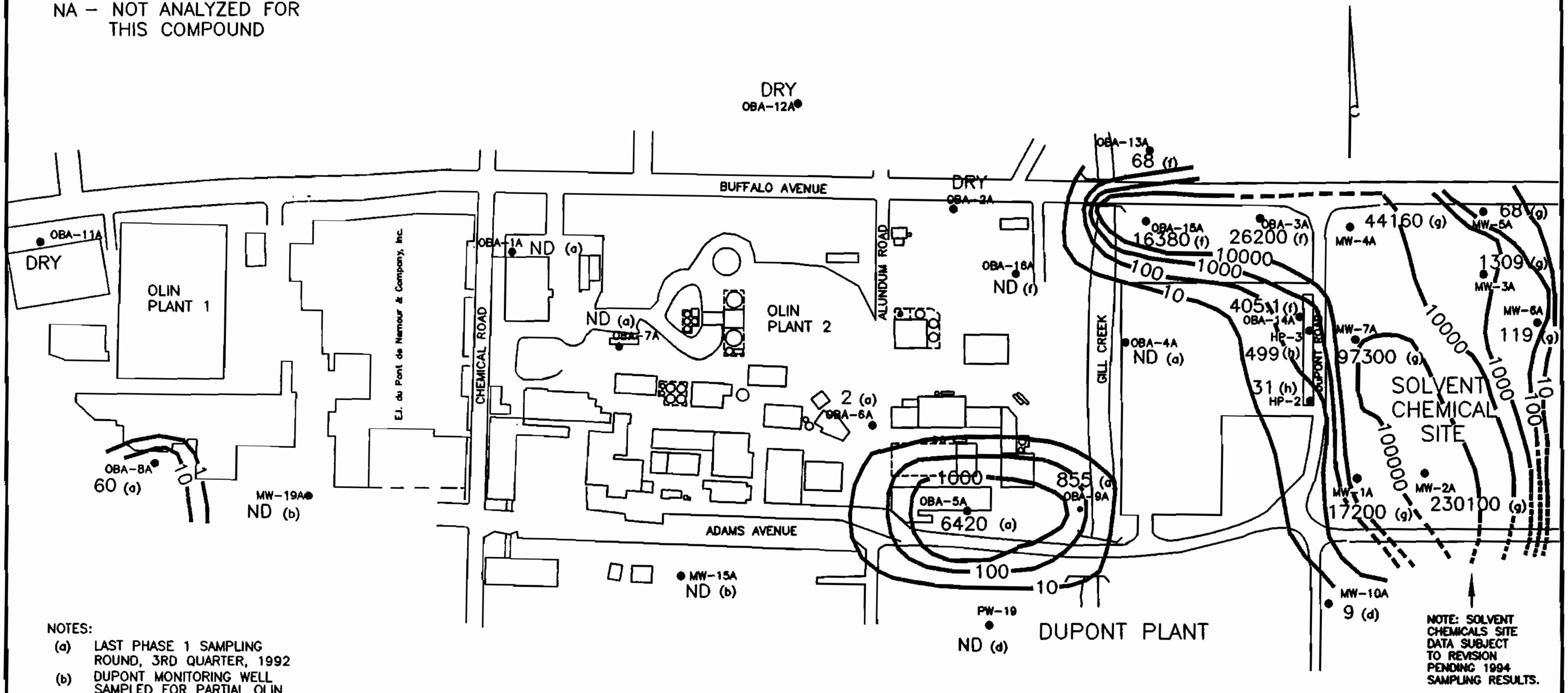
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

BENZENE CONCENTRATIONS
IN GROUNDWATER
C/CD-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-11-94
Checked by: KRM	Rev. No.:	FIGURE 7-9
Scale: 0 — 200 Feet		

ND - NOT DETECTED
NA - NOT ANALYZED FOR THIS COMPOUND



NOTES:

(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990
(h) SOLVENT CHEMICAL SITE (HYDROPUNCH) ANALYSIS, FEBRUARY, 1994

LEGEND:

OBA-8A ● —— WELL ID
60 —— TOTAL CHLORINATED BENZENE CONCENTRATION (ug/L)

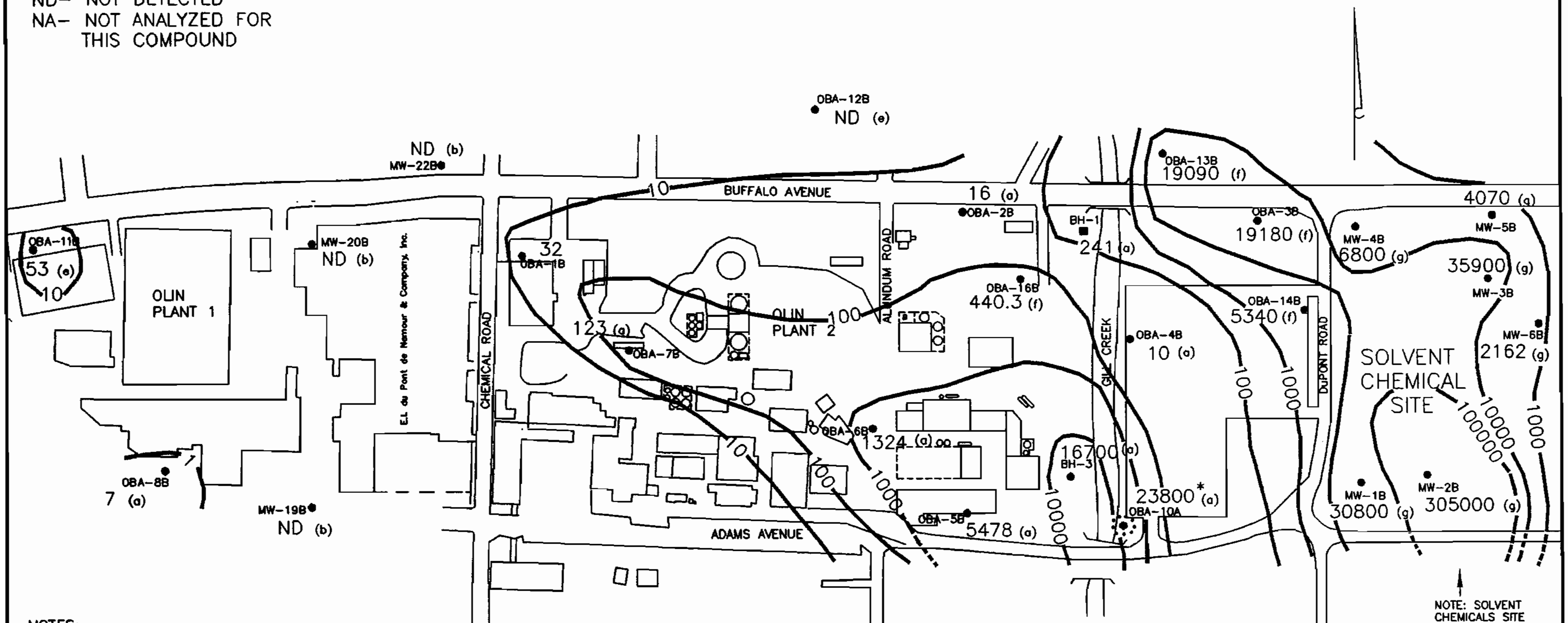
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL CHLORINATED BENZENE
CONCENTRATIONS IN GROUNDWATER:
A-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-7-94
Checked by: KRM	Rev. No.:	FIGURE 7-10
Scale: 0 200 Feet		

ND- NOT DETECTED
NA- NOT ANALYZED FOR
THIS COMPOUND



NOTES:

(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THR 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990

* OBA-10A INSTALLED IN SEWER TRENCH CUT INTO ROCK, NOT USED IN GROUNDWATER ISOCONCENTRATION MAPS

LEGEND:

OBA-8B ● ——WELL ID
7 —— TOTAL CHLORINATED BENZENE CONCENTRATION (ug/L)

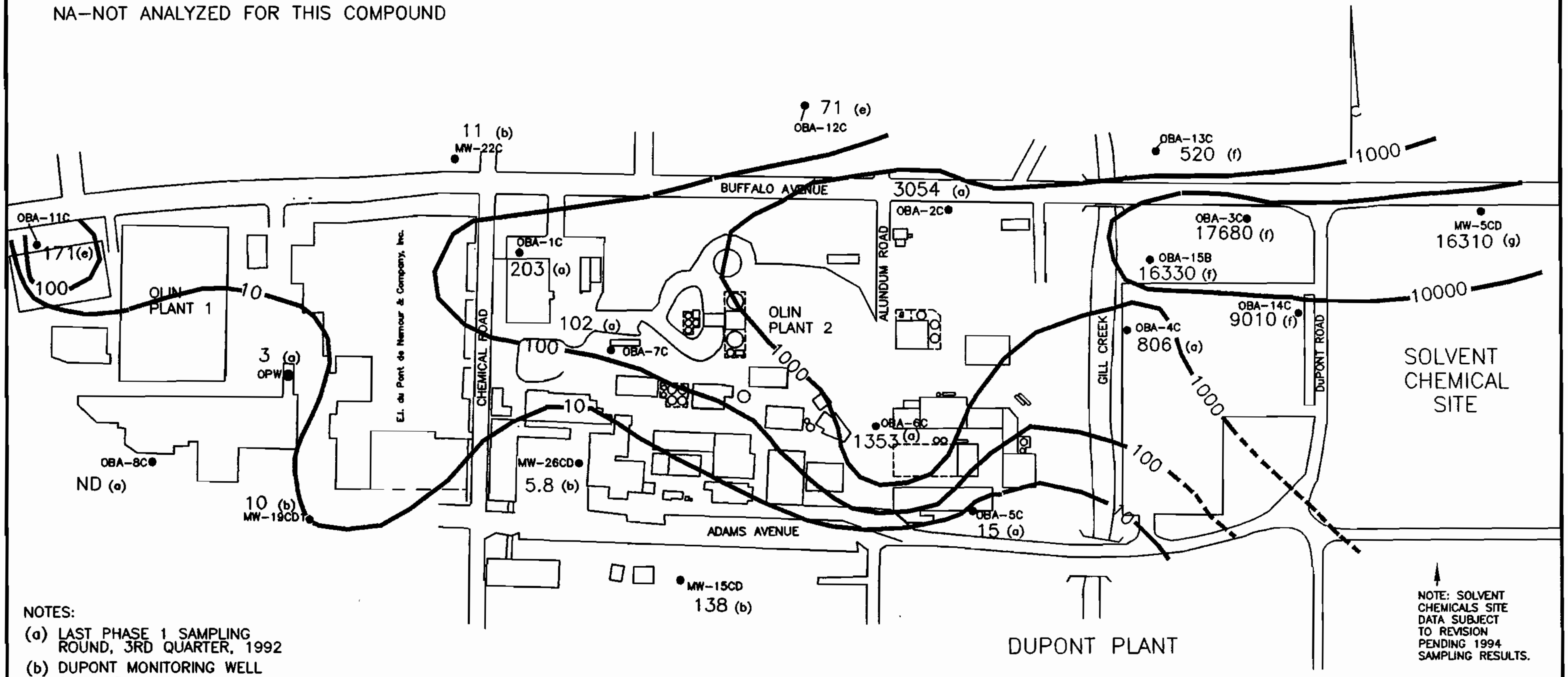
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL CHLORINATED BENZENE
CONCENTRATIONS IN GROUNDWATER
B-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-8-94
Checked by: KRM	Rev. No.:	FIGURE 7-11
Scale: 0 — 200 Feet		

ND-NOT DETECTED
NA-NOT ANALYZED FOR THIS COMPOUND



NOTE: SOLVENT CHEMICALS SITE DATA SUBJECT TO REVISION PENDING 1994 SAMPLING RESULTS.

NOTES:
(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV. 1990

LEGEND:
OBA-8C ← WELL ID
●
ND ← TOTAL CHLORINATED BENZENE CONCENTRATIONS (ug/L)

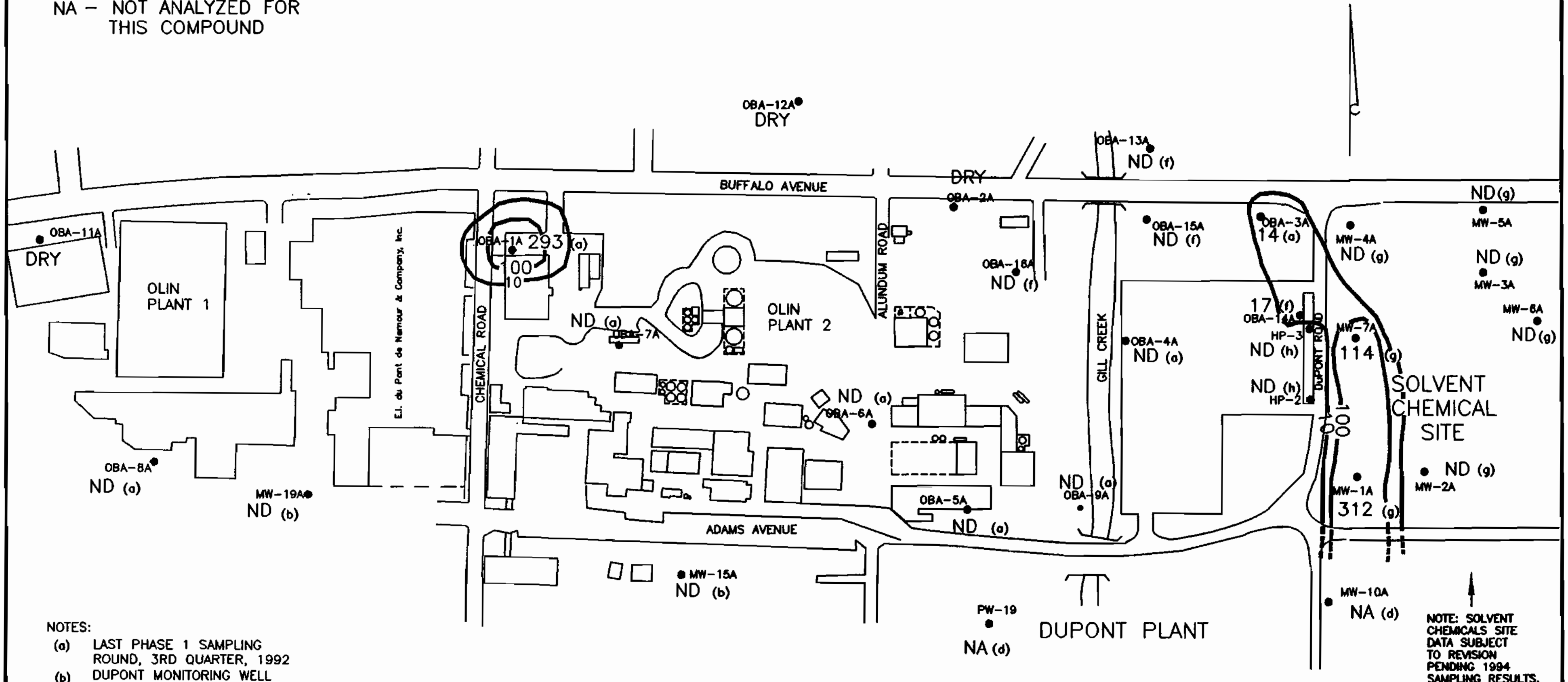
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL CHLORINATED BENZENE
CONCENTRATIONS IN GROUNDWATER:
C/CD-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-11-94
Checked by: KRM	Rev. No.:	FIGURE 7-12
Scale: 0 200 Feet		

ND - NOT DETECTED
NA - NOT ANALYZED FOR THIS COMPOUND



NOTE: SOLVENT CHEMICALS SITE DATA SUBJECT TO REVISION PENDING 1994 SAMPLING RESULTS.

NOTES:
(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990
(h) SOLVENT CHEMICAL SITE (HYDROPUNCH) ANALYSIS, FEBRUARY, 1994

LEGEND:
OBA-8A ● —— WELL ID
ND —— TOTAL CHLORINATED PHENOL CONCENTRATION (ug/L)

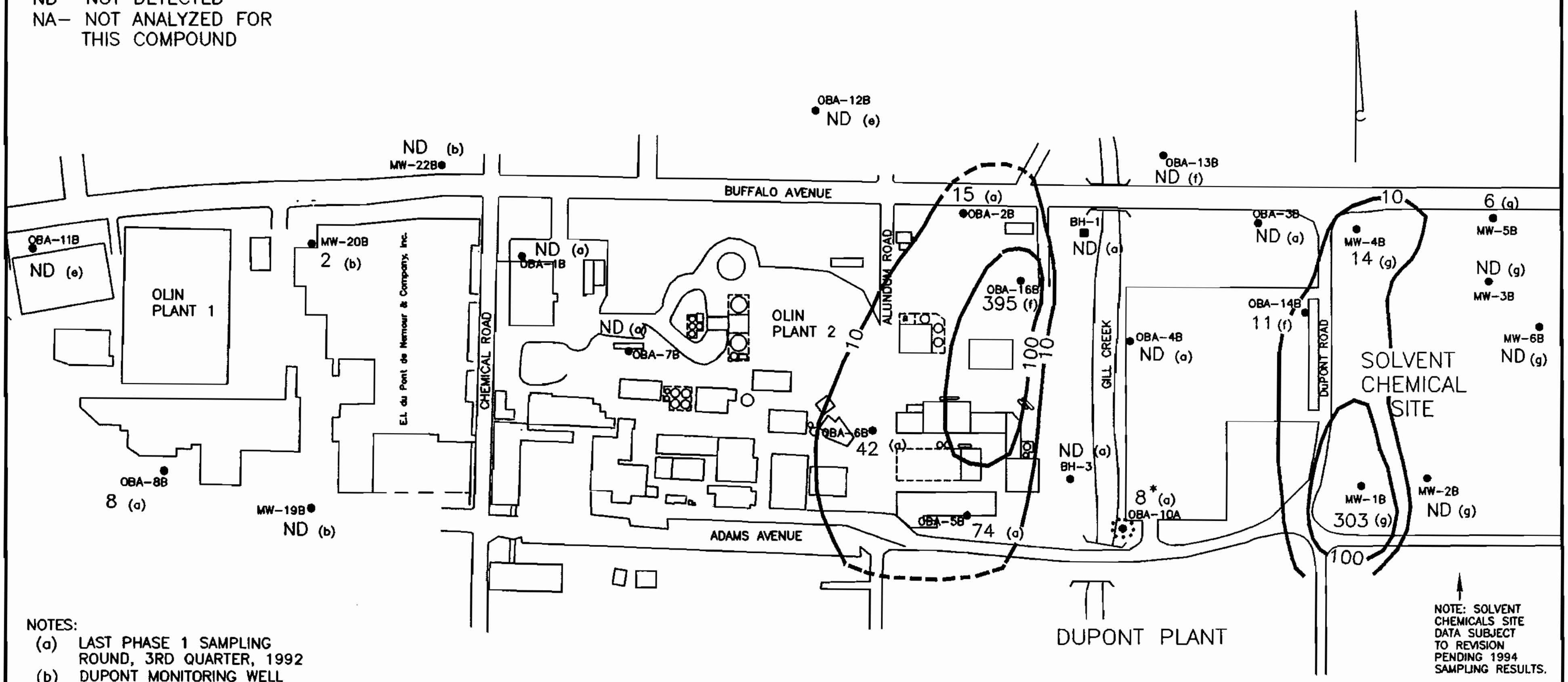
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL CHLORINATED PHENOL CONCENTRATIONS IN GROUNDWATER A-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-7-94
Checked by: KRM	Rev. No.:	FIGURE 7-13
Scale: 0 200 Feet		

ND- NOT DETECTED
NA- NOT ANALYZED FOR
THIS COMPOUND



NOTES:

(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THR 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990

* OBA-10A INSTALLED IN SEWER TRENCH CUT INTO ROCK, NOT USED IN GROUNDWATER ISOCONCENTRATION MAPS

LEGEND:

OBA-8B ● ⟵ WELL ID
8

—— TOTAL CHLORINATED PHENOL CONCENTRATIONS (ug/L)

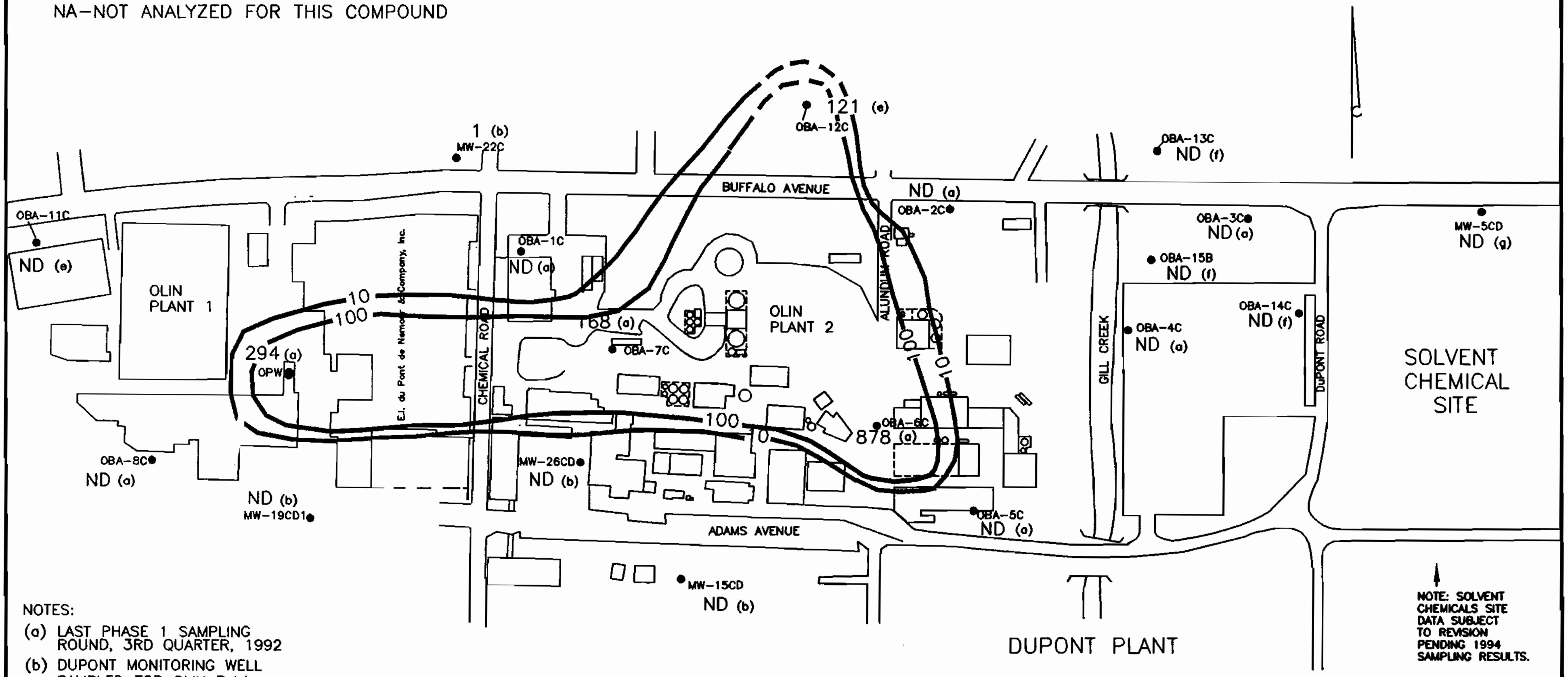
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL CHLORINATED PHENOL
CONCENTRATIONS IN GROUNDWATER
B-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-8-94
Checked by: KRM	Rev. No.:	FIGURE 7-14
Scale: 0 — 200 Feet		

ND-NOT DETECTED
NA-NOT ANALYZED FOR THIS COMPOUND



NOTE: SOLVENT CHEMICALS SITE DATA SUBJECT TO REVISION PENDING 1994 SAMPLING RESULTS.

NOTES:
(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT,INC., NOV. 1990

LEGEND:
OBA-8C ← WELL ID
●
ND ← TOTAL CHLORINATED PHENOL CONCENTRATION (ug/L)

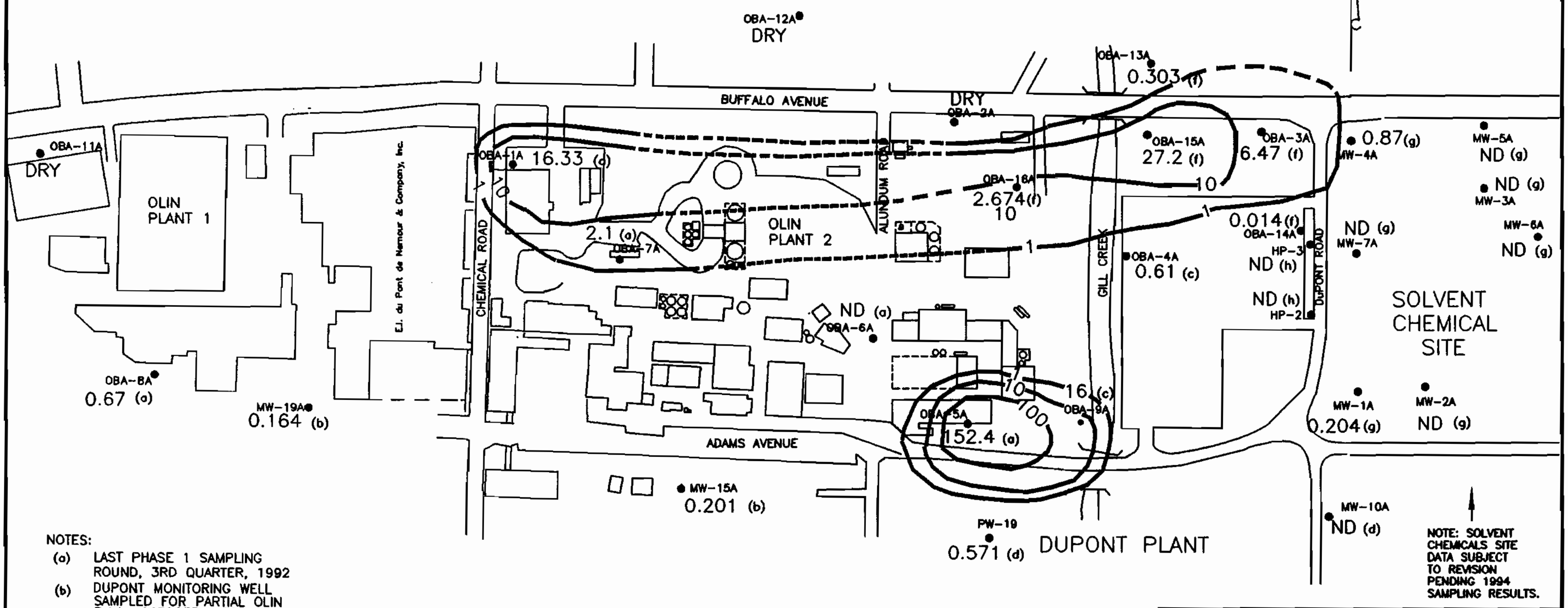
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL CHLORINATED PHENOL
CONCENTRATIONS IN GROUNDWATER
C/CD-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-11-94
Checked by: KRM	Rev. No.:	FIGURE 7-15
Scale: 0 200 Feet		

ND - NOT DETECTED
NA - NOT ANALYZED FOR
THIS COMPOUND



NOTE: SOLVENT CHEMICALS SITE DATA SUBJECT TO REVISION PENDING 1994 SAMPLING RESULTS.

NOTES:
- (a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
- (b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
- (c) PHASE II SAMPLING ROUND-MAY, 1994
- (d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
- (e) PHASE II SAMPLING ROUND-JANUARY, 1994
- (f) PHASE II SAMPLING ROUND-JULY, 1994
- (g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990
- (h) SOLVENT CHEMICAL SITE (HYDROPUNCH) ANALYSIS, FEBRUARY, 1994

LEGEND:

OBA-8A ● —— WELL ID
0.67 —— TOTAL BHC CONCENTRATION (ug/L)

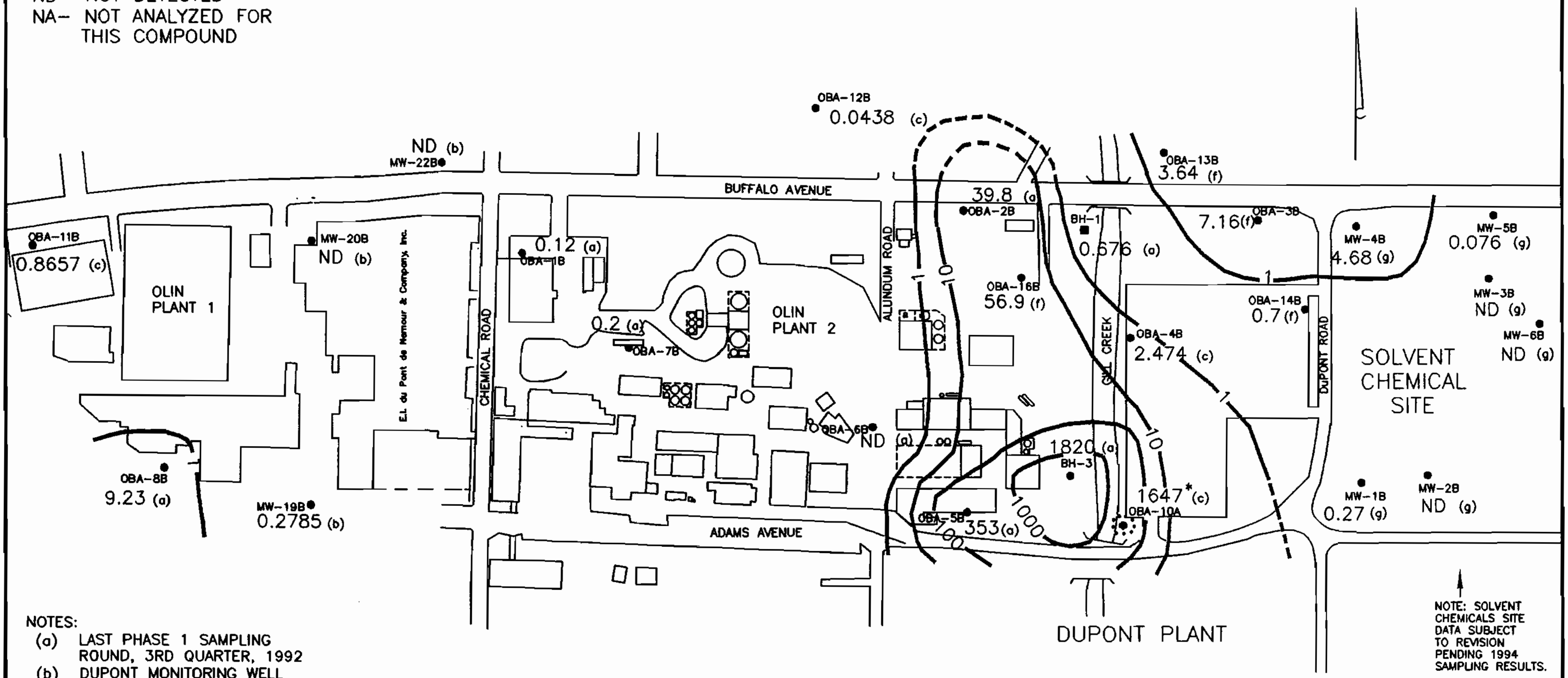
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL BHC CONCENTRATION
IN GROUNDWATER:
A-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-7-94
Checked by: KRM	Rev. No.:	FIGURE 7-16
Scale: 0 — 200 Feet		

ND– NOT DETECTED
NA– NOT ANALYZED FOR
THIS COMPOUND



NOTES:
(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.–OCTOBER, 1993
(c) PHASE II SAMPLING ROUND–MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS–OCTOBER, 1993
(e) PHASE II SAMPLING ROUND–JANUARY, 1994
(f) PHASE II SAMPLING ROUND–JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THR 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990

* OBA-10A INSTALLED IN SEWER TRENCH CUT INTO ROCK, NOT USED IN GROUNDWATER ISOCONCENTRATION MAPS

LEGEND:
OBA-8B ← WELL ID
● 9.23 ← TOTAL BHC CONCENTRATIONS (ug/L)

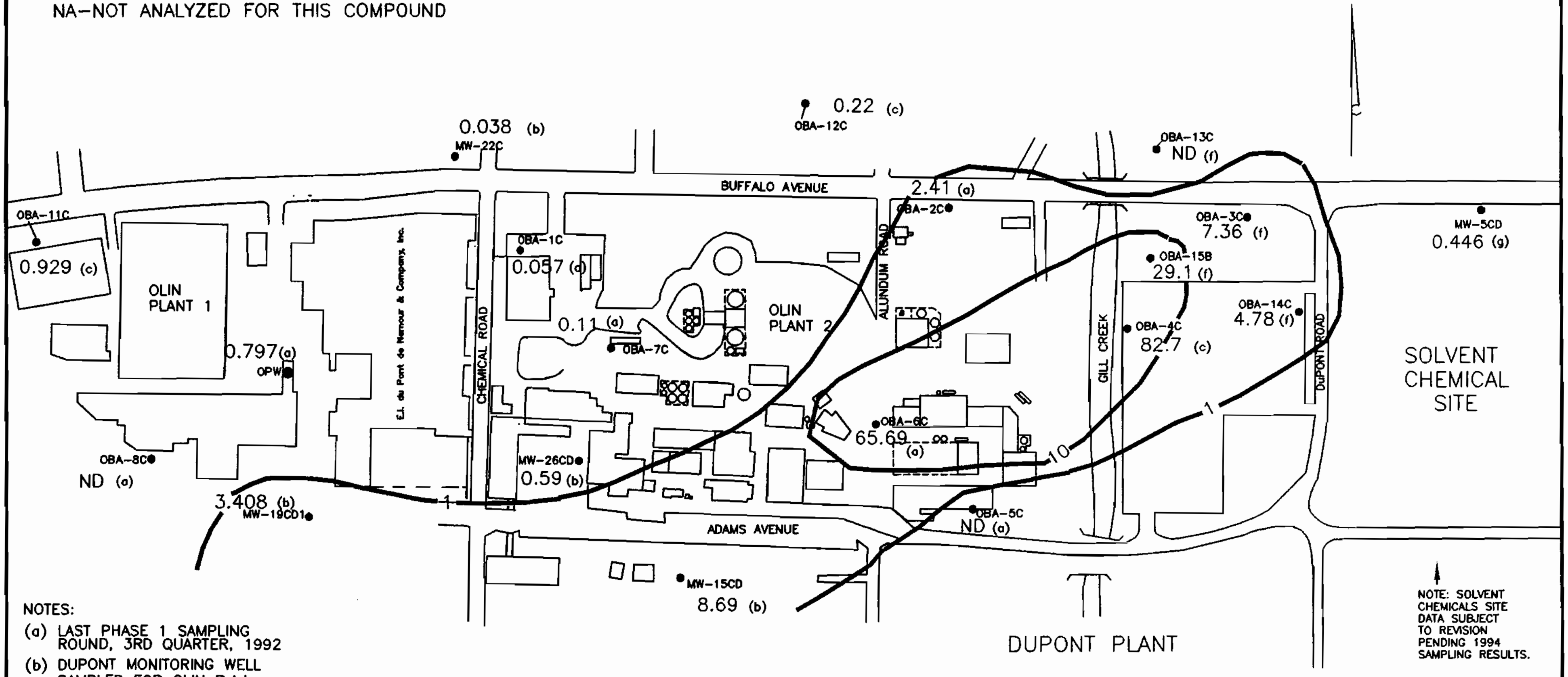
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL BHC CONCENTRATIONS
IN GROUNDWATER
B-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-8-94
Checked by: KRM	Rev. No.:	FIGURE 7-17
Scale: 0 200 Feet		

ND-NOT DETECTED
NA-NOT ANALYZED FOR THIS COMPOUND



NOTE: SOLVENT CHEMICALS SITE DATA SUBJECT TO REVISION PENDING 1994 SAMPLING RESULTS.

NOTES:
(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT,INC., NOV. 1990

LEGEND:
OBA-8C ● ← WELL ID
ND ← TOTAL BHC CONCENTRATIONS (ug/L)

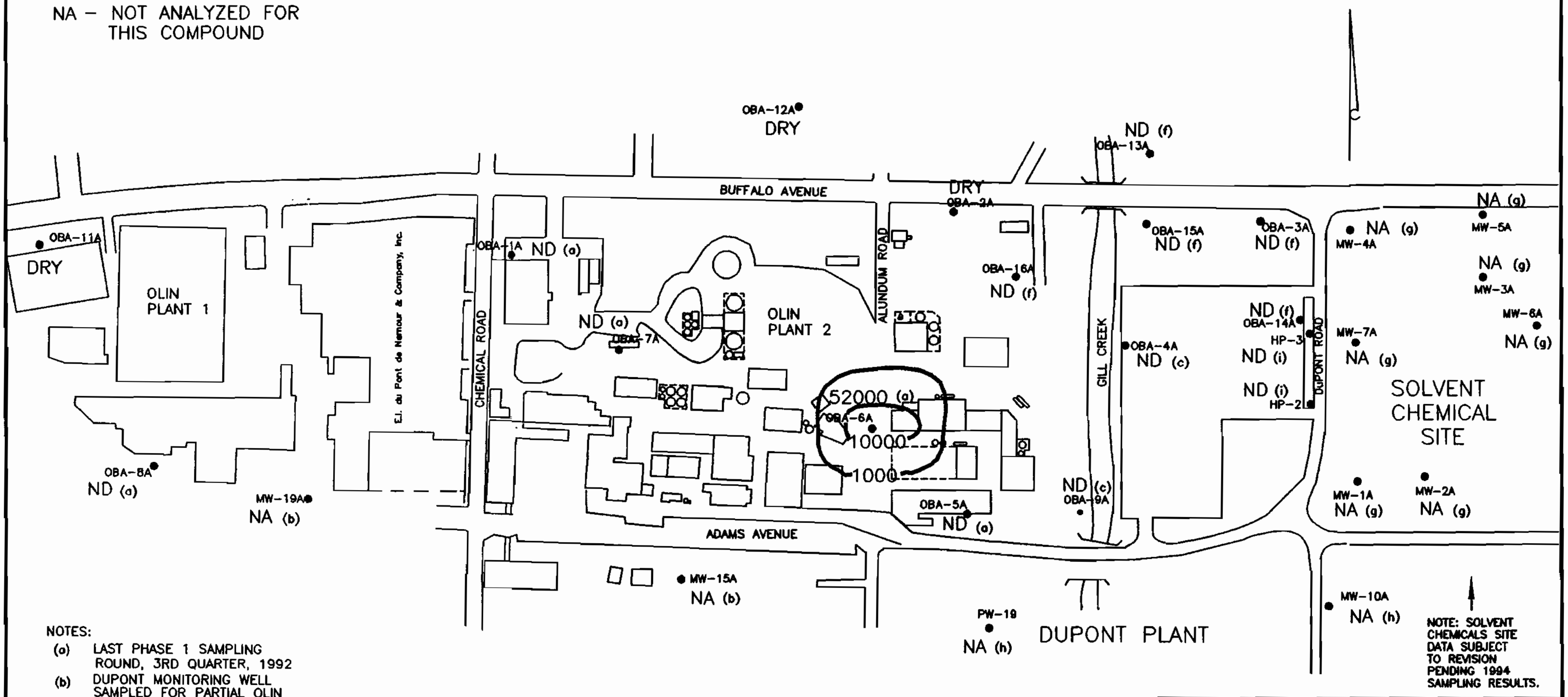
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

TOTAL BHC
CONCENTRATIONS IN GROUNDWATER
C/CD-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-11-94
Checked by: KRM	Rev. No.:	FIGURE 7-18
Scale: 0 — 200 Feet		

ND – NOT DETECTED
NA – NOT ANALYZED FOR THIS COMPOUND



NOTE: SOLVENT CHEMICALS SITE DATA SUBJECT TO REVISION PENDING 1994 SAMPLING RESULTS.

NOTES:
(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.–OCTOBER, 1993
(c) PHASE II SAMPLING ROUND–MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS–OCTOBER, 1993
(e) PHASE II SAMPLING ROUND–JANUARY, 1994
(f) PHASE II SAMPLING ROUND–JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990
(h) QUARTERLY ANALYSIS FOR DUPONT INDICATOR CHEMICALS, FOURTH QUARTER, 1993
(i) SOLVENT CHEMICAL SITE (HYDROPUNCH) ANALYSIS, FEBRUARY, 1994

LEGEND:
OBA-8A — WELL ID
●
ND — METHANOL CONCENTRATION (ug/L)

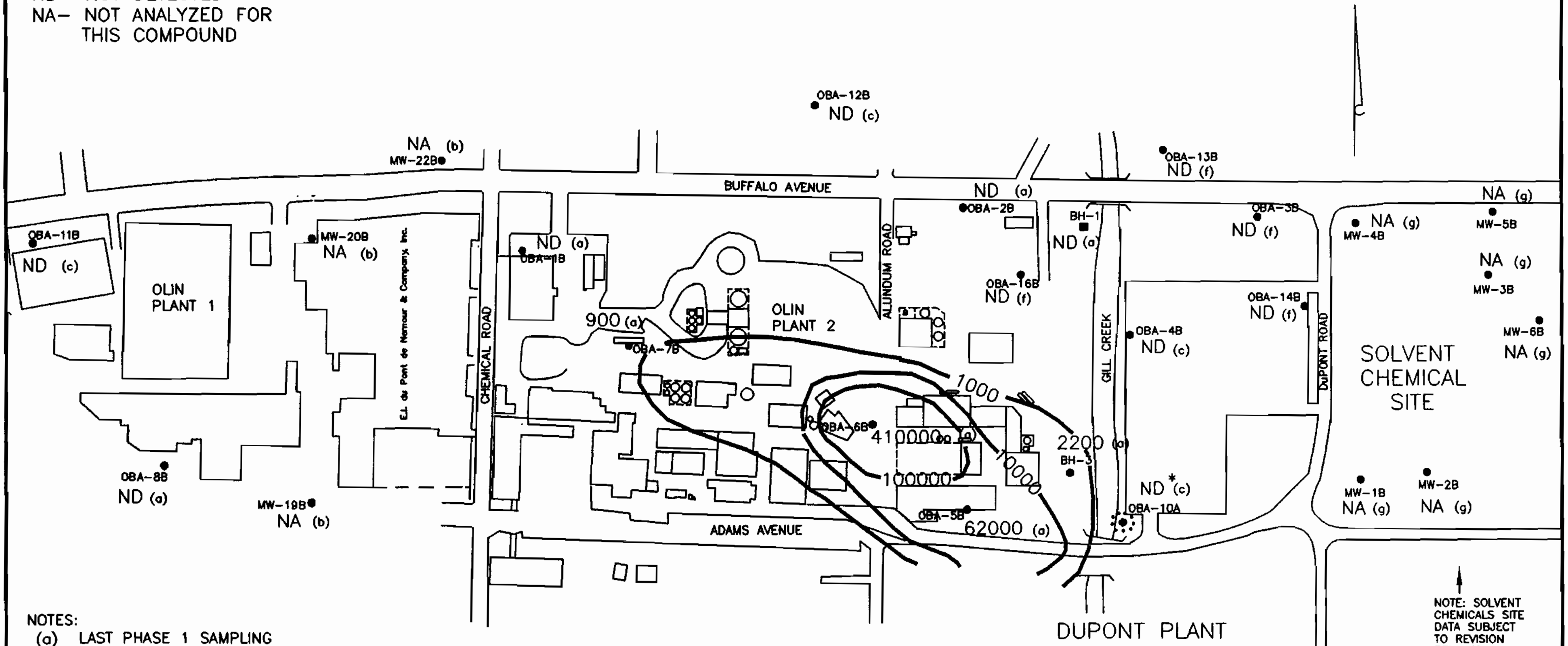
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

METHANOL CONCENTRATIONS
IN GROUNDWATER
A-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-7-94
Checked by: KRM	Rev. No.:	FIGURE 7-19
Scale: 0 — 200 Feet		

ND- NOT DETECTED
NA- NOT ANALYZED FOR THIS COMPOUND



NOTE: SOLVENT CHEMICALS SITE DATA SUBJECT TO REVISION PENDING 1994 SAMPLING RESULTS.

NOTES:

(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR PARTIAL OLIN P.A.L.-OCTOBER, 1993
(c) PHASE II SAMPLING ROUND-MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS-OCTOBER, 1993
(e) PHASE II SAMPLING ROUND-JANUARY, 1994
(f) PHASE II SAMPLING ROUND-JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THR 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT, INC., NOV., 1990

* OBA-10A INSTALLED IN SEWER TRENCH CUT INTO ROCK, NOT USED IN GROUNDWATER ISOCONCENTRATION MAPS

LEGEND:

OBA-8B ● —— WELL ID
ND —— METHANOL CONCENTRATION (ug/L)

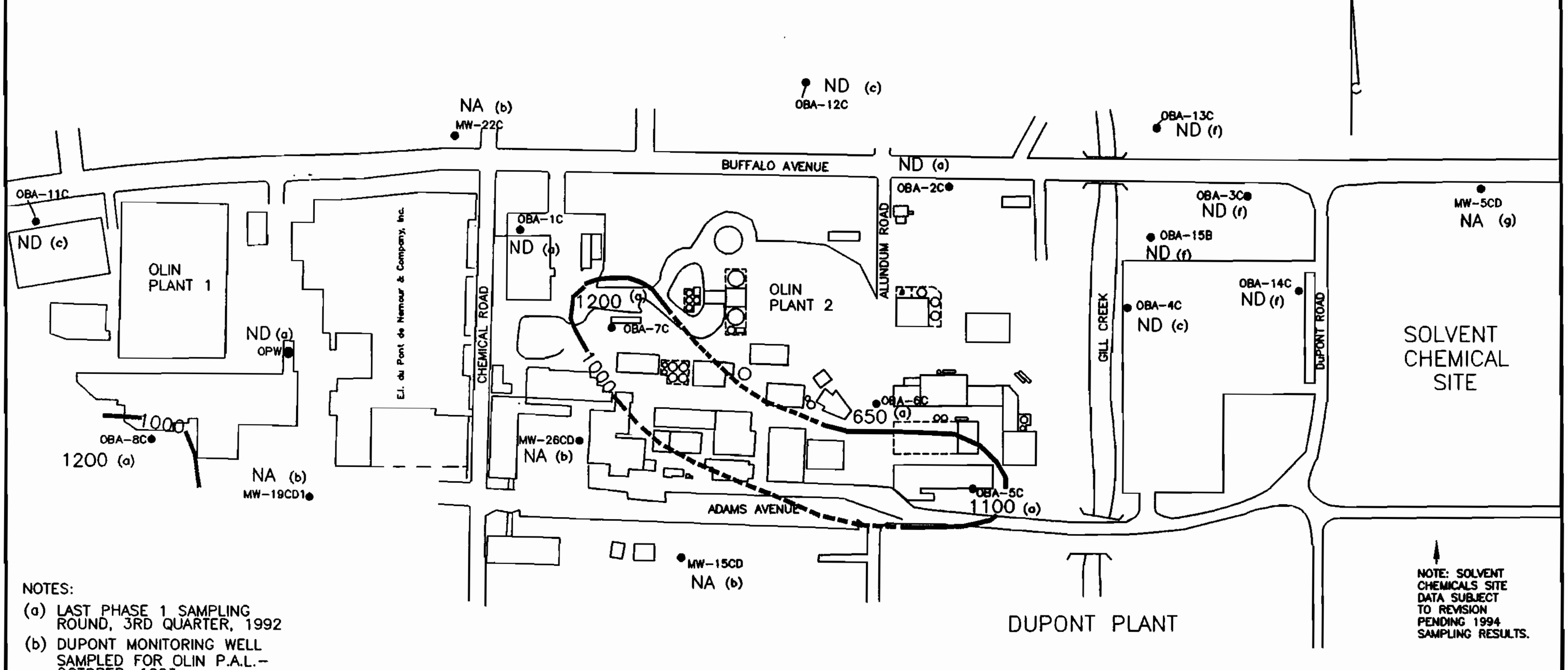
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

METHANOL CONCENTRATIONS
IN GROUNDWATER
B-ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-8-94
Checked by: KRM	Rev. No.:	FIGURE 7-20
Scale: 0 — 200 Feet		

ND–NOT DETECTED
NA–NOT ANALYZED FOR THIS COMPOUND



NOTE: SOLVENT CHEMICALS SITE DATA SUBJECT TO REVISION PENDING 1994 SAMPLING RESULTS.

NOTES:

(a) LAST PHASE 1 SAMPLING ROUND, 3RD QUARTER, 1992
(b) DUPONT MONITORING WELL SAMPLED FOR OLIN P.A.L.– OCTOBER, 1993
(c) PHASE II SAMPLING ROUND– MAY, 1994
(d) DUPONT MONITORING WELL SAMPLED FOR DUPONT INDICATOR PARAMETERS–OCTOBER, 1993
(e) PHASE II SAMPLING ROUND– JANUARY, 1994
(f) PHASE II SAMPLING ROUND–JULY, 1994
(g) FROM "REMEDIAL INVESTIGATION REPORT FOR THE 3163 BUFFALO AVENUE SITE, NIAGARA FALLS, NY", ECOLOGY & ENVIRONMENT,INC., NOV. 1990

LEGEND:

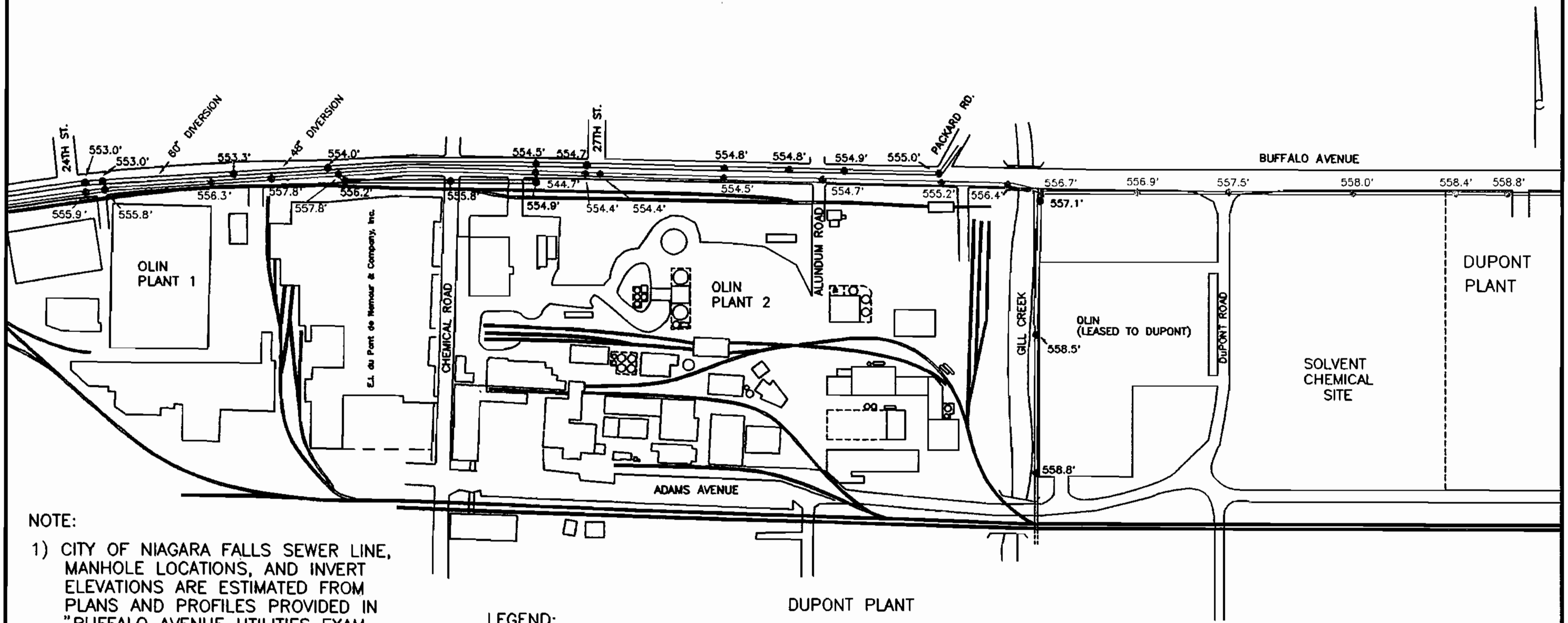
OBA-8C ● ← WELL ID
1200 ← METHANOL CONCENTRATION (ug/L)

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

METHANOL CONCENTRATIONS
IN GROUNDWATER
C/CD–ZONE WELLS

Job No.: 4E02704	Drawing No.	Date: 7-11-94
Checked by: KRM	Rev. No.:	FIGURE 7-21
Scale: 0 200 Feet		



NOTE:

1) CITY OF NIAGARA FALLS SEWER LINE, MANHOLE LOCATIONS, AND INVERT ELEVATIONS ARE ESTIMATED FROM PLANS AND PROFILES PROVIDED IN "BUFFALO AVENUE UTILITIES EXAMINATION, CITY OF NIAGARA FALLS, NIAGARA COUNTY, NEW YORK" (O'BRIEN & GERE, SEPTEMBER, 1989)
2) DUPONT SANITARY SEWER LINE, MANHOLE LOCATIONS, AND INVERT ELEVATIONS ARE ESTIMATED BASED ON WOODWARD-CLYDE CONSULTANTS FIELD INVESTIGATION.

LEGEND:

554.5'	24" BUFFALO AVENUE SANITARY SEWER WITH MANHOLE AND INVERT ELEVATION
554.0'	48" AND 60" DIVERSION SEWER WITH MANHOLE AND INVERT ELEVATION
558.8'	DUPONT SANITARY SEWER WITH MANHOLE AND INVERT ELEVATION
555.8'	24" SANITARY SEWER WITH MANHOLE AND INVERT ELEVATION

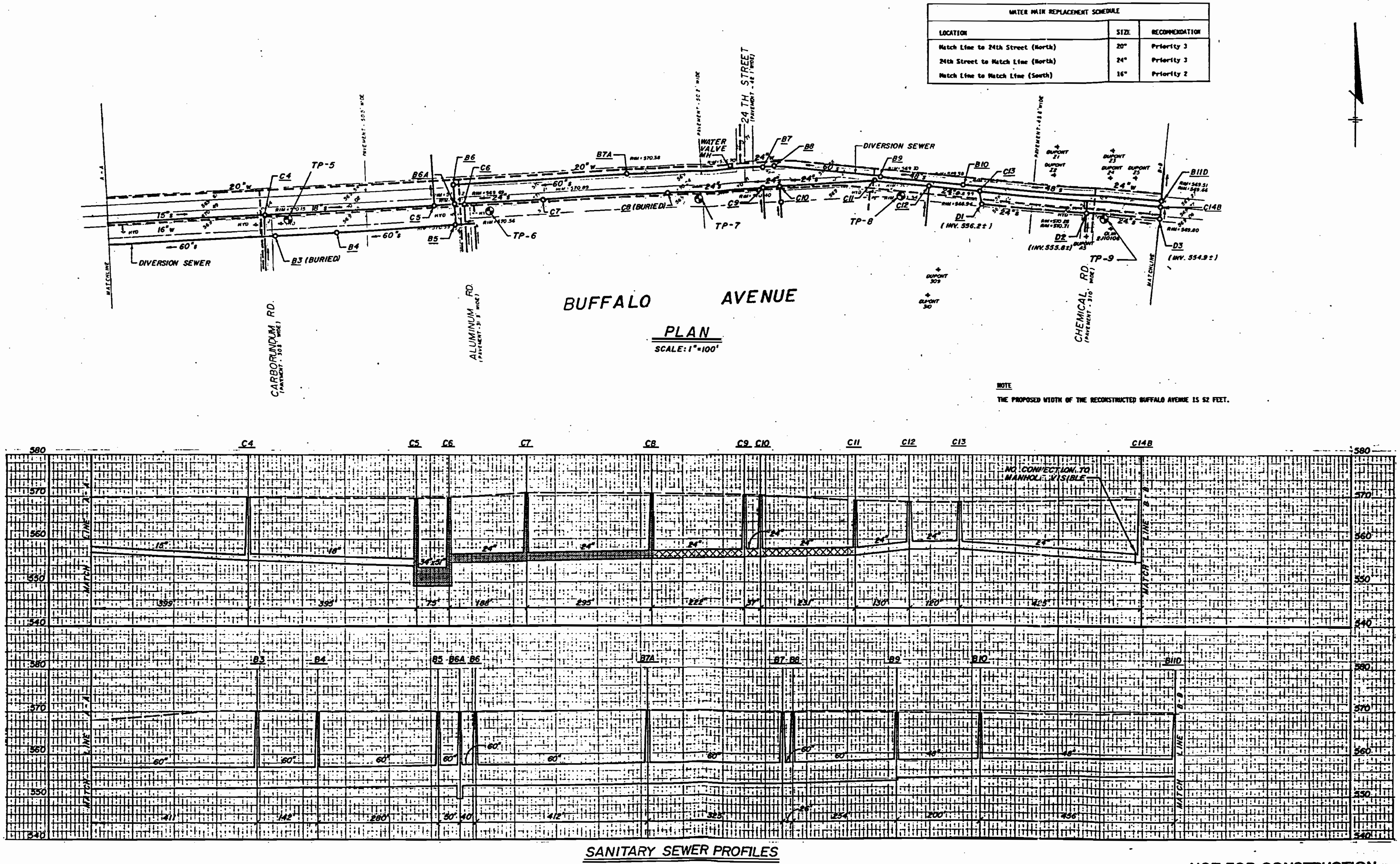
OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

SEWERS INFLUENCING
GROUNDWATER FLOW

Job No.: 4E02704	Drawing No.	Date: 07-27-94
Checked by: KRM	Rev. No.:	FIGURE 8-1
Scale: 0 200 Feet		

WATER MAIN REPLACEMENT SCHEDULE		
LOCATION	SIZE	RECOMMENDATION
Match Line to 24th Street (North)	20"	Priority 3
24th Street to Match Line (North)	24"	Priority 3
Match Line to Match Line (South)	16"	Priority 2



PLAN

SCALE: 1" = 100'

NOTE
THE PROPOSED WIDTH OF THE RECONSTRUCTED BUFFALO AVENUE IS 52 FEET.

SANITARY SEWER PROFILES

SCALES: HORIZ. 1" = 100'
VERT. 1" = 10'

NOT FOR CONSTRUCTION

In charge of ____________
Designed by ________ Checked by ________
Made by ____________

1" = 100' 100 0 100 200
1" = 10' 10 0 10 20

NO.	DATE	REVISION	INT.
1	9/21/89	PROPOSED TEST POINT LOCATIONS ADDED	BAG
2	1/10/90	REVISED PROPOSED TEST POINT LOCATIONS	BAG

O'BRIEN & GERE ENGINEERS, INC.
Syracuse, New York

CITY OF NIAGARA FALLS
NIAGARA COUNTY, NEW YORK
BUFFALO AVENUE UTILITIES EXAMINATION

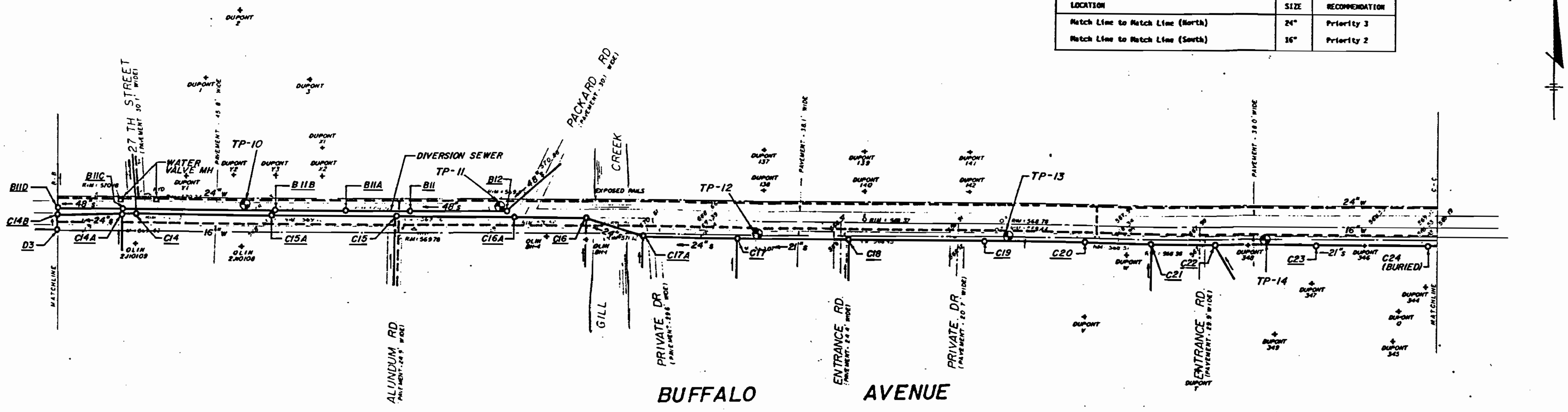
PLAN & PROFILES

FILE NO. 1736.028-03F
DATE SEPT. 1989

2

FIGURE 8-2

WATER MAIN REPLACEMENT SCHEDULE		
LOCATION	SIZE	RECOMMENDATION
Match Line to Match Line (North)	24"	Priority 3
Match Line to Match Line (South)	16"	Priority 2

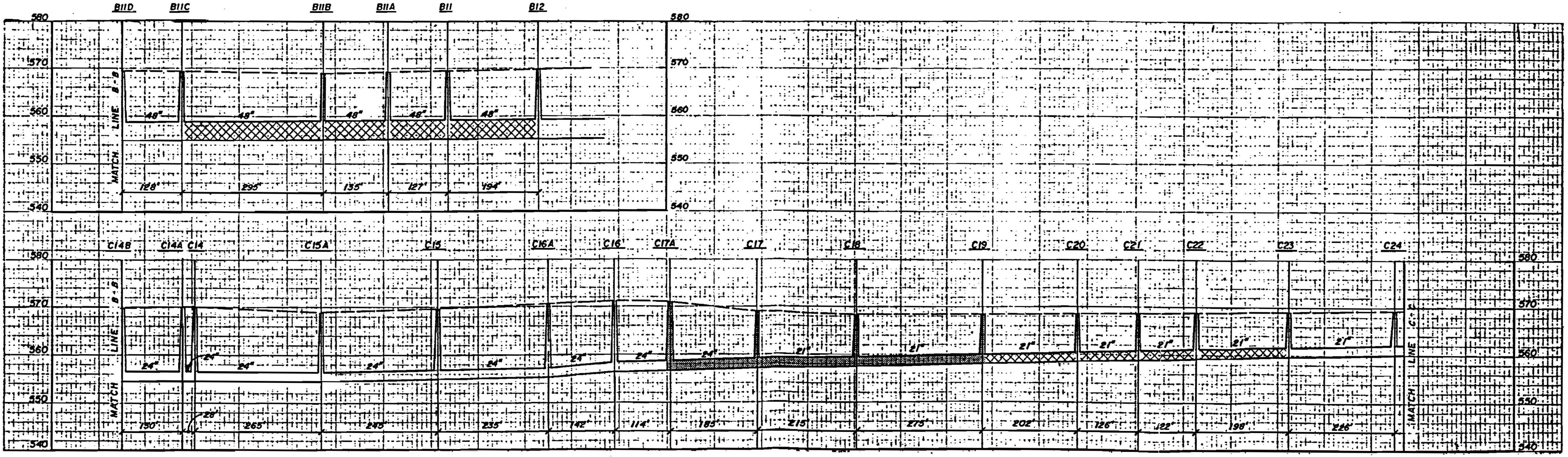


PLAN

SCALE: 1" = 100'

NOTE

THE PROPOSED WIDTH OF THE RECONSTRUCTED BUFFALO AVENUE IS 52 FEET.



SANITARY SEWER PROFILES

SCALES: HORIZ 1" = 100'
VERT 1" = 10'

NOT FOR CONSTRUCTION

In charge of ______	1" = 100'	NO.	DATE	REVISION	INIT.
Designed by ______ Checked by ______	1" = 10'	1	9/21/89	PROPOSED TEST POINT LOCATIONS ADDED	BHG
Made by ______		2	1/10/90	REVISED PROPOSED TEST POINT LOCATIONS	BGR

O'BRIEN & GERE ENGINEERS, INC.
Syracuse, New York

CITY OF NIAGARA FALLS
NIAGARA COUNTY, NEW YORK
BUFFALO AVENUE UTILITIES EXAMINATION

PLAN & PROFILES

FILE NO. 1736.028-04F
DATE SEPT. 1989
3

FIGURE 8-3