ASSESSMENT OF APL/NAPL MIGRATION FROM S-AREA IN THE OVERBURDEN TOWARD THE NIAGARA RIVER

S-Area Remedial Program

CRA 5-0038881

July 1988
Ref. No. 1769

CONESTOGA-ROVERS & ASSOCIATES

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1.0 INTRODUCTION

One of the purposes of the surveys undertaken at the S-Area Landfill was to provide data to perform "an assessment of the areal and vertical migration of the aqueous (APL) and non-aqueous phase chemicals (NAPL), if any, from the Landfill Site in the overburden toward the Niagara River". (Stipulation and Judgment Approving Settlement Agreement (Settlement Agreement) - Subparagraph B[2].)

In addition, the assessment was also to "address whether additional data is required to assess the areal extent of chemical migration from the Landfill Site in the Overburden toward the Niagara River". (Settlement Agreement - Subparagraph B[5][b].)

This report presents the results of the surveys conducted in the field, discusses the overburden hydrogeology, assesses the areal and vertical migration of APL and NAPL in the overburden from the S-Area Landfill toward the Niagara River and assesses the need for additional data.

The study area for these assessments is the land south of Occidental Chemical Corporation's (OCC) N and S Areas and south of the City of Niagara Falls Drinking Water Treatment Plant (WTP) as shown in Figure 1.

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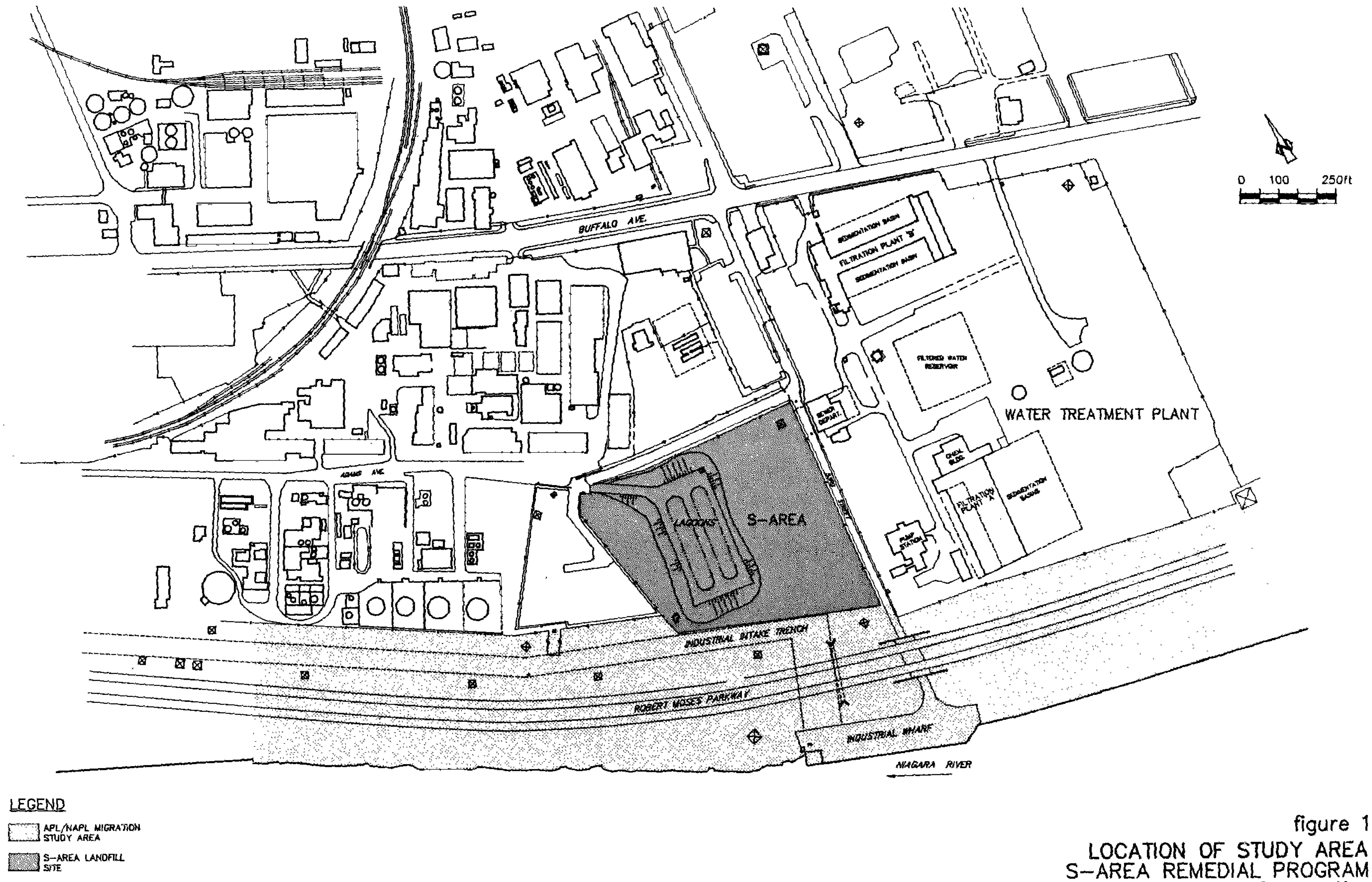

figure 1
LOCATION OF STUDY AREA
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-1/06/88-22-D-0 (P-17)

2.0 BACKGROUND INFORMATION

There have been several geologic/hydrogeologic study programs conducted in the study area over the past 10 years. The list of studies conducted in the vicinity of the study area that provide relevant information includes the following:

- 1979 - Niagara Plant Groundwater Monitoring Well Installation Program (SP wells)
- 1980 - Drinking Water Treatment Plant Borehole Investigation Program (BH1 through 7-80)
- 1980 - S-Area Groundwater Monitoring Well Installation (OW1S through 9S-80)
- 1981-82 - Discontinuity Investigation (BH1-82 through BH23-82)
- 1986-88 - S-Area Survey
  - Overburden Well Installations (OW260 through OW273)
  - Discontinuity Investigation and Barrier Alignment Boreholes (BH100 through BH223)

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- Underground Utility Bedding
  Boreholes/Excavations

The geologic descriptions of strata encountered in all of the boreholes and wells use similar protocols and the same nomenclature as those employed during the S-Area Survey. Therefore, all of the geologic descriptions have been used in the overall geologic stratigraphy mapping. Descriptions of other characteristics, such as the presence of odors and iridescent sheens may be less reliable in the older installations and are treated accordingly. Notations of the presence of NAPL are typically consistent with the recent S-Area Survey and are therefore considered to have been accurately and consistently recorded.

Copies of the stratigraphic logs for all of the boreholes and wells installed are available in one of the following reports:

- "Information Summary Report - S-Area Remedial Program" June 1988 (Information Summary Report).
- "Historical Information S-Area - Water Treatment Plant 1982".

The locations of all of the wells and boreholes in the study area are presented in Figure 2.

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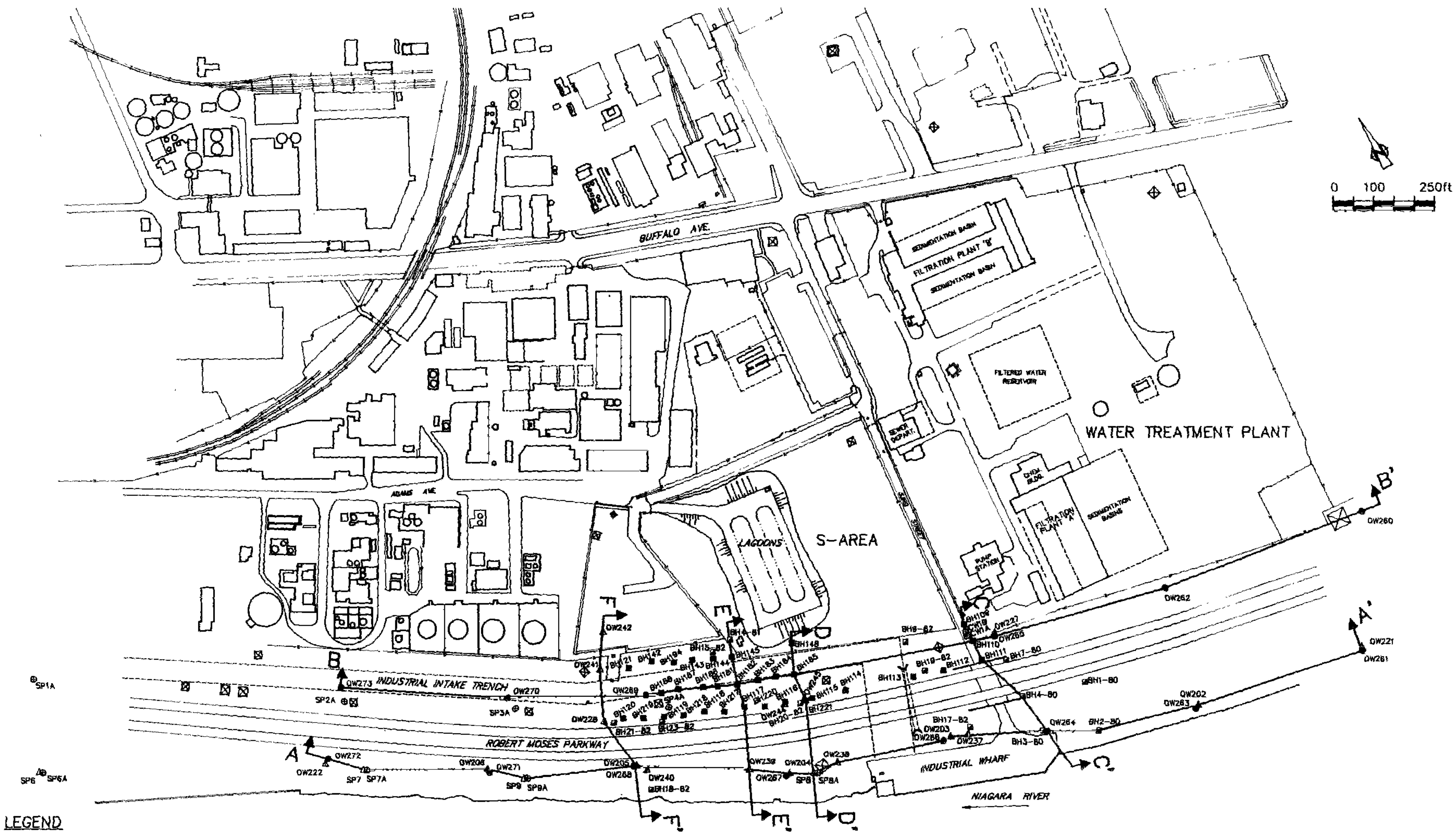

LEGEND

REMEDIAL INVESTIGATION – WELLS / BOREHOLES
- BEDROCK – SURVEY
- BEDROCK – CHEMICAL
- BEDROCK – HYDRAULIC GRADIENT
- BEDROCK – TRACER
- S AREA OVERBURDEN
- WATER TREATMENT PLANT OVERBURDEN
- BOREHOLES

HISTORICAL – WELLS / BOREHOLES
- OVERBURDEN WELLS
- BEDROCK
- BOREHOLES

A A' CROSS-SECTION LOCATIONS

CRA

figure 2

STUDY AREA WELLS & BOREHOLES
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-1/06/88-22-D-0 (P-18)

3.0 GEOLOGIC SUMMARY

The geologic stratigraphy in the overburden between the Site and the Niagara River is comprised of essentially four overburden units. From ground surface to top of bedrock, the stratigraphic units encountered are:

- Fill
- Native Alluvial River Deposits (Alluvium)
- Native Glaciolacustrine Clay (Clay)
- Native Glacial Till (Till)

The "Information Summary Report" contains plans illustrating the contours of the top of each stratigraphic unit as well as isopach maps showing the thickness of each unit over the entire study area. A series of geologic cross sections of the overburden have been prepared and are presented in Figures 3 through 8. The locations of the cross sections are presented in Figure 2.

FILL

The area of study for this assessment is essentially comprised of land reclaimed from the Niagara River in the late 1950's and early 1960's as part of the construction of the Robert Moses Parkway and intake structures for the Robert Moses Generating Station. The fill

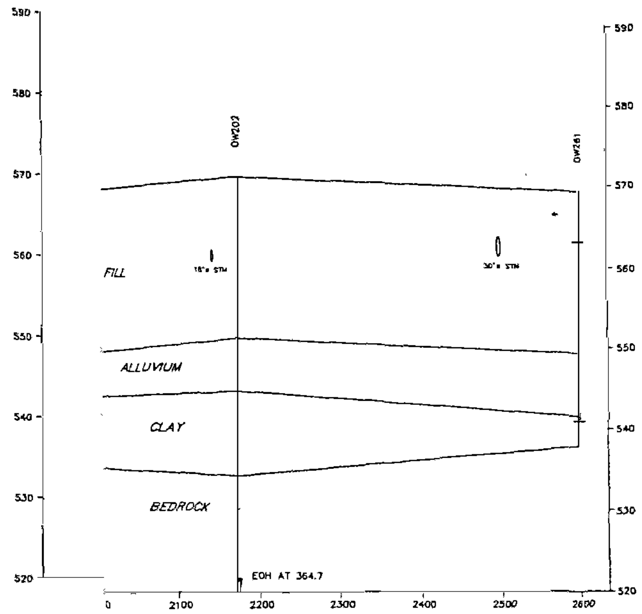

figure 3
CROSS-SECTION A-A'
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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1769-18/05/88-22-D-0

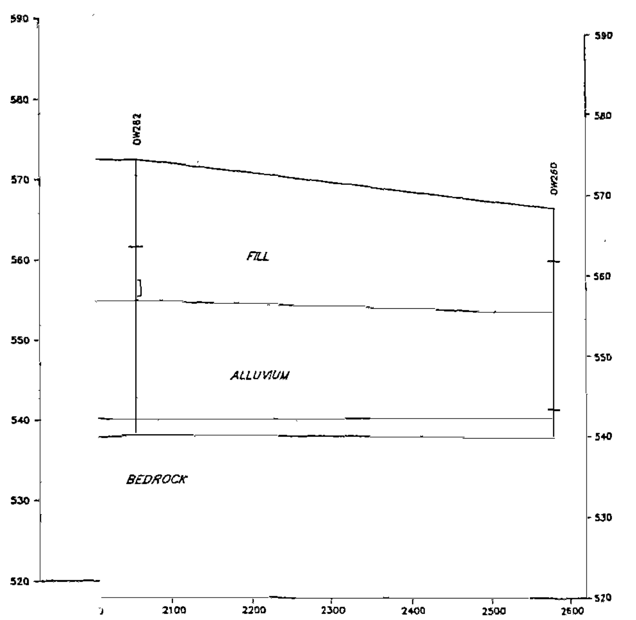

figure 4
CROSS-SECTION B-B'
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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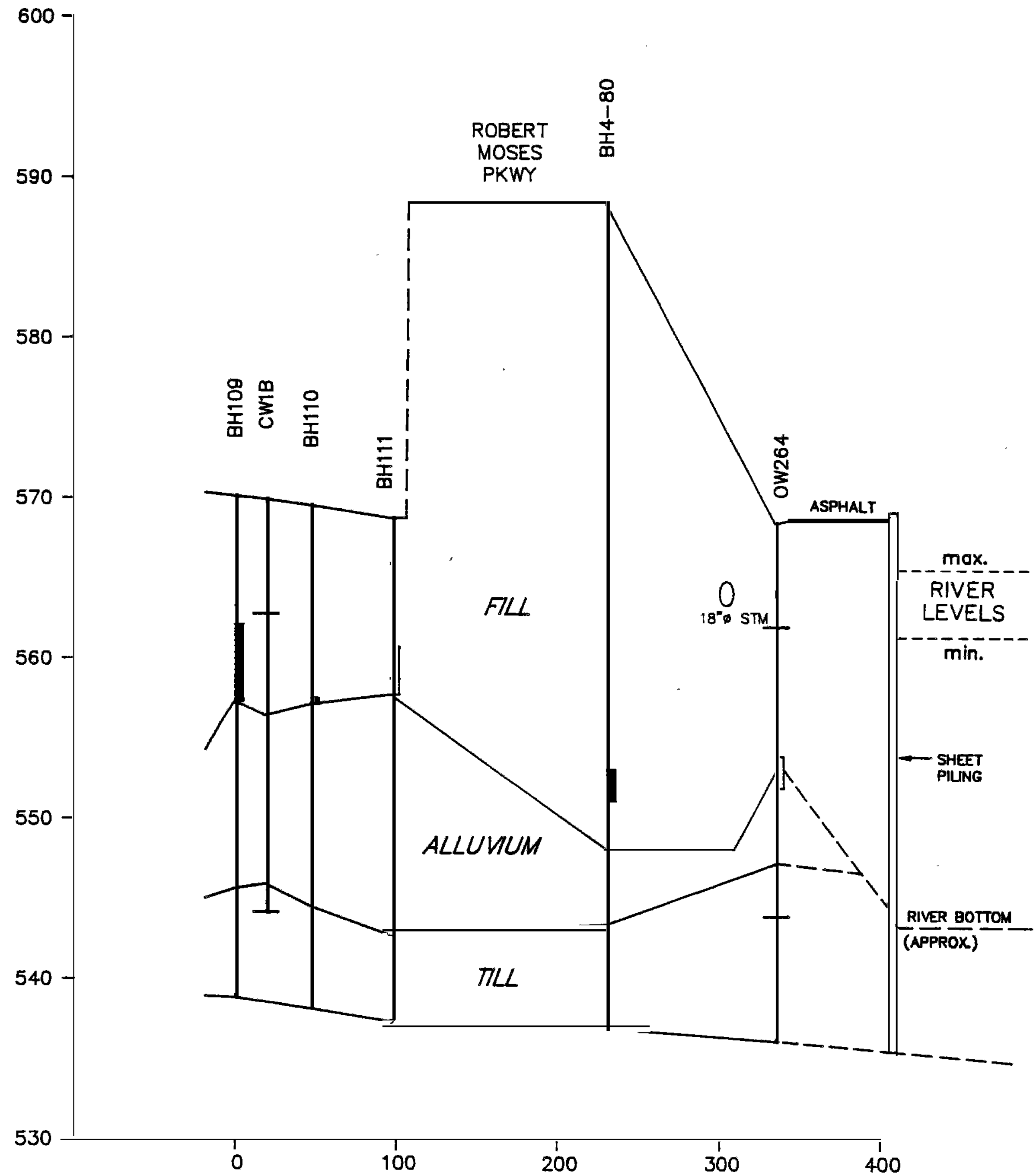

LEGEND

MONITORING INTERVAL

SHEEN

NAPL

SCALE: 1"=10' VER.
1"=100' HOR.

ALL ELEVATIONS BASED ON
1986 OCC DATUM
(REF. DWG. A-11-19200)

figure 5

CROSS-SECTION C-C'
S-AREA REMEDIAL PROGRAM
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1769-24/06/88-22-D-0(X-40)

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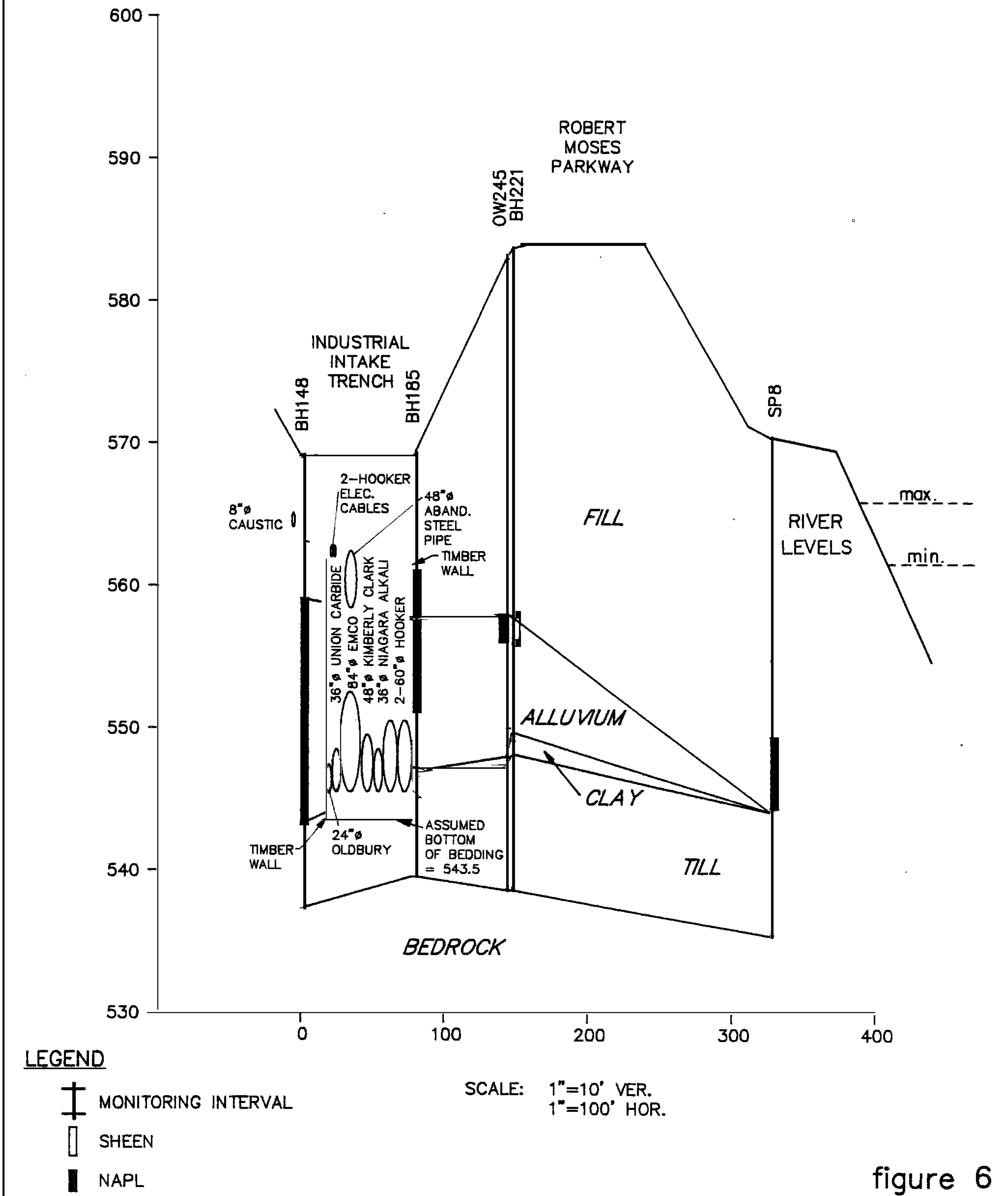

figure 6

CROSS–SECTION D–D'
S–AREA REMEDIAL CORPORATION
Occidental Chemical Corporation

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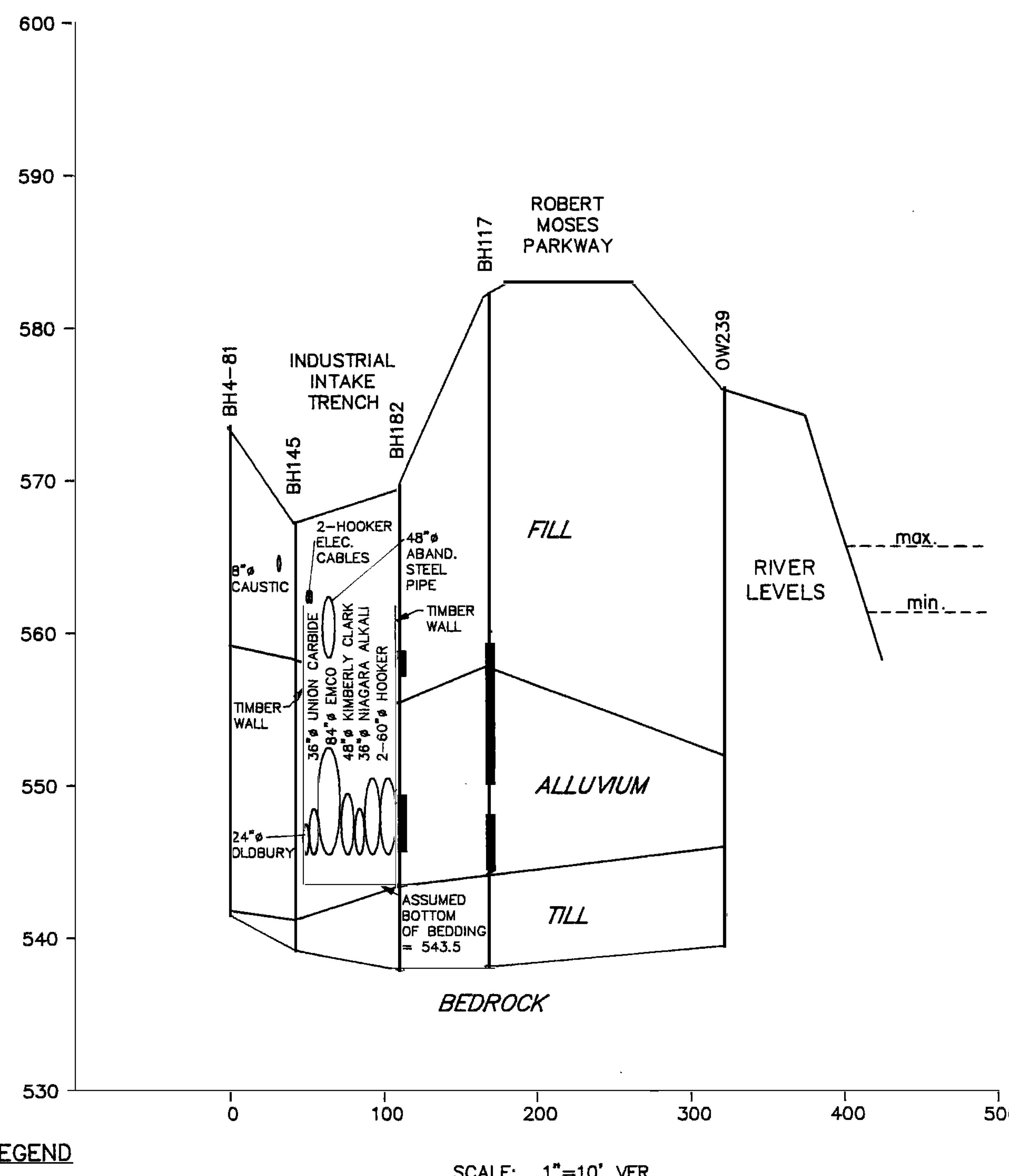
1769–26/06/88–22–D–0(X–46)

CRA 5-0038894



LEGEND

MONITORING INTERVAL

SHEEN

NAPL

SCALE: 1"=10' VER.
1"=100' HOR.

ALL ELEVATIONS BASED ON
1986 OCC DATUM
(REF. DWG. A-11-19200)

figure 7

CROSS-SECTION E-E'
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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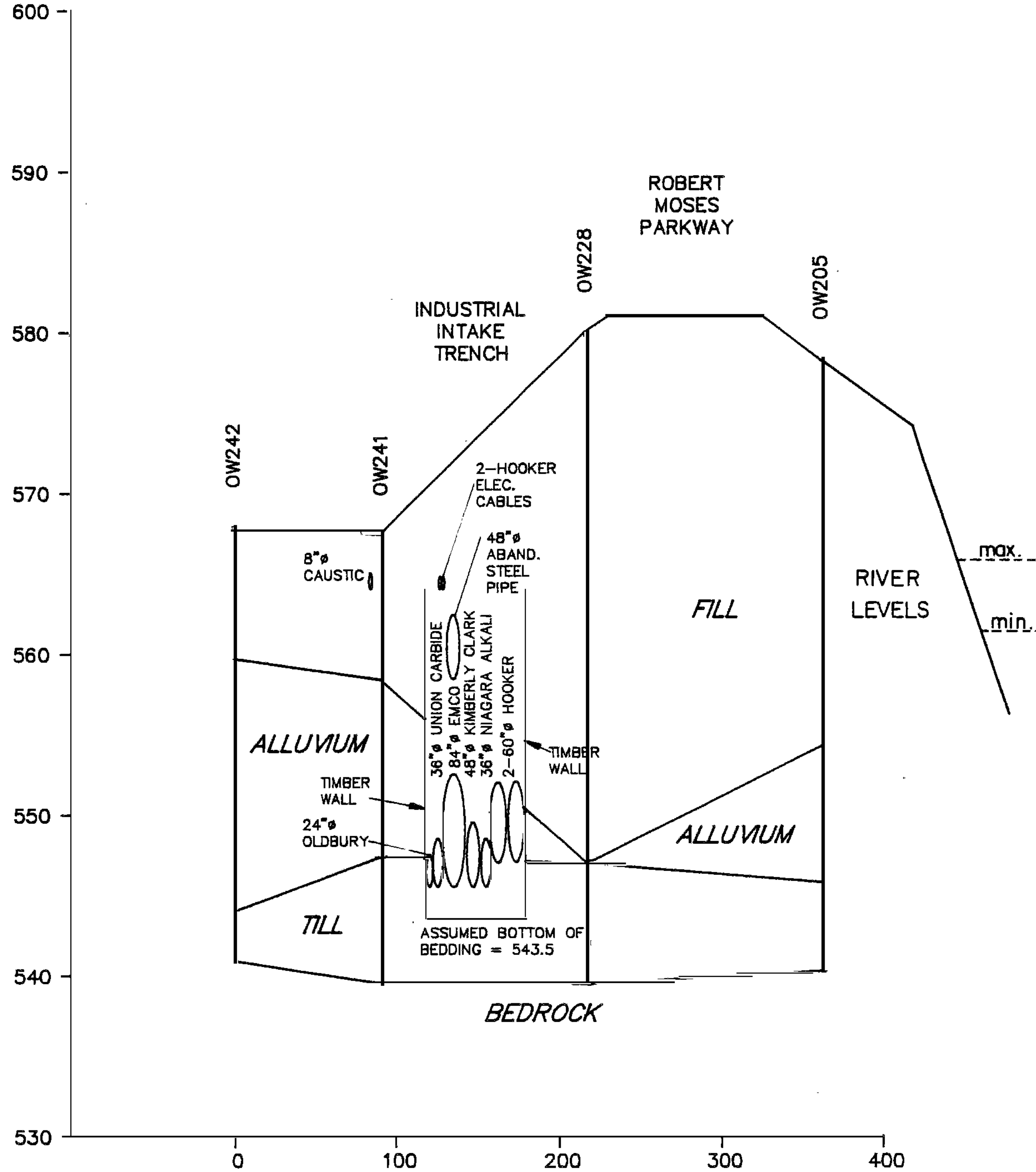

LEGEND

MONITORING INTERVAL

SHEEN

NAPL

SCALE: 1"=10' VER.
1"=100' HOR.

figure 8

CROSS-SECTION F-F'
S-AREA REMEDIAL CORPORATION
Occidental Chemical Corporation

ALL ELEVATIONS BASED ON
1986 OCC DATUM
(REF. DWG. A-11-19200)

CRA

1769-26/06/88-22-D-0(X-44)

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used to construct the Robert Moses Parkway mainly came from the excavation of soil and bedrock for the twin conduits which transfer water from the upper Niagara River to the Robert Moses Generating Station located north of the City of Niagara Falls. The excavation and blasting methods used to provide the channel for the conduits resulted in a considerable portion of the blasted rock (shotrock) being removed in large pieces (often as large as the size of a car). Consequently, penetration of the fill in the study area often encountered shotrock layers that were difficult to penetrate. The remainder of the fill consists of relocated soils, cinders, flyash and stone fragments. The relocated soils range from sandy to clayey.

The elevation of the bottom of fill is typically in the range of 548 to 556. The thickness of the fill strata ranged from 30 feet along the Robert Moses Parkway at 53rd Street to 12 feet along the southern property line of the S-Area. Within the limits of the Industrial Intake Pipe Trench, the fill can be as thick as 40 feet.

ALLUVIUM

The alluvium generally consists of gray silts and sands. The thickness of the alluvium varies from not present to approximately 14 feet in the study area. The thickest section follows along the westbound lanes of the Robert Moses Parkway and thins considerably toward the River. The alluvium is absent at the western end of the study area. The alluvium would also have been physically removed from within the Industrial Intake Pipe Trench for the installation of the pipes. In fact, all of the soil to a depth of approximately 543.5 feet was removed during the intake pipe installation project.

CLAY

The glaciolacustrine clay has essentially been completely scoured from the study area by the flowing water of the Niagara River and has been replaced by the alluvium layers. A few isolated pockets of clay still exist in the area of BH115/OW245/BH221, BH119/BH218 and BH194/OW241, although these deposits are very thin. As one moves north of the study area, the thickness of the clay quickly increases to as much as 24 feet.

TILL

Underlying the clay is a layer of glacial till comprised principally of silt. Sand and gravel/rock fragments are common. Although clay is not the major component of the till, it is consistently found to be present. The till immediately overlies the bedrock.

As discussed and documented in the upcoming report entitled "Evaluation of Confining Layer", the clay and till stratum beneath the study area are fine grained units exhibiting permeabilities on the order of $1x10^{-7}$ cm/sec or less. Conversely, the fill and alluvium units are more permeable and are capable of transmitting both APL and NAPL and are therefore the strata of potential environmental concern for the purposes of these assessments. The combined clay/till strata is an aquitard and the rate of potential APL or NAPL migration through these units is very minor when compared to the potential for APL or NAPL migration in the fill and alluvium strata.

4.0 NAPL

4.1 NAPL MIGRATION

In order to assess the migration potential of NAPL, it is first necessary to understand the factors that influence NAPL movement. The primary factors influencing the S-Area NAPL include:

- soil permeability
- NAPL density
- NAPL viscosity
- NAPL head
- NAPL surface tension

The S-Area NAPL was originally deposited in the fill and alluvium strata within the areal limits of the S-Area. From this point of origin, NAPL may migrate vertically downward through the naturally occurring or manmade preferential pathways in the fill to the top of the groundwater table. Due to the fact that the S-Area NAPL has a higher specific gravity than water, it could continue downward through the saturated permeable strata until it reaches a layer of lower permeability. One such layer of slightly less permeable soil is often encountered at the elevation of the original river bottom sediment. This layer is frequently identified by its topsoil-like characteristic and through the presence of vegetative and root fibers. This layer is often slightly less permeable than the overlying fill or underlying alluvium and consequently provides a temporary and discontinuous barrier to downward vertical NAPL migration. At each such layer of lower permeable soil, NAPL may temporarily cease its vertical downward movement and begin to flow downward and laterally at an angle along the steepest depositional gradient over the lower permeable stratum. In addition to the potential for lateral migration of the NAPL, once the head of NAPL resting on the lower permeable layer overcomes the surface tension prohibiting penetration into the layer, penetration through the layer may occur and continue at the rate physically achievable given the head of NAPL driving the penetration (applied pressure head) and the permeability of the layer. These lower permeable layers mostly occur in the fill materials which are heterogeneous in composition. The underlying alluvium is more homogeneous and therefore, NAPL migration in the alluvium is more predictable.

The vertical migration of NAPL may continue downward through the alluvium until it reaches the top of the clay or till stratum. Penetration of NAPL into the clay and till stratum was not observed and is not expected due to the low permeability of these units. Physical and visual evidence of the lack of this penetration will be discussed in

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a report to be submitted entitled "Evaluation of Confining Layer". Upon reaching the top of the clay/till layer, the NAPL flows along the path combining the most favorable of the following conditions: the steepest depositional gradient and the most permeable pathway of the overlying deposits.

4.2 EXTENT OF NAPL PRESENCE AND MIGRATION

In defining the lateral and vertical extent of NAPL from the Site toward the Niagara River, all of the historical stratigraphic data has been compiled along with the information collected during the S-Area Surveys. This compilation of stratigraphic information has been reviewed for references of black residues, oily appearances and other properties associated with NAPL. All such references have been summarized and are presented in Tables 1A and 1B. Using the references of NAPL, a plan view representation of the areal extent of NAPL presence and migration in the overburden from the Landfill toward the Niagara River was constructed. Figure 9 presents the defined areal limits of NAPL presence and migration in the overburden.

NAPL extends southward from the S-Area Landfill along four finger-like pathways. NAPL is generally not present in the area south of the Robert Moses Parkway.

TABLE 1A - STRATIGRAPHIC INFORMATION - S AREA REMEDIAL PROGRAM

WELL/BH #	GROUND ELEVATION	GRID CO-ORDINATES NORTH	EAST	DEPTH TO ALLUVIUM (FEET)	ELEV.OF ALLUVIUM	DEPTH TO CLAY (FEET)	ELEV.OF CLAY	DEPTH TO TILL (FEET)	ELEV.OF TILL	DEPTH TO BEDROCK (FEET)	ELEV.OF BEDROCK	NAPL/SHEEN DEPTH OBSERVED (FEET)
OW200	572.80	1043.48	1624.60	3.50	569.30	8.00	564.80	25.80	547.00	28.50	544.30	ND
OW201	568.90	680.93	1724.27	--	--	7.00	561.90	28.80	540.10	29.50	539.40	ND
OW202	571.50	-180.68	2028.67	20.00	551.50	--	--	26.50	545.00	37.00	534.50	ND
OW203	568.20	-255.89	1419.75	17.50	550.70	--	--	19.00	549.20	30.10	538.10	ND
OW204	572.30	-346.91	1023.05	21.00	551.30	--	--	24.30	548.00	34.50	537.80	ND
OW205	578.30	-327.96	647.66	24.00	554.30	--	--	32.50	545.80	38.00	540.30	s24.8
OW206	575.10	-335.15	280.08	23.00	552.10	--	--	25.30	549.80	32.50	542.60	ND
OW207	568.70	111.01	450.12	8.00	560.70	18.00	550.70	21.00	547.70	26.00	542.70	ND
OW207A	568.70	98.07	305.64	7.60	561.10	--	--	21.00	547.70	26.50	542.20	n4.5-6.5
OW208	569.60	614.20	341.18	--	--	7.20	562.40	16.00	553.60	24.00	545.60	ND
OW209	571.00	757.27	816.33	--	--	8.50	562.50	25.40	545.60	29.50	541.50	ND
OW210	571.10	627.43	1177.71	8.80	562.30	10.80	560.30	30.60	540.50	32.50	538.60	ND
OW211	570.60	329.12	1377.32	19.00	551.60	19.20	551.40	28.00	542.60	31.00	539.60	ND
OW212	570.10	294.40	639.35	8.60	561.50	11.90	558.20	24.00	546.10	27.40	542.70	s6-8.6 n8.6-10 n15.8
OW213	568.60	15.62	684.92	8.00	560.60	24.10	544.50	25.10	543.50	28.00	540.60	ND
OW214	569.70	383.87	257.73	8.00	561.70	8.00	561.70	16.50	553.20	24.00	545.70	ND
OW215	575.10	425.21	1696.23	17.00	558.10	19.00	556.10	30.70	544.40	37.10	538.00	ND
OW216*	572.30	956.58	1209.20	2.30	570.00	6.90	565.40	24.00	548.30	31.00	541.30	ND
OW217	572.30	1034.86	514.18	2.00	570.30	7.80	564.50	13.50	558.80	26.90	545.40	ND
OW218	574.10	1421.97	925.20	5.00	569.10	9.00	565.10	23.90	550.20	26.50	547.60	ND
OW219	568.50	634.56	43.74	--	--	--	--	5.30	563.20	20.70	547.80	ND
OW220	572.40	1020.03	2018.49	0.50	571.90	7.90	564.50	30.00	542.40	30.10	542.30	ND
OW221*	570.40	-40.07	2431.73	20.00	550.40	--	--	27.80	542.60	31.50	538.90	ND
OW222*	571.60	-312.86	-119.99	20.70	550.90	--	--	20.80	550.80	27.00	544.60	ND
OW223	571.00	860.39	-146.21	2.30	568.70	--	--	4.00	567.00	21.00	550.00	ND
OW224	574.10	1465.37	905.27	5.50	568.60	8.50	565.60	18.00	556.10	25.30	548.80	ND
OW225	571.40	643.24	830.62	--	--	9.00	562.40	27.00	544.40	31.20	540.20	ND
OW226	571.90	559.78	1307.62	--	--	8.00	563.90	32.80	539.10	33.00	538.90	ND
OW227*	574.00	-4.30	1526.20	16.60	557.40	--	--	29.80	544.20	34.80	539.20	ND
OW228	580.00	-218.15	565.59	--	--	--	--	33.00	547.00	40.50	539.50	n40.5
OW229	569.20	237.92	575.39	9.40	559.80	14.00	555.20	25.50	543.70	26.50	542.70	n7.2-13
OW230	569.40	398.60	730.59	8.30	561.10	10.00	559.40	25.00	544.40	28.40	541.00	n6.7-10
OW231	570.10	584.96	737.57	7.70	562.40	9.00	561.10	24.00	546.10	28.80	541.30	ND
OW232*	572.40	738.23	842.29	--	--	8.50	563.90	25.40	547.00	31.00	541.40	ND
OW233	571.00	676.25	1047.00	--	--	8.20	562.80	28.00	543.00	31.00	540.00	ND
OW234*	569.80	659.25	1244.42	--	--	8.00	561.80	29.30	540.50	32.00	537.80	ND
OW235	570.80	377.35	1347.48	9.00	561.80	14.00	556.80	29.50	541.30	31.50	539.30	ND
OW236	577.00	196.55	1395.81	18.00	559.00	29.60	547.40	33.90	543.10	37.50	539.50	s14-16 s22-24
OW237*	568.00	-249.94	1461.42	17.50	550.50	--	--	19.00	549.00	30.00	538.00	ND
OW238	569.40	-319.68	1139.77	20.00	549.40	--	--	24.00	545.40	32.30	537.10	ND
OW239	576.00	-337.40	924.00	24.00	552.00	--	--	29.20	546.80	36.50	539.50	ND
OW240*	576.90	-338.17	671.66	24.00	552.90	--	--	32.50	544.40	38.00	538.90	s24.8
OW241	567.40	-92.36	554.99	9.00	558.40	20.00	547.40	21.80	545.60	27.90	539.50	s9-11 n11-15 s15-17 n17-20
OW242	567.90	-0.95	562.09	8.20	559.70	--	--	23.90	544.00	27.00	540.90	n18-23.9
OW243	568.90	195.61	572.24	10.00	558.90	13.90	555.00	24.00	544.90	28.00	540.90	n6.2-6.4 s9-10
OW244*	583.20	-176.10	1009.37	28.60	554.60	--	--	38.80	544.40	44.10	539.10	s25-25.9 s31-35
OW245	583.00	-165.71	1058.80	25.00	558.00	35.00	548.00	35.60	547.40	44.40	538.60	n25-27 s33-35
OW260	568.40	295.06	2429.24	13.00	555.40	24.40	544.00	26.00	542.40	28.50	539.90	ND
OW261	569.50	-49.36	2431.83	20.00	549.50	--	--	27.80	541.70	31.50	538.00	ND
OW262	574.50	105.34	1946.31	17.50	557.00	--	--	32.40	542.10	34.20	540.30	s15-17
OW263*	571.00	-189.08	2022.55	20.00	551.00							ND
OW264	568.40	-243.92	1655.65	15.50	552.90	--	--	21.20	547.20	32.30	536.10	s14.5-16.5

NOTE: * = PARTIAL OR TOTAL STRATIGRAPHY DENOTED AT ADJACENT WELL/BOREHOLE

TABLE 1A - STRATIGRAPHIC INFORMATION - S AREA REMEDIAL PROGRAM

WELL/BH #	GROUND ELEVATION	GRID CO-ORDINATES NORTH	EAST	DEPTH TO ALLUVIUM (FEET)	ELEV.OF ALLUVIUM	DEPTH TO CLAY (FEET)	ELEV.OF CLAY	DEPTH TO TILL (FEET)	ELEV.OF TILL	DEPTH TO BEDROCK (FEET)	ELEV.OF BEDROCK	NAPL/SHEEN DEPTH OBSERVED (FEET)
OW265	574.50	-12.76	1526.50	16.60	557.90	--	--	29.80	544.70	36.30	538.20	ND
OW266*	568.20	-265.36	1400.84	17.50	550.70	--	--	19.00	549.20			ND
OW267*	571.90	-352.79	1013.35	21.00	550.90	--	--	24.30	547.60			ND
OW268*	578.50	-328.42	637.26	24.00	554.50	--	--	32.50	546.00			s24.8
OW269	573.00	-153.64	668.13	29.20	543.80	--	--	29.30	543.70	33.20	539.80	s12.6-14.8 s16-22
OW270	571.60	-160.48	329.30	--	--	--	--	26.40	545.20	29.80	541.80	s24-26.4
OW271*	574.60	-343.92	284.82	23.00	551.60	--	--	25.30	549.30			ND
OW272	572.00	-308.77	-113.96	20.70	551.30	--	--	20.80	551.20	28.00	544.00	ND
OW273	570.50	-135.07	-83.15	--	--	--	--	18.80	551.70	26.70	543.80	s12.8-16
OW274	572.10	943.32	1214.59	2.30	569.80	6.90	565.20	24.00	548.10	32.50	539.60	ND
OW275	570.50	740.20	1202.36	7.00	563.50	7.50	563.00	27.50	543.00	32.00	538.50	ND
OW276	571.50	782.28	1294.72	--	--	7.80	563.70	29.00	542.50	32.80	538.70	ND
OW277	570.20	650.73	1248.56	--	--	8.00	562.20	29.30	540.90	32.50	537.70	ND
OW278	570.50	666.96	1344.48	--	--	8.40	562.10	29.80	540.70	33.00	537.50	ND
OW279	570.50	753.09	1425.55	--	--	8.00	562.50	28.50	542.00	31.30	539.20	ND
OW280	569.90	806.38	1538.41	--	--	8.00	561.90	28.00	541.90	29.90	540.00	ND
OW281	570.30	858.05	1625.74	--	--	7.00	563.30	25.80	544.50	28.90	541.40	ND
OW282	571.10	595.36	1384.35	--	--	12.00	559.10	30.50	540.60	32.60	538.50	ND
OW283	571.70	577.50	1494.61	--	--	11.50	560.20	30.00	541.70	32.10	539.60	ND
OW284	569.60	747.38	1558.05	--	--	6.20	563.40	29.00	540.60	29.90	539.70	ND
OW285	569.80	779.13	1640.13	--	--	7.00	562.80	27.80	542.00	28.50	541.30	ND
OW286	570.70	671.65	1695.42	--	--	6.90	563.80	28.20	542.50	31.00	539.70	ND
OW287	574.20	528.69	1624.48	17.80	556.40	20.80	553.40	34.00	540.20	36.10	538.10	ND
OW288	572.20	528.44	1413.92	8.00	564.20	14.00	558.20	31.50	540.70	33.80	538.40	ND
OW289	573.10	416.22	1462.98	9.80	563.30	17.70	555.40	33.60	539.50	34.70	538.40	ND
OW290	574.80	398.67	1557.71	14.50	560.30	19.80	555.00	33.20	541.60	35.70	539.10	ND
OW291	574.40	472.17	1663.21	14.00	560.40	19.80	554.60	33.90	540.50	36.30	538.10	ND
OW292	576.00	156.44	1622.52	22.00	554.00	33.90	542.10	34.00	542.00	37.50	538.50	ND
OW293	575.60	66.87	1667.09	29.80	545.80	--	--	34.20	541.40	37.10	538.50	ND
OW294	574.60	96.18	1757.57	20.00	554.60	--	--	32.00	542.60	36.20	538.40	s15-15.6
BH100	571.80	684.08	1122.39	8.40	563.40	9.00	562.80	30.50	541.30	33.50	538.30	ND
BH101	571.20	565.14	1213.40	9.00	562.20	10.00	561.20	29.70	541.50	32.50	538.70	ND
BH102	571.80	464.47	1231.32	9.00	562.80	13.70	558.10	32.90	538.90	33.80	538.00	s6.8-9 n11.8-13.7
BH103	572.10	373.24	1272.69	11.00	561.10	16.00	556.10	33.00	539.10	34.10	538.00	s4-6 n8-8.5 n14-16
BH104	572.50	281.82	1314.02	12.80	559.70	16.60	555.90	32.00	540.50	33.40	539.10	s12.8-16 n16-16.6
BH105	572.10	190.08	1355.35	13.00	559.10	27.00	545.10	32.00	540.10	33.10	539.00	n12.5-13
BH106	571.60	144.75	1377.14	20.00	551.60	--	--	29.00	542.60	33.10	538.50	s11.3-11.4
BH107	571.10	104.04	1395.43	15.00	556.10	26.50	544.60	27.20	543.90	33.10	538.00	n10-11 n12-13.3 n16-22
BH108	570.70	57.69	1416.07	12.90	557.80	--	--	27.00	543.70	31.60	539.10	s8-12.9 n14-27
BH109	570.10	15.50	1451.81	12.80	557.30	--	--	24.50	545.60	31.30	538.80	n8-12.8
BH110	569.50	-24.45	1473.90	12.40	557.10	--	--	25.00	544.50	31.40	538.10	n12-12.4
BH111	568.70	-69.17	1495.61	11.00	557.70	--	--	26.00	542.70	31.40	537.30	n8-10 s10-11
BH112	585.60	-96.55	1401.34	29.70	555.90	--	--	39.50	546.10	48.40	537.20	ND
BH113	584.90	-112.45	1327.50	26.00	558.90	--	--	39.50	545.40	46.40	538.50	ND
BH114	583.60	-144.82	1160.25	28.40	555.20	--	--	36.80	546.80	45.60	538.00	s28-28.4
BH115	583.20	-162.33	1078.08	25.00	558.20	35.30	547.90	37.80	545.40	44.60	538.60	n25-27
BH116	582.70	-171.45	1010.65	28.60	554.10	--	--	38.80	543.90	44.30	538.40	s25-25.9 s31-35
BH117	582.10	-183.87	912.11	24.20	557.90	--	--	38.00	544.10	44.50	537.60	s22-22.8 n22.8-32 n34-37.6
BH118	581.20	-195.37	813.80	23.10	558.10	--	--	37.00	544.20	42.50	538.70	n23.1-37
BH119	580.80	-207.70	714.67	24.00	556.80	37.00	543.80	37.80	543.00	42.30	538.50	ND
BH120	580.80	-211.58	612.99	24.00	556.80	--	--	34.50	546.30	40.90	539.90	ND
BH121	566.80	-89.83	626.13	12.00	554.80	--	--	23.30	543.50	28.50	538.30	ND

NOTE: * = PARTIAL OR TOTAL STRATIGRAPHY DENOTED AT ADJACENT WELL/BOREHOLE

CRA 5-0038904

TABLE 1A - STRATIGRAPHIC INFORMATION - S AREA REMEDIAL PROGRAM

WELL/BH #	GROUND ELEVATION	GRID CO-ORDINATES NORTH	EAST	DEPTH TO ALLUVIUM (FEET)	ELEV.OF ALLUVIUM	DEPTH TO CLAY (FEET)	ELEV.OF CLAY	DEPTH TO TILL (FEET)	ELEV.OF TILL	DEPTH TO BEDROCK (FEET)	ELEV.OF BEDROCK	NAPL/SHEEN DEPTH OBSERVED (FEET)
BH122	567.90	8.18	624.68	8.00	559.90	23.90	544.00	25.30	542.60	26.00	541.90	ND
BH123	568.30	109.59	629.24	8.90	559.40	20.70	547.60	27.70	540.60	27.90	540.40	s24-26
BH124	568.50	182.85	632.32	8.00	560.50	14.30	554.20	27.70	540.80	28.00	540.50	s6-14
BH125	570.50	321.27	694.55	9.70	560.80	12.50	558.00	28.00	542.50	29.60	540.90	n6-12.5
BH126	570.70	381.26	822.28	8.10	562.60	13.30	557.40	28.00	542.70	29.80	540.90	n6-18
BH127	570.80	417.92	908.13	8.00	562.80	13.30	557.50	29.50	541.30	31.20	539.60	n4-13.3
BH128	570.90	458.31	999.50	8.00	562.90	13.20	557.70	28.50	542.40	32.20	538.70	n6-13.2
BH129	571.00	488.25	1061.23	8.60	562.40	12.90	558.10	31.00	540.00	33.00	538.00	s6-8 n8.6-12.9
BH130	571.10	541.67	1183.98	7.00	564.10	11.00	560.10	30.00	541.10	32.80	538.30	s6-7 s8-11
BH131	569.50	433.11	807.18	6.30	563.20	10.20	559.30	28.00	541.50	29.00	540.50	n6-8 n10-10.2
BH132	569.40	527.70	825.35	7.20	562.20	8.00	561.40	26.00	543.40	29.00	540.40	ND
BH133	571.80	606.20	812.10	8.40	563.40	10.20	561.60	28.50	543.30	31.00	540.80	ND
BH134	571.80	628.08	865.67	10.00	561.80	11.00	560.80	26.80	545.00	32.20	539.60	ND
BH135	570.90	575.24	946.56	9.10	561.80	10.20	560.70	29.60	541.30	32.50	538.40	ND
BH136	570.60	630.89	1031.41	8.10	562.50	8.20	562.40	29.70	540.90	31.50	539.10	ND
BH137	570.90	238.10	676.40	10.40	560.50	14.00	556.90	27.30	543.60	29.90	541.00	n4-14 n16-18
BH138	571.30	164.81	749.81	12.00	559.30	20.40	550.90	26.00	545.30	31.10	540.20	n6-22.6
BH139	570.90	88.82	810.34	10.00	560.90	--	--	24.50	546.40	30.60	540.30	n4-24.5
BH140	571.60	47.52	853.12	12.00	559.60	26.80	544.80	27.00	544.60	30.80	540.80	s6-8 n8-10 n16-26.8
BH141	572.30	8.95	895.25	14.00	558.30	--	--	30.00	542.30	32.00	540.30	n6-12 n22-30
BH142	567.80	-76.28	738.38	14.00	553.80	--	--	25.50	542.30	26.80	541.00	n8-12
BH143	567.30	-70.10	782.64	8.20	559.10	--	--	21.00	546.30	27.00	540.30	n6-14 s14-18 n21-25
BH144	567.70	-67.10	835.24	8.50	559.20	--	--	23.00	544.70	27.80	539.90	n21-23
BH145	567.20	-63.06	880.92	8.90	558.30	--	--	26.00	541.20	28.00	539.20	n12-14 n23.1-27.4
BH146	570.40	-48.84	931.93	12.00	558.40	--	--	27.00	543.40	31.40	539.00	s8-10 n10-21 n24-27
BH147	569.10	-43.83	974.99	11.00	558.10	--	--	25.00	544.10	31.20	537.90	n4-25
BH148	569.10	-28.30	1027.21	10.00	559.10	--	--	25.90	543.20	31.80	537.30	s6-10 n10-25.9
BH149	569.10	-20.20	1074.92	11.00	558.10	--	--	25.00	544.10	30.30	538.80	s6-10 n10-12 n18-25
BH150	569.00	-12.69	1124.81	11.50	557.50	--	--	25.80	543.20	30.90	538.10	s6-10 n10-18 n23-25.8
BH151	569.60	-11.52	1178.79	14.00	555.60	--	--	25.00	544.60	30.40	539.20	s6-14 n23-25
BH152	569.50	-4.87	1222.02	12.00	557.50	--	--	25.80	543.70	30.20	539.30	s8-10 n22-25.8
BH153	569.20	6.59	1281.00	14.00	555.20	--	--	25.50	543.70	30.50	538.70	n8-10
BH154	569.70	14.57	1349.31	10.00	559.70	--	--	26.00	543.70	31.30	538.40	s8-12 n14-20 s20-24
BH155	572.80	55.60	1372.58	19.00	553.80	--	--	29.40	543.40	34.20	538.60	s12-14 n19-22
BH156	572.80	240.49	773.54	13.50	559.30	18.50	554.30	29.00	543.80	32.50	540.30	n12-18
BH157	586.20	317.83	908.90	27.30	558.90	29.00	557.20	45.00	541.20	46.50	539.70	n16-18 s19.3-27.3
BH158	576.10	377.73	1044.17	14.50	561.60	18.50	557.60	33.60	542.50	37.50	538.60	n4-6 n16-18.5
BH159	575.10	403.80	1151.45	13.90	561.20	17.50	557.60	34.00	541.10	37.50	537.60	n8-12
BH160	578.10	284.07	1203.01	17.50	560.60	21.90	556.20	34.00	544.10	39.50	538.60	n6-16 n18-20
BH161	585.90	184.24	963.28	26.00	559.90	34.00	551.90	43.00	542.90	46.20	539.70	n14.5-18.5
BH162	573.20	144.26	827.41	13.80	559.40	22.80	550.40	28.00	545.20	32.10	541.10	n6-22.8
BH163	567.50	81.19	683.36	8.10	559.40	22.40	545.10	24.00	543.50	28.00	539.50	n8-12 s18-20
BH164	568.30	-5.93	705.10	9.00	559.30	--	--	25.00	543.30	28.30	540.00	n6-9
BH165	575.30	139.77	1111.59	14.90	560.40	28.00	547.30	33.00	542.30	37.60	537.70	n12-14.9
BH166	573.40	169.84	1237.20	14.00	559.40	25.50	547.90	30.00	543.40	35.10	538.30	n6-25.5
BH167	569.80	-14.28	1067.02	11.00	558.80	--	--	24.00	545.80	30.00	539.80	n6-11
BH168	578.20	348.12	1058.56	22.00	556.20	23.00	555.20	35.50	542.70	40.00	538.20	n14-22
BH169	578.80	294.43	1072.33	18.00	560.80	23.00	555.80	38.00	540.80	40.20	538.60	n8-22
BH170	578.30	251.52	1079.10	17.50	560.80	22.70	555.60	37.50	540.80	40.10	538.20	n6-17.5
BH171	572.00	37.92	880.45	13.20	558.80	27.60	544.40	28.00	544.00	32.00	540.00	n8-27.6
BH172	586.20	18.74	958.53	27.00	559.20	44.00	542.20	45.00	541.20	46.80	539.40	n24-44
BH173	586.30	50.22	1019.14	27.00	559.30	--	--	43.50	542.80	47.10	539.20	n22-24 n27-43.5

NOTE: * = PARTIAL OR TOTAL STRATIGRAPHY DENOTED AT ADJACENT WELL/BOREHOLE

TABLE 1A - STRATIGRAPHIC INFORMATION - S AREA REMEDIAL PROGRAM

WELL/BH #	GROUND ELEVATION	GRID CO-ORDINATES NORTH	EAST	DEPTH TO ALLUVIUM (FEET)	ELEV.OF ALLUVIUM	DEPTH TO CLAY (FEET)	ELEV.OF CLAY	DEPTH TO TILL (FEET)	ELEV.OF TILL	DEPTH TO BEDROCK (FEET)	ELEV.OF BEDROCK	NAPL/SHEEN DEPTH OBSERVED (FEET)
BH174	576.80	69.68	1171.49	18.80	558.00	--	--	34.60	542.20	39.80	537.00	n14-17 s18-18.8 s33.4-34.6
BH175	574.20	86.43	1254.84	22.00	552.20	--	--	32.00	542.20	35.20	539.00	n14-22.7 s24-26 n26-31.9
BH176	573.10	120.18	1335.65	16.00	557.10	--	--	28.00	545.10	34.30	538.80	n8-10 n14-28
BH177	568.60	-4.37	793.52	10.00	558.60	--	--	26.00	542.60	28.30	540.30	n22-26
BH178	573.20	-29.11	915.27	14.00	559.20	--	--	29.70	543.50	33.50	539.70	s12-14 n14-22 n24-29.7
BH179	586.40	50.18	943.78	27.50	558.90	--	--	43.50	542.90	45.10	541.30	n20.6-27.5 n30-32 n36-43.5
BH180	585.90	30.13	985.19	30.00	555.90	41.80	544.10	42.00	543.90	47.50	538.40	n20-41.8
BH181	569.30	-134.47	845.87	--	--	--	--	25.30	544.00	28.20	541.10	s15-17
BH182	569.40	-129.11	894.71	14.00	555.40	--	--	26.00	543.40	31.50	537.90	n10.2-11.8 s20-23.7
BH183	568.80	-119.93	944.33	--	--	--	--	22.00	546.80	30.00	538.80	n10-14 s14-22
BH184	568.20	-111.38	987.64	14.00	554.20	--	--	24.30	543.90	29.40	538.80	s8-14 s18-22
BH185	569.10	-106.35	1032.91	11.50	557.60	--	--	25.00	544.10	29.50	539.60	n8-18 s18-24
BH186	568.90	-136.79	809.84	14.10	554.80	--	--	23.00	545.90	29.20	539.70	s12-18
BH187	568.50	-141.16	748.60	--	--	--	--	26.70	541.80	29.30	539.20	s6-10 n28.6-29.3
BH188	573.10	-149.57	707.03	20.00	553.10	--	--	27.50	545.60	30.80	542.30	s26-27.5
BH189	574.10	95.97	1292.47	15.70	558.40	--	--	31.50	542.60	34.30	539.80	n10-28
BH190	586.40	70.94	1008.97	26.00	560.40	--	--	43.30	543.10	48.10	538.30	n20-26 n40-43.3
BH191	586.50	92.85	928.96	26.50	560.00	--	--	41.50	545.00	46.00	540.50	n20-24 n25.5-41.5
BH192	568.90	25.50	759.62	9.00	559.90	23.90	545.00	26.70	542.20	28.50	540.40	s18-23.9 n23.9-24
BH193	568.80	-13.65	744.45	9.40	559.40	--	--	24.50	544.30	28.00	540.80	n8-24.5
BH194	567.50	-72.52	682.75	11.00	556.50	23.90	543.60	24.00	543.50	28.20	539.30	n6-11 n22-23.9
BH195	568.20	-34.97	614.14	9.20	559.00	23.80	544.40	24.00	544.20	28.70	539.50	s6-23.8
BH196	568.80	57.38	629.30	9.50	559.30	23.90	544.90	24.00	544.80	27.70	541.10	n6-23.9
BH197	568.50	-28.67	654.19	9.00	559.50	24.00	544.50	24.70	543.80	28.70	539.80	n9-14
BH198	568.90	30.33	802.08	14.00	554.90	24.30	544.60	26.00	542.90	28.00	540.90	n6-14 n22-24
BH199	586.80	73.68	1085.52	32.00	554.80	42.50	544.30	43.50	543.30	48.00	538.80	n22-38 n40-42.5
BH200	577.10	115.34	1178.17	17.50	559.60	--	--	34.00	543.10	37.80	539.30	s12-14 n14-34
BH201	576.00	121.32	1225.54	14.00	562.00	32.00	544.00	34.00	542.00	37.00	539.00	n10-15.3 n16-32
BH202	573.90	132.83	1276.76	14.20	559.70	--	--	30.50	543.40	34.80	539.10	n8.2-10 s12-14.2 n16-30.5
BH203	576.70	92.42	1204.44	27.30	549.40	--	--	33.50	543.20	37.60	539.10	n20-33.5
BH204	575.40	105.00	1133.72	28.50	546.90	--	--	31.00	544.40	36.80	538.60	n28-31
BH205	573.20	25.92	1129.73	13.00	560.20	28.50	544.70	29.50	543.70	33.20	540.00	s6-9.3 n12-14 n16-28.5
BH206	573.80	21.68	1189.15	15.00	558.80	29.80	544.00	30.00	543.80	34.80	539.00	n14-16
BH207	573.60	33.73	1244.36	18.00	555.60	30.00	543.60	31.00	542.60	34.70	538.90	n16-18 n24-27
BH208	575.10	48.81	1218.91	14.50	560.60	--	--	31.50	543.60	35.80	539.30	n10-14.5 n24-31.5
BH209	573.70	52.93	1288.03	14.50	559.20	28.30	545.40	30.00	543.70	34.50	539.20	n14.5-16
BH210	568.80	38.09	657.85	8.00	560.80	23.70	545.10	24.00	544.80	28.70	540.10	s8-10 n10-16
BH211	569.00	43.52	716.30	8.30	560.70	--	--	24.00	545.00	29.00	540.00	n4-8
BH212	569.10	68.99	770.50	8.00	561.10	--	--	23.50	545.60	29.50	539.60	n20-23.5
BH213	568.60	-21.74	699.16	12.00	556.60	24.00	544.60	25.00	543.60	28.50	540.10	s4-6 n8-24.5
BH214	568.70	-9.04	836.18	9.20	559.50	--	--	25.30	543.40	28.50	540.20	s8-9.2 n21.5-25.3
BH215	572.70	74.76	879.97	16.00	556.70	--	--	26.00	546.70	31.70	541.00	n6-10 n14-18 n22-24
BH216	586.70	149.92	906.28	26.00	560.70	35.50	551.20	43.00	543.70	47.00	539.70	n14-26
BH217	582.00	-195.76	862.57	26.00	556.00	--	--	34.90	547.10	43.60	538.40	n26-30 s30-33.8
BH218	581.20	-204.47	761.50	25.00	556.20	--	--	33.40	547.80	42.20	539.00	n25-29 s29-34.4
BH219	580.30	-210.98	662.91	25.00	555.30	--	--	33.40	546.90	40.20	540.10	ND
BH220	582.60	-183.05	961.88	25.00	557.60	--	--	38.50	544.10	44.00	538.60	s25-36
BH221	583.20	-168.45	1062.27	25.40	557.80	33.50	549.70	35.00	548.20	44.60	538.60	n25-25.4 s25.4-27 n27-27.4
BH222	575.20	97.61	1807.61	18.00	557.20							ND
BH223	574.80	73.85	1767.95	18.00	556.80							s14.3-16

NOTE: * = PARTIAL OR TOTAL STRATIGRAPHY DENOTED AT ADJACENT WELL/BOREHOLE

TABLE 1B - STRATIGRAPHIC INFORMATION - S AREA HISTORIC INFORMATION

WELL/BH #	GROUND ELEVATION	GRID CO-ORDINATES NORTH	EAST	DEPTH TO ALLUVIUM (FEET)	ELEV.OF ALLUVIUM	DEPTH TO CLAY (FEET)	ELEV.OF CLAY	DEPTH TO TILL (FEET)	ELEV.OF TILL	DEPTH TO BEDROCK (FEET)	ELEV.OF BEDROCK	NAPL/SHEEN DEPTH OBSERVED (FEET)
B1		258.00	2159.00		--		--		--		--	
B2		368.00	2106.00		--		--		--		--	
B3		723.00	1800.00		--		--		--		--	
B4		884.00	1895.00		--		--		--		--	
B5		1065.00	1811.00		--		--		--		--	
B6		307.00	2306.00		--		--		--		--	
B7		431.00	2250.00		--		--		--		--	
B8		724.00	2117.00		--		--		--		--	
B9		888.00	2045.00		--		--		--		--	
B10		1090.00	1960.00		--		--		--		--	
B11		1033.00	1697.00		--		--		--		--	
B12		276.00	2053.00		--		--		--		--	
H7	546.00	-555.00	-93.00		--		--		--	3.50	542.50	
H8	546.10	-465.00	-300.00		--		--		--	3.00	543.10	
H9	562.90	-63.00	-572.00		--		--		--	22.00	540.90	
H16	550.80	-872.00	1205.00		--		--		--	12.00	538.80	
SP1A	571.80	-116.00	-840.00	20.50	551.30	--	--	24.50	547.30		--	ND
SP2A	573.70	-169.00	-74.00	--	--	--	--	23.00	550.70		--	ND
SP3A	574.20	-187.00	348.00	--	--	--	--	28.00	546.20		--	ND
SP4A	573.70	-184.00	725.00	24.00	549.70	--	--	30.00	543.70	31.00	542.70	ND
SP6&6A	568.30	-345.00	-825.00	--	--	--	--	25.00	543.30	26.00	542.30	ND
SP7&7A	572.80	-339.00	-27.50	--	--	--	--	25.00	547.80	30.50	542.30	ND
SP8&8A	570.40	-347.90	1080.90	--	--	--	--	26.00	544.40	35.00	535.40	n21-26
SP9&9A	574.10	-360.00	369.00	24.00	550.10	--	--	26.00	548.10	29.00	545.10	ND
SS1*	571.00	70.00	1418.90	20.00	551.00	--	--	28.50	542.50	31.50	539.50	n30.5
SS2*	570.90	45.70	1430.80	20.00	550.90	--	--	28.50	542.40	31.50	539.40	n30.5
CW1	570.90	57.10	1424.67	20.00	550.90	--	--	28.50	542.40	31.50	539.40	n30.5
CW1A*	569.90	-12.95	1458.23	13.50	556.40		--		--		--	ND
CW1B	569.90	-3.13	1455.36	13.50	556.40	--	--	24.00	545.90		--	ND
CW2A	570.50	347.00	1348.00	9.00	561.50	17.50	553.00		--		--	ND
CW3A	571.20	595.00	1276.00	--	--	10.50	560.70		--		--	ND
CW4A	571.50	836.00	1118.00	--	--	6.00	565.50		--		--	ND
CW5	576.10	125.00	1654.00	--	--	--	--	32.50	543.60	37.00	539.10	ND
CW6	575.40	383.00	1523.00	16.00	559.40	20.50	554.90	33.50	541.90	36.00	539.40	ND
CW6A*	575.40	373.00	1527.00		--		--		--		--	ND
CW6B*	575.40	381.00	1531.00	16.00	559.40	20.50	554.90		--		--	ND
CW7	570.70	682.00	1428.00	--	--	12.00	558.70	30.00	540.70	30.50	540.20	ND
CW7A*	570.70	688.00	1434.00	--	--	12.00	558.70		--		--	ND
CW8A	577.20	98.00	1514.00	22.50	554.70		--		--		--	ND
CW9	572.30	534.00	1480.00	--	--	16.50	555.80	30.00	542.30	33.00	539.30	ND
CW9A*	572.30	541.00	1476.00		--		--		--		--	ND
CW10	576.90	269.10	1574.00	15.00	561.90	26.50	550.40	36.00	540.90	37.00	539.90	ND
CW10A*	576.90	276.15	1570.00	15.00	561.90		--		--		--	ND
CW11	574.60	513.00	1618.00	22.50	552.10	25.50	549.10	34.50	540.10	36.00	538.60	ND
CW11A*	574.60	510.00	1610.00	22.50	552.10	25.50	549.10		--		--	ND
CW13	573.70	576.18	1731.45	--	--	16.50	557.20	33.00	540.70	36.00	537.70	ND
CW13A*	573.70	575.00	1729.00		--		--		--		--	ND
OW1S-80	576.20	235.00	1170.00	18.50	557.70	22.50	553.70		--		--	n6.5-12.5
OW2S-80	575.30	92.00	1138.00	22.00	553.30	--	--	31.70	543.60		--	n14-31.7
OW3S-80	573.20	157.00	847.00	18.00	555.20	22.80	550.40		--		--	n13-22.8
OW4S-80	572.40	82.00	879.00	16.00	556.40	--	--	26.00	546.40		--	n12-16 n20-24
OW5S-80	578.80	276.00	1042.00	18.00	560.80	22.30	556.50		--		--	n8-22

NOTE: * = PARTIAL OR TOTAL STRATIGRAPHY DENOTED AT ADJACENT WELL/BOREHOLE

TABLE 1B - STRATIGRAPHIC INFORMATION - S AREA HISTORIC INFORMATION

WELL/BH #	GROUND ELEVATION	GRID CO-ORDINATES NORTH	EAST	DEPTH TO ALLUVIUM (FEET)	ELEV.OF ALLUVIUM	DEPTH TO CLAY (FEET)	ELEV.OF CLAY	DEPTH TO TILL (FEET)	ELEV.OF TILL	DEPTH TO BEDROCK (FEET)	ELEV.OF BEDROCK	NAPL/SHEEN DEPTH OBSERVED (FEET)
OW6S-80	571.70	211.00	715.00	12.00	559.70	15.70	556.00		--		--	n8.3-10
OW7S-80	579.00	298.00	1070.00	18.00	561.00	22.30	556.70		--		--	n12-14
OW8S-80	570.50	-12.69	1061.36	10.50	560.00	--	--	27.00	543.50		--	ND
OW9S-80	569.80	-38.00	995.00	14.00	555.80	--	--	26.50	543.30		--	n8-10
BH1A-08	564.40	738.19	1774.78	--	--	0.00	564.40	25.00	539.40	27.00	537.40	ND
BH2A-08	550.50	-860.00	2090.00		--		--		--	22.00	528.50	ND
BH3-43	564.20	769.19	1229.78	1.00	563.20	3.00	561.20	25.00	539.20	26.00	538.20	ND
BH1B-43	568.30	691.19	1457.78	--	--	6.60	561.70	27.80	540.50	28.30	540.00	ND
BH2B-43	569.70	449.19	1634.78	--	--	14.10	555.60	29.20	540.50	30.50	539.20	ND
BH3B-43	569.30	539.19	1813.78	--	--	13.20	556.10	30.80	538.50	31.70	537.60	ND
BH4B-43	568.80	788.19	1642.78	--	--	8.20	560.60	--	--	29.10	539.70	ND
BH5B-43	566.70	650.19	1601.78	--	--	7.00	559.70	28.60	538.10	29.70	537.00	ND
BH1-49	569.40	391.19	1605.78	--	--	9.10	560.30	--	--	29.10	540.30	ND
BH2-49	568.40	421.19	1829.78	--	--	11.10	557.30	--	--	30.00	538.40	ND
BH3-49	570.10	259.19	1762.78	10.00	560.10	16.00	554.10	28.00	542.10	32.00	538.10	ND
BH4-49	571.40	194.19	1489.78	--	--	17.00	554.40	27.90	543.50	31.80	539.60	ND
BH5-49	570.20	207.19	1930.78	10.00	560.20	23.90	546.30	30.00	540.20	33.00	537.20	ND
BH6-49	572.00	99.19	1691.78	12.00	560.00	--	--	30.00	542.00	33.00	539.00	ND
BH7-49	571.70	1053.19	1546.78	0.00	571.70	7.10	564.60	26.50	545.20	28.50	543.20	ND
BH1-77	574.90	441.19	1696.78	--	--	17.00	557.90	30.00	544.90	37.00	537.90	ND
BH2-77	569.90	546.19	1887.78	9.00	560.90	17.50	552.40		--		--	ND
BH3-77	568.80	621.19	1880.78	3.50	565.30	9.50	559.30	29.50	539.30	33.00	535.80	ND
BH4-77	568.60	656.19	1903.78	7.00	561.60	7.50	561.10	29.00	539.60	33.50	535.10	ND
BH5-77	569.20	663.19	1955.78	6.50	562.70	8.50	560.70	29.00	540.20	34.00	535.20	ND
BH6-77	573.90	236.19	2016.78	16.00	557.90		--		--		--	ND
BH7-77	575.90	116.19	1829.78	18.00	557.90	--	--	33.00	542.90		--	ND
BH1-80	586.90	-124.81	1747.78	39.00	547.90	--	--	42.00	544.90	43.50	543.40	ND
BH2-80	569.00	-242.81	1782.78	20.00	549.00	--	--	25.00	544.00	33.10	535.90	ND
BH3-80	568.30	-242.81	1644.78	17.00	551.30	--	--	22.00	546.30	30.10	538.20	ND
BH4-80	588.40	-158.81	1594.78	37.00	551.40	--	--	45.00	543.40	51.50	536.90	n35-37
BH5-80	574.40	36.19	1518.78	13.00	561.40	--	--	29.50	544.90	35.20	539.20	ND
BH6-80	574.30	3.19	1528.78	21.00	553.30	--	--	28.00	546.30	35.00	539.30	ND
BH7-80	588.10	-69.81	1554.78	31.00	557.10	--	--	42.00	546.10	50.00	538.10	ND
BH1-81	576.50	55.19	1170.78	17.50	559.00	--	--	33.00	543.50		--	n14-17.5 n22-24 n28-33
BH2-81	573.80	54.19	1255.78	16.00	557.80	--	--	31.30	542.50		--	n10-16 n20-31.3
BH3-81	573.20	49.19	1324.78	14.00	559.20	--	--	27.70	545.50		--	n12-14 n16-18
BH4-81	573.50	-20.81	874.78	14.00	559.50	--	--	31.40	542.10	31.70	541.80	n12-14 n26-31.4
BH5-81	573.70	-11.25	909.36	14.00	559.70	--	--	31.50	542.20	31.80	541.90	n8-9 n12-31.5
BH6-81	571.70	21.19	843.78	12.00	559.70	--	--	29.00	542.70		--	n8-29
BH7-81	573.20	30.19	881.78	13.00	560.20	--	--	27.80	545.40		--	n10-29.8
BH8-81	573.40	-33.81	926.78	13.50	559.90	--	--	29.50	543.90		--	n12-29.5
BH14-81	573.00	-45.81	900.78	14.00	559.00	--	--	31.30	541.70	31.50	541.50	n10-12 n27.5-30
BH9-82	569.90	-25.81	1306.78	11.20	558.70	--	--	26.80	543.10	31.80	538.10	ND
BH15-82	568.40	-50.81	832.78	8.50	559.90	--	--	25.00	543.40	28.20	540.20	n21-23.5
BH16-82	568.90	-2.81	782.78	9.20	559.70	--	--	25.50	543.40	28.60	540.30	n21-25
BH17-82	568.10	-233.81	1466.78	14.00	554.10	--	--	20.00	548.10	23.70	544.40	ND
BH18-82	575.10	-384.69	682.21	22.00	553.10	--	--	28.30	546.80	35.40	539.70	ND
BH19-82	585.90	-96.81	1354.78	32.50	553.40	--	--	39.00	546.90	48.50	537.40	ND
BH20-82	583.40	-181.69	1064.21	27.00	556.40	--	--	34.50	548.90	44.20	539.20	ND
BH21-82	580.20	-221.81	588.78	24.00	556.20	--	--	33.20	547.00	41.20	539.00	ND
BH22-82	568.80	42.19	610.78	9.00	559.80	--	--	23.70	545.10	28.70	540.10	ND
BH23-82	580.40	-219.81	707.78	22.70	557.70	--	--	32.50	547.90	41.90	538.50	ND

NOTE: * = PARTIAL OR TOTAL STRATIGRAPHY DENOTED AT ADJACENT WELL/BOREHOLE

TABLE 1B - STRATIGRAPHIC INFORMATION - S AREA HISTORIC INFORMATION

WELL/BH #	GROUND ELEVATION	GRID CO-ORDINATES NORTH	EAST	DEPTH TO ALLUVIUM (FEET)	ELEV.OF ALLUVIUM	DEPTH TO CLAY (FEET)	ELEV.OF CLAY	DEPTH TO TILL (FEET)	ELEV.OF TILL	DEPTH TO BEDROCK (FEET)	ELEV.OF BEDROCK	NAPL/SHEEN DEPTH OBSERVED (FEET)
WS9	570.40	0.00	-638.00	9.50	560.90	--	--	18.50	551.90	28.00	542.40	ND
WS9A*	570.30	4.00	-652.00	9.50	560.80		--		--		--	ND
WS10	570.00	-21.00	-228.00	10.50	559.50	--	--	16.00	554.00	25.50	544.50	ND
WS10A*	569.70	-13.00	-225.00	10.50	559.20		--		--		--	ND
WS11	567.70	-12.00	9.00	9.00	558.70	--	--	15.00	552.70	24.00	543.70	ND
WS11A*	567.70	-6.00	2.00	9.00	558.70		--		--		--	ND
WS12	568.90	75.00	264.00	12.00	556.90	--	--	21.00	547.90	26.50	542.40	ND
WS12A*	569.30	75.00	276.00	12.00	557.30		--		--		--	ND
WS13	567.60	-56.00	471.10	7.50	560.10	--	--	21.00	546.60	27.00	540.60	ND
WS13A*	568.10	-47.00	-471.00	7.50	560.60		--		--		--	ND
WS14A	573.60	0.00	879.00	--	--	--	--	--	--	32.70	540.90	n28.5-30.5
WS14B*	573.30	7.00	872.00		--		--		--		--	ND
WS15A	573.20	11.00	1100.00	--	--	29.00	544.20		--		--	n26.5-29
WS16	570.70	19.00	1420.00	19.50	551.20	--	--	25.50	545.20	31.00	539.70	ND
WS16A*	570.90	8.72	1423.39	19.50	551.40	--	--	25.50	545.40		--	ND
WS17	572.00	268.00	1306.00	13.50	558.50	20.50	551.50	31.00	541.00	33.00	539.00	n7.5-12
WS17A*	572.20	259.00	1310.00	13.50	558.70	20.50	551.70		--		--	n7.5-12
WS18	571.60	509.60	1195.60	--	--	17.50	554.10	31.50	540.10	33.00	538.60	n31.5-33
WS18A*	571.60	517.00	1192.00	--	--	17.50	554.10		--		--	ND
WS19	571.90	750.00	961.00	--	--	8.50	563.40	24.00	547.90	30.50	541.40	ND
WS19A*	571.90	758.00	956.00	--	--	8.50	563.40		--		--	ND
WS20	572.50	1047.00	776.00	3.00	569.50	8.00	564.50	19.50	553.00	25.50	547.00	ND
WS20A*	572.50	1047.00	767.00	3.00	569.50	8.00	564.50		--		--	ND
WS21	573.20	1313.00	873.00	1.50	571.70	8.50	564.70	18.00	555.20	27.50	545.70	ND
WS21A*	573.20	1301.00	871.00	1.50	571.70	8.50	564.70		--		--	ND
WS22	573.50	1580.00	870.00	3.00	570.50	7.50	566.00	20.00	553.50	21.50	552.00	ND
WS22A*	573.50	1575.00	880.00	3.00	570.50	7.50	566.00		--		--	ND
WS23	572.80	2203.00	992.00	--	--	7.00	565.80	19.50	553.30	24.00	548.80	ND
WS23A*	572.80	2195.00	996.00	--	--	7.00	565.80		--		--	ND
WS24	573.90	1846.00	-40.00	5.00	568.90	9.00	564.90	15.50	558.40	22.50	551.40	ND
WS24A*	573.90	1850.00	-35.00	5.00	568.90	9.00	564.90		--		--	ND
WS28	570.40	835.00	-741.00	3.00	567.40	6.00	564.40	9.00	561.40	22.50	547.90	ND
WS28A*	570.40	837.00	-752.00	3.00	567.40	6.00	564.40		--		--	ND
WS29	571.10	850.00	-222.00	3.00	568.10	--	--	5.50	565.60	21.00	550.10	ND
WS29A*	571.10	838.00	-222.00	3.00	568.10	--	--	5.50	565.60		--	ND
WS30	572.20	956.70	332.40	1.50	570.70	7.30	564.90	9.00	563.20	25.00	547.20	ND
WS30A*	572.20	952.00	340.00	1.50	570.70	7.30	564.90		--		--	ND
WS31	572.10	1270.00	105.00	3.00	569.10	6.00	566.10	11.00	561.10	23.50	548.60	ND
WS31A*	572.10	1278.00	108.00	3.00	569.10	6.00	566.10		--		--	ND
WS32	568.80	254.00	300.00	9.50	559.30	12.00	556.80	20.00	548.80	24.50	544.30	ND
WS32A*	568.80	263.00	300.00	9.50	559.30	12.00	556.80		--		--	ND
WS33A	570.60	495.00	-697.00	7.50	563.10	9.00	561.60		--		--	ND
WS34	570.20	690.00	470.00	--	--	6.00	564.20	12.00	558.20	24.90	545.30	ND
WS34A*	570.20	700.00	470.00	6.00	564.20	7.50	562.70		--		--	ND
WS35A	569.70	446.00	810.00	7.50	562.20	10.50	559.20		--		--	n7.5-10.5
WS36A	575.50	397.00	1057.00	12.00	563.50	20.00	555.50		--		--	n7.5-20
WS37A	572.20	1624.00	1260.00	0.00	572.20	8.00	564.20		--		--	ND
WS38A	572.50	2040.00	463.00	--	--	4.50	568.00		--		--	n1.5-4.5
WS39A	572.80	1660.00	288.00	--	--	5.50	567.30		--		--	n0.5-5.5
WS40	572.40	1155.00	-412.00	3.00	569.40	7.50	564.90	9.00	563.40	22.00	550.40	ND
WS40A*	572.40	1150.00	-402.00	3.00	569.40	7.50	564.90		--		--	ND
WS40B*	572.40	1152.00	-391.00	3.00	569.40	7.50	564.90	9.00	563.40		--	ND

NOTE: * = PARTIAL OR TOTAL STRATIGRAPHY DENOTED AT ADJACENT WELL/BOREHOLE

TABLE 1B - STRATIGRAPHIC INFORMATION - S AREA HISTORIC INFORMATION

WELL/BH #	GROUND ELEVATION	GRID CO-ORDINATES NORTH	GRID CO-ORDINATES EAST	DEPTH TO ALLUVIUM (FEET)	ELEV.OF ALLUVIUM	DEPTH TO CLAY (FEET)	ELEV.OF CLAY	DEPTH TO TILL (FEET)	ELEV.OF TILL	DEPTH TO BEDROCK (FEET)	ELEV.OF BEDROCK	NAPL/SHEEN DEPTH OBSERVED (FEET)
WS42A	573.10	1114.00	1078.00	4.50	568.60	9.50	563.60		--		--	ND
WS43A	568.50	539.00	1032.00	--	--	7.50	561.00		--		--	n3-6
WS44A	573.50	1181.00	1428.00	3.00	570.50	9.50	564.00		--		--	ND
WS45A	571.90	296.00	1292.00	12.00	559.90	19.20	552.70		--		--	n12-15 n18-19.2
WS46A	573.00	381.00	1255.00	--	--	15.00	558.00		--		--	ND
WS47A	572.30	155.00	1353.00	12.00	560.30	27.00	545.30		--		--	ND
WS53	569.40	521.00	1012.00		--		--		--		--	ND
WS54	570.70	490.00	1032.00		--		--		--		--	n5-8
WS55	572.20	848.00	951.00		--	7.00	565.20		--		--	ND
WS56	572.20	853.00	963.00		--	8.00	564.20		--		--	ND
WS57	572.20	866.00	984.00		--	8.00	564.20		--		--	ND
WS58	570.30	710.00	-664.00	--	--	4.00	566.30		--		--	ND
WS59	570.30	670.00	-660.00	--	--	6.00	564.30		--		--	ND
WS83	569.00	583.00	124.00		--	7.00	562.00		--		--	ND
WS84	569.20	582.00	151.00		--	7.00	562.20		--		--	ND
WS89	569.80	273.00	658.00		--		--		--		--	ND
WS93	573.10	1100.00	464.00		--	7.50	565.60		--		--	ND
WS94	572.80	1086.00	452.00		--	7.50	565.30		--		--	ND
WS95	572.60	1071.00	440.00		--	8.00	564.60		--		--	ND
WS96	573.60	1182.00	726.00		--	7.00	566.60		--		--	ND
WS97	573.60	1200.00	761.00		--	7.00	566.60		--		--	ND
WS98	573.60	1211.00	782.00		--	7.00	566.60		--		--	ND
WS105	573.00	1896.00	-36.00		--	7.00	566.00		--		--	ND
WS107	573.90	1850.00	-7.00		--	6.00	567.90		--		--	ND
WS109	572.60	1854.00	272.00		--	8.00	564.60		--		--	n5-8
WS113	571.80	1078.00	-348.00		--	7.50	564.30		--		--	ND
BH1		800.00	2488.00	--	--	17.10		33.90		40.90		ND
BH2		910.00	2282.00	6.20		11.40		28.60		36.80		ND
BH3		1010.00	2525.00	10.10		11.50		28.60		34.00		ND
BH4		1115.00	2482.00	4.90		8.20		27.20		33.00		ND
BH6		1095.00	2200.00	1.70		6.10			--		--	ND
BH9		982.00	2890.00		--	17.50		33.60		36.60		ND
OW1-82	572.30	910.00	2167.00	6.00	566.30	10.00	562.30	28.00	544.30	36.10	536.20	ND
OW2-82	570.50	460.00	2340.00	12.20	558.30	24.20	546.30	31.20	539.30	34.00	536.50	ND
OW3-82	576.10	732.00	2445.00	16.80	559.30	25.80	550.30	31.80	544.30	39.20	536.90	ND
OW4-82	574.10	1015.00	2525.00	--	--	11.80	562.30	26.80	547.30	33.30	540.80	ND
OW5-82	574.50	595.00	2715.00	18.20	556.30	--	--	28.20	546.30	35.70	538.80	ND

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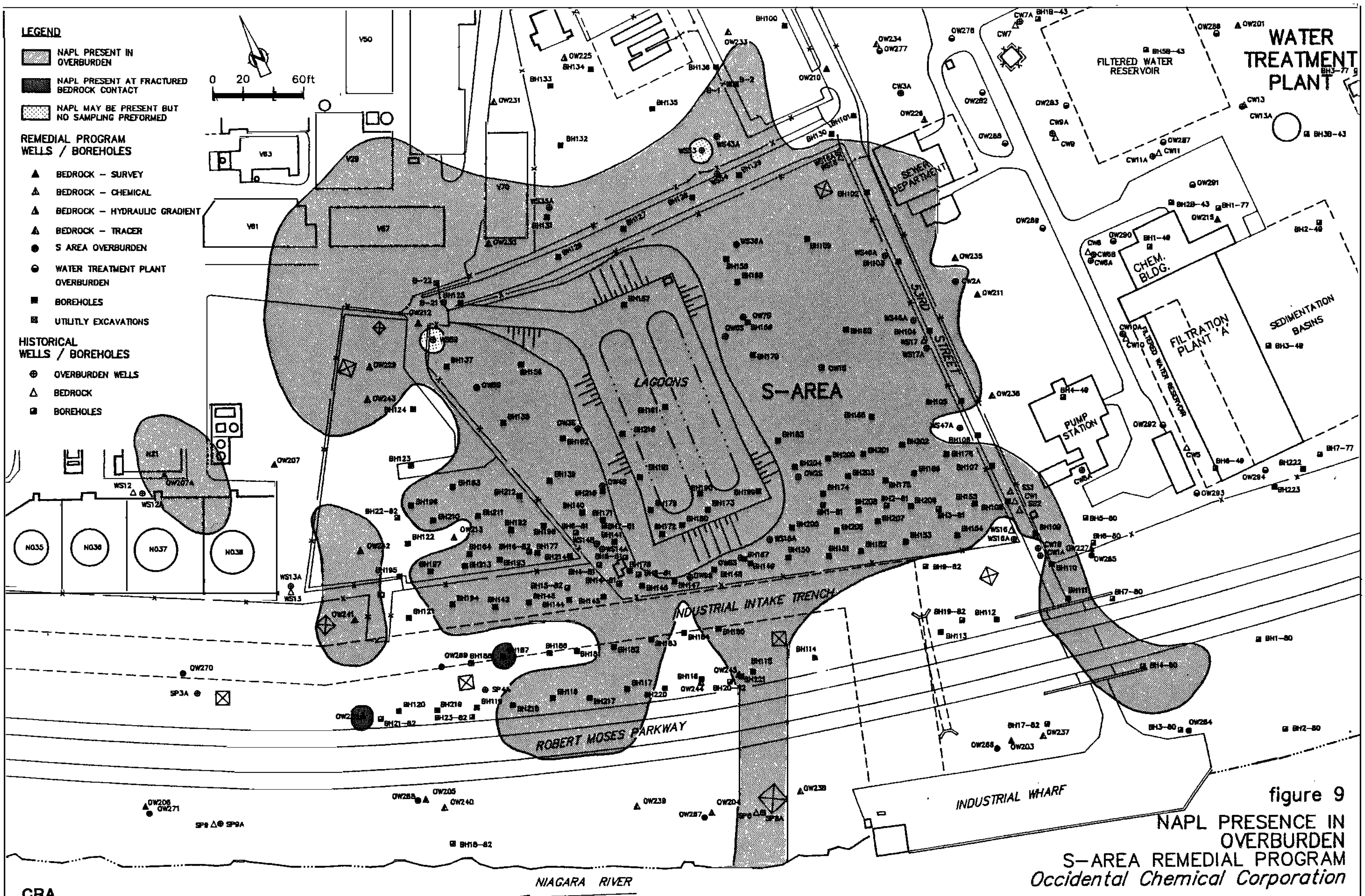
NOTE: * = PARTIAL OR TOTAL STRATIGRAPHY DENOTED AT ADJACENT WELL/BOREHOLE



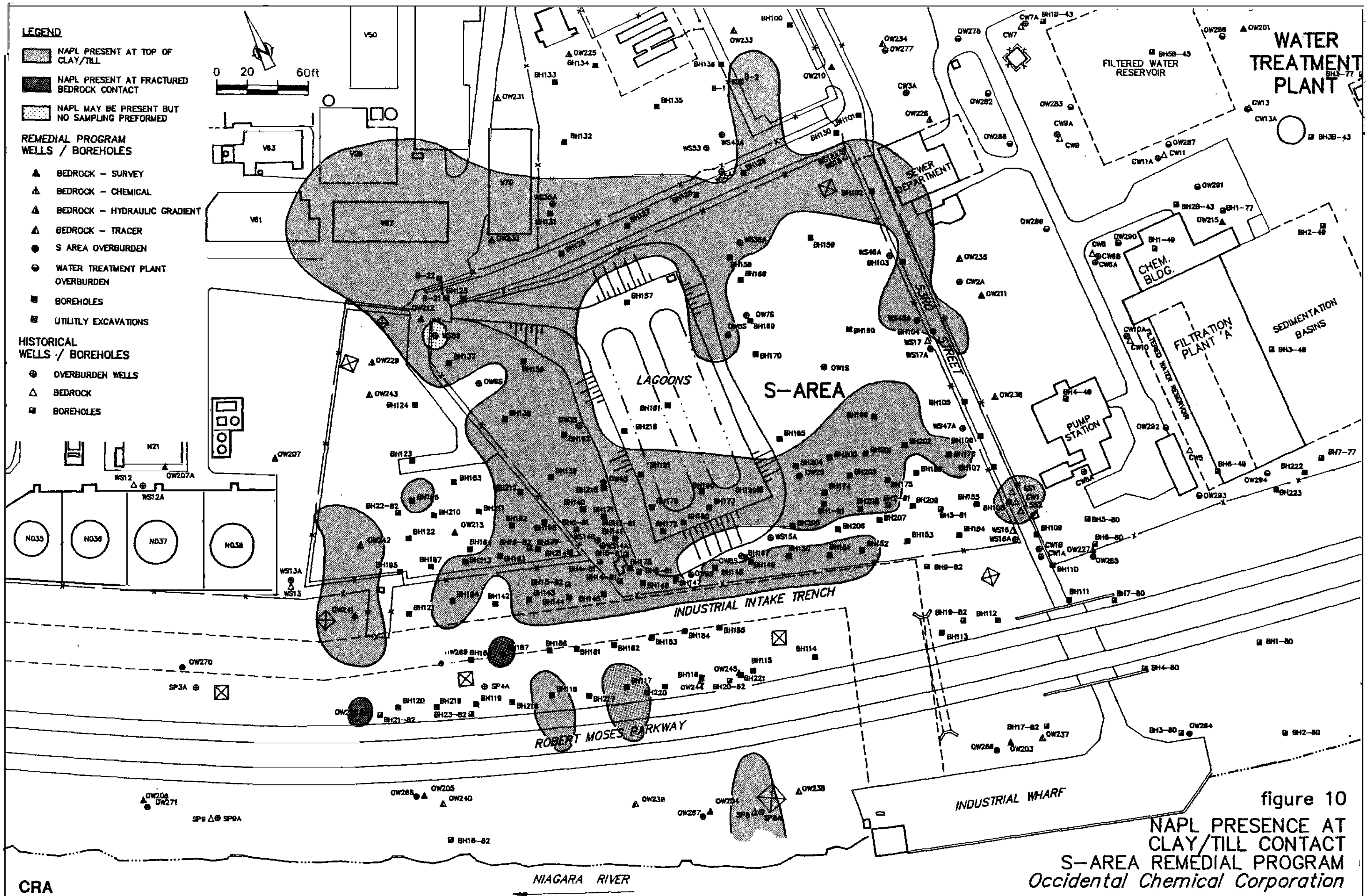
1769-24/06/88-22-D-0

CRA 5-0038911

Only two of the 27 boreholes/wells within the study area south of the Robert Moses Parkway identified the presence of NAPL. Those two finger-like pathways are along SP8 and BH4-80. A third discontinuous finger-like extension of NAPL extends from the area west of the S-Area and has migrated toward well OW241. The fourth and largest area of off-site NAPL presence is observed adjacent to the southwest corner of the S-Area Landfill (BH218/BH117). It is to be noted, as discussed subsequently, that the lateral migration of NAPL from the northwest corner of the landfill may be an artifact of plotting between wells where NAPL was identified and wells where NAPL was not identified.

The area immediately south of the S-Area and south of the Industrial Intake Pipe Trench, with the exception of the finger of NAPL leading toward SP8, is free of NAPL. The apparently irregular areal distribution of NAPL migration south of the Industrial Intake Pipe Trench is probably due to the presence of elevated till centered near OW203. This forces flow of NAPL around the mound along the two observed fingers.

As previously stated, NAPL will preferentially migrate laterally over and in the direction of the slope of low permeable geologic units such as the clay, till and other low permeable layers underlying the study area. Figures 10 and 11 illustrate the areal extent of NAPL



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CRA 5-0038913

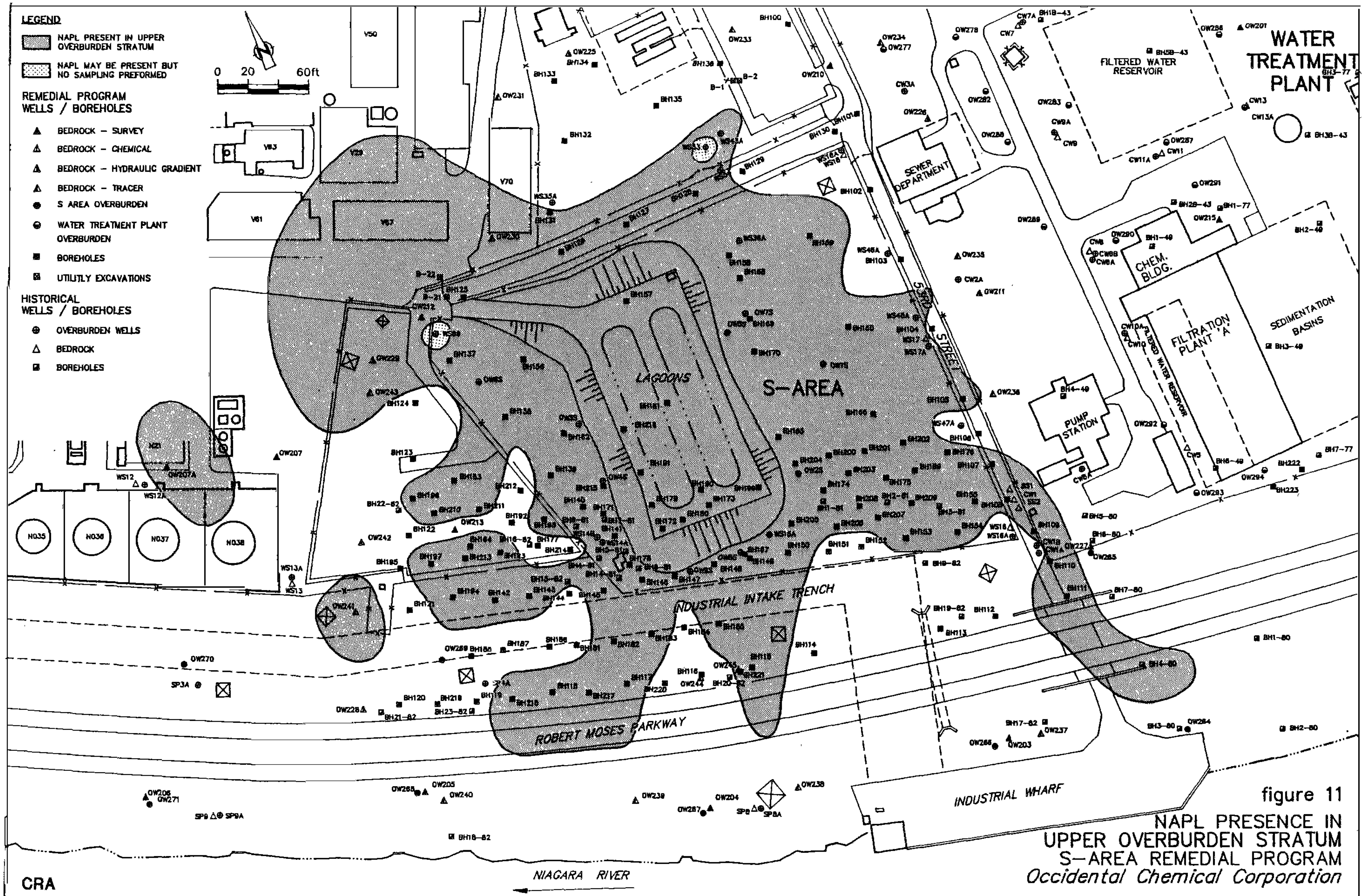

figure 11
NAPL PRESENCE IN UPPER OVERBURDEN STRATUM
S–AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769–24/06/88–22–D–0

CRA 5-0038914

migration over the surface of clay/till and other lower permeable layers. Figure 10 presents the areal distribution of NAPL that is migrating along the top of clay or till and Figure 11 presents NAPL that is migrating along low permeable strata at elevations above the top of the clay or till.

Comparison of Figures 9, 10 and 11 show that the area of NAPL in the shallow layers above the clay/till is larger than the area of NAPL in the deeper layer. The areal extent of NAPL presence on top of the Confining Layer of clay/till covers approximately 60 percent of the overall area of NAPL presence. There is an area in the central portion of the S-Area itself where the presence of NAPL was not observed to have migrated to the top of the Confining Layer. The two isolated areas showing the presence of NAPL south of the Industrial Intake Pipe Trench, at BH117 and BH118, are apparently the result of downward migration through the low permeable layers above the clay/till rather than continuous southerly flow along the top of the Confining Layer.

One other important factor influencing NAPL migration toward the Niagara River from the S-Area is the influence of the Industrial Intake Pipe Trench construction on the local geologic stratigraphy.

The alignment of the Industrial Intake Pipe Trench is illustrated on Figure 1. In order to install the Industrial Intake Pipes, an open cut trench (approximately 50 feet in width) was excavated to an elevation of approximately 543.5 feet AMSL (1986 OCC datum). The walls of the excavation west of the S-Area lagoons were vertical and supported by 10-inch by 10-inch timbers laid horizontally one on top of another. Vertical and horizontal bracing was used to maintain the vertical position of the timbers. (It is to be noted that the segment of the Industrial Intake Pipes located east of the S-Area lagoons was constructed using open trench methodology).

Observations made in a test pit excavation in 1982 indicate that the timber walls were not removed as the trench was backfilled and remain in place today. Consequently, not only do the timber walls sever the continuity of geologic units traversing the trench, but the type of material used as backfill will also serve as a discontinuity. To illustrate this factor, geologic cross-sections have been prepared along the fingers of southerly NAPL migration and are presented in Figures 5 through 8.

As can be seen in Figures 5 through 7, the presence of NAPL south of the intakes at elevations above 543.5 are separated from the S-Area source by the Industrial

Intake Pipe Trench. It therefore appears that the source of the NAPL identified at BH117, BH118, BH217, BH218, BH221 and OW245 at elevations above 543.5 is the residue of NAPL migration prior to the construction of the intakes. Now that the Industrial Intake Pipe Trench has severed the source of NAPL from the leading edge of flow and the head of NAPL driving the plume has been cut off, the potential for further migration of the leading edge of the NAPL is substantially eliminated. Considering that the trench was cut approximately 30 years ago, it is believed that the NAPL within the upper soil units is essentially captive within the pore space of soil and no longer continues to migrate.

Even the easternmost finger of NAPL (Figure 9) in the upper strata was not observed more than 100 feet from the Landfill and this finger was not in the area severed by the trench. The lack of extensive migration in the upper strata along this finger is indicative of the low head of NAPL available in this area to promote migration. It is apparent from this that the greater potential for migration is in fact at depth along the top of clay/till or into the bedrock regime. Based upon the information obtained in the field, the timber walls of the trench would be expected to serve as vertical pathways for NAPL in the upper layers to migrate deeper into the overburden regime.

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The NAPL migration pathways are easier to predict and trace over the top of the clay/till stratum. NAPL will migrate along pathways exhibiting the most favorable conditions of gradient and fill/alluvium permeability. For this reason, as previously discussed, NAPL at depth has typically not been observed in the central area along the southern boundary of the Landfill as shown in Figure 7. The slightly elevated mound of clay/till observed in the area stretching from OW203 to BH221 prevents NAPL which has settled in the low areas (sub 544 elevation) from flowing along the clay/till incline found along the Robert Moses Parkway. Consequently, in this area, the NAPL is confined to the Site boundary.

Review of the top of clay/till contour plan indicates that along the entire River shoreline area, the elevation of the top of clay/till is slightly higher than the elevation present along the southern property boundary of the S-Area. Although this topographical relief is minor, in the absence of a significant volume of NAPL, this incline will impede and possibly prevent continued southerly NAPL migration through the overburden toward the Niagara River.

It is to be noted that the Industrial Intake Pipe Trench has cut into the clay/till stratum in most areas along its length. In these areas, it is anticipated that the possibility of further southerly NAPL migration has been effectively severed. Once NAPL enters the intake trench, it may preferentially migrate along the Intake Pipe timber walls or bedding material to the west or east and south to the intake structure on the edge of the River. The exact details of the timber walls and bedding material are not fully known as all records are not available. Consequently, the information presented in this regard is based upon the current and historic field information that can be assembled. For example, from historic photographs, it is apparent that a layer of bedding material was laid down on the bottom of the trench. The sections of intake pipe were laid directly upon the bedding material.

It also appears that the bedding material consisted of a layer of crushed stone and rock fragments and consequently would be very porous. However, during the drilling of boreholes within the Industrial Intake Pipe Trench alignment, the presence of such a gravelly layer was not observed. The boreholes within the trench indicated that backfill material may have extended to an average elevation 543.5 ft. AMSL indicating that the bedding material may have been as thick as 18 inches, assuming a pipe wall thickness of approximately 6 inches and a pipe invert elevation of 545.5 ft. AMSL (Corrected to 1986 OCC Datum).

The wells installed into the Industrial Intake Pipe Trench at the western end of the study area

(OW270 and OW273) do not identify the presence of NAPL but do indicate the presence of iridescent sheens in the saturated soil samples observed. It is to be noted that it is possible that these wells are not seated directly into the Industrial Intake Pipe Trench. In any event, the intake pipes and bedding material surrounding the pipes do not come in contact with the River shoreline as they continue westward and therefore potential westward migration of NAPL along the trench would not be expected to enter the River. At the southern end of the Industrial Intake Pipe Trench immediately adjacent to the River, boreholes C4A and C4B were installed. These boreholes did not identify the presence of NAPL. Consequently, NAPL is not migrating via the Industrial Intake Pipe Trench bedding material to the Niagara River.

There are a few locations near the southwest corner of the Landfill Site where it is possible for NAPL that is resting upon the clay/till stratum to cross beneath the Industrial Intake Pipe Trench from the Landfill to the River side of the trench. Based upon the assumption previously stated that the bedding of the Industrial Intake Pipe Trench may extend to an approximate elevation of 543.5 ft. AMSL, it is possible for NAPL to pass beneath the bedding in areas where the top of the clay/till confining layer is below 543.5 ft. AMSL. This occurs in at least one area adjacent to BH187. Even if such southerly migration occurs, it must be remembered that the top of the clay/till

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stratum on the south side of the Industrial Intake Pipe Trench rises to an elevation in excess of 545 and consequently the extent of southerly NAPL migration is physically limited due to the topography.

4.3 SUMMARY

Based upon all of the information reviewed, it is concluded that:

i) NAPL flow along the top of the clay/till stratum has not reached the Niagara River and the potential for migration has been substantially eliminated.

ii) The NAPL finger reaching SP8 is migrating along a low permeable layer which is above the elevation of the clay/till. The permeable unit through which the NAPL has migrated has been severed by the construction of the utility trench and consequently the driving force of the NAPL migration has also been severed. Considering that this construction occurred approximately 30 years ago, it is believed that the NAPL observed at SP8 is due to residual saturation and is no longer migrating.

iii) There is no evidence that NAPL has migrated along the Industrial Intake Pipe Trench walls or bedding material at the southern limit of the intakes adjacent to the River and it is therefore assumed that there has been no NAPL migration to the River in this area.

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5.0 APL

5.1 GROUNDWATER FLOW

Aqueous phase liquid (APL) is present in the overburden around the S-Area Landfill. The sources of APL are as follows:

- contact of migrating groundwater with chemicals in the soils in the saturated strata beneath the Site,

- contact of precipitation infiltration with chemicals in the soils and waste as it descends to the water table,

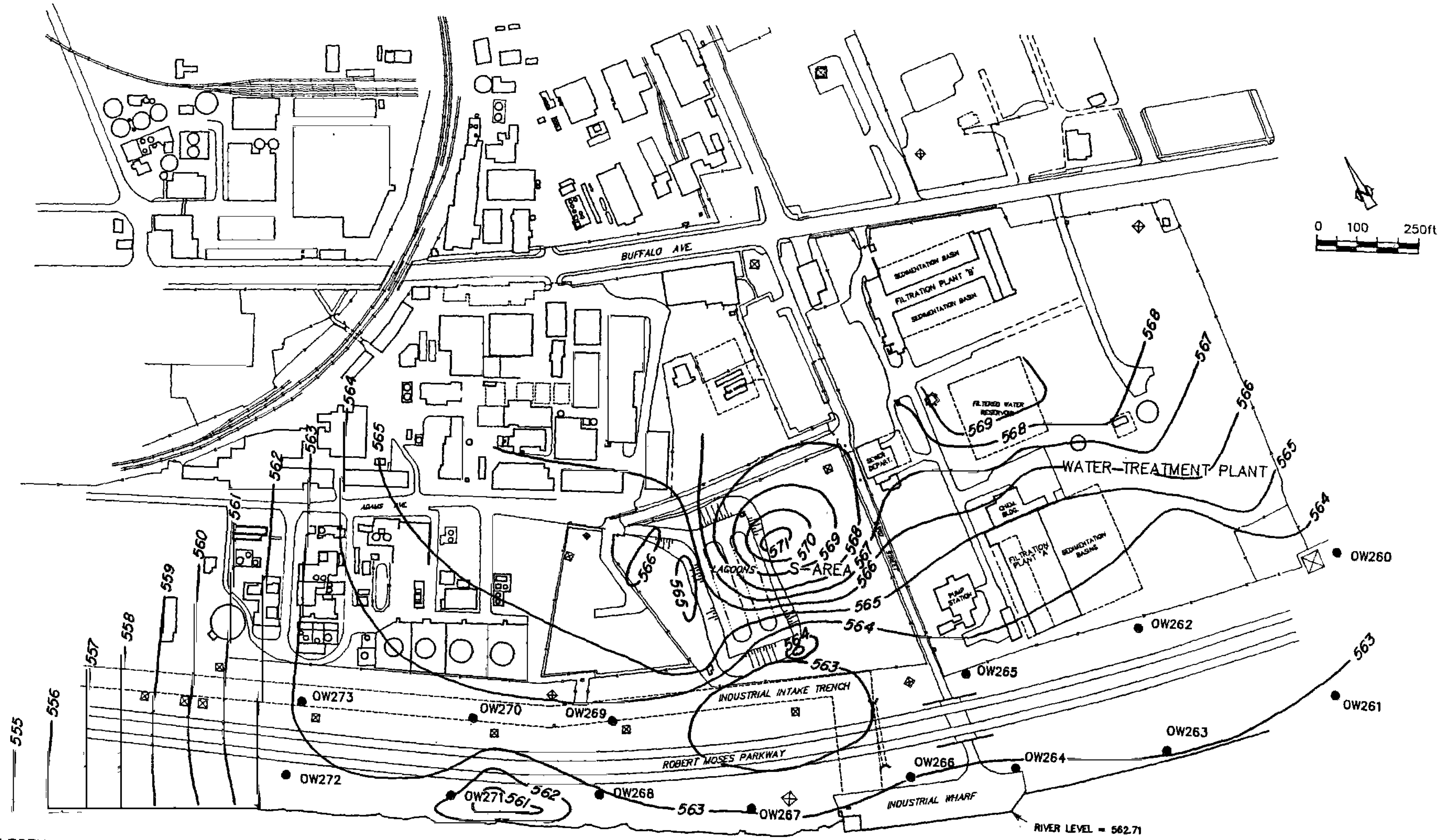
- contact of groundwater with NAPL either on site or with any NAPL which has migrated off-Site.

Groundwater in contact with chemicals in the soil or NAPL, will dissolve some of the chemicals and form APL. Thereafter, the migration of APL is subject to the effects of dispersion and dilution.

As previously discussed, the groundwater flow in the overburden is limited to the fill and alluvium strata. The clay/till stratum exhibits low permeabilities typically of less than 1×10^{-7} cm/sec and small vertical gradients and is therefore not subject to substantial groundwater flow. Based upon the groundwater levels measured in the fill and alluvium strata in early 1988, the groundwater flow through the APL source area is generally southerly as shown in Figure 12. As a result, the movement of the APL plume in the overburden regime is expected to be southerly toward the Niagara River.

The groundwater contours presented on Figure 12 indicate the presence of a groundwater mound in the center of the S-Area. As has been previously discussed, this mound is believed to be due to leakage from the lagoons.

At the western end of the study area, some overburden groundwater flows north away from the River. This condition is created as a result of operating conditions of the Robert Moses Generating Plant's River Intake structure and Conduits. The Conduits create a dewatering condition in the overburden and bedrock groundwater table due to the inclusion of an external dewatering system, which was installed to protect the structural integrity of the Conduits. As a result, the groundwater from the surrounding area is drawn toward the Conduits. At the Niagara River's edge, the Intake structure that was constructed to feed the River water into the Conduits is constructed through the entire overburden regime and is keyed into the top of the bedrock. Consequently, the overburden groundwater flow regime is cut off from the river along the length of the



LEGEND

— 565 — GROUNDWATER CONTOURS (FT. AMSL)

NIAGARA RIVER

CRA

1769-26/06/88-22-D-0

figure 12
OVERBURDEN GROUNDWATER CONTOURS
APRIL 18, 1988
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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River Intake structure. Due to the dewatering effect of the Conduits in the overburden behind the River Intakes, localized groundwater flow conditions around the wall are observed at the eastern end of the Intake structure and consequently groundwater in this area flows from the River around the Intake Structure and toward the Conduits. It is to be noted that the influence of the conduits/intakes does not impact groundwater flow in the immediate vicinity of the S-Area.

The Industr OVER-BURDEN GW CONTOURS er walls

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5.2

In April/May 1988, OCC collected groundwater samples from the fourteen overburden groundwater survey wells. The well installation, development and sampling were conducted in accordance with the protocols specified and details of these programs are further described in the "Information Summary Report". The analytical results from this sampling event are presented in Table 2 and summarized

TABLE 2

Report Date: 06/13/88

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

| ND - Not Detected above survey level |

S AREA
OVERBURDEN SURVEY WELLS

Special Codes: D - FIELD DUPLICATE

		Sample Date:-------->	04/19/88	04/22/88	04/19/88	04/22/88	05/03/88	04/21/88	05/04/88
		Sample Description:->	OW 260	OW 261	OW 262	OW 263	OW 264	OW 265	OW 266
		Special Code:------->							
Analytes:	Units:	Survey Levels:							
PH			7.2	7.5	7.6	7.0	7.8	8.1	6.9
SPECIFIC CONDUCTANCE	mmh/cm		1.9	0.9	1.2	8.0	0.5	2.3	3.9
TOTAL ORGANIC CARBON (TOC)	mg/L	20	ND	ND	ND	ND	ND	ND	ND
TOTAL ORGANIC HALIDES (TOX)	mg/L	0.1	ND	0.3	ND	0.6	0.2	0.3	3.8
CHLOROBENZOIC ACIDS, TOTAL	mg/L	0.5	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZENE	ug/L	10	ND	ND	ND	ND	ND	14	190
TRICHLOROBENZENE, TOTAL	ug/L	10	ND	ND	ND	ND	ND	ND	58
TETRACHLOROBENZENES, TOTAL	ug/L	10	ND	ND	ND	ND	ND	ND	82
HEXACHLOROBENZENE	ug/L	10	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROBUTADIENE	ug/L	10	ND	ND	ND	ND	ND	ND	ND
OCTACHLOROCYCLOPENTENE	ug/L	10	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOHEXANE (BHC) TOTAL	ug/L	10	ND	ND	ND	ND	ND	ND	327
PERCHLOROPENTACYCLODECANE (MIREX)	ug/L	10	ND	ND	ND	ND	ND	ND	ND

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TABLE 2

Report Date: 06/13/88

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

| ND - Not Detected above survey level |

S AREA
OVERBURDEN SURVEY WELLS

Special Codes: D - FIELD DUPLICATE

		Sample Date:-------->	04/28/88	04/27/88	04/27/88	04/21/88	04/20/88	04/25/88	04/25/88	05/04/88
		Sample Description:->	OW 267	OW 268	OW 268	OW 269	OW 270	OW 271	OW 272	OW 273
		Special Code:------->			D					
Analytes:	Units:	Survey Levels:								
PH			9.0	7.4	7.4	7.4	7.6	8.7	7.8	7.1
SPECIFIC CONDUCTANCE	mmh/cm		0.3	0.4	0.4	7.2	4.6	1.0	1.4	11
TOTAL ORGANIC CARBON (TOC)	mg/L	20	ND	ND	ND	30	ND	ND	ND	ND
TOTAL ORGANIC HALIDES (TOX)	mg/L	0.1	0.4	ND	ND	27	4.7	0.1	0.2	10
CHLOROBENZOIC ACIDS, TOTAL	mg/L	0.5	ND	ND	ND	6.7	1.5	ND	ND	9.5
CHLOROBENZENE	ug/L	10	ND	ND	ND	2180	679	ND	ND	778
TRICHLOROBENZENE, TOTAL	ug/L	10	146	ND	ND	2500	243	ND	ND	83
TETRACHLOROBENZENES, TOTAL	ug/L	10	196	ND	ND	1080	213	ND	ND	79
HEXACHLOROBENZENE	ug/L	10	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROBUTADIENE	ug/L	10	ND	ND	ND	228	27	ND	ND	ND
OCTACHLOROCYCLOPENTENE	ug/L	10	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOHEXANE (BHC) TOTAL	ug/L	10	ND	ND	ND	86	495	ND	ND	865
PERCHLOROPENTACYCLODECANE (MIREX)	ug/L	10	ND	ND	ND	ND	ND	ND	ND	ND

on Figure 13. The areal distribution of each individual survey parameter has been plotted in Figures 14 through 26 and are discussed in the following subsections.

pH - Figure 14

None of the pH results from the fourteen overburden survey wells along the River exceeded the survey level for pH. In fact, all of the pH levels measured were within the range of 6.9 to 9.0.

Conductivity - Figure 15

As discussed in the report entitled "Assessment of the Extent of APL/NAPL Migration from the S-Area in the Lockport Bedrock - S-Area Remedial Program - June 1988", the survey level for conductivity is 18,600 umhos/cm. The highest conductivity level measured along the Niagara River was 11,000 umhos/cm at OW273 and therefore no conductivity measurement exceeded the survey level.

Total Organic Carbon (TOC) - Figure 16

TOC was observed to be above the survey level of 20 mg/L at only one location; OW269. At this well, which is located adjacent to the southwest corner of the S-Area, the TOC concentration was 30 mg/L. Considering the location

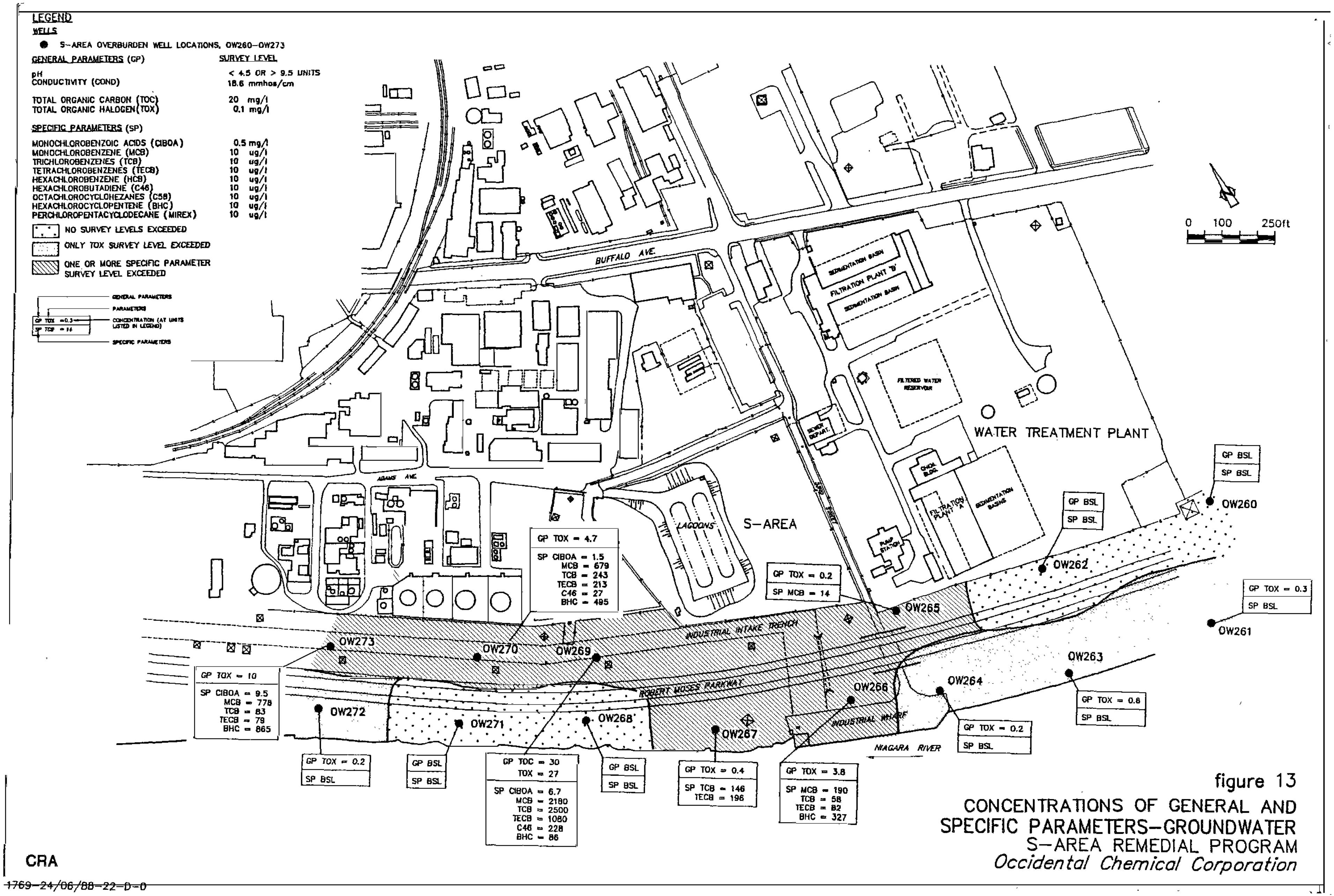

figure 13

CONCENTRATIONS OF GENERAL AND SPECIFIC PARAMETERS-GROUNDWATER
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-24/06/88-22-D-0

CRA 5-0038929

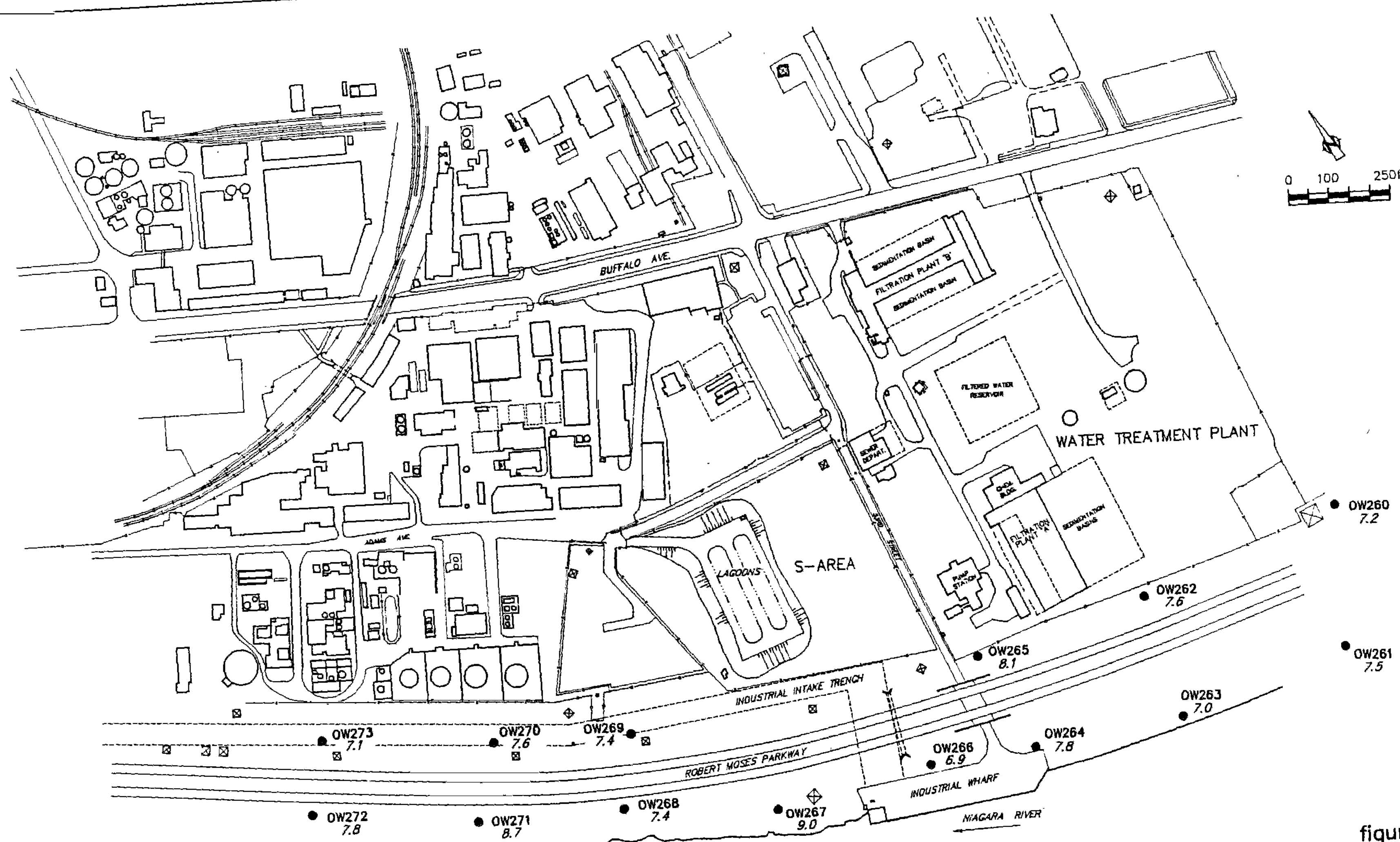

figure 14

OVERBURDEN GROUNDWATER CONCENTRATIONS
pH RESULTS

S-AREA REMEDIAL PROGRAM

Occidental Chemical Corporation

LEGEND

● S-AREA OVERBURDEN WELL LOCATIONS, OW260-OW273

7.1 pH VALUE IN GROUNDWATER SAMPLE

BSL BELOW SURVEY LEVEL
SURVEY LEVEL = <4.5 or >9.5

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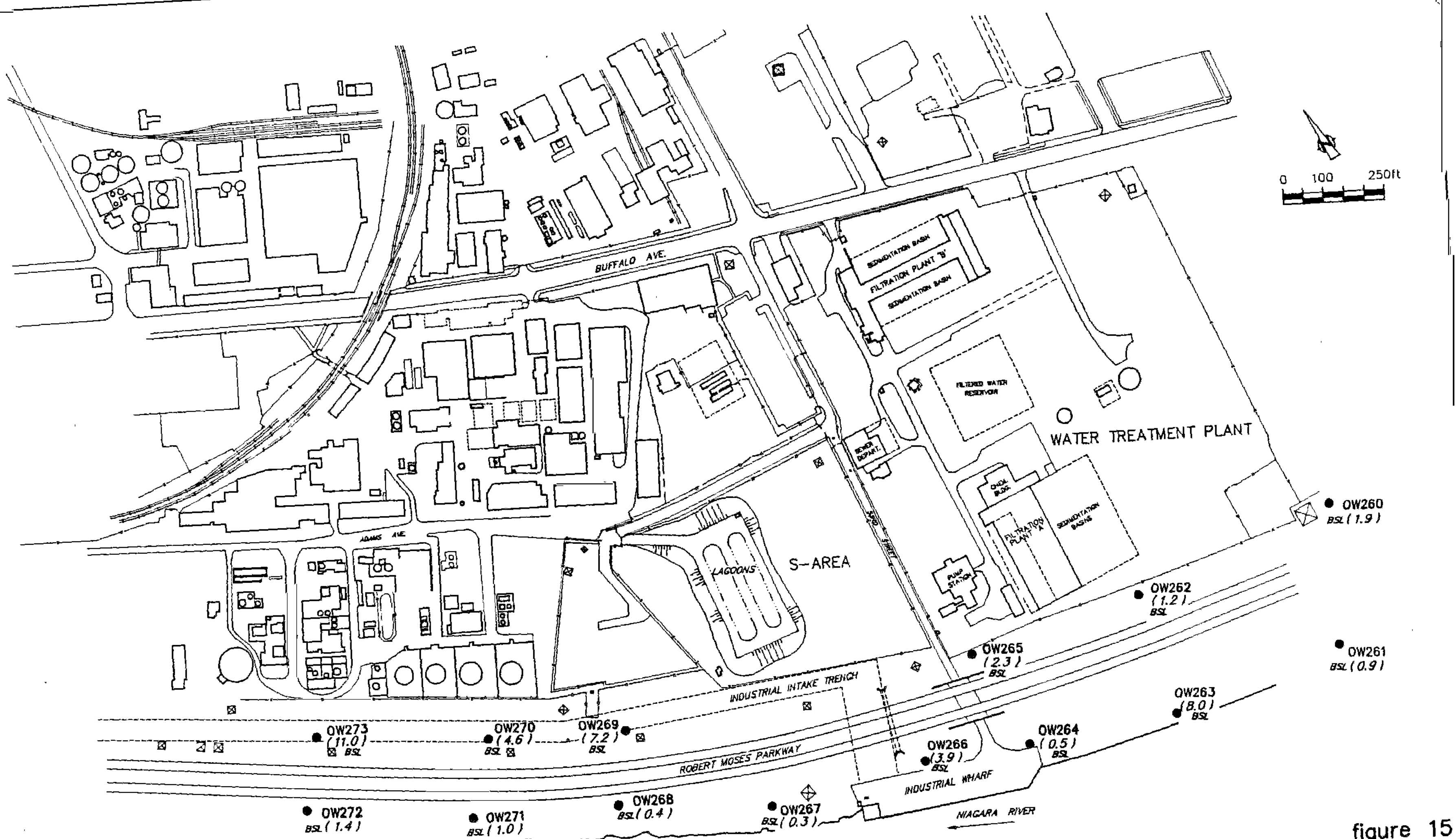

figure 15

OVERBURDEN GROUNDWATER CONCENTRATIONS
CONDUCTIVITY RESULTS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

LEGEND

● S-AREA OVERBURDEN WELL LOCATIONS, OW260-OW273

(11) CONDUCTIVITY VALUE IN GROUNDWATER SAMPLE (mmhos/cm)

BSL BELOW SURVEY LEVEL
SURVEY LEVEL =18.60 mmhos/cm

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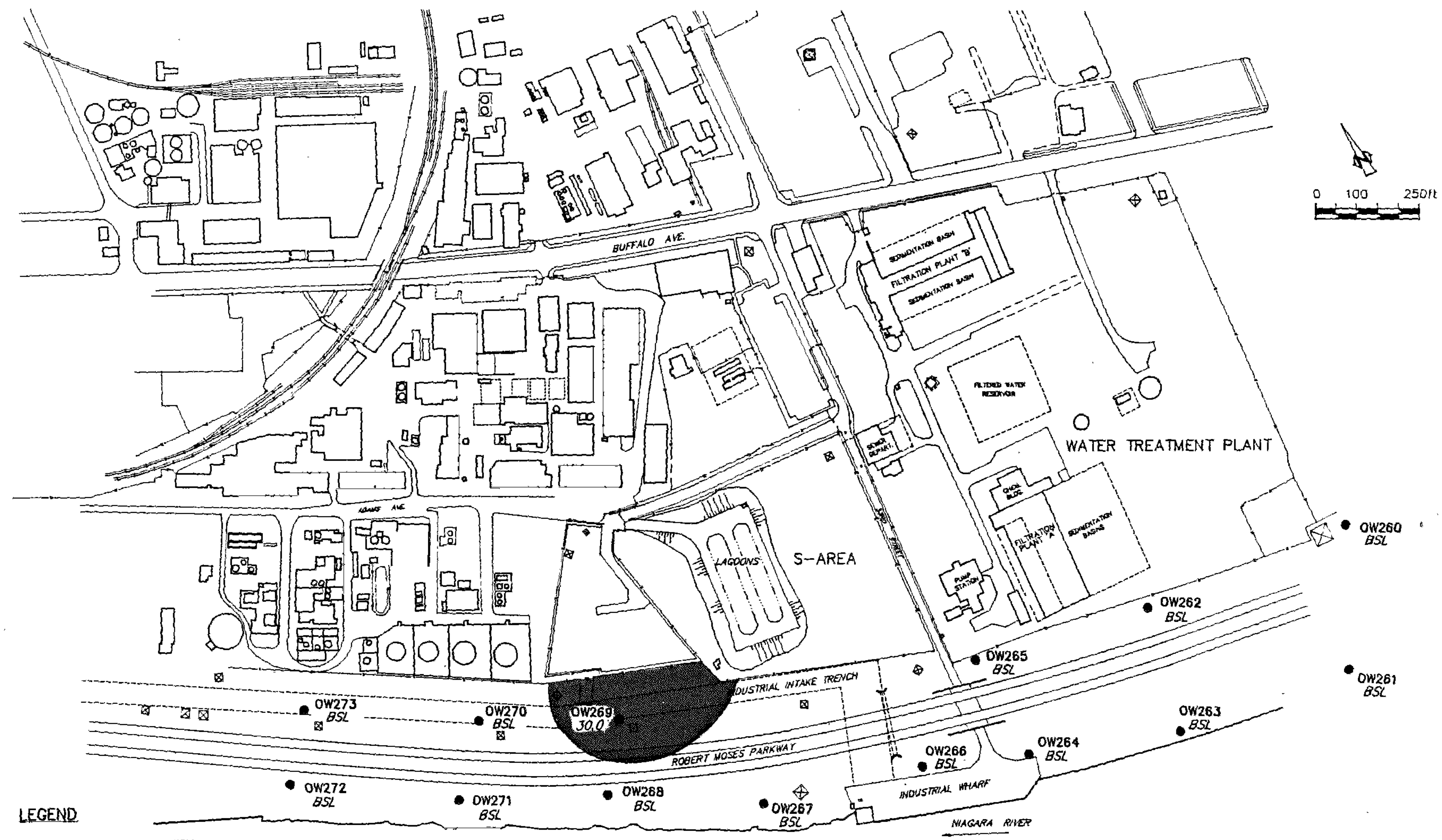
1769-24/06/88-22-D-0

CRA 5-0038931



LEGEND

- ● S-AREA OVERBURDEN WELL LOCATIONS, OW260-OW273
- *30* CONCENTRATION OF TOC IN GROUNDWATER SAMPLE (mg/l)
- *BSL* BELOW SURVEY LEVEL SURVEY LEVEL = 20 mg/l
- ▆ >20 mg/l

figure 16

OVERBURDEN GROUNDWATER CONCENTRATIONS
TOTAL ORGANIC CARBON (TOC) RESULTS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-24/06/88-22-D-0

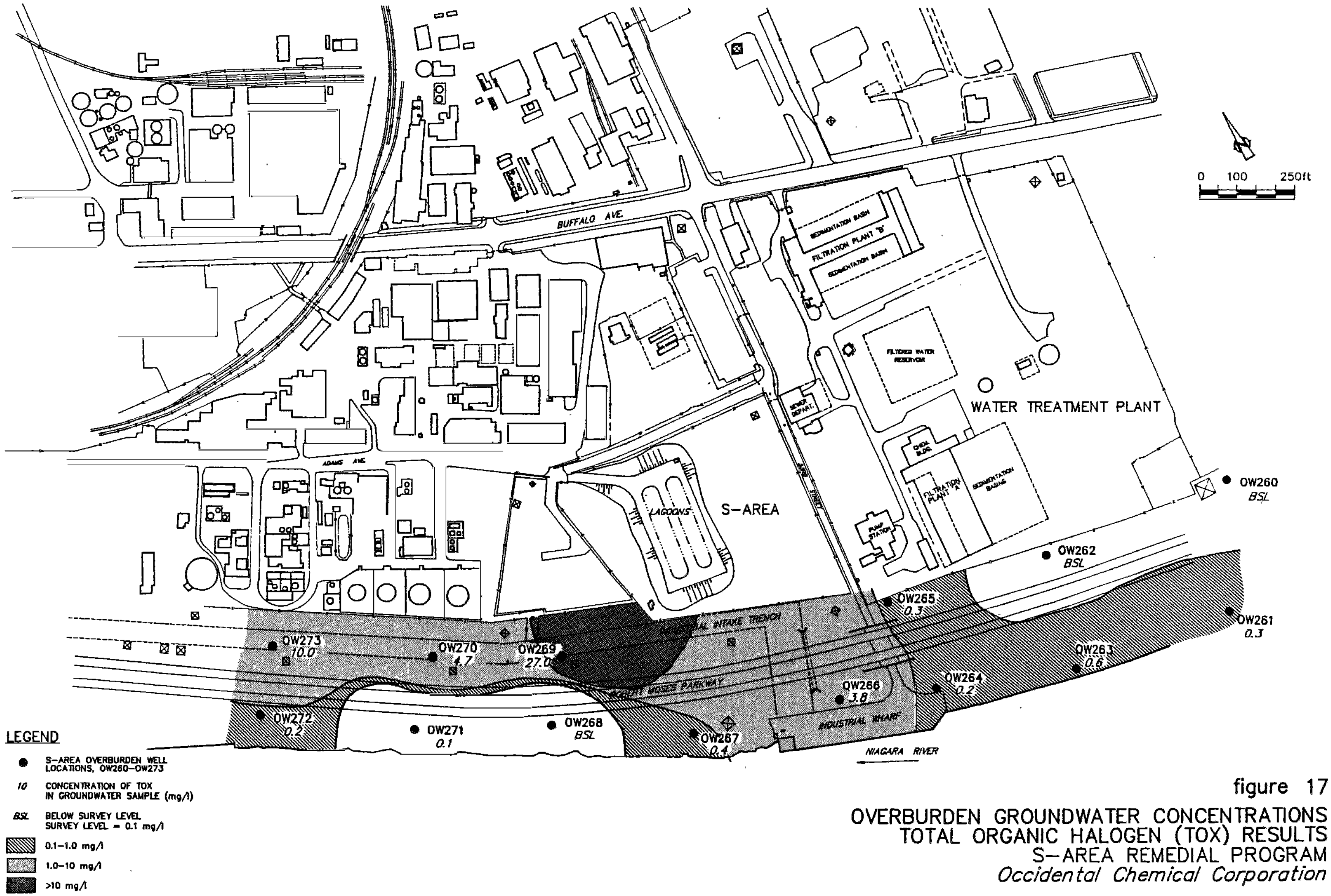


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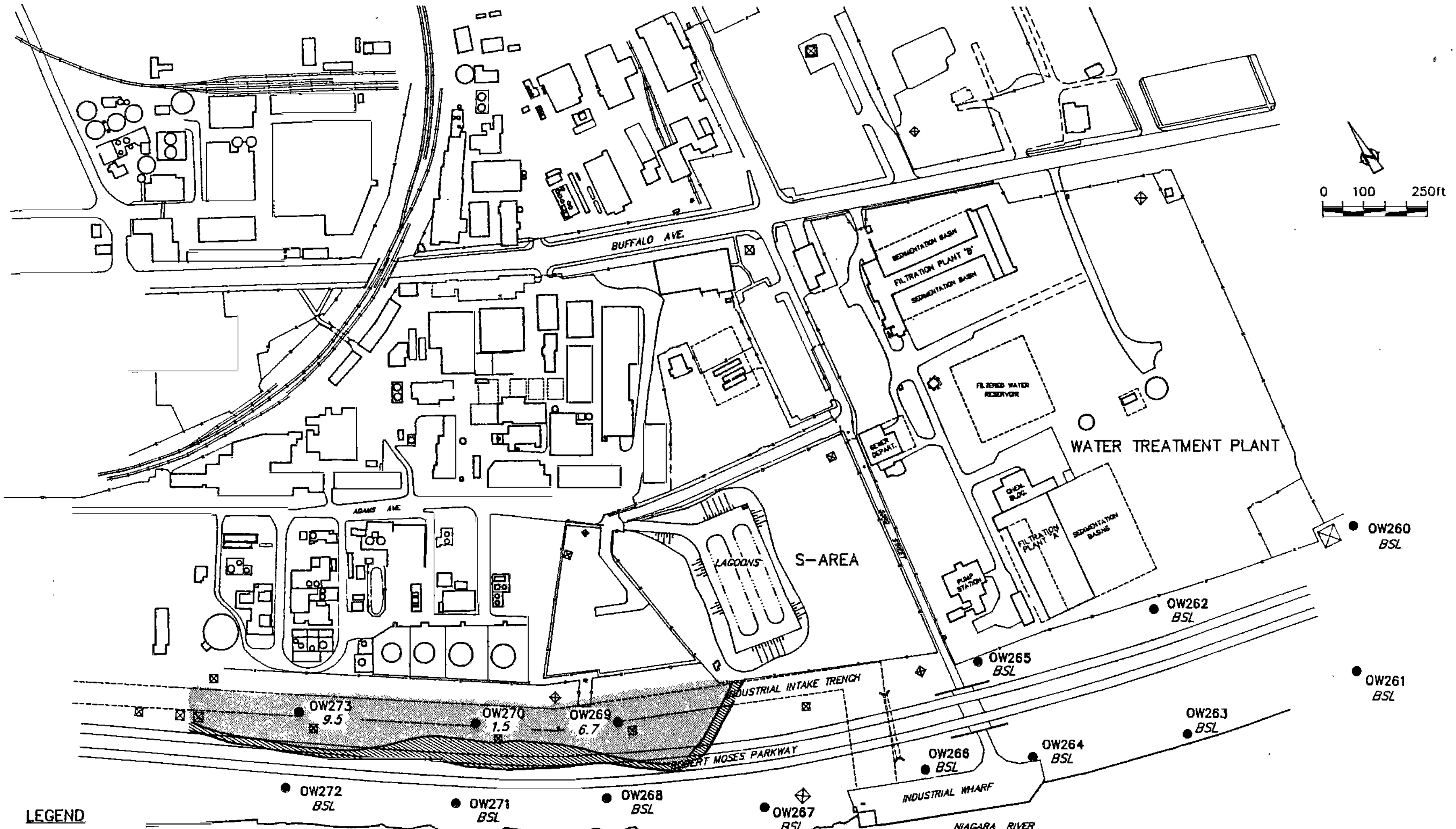
figure 17

OVERBURDEN GROUNDWATER CONCENTRATIONS
TOTAL ORGANIC HALOGEN (TOX) RESULTS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-24/06/88-22-D-0

CRA 5-0038933



LEGEND

- ● S-AREA OVERBURDEN WELL LOCATIONS, OW260–OW273
- *9.5* CONCENTRATION OF ClBOA IN GROUNDWATER SAMPLE (mg/l)
- *BSL* BELOW SURVEY LEVEL SURVEY LEVEL ≈ 0.5 mg/l
- 0.5–1.0 mg/l
- >1.0 mg/l

CRA

figure 18

OVERBURDEN GROUNDWATER CONCENTRATIONS
MONOCHLOROBENZOIC ACIDS (Cl BOA) RESULTS
S–AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769–24/06/88–22–D–0

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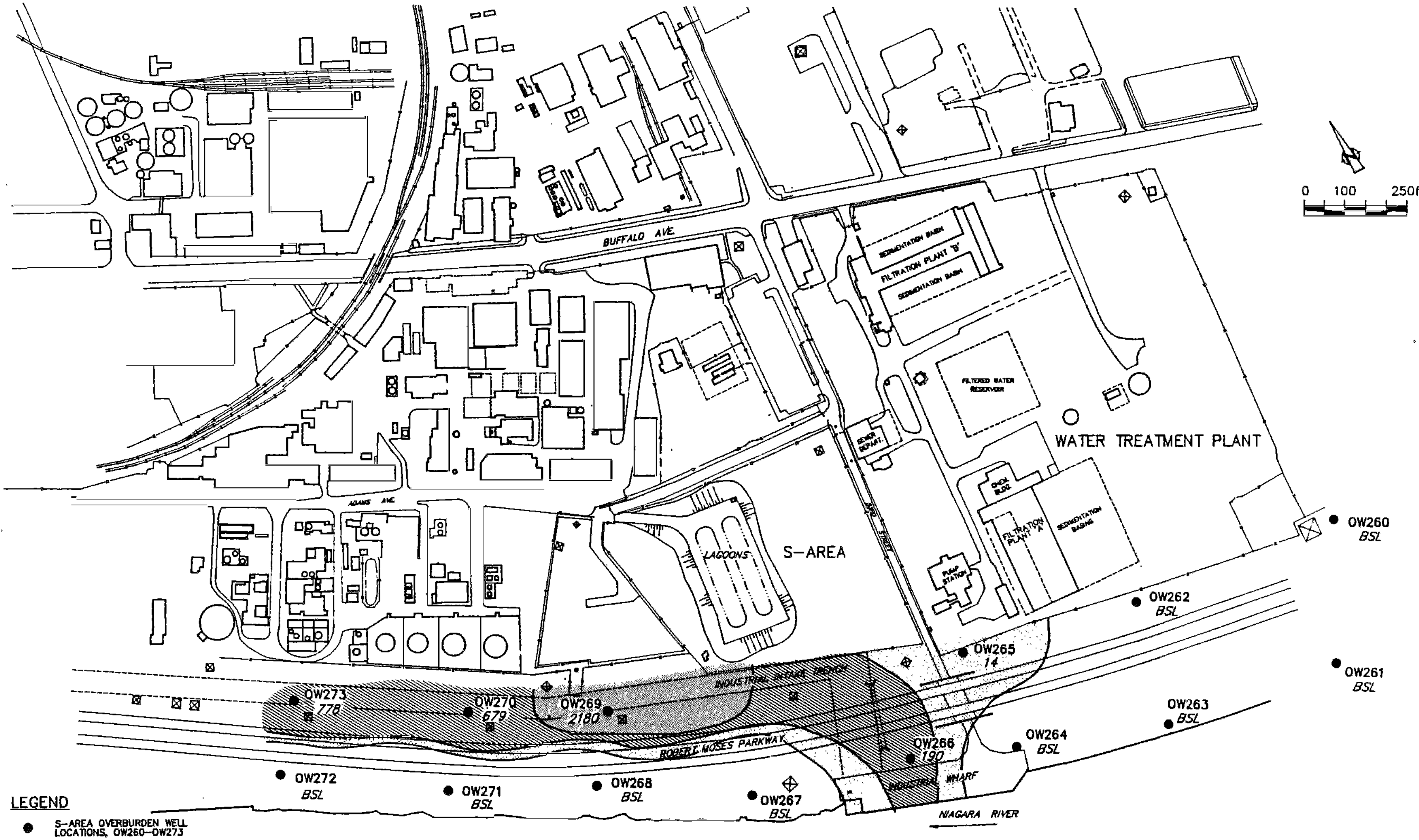


LEGEND

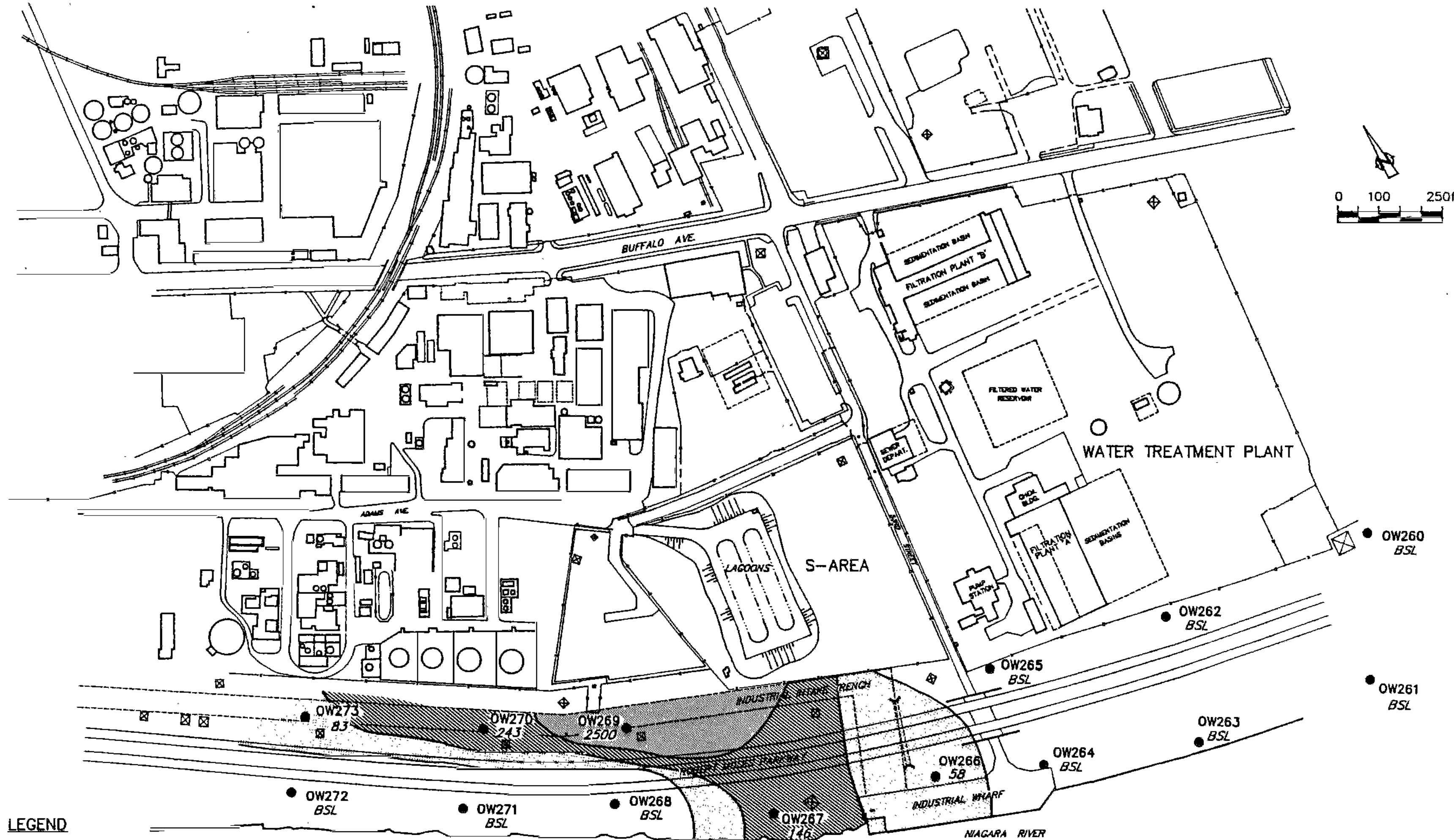
- ● S-AREA OVERBURDEN WELL LOCATIONS, OW260-OW273
- *778* CONCENTRATION OF MCB IN GROUNDWATER SAMPLE (ug/l)
- *BSL* BELOW SURVEY LEVEL SURVEY LEVEL = 10 ug/l
- 10-100 ug/l
- 100-1,000 ug/l
- >1,000 ug/l

CRA

figure 19

OVERBURDEN GROUNDWATER CONCENTRATIONS
MONOCHLOROBENZENE (MCB) RESULTS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-24/06/88-22-D-0



LEGEND

- ● S-AREA OVERBURDEN WELL LOCATIONS, OW260-OW273
- *83* CONCENTRATION OF TCB IN GROUNDWATER SAMPLE (ug/l)
- *BSL* BELOW SURVEY LEVEL SURVEY LEVEL = 10 ug/l
- 10-100 ug/l
- 100-1,000 ug/l
- >1,000 ug/l

CRA

figure 20

OVERBURDEN GROUNDWATER CONCENTRATIONS
TRICHLOROBENZENES (TCB) RESULTS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-24/06/88-22-D-0

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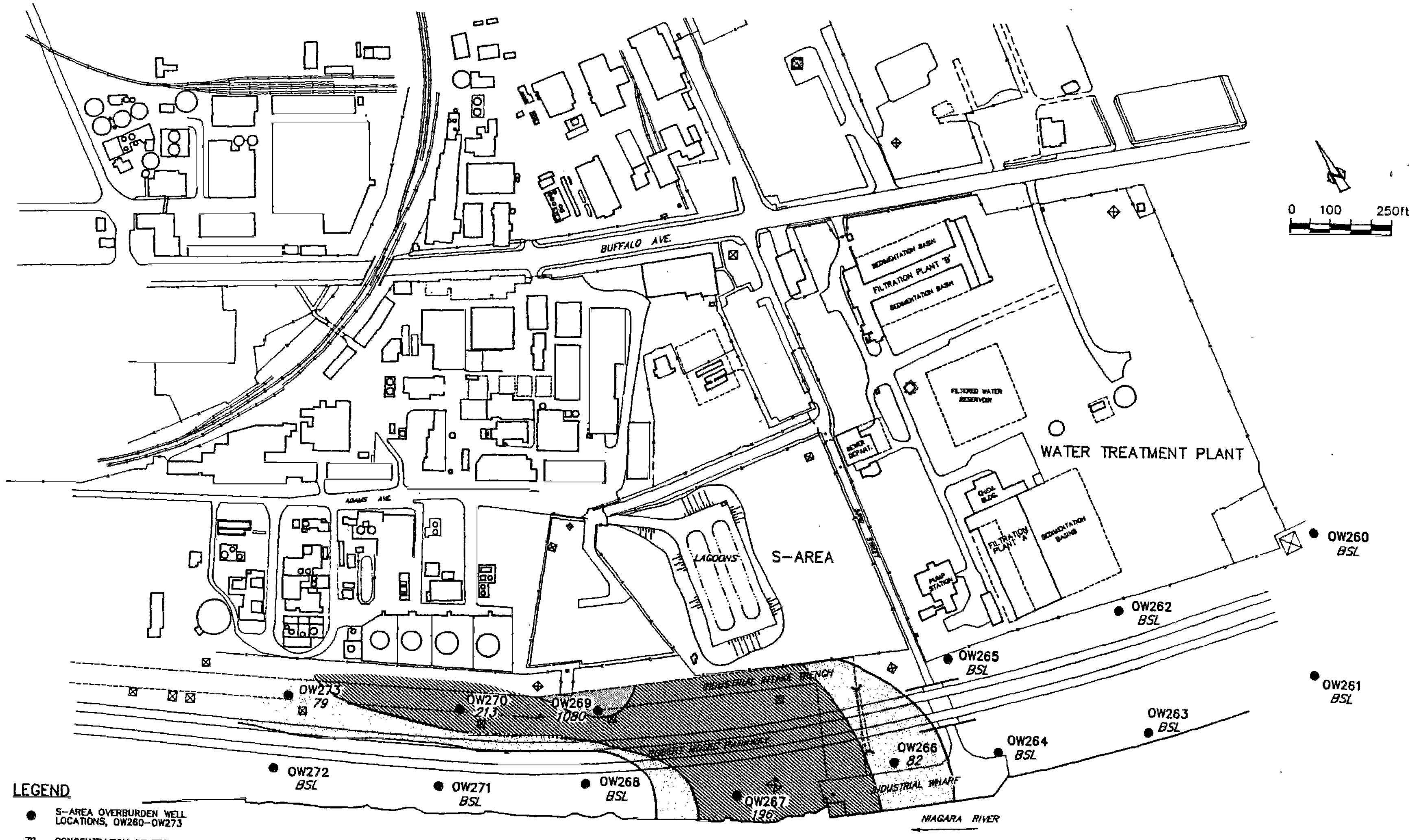

LEGEND

- ● S-AREA OVERBURDEN WELL LOCATIONS, OW260-OW273
- *79* CONCENTRATION OF TECB IN GROUNDWATER SAMPLE (ug/l)
- *BSL* BELOW SURVEY LEVEL SURVEY LEVEL = 10 ug/l
- 10-100 ug/l
- 100-1,000 ug/l
- >1,000 ug/l

CRA

figure 21

OVERBURDEN GROUNDWATER CONCENTRATIONS
TETRACHLOROBENZENES (TECB) RESULTS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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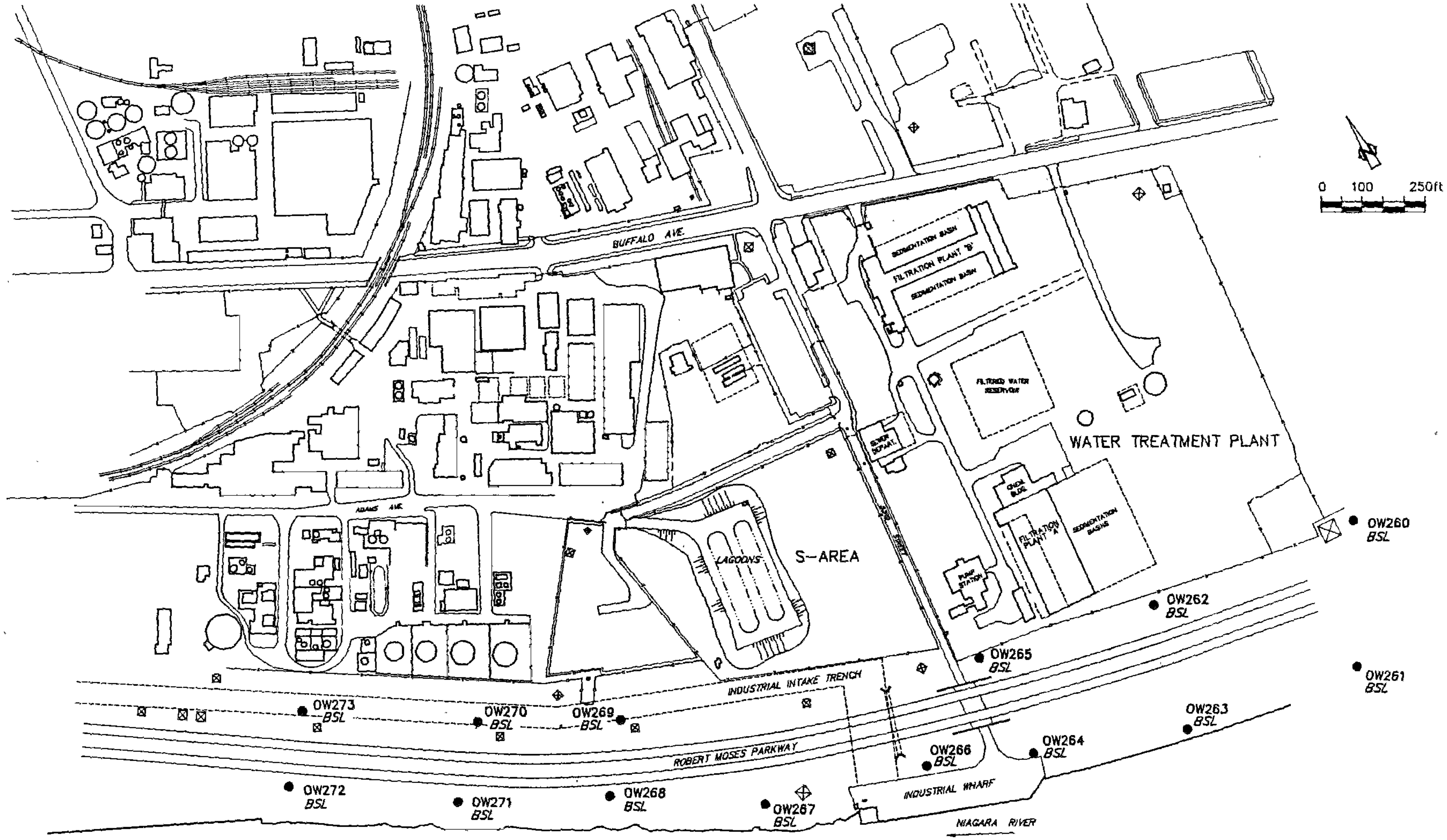

LEGEND

- ● S-AREA OVERBURDEN WELL LOCATIONS, OW260-OW273
- *BSL* BELOW SURVEY LEVEL SURVEY LEVEL = 10 ug/l

figure 22

OVERBURDEN GROUNDWATER CONCENTRATIONS
HEXACHLOROBENZENE (HCB) RESULTS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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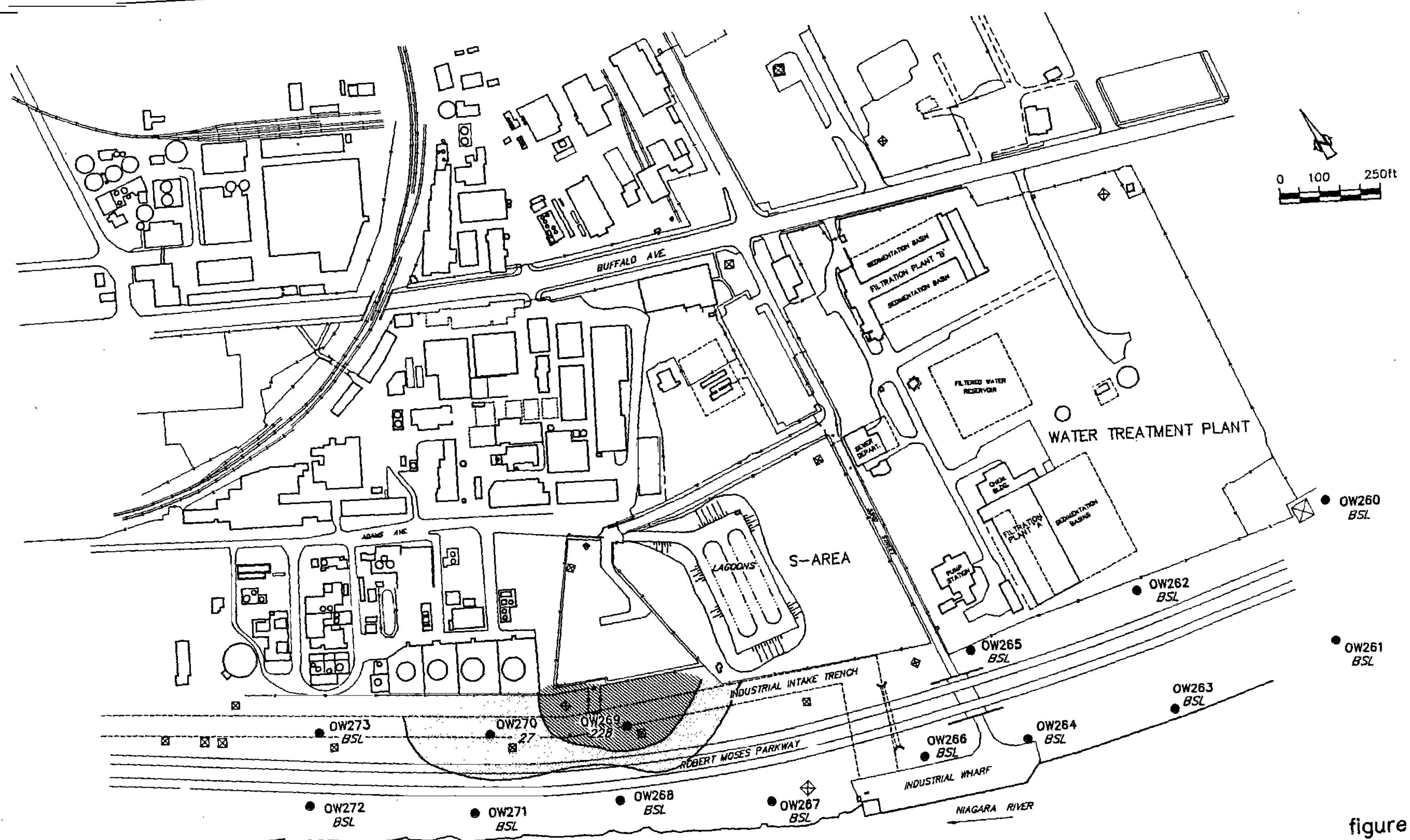
1769-26/06/88-22-D-0



LEGEND

- ● S-AREA OVERBURDEN WELL LOCATIONS, OW260–OW273
- *27* CONCENTRATION OF C46 IN GROUNDWATER SAMPLE (ug/l)
- *BSL* BELOW SURVEY LEVEL SURVEY LEVEL = 10 ug/l
- 10–100 ug/l
- >100 ug/l

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figure 23

OVERBURDEN GROUNDWATER CONCENTRATIONS
HEXACHLOROBUTADIENE (C46) RESULTS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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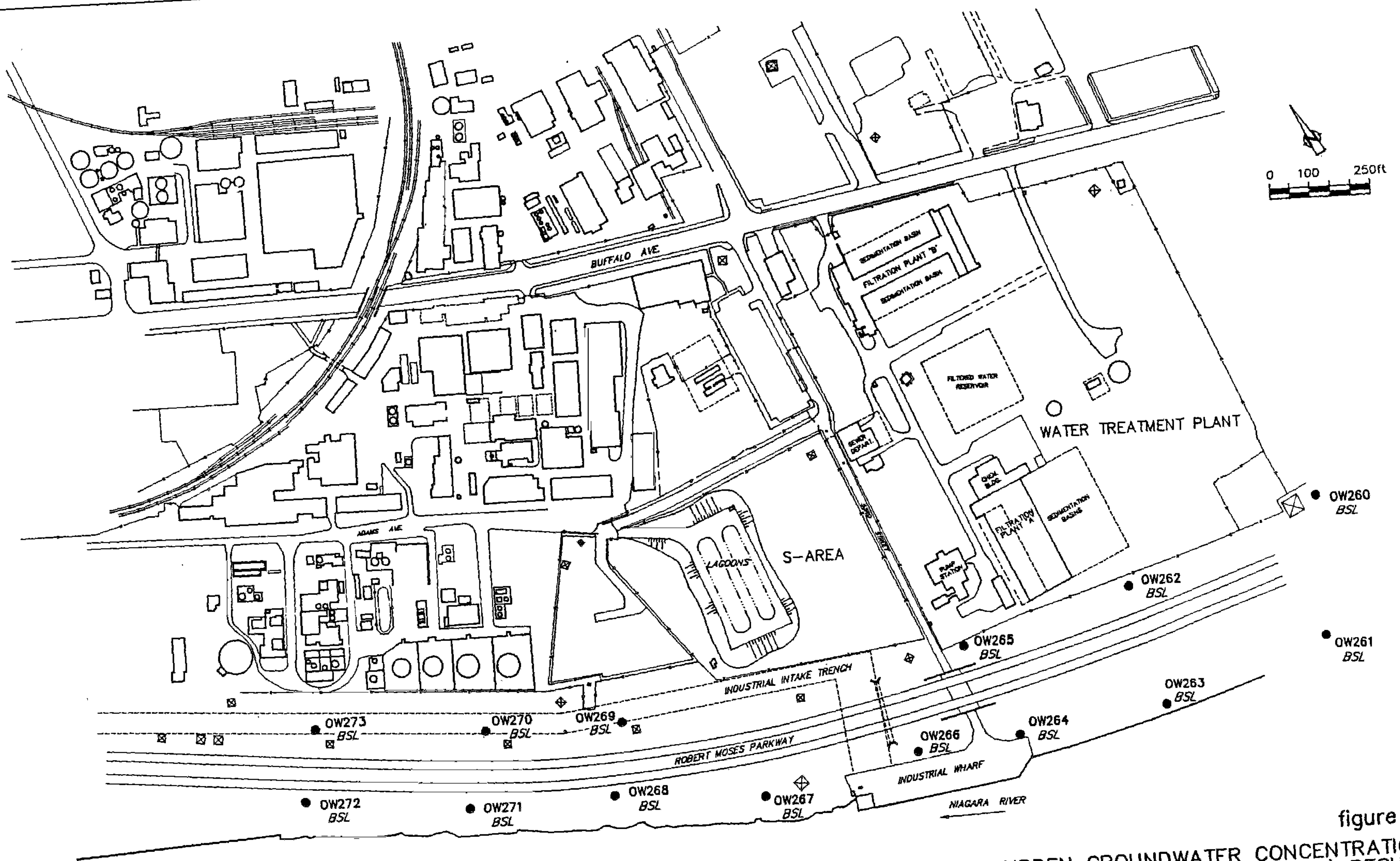

CRA 5-0038940

figure 24

OVERBURDEN GROUNDWATER CONCENTRATIONS
OCTACHLOROCYCLOPENTENE (C58) RESULTS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

LEGEND

● S-AREA OVERBURDEN WELL LOCATIONS, OW260-OW273

BSL BELOW SURVEY LEVEL
SURVEY LEVEL = 10 ug/l

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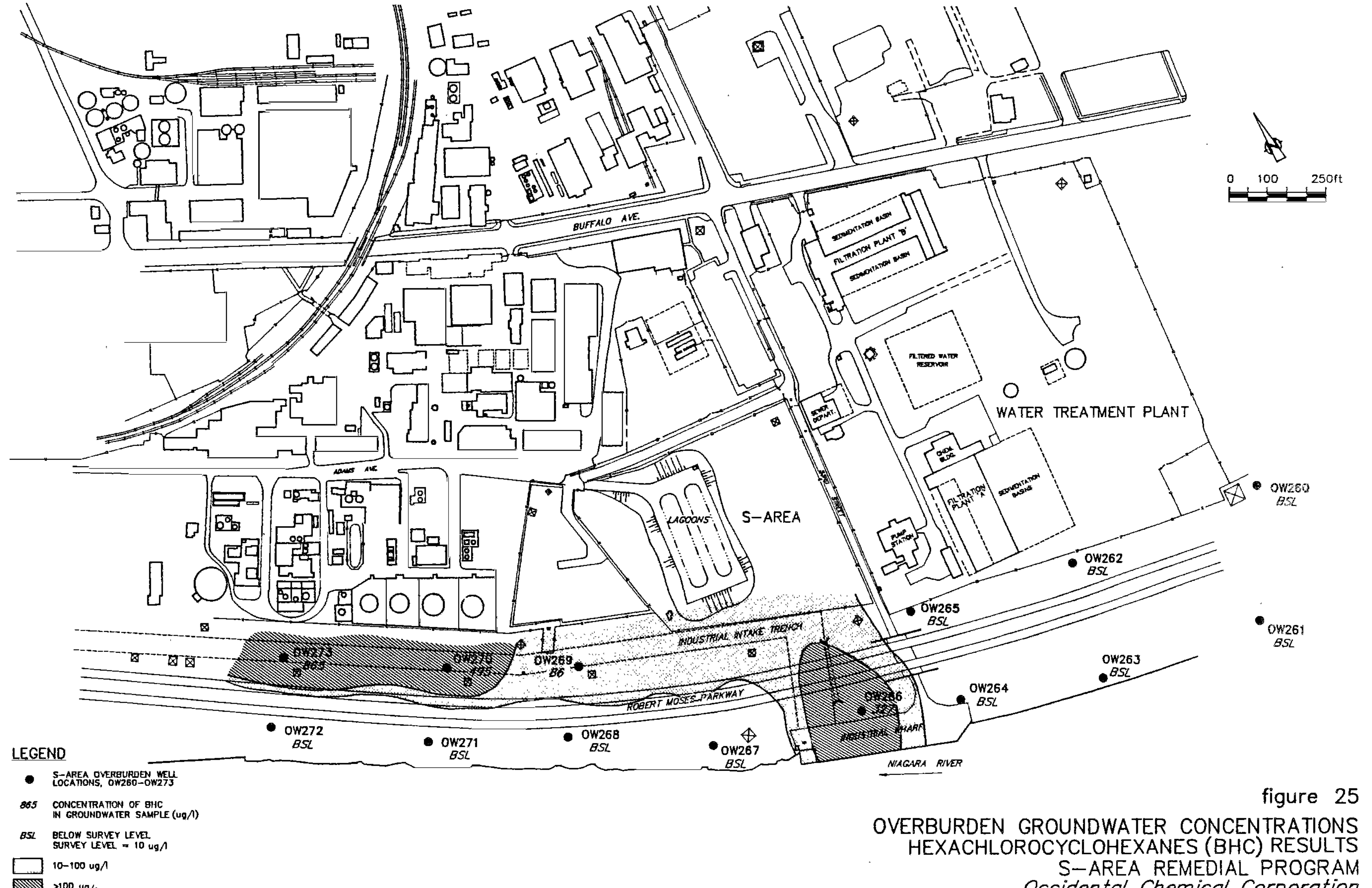

CRA

figure 25

OVERBURDEN GROUNDWATER CONCENTRATIONS
HEXACHLOROCYCLOHEXANES (BHC) RESULTS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-24/06/88-22-D-0

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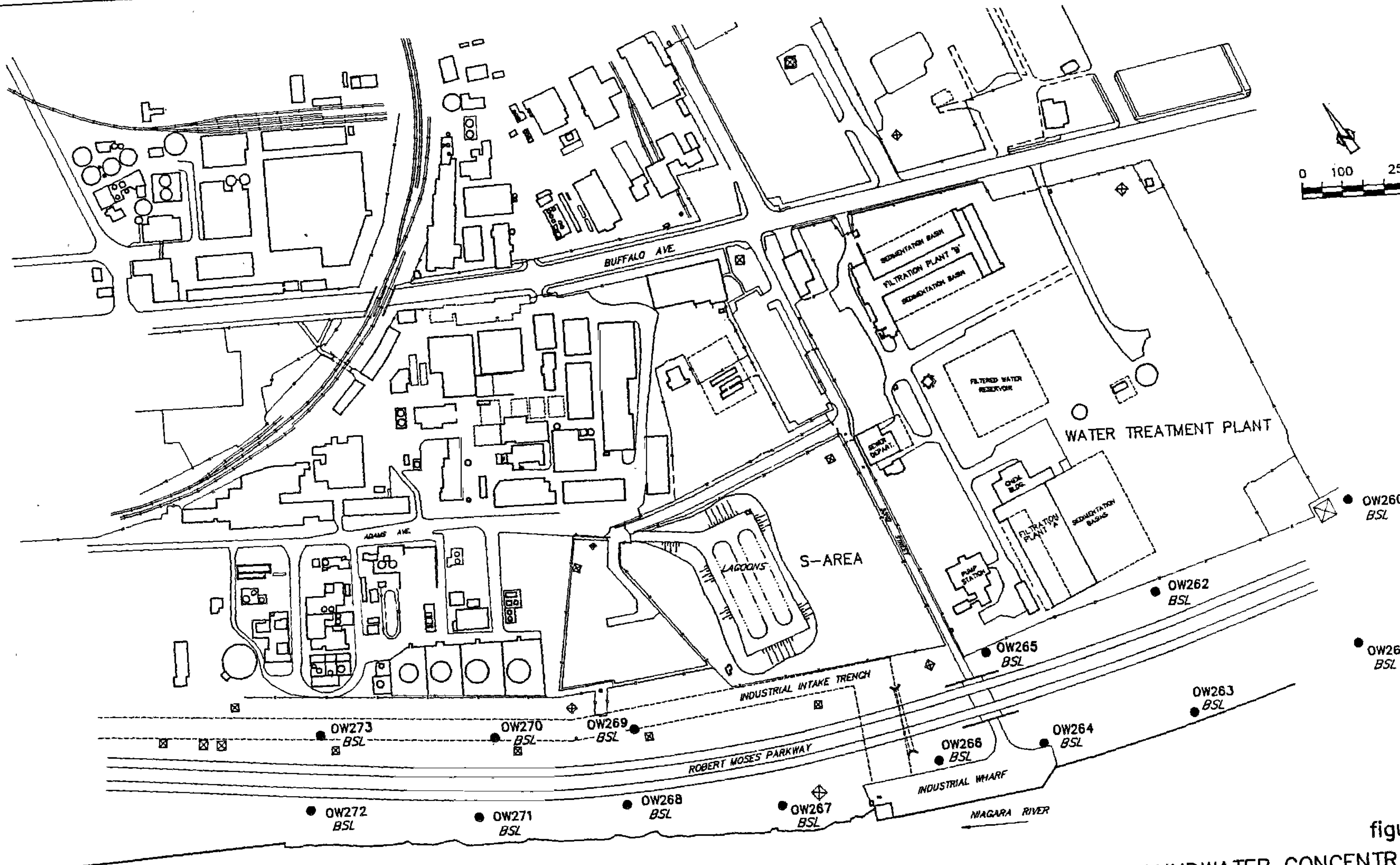

LEGEND

● S-AREA OVERBURDEN WELL LOCATIONS, OW260-OW273

BSL BELOW SURVEY LEVEL
SURVEY LEVEL = 10 ug/l

figure 26

OVERBURDEN GROUNDWATER CONCENTRATIONS
PERCHLOROPENTACYCLODECANE (MIREX) RESULTS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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of the well in reference to the S-Area, the NAPL plume and the groundwater gradient, the presence of TOC at this location would be consistent with chemical migration from S-Area.

Total Organic Halogen (TOX) - Figure 17

The presence of TOX was identified at or above the survey level of 0.1 mg/L at all but three of the fourteen survey wells. The highest concentrations were measured along the Industrial Intake Pipe Trench where concentrations reached as high as 27 mg/L (OW269). The TOX observed at OW273 (10 mg/L), the most westerly well along the Industrial Intake Pipe Trench, may be a result of groundwater flow along the Trench or from groundwater discharges from the N-Area of the Niagara Plant. All of the wells south of the City of Niagara Falls Drinking Water Treatment Plant (WTP) and all of the wells south of the Robert Moses Parkway (with the exception of OW286 at 3.8 mg/L) exhibited TOX concentrations of less than 0.6 mg/L. The concentrations of TOX at OW263 (0.6 mg/L) and OW261 (0.3 mg/L) are not consistent with APL flow patterns from the S-Area since the wells upgradient of these wells (OW260 and OW262) which are closer to S-Area did not contain TOX above the survey level.

Monochlorobenzoic Acids (ClBOA) - Figure 18

The presence of ClBOA was observed in only the three wells located along the Industrial Intake Pipe Trench. The concentrations ranged from 1.5 to 9.5 mg/L with the highest concentration being observed at the westernmost well, OW273, and the middle well, OW270, exhibiting the lowest concentration. While these concentrations are not consistent with the decreasing trend that would be expected from the S-Area, the impact of the Industrial Intake Pipe Trench on flow conditions and the location of the wells in the Trench could account for some degree of the variation observed. Equally possible is that the groundwater quality at OW270 and OW273 is impacted by migration from the N-Area. ClBOA was not observed at any of the wells located immediately adjacent to the River and is therefore assumed not to have migrated to the River.

Monochlorobenzene (MCB) - Figure 19

Elevated concentrations of MCB were observed in the three wells along the Industrial Intake Pipe Trench with the highest concentration measured at the southwest corner of the S-Area (OW269 - 2,180 ug/L). The chemical distribution westward along the Industrial Intake Pipe Trench from OW269 is consistent with those expected concentrations from S-Area APL along the Trench. Two additional locations of low MCB concentrations were noted at the southeast corner of the S-Area (OW285 - 14 ug/L) and by the Industrial Wharf (OW266 - 190 ug/L). Both of these locations are downgradient of the S-Area. Of the wells adjacent to the river, MCB was present only in well OW266.

Trichlorobenzenes (TCB) - Figure 20

The TCB distribution pattern in the overburden groundwater regime indicates the highest concentration is present at OW269 (2,500 ug/L) at the southwest corner of the S-Area. The concentrations radiating west and south from this location decrease with distance, which is consistent with expected APL flow patterns from S-Area. If APL does flow west along the Industrial Intake Pipe Trench, the observed concentrations at OW270 (243 ug/L) and OW273 (83 ug/L) located further west are consistent with expectations. Similarly, the observed concentrations to the south at OW266 (50 ug/L) and OW267 (146 ug/L) are also consistent with expectations.

Wells OW266 and OW267 are the only wells adjacent to the Niagara River in which TCB was present.

Tetrachlorobenzenes (TECB) - Figure 21

The distribution pattern for TECB is identical to that of TCB. The highest concentration was 1,080 ug/L at OW269 with decreasing concentrations along the Industrial Intake Pipe Trench to the west and also to the south towards the Niagara River. Wells OW266 and OW267 are the only wells adjacent to the Niagara River in which TECB is present.

Hexachlorobenzene (HCB) - Figure 22

HCB was not detected at any well in the study area. This demonstrates that HCB has not migrated to the Niagara River through the overburden.

Hexachlorobutadiene (C46) - Figure 23

C46 was identified to be present in only two wells in the study area and both are located adjacent to the southwest corner of the S-Area. The highest concentration was at OW269 (228 ug/L) at the corner of the landfill and a reduced concentration in adjacent well OW270 (27 ug/L) just slightly further west along the Industrial Intake Pipe Trench. C46 was not present in any well along the Niagara River, indicating that C46 has not migrated to the Niagara River through the overburden.

Octachlorocyclopentene (C58) - Figure 24

C58 was not detected at any well in the study area. This indicates that C58 has not migrated to the Niagara River through the overburden.

Hexachlorocyclohexane (BHC) - Figure 25

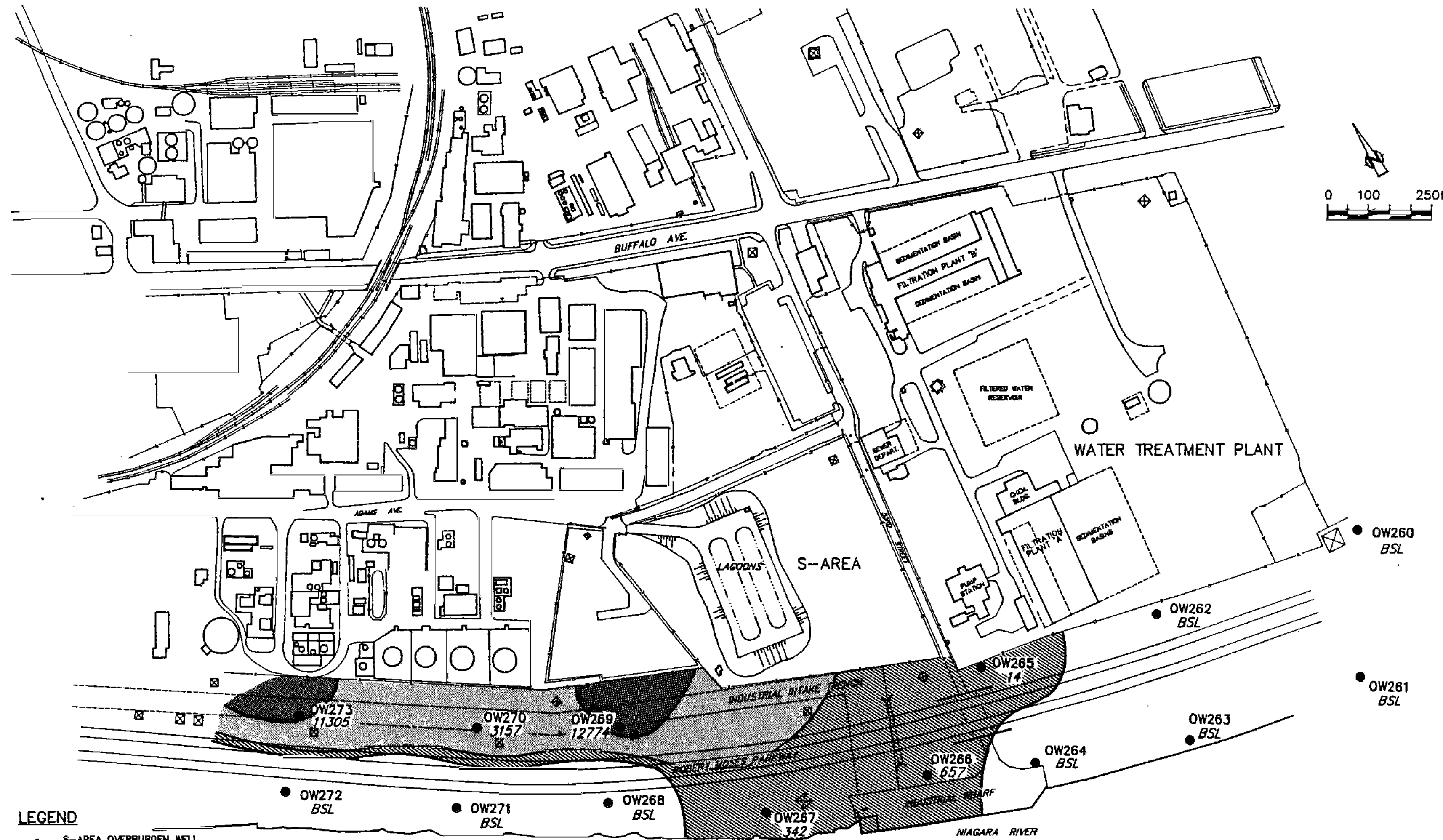
The presence of BHC was identified at four wells south and west of the S-Area. The highest concentration was observed at the well furthest west of the S-Area at OW273 (865 ug/L). Conversely, at the southwest corner of the S-Area, the concentration was 86 ug/L. This pattern is inconsistent with expected chemical distribution patterns from the S-Area and may be indicative of chemicals migrating from the N-Area. In any event, this migration to the west is not continuous to the Niagara River as evidenced by the wells located between OW270/OW273 and the Niagara River (OW268, OW271 and OW272) where no BHC was present. BHC was identified adjacent to the Niagara River only at OW266 (327 ug/L) which is downgradient of the S-Area.

Perchloropentacyclodecane (Mirex) - Figure 26

Mirex was not detected at any well in the study area. This demonstrates that Mirex is not reaching the Niagara River through the overburden.

Combined Specific Parameters - Figure 27

When all of the specific parameters identified in the overburden are combined and plotted on a plan, (see Figure 27) the data indicate that there is an area of elevated Survey parameter presence at the southwest corner of the S-Area at OW269 (12,774 ug/L). The concentrations remain elevated along the Industrial Intake Pipe Trench to the west. In the southerly direction, only two wells contain specific parameters in the overburden groundwater in excess of the survey level and both of these wells are located due south of the S-Area. The concentrations at these two wells (OW266 and OW267) are 657 and 342 ug/L respectively. As can be seen on Figure 27, no other wells along the river contain any specific parameters.



LEGEND

- ● S-AREA OVERBURDEN WELL LOCATIONS, OW260-OW273
- *11305* SUMMATION OF CONCENTRATIONS OF THE NINE SPECIFIC PARAMETERS (ug/l)
- *BSL* BELOW SURVEY LEVEL SURVEY LEVEL = 10 ug/l
- 10-1000 ug/l
- 1,000-10,000 ug/l
- >10,000 ug/l

CRA

figure 27

SUMMATION OF SPECIFIC PARAMETER CONCENTRATIONS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-24/06/88-22-D-0

6.0 DISCUSSION OF SURVEY RESULTS

The flow of groundwater in the overburden is restricted to the fill and alluvium strata and consequently the flow of APL in the overburden is similarly limited. Although there is a component of groundwater flow from the northeast corner of the S-Area lagoons, the primary direction of groundwater flow within the limits of the S-Area is to the south toward the Niagara River. At the western end of the study area north of the River, it can also be seen that there is a strong westerly component of groundwater flow. This is due to the dewatering effect created by the Power Conduits and the Power Conduit Intake Wall which prevents recharge of the dewatered soils from the River. Consequently, groundwater flow along the River in the area immediately east of the Intake Wall is northward away from the River providing recharge into the dewatered soils behind the Intake Wall.

The distribution of chemicals from the S-Area in the groundwater flow regime in the study area between the Site and the Niagara River was summarized and presented in Figure 27. Based upon the groundwater flow conditions and the understanding of APL and NAPL presence on the S-Area, the distribution of chemicals in the study area is essentially consistent with groundwater movement. The highest chemical concentration was observed immediately south of the S-Area at

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OW269. The area south of the Site but north of the Robert Moses Parkway is known to contain NAPL and therefore the presence of elevated APL concentrations in this vicinity is expected particularly since the groundwater flow in this area is southerly. Although OW269 is located at the southwest corner of this area and there are no wells further east toward 53rd Street, it is expected that similar chemical concentrations as far east as 53rd Street would be consistent with chemical migration patterns from the S-Area.

Due to the relatively flat groundwater gradient between the Robert Moses Parkway and the Niagara River in the area south of the S-Area, the reduction in specific parameter concentrations by 1 to 2 orders of magnitude compared to concentrations north of the Robert Moses Parkway is also consistent with expected migration trends from the S-Area. This area south of the Robert Moses Parkway is essentially beyond the limit of the NAPL plume.

One other factor that influences groundwater flow in the vicinity of the Industrial Wharf is the sheet pile wall that protects the face of the Industrial Wharf. The sheet piling extends to considerable depth below grade and may even extend to the top of bedrock. In any event, this sheet piling creates a physical barrier between the River and on-shore soils. Although not watertight, this barrier would be expected to create an area of stagnant or at least slower moving groundwater which would impede the rate of groundwater and chemical flow toward the Niagara River in the immediate vicinity. This would be a factor contributing to the lower chemical concentrations identified in the vicinity of well OW266.

The trace presence of specific parameters at OW265 (14 ug/L) to the east of 53rd Street is also consistent with the migration of chemicals from the S-Area. Since this well is close to but just outside of the groundwater flow pattern from beneath the S-Area and area of NAPL presence, little chemical presence would be expected. Similarly, all of the other wells south of the WTP are outside of the groundwater flow path from the S-Area and would therefore be expected to not contain any chemicals migrating from the S-Area as the data demonstrate. The presence of trace concentrations of TOX in these wells could be the result of groundwater contact with the fill that has been placed on the WTP or the fill used to construct the Robert Moses Parkway itself.

The absence of specific parameter presence in the three wells along the River at the western end of the study area (OW268, OW271 and OW272) is also consistent with expected conditions. This area is subject to the flow of water from the River into the area south of the Robert Moses Parkway which is then directed toward the Power Conduits to the west. Consequently, the water quality through much of this area should be representative of river water quality and should therefore not contain the S-Area specific parameters at concentrations above the survey level.

The only segment of the study area which may not be consistent with expected chemical distribution patterns from the S-Area is the area west of the S-Area and north of the Robert Moses Parkway along the Industrial Intake Pipe Trench. In this segment, the chemical concentrations typically are elevated at the southwest corner of the Landfill (OW269) as expected, then decrease in a westerly direction to OW270 and then increase as one moves further west to OW273. It is possible that the chemicals observed to be present at OW270 and OW273 could be the result of groundwater flow in the backfill and bedding material of the Industrial Intake Pipe Trench. It is also possible that the fact that chemical concentrations do not decrease uniformly along the Trench may be partially attributable to the variation in pathways in the fill and alluvium along the Trench or the position of the two wells in relation to the Trench. Based upon the stratigraphy encountered at these two wells, it appears that the wells are located just outside of the Trench and therefore, the distance between the Trench and the well may be critical to the concentrations observed.

A more likely explanation for the presence of elevated concentrations of specific parameters at OW270 and OW273 is that these wells are downgradient of the N-Area and may be impacted by chemical discharges from other areas of the Plant. This would also account for the increasing chemical concentrations in a westerly direction which is inconsistent with APL migration from the S-Area. There is no historical chemical information available for the specific parameters in the vicinity of the southern N-Area (Historic Wells WS11 and WS12).

In any event, regardless of the source of the elevated chemicals noted in OW270 and OW273, the analytical data from OW268, OW271 and OW272 indicate that these chemicals are not migrating further south and therefore have not migrated to the Niagara River.

From a chemical perspective, the presence of ClBOA, MCB, TCB and TECB in the two wells south of the S-Area along the Niagara River (OW266 and OW267) and along the Industrial Intake Pipe Trench (OW270 and OW273) are not inconsistent with the physical properties of these parameters and their ability to migrate. The specific parameters which tend to stay attenuated on the soil (i.e. Mirex and C58) were not present in the groundwater at any well in the study area.

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The decreasing concentrations with distance from the S-Area of MCB, TCB, TECB and C46 are all consistent with their chemical properties and are the expected conditions. Table 3 presents a summary of each specific parameter's physical and chemical properties.

TABLE 3

PHYSICAL/CHEMICAL CONSTANTS FOR SELECTED ANALYTES

Compound	Formula	Molecular Weight	Boiling Point (°C)	Melting Point (°C)	Liquid Density (g/mL) @ °C	Solubility (ppb) @ °C	Kow @ 25°C	Koc @ 25°C
Chlorobenzoic Acids								
• 2-Chlorobenzoic Acid	C7H5O2Cl	157	[2]	142	NA	2,130,000	95	59
• 3-Chlorobenzoic Acid	C7H5O2CL	157	[2]	158	NA	385,000	479	295
Chlorobenzenes	C6H5Cl	113	132	-45.6	1.1058 @ 20°	488,000	692	380
Trichlorobenzenes	C6H3Cl	181	218.5	52.5	1.41 @ 53°	30,000	19,000	10,000
• 1,2,3-Trichlorobenzene	C6H3Cl	181	213	16.5	1.571 7 @ 20°	25,000	19,000	10,000
• 1,2,4-Trichlorobenzene	C6H3Cl	181	208	63.5	1.39 @ 64°	6,000	19,000	10,000
• 1,3,5-Trichlorobenzene								
Tetrachlorobenzenes		216	254	46.5	1.54 @ 47°	4,000	NA	69,180
• 1,2,3,4-Tetrachlorobenzene	C6H2Cl4	216	246	54.5	1.53 @ 55°	3,000	NA	69,180
• 1,2,3,5-Tetrachlorobenzene	C6H2Cl4	216	245	139	1.43 @ 140°	NA	NA	69,180
• 1,2,4,5-Tetrachlorobenzene	C6H2Cl4							
Hexachlorobenzene	C6Cl6	285	322 [2]	230	1.53 @ 230°	6.00	13,500	3,900
Hexachlorobutadiene	C4Cl6	261	215	-21	1.682 @ 20°	2,000	1,820	1,000
Octachlorocyclopentene	C5Cl8	344	283	41	1.82 @ 50°	NA	407,380	251,190
Mirex	C10Cl12	546	NA [3]	485	NA	NA	239,880	24,000,000
Hexachlorocyclohexanes								
alpha-BHC	C6H6Cl6	291		157	1.46 @ 157°	1,600	7,760	4,270
beta-BHC	C6H6Cl6	291		309	1.34 @ 309°	240	7,760	4,270
gamma-BHC	C6H6Cl6	291		112.9	1.53 @ 113°	7,500	7,760	4,270
delta-BHC	C6H6Cl6	291		138	1.52 @ 138°	31,400	7,760	4,270

(1) Reference: Reference Constants for Priority Pollutants and Selected Chemicals, Arthur D. Little, Inc., March 1981
(2) Sublimination Reported
(3) NA = Not Available

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7.0 NEED FOR ADDITIONAL DATA

Based upon the surveys completed, there are two areas in which additional data collection would be appropriate to better define the conditions that exist.

The first area recommended for additional information is in the vicinity of SP8. NAPL was identified to be present in the interval between 21.5 and 26 feet below grade overlying the till layer. In order to determine whether the NAPL identified at SP8 has reached the shoreline of the Niagara River, it is proposed that two additional borings be installed between SP8 and the Niagara River immediately adjacent to the shoreline.

The second area recommended for additional information is the plume of chemicals identified along the Industrial Intake Pipe Trench at OW270 and OW273. It is possible that the source of chemicals identified at these wells is the N-Area. To attempt to confirm the source of the chemicals identified, it is proposed that one additional well be installed as part of the Niagara Plant studies near former well WS11. Once installed, this well plus the overburden well already proposed for installation in the Niagara Plant Supplemental Data Collection Program near former well WS13 would be sampled for the S-Area survey parameters.

8.0 SUMMARY AND CONCLUSION

The results of the survey and assessments that have been completed concerning the migration of S-Area NAPL and survey parameters in the overburden toward the Niagara River are summarized in the following.

8.1 SUMMARY

APL

1) S-Area survey parameters are present in the overburden groundwater adjacent to the Niagara River in the vicinity of wells OW266 and OW267.

2) Based upon the southerly direction of groundwater flow through the area of OW266 and OW267, the data indicate that S-Area survey parameters are migrating via APL toward the Niagara River through the overburden. The flow of APL from the area of these wells toward the Niagara River is impeded to some degree by the sheet pile wall installed to support the Industrial Wharf.

3) The groundwater sampled to the east of 53rd Street is not downgradient of the S-Area and as expected, the wells in this area generally did not contain S-Area survey parameters. The one exception to this was the presence

of MCB at 14 ug/L at OW265 which is immediately adjacent to the southeast corner of the S-Area and is therefore not totally unexpected. The presence of low concentrations of TOX in these wells is not consistent with migration from the S-Area and is therefore assumed to be due to the fill used at the WTP or on the Robert Moses Parkway.

4) Groundwater flow at the western end of the study area is from the River to the overburden. Consequently, chemicals from the S-Area should not migrate via APL from the Site toward the River in this area.

5) The northwest corner of the study area near OW270 and OW273 exhibits elevated levels of specific parameters. The source of these chemicals could be either the N-Area or from S-Area groundwater flow which has been directed along the Industrial Intake Pipe Trench though the lack of a consistent groundwater gradient to the west along the Industrial Intake Pipe Trench between OW269 and OW273 makes the N-Area source theory appear more reasonable. In any event, the chemicals present in this northwest quadrant have not migrated into the Niagara River as demonstrated by the absence of APL in wells OW268, OW271 and OW272.

6) Additional information should be collected to better define the source of chemicals near OW270 and OW273.

NAPL

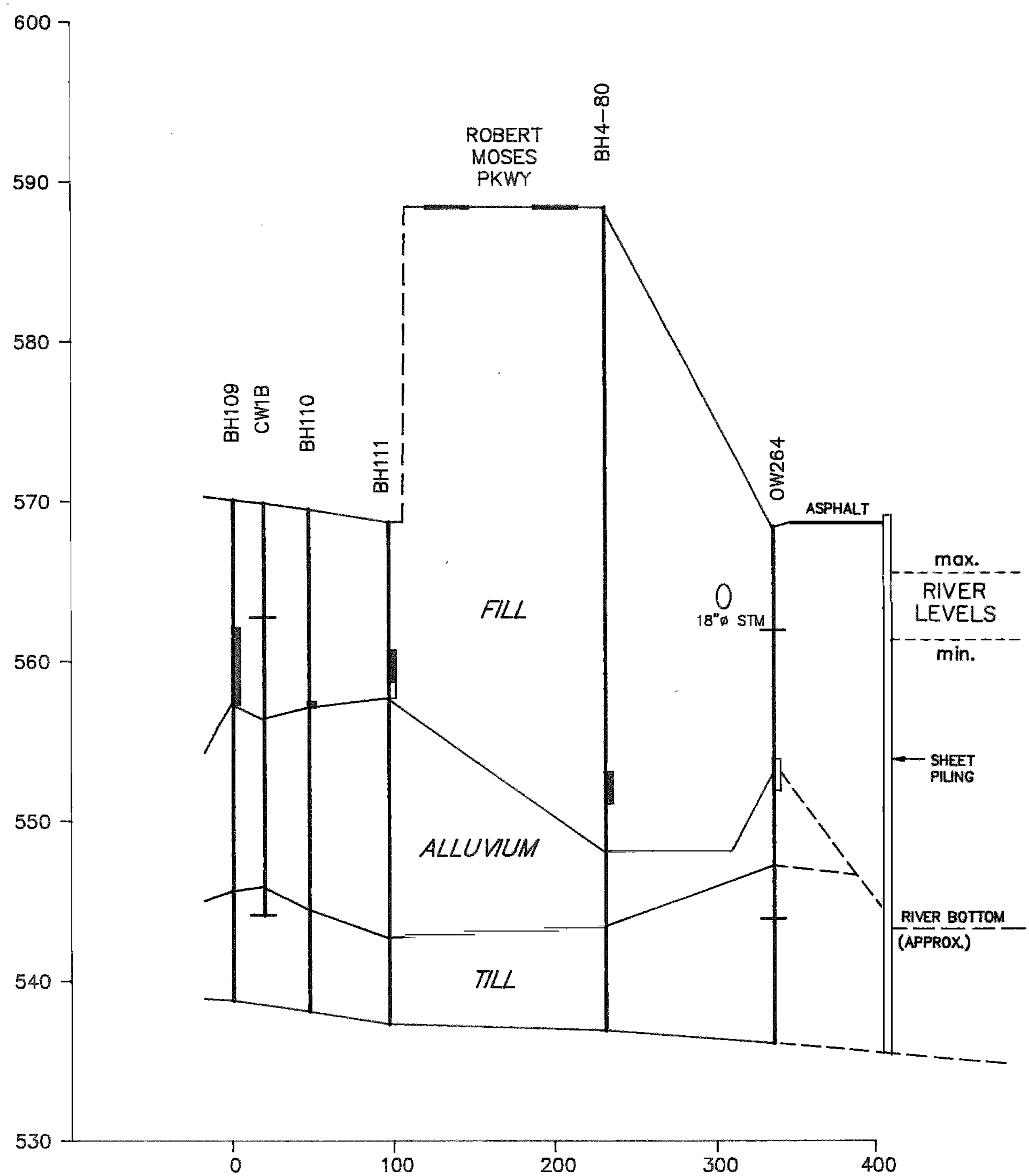
1) The migration of NAPL in the overburden is adequately defined by the survey completed with the exception of two areas:

   - South of SP8 - additional borings are proposed

   - In the northwest corner of the S-Area - additional borings are proposed in the report entitled, "Assessment of NAPL Migration Via Underground Utility Bedding"

8.2 CONCLUSION

Based upon the areal extent of APL and NAPL defined by the surveys, the data indicate that some APL and NAPL has migrated in the overburden toward the Niagara River into an area which is not addressed by the proposed S-Area Containment System.



LEGEND

MONITORING INTERVAL

SHEEN

NAPL

SCALE: 1"=10' VER.
1"=100' HOR.

ALL ELEVATIONS BASED ON
1986 OCC DATUM
(REF. DWG. A-11-19200)

figure 5

CROSS-SECTION C-C'
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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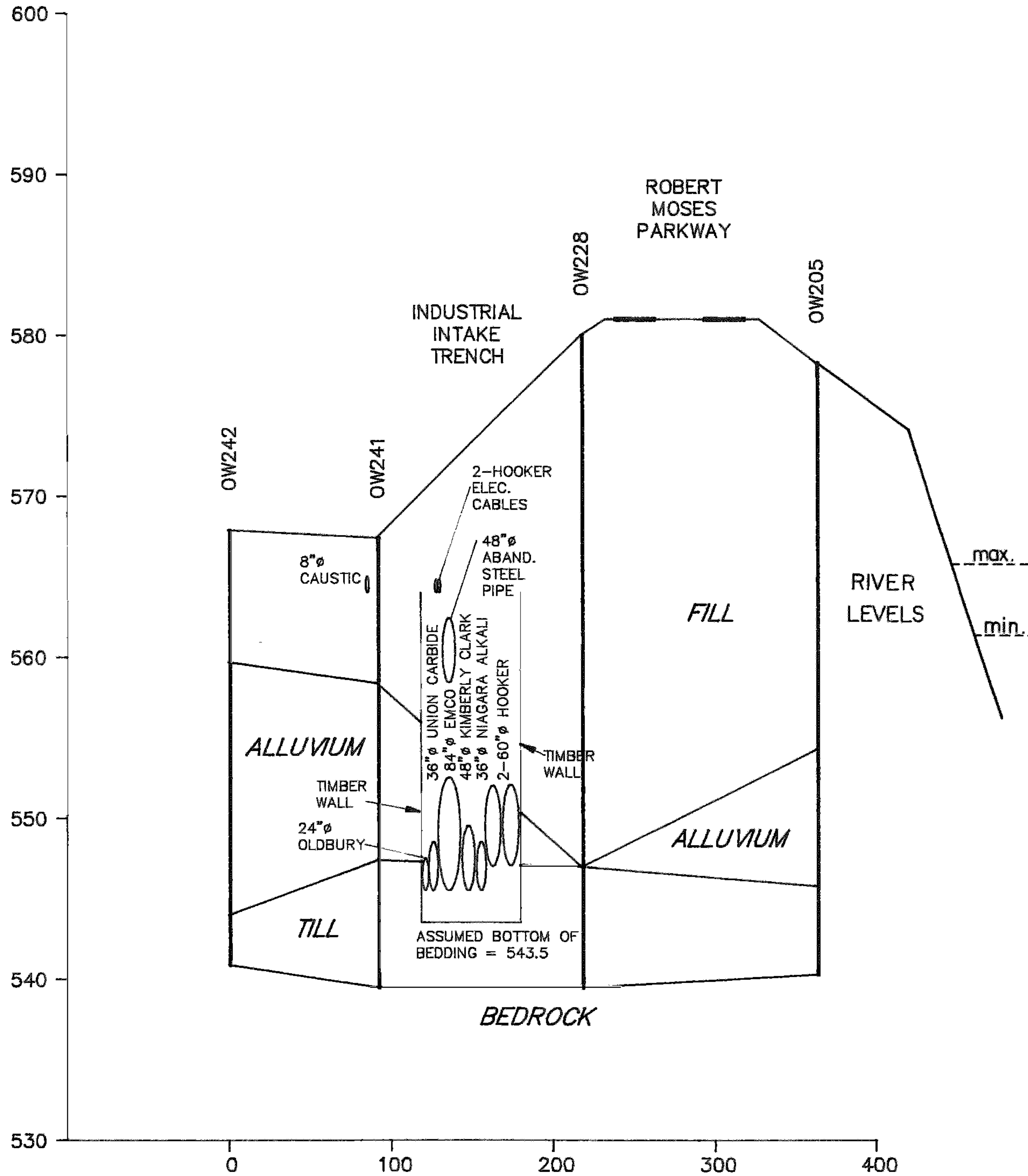


LEGEND

MONITORING INTERVAL

SHEEN

NAPL

SCALE: 1"=10' VER.
1"=100' HOR.

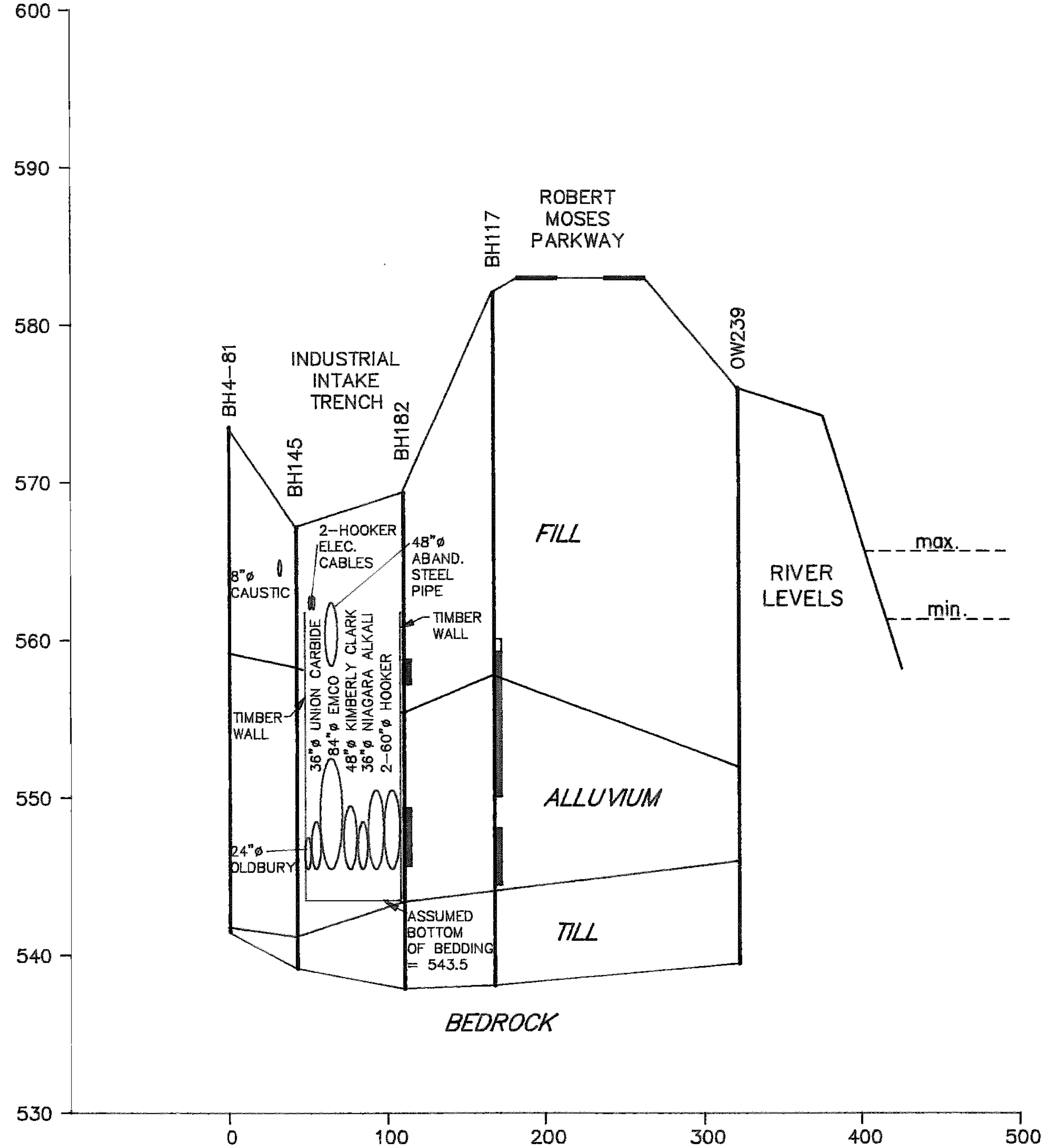
figure 8

CROSS-SECTION F-F'
S-AREA REMEDIAL CORPORATION
Occidental Chemical Corporation

ALL ELEVATIONS BASED ON
1986 OCC DATUM
(REF. DWG. A-11-19200)

CRA

1769-26/06/88-22-D-0(X-44)



LEGEND

MONITORING INTERVAL

SHEEN

NAPL

SCALE: 1"=10' VER.
1"=100' HOR.

ALL ELEVATIONS BASED ON
1986 OCC DATUM
(REF. DWG. A-11-19200)

CRA

figure 7

CROSS-SECTION E-E'
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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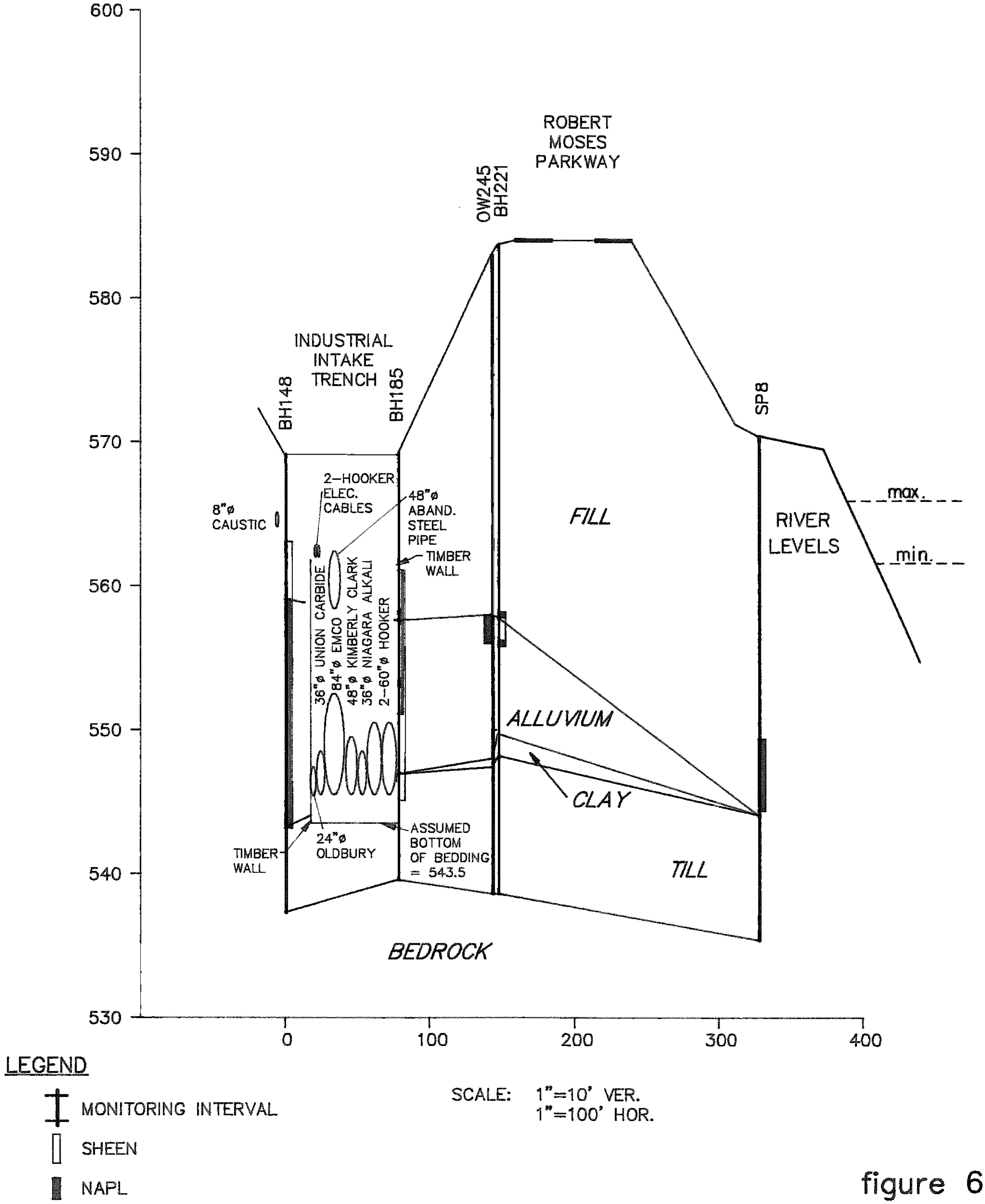

figure 6

CROSS-SECTION D-D'
S-AREA REMEDIAL CORPORATION
Occidental Chemical Corporation

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1769-26/06/88-22-D-0(X-46)

River Intake structure. Due to the dewatering effect of the Conduits in the overburden behind the River Intakes, localized groundwater flow conditions around the wall are observed at the eastern end of the Intake structure and consequently groundwater in this area flows from the River around the Intake Structure and toward the Conduits. It is to be noted that the influence of the conduits/intakes does not impact groundwater flow in the immediate vicinity of the S-Area.

The Industrial Intakes and the timber walls remaining in place around the Industrial Intake Pipe Trench are not expected to interfere with the southerly flow and discharge of overburden groundwater to the Niagara River. It is expected that the timber walls are porous enough that groundwater flow will continue through the wall.

5.2 CHEMISTRY

In April/May 1988, OCC collected groundwater samples from the fourteen overburden groundwater survey wells. The well installation, development and sampling were conducted in accordance with the protocols specified and details of these programs are further described in the "Information Summary Report". The analytical results from this sampling event are presented in Table 2 and summarized