CITY OF NIAGARA FALLS
DRINKING WATER TREATMENT PLANT

• ASSESSMENT OF OVERBURDEN CHEMICAL MIGRATION TO THE WATER TREATMENT PLANT

S-Area Remedial Program

June 1988
Ref. No. 1769

CONESTOGA-ROVERS & ASSOCIATES

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1.0 INTRODUCTION

This report presents the results of soil and groundwater surveys at the City of Niagara Falls Drinking Water Treatment Plant (WTP) and assesses the areal extent to which soil and groundwater in the overburden adjacent to the Filtration Plant/Reservoir Collection System contain chemicals, if any, which have migrated from the S-Area Landfill in excess of the Treatment Plant Survey Levels. These surveys and assessments are submitted in satisfaction of the requirements of sub-paragraph E(3)(d) of Addendum I of the S-Area Stipulation and Judgment Approving Settlement Agreement, No. 79-988 (Settlement Agreement).

Figure 1 locates the Filtration Plant/ Reservoir at the WTP.

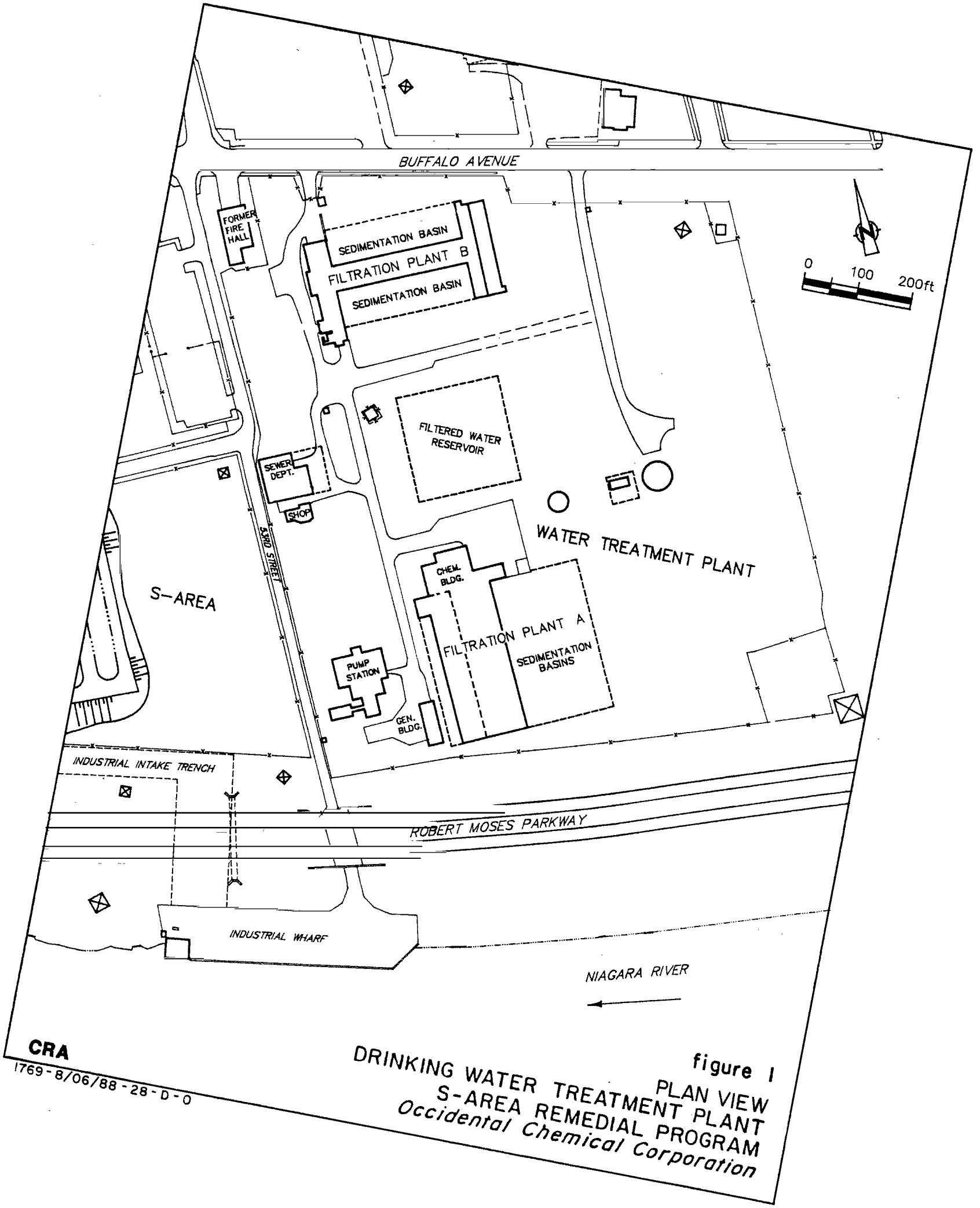

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figure 1

DRINKING WATER TREATMENT PLANT
PLAN VIEW
S-AREA REMEDIAL PROGRAM
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2.0 WTP HYDROGEOLOGY

Pertinent reports containing background data regarding the environmental data base and hydrogeology at the WTP include the following reports submitted June 1, 1988:

1) "City of Niagara Falls Drinking Water Treatment Plant Mapping and Assessment of Groundwater Table Contours, S-Area Remedial Program" (hereinafter "Groundwater Table Report");

2) "City of Niagara Falls Drinking Water Treatment Plant Pump Station ° Hydrogeologic and Environmental Conditions ° Collection System Design Considerations, S-Area Remedial Program" (hereinafter "Pump Station Report");

3) "Information Summary Report, S-Area Remedial Program," (hereinafter "Information Summary Report").

The hydrogeology of the overburden in the vicinity of the WTP and the S-Area has been characterized through investigations which have been conducted over the past 74 years. The most recent investigation, the S-Area Survey (1986-1988), included the installation of 21 overburden wells at the WTP. Figure 2 illustrates the locations of the various wells and boreholes installed at the WTP.

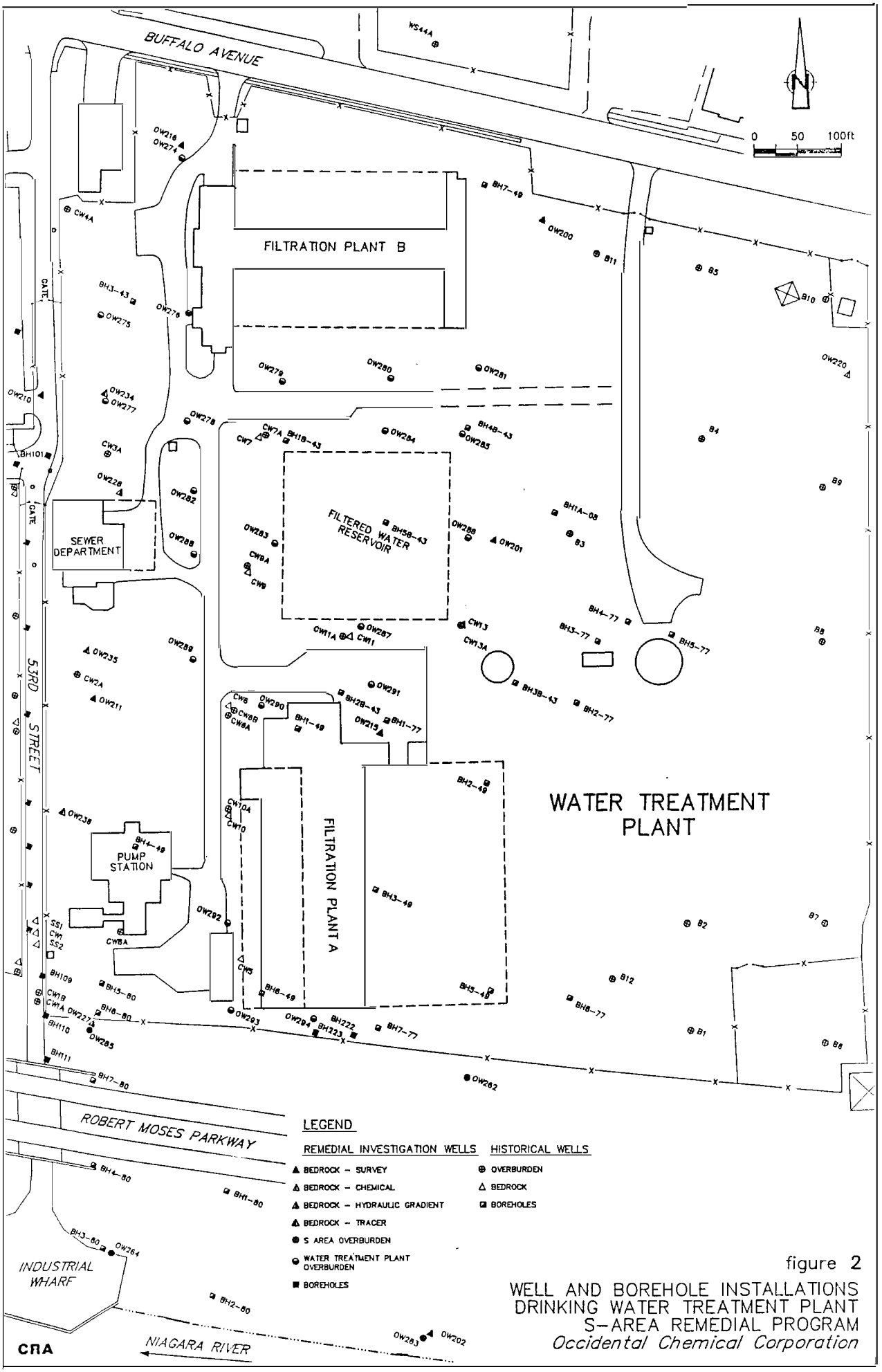

figure 2

WELL AND BOREHOLE INSTALLATIONS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
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The data obtained during the S-Area Survey and the historic data is summarized in the "Information Summary Report". This report includes a general discussion of both regional and local hydrogeology of the S-Area, WTP and vicinity.

The "Groundwater Table Report" details the character of the overburden within the boundaries of the WTP. The following presents a summary of the overburden characterization presented in the "Groundwater Table Report".

2.1 SITE GEOLOGY

The overburden at the WTP is comprised of four main stratigraphic layers which overlay each other in descending order:

Fill - silty, sandy, gravelly soils, cinders, slag and construction type rubble including bricks, wood and concrete,
- thickness varies from two feet to 30 feet.

Native Alluvial River Deposits
(Alluvium) - silty sand with gravel, clay and cobbles,
- thickness varies from 0 to 14 feet.

Native Glaciolacustrine Clay

(Clay) - silty clay with traces of fine sand and fine gravel,

- thickness varies from 0 to 25 feet.

Native Glacial Till

(Till) - sandy silt, with clay and fine gravel,

- thickness varies from 0 to four feet.

The depth to bedrock in the area of the WTP varies from 26.0 feet to 37.5 feet below ground surface.

2.2 SITE HYDROGEOLOGY

Because of permeability and therefore waterbearing characteristics, the overburden can be described as being composed of two hydrogeologic units. The uppermost unit comprises the fill and alluvium layers which are fairly permeable and act as an unconfined aquifer. Underlying this waterbearing strata is the second unit which is a low permeable layer of clay and till acting as an aquitard. This aquitard maintains the vertical separation between the alluvium/fill waterbearing stratum and the next lower waterbearing stratum which is present in the upper fractured bedrock formation of the Lockport Group.

The two overburden hydrogeologic units exhibit the following characteristics:

fill/alluvium water bearing zone:

- the hydraulic gradient is southward with discharge to the Niagara River,
- a vertical downward gradient exists,
- recharge sources include: infiltration, upgradient overburden, surface drainage, leakage from WTP facilities,
- moderate to highly permeable.

clay/till layer:

- the hydraulic conductivity of clay is approximately 1×10^{-8} cm/sec,
- the hydraulic conductivity of till is less than 1×10^{-7} cm/sec,
- the horizontal and vertical groundwater flow is minimal, i.e. confining layer.

2.3 POTENTIOMETRIC SURFACE ASSESSMENT

The groundwater contours in the unconfined aquifer at the WTP are shown on Figure 3, which is based upon groundwater surface elevations measured on April 18, 1988. A discussion of the groundwater conditions at the WTP was

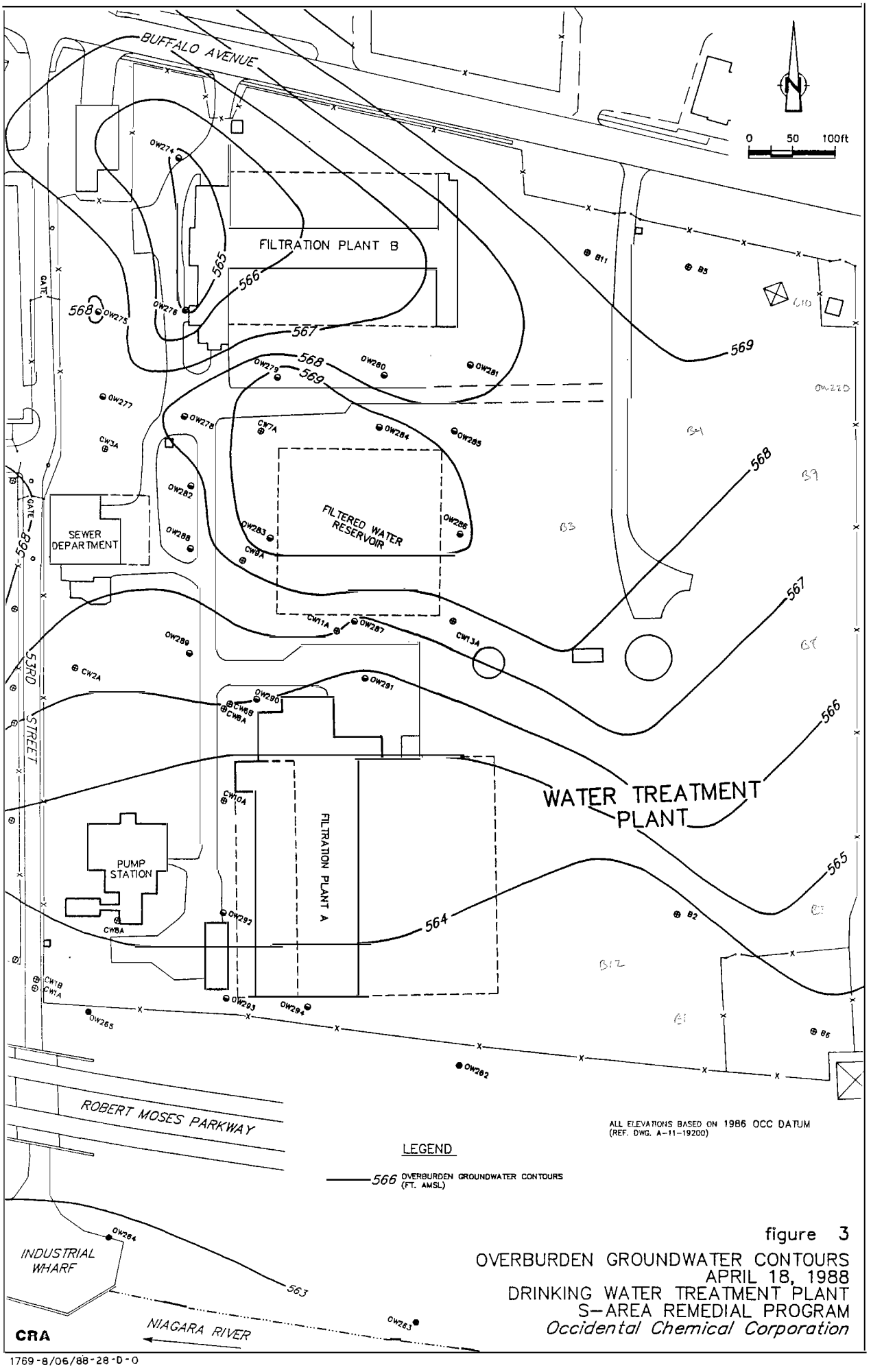

figure 3

OVERBURDEN GROUNDWATER CONTOURS
APRIL 18, 1988
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-8/06/88-28-D-0

presented in the "Groundwater Table Report" and is summarized as follows:

i) The overall groundwater flow in the overburden at the S-Area and WTP is southward toward the Niagara River.

ii) The horizontal gradient in the overburden ranges from 0.005 to 0.011 and the vertical gradient ranges from 0.099 to 0.393 downward towards the bedrock.

iii) A mound exists in the area of the Reservoir and is most likely due to leakage from the Reservoir.

iv) A small mound exists approximately 100 feet west of Plant B in the area of well OW275. The mound may exist due to the local influence of the underground watermains and/or sewers in the area, or due to the combination of increased infiltration through the gravel ground surface and poor surface drainage.

v) A sink exists in the area immediately west of Plant B, probably due to the influence of the sewer and/or sewer bedding running north-south.

vi) The lower floor elevations of the filtration basins of Plant B, the Reservoir, the water reservoir of Plant A,

the Pump Station, and 80 percent of the underground utilities at the WTP are below the water table.

2.4 STRUCTURAL FACTORS IMPACTING HYDROGEOLOGY

The location of underground utilities, water transmission pipes and structures in relation to the water table and the geologic units, primarily the clay formation, can affect chemical migration patterns. As presented in the "Groundwater Table Report", it is believed that most pipes, utilities, etc., are partially or totally installed below the water table. The "Groundwater Table Report" discusses in further detail the relationship of the underground piping system at the WTP with the local hydrogeologic conditions.

3.0 CHEMICAL PRESENCE AND MIGRATION IN THE OVERBURDEN

3.1 SOIL SURVEY

The survey to investigate chemicals in soil included the installation of 21 overburden survey wells, OW274 to OW294, at the WTP. In conjunction with the installation of each survey well a borehole was drilled, numbered BHW274 through BHW294, and a composite sample of the overburden soils from the top of the water table to the top of the clay, or to the top of the till where no clay was identified, was collected using split spoon sampling techniques. BHW293 and BHW294 were sampled to the top of the till. The composite soil samples were analyzed for the presence of the S-Area general and specific parameters. The parameters and respective soil survey levels are presented in Table 1. Table 2 presents the soil sample analytical results from the S-Area Remedial Program. Table 3 presents historical soil analytical data.

Figures 5 through 15 illustrate the distribution of each soils survey parameter in the overburden at the WTP.

In reviewing the soil survey data, it is important to evaluate the pathways by which the migration

TABLE 1

SOIL AND GROUNDWATER PARAMETERS

WTP SOIL SURVEY LEVELS

	Soil Survey Level
General Parameters	
Total Organic Carbon (TOC)	20 mg/kg
Total Organic Halogen (TOX)	0.1 mg/kg
Specific Parameters	
Monochlorobenzoic Acids (ClBOA)	1000 ug/kg
Monochlorobenzene (MCB)	10 ug/kg
Trichlorobenzenes (TCB)	100 ug/kg
Tetrachlorobenzenes (TECB)	100 ug/kg
Hexachlorobenzene (HCB)	100 ug/kg
Hexachlorobutadiene (C46)	100 ug/kg
Octachlorocyclopentene (C58)	100 ug/kg
Hexachlorocyclohexanes (BHC)	100 ug/kg
Perchloropentacyclodecane (Mirex)	100 ug/kg

WTP GROUNDWATER SURVEY LEVELS

	Groundwater Survey Level
General Parameters	
pH	Less than 4.5 or greater than 9.5 units
Conductivity (Cond.)	10 times background level (umhos/cm)
Total Organic Carbon (TOC)	20 mg/L
Total Organic Halogen (TOX)	0.1 mg/L
Specific Parameters	
Monochlorobenzoic Acids (ClBOA)	0.5 mg/L
Monochlorobenzene (MCB)	10 ug/L
Trichlorobenzenes (TCB)	10 ug/L
Tetrachlorobenzenes (TECB)	10 ug/L
Hexachlorobenzene (HCB)	10 ug/L
Hexachlorobutadiene (C46)	10 ug/L
Octachlorocyclopentene (C58)	10 ug/L
Hexachlorocyclohexanes (BHC)	10 ug/L
Perchloropentacyclodecane (Mirex)	10 ug/L

TABLE 2

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

| ND - Not Detected above survey level |

S AREA
WATER TREATMENT PLANT SOIL ANALYSIS

Special Codes: D - FIELD DUPLICATE

			Sample Date:-------->	07/14/87	07/14/87	05/13/87	07/14/87	07/14/87	06/01/87	05/12/87	05/13/87
			Sample Description:->	BH 277 FDUP	BH 277 2' - 10'	BH 286 4' -8'	BH 291 FDUP	BH 291 2'- 18.4	OW 284 6' -8'	BHR 279 4' -8'	BHR 280 4' -8'
			Special Code:------->	D			D				
Analytes:	Units:	Survey Levels:									
TOTAL ORGANIC CARBON (TOC)	mg/Kg	20		ND	ND	ND	ND	ND	ND	ND	ND
TOTAL ORGANIC HALIDES (TOX)	mg/Kg	0.1		ND	ND	0.2	5.2	1.8	ND	ND	ND
CHLOROBENZOIC ACIDS, TOTAL	ug/Kg	1000		ND	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZENE	ug/Kg	10		ND	ND	ND	320	240	ND	ND	ND
TRICHLOROBENZENE, TOTAL	ug/Kg	100		ND	ND	201	1970	1750	ND	ND	ND
TETRACHLOROBENZENES, TOTAL	ug/Kg	100		ND	ND	580	3180	2670	ND	ND	ND
HEXACHLOROBENZENE	ug/Kg	100		ND	ND	1700	4000	3800	ND	ND	410
HEXACHLOROBUTADIENE	ug/Kg	100		ND	ND	ND	ND	ND	ND	ND	ND
OCTACHLOROCYCLOPENTENE	ug/Kg	100		ND	ND	ND	4500	4200	ND	ND	ND
HEXACHLOROCYCLOHEXANE (BHC) TOTAL	ug/Kg	100		ND	ND	267	2880	2610	ND	ND	ND
PERCHLOROPENTACYCLODECANE (MIREX)	ug/Kg	100		ND	ND	ND	1300	1500	ND	ND	ND

TABLE 2

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

S AREA
WATER TREATMENT PLANT SOIL ANALYSIS

| ND - Not Detected above survey level |

Special Codes: D - FIELD DUPLICATE

Analytes:	Units:	Survey Levels:	Sample Date:-------->	05/12/87	05/01/87	06/09/87	05/15/87	06/11/87	05/07/87	06/03/87	05/11/87
			Sample Description:->	BHR 282 4' -10'	BHW 274 2' -8'	BHW 275 6' -8'	BHW 276 4' -8'	BHW 277 2.5' -5.2	BHW 281 4' -8'	BHW 283 6' -14'	BHW 285 RRUN
			Special Code:------->								
TOTAL ORGANIC CARBON (TOC)	mg/Kg	20		ND	ND	ND	ND	ND	ND	ND	
TOTAL ORGANIC HALIDES (TOX)	mg/Kg	0.1		ND	0.4	0.2	ND	ND	ND	0.1	
CHLOROBENZOIC ACIDS, TOTAL	ug/Kg	1000		ND	ND	ND	ND	ND	ND	96000	
CHLOROBENZENE	ug/Kg	10		ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROBENZENE, TOTAL	ug/Kg	100		ND	ND	ND	ND	ND	ND	215	ND
TETRACHLOROBENZENES, TOTAL	ug/Kg	100		ND	ND	ND	ND	ND	ND	124	ND
HEXACHLOROBENZENE	ug/Kg	100		2000	ND	ND	ND	ND	ND	449	ND
HEXACHLOROBUTADIENE	ug/Kg	100		ND	ND	ND	ND	ND	ND	ND	ND
OCTACHLOROCYCLOPENTENE	ug/Kg	100		ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOHEXANE (BHC) TOTAL	ug/Kg	100		ND	ND	ND	ND	ND	ND	ND	ND
PERCHLOROPENTACYCLODECANE (MIREX)	ug/Kg	100		ND	ND	ND	ND	ND	ND	ND	ND

TABLE 2

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

S AREA
WATER TREATMENT PLANT SOIL ANALYSIS

| ND - Not Detected above survey level |

Special Codes: D - FIELD DUPLICATE

Analytes:	Units:	Survey Levels:	Sample Date:-------->	05/11/87	06/05/87	05/08/87	05/08/87	05/15/87	06/15/87	06/18/87	05/18/87
			Sample Description:->	BHW 285 4' -8'	BHW 287 6'- 20.8	BHW 288 RRUN	BHW 288 6' -14'	BHW 289 7' -18'	BHW 290 8' -20'	BHW 291 2'- 19.8	BHW 292 14' -34'
			Special Code:------->								
TOTAL ORGANIC CARBON (TOC)	mg/Kg	20		ND	59		ND	ND	47	ND	ND
TOTAL ORGANIC HALIDES (TOX)	mg/Kg	0.1		ND	0.3		ND	ND	0.1	0.2	ND
CHLOROBENZOIC ACIDS, TOTAL	ug/Kg	1000		ND	ND		ND	ND	ND	ND	ND
CHLOROBENZENE	ug/Kg	10		24	39	12	14	170	132	33	ND
TRICHLOROBENZENE, TOTAL	ug/Kg	100		ND	ND	106	ND	ND	168	1400	ND
TETRACHLOROBENZENES, TOTAL	ug/Kg	100		ND	ND	ND	156	ND	156	1190	ND
HEXACHLOROBENZENE	ug/Kg	100		128	1000	ND	125	ND	177	463	140
HEXACHLOROBUTADIENE	ug/Kg	100		ND	ND	ND	ND	ND	ND	ND	ND
OCTACHLOROCYCLOPENTENE	ug/Kg	100		ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOHEXANE (BHC) TOTAL	ug/Kg	100		ND	ND	ND	ND	189	ND	ND	ND
PERCHLOROPENTACYCLODECANE (MIREX)	ug/Kg	100		ND	ND	ND	ND	ND	ND	ND	ND

TABLE 2

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

S AREA
WATER TREATMENT PLANT SOIL ANALYSIS

| ND - Not Detected above survey level |

Special Codes: D - FIELD DUPLICATE

Analytes:	Units:	Survey Levels:	Sample Date:-------->	05/19/87	05/27/87	05/28/87	05/08/87	05/08/87
			Sample Description:->	BHW 293 9' -34'	BHW 294 12' -30'	BHW 294 30' -32'	BHWR 278 RRUN	BHWR 278 6' -12'
			Special Code:------->					
TOTAL ORGANIC CARBON (TOC)	mg/Kg	20		ND	46	ND		ND
TOTAL ORGANIC HALIDES (TOX)	mg/Kg	0.1		ND	25	0.1		ND
CHLOROBENZOIC ACIDS, TOTAL	ug/Kg	1000		ND	ND	ND		ND
CHLOROBENZENE	ug/Kg	10		12	18	ND	ND	ND
TRICHLOROBENZENE, TOTAL	ug/Kg	100		135	333	ND		ND
TETRACHLOROBENZENES, TOTAL	ug/Kg	100		219	5360	158		ND
HEXACHLOROBENZENE	ug/Kg	100		606	8450	267		ND
HEXACHLOROBUTADIENE	ug/Kg	100		ND	ND	ND		ND
OCTACHLOROCYCLOPENTENE	ug/Kg	100		ND	971	ND		ND
HEXACHLOROCYCLOHEXANE (BHC) TOTAL	ug/Kg	100		ND	13200	291		ND
PERCHLOROPENTACYCLODECANE (MIREX)	ug/Kg	100		ND	633	ND		ND

TABLE 3

HISTORICAL SOILS DATA (1979) - WTP

	WS 16A	WS 17A	WS 18A	WS 46A
GENERAL PARAMETERS				
Total Organic Carbon (TOC)	NT	NT	NT	NT
Total Organic Halogen (TOX)	NT	NT	NT	NT
SPECIFIC PARAMETERS				
Monochlorobenzoic Acid	NT	NT	NT	NT
Monochlorobenzene (mg/kg)	BSL	0.6	2.5	BSL
Trichlorobenzenes (mg/kg)	BSL	100	130	62
Tetrachlorobenzenes (mg/kg)	0.3	240	600	210
Hexachlorobenzene	NT	NT	NT	NT
Hexachlorobutadiene	NT	NT	NT	NT
Octachlorocyclopentene	NT	NT	NT	NT
Hexachlorocyclohexanes	NT	NT	NT	NT
Perchloropentacyclodecane (Mirex)	NT	NT	NT	NT

NT - Not Tested
BSL - Below Survey Level

of chemicals from the S-Area to the WTP soils may occur through the overburden. One pathway would be via groundwater flow, whereby chemicals are taken into solution in the S-Area landfill (or in an area containing S-Area NAPL as exhibited along 53rd Street), transported onto the WTP property and absorbed onto the soil particles at the WTP. The primary flowpath of the groundwater through and beneath the S-Area landfill is southerly toward the River and not toward the WTP to the east. Data indicates however, that there is a localized easterly component of groundwater flow from the northeast corner of S-Area. As can be seen on Figure 3, this component of flow is then diverted into a southerly direction within close proximity to 53rd Street and therefore does not flow extensively onto the WTP property.

A second pathway could be the flow of non-aqueous phase liquid (NAPL) from the S-Area landfill over the clay surface below the ground surface. Figure 4 presents the top of clay contours at the WTP. Except to the extent that underground installations may intercept flow, NAPL might migrate over the clay surface to the Filtration Plant/Reservoir.

In general, groundwater pathways by which chemicals migrate through the overburden from a source such as the S-Area landfill exhibit a decreasing concentration trend with distance from the source. It is recognized that

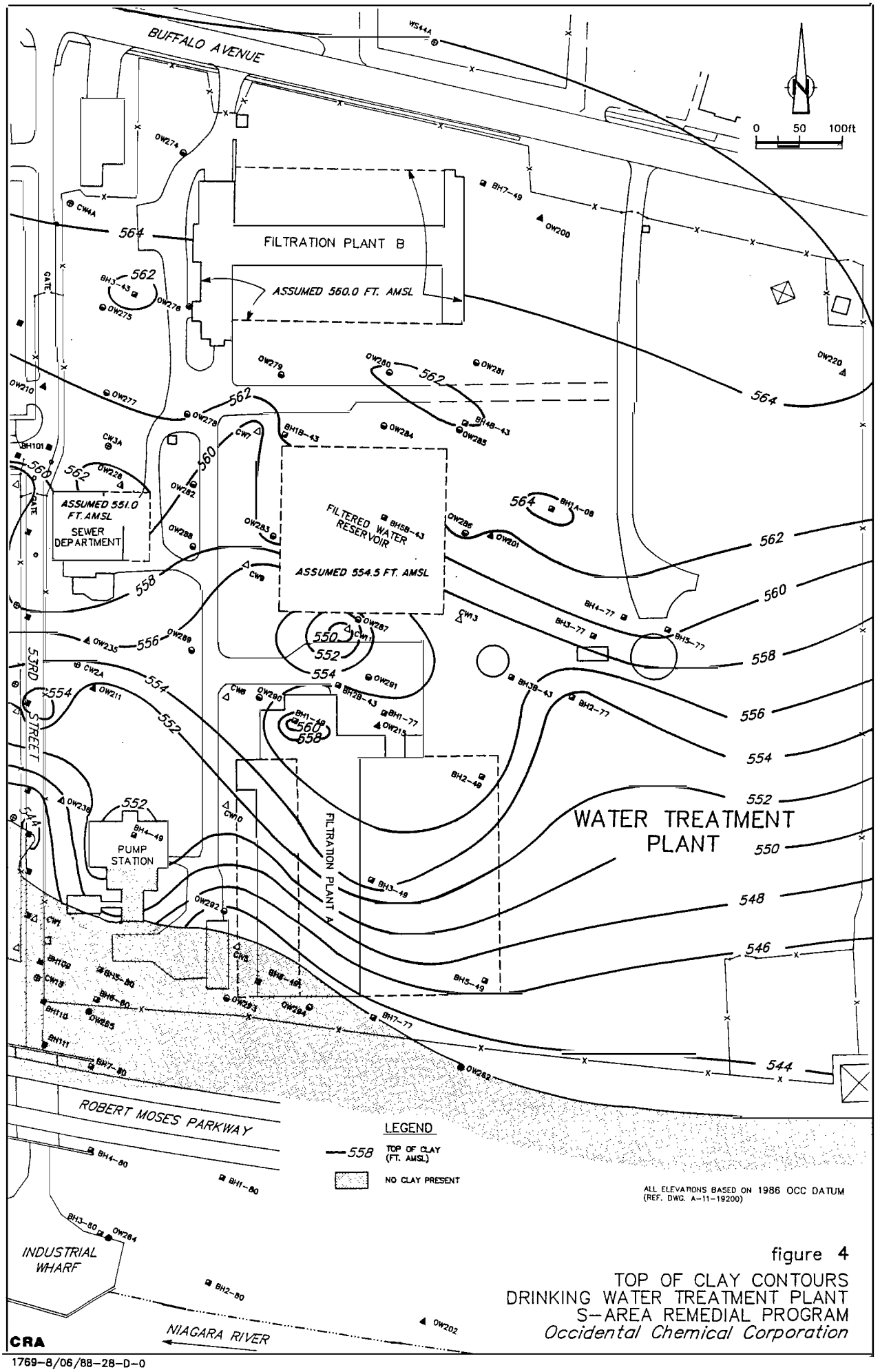

figure 4

TOP OF CLAY CONTOURS
DRINKING WATER TREATMENT PLANT
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the chemical pathways followed may somewhat mask the concentration distributions observed from soil samples collected at point locations, but the general trend is still expected to be prevalent.

With these factors in mind, the chemical distribution patterns for each soil survey parameter will be reviewed individually in the following subsections.

Total Organic Carbon (TOC) - Figure 5

Concentrations of the general parameter TOC exceeded the soil survey level of 20 mg/kg in three of the 21 soil samples analyzed. These exceedances were at OW287 (59 mg/kg) and OW290 (47 mg/kg) located between the Filtered Water Reservoir and Plant A, and at OW294 (46 mg/kg) located south of Plant A. TOC did not exceed the soil survey level in any of the other 18 soil samples collected at the WTP. These results are not consistent with concentration patterns that would be expected if the source of TOC was from the S-Area because all of the samples collected between the three identified TOC exceedances and the S-Area were below the survey level. This includes samples collected at OW282, OW288, OW289, OW292 and OW293.

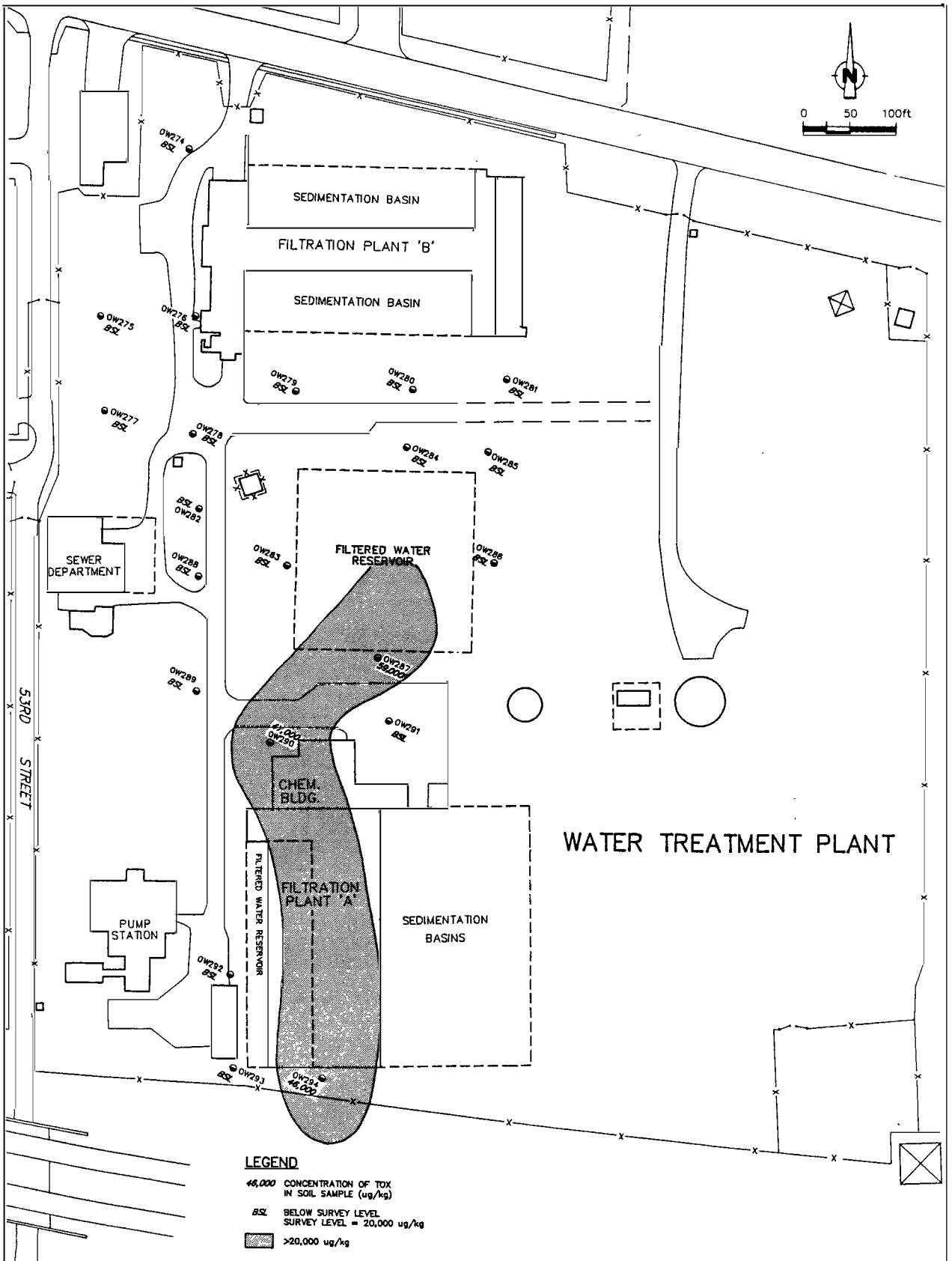

figure 5

OVERBURDEN SOIL CONCENTRATIONS
TOTAL ORGANIC CARBON (TOC) RESULTS
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Total Organic Halogen (TOX) - Figure 6

Concentrations of the general parameter TOX exceeded the survey level of 0.1 mg/kg in six of the soil samples collected. At two other locations, the survey level was equaled. The highest concentration measured was collected at OW294 (25 mg/kg) on the south side of Plant A with the second highest concentration (5.2 mg/kg) found at OW291 on the north side of Plant A. Between these locations and the S-Area, there is a line of non-detect samples at wells OW278, OW282, OW288, OW289, OW292 and OW293. These results indicate that the S-Area landfill is not the source of these observed TOX results. Similarly, in the northwest corner of the WTP, OW274 and OW275 identified trace TOX concentrations (0.4 and 0.2 mg/kg respectively) which are not within the migratory pathways from the S-Area.

Monochlorobenzoic Acids (ClBOA) - Figure 7

ClBOA was identified to be present in excess of the survey level at only one location in the soil at the WTP. This occurred at OW283 at a concentration of 96,000 ug/kg. Sampling of OW278, OW282, OW288 and OW289, which are directly between OW283 and the S-Area Landfill, did not detect the presence of ClBOA. Thus, the isolated nature of this observation of ClBOA presence is clearly indicative of a chemical that has not migrated from the S-Area.

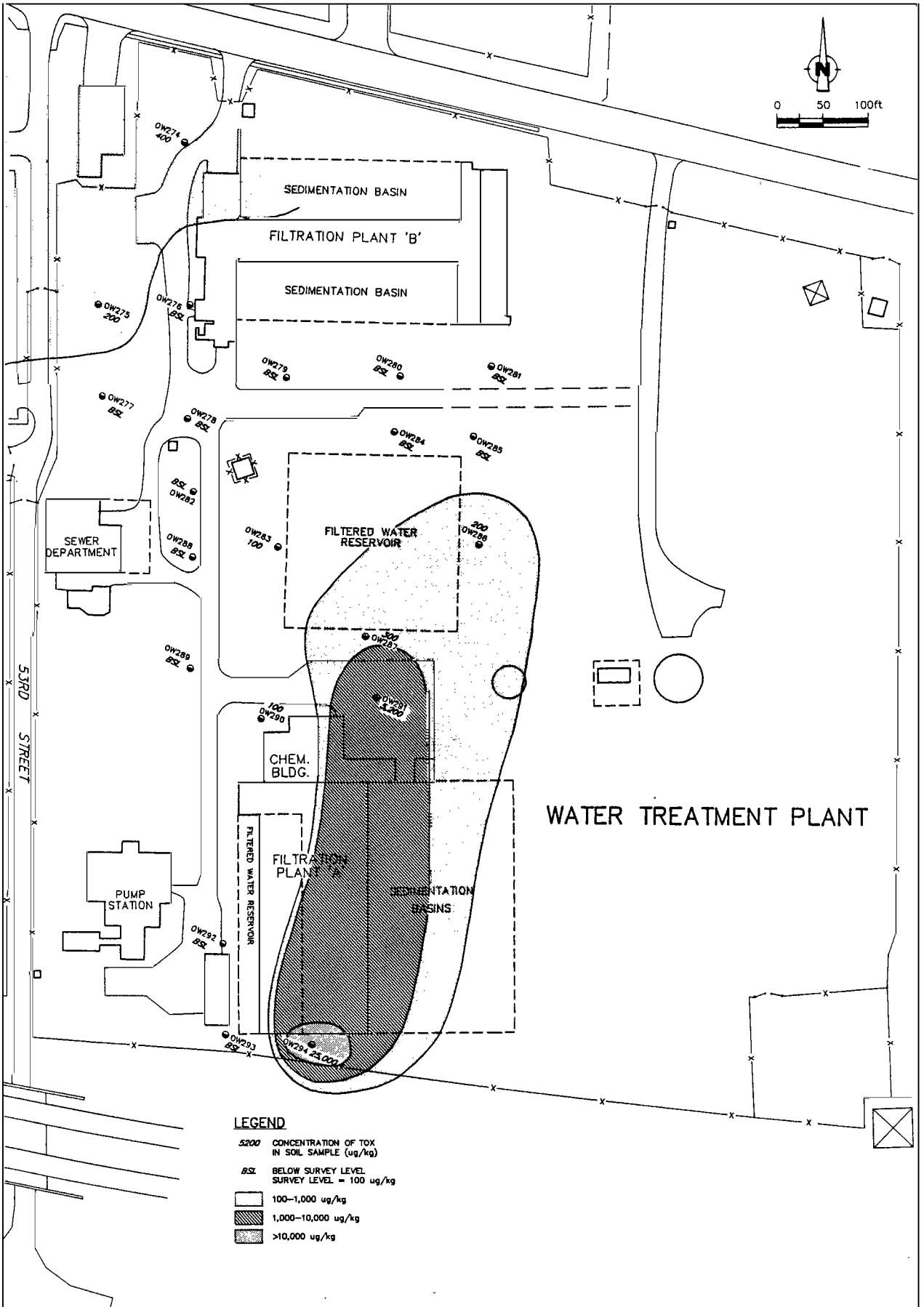

figure 6

OVERBURDEN SOIL CONCENTRATIONS
TOTAL ORGANIC HALOGEN (TOX) RESULTS
S–AREA REMEDIAL PROGRAM
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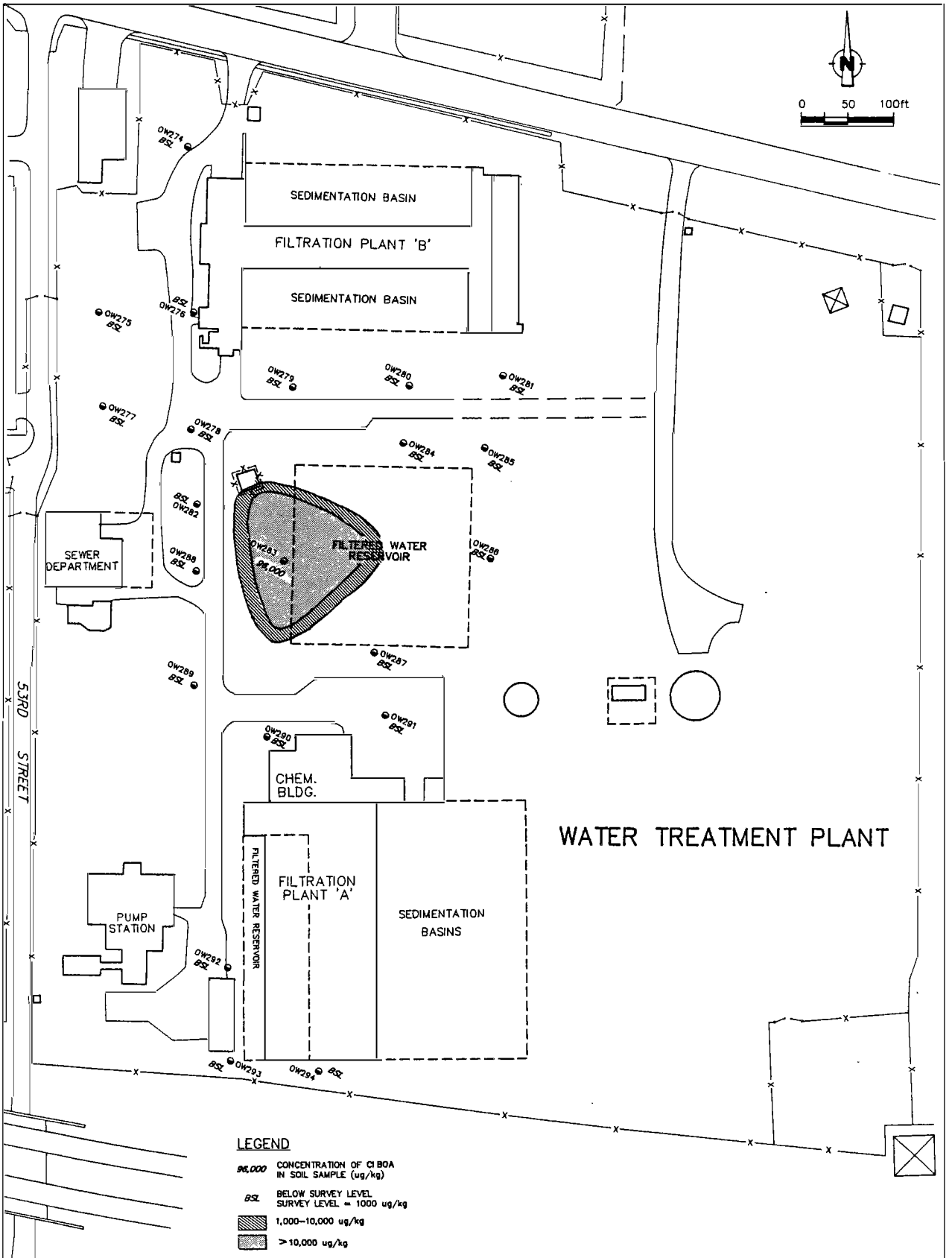

figure 7

OVERBURDEN SOIL CONCENTRATIONS
MONOCHLOROBENZOIC ACIDS (CIBOA) RESULTS
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Monochlorobenzene (MCB) - Figure 8

MCB above a survey level of 10 ug/kg has been detected at locations over much of the southern half of the WTP. The MCB data from the S-Area Survey indicate concentrations as high as 320 ug/kg on the WTP property (at OW291). By comparison, concentrations obtained from historical soil data (1981) collected along the eastern property line indicate MCB concentrations as high as 2500 ug/kg at WS18. The historic data was presented in a 1981 sampling report, "Chemical Analysis of S-Area Soil Samples", by Arthur D. Little Inc. Although the historic samples were not analyzed for each S-Area survey parameter and the data was not subjected to the same QA/QC procedures as the S-Area Survey data, it still provides a useful tool for comparison and data interpretation. Table 3 presents a list of the historic data. The data indicates the presence of elevated concentrations along the S-Area landfill, and a drop in concentrations to levels of 14, 170 and 132 ug/kg at wells OW288, OW289 and OW290 before rising to the concentration of 320 ug/kg observed at OW291. This result is not readily explained by the available migration pathways from S-Area through the overburden where a decreasing trend from S-Area is expected.

The observed presence of MCB at OW285 is also inconsistent with migration from S-Area since both surrounding soil

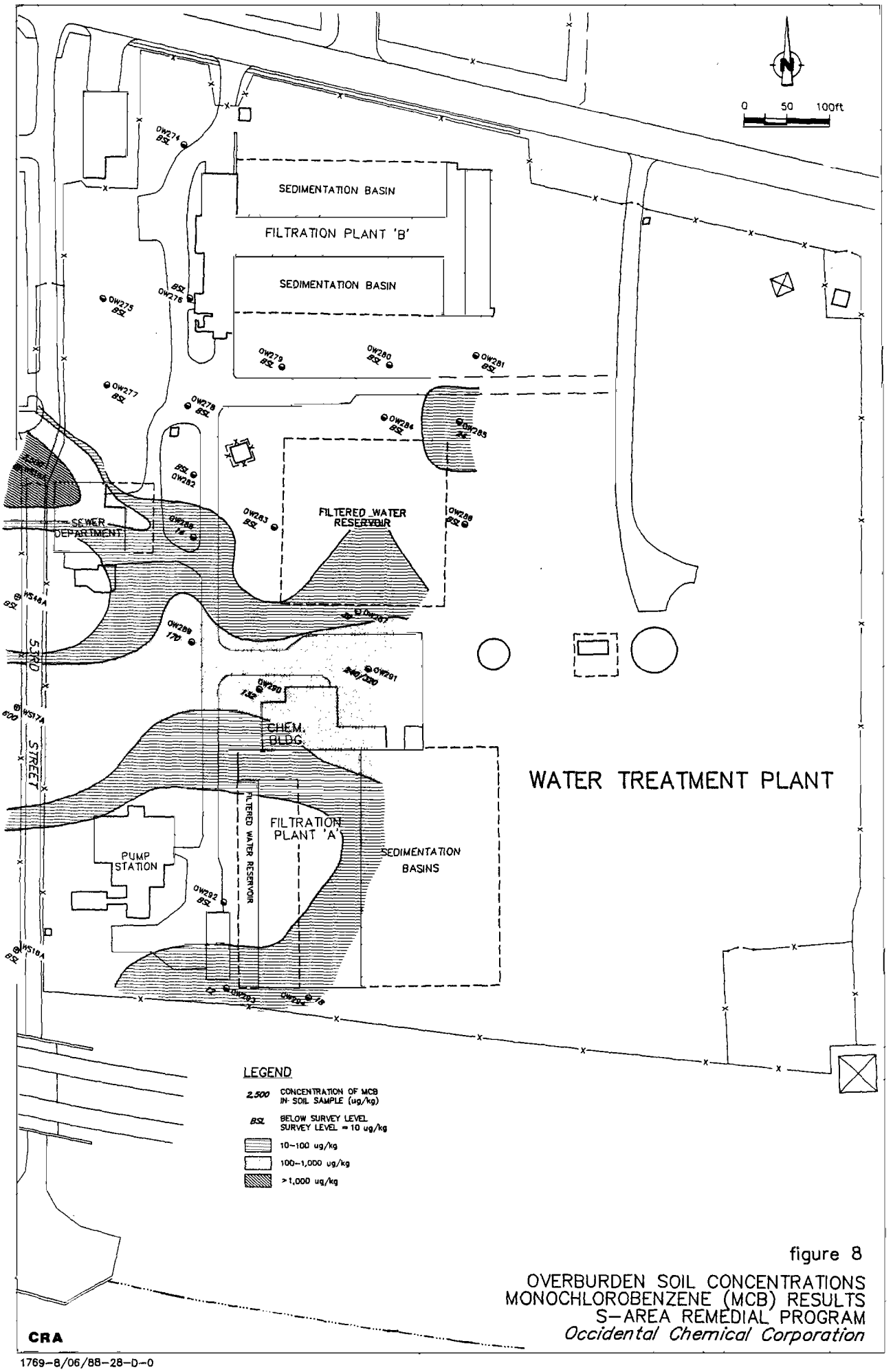

figure 8

OVERBURDEN SOIL CONCENTRATIONS
MONOCHLOROBENZENE (MCB) RESULTS
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samples OW284 and OW286 did not contain MCB above the survey level.

Trichlorobenzene (TCB) - Figure 9

The areal distribution of TCB is similar to the pattern detected for MCB. Again, the highest concentration of TCB observed on the WTP was located at OW291 (1970 ug/kg). This concentration is an order of magnitude higher than the concentrations measured in the surrounding wells including those between OW291 and the S-Area (i.e. OW283, OW288 and OW290). Comparative 1981 historical soil concentrations for TCB along the eastern property line of the S-Area indicate concentrations reached as high as 130,000 ug/kg at WS18. This data is inconsistent with migration from the S-Area landfill.

The absence of TCB at OW282, OW289 and OW292 is also inconsistent with migratory flow of TCB from the S-Area. If TCB is capable of reaching OW291 at the concentrations measured, then TCB would be expected to be more widespread in the area of OW282 and OW289 and to be present at these locations.

Tetrachlorobenzene (TECB) - Figure 10

The distribution pattern of TECB is similar to the pattern for TCB and MCB. There are elevated concentrations at OW291 (3180 ug/kg) and concentrations an order of magnitude lower in the surrounding wells (OW283, OW286, OW288 and OW290). Concentrations at Wells OW282, OW287, OW289 and OW292 were below survey levels. Concentrations obtained from historical data along the eastern S-Area boundary indicate concentrations as high as 600,000 ug/kg at WS18.

The one substantial difference between the TCB and TECB distribution pattern is that a second peak of TECB was observed south of Plant A at OW294. The concentration of 5360 ug/kg measured at OW294 is the highest concentration measured on the WTP. When the data from OW292 (BSL) and OW293 (219 ug/kg) are considered, this data is inconsistent with chemical migration from the S-Area.

Hexachlorobenzene (HCB) - Figure 11

With the exception of the HCB concentration observed at OW282 (2000 ug/kg) all of the HCB concentrations in excess of 1 ppm (OW286, OW287, OW291 and OW294) are located east of the area where concentrations less than 1 ppm were identified. The two highest concentrations measured on the WTP are again OW294 (8450 ug/kg) and OW291 (4800 ug/kg).

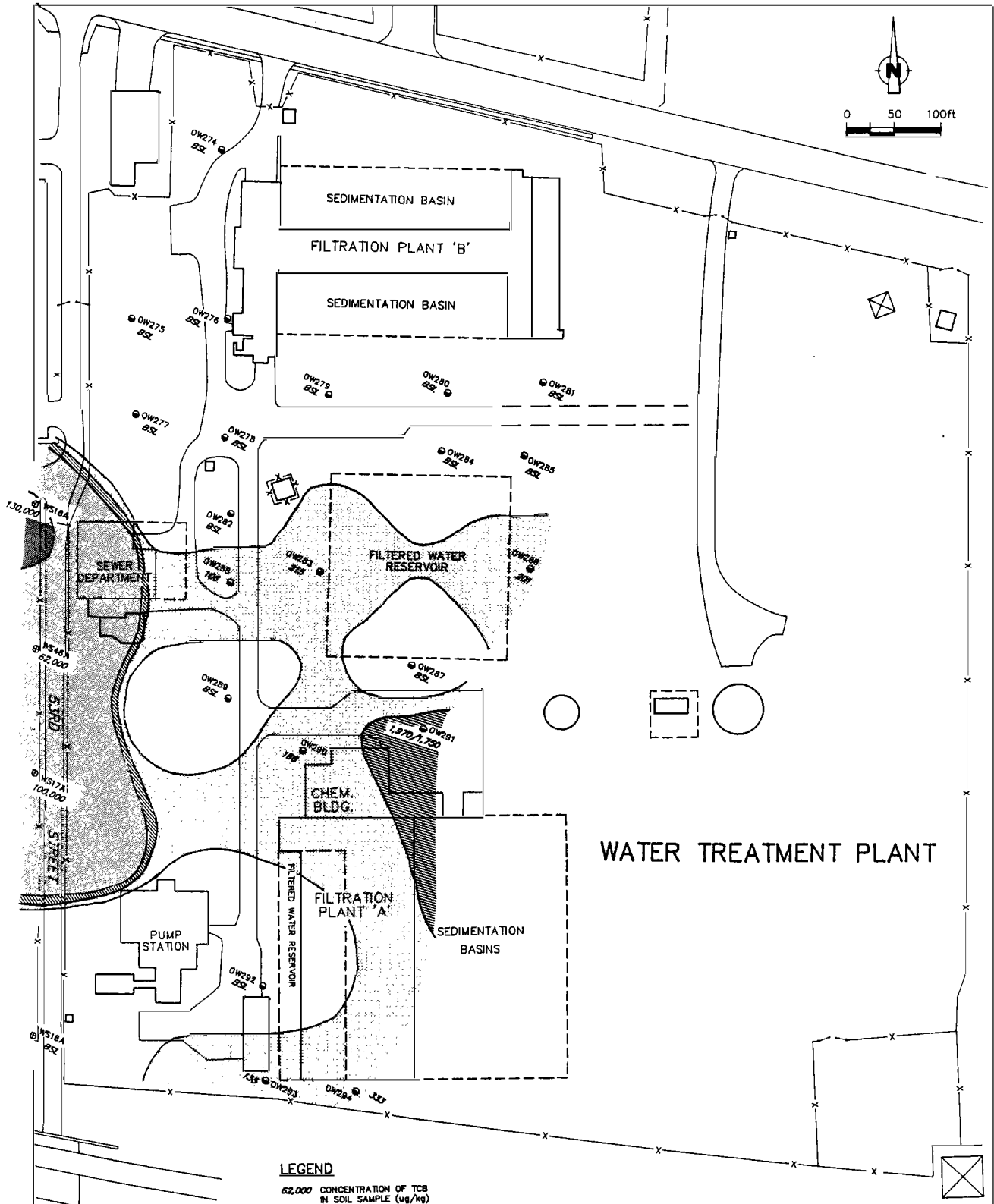

figure 9

OVERBURDEN SOIL CONCENTRATIONS
TRICHLOROBENZENES (TCB) RESULTS
S–AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769–8/06/88–28–D–0

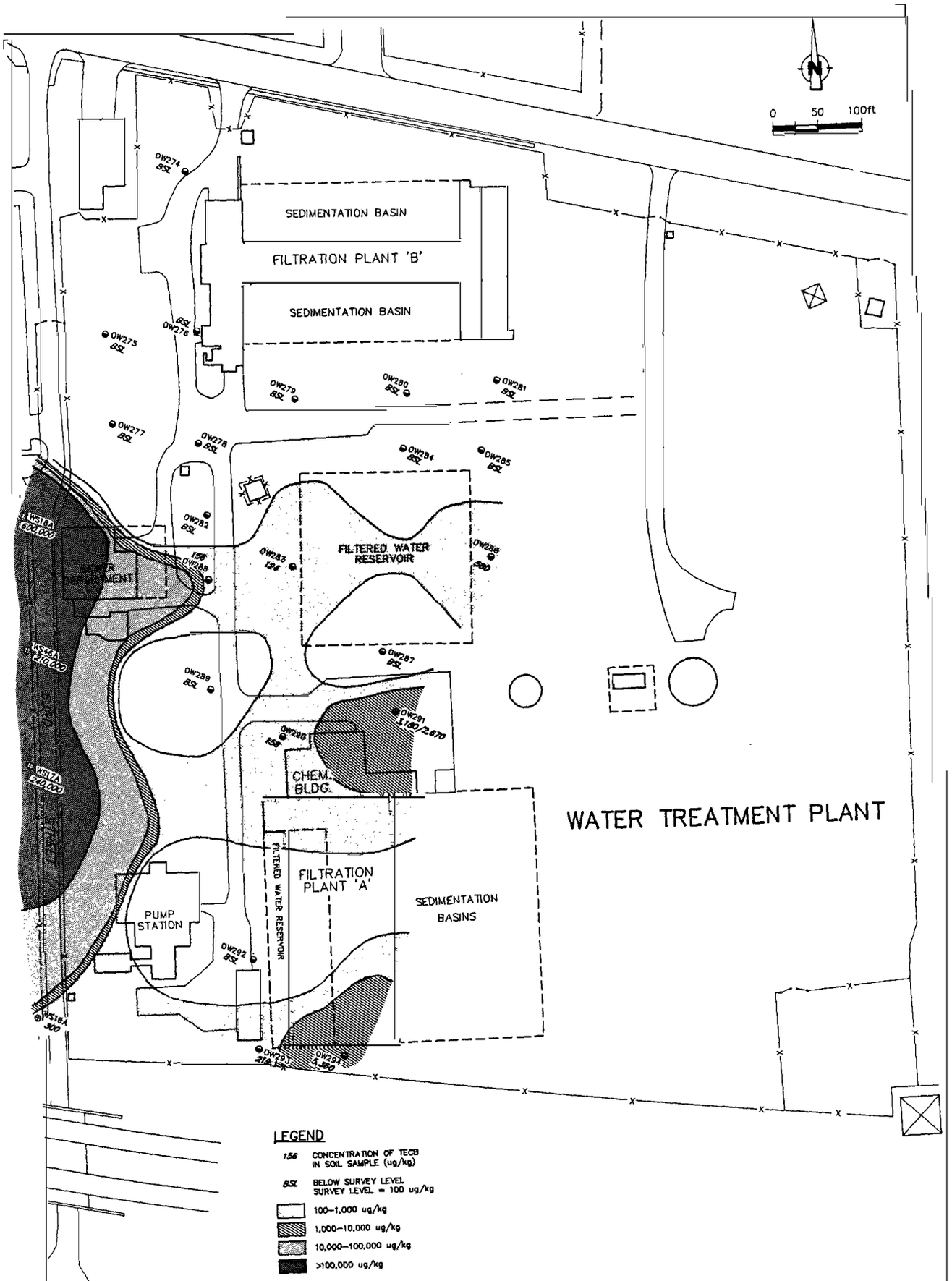

figure 10

OVERBURDEN SOIL CONCENTRATIONS
TETRACHLOROBENZENES (TECB) RESULTS
S–AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769–8/06/88–28–D–0

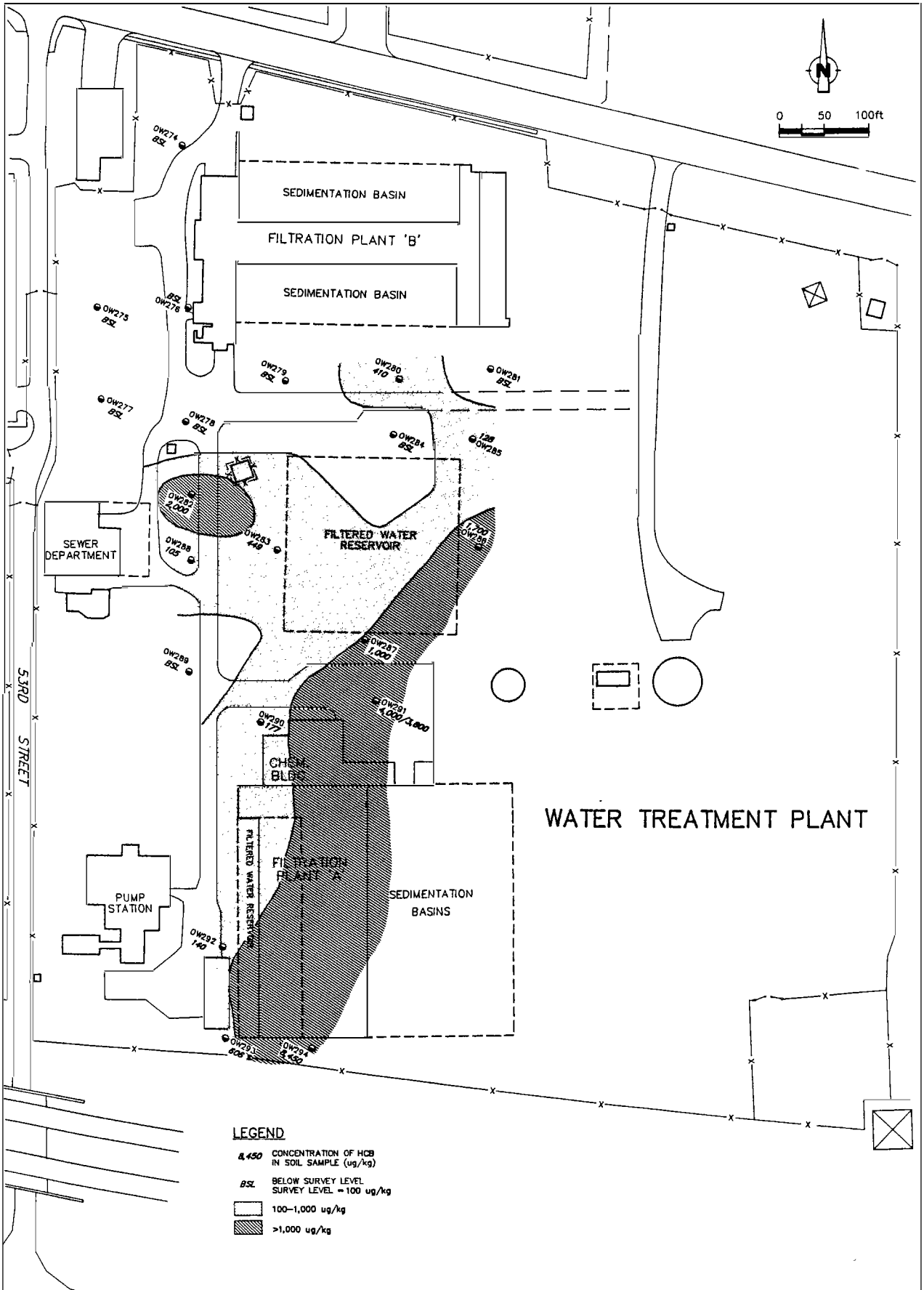

figure 11

OVERBURDEN SOIL CONCENTRATIONS
HEXACHLOROBENZENE (HCB) RESULTS
S–AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-8/06/88-28-D-0

The presence of HCB at OW280 (410 ug/kg) is the only case in which a specific survey parameter was present adjacent to Plant B. The presence of any specific parameter this far north is inconsistent with migration from the S-Area via groundwater flow or NAPL flow. This is especially so considering that HCB was not detected above the survey level at wells at OW278, OW279 and OW284.

Hexachlorobutadiene (C46) - Figure 12

C46 was not detected above the survey level in any of the soil samples collected.

Octachlorocyclopentene (C58) - Figure 13

With the exception of the two samples collected at OW291 and OW294, C58 was not detected in any soil samples collected during the Survey. The concentrations measured, 4500 ug/kg at OW291 and 971 ug/kg at OW294 are not explained by potential migration pathways from the S-Area.

Hexachlorocyclohexanes (HCCH) - Figure 14

The HCCH chemical distribution pattern is similar to the C58 distribution pattern except that it extends further north to include OW286. At OW289, a concentration of 189 ug/kg of

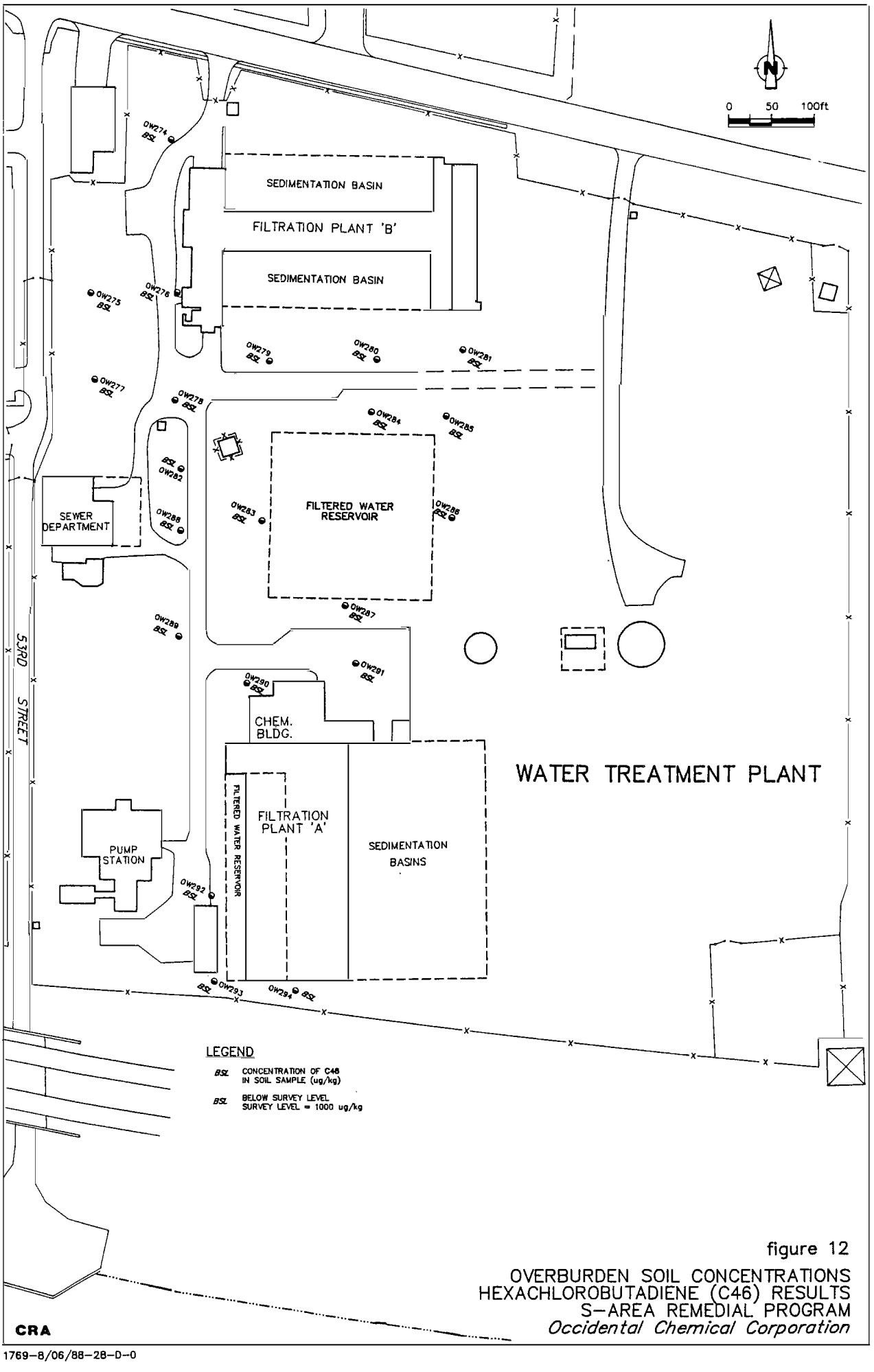

figure 12

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

CRA

1769-8/06/88-28-D-0

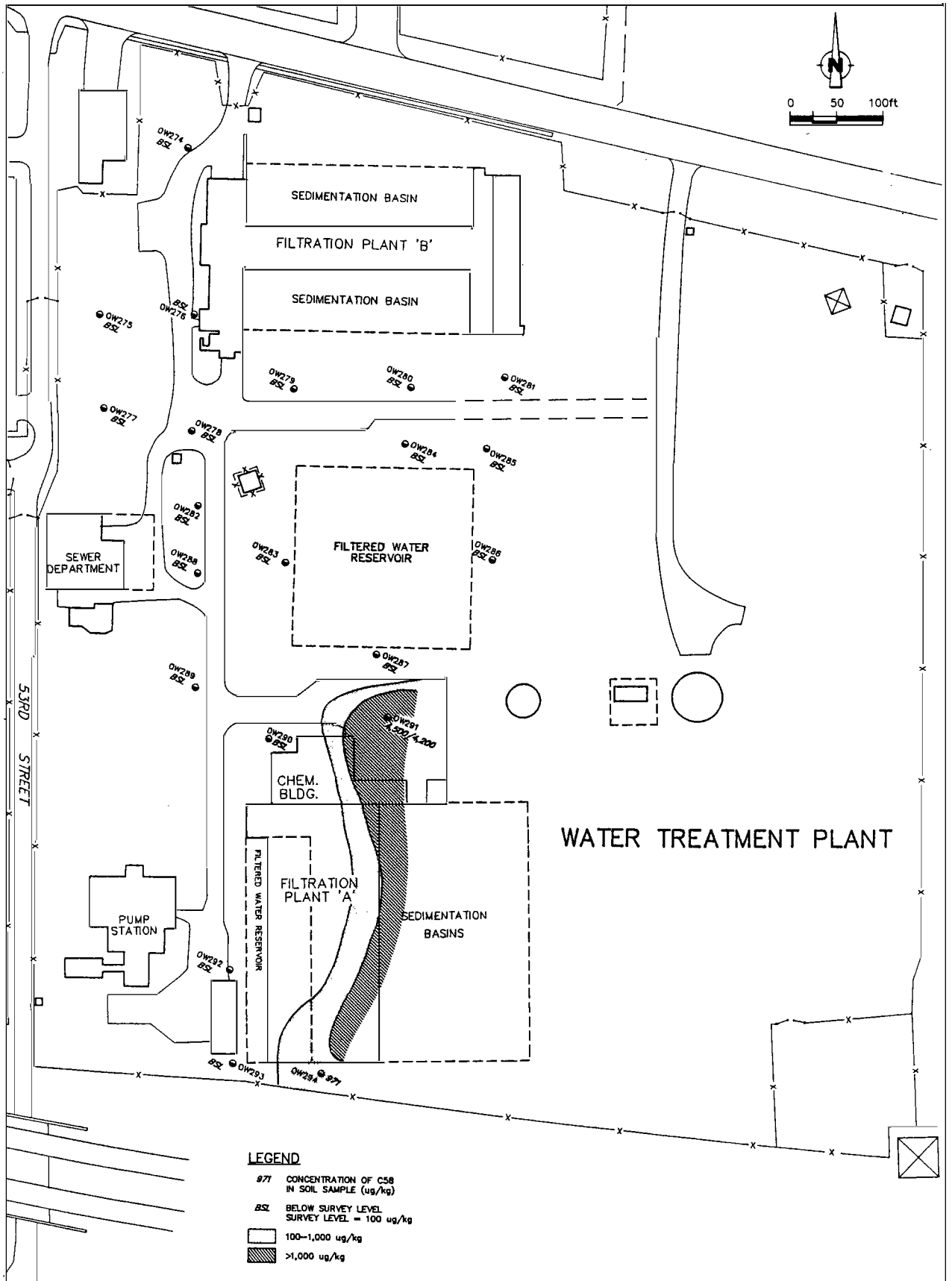

figure 13

OVERBURDEN SOIL CONCENTRATIONS
OCTACHLOROCYCLOPENTENE (C58) RESULTS
S–AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769–8/06/88–28–D–0

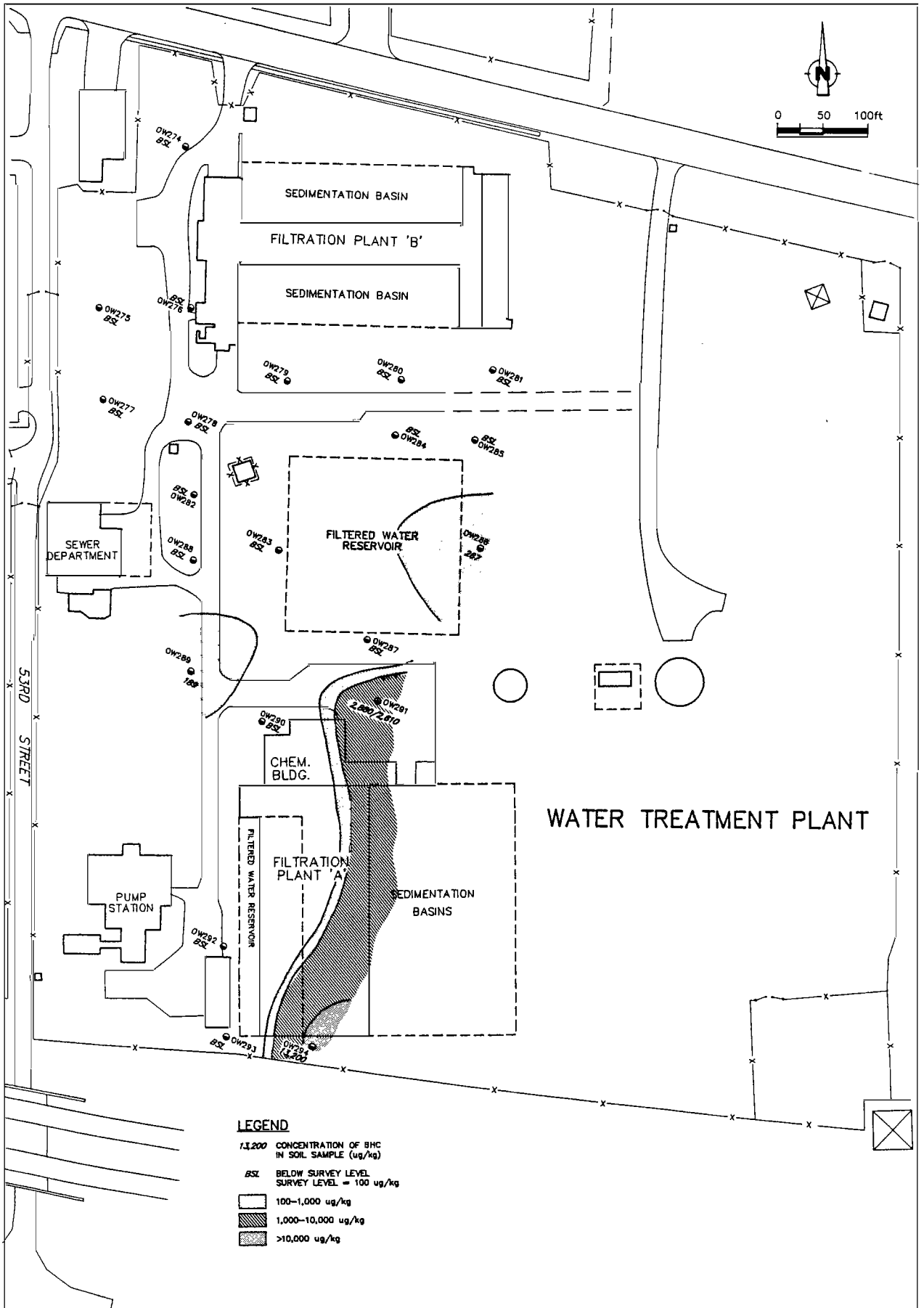

figure 14

OVERBURDEN SOIL CONCENTRATIONS
HEXACHLOROCYCLOHEXANES (BHC) RESULTS
S–AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769–8/06/88–28–D–0

HCCH was measured but this location is separated from the elevated concentration measured at OW291 (2880 ug/kg) by two "clean" wells (OW287 and OW290). The highest HCCH concentration measured on the WTP was 13,200 ug/kg at OW294 located south of Plant A. This concentration at OW284 is again inconsistent with migration from the S-Area considering that HCCH was not detected at nearby wells OW292 and OW293 which are located between OW294 and the S-Area.

Perchloropentacyclodecane (Mirex) - Figure 15

The Mirex distribution pattern is similar to the C58 distribution pattern which identified chemical presence above the survey level at only two wells - OW291 and OW294. The Mirex concentrations at these wells are 1300 and 633 ug/kg, respectively. Again, these concentrations are not supported by migration patterns from S-Area since wells OW287, OW290, OW292 and OW293 did not identify a chemical presence above the survey level.

Combined Specific Parameters - Figures 16 and 17

Figure 16 presents a summary of the analytical results from the WTP Soil Survey. When the concentrations of the specific parameters are summed and plotted as shown in Figure 17, it is apparent that a trend is present. Elevated levels of specific parameters are present in the area of Plant A and

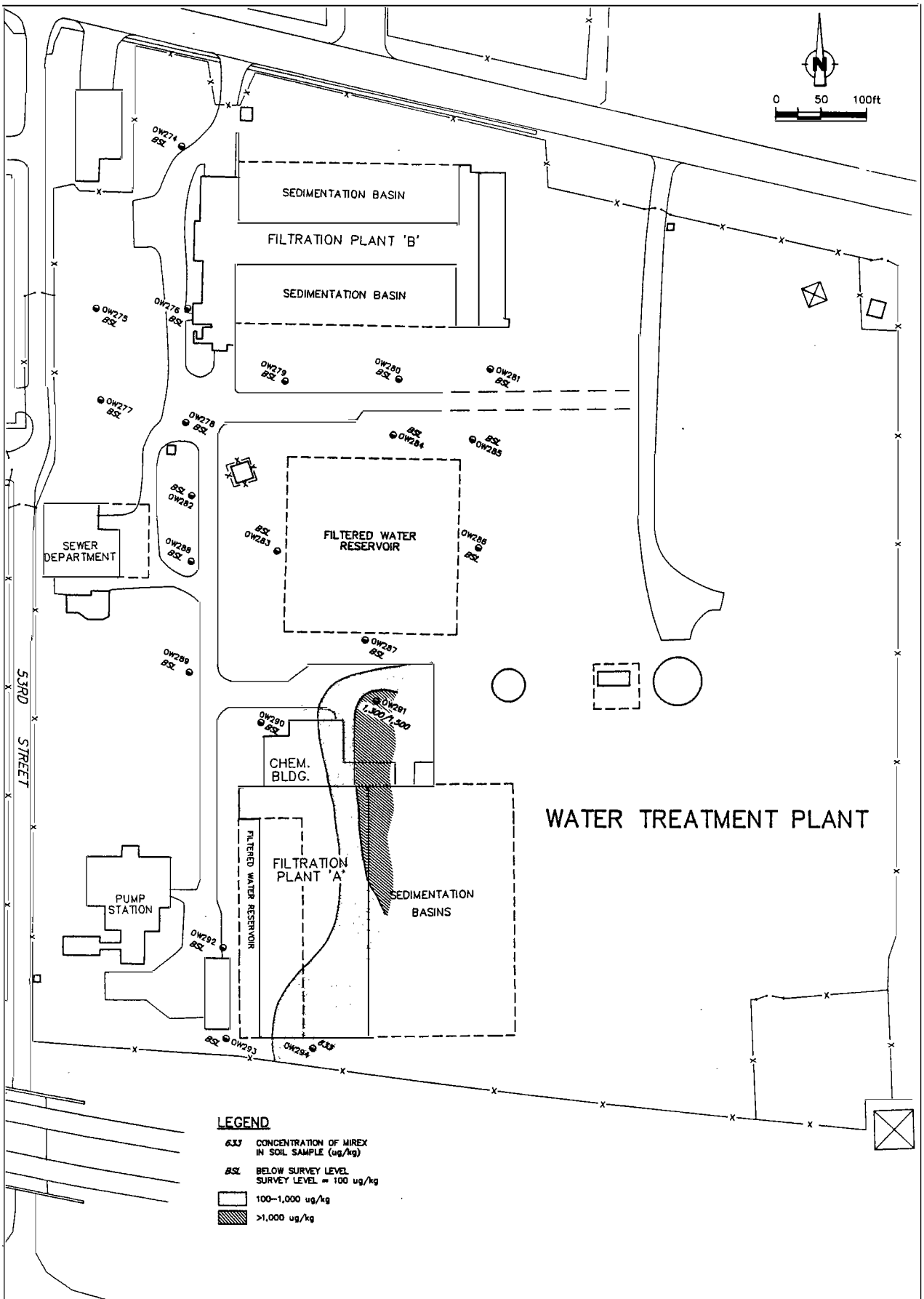

figure 15

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

CRA

1769-8/06/88-28-D-0

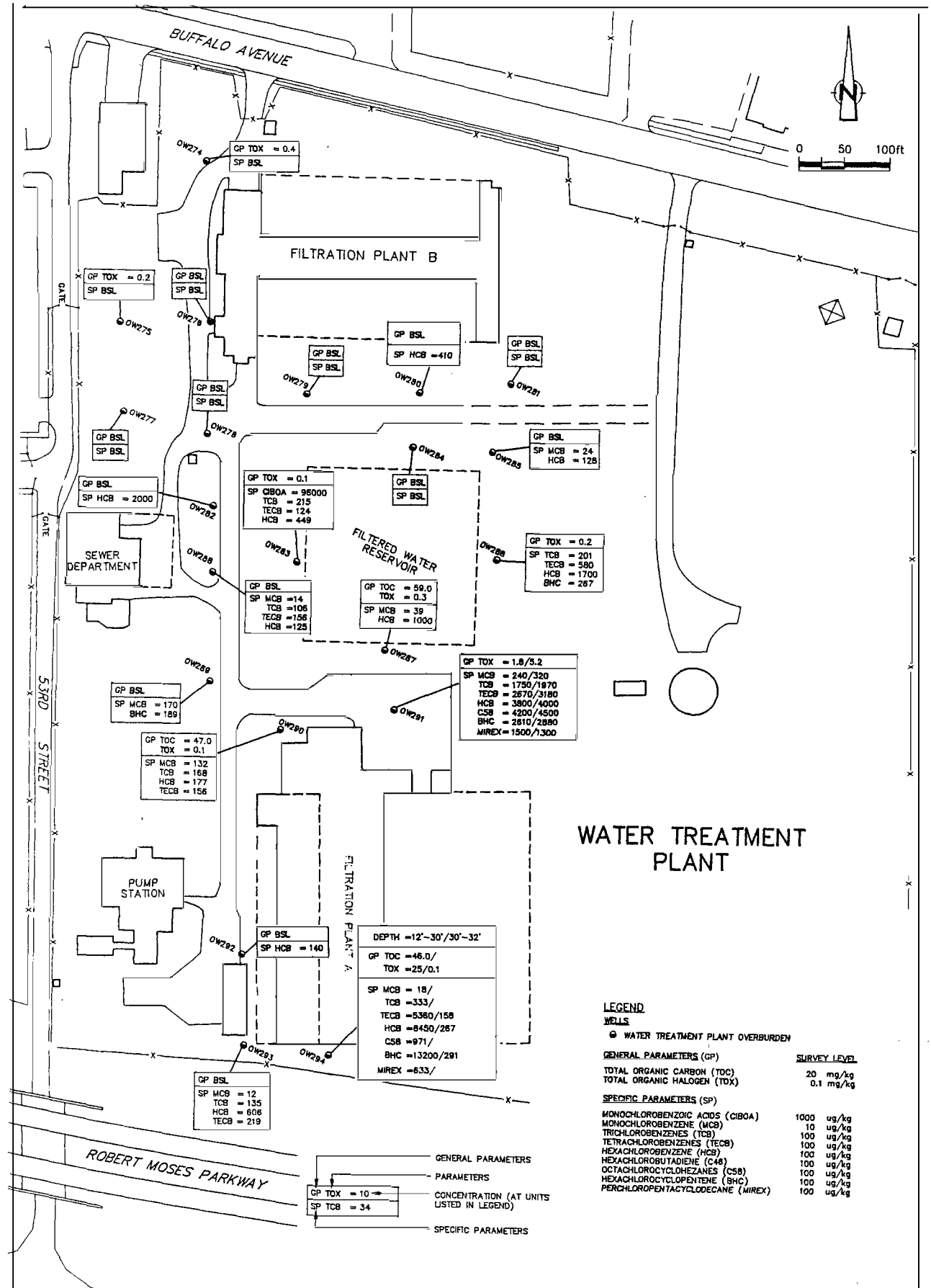

figure 16

CONCENTRATIONS OF GENERAL AND SPECIFIC PARAMETERS–SOIL

S–AREA REMEDIAL PROGRAM

Occidental Chemical Corporation

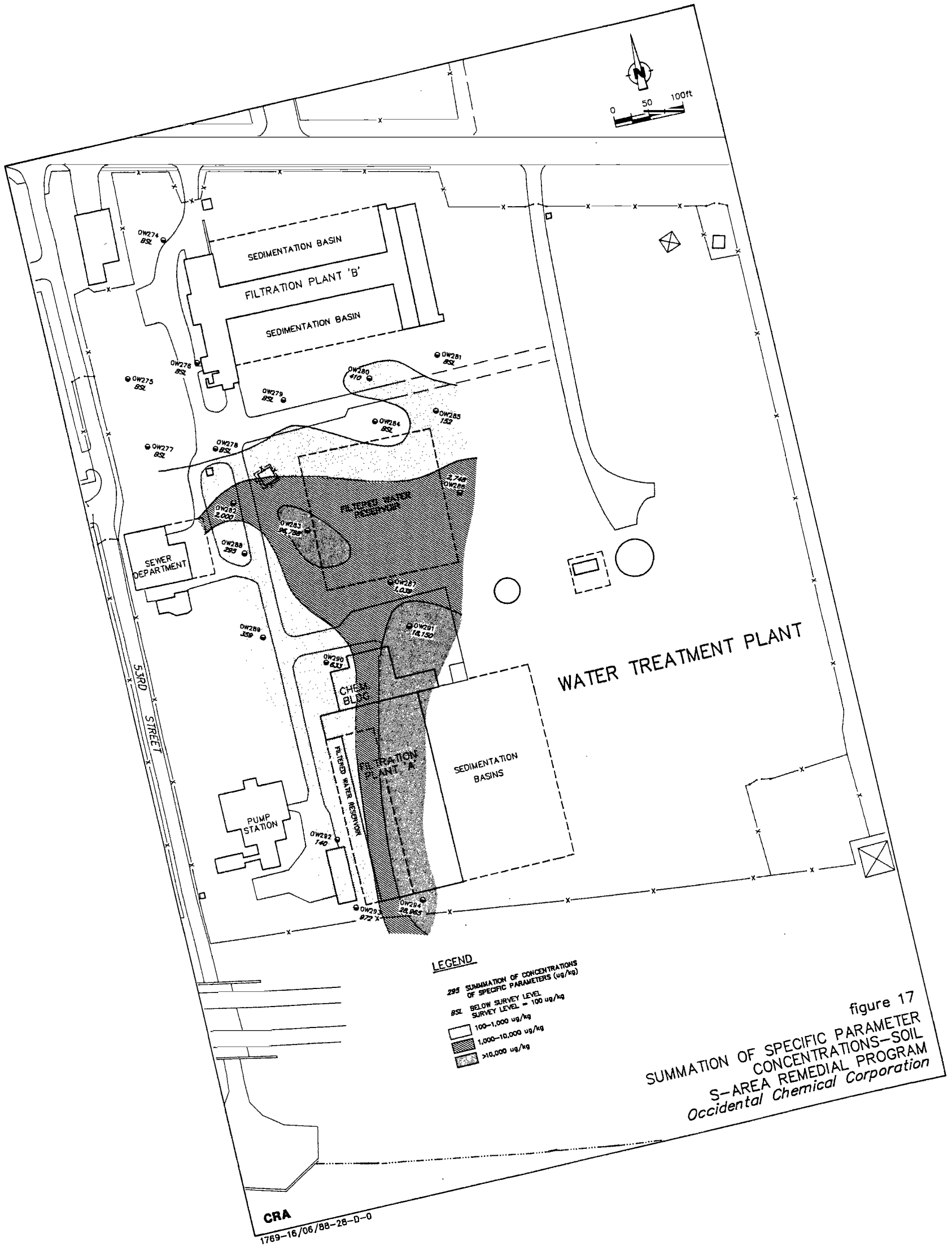

figure 17

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

the concentrations decrease as one moves in a westerly direction back toward the S-Area. This is inconsistent with migration from the S-Area and indicates that the chemicals are not present as a result of migration through the overburden from the S-Area.

The data also indicates a second elevated concentration area near the reservoir at OW283 which is the result of the isolated presence of monochlorobenzoic acids (96000 ug/kg). These chemicals were not detected at any other sampling location.

It should be noted that semi-solid chemicals were identified during the soil sampling conducted at well OW294 south of Plant A. A sample of the material collected from the borehole was subjected to centrifuge mobility testing and found to be non-mobile.

3.2 GROUNDWATER - SURVEY RESULTS

Groundwater samples from the recently installed WTP survey wells and from eight historic survey wells have been analyzed for the general and specific parameters (see Table 1). Table 4 presents the analytical results for groundwater samples collected from these 29 WTP monitoring wells. Figure 18 presents the concentration of

Report Date: 05/27/88

TABLE 4

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

| ND - Not Detected above survey level

S AREA
OVERBURDEN SURVEY WELLS

Special Codes: D - FIELD DUPLICATE

Analytes:	Units:	Survey Levels:	Sample Date:	03/24/88	03/07/88	03/10/88	03/02/88	03/03/88	03/04/88	03/04/88	03/03/88
			Sample Description:	CW 3 A	CW 6 A	CW 6 B	CW 7 A	CW 9 A	CW 10 A	CW 10 A	CW 11 A
			Special Code:							D	
PH				7.2	7.3	9.1	7.2	8.4	7.4	7.5	12
SPECIFIC CONDUCTANCE	mmh/cm			2.0	1.7	1.3	1.3	1.2	1.4	1.3	3.5
TOTAL ORGANIC CARBON (TOC)	mg/L	20		20	ND	24	25	ND	ND	ND	ND
TOTAL ORGANIC HALIDES (TOX)	mg/L	0.1		0.1	0.9	0.4	ND	3.0	0.2	0.3	1.9
CHLOROBENZOIC ACIDS, TOTAL	mg/L	0.5		ND	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZENE	ug/L	10		ND	641	364	ND	1220	35	32	ND
TRICHLOROBENZENE, TOTAL	ug/L	10		ND	ND	ND	ND	49	ND	ND	ND
TETRACHLOROBENZENES, TOTAL	ug/L	10		ND	ND	ND	ND	18	ND	ND	ND
HEXACHLOROBENZENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROBUTADIENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
OCTACHLOROCYCLOPENTENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOHEXANE (BHC) TOTAL	ug/L	10		ND	ND	ND	ND	67	ND	ND	ND
PERCHLOROPENTACYCLODECANE (MIREX)	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND

TABLE 4

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

ND - Not Detected above survey level

S AREA
OVERBURDEN SURVEY WELLS

Special Codes: D - FIELD DUPLICATE

Analytes:	Units:	Survey Levels:	Sample Date:------->	03/08/88	04/19/88	04/22/88	04/19/88	04/22/88	05/03/88	04/21/88	05/04/88
			Sample Description:->	OW 13 A	OW 260	OW 261	OW 262	OW 263	OW 264	OW 265	OW 266
			Special Code:------->								
PH				7.4	7.2	7.5	7.6	7.0	7.8	8.1	6.9
SPECIFIC CONDUCTANCE	mmh/cm			1.2	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	ND
TOTAL ORGANIC HALIDES (TOX)	mg/L	0.1		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	ND
CHLOROBENZENE	ug/L	10		ND	ND	ND	ND	ND	ND	14	190
TRICHLOROBENZENE, TOTAL	ug/L	10		ND	ND	ND	ND	ND	ND	ND	58
TETRACHLOROBENZENES, TOTAL	ug/L	10		ND	ND	ND	ND	ND	ND	ND	82
HEXACHLOROBENZENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROBUTADIENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
OCTACHLOROCYCLOPENTENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOHEXANE (BHC) TOTAL	ug/L	10		ND	ND	ND	ND	ND	ND	ND	327
PERCHLOROPENTACYCLODECANE (MIREX)	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND

TABLE 4

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

S AREA
OVERBURDEN SURVEY WELLS

| ND - Not Detected above survey level

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

TABLE 4

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

ND - Not Detected above survey level

S AREA
OVERBURDEN SURVEY WELLS

Special Codes: D - FIELD DUPLICATE

Analytes:	Units:	Survey Levels:	Sample Date:------->	03/18/88	03/15/88	03/17/88	03/14/88	03/15/88	03/24/88	03/24/88	03/25/88
			Sample Description:->	OW 274	OW 275	OW 276	OW 277	OW 278	OW 279	OW 279	OW 280
			Special Code:------->							D	
PH				7.8	6.8	8.3	8.0	9.9	8.4	8.5	8.5
SPECIFIC CONDUCTANCE	mmh/cm			1.7	1.7	1.1	2.4	0.8	0.9	0.8	1.3
TOTAL ORGANIC CARBON (TOC)	mg/L	20		ND	ND	ND	ND	ND	ND	ND	ND
TOTAL ORGANIC HALIDES (TOX)	mg/L	0.1		ND	ND	0.2	ND	ND	1.3	0.2	0.1
CHLOROBENZOIC ACIDS, TOTAL	mg/L	0.5		ND	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROBENZENE, TOTAL	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
TETRACHLOROBENZENES, TOTAL	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROBENZENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROBUTADIENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
OCTACHLOROCYCLOPENTENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOHEXANE (BHC) TOTAL	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
PERCHLOROPENTACYCLODECANE (MIREX)	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND

TABLE 4

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

| ND - Not Detected above survey level |

S AREA
OVERBURDEN SURVEY WELLS

Special Codes: D - FIELD DUPLICATE

Analytes:	Units:	Survey Levels:	Sample Date:-------->	03/22/88	03/11/88	03/14/88	03/22/88	03/23/88	03/23/88	03/23/88	03/25/88
			Sample Description:->	OW 281	OW 282	OW 283	OW 284	OW 285	OW 285	OW 286	OW 287
			Special Code:-------->						D		
PH				7.3	12	9.3	7.1	9.1	8.9	8.2	12
SPECIFIC CONDUCTANCE	mmh/cm			1.1	2.3	3.4	1.2	0.6	0.6	2.0	5.5
TOTAL ORGANIC CARBON (TOC)	mg/L	20		ND	ND	33	24	ND	ND	ND	ND
TOTAL ORGANIC HALIDES (TOX)	mg/L	0.1		ND	0.1	0.7	ND	ND	ND	0.3	0.1
CHLOROBENZOIC ACIDS, TOTAL	mg/L	0.5		ND	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROBENZENE, TOTAL	ug/L	10		ND	ND	ND	ND	ND	ND	34	ND
TETRACHLOROBENZENES, TOTAL	ug/L	10		ND	ND	ND	ND	ND	ND	ND	10
HEXACHLOROBENZENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROBUTADIENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
OCTACHLOROCYCLOPENTENE	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOHEXANE (BHC) TOTAL	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND
PERCHLOROPENTACYCLODECANE (MIREX)	ug/L	10		ND	ND	ND	ND	ND	ND	ND	ND

TABLE 4

OCCIDENTAL CHEMICAL CORPORATION
ENVIRONMENTAL DATABASE SYSTEM

ND - Not Detected above survey level

S AREA
OVERBURDEN SURVEY WELLS

Special Codes: D - FIELD DUPLICATE

	Sample Date:-------->		03/10/88	03/10/88	03/10/88	03/20/88	03/24/88	03/08/88	03/09/88	03/09/88
	Sample Description:->		OW 288	OW 289	OW 289	OW 290	OW 291	OW 292	OW 293	OW 294
	Special Code:------->			D						
Analytes:	Units:	Survey Levels:								
PH			7.6	7.6	7.6	7.8	12	10	8.0	8.3
SPECIFIC CONDUCTANCE	mmh/cm		12	1.6	1.7	2.1	3.5	0.4	1.3	0.9
TOTAL ORGANIC CARBON (TOC)	mg/L	20	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL ORGANIC HALIDES (TOX)	mg/L	0.1	0.1	ND	ND	0.4	0.7	ND	ND	ND
CHLOROBENZOIC ACIDS, TOTAL	mg/L	0.5	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZENE	ug/L	10	38	ND	ND	72	11	ND	ND	ND
TRICHLOROBENZENE, TOTAL	ug/L	10	ND	ND	ND	ND	180	ND	ND	ND
TETRACHLOROBENZENES, TOTAL	ug/L	10	ND	ND	ND	ND	47	ND	ND	ND
HEXACHLOROBENZENE	ug/L	10	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROBUTADIENE	ug/L	10	ND	ND	ND	ND	ND	ND	ND	ND
OCTACHLOROCYCLOPENTENE	ug/L	10	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOHEXANE (BHC) TOTAL	ug/L	10	ND	ND	ND	ND	ND	ND	ND	ND
PERCHLOROPENTACYCLODECANE (MIREX)	ug/L	10	ND	ND	ND	ND	ND	ND	ND	ND

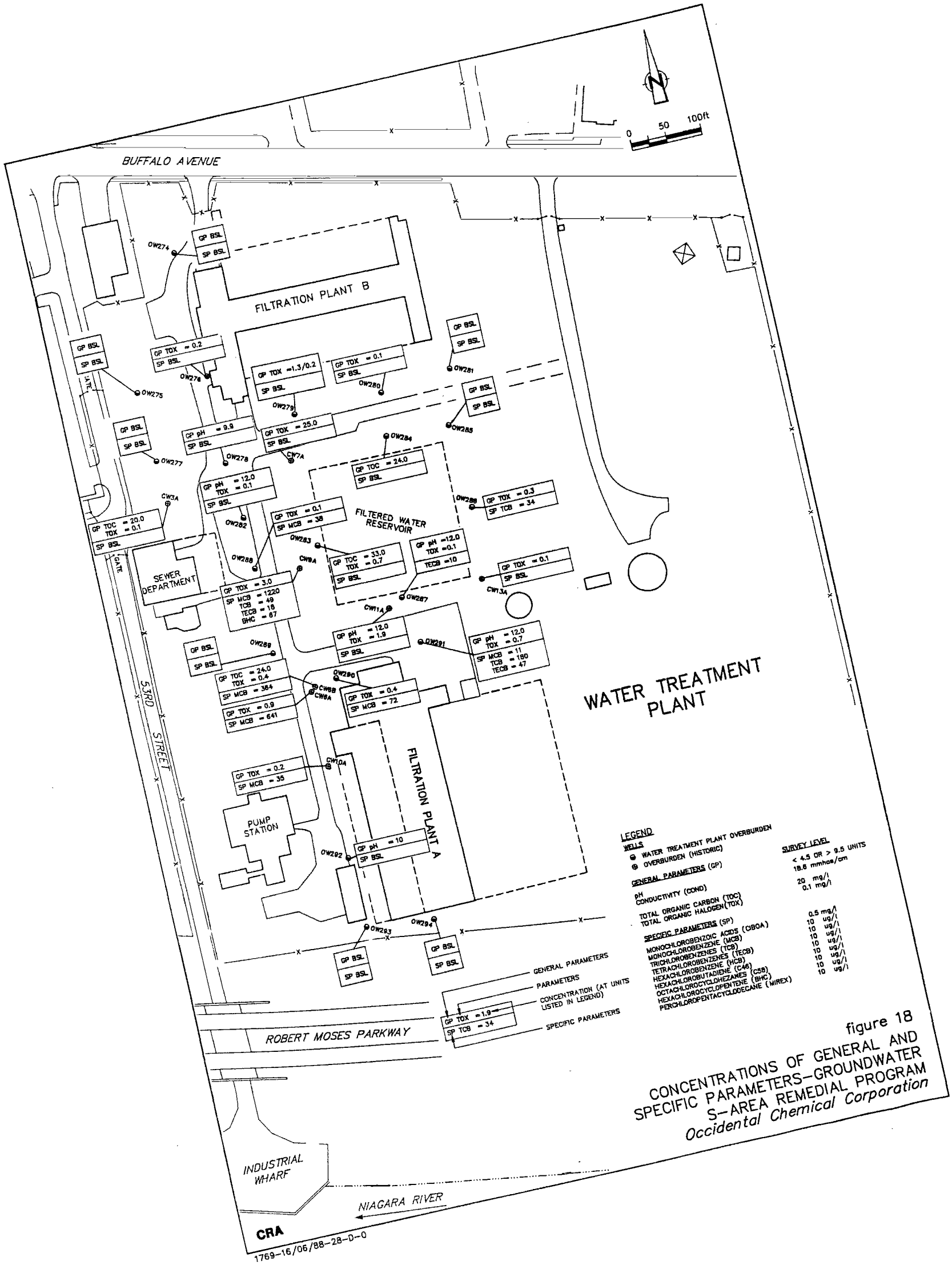

figure 18

CONCENTRATIONS OF GENERAL AND SPECIFIC PARAMETERS–GROUNDWATER S–AREA REMEDIAL PROGRAM

Occidental Chemical Corporation

each parameter detected above the survey level at the sampling locations.

Groundwater samples collected from overburden survey wells OW274 through OW285 exhibit no concentrations of the specific parameters above the survey levels.

Only 9 of the 29 groundwater sampling locations, as listed below, exhibited concentrations of one or more specific parameters in excess of the groundwater survey levels:

i) OW288 and CW9A located to the west of the Reservoir,
ii) OW286 to the east of the Reservoir,
iii) OW287, OW290, OW291, CW6A and CW6B located between the Reservoir and Plant A, and
iv) CW10A located west of Filtration Plant A.

The analytical results from the groundwater survey are discussed in the following subsections on a parameter by parameter basis. Where available, evaluation of the survey data has been supplemented by reference to historical groundwater data from samples collected in February 1980. While it is recognized that sampling protocols, analytical procedures, time differences and other factors do not always allow a direct correlation between historic and Survey data, the information is valuable for

comparison and interpretation purposes. A list of the available historical analytical results is presented in Table 5. The survey data has also been supplemented by groundwater data obtained during the S-Area Survey from along the Robert Moses Parkway south of the WTP.

The chemical distribution patterns for each groundwater survey parameter will be reviewed individually in the following sub-sections:

pH - Figure 19

The pH levels measured at the WTP were typically in the 6.7 to 9.3 range, although two areas of elevated pH were observed. The first of these two areas is located at the northeast corner of the Sewer Department building where a pH of 12 was measured at OW282. The second area is located between the Filtered Water Reservoir and Plant A and may extend to the southern edge of the Pump Station near OW292 and CW8A. In this second area, the pH was typically 12. These elevated pH measurements are inconsistent with the pH levels observed along the eastern edge of the S-Area where pH values of 5.7 to 7.0 were measured in the groundwater. Therefore, these elevated pH levels on the WTP do not appear to be indicative of migration from S-Area.

TABLE 5

HISTORICAL GROUNDWATER DATA 1979/1980 - WTP

	WS 16A	WS 17A	WS 18A	CW 1A	CW 1B	CW 2A	CW 4A	CW 8A
GENERAL PARAMETERS								
pH	6.5	6	5.9	8.2	NT	6.7	7.7	12
Conductivity (mmhos/cm)	9.56	12.4	0.002	1.86	NT	9.9	0.38	13
Total Organic Carbon (TOC) (mg/L)	38.9	102	57.2	BSL	BSL	50	34.5	BSL
Total Organic Halogen (TOX) (mg/L)	9.8	34.5	37	4.1	6.1	21	0.1	0.1
SPECIFIC PARAMETERS								
Monochlorobenzoic Acids (ug/L)	2200	20500	580	410	6.6	1820	BSL	BSL
Monochlorobenzene (ug/L)	1080	8320	7600	2110	247	998	BSL	86
Trichlorobenzenes (ug/L)	175	20900	15000	126	0.3	1760	2.1	0.5
Tetrachlorobenzenes (ug/L)	287	14500	2720	5	2.5	818	1	1.3
Hexachlorobenzene (ug/L)	16	6370	3820	BSL	BSL	631	16.7	BSL
Hexachlorobutadiene (ug/L)	36.8	5680	5950	BSL	BSL	774	BSL	BSL
Octachlorocyclopentene (ug/L)	BSL	BSL	BSL	BSL	BSL	600	BSL	BSL
Hexachlorocyclohexanes (ug/L)	110	2720	163	102	2.3	39.6	25.2	BSL
Perchloropentacyclodecane (Mirex) (ug/L)	15	1170	619	NT	BSL	10.3	11	BSL

NT - Not Tested
BSL - Below Survey Level

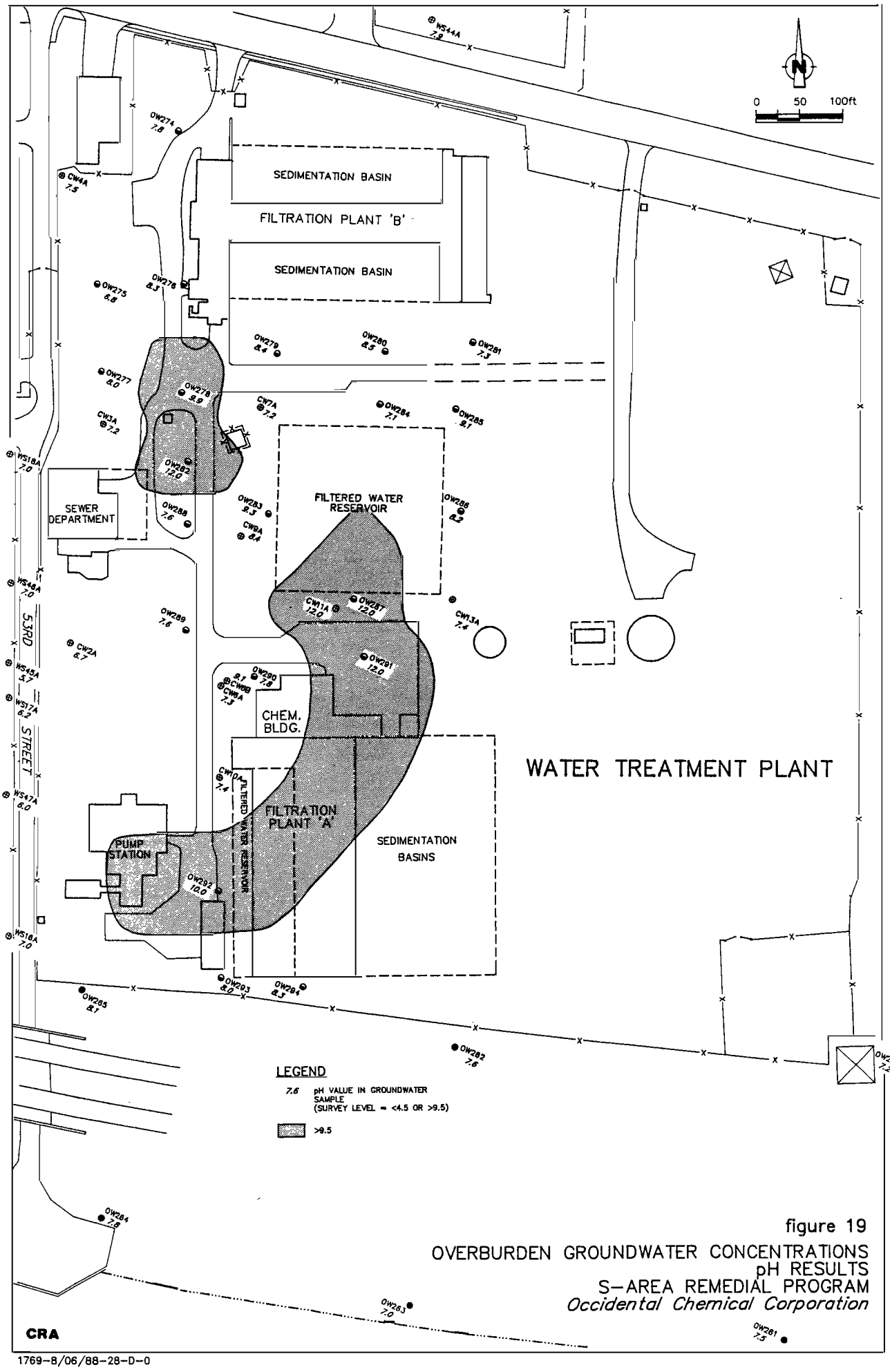

figure 19

OVERBURDEN GROUNDWATER CONCENTRATIONS
pH RESULTS
S-AREA REMEDIAL PROGRAM
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Specific Conductance - Figure 20

No occurrence of specific conductance at levels 10 times background (1860 umhos/cm) was found at the WTP. The background level was established 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".

Total Organic Carbon (TOC) - Figure 21

Results of the S-Area Survey indicate two isolated areas of TOC presence in excess of the survey level. The first is located around the northwest corner of the Filtered Water Reservoir. However, this area of TOC presence is separated from the historic TOC plume identified along the eastern S-Area property boundary by a line of wells (OW278, OW282, and OW288) having concentration below the survey level. The second isolated area is located at CW6B. Even CW6A which is located immediately adjacent to CW6B did not contain TOC above the survey level. Well CW6B is screened deeper into the fill/alluvium waterbearing strata than CW6A. Historical information indicates that CW4A in the northwest corner of the WTP and WS44A on the north side of Buffalo Avenue also contain TOC concentrations in excess of the survey levels although both of these locations are not located hydraulically downgradient of S-Area.

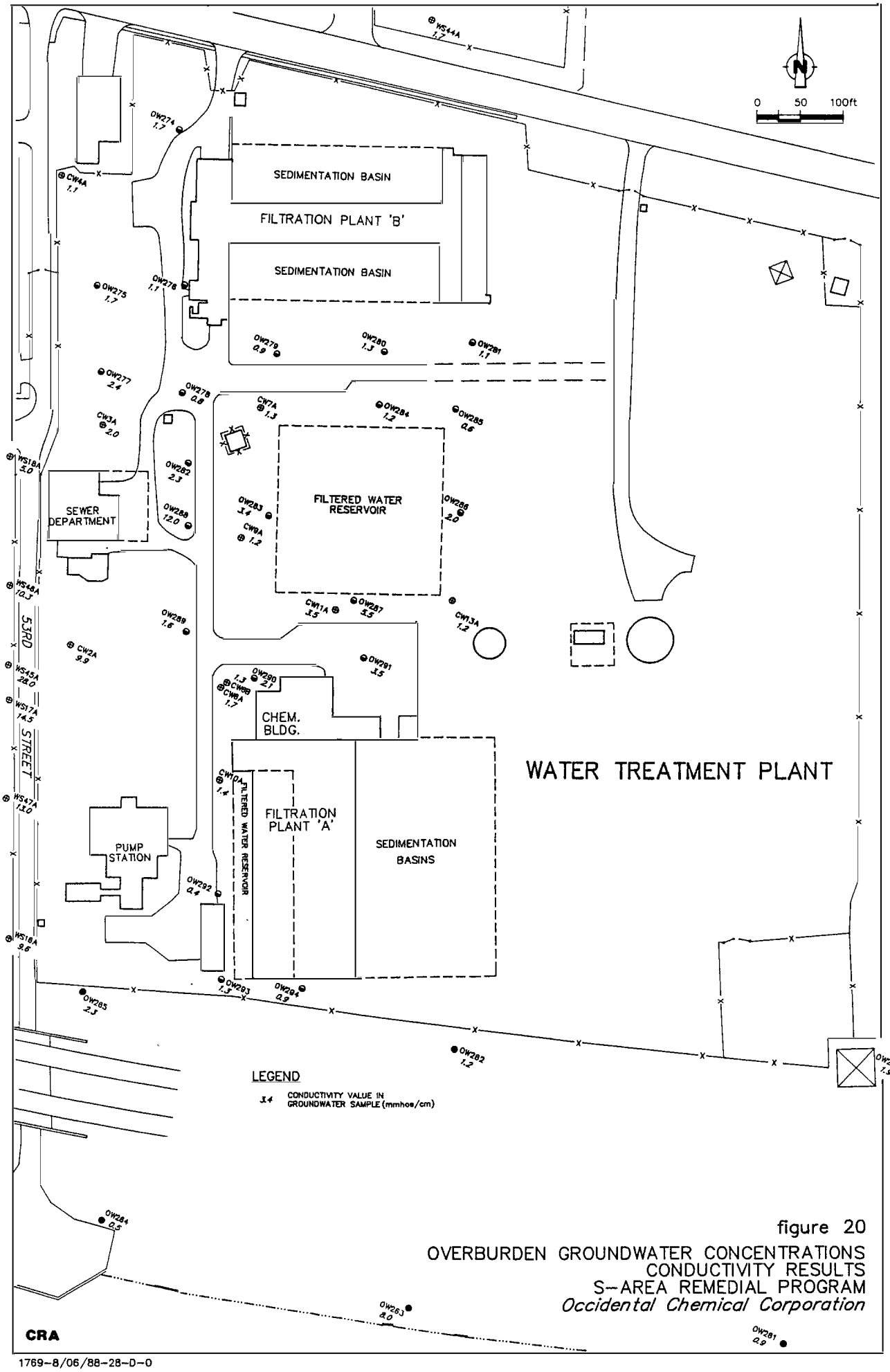

figure 20

OVERBURDEN GROUNDWATER CONCENTRATIONS
CONDUCTIVITY RESULTS
S-AREA REMEDIAL PROGRAM
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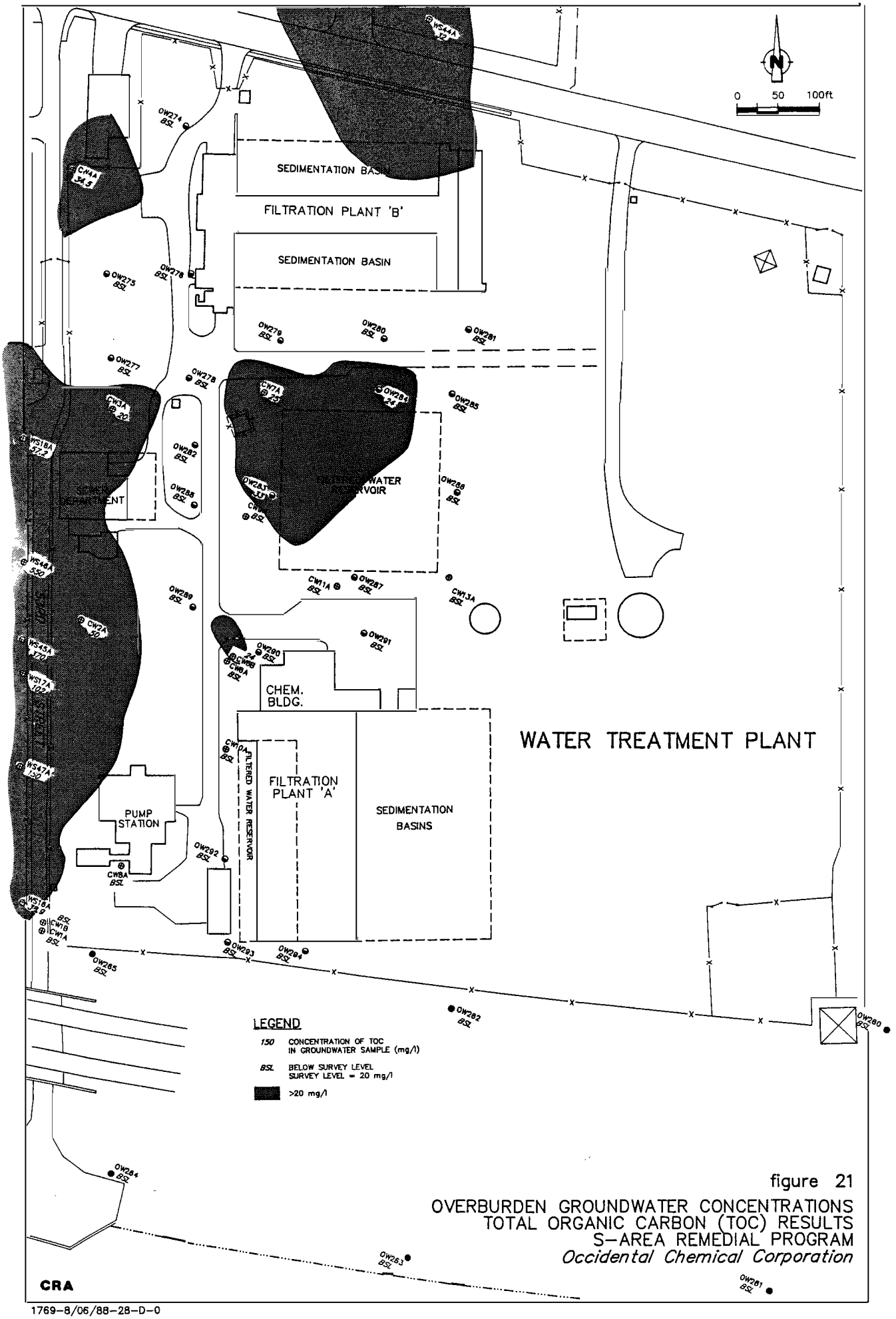

figure 21

OVERBURDEN GROUNDWATER CONCENTRATIONS
TOTAL ORGANIC CARBON (TOC) RESULTS
S-AREA REMEDIAL PROGRAM
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Total Organic Halogen (TOX) - Figure 22

The TOX concentrations from the S-Area Survey indicate the presence of low concentration TOX throughout a large portion of the WTP. At the southwest corner of the Filtered Water Reservoir the concentrations reach as high as 3 mg/l (CW9A) and 1.9 mg/l (CW11A). Between this location and the S-Area several lower concentration and non-detect samples were collected. At the southwest corner of Plant B, a second area of TOX presence was observed centered at OW279 (1.3 mg/l). With the exception of these three wells, all other reported concentrations on the WTP were less than 1 mg/l. In fact, six of the reported locations identifying TOX presence were measured to be at the survey level of 0.1 mg/l. Neither of the two locations exhibiting the TOX peaks indicate migration in the overburden from the S-Area.

Monochlorobenzoic Acids (ClBOA) - Figure 23

Although ClBOA was noted in samples from historical groundwater samples along the S-Area property boundary, no survey well on the WTP identified the presence of ClBOA. Even OW283, which had a concentration of 96,000 ug/kg in the soil, does not contain ClBOA in groundwater above the survey level.

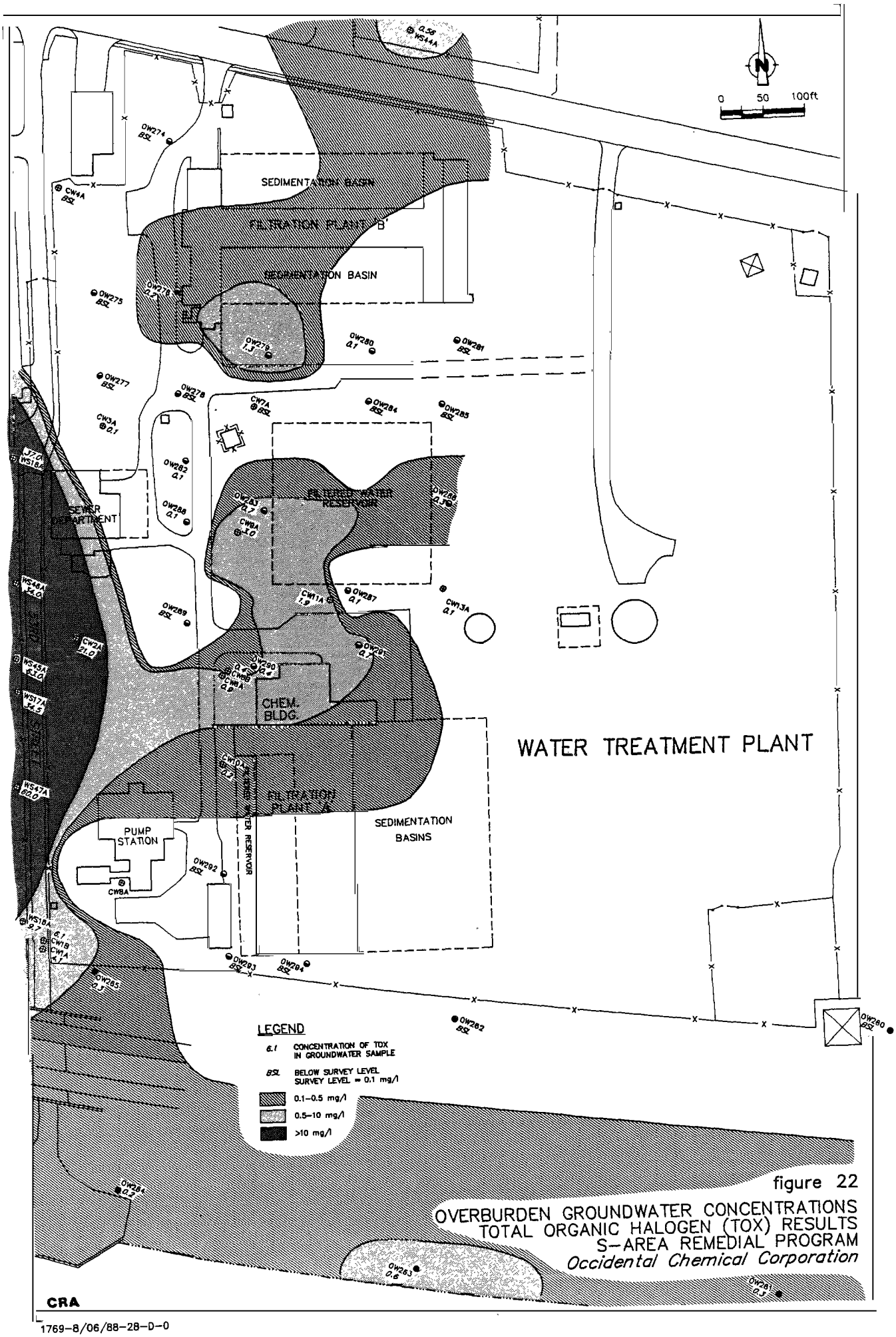

figure 22

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

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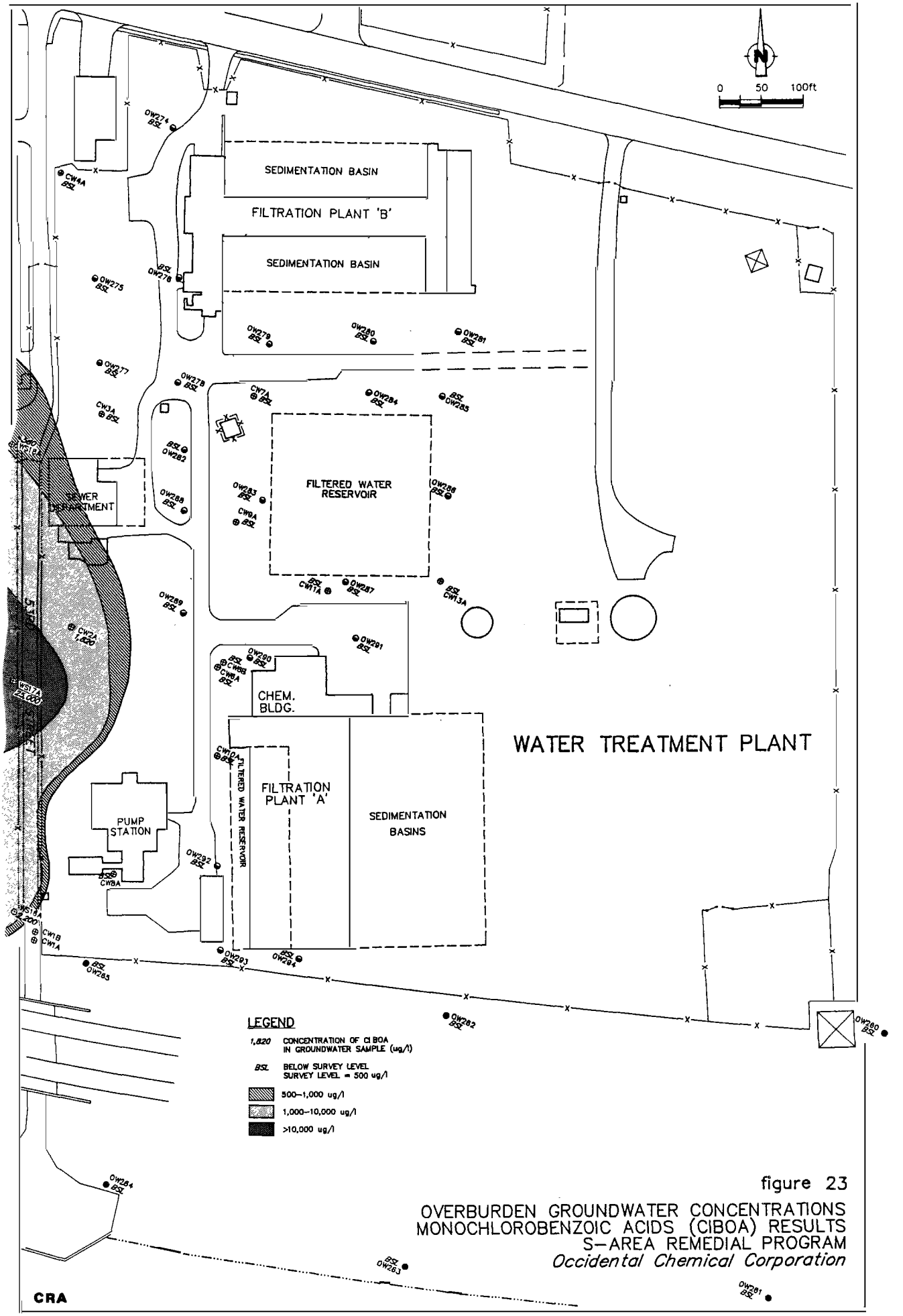

figure 23

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

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Monochlorobenzene (MCB) - Figure 24

The presence of MCB at the WTP is mostly limited to the west central area. Concentrations as high as 64.1 ug/l at CW6A and 1220 ug/l at CW9A were measured. The peak concentration measured at CW9A is separated from the high concentrations observed at the S-Area by OW282, OW288 and OW289 (BSL, 38 ug/l and BSL, respectively). The concentration of MCB measured at CW6A is not explained by potential migration pathways from the S-Area since concentrations measured at OW289 and CW10A are BSL and 35 ug/l, respectively. It is to be noted that there is no data available from the area between CW6A and the S-Area along the alignment of the WTP access road.

Trichlorobenzene (TCB) - Figure 25

TCB was identified to be present at three isolated locations on the WTP; these locations were CW9A (49 ug/l), OW286 (34 ug/l) and OW291 (180 ug/l). Each of these locations is separated from locations of the elevated concentrations noted in the historic sampling on the S-Area by a row of wells where TCB was not present (OW282, OW288, OW289, OW290, CW6A, CW6B and CW10A). It is also to be noted that the TCB groundwater concentrations are consistent with TCB concentrations measured in the soil where OW291 exhibited the highest concentrations in both the soil and groundwater.

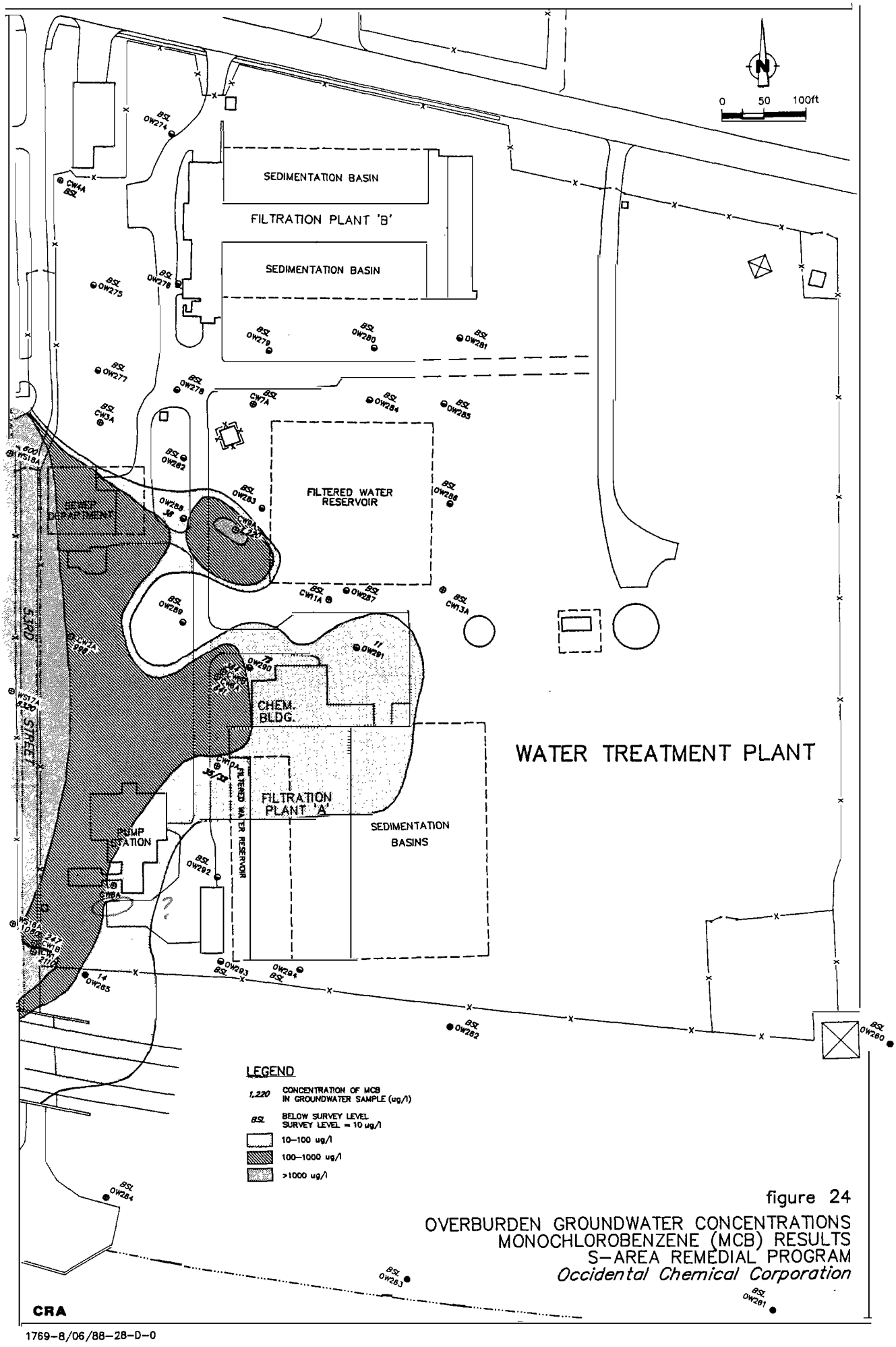

figure 24

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

1769-8/06/88-28-D-0

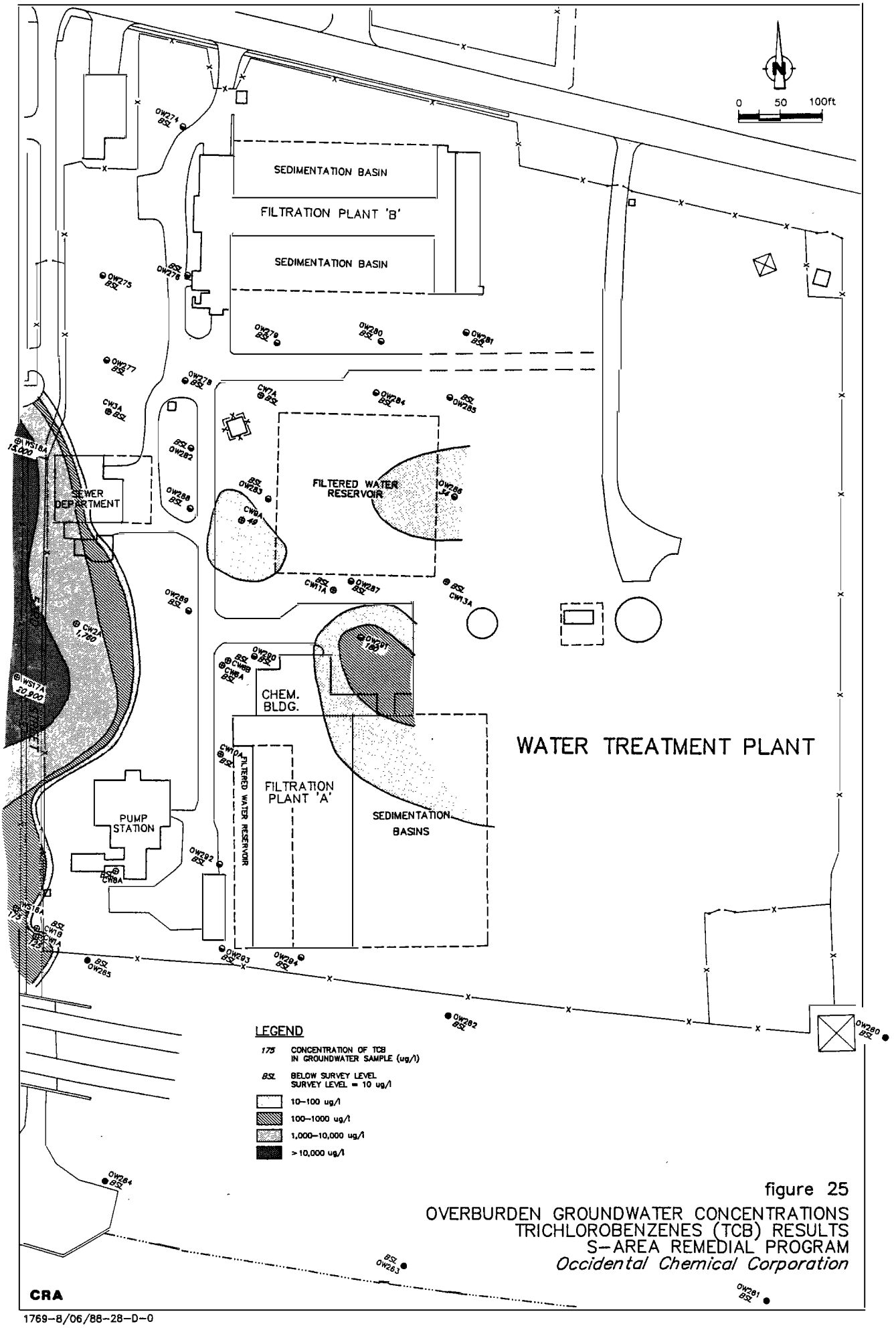

figure 25

OVERBURDEN GROUNDWATER CONCENTRATIONS
TRICHLOROBENZENES (TCB) RESULTS
S–AREA REMEDIAL PROGRAM
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Consequently, the presence of TCB at these three locations is inconsistent with migration from the S-Area.

Tetrachlorobenzene (TECB) - Figure 26

The presence of TECB on the WTP is limited to low concentrations centered between the Filtered Water Reservoir and Plant A. The observed concentrations were 47 ug/l at OW291, 18 ug/l at CW9A and 10 ug/l (equal to the survey level) at OW287. These locations are separated from the elevated S-Area concentrations by wells OW282, OW288, OW289, OW290, CW6A, CW6B, CW10A and CW11A which did not contain TECB above the survey level. These concentrations are consistent with the elevated soil concentration observed at OW291 (3180 ug/kg). These data are not consistent with migration from the S-Area through the overburden.

Hexachlorobenzene (HCB) - Figure 27

Although present in historic groundwater samples collected at the S-Area, HCB was not detected above the survey level at any well included in the S-Area Survey. It is to be noted that, although HCB had been found in the soil adjacent to Plant B at OW280 (410 ug/kg), it was not present in the groundwater sample collected from that well.

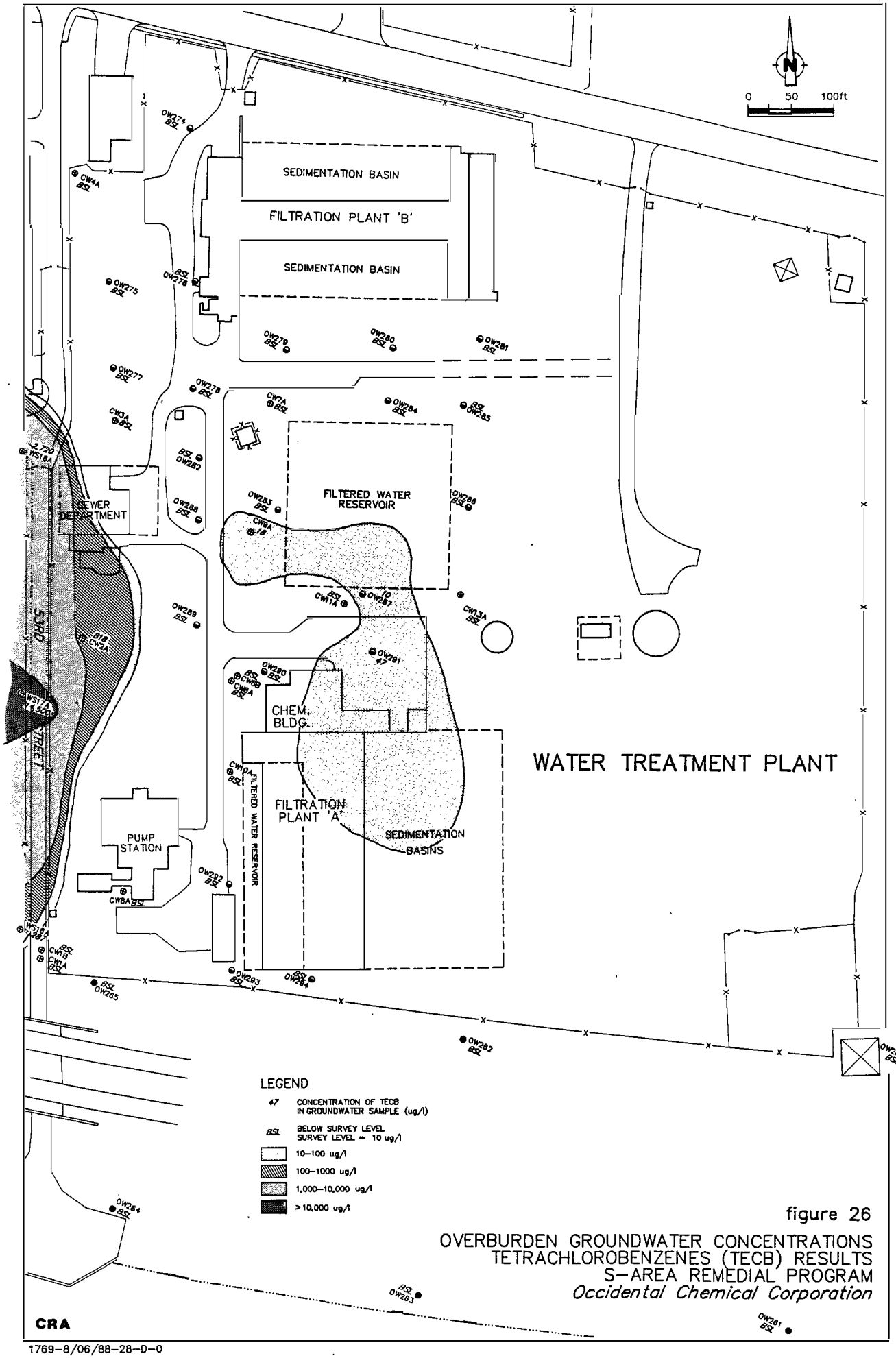

figure 26

OVERBURDEN GROUNDWATER CONCENTRATIONS
TETRACHLOROBENZENES (TECB) RESULTS
S–AREA REMEDIAL PROGRAM
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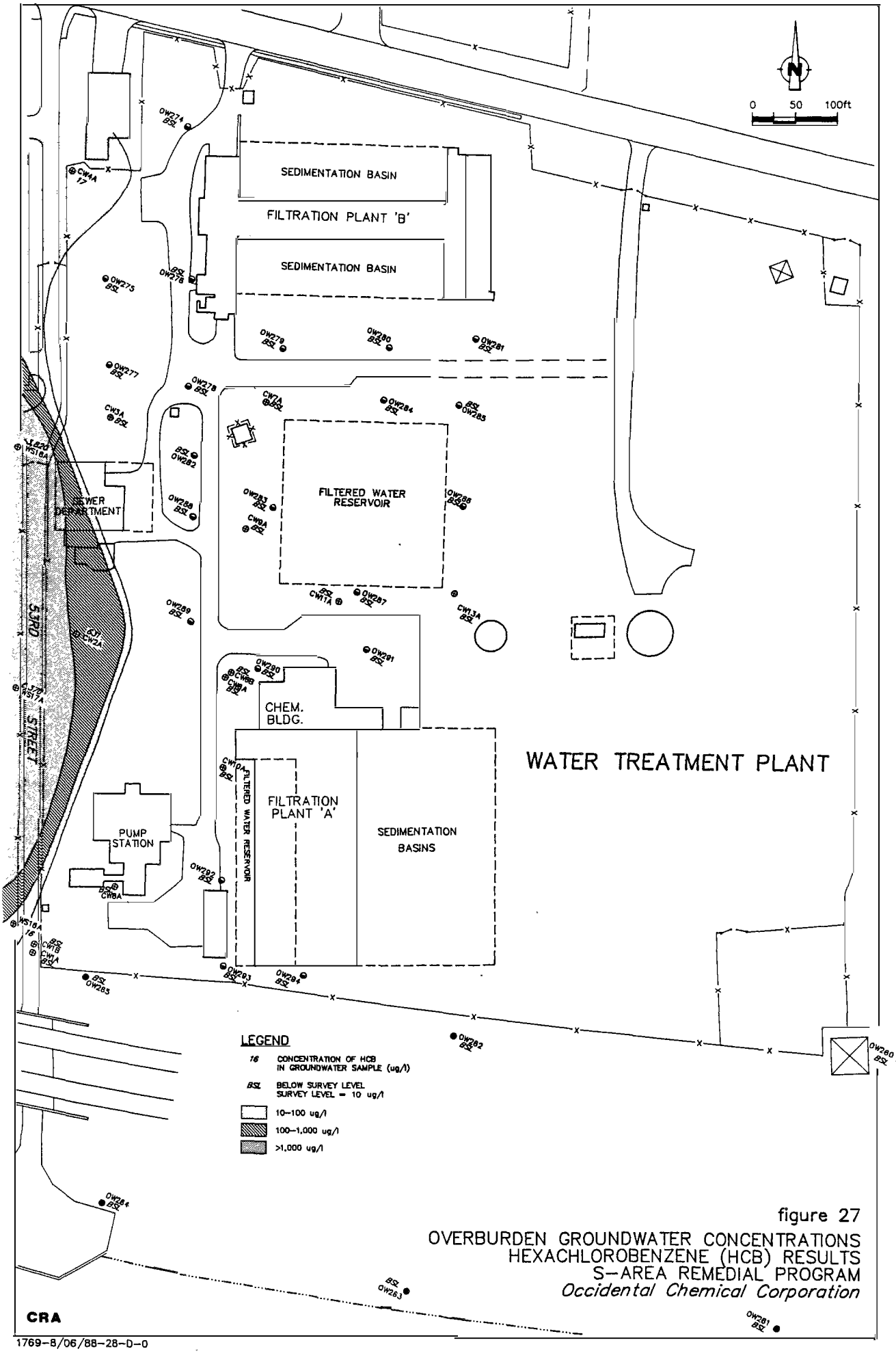

figure 27
OVERBURDEN GROUNDWATER CONCENTRATIONS
HEXACHLOROBENZENE (HCB) RESULTS
S–AREA REMEDIAL PROGRAM
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Hexachlorobutadiene (C46) - Figure 28

C46 was not detected in any survey well on the WTP. It was noted to be present at the S-Area.

Octachlorocyclopentene (C58) - Figure 29

C58 was not detected in any survey well on the WTP. It was present in only one historic well near the S-Area -- CW2A at a concentration of 600 ug/l.

Hexachlorocyclohexanes (HCCH) - Figure 30

HCCH was only detected at one well in the survey conducted on the WTP. The measured concentration at CW9A was 67 ug/L. However, in the adjacent wells between CW9A and the S-Area where elevated concentrations were observed in the historical data (OW282, OW288 and OW289), HCCH was not detected.

Perchloropentacyclodecane (Mirex) - Figure 31

Mirex was not detected in any survey well on the WTP, even though Mirex was detected on the S-Area's eastern boundary at elevated concentrations.

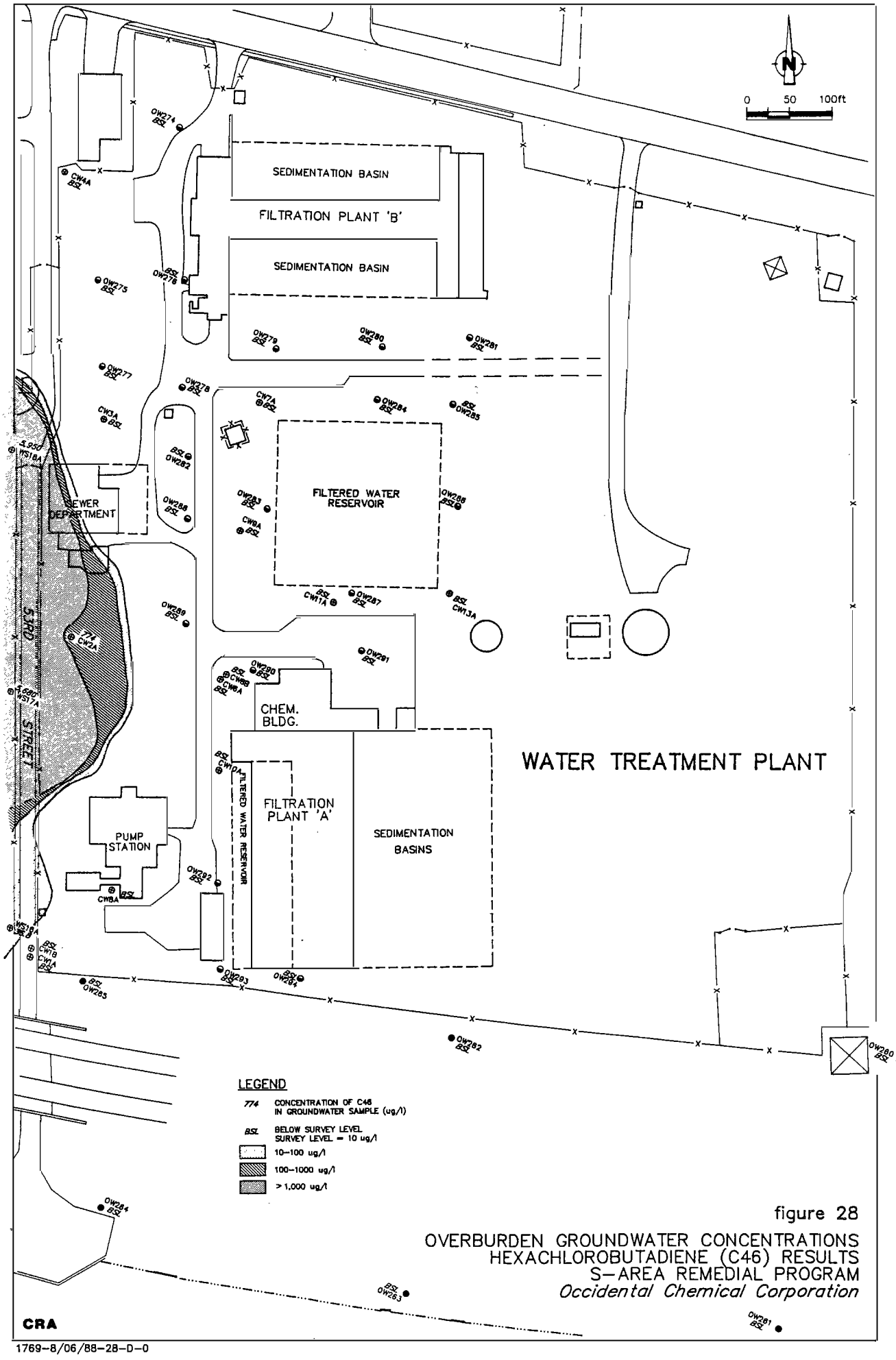

figure 28

OVERBURDEN GROUNDWATER CONCENTRATIONS
HEXACHLOROBUTADIENE (C46) RESULTS
S–AREA REMEDIAL PROGRAM
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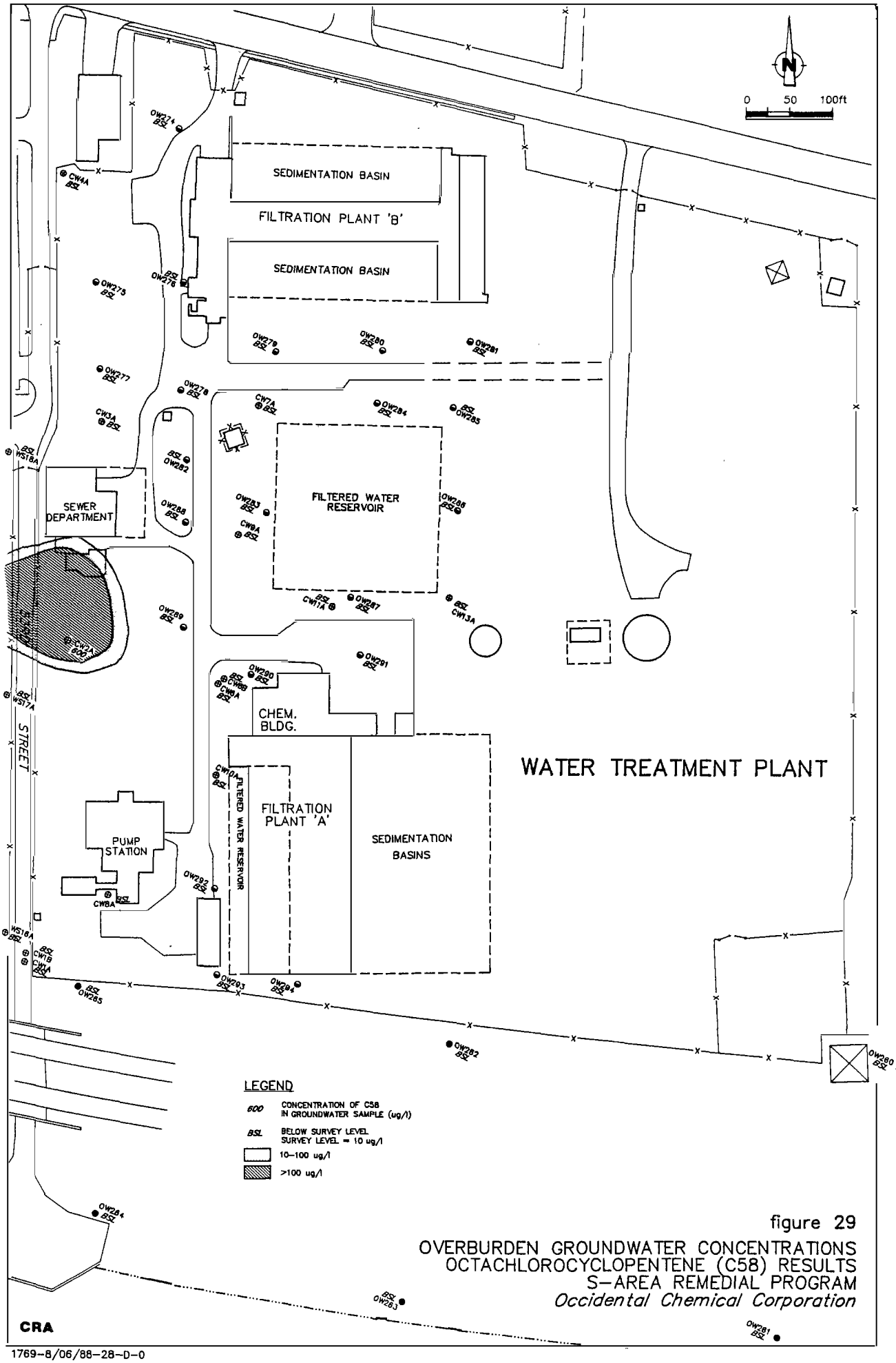

figure 29

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

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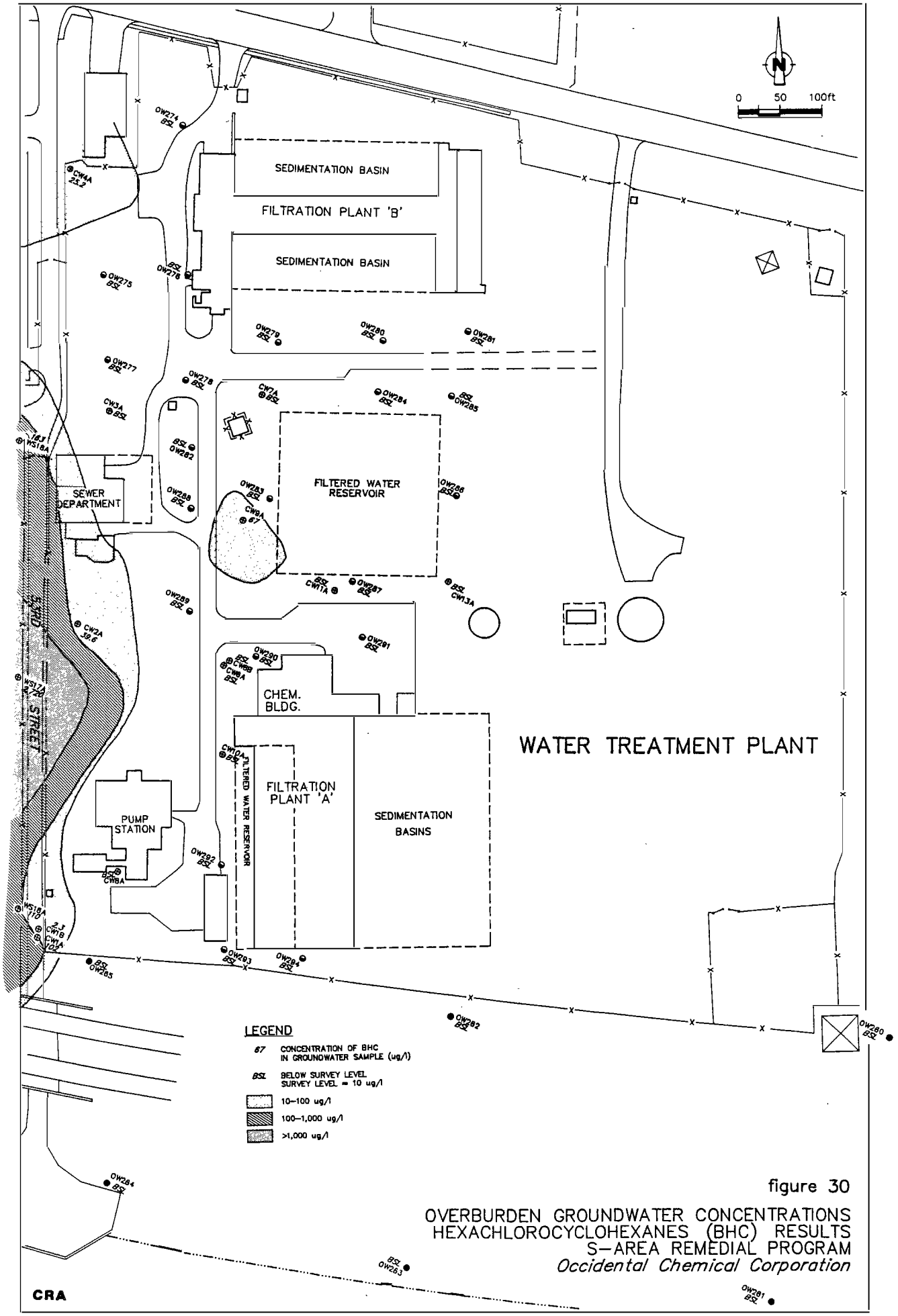

figure 30

OVERBURDEN GROUNDWATER CONCENTRATIONS
HEXACHLOROCYCLOHEXANES (BHC) RESULTS
S–AREA REMEDIAL PROGRAM
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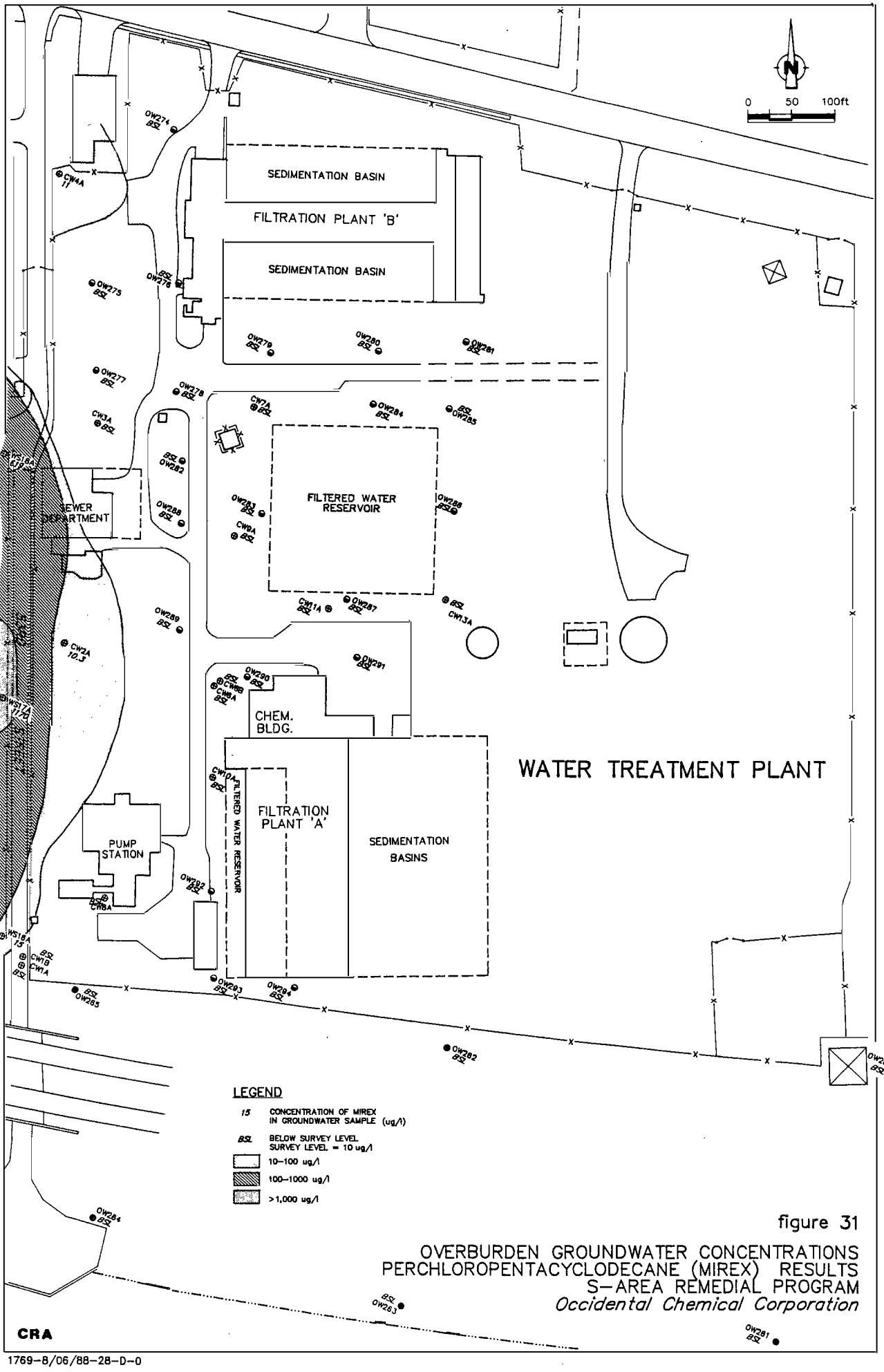

figure 31

OVERBURDEN GROUNDWATER CONCENTRATIONS
PERCHLOROPENTACYCLODECANE (MIREX) RESULTS
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Combined Specific Parameters - Figure 32

Based only upon the data from the S-Area Survey (i.e. not including historical information), Figure 32 shows the combined specific parameter concentrations measured at the survey wells on the WTP. As can be seen from Figure 32, the groundwater across the Site is "clean" in the north and south. Specific parameter presence was observed only in the vicinity between the Filtered Water Reservoir and Plant A. The highest combined concentration of specific parameters in the groundwater was measured at CW9A at a concentration of 1354 ug/l. By comparison, the three wells between CW9A and the S-Area (OW282, OW288 and OW289) had combined specific parameter concentrations of BSL, 38 ug/l and BSL respectively.

This data indicates that chemicals at the S-Area landfill are not migrating in the overburden groundwater to the area of the Filtration Plants and Filtered Water Reservoir.

3.3 PRESENCE OF NAPL

3.3.1 Survey for NAPL

According to the Settlement Agreement, survey levels are deemed exceeded at any soil sampling location

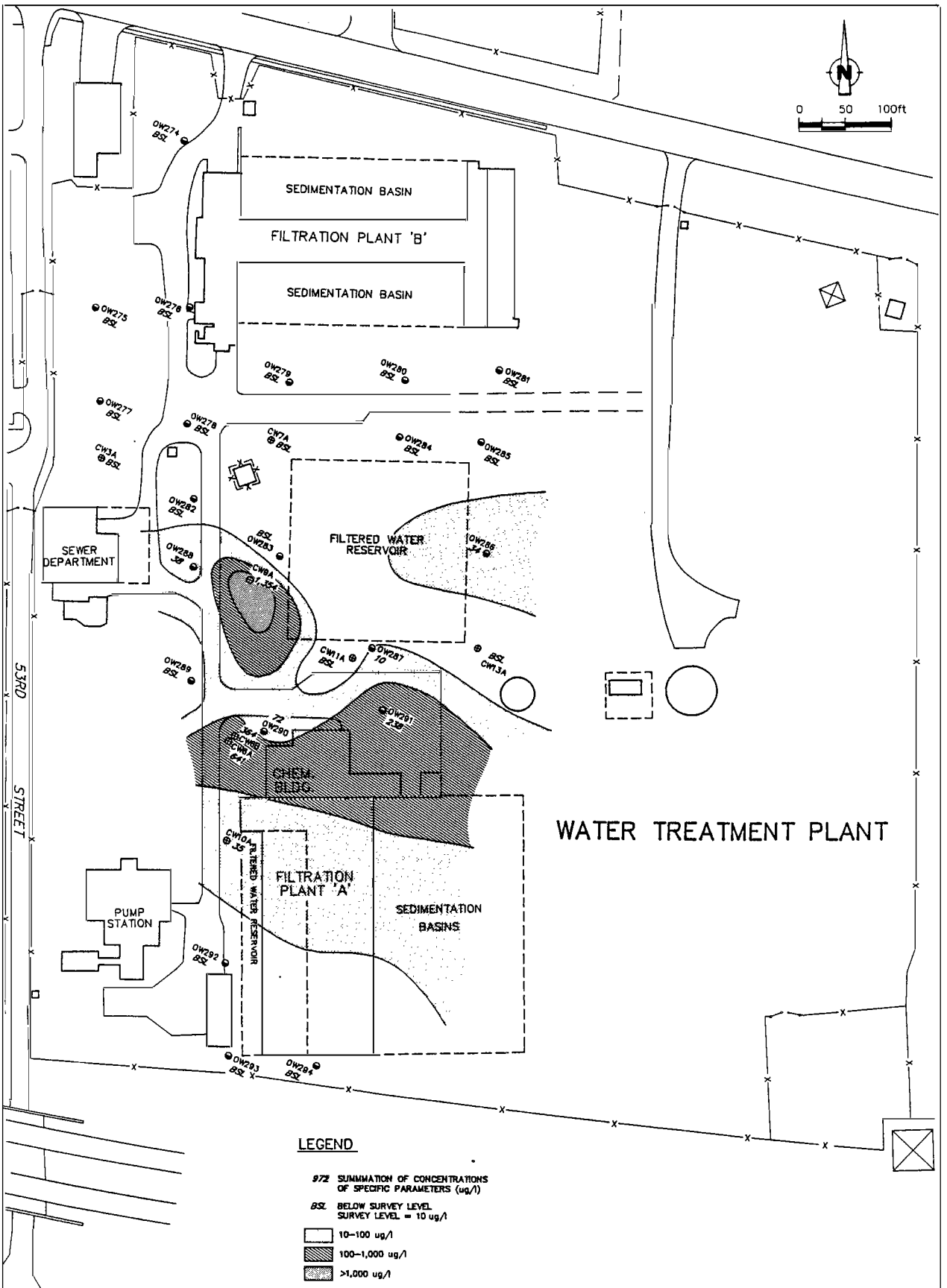

figure 32
SUMMATION OF SPECIFIC PARAMETER CONCENTRATIONS–GROUNDWATER
S–AREA REMEDIAL PROGRAM
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above the water table where evidence of non-aqueous or solid phase chemicals is found.

During the split spoon soil sampling for the 21 survey well installations on the WTP, the soil logging included notations of visual and olfactory evidence of the presence of non-aqueous phase liquid or solid phase chemicals. All relevant data has been reviewed for references to black residues, oily appearances and other properties associated with NAPL, and is presented in the "Information Summary Report". Using the identified occurrences of NAPL, a plan view showing the areal extent of NAPL migration from the Landfill toward and onto the WTP property was mapped. Figure 33 presents the defined limits of NAPL migration in the overburden.

As illustrated by Figure 33, NAPL was found to be present in the overburden at CW1 and CW2A. NAPL was noted to be present during the installation of CW1 when the soil was washed out to clear a path for the overburden casing installation. NAPL was not observed during the installation of CW2A but was observed during the collection of groundwater samples from CW2A. NAPL presence, as a result of migration through the overburden, has not been observed to be present at any other location at the WTP.

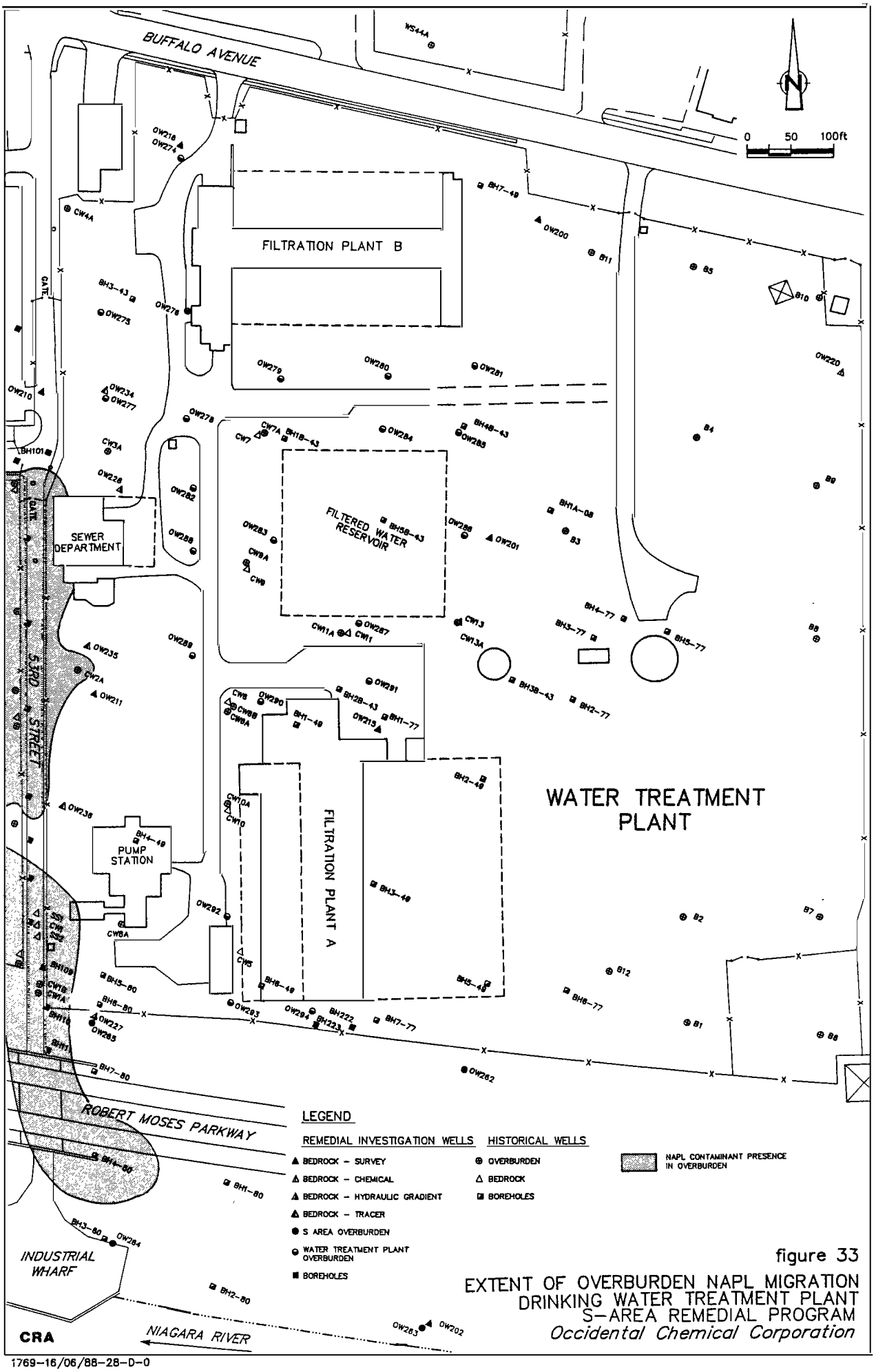

figure 33

EXTENT OF OVERBURDEN NAPL MIGRATION
DRINKING WATER TREATMENT PLANT
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3.3.2 Mobility Testing

The Settlement Agreement requires that following the identification of NAPL or chemicals at any well or excavation, OCC shall conduct a test to assess whether any identified Survey NAPL or chemicals are mobile in the overburden. (Add. I,E[4][b])

During the Settlement Agreement surveys completed to date, no NAPL has been observed during any drilling or excavation on the WTP property or during the collection of groundwater or soil samples from survey sites at the WTP. However, the historic data base indicates that NAPL was detected on the WTP in the vicinity of CW2A near 53rd Street. The area of NAPL presence around CW2A appears to be very limited since NAPL was not observed at either well OW211 and OW235. In any event, the continued easterly migration of NAPL further into the WTP is unlikely for the following reasons:

- The top of the clay/till confining layer in this area dips to the south and therefore the flow of NAPL that lies on top of this low permeable strata should also be to the south.

- Given the depleted volume of NAPL left at the S-Area, and the extended period over which it has taken the NAPL to migrate as far as it has, it should not now migrate beyond the western portion of the WTP.

- In the future, the trench from the abandoned 48-inch and 54-inch water service lines and the proposed Pump Station Collection System should intercept any easterly NAPL migration.

As previously noted in Section 3.1, only one instance of semi-solid phase chemicals was encountered during the course of the S-Area Survey. This occurred at OW294 which is located south of Plant A. A sample of this material was forwarded to the laboratory for centrifuge testing and was determined to be non-mobile.

Because no other NAPL or NAPL samples were observed, no other mobility testing was undertaken.

3.4 ASSESSMENT OF SURVEY RESULTS

3.4.1 Soil

The presence of soil survey parameters above the survey levels has been identified at the WTP. However, the distribution pattern of the chemicals present is inconsistent with the hypothesis that these chemicals migrated from the S-Area through the overburden into the central area of the WTP.

The highest concentrations of specific parameters present were identified at OW283, OW291 and OW294. Essentially, all of the specific parameters present at OW283 were the result of monochlorobenzoic acids. Well OW283 was the only location where monochlorobenzoic acids were identified in either the soil or groundwater. Consequently, its presence must be associated with a source local to that well, not migration from the S-Area.

Similarly, the chemical presence at OW294 is probably due to the semi-solid phase chemicals identified to be present in the soil at this location. Again, the absence of similar chemicals at OW292 and OW293 located between the S-Area and OW294 indicates that this chemical did not migrate in the overburden from the S-Area.

The concentrations observed at OW291 are also indicative of chemical sources in the immediate area and not of chemicals which have migrated from S-Area. Essentially, in the case of every parameter involved in the survey, the concentrations observed in the soil at OW291 were higher than the concentrations observed in the wells between OW291 and the S-Area.

The most plausible explanation for this data is that the source of the chemicals present in the soil is in the fill material placed in the immediate vicinity of the

well and not as a result of migration from the S-Area. A review of the historic conditions at the WTP show that in fact the entire southern half of the WTP is built on land that has been reclaimed from the River by the placement of fill material. Figure 34 shows the progression of the shoreline over the years. As can be seen by comparing the fill area (1920 and after) with the areas of chemical presence in the soil, the area where chemicals are present in the soils correlates reasonably well with the area of fill.

It is therefore concluded that the source of the chemicals identified in the soils in the vicinity of the Filtered Water Reservoir, Plant A and Plant B is not migration from the S-Area but most likely the result of filling activities.

3.4.2 Groundwater

Review of the analytical results from the historical data base clearly indicate that there is a chemical plume of elevated chemical concentrations on the S-Area and immediately adjoining property of the WTP (i.e. in the vicinity of CW2A). It is to be noted that this plume also coincides with the area of NAPL detected during the S-Area Survey.

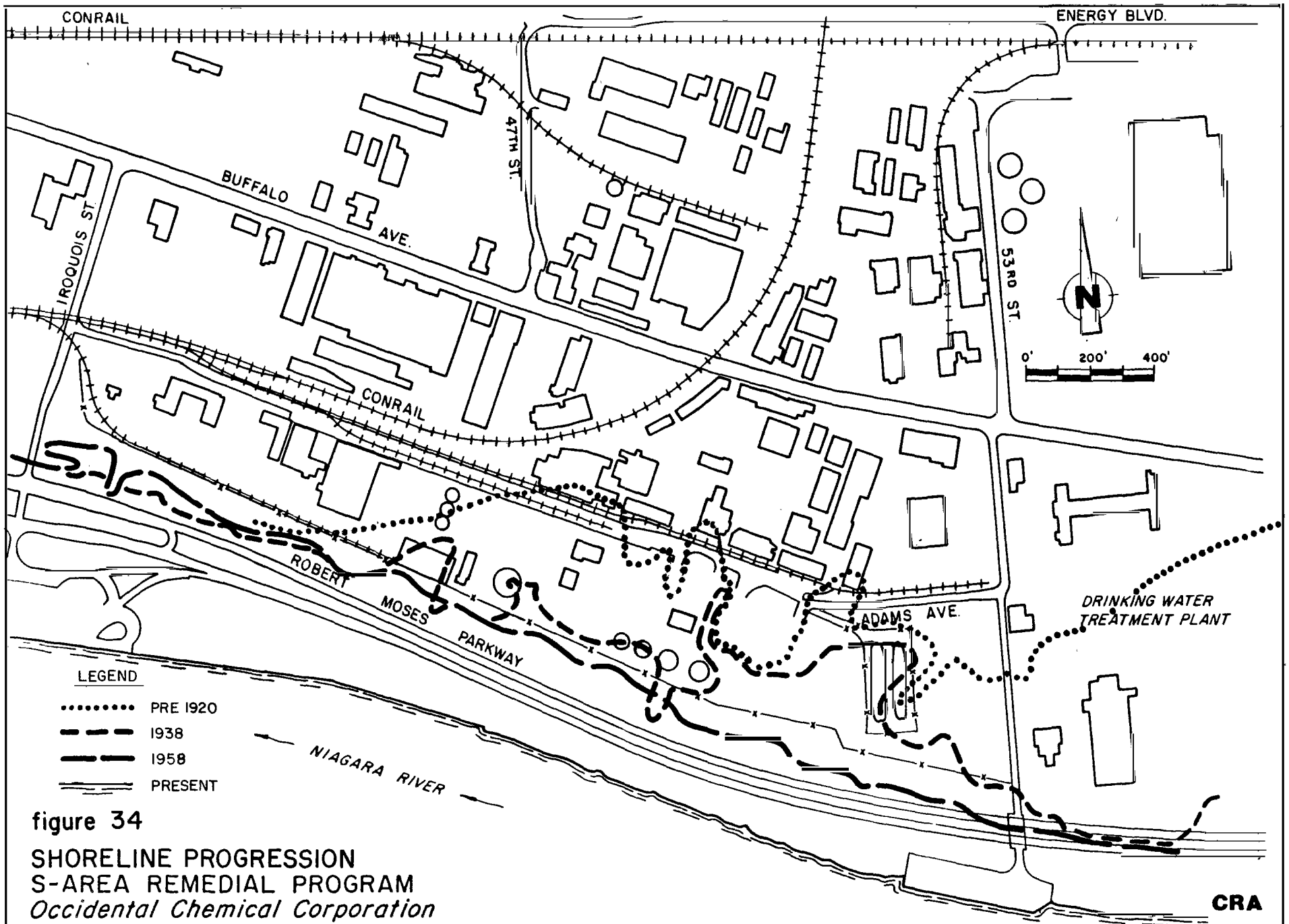

figure 34

SHORELINE PROGRESSION
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The data demonstrate that the flow of groundwater at the WTP is predominantly to the south. Consequently, the area of the WTP, particularly in the vicinity of CW9A and OW291, would not be expected to be impacted by migration of groundwater from the S-Area. Nevertheless, chemicals are present in these areas. In fact, often the highest concentrations observed are located at these wells (CW9A and OW291) even though the well samples closer to the S-Area have lesser concentrations or do not even reveal the chemical. Trichlorobenzene, tetrachlorobenzene and pH are prime illustrations of this condition.

It is interesting to note that in three of the areas at the WTP where data indicated the presence of elevated levels of specific parameters in the soil, groundwater samples collected from these same areas indicated no concentrations of specific parameters above survey levels. Two were the area south of Plant A in the vicinity of OW293 and OW294 and the area south of Plant B in the vicinity of OW280. The third area was the location exhibiting the highest concentration of specific parameters in the soil, OW283 (monochlorobenzoic acids) which did not show any concentration above the survey level in the groundwater.

The distribution of S-Area parameters observed in the groundwater at the WTP is consistent with the

hypothesis that the chemical source of these concentrations is fill material in the immediate area of the wells and not migration through the overburden from the S-Area.

3.4.3 Chemical Migration

The attenuation of chemicals in a geologic regime is affected by various physiochemical and biological factors. The primary mechanisms of attenuation may include covalent, ionic and hydrogen bonding, biodegradation, precipitation, volatilization, VandeWaals attractions and hydrolysis. Each of these is subsequently influenced by the local environment (i.e. pH, temperature, oxidation/reduction potential, carbon content of the matrix, contact time, grain size, ionic concentration, permeability, porosity, etc.).

In reviewing the specific parameters identified in the WTP soils, the best indicator of their relative mobilities is given by their octanol-water (K_{OW}) and soil sorption (K_{OC}) partition coefficients. The octanol-water partition coefficent is the ratio of concentration of analyte in an octanal phase to concentration of analyte in water, expressed algebraically as follows:

$$K_{ow} = \frac{C_{oct}}{C_{H_2O}}$$

Where C_{oct} = concentration in octanol phase

C_{H_2O} = concentration in aqeuous phase

The soil sorption coefficient is, like K_{ow}, dimensionless and gives an indication of the chemical's propensity to adsorb to a geologic matrix. This parameter is calculated as the ratio of the concentration of chemical in a geologic matrix to the concentration in water divided by the fractional organic content of the matrix.

In determining relative chemical mobility, K_{oc} is likely the most useful indicator. Table 6 presents K_{oc}, K_{ow} and other physiochemical constants for chemicals found in the WTP soils.

As indicated, chlorobenzoic acid has an extremely high water solubility (2.13×10^6 ug/l at 25°C for 2-chlorobenzoic acid) and correspondingly low K_{ow}

TABLE 6

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

and K_{OC} values. On this basis, chlorobenzoic acid would be expected to be the least attenuated compound and therefore has the greatest potential to migrate from S-Area onto the WTP. It is to be noted that this chemical was found in S-Area groundwater at high concentrations but was observed only once in WTP soils (BHW283) at 96,000 ug/kg. Since chlorobenzoic acid is not observed at monitoring points on the WTP's western boundary, it is concluded that the source is localized and not due to migration from the S-Area.

Mirex was observed once at BHW294 and, unlike chlorobenzoic acid species, is relatively immobile (K_{OC} = $24x10^6$). Therefore, it is concluded that this chemical's source must be localized.

Monochlorobenzene was the most pervasive compound found in the WTP soils and is somewhat localized to the area between the Filtered Water Reservoir and Plant A. MCB was also found in soils collected south of Plant A. MCB was a major component of S-Area NAPL, was present in S-Area APL and has a low K_{OC} and K_{OW} (380 and 692, respectively). However, the hydrogeologic data indicates that groundwater flow is southerly and not easterly from the S-Area. In addition, the concentrations of MCB observed in the vicinity of CW6B and CW9A seem separated from the S-Area by the low concentrations and non-detect samples collected from wells OW282, OW288 and OW289 located between the S-Area and the elevated concentration locations identified in the

S-Area. However, this conclusion could only be confirmed by installation of a well further west of CW6B.

One other factor of importance in assessing chemical migration is the concentration of the various parameters retained in the soil. Once a parameter has migrated through a soil, it should become adsorbed to the soil in concentrations relative to the concentrations of the migrating fluid that has passed through it. Consequently, it would be expected that the concentrations would decrease with distance from the source since the concentrations of the parameter in the migrating fluid is diluted, dispersed and attenuated. As a result, the fact that the highest concentrations of particular parameters are identified considerable distances from the S-Area with no apparent high concentration plume in between is indicative of localized sources and not migration from the S-Area.

4.0 RE-EVALUATION OF COLLECTION SYSTEMS

Based upon a review of the analytical results of soil and groundwater samples and upon an evaluation of NAPL presence, the conceptual design of the various collection systems (see Figures 35, 36, 37 and 38), was re-evaluated. The conclusions drawn from this re-evaluation are described in the following sub-sections.

Pump Station Collection System - Figure 36

The data from the Surveys indicate that the groundwater at the southeast corner of the Pump Station does not contain any specific parameters. In addition, historic data from CW8A indicated the presence of only trace concentrations of MCB, TCB and TECB (86, 0.5 and 1.3 ug/l respectively). Consequently, installation of the southern leg of the Collection System, extending from MH31 to MH32, appears to be unnecessary. A sample from CW8A should be collected to confirm the appropriateness of such a reduction to the System.

Plant B Collection System

No chemistry or NAPL was detected in the overburden around Filtration Plant B. Although HCB was detected in the soil at OW280 (410 ug/l), it is evident from the clean groundwater

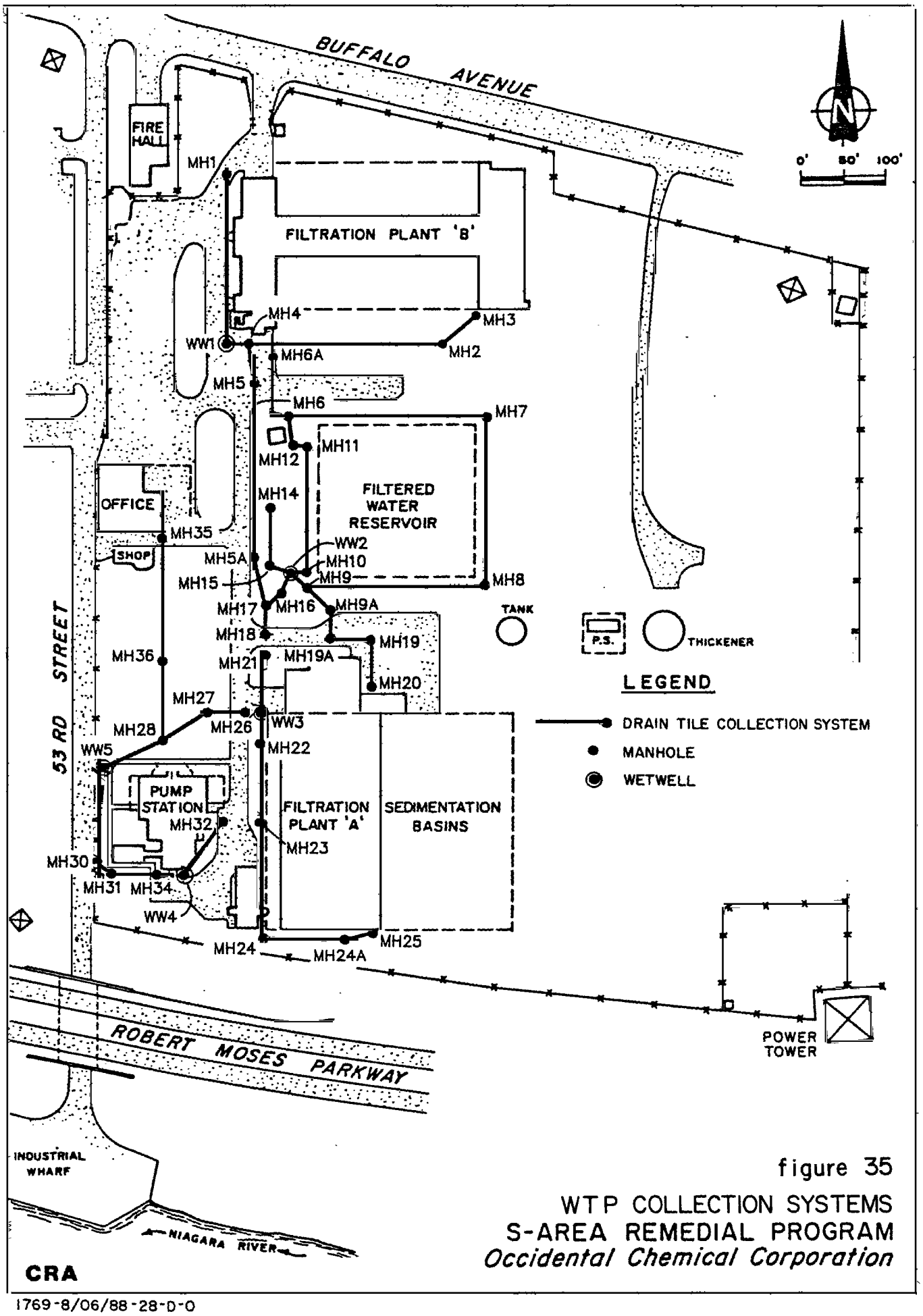

figure 35

WTP COLLECTION SYSTEMS
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-8/06/88-28-D-0

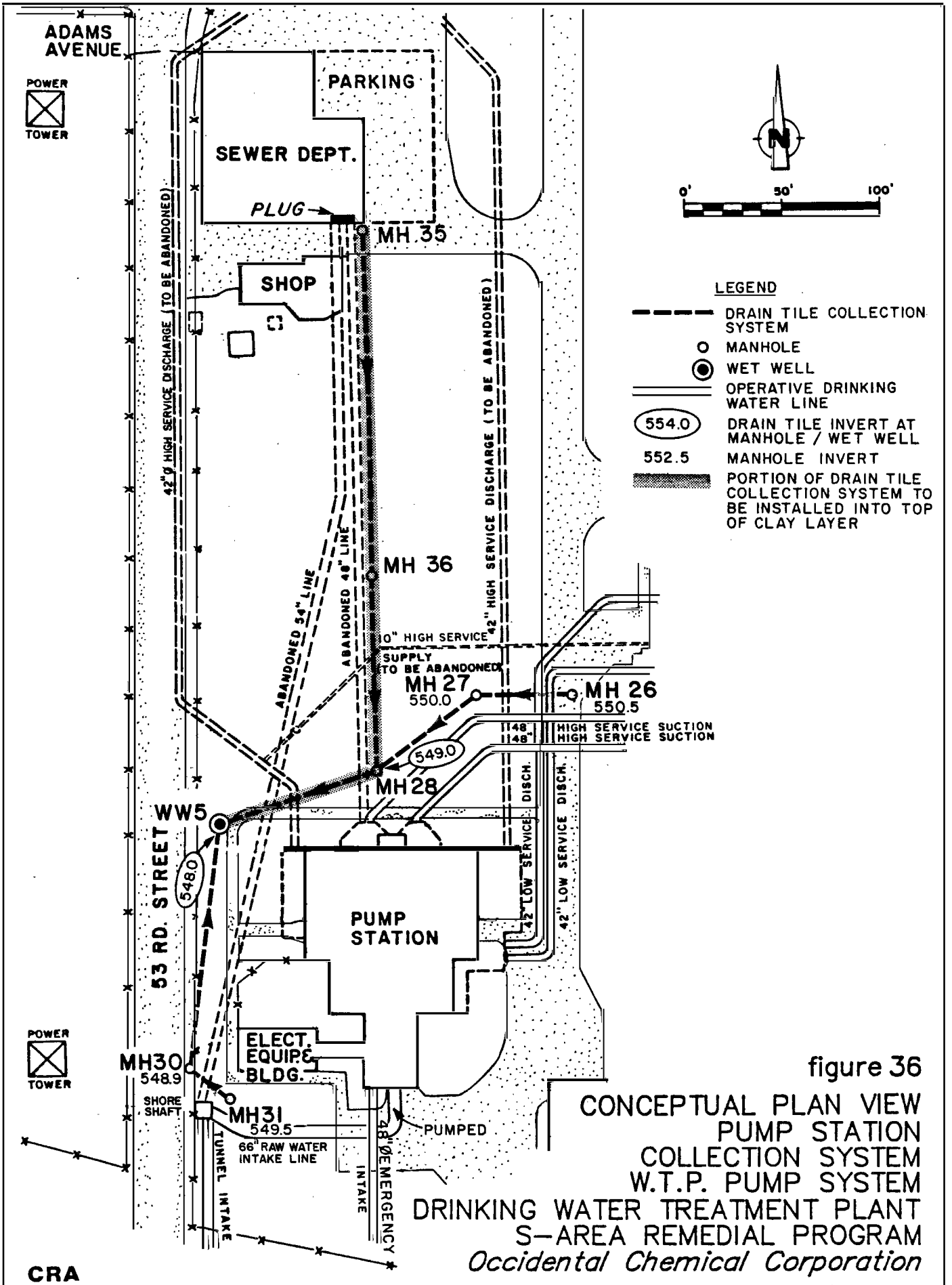

figure 36

CONCEPTUAL PLAN VIEW
PUMP STATION
COLLECTION SYSTEM
W.T.P. PUMP SYSTEM
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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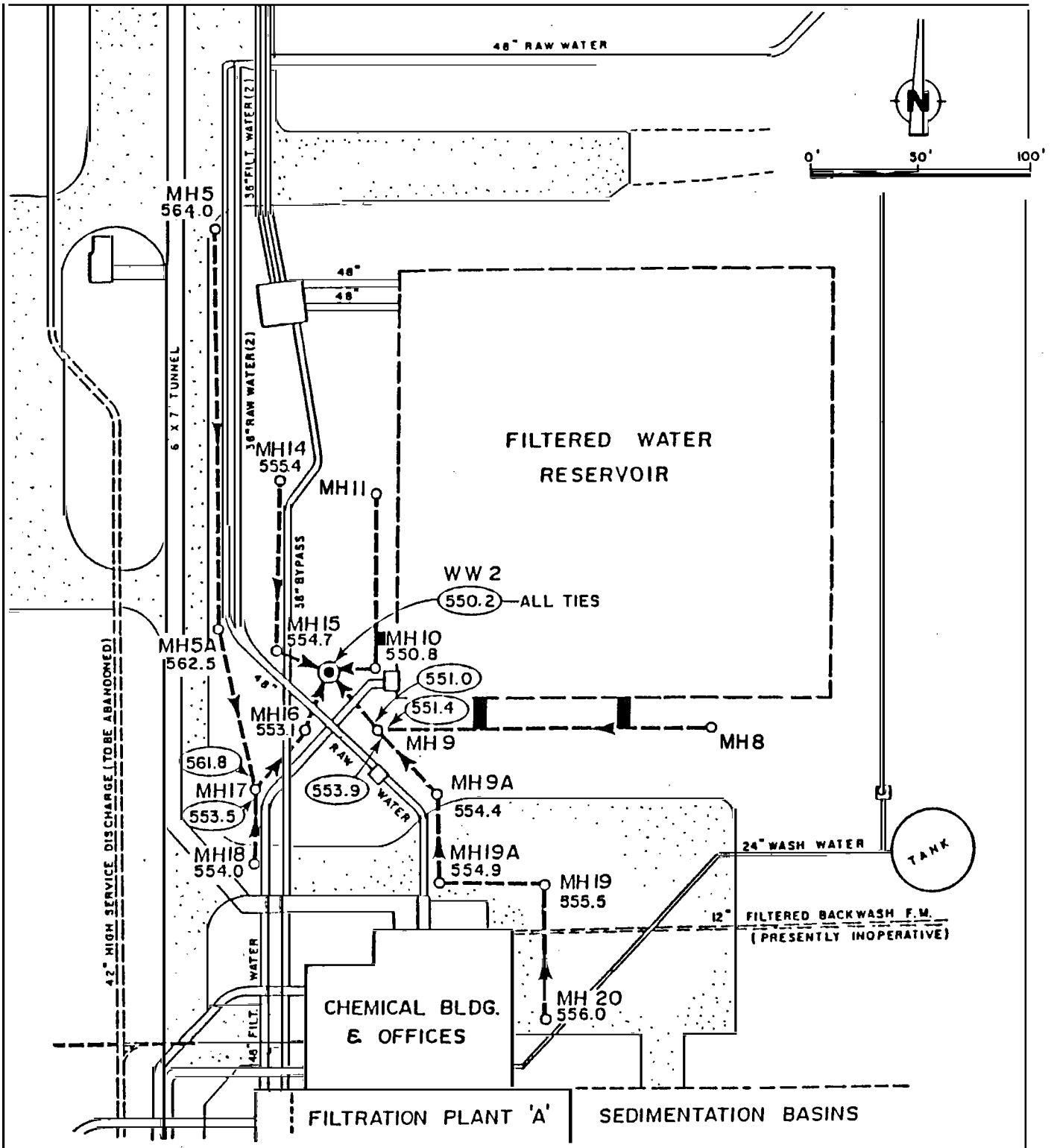

LEGEND

- DRAIN TILE COLLECTION SYSTEM
- (552.3) DRAIN TILE INVERT AT MANHOLE/WET WELL
- MH 17 o MANHOLE
- WW2 ◉ WET WELL
- 551.0 MANHOLE INVERT
- OPERATIVE DRINKING WATER LINE
- DRAIN TILE LATERALS

CRA

figure 37

CONCEPTUAL PLAN VIEW
RESERVOIR COLLECTION SYSTEM
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

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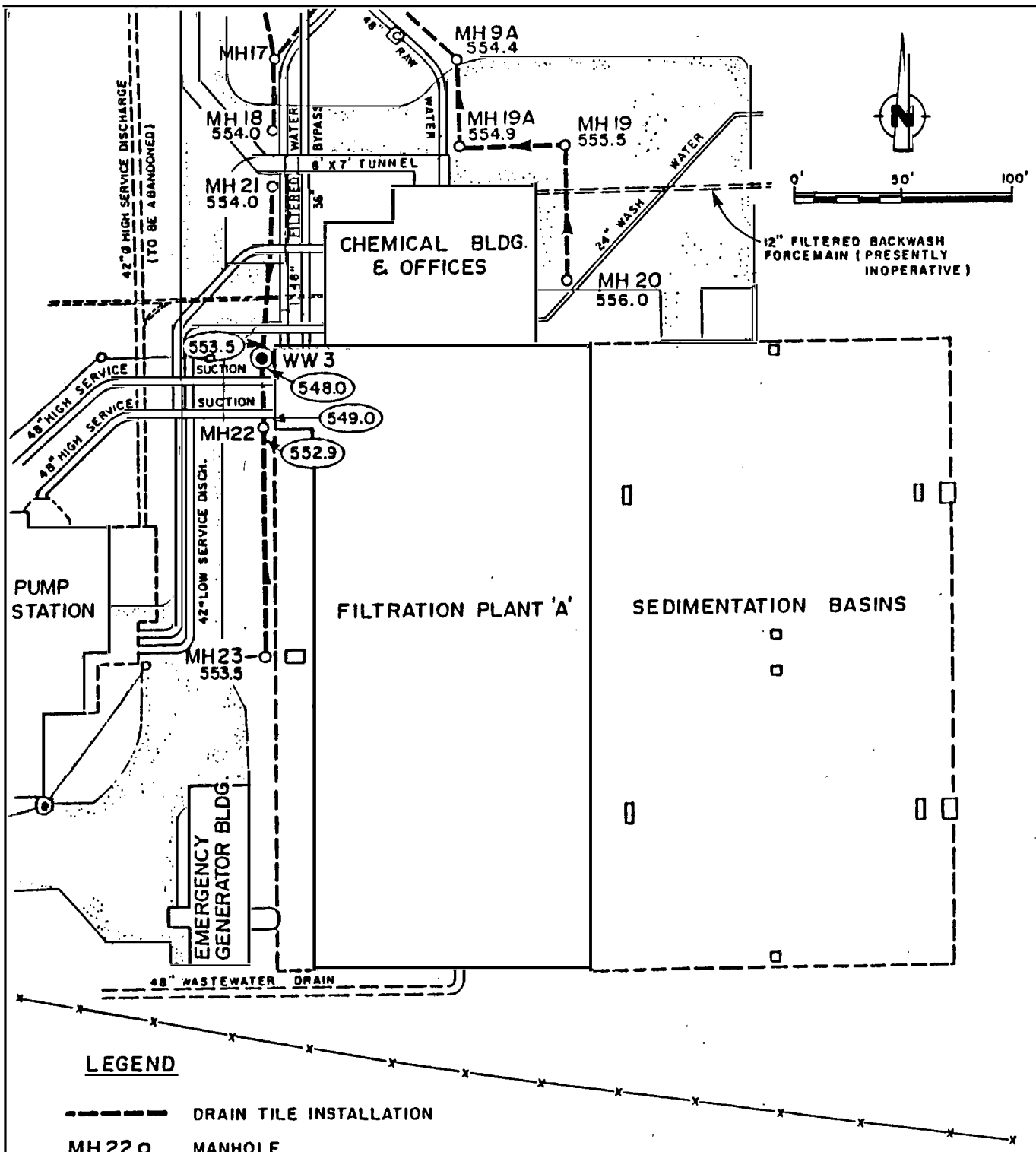

figure 38

CONCEPTUAL PLAN VIEW
FILTRATION PLANT A COLLECTION SYSTEM
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-16/06/88-28-D-0

samples collected that the HCB concentration in the soil in the area of OW280 (see Table 2) is no longer leaching from the soil in that area. Based upon the sampling undertaken in the vicinity of Plant B, it is also evident that there is little water available in this area as three of the wells sampled in this area required more than one day to recover sufficiently to provide the volume of water needed just for the sample analysis (OW274, OW276 and OW280).

Therefore, the installation of the proposed Filtration Plant B Collection System is not necessary.

Filtered Reservoir Collection System - Figure 37

Concentrations of TCB, TECB and HCB on the east side of the Reservoir are present in the soil. However, these parameters are retained on the soil and are not being released to the groundwater. As a result, it appears unecessary to install the eastern portion of the Collection System.

Plant A Collection System - Figure 38

During the Survey, no chemicals were detected in the groundwater in the vicinity of the southern segment of Plant A. It is therefore suggested that the southern section of the Filtration Plant A Collection System, extending from MH23 to MH25, is unnecessary.

5.0 ADDITIONAL DATA REQUIREMENTS

The characterization of overburden soil and groundwater quality at the WTP is essentially sufficient to determine the appropriateness of the installation of the collection systems. However, it is recommended that additional data be collected from these areas to finalize/confirm the conclusions of the Survey.

The three areas are as follows:

i. Soil Samples - Above Water Tables

In order to verify that the chemicals present in the soil in specific areas of the WTP are not a result of migration from the S-Area via groundwater flow, additional soil samples should be collected from the unsaturated soils above the water table at particular locations. It is proposed that these locations include: OW291, OW294, CW6B and CW9A. Soil samples should be collected and analyzed according to the S-Area Survey Protocols except that the sample will be a homogenized composite collected from the surface to within two feet of the top of the water table as opposed to being collected from the top of the water table to the top of the clay or till.

ii. Groundwater Sample - Existing Well

A groundwater sample should be collected from monitoring well CW8A to provide current chemical data for the groundwater in the southern area of the Pump Station. Groundwater quality data for CW8A presented previously in this report is based upon historic data. In order to make an accurate assessment of the need for the southern leg of the Pump Station Collection System, the groundwater quality in this area should be reviewed. Groundwater sampling and analysis of CW8A should be completed as per protocols implemented during similar S-Area Survey sample collection events.

iii. Groundwater Sample - Proposed Well

A new well should be installed and a groundwater sample collected from one location west of CW6A to further define overburden groundwater quality in that area. Specifically, this well will assist in the definition of the areal extent of the monochlorobenzene plume in that area. Construction of the monitoring well and collection and analysis of the groundwater sample should be completed according to protocols implemented during the S-Area Survey.

Figure 39 illustrates the proposed locations of all of the sampling/installations recommended to complete the assessment.

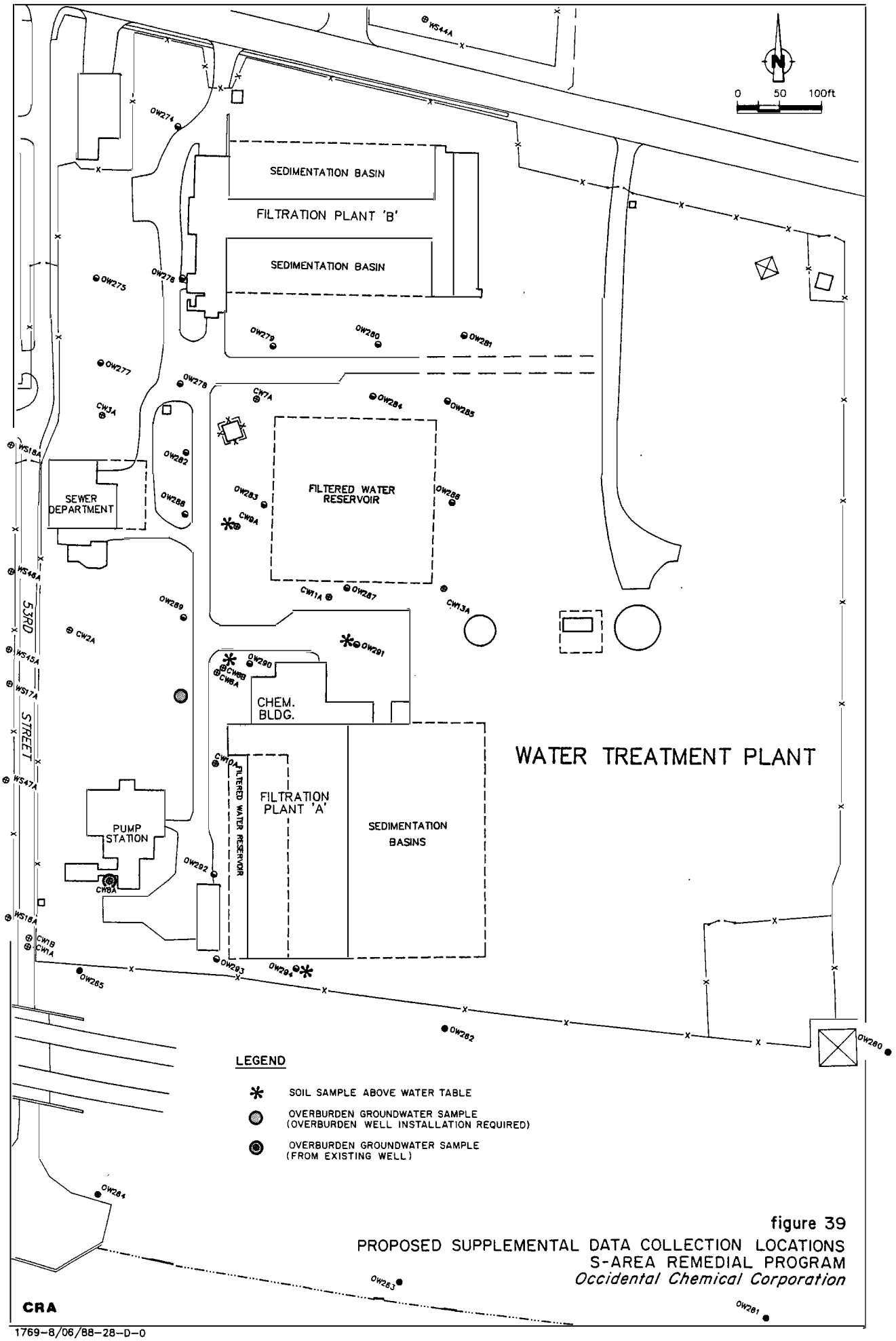

figure 39
PROPOSED SUPPLEMENTAL DATA COLLECTION LOCATIONS
S-AREA REMEDIAL PROGRAM
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6.0 SUMMARY

The results of the survey and assessments that have been completed concerning the presence of S-Area survey parameters in the soil and groundwater at the WTP are summarized in the following:

1) S-Area Survey Parameters are present at a number of sampling locations in the soil and groundwater on the WTP.

2) The presence of NAPL on the WTP is limited to the extreme western limit of the property and was not identified to be present at any sampling location on the WTP during the Survey. The proposed installation of the Pump Station Collection System will eliminate the potential for easterly migration of NAPL beyond the Pump Station Collection System once installed. Even without the installation of the Pump Station Collection System, further easterly NAPL migration is unlikely to occur.

3) The concentrations of S-Area Survey Parameters in the soil at the WTP generally indicate a trend of decreasing concentrations in a westerly direction (i.e. towards the S-Area). This is inconsistent with chemical migration from S-Area in the Overburden.

4. The concentrations of S-Area Survey Parameters in the groundwater at the WTP indicate that the wells exhibiting the highest survey parameter concentrations on the WTP are typically separated from the elevated S-Area APL plume observed along the eastern property line of the S-Area by an area showing no survey parameters. This lack of continuity in the plume and the plume concentrations does not suggest chemical migration in the Overburden from S-Area.

5. From a hydrogeologic perspective of the overburden groundwater, the WTP is not downgradient of the S-Area and therefore would not be expected to receive chemicals which have migrated from the S-Area in the groundwater.

6. The patterns of identified chemical presence in the soil and water are inconsistent with the solubility, transport properties and attenuation characteristics of chemicals which would have migrated from the S-Area.

7. Fill materials were observed at the WTP property, including one case of non-mobile, non-aqueous phase chemical presence. The areas of identified placement of fill on the WTP are consistent with historical records of the southerly progression of the Niagara River shoreline. The sources of the fill material used to extend the WTP property are unknown.

8. It is evident from the survey that fill materials containing chemicals have, in fact, been deposited on the WTP in the vicinity of the Filtered Water Reservoir and Plant A. The chemical concentrations measured in the soil and groundwater collected in this area are consistent with the pattern that would be expected from filling using contaminated soil.

9. Due to the fact that chemicals are not present in the soil and groundwater around certain portions of the Filtration Plants and Reservoirs, portions of the Collection Systems are not necessary to protect those facilities. These include:

° Pump Station Collection System - southern leg of system is unnecessary

° Filtration Plant A Collection System - southern leg is unnecessary

° Filtered Water Reservoir Collection System - northern and eastern portions are unnecessary

° Filtration Plant B Collection System - no collection system is necessary.

10. Additional data is required for the following:

i) Confirm chemical presence in fill around the Filtered Water Reservoir and Filtration Plant A.

ii) Confirm groundwater quality on south side of Pump Station by additional sampling of existing wells.

iii) Confirm groundwater quality west of CW6B by installation of new well and sampling.