The electronic version of this file/report should have the file name:

Type of document . Site Number . Year-Month ..File *Year-Year* or Report name . pdf

letter.____________ ._______-___.CorrespondenceFile_____________.pdf

example: *letter . Site Number . Year-Month . CorrespondanceFileYear-Year . pdf*

report. hw915156 . 1996-03 . Feasibility Study .pdf

example: *report . Site Number . Year-Month . ReportName . pdf*

if a non-foilable site: add ".nf.pdf" at end of file name

Project Site numbers will be proceeded by the following:

Municipal Brownfields - B
Superfund - HW
Spills - SP
ERP - E
VCP - V
BCP - C

FEASIBILITY STUDY

Leica Inc.
Cheektowaga, New York
Site Code: 915156

RECEIVED
MAR 07 1996
N.Y.S. DEPT. OF
ENVIRONMENTAL CONSERVATION
REGION 9

FEASIBILITY STUDY

Leica Inc.
Cheektowaga, New York
Site Code: 915156

PRINTED ON
MAR 05 1996

STATE OF NEW YORK
RICHARD J. SNYDER
No. 66242
LICENSED PROFESSIONAL ENGINEER

March 5, 1996

MARCH 1996
REF. NO. 3967 (8)
This report is printed on recycled paper.

CONESTOGA-ROVERS & ASSOCIATES

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF APPENDICES

APPENDIX A	ASSESSMENT OF SOIL TREATMENT TECHNOLOGIES
APPENDIX B	ASSESSMENT OF GROUNDWATER TREATMENT TECHNOLOGIES
APPENDIX C	HYDROGEOLOGIC EVALUATION OF ALTERNATIVES
APPENDIX D	RESULTS OF THE PLANT BOREHOLE PROGRAM - MARCH 1995
APPENDIX E	TAGM 4030 REMEDIAL ALTERNATIVE SCORE SHEETS
APPENDIX F	NYSDEC MASTER LIST OF STANDARDS, CRITERIA AND GUIDANCE

EXECUTIVE SUMMARY

I. BACKGROUND

A Feasibility Study (FS) was conducted under the Administrative Order on Consent (Index Number B9-0396-91-01) for the Leica Inc. Facility (Site) located in Cheektowaga, New York. The FS was completed in accordance with the following:

- RI/FS Work Plan;
- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, October 1988;
- 6NYCRR Section 375; and
- National Contingency Plan (NCP).

The information presented and evaluated in the report entitled "Remedial Investigation Report" [RI Report (CRA, October 1994) serves as the basis for conducting this FS.

This FS Report has been developed to assess the remedial actions that may be required based on human health risks, environmental risk or exceedances of chemical-specific standards, criteria, or guidance (SCGs).

This FS provides a review of the chemical distribution including exceedances of SCGs for groundwater and soil and the Baseline Risk Assessment (BRA). The results of the BRA and the exceedances of chemical-specific SCGs form the basis for developing remedial action objectives for the Site.

II. CHEMICAL DISTRIBUTION

Subsurface Soils

Three areas of the Site have been identified that contain subsurface soils with organic chemical concentrations exceeding applicable

NYSDEC soil cleanup objectives. The primary chemicals detected in the subsurface soil samples were chlorinated ethenes, chlorinated ethanes and BTEX compounds.

The three areas, designated A, B, and C are associated with the former drum storage area, the northeastern source area and the southeastern fill area, respectively. In addition, a secondary area consisting of the remainder of the fill area outside of Area C, may required remediation. The following areas and volumes have been estimated for these areas: (FIG. 7.0)

	Areal Extent (ft^2)	*Average Depth (ft)*	*Volume (yd^3)*
Area A	990	3	110
Area B	12,450	13	6,000
Area C	22,050	12.5	10,210
Secondary Southeast Area	22,900	14	11,870

Inorganic concentrations detected above soil cleanup objectives in the overburden soils are most likely naturally occurring and probably do not represent a Site-related impact.

Surface Soil

One surface soil sample, collected in the cemetery property, has six SVOCs and four metals detected at concentrations above soil cleanup objectives. However, the source of these parameters is probably not Site-related.

Overburden Groundwater

The primary chemicals detected in the overburden groundwater at concentrations exceeding Class GA groundwater standards are chlorinated ethenes, chlorinated ethanes and BTEX compounds in the northeast area of the Site and chlorinated ethenes and BTEX compounds in the southeast portion of the Site. The VOCs detected most frequently at the highest concentrations include 1,1-dichloroethene, 1,2-dichloroethene, trichloroethene and vinyl chloride.

Bedrock Groundwater

The primary chemicals detected in the bedrock groundwater at concentrations exceeding Class GA groundwater standards are chlorinated ethenes, chlorinated ethanes and BTEX compounds in the northeast area of the Site and chlorinated ethenes and BTEX compounds in the southeast area of the Site. The VOCs detected most frequently at concentrations exceeding SCGs include 1,2-dichloroethene and vinyl chloride in the northeast and southeast areas and 1,1-dichloroethene, trichloroethene and tetrachloroethene in the northeast area only.

Inorganic parameters detected in both the overburden and bedrock groundwater at concentrations exceeding SCGs are considered to be naturally occurring and do not indicate a Site-related impact.

Surface Water

Minor exceedances of Class C surface water SCGs for metals in the surface water sample collected from the small pool of standing water located in the off-Site parcel do not indicate a Site-related impact, but may be the result of naturally occurring conditions or a source unrelated to the Site.

VOCs and SVOCs were not detected at concentrations exceeding SCGs in the surface water sample.

NAPL

NAPL was detected in the overburden groundwater at wells MW-8 and MW-11. The NAPL was found to consist primarily of trichloroethene, 1,2-dichloroethene, xylene, vinyl chloride, ethylbenzene and tetrachloroethene at concentrations ranging from 160,000 J µg/L to 330,000,000 µg/L.

III. BASELINE RISK ASSESSMENT

The BRA was completed during the RI to evaluate the present and future potential impact of Site activities on public health and the environment.

The BRA identified the following three sectors to evaluate soil exposure:

Sector A - the undeveloped cemetery property;
Sector B - the grassed area in front of and along the sides of the plant; and
Sector C - the primarily paved areas to the south and east of the plant.

Exposure pathways which were evaluated in the BRA are summarized as follows:

Media	***Exposure Pathway***	***Receptor Population***
Cemetery Property (Sector A)		
Surface and Subsurface soil	Dermal Contact Incidental Ingestion	Workers Trespassers (residents from adjacent homes)
Plant Site (Sector C)		
Subsurface soil	Dermal Contact Incidental Ingestion	On-Site Workers Contractors
Bedrock		
Groundwater (hypothetical future use)	Ingestion Dermal Contact Inhalation	Residential Use of Private Well (home owners)

The BRA estimated carcinogenic and non-carcinogenic health risks posed by the various exposure pathways. A combination of mid-range and upper-bound exposure assumption factors were used to calculate the average (Mean) and the reasonable maximum exposure (RME) expected to occur under exposure scenarios explicitly developed for the Site. The most likely exposure conditions utilized the average or mean value for the assumption. The reasonable maximum exposure or the RME was based on the 90th or 95th percentile confidence level for the assumption and was intended to be a conservative (i.e., well above the average case) estimate of any potential exposure.

The estimated cancer risks associated with all exposure pathways evaluated for soils were below or within the acceptable range of 1.0E-06 to 1.0E-04 established by the U.S. EPA. It appeared that approximately 80 percent of the total risk was attributable to PAHs reported in one "sediment" sample which was included as a surface soil sample. The remainder of the risk was attributable to arsenic and beryllium which were reported at levels at or slightly above background concentrations expected in soil.

The hazard indices associated with all exposure pathways evaluated for soils were below 1.0, the level of concern.

The future hypothetical use of groundwater from the bedrock below the Site for household use (drinking and bathing) resulted in estimated risks and hazards in excess of the acceptable range. Although there are currently no groundwater users on Site or in the vicinity of the Site, it was hypothesized that the bedrock groundwater could potentially be developed as a potable water source in the future.

The hypothetical future consumption of groundwater by off-Site residents yielded estimated cancer risks that were above the 1.0E-04, the high end of the acceptable range of 1.0E-06 to 1.0E-04 prescribed by U.S. EPA. Arsenic contributed essentially 100 percent of the estimated carcinogenic risk while barium, arsenic and nickel accounted for 99.5 percent of the non-carcinogenic hazard. Although the inorganic constituents resulted in exceedances of the acceptable risk and hazard limits, the RME concentrations of arsenic, barium, and nickel were well below their respective MCLs.

It was concluded in the RI report that although the on-Site bedrock is contaminated, the movement off Site is limited and the present downgradient perimeter conditions do not exceed the MCL levels for the inorganic chemicals which are the primary parameters in bedrock groundwater at the perimeter wells. Concentrations of metals reported in downgradient wells may be in part or totally a result of normal background conditions.

IV. REMEDIAL ACTION OBJECTIVES

Subsurface Soil

Remedial action objectives for subsurface soil at the Site are to prevent or mitigate the migration of chemicals, to the maximum extent practicable, from Areas A, B, and C and possibly the secondary southeast area that would result in groundwater contamination in excess of Class GA groundwater standards. NYSDEC soil cleanup objectives are, therefore, remedial goals for the subsurface soils.

Overburden Groundwater

The remedial objective for the overburden groundwater at the Site is to restore groundwater quality, to the maximum extent practicable, to levels that are protective of human health and the environment. The Class GA groundwater SCGs are, therefore, remedial goals for the overburden groundwater. In addition, remedial goals for the overburden groundwater are to prevent the migration of contaminants, to the maximum extent practicable, to the bedrock aquifer for the protection of human health and the environment.

Bedrock Groundwater

Remedial objectives for the bedrock groundwater at the Site are to prevent the future ingestion and exposure, to the maximum extent practicable, to groundwater with chemicals that pose carcinogenic and non-carcinogenic risks in excess of the established acceptable levels. In addition, remedial goals for the Site bedrock groundwater are to reduce chemical concentrations, to the maximum extent practicable, to the applicable Class GA SCGs for the protection of human health and the environment.

NAPL

The remedial objective for NAPL at the Site is to prevent or mitigate, to the maximum extent practicable, the migration of chemicals from this source area to the groundwater and soil for the protection of human health and the environment.

Surface Water and Surface Soil

Remedial objectives or goals for surface water and surface soils are not necessary based on the results of the RI and BRA.

V. IDENTIFICATION AND SCREENING OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES AND PROCESS OPTIONS

General response actions, technologies and process options were developed and screened for the media of concern at the Site - soil, groundwater and NAPL. General response actions are broad remedial approaches capable of satisfying the remedial action objectives. Technologies were then identified that are applicable to each general response action. Technologies and process options were screened based on technical feasibility, cost, effectiveness and implementability to eliminate the less effective or less reliable technologies and process options.

Based upon the screening process, the following general response actions, technologies and process options were retained for further evaluation:

Subsurface Soil

General Response Actions	*Remedial Technologies*	*Process Options*
1. No Action	--	--
2. Limited Action	a) Institutional Controls	--
3. Removal/Treatment Action	a) On-Site Physical	i) Soil Vapor Extraction/Biological ii) Mechanical Volatilization

Groundwater

General Response Actions	*Remedial Technologies*	*Process Options*
1. No Action	--	--
2. Limited Action	a) Institutional Controls	--
3. Hydraulic Containment Action	a) Bedrock Groundwater Extraction Wells b) Overburden Groundwater Collection Drain	--
4. Source Removal Action	a) Bedrock Groundwater Extraction Wells b) Overburden Groundwater Collection Drain	--
5. Collected Groundwater Treatment Action	a) On-Site Physical	i) Air Stripping (other options including UV/oxidation and carbon adsorption may also be appropriate)
6. Collected Groundwater Disposal Action	a) Disposal at POTW	--

VI. DEVELOPMENT OF REMEDIAL ALTERNATIVES

The following four remedial alternatives for the Site were assembled utilizing the general response actions, technologies and process options retained from the initial screening:

Alternative 1:
- No Action
- Groundwater Monitoring

Alternative 2:
- Institutional Controls
- Groundwater Monitoring

Alternative 3:
- Institutional Controls
- Groundwater Hydraulic Containment (Overburden and Bedrock)/Source Removal, On-Site Treatment
- NAPL Collection, Off-Site Treatment
- Groundwater Monitoring

Alternative 4:
- Institutional Controls
- Groundwater Hydraulic Containment (Bedrock)/Source Removal, On-Site Treatment
- Soil Source Removal, On-Site Treatment (Mechanical Volatilization and Soil Vapor Extraction/Biological)
- Groundwater Monitoring

VII. DETAILED ANALYSIS OF ALTERNATIVES

Each alternative was evaluated in terms of the seven evaluation criteria which encompass technical, cost, and institutional considerations; and compliance with statutory requirements.

The following seven evaluation criteria were used in the detailed analysis of remedial alternatives:

i) overall protection of human health and the environment;
ii) compliance with applicable or appropriate and relevant requirements (ARARs);

iii) short-term impacts and effectiveness;
iv) long-term effectiveness and permanence;
v) reduction of toxicity, mobility, and volume;
vi) implementability; and
vii) cost.

VIII. SUMMARY OF EVALUATION AND RECOMMENDED ALTERNATIVE

Based upon the evaluation presented in this FS, Alternative 4 was recommended as the preferred alternative to address the environmental and human health concerns at the Site. Alternative 4 involves the following remedial components:

- soil source removal with on-Site treatment (mechanical volatilization and soil vapor extraction/biological);
- bedrock groundwater containment/source removal with on-Site treatment;
- institutional controls; and
- groundwater monitoring program.

The No Action alternative (Alternative 1) provides no reduction in risks to human health and the environment. The TAGM 4030 total score of 38 for Alternative 1 was the lowest of the 4 alternatives that were evaluated.

Alternative 2 would reduce the risks associated with all exposure scenarios with the exception of the potential off-Site future groundwater use scenario. However, chemical-specific SCGs would continue to be exceeded for Alternative 2. The TAGM 4030 total score of 39 for Alternative 2 was significantly less than Alternatives 3 and 4.

Alternative 3 would reduce the risks to human health for all exposure scenarios by providing overburden and bedrock groundwater containment and treatment. Alternative 3 had a TAGM 4030 total score of 65 which is significantly greater than Alternatives 1 and 2 but less than Alternative 4.

Alternative 4, which includes soil source removal and on-Site mechanical volatilization and soil vapor extraction supplemented with biological treatment, would also remove the majority of the chemicals in the overburden groundwater and would likely reduce the time required to achieve chemical-specific SCGs in the bedrock groundwater in comparison to Alternative 3. The residual chemicals remaining in the soil and groundwater following soil source removal and treatment for Alternative 4 would require bedrock groundwater containment and treatment for a much shorter duration than would be required for Alternative 3.

The total TAGM 4030 score of 70 for Alternative 4 was the highest of the alternatives evaluated in this FS.

The effectiveness of Alternative 4 would be monitored by implementation of the groundwater monitoring program. The bedrock groundwater containment and treatment system could be extended or reduced as required based upon the results of the monitoring program.

The following pre-design studies would be required to provide supplemental data to support the detailed design requirements for Alternative 4:

- groundwater treatability study;

- pre-design hydrogeologic investigation study:
  - aquifer properties testing, DONE
  - groundwater extraction pumping test, and
  - groundwater extraction system influent chemistry evaluation; and

- soil treatability study. DONE

The pre-design studies would be completed either before or during the preparation of the remedial design. The results of the pre-design studies would be incorporated in the final remedial design.

1.0 INTRODUCTION

Conestoga-Rovers & Associates (CRA) was retained to conduct a Remedial Investigation/Feasibility Study (RI/FS) at the former Leica Inc. facility (Site) located in Cheektowaga, New York. The RI/FS was conducted pursuant to the terms and conditions of the Administrative Order on Consent (Order) (Index Number B9-0396-91-01) between the New York State Department of Environmental Conservation (NYSDEC) and Leica Inc. (Leica).

NYSDEC has classified the Site as a Classification "2" inactive hazardous waste disposal site pursuant to Environmental Conservation Law of the State of New York (ECL) Section 27-1305.4.b. That classification is a determination by NYSDEC that the Site poses a significant environmental threat. The Site is listed in the Registry of Inactive Hazardous Waste Disposal Sites in New York State as Site Number 915156.

In accordance with the Order, the objectives of the RI/FS for the Site include the following components:

1. A RI defining the nature and extent of the release or threatened release of hazardous substances, pollutants or contaminants at and from the Site;

2. A Baseline Risk Assessment; and

3. A FS to identify and evaluate alternatives for remedial action, if any, to eliminate or mitigate all significant threats to the public health or the environment posed by the release or threatened release of hazardous substances, pollutants or contaminants at or from the Site.

A RI/FS Work Plan was developed in accordance with the United States Environmental Protection Agency (U.S. EPA) interim final guidance document entitled "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA", dated October 1988 and NYSDEC regulations and applicable guidance. The RI/FS Work Plan was approved by the NYSDEC and the Order was signed on October 24, 1993.

The Scope of Work (SOW) for the RI/FS presented in Table 1.1 is a compilation of all the work tasks to be performed during the study. A report entitled, "Remedial Investigation Report" [RI Report (CRA, October 1994)] was prepared to satisfy the RI report requirements of Task 10 of the RI SOW. The information presented and evaluated in the RI Report serves as the basis for conducting the FS.

1.1 BASIS FOR REMEDIAL ACTION

Remedial action is required to eliminate all significant threats to human health and the environment (6 NYCRR Section 375-1.10 (b); Consent Order Section III.A).

Therefore, in determining whether remedial action is warranted, the following factors must be considered:

- whether there is a release or threat of a release of a hazardous substance into the environment, or whether there is a release or threat of a release into the environment of a pollutant or contaminant *"which may present an imminent and substantial danger to public health or welfare;"*
- *"Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than* 10^{-4}*, and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts. "*
- whether chemical-specific standards that define acceptable risk are violated;
- whether there are non-carcinogenic effects or adverse environmental impacts that warrant action;

- whether there are uncertainties in risk assessment results;

- whether there are possible future releases (based on quantities of material and environmental setting and reasonably foreseeable future land use); and

- whether other Site-specific conditions warrant action.

(Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions, OSWER Directive 9355.0-30, U.S. EPA, April 22, 1991).

The Risk Assessment Guidance for Superfund (RAGS) states that:

- *"When the cumulative current or future baseline cancer risk for a medium is within the range of 10^{-6} to 10^{-4}, a decision about whether or not to take action is a site-specific determination."* (RAGS, VI, Part B)

In summary, U.S. EPA guidance generally requires that remedial actions be completed at sites where current or future human health carcinogenic risks are identified to exceed 10^{-4} or a non-carcinogenic hazard index exceeds the level of concern (1.0) or chemical-specific standards defining acceptable risks are violated. The guidance further recommends that once the necessity to complete remedial actions has been determined, U.S. EPA has expressed a preference for cleanups that achieve a residual carcinogenic risk level of 10^{-6} (the acceptability of cleanups to residual risk levels in the 10^{-4} to 10^{-6} range is determined on a Site-specific basis). If the Baseline Risk Assessment does not identify unacceptable human health risks (i.e., carcinogenic risks $>10^{-4}$ or hazard index >1.0), it is necessary to assess the requirements for remedial actions to be undertaken based upon the determination of unacceptable environmental risks or the exceedence of chemical-specific standards.

This FS Report has been developed consistent with the NCP to assess the remedial actions that may be required based on human health risks, environmental risk or exceedances of chemical-specific standards.

1.2 FS SCOPE

This FS has been assembled in accordance with the approved Work Plan.

The remedial alternative evaluation presented in this FS was conducted in accordance with 6 NYCRR Section 375.1.10 (c) and the NCP and U.S. EPA guidance documents (U.S. EPA, October 1988). In accordance with The National Contingency Plan (NCP) (40 CFR 300), the appropriate remedy will be a *"cost effective remedial alternative that effectively mitigates and minimizes threats to and provides adequate protection of public health and welfare and the environment."*

Soil and groundwater remediation technologies are evaluated separately in this report.

1.3 REPORT ORGANIZATION

The FS report is presented in the following sections:

1.0 Introduction;
2.0 Site Background;
3.0 Determination of SCGs;
4.0 Identification and Screening of Technologies;
5.0 Development and Detailed Analysis of Alternatives;
6.0 Recommended Alternative; and
7.0 Designation of Corrective Action Management Unit.

Section 2.0 presents an overview of the Site history and background including the results of the RI.

Section 3.0 presents a description of Standards, Criteria, and Guidance (SCGs) potentially applicable to the Site.

Section 4.0 presents the development of the media-specific remedial action objectives and the identification and preliminary screening of potential remedial response actions, technologies, and process options. Each remedial response action and technology is evaluated based upon technical feasibility. Alternative process options are then screened based upon effectiveness, implementability, and cost effectiveness to select a representative process (or processes) for each technology type.

Section 5.0 presents the development of remedial action alternatives utilizing the general response actions, technologies, and process options retained from the initial screening conducted in Section 4.0. A detailed analysis of the remedial action alternatives is presented in Section 5.0. The remedial action alternatives are evaluated in terms of the following:

1) compliance with SCGs;
2) the overall protection of human health and the environment;
3) short-term effectiveness;
4) long-term effectiveness;
5) the reduction of toxicity, mobility, and volume of contaminants;
6) implementability; and
7) cost effectiveness.

Section 6.0 presents the recommended alternative for the Site based on the detailed analysis of alternatives presented in Section 5.0.

Section 7.0 presents a description of the corrective action management unit which would be designated for the recommended alternative.

2.0 SITE BACKGROUND

2.1 SITE DESCRIPTION

The Site is located at the intersection of Eggert Road and Sugar Road in the Town of Cheektowaga, New York. The west boundary of the Site abuts the eastern boundary of the City of Buffalo, New York. The location of the Site is shown on Figure 2.1.

The Site is approximately 24 acres in size situated on a generally flat plain. The Site layout showing surface characteristics is presented on Figure 2.2. An adjoining off-Site parcel of land approximately 6 acres in size owned by the St. Johns Cemetery Association was also investigated during the RI. This off-Site parcel was planned as an extension of Preston Road from Rowan Road to Sugar Road. Storm and sanitary sewer lines and a gravel subbase were installed but the road was never completed.

As shown on Figure 2.2, there are three permanent buildings on Site, including the brick multi-story Main Building of approximately 360,000 square feet, a single story metal storage building of approximately 3,100 square feet, and a 1-story brick fire protection system pump house of 325 square feet. The remainder of the Site is either paved for parking use or landscaped as presented on Figure 2.2.

The buildings and asphalt parking areas occupy approximately 65 percent of the Plant Site. The off-Site parcel is approximately 50 percent wooded with mature growth trees, with the rest of the off-Site parcel being shrub/open meadow vegetation. Soil from grave sites at the adjacent cemeteries is currently being placed in two small areas of this off-Site parcel.

Six storage tanks are or were present on Site as follows:

i) one 110-gallon steel aboveground diesel fuel tank located inside the fire protection system pump house to fuel the diesel pump motor;

ii) one 100-gallon steel aboveground diesel fuel tank formerly located south of the boiler room. This tank was used to fuel a diesel generator. The tank was closed and removed in July 1993;

iii) two aboveground steel solvent storage tanks, one 750-gallon and one 250-gallon, for storage of trichloroethene and 1,1,1-trichloroethane. These tanks were formerly located on the concrete dock area north of the boiler room. The two tanks were removed from service in 1987 and removed from the Site in July 1991;

iv) one 10,000-gallon steel underground tank for storage of #6 fuel oil. This tank, located northeast of the boiler room, is still in service and contains approximately 2,000 gallons of #6 fuel oil; and

v) one 20,000-gallon steel underground tank for storage of #6 fuel oil. This tank, located east of the boiler room, is still in service and contains approximately 11,000 gallons of #6 fuel oil.

The two USTs are registered with the NYSDEC under Permit Number 221775, under the name of Reichart-Jung.

Figure 2.2 shows the general location of these tanks at the Site.

2.2 SITE HISTORY

The manufacturing facility was built on the Site in 1938 by the Spencer Lens Company for the manufacture of scientific instruments and high quality optical devices. Spencer Lens operated at the Site from 1938 to 1945. American Optical Corporation owned and operated the Site from 1945 to 1986, manufacturing the same type of products. From 1986 to 1990, Cambridge Instruments Inc. owned and occupied the Site for the manufacture of similar optical products. In 1990, Cambridge Instruments Inc. merged with Leica Inc. and operated under the Leica name at this Site until 1993. In July 1993, Leica Inc. ceased manufacturing operations at the Site. In

October 1993 the facility and most of the land was sold to Samson Distribution Corporation/Calypso Development Corporation (Samson) for use as a distribution warehouse. Leica retained title to a 100 x 390-foot area in the southeast corner of the Site. Portions of the Main Building are also being subleased by Samson to other businesses.

Prior to 1993, the owners and operators of the facility had all been involved in the manufacture of scientific instruments and optical devices. This involved two primary production processes: a metals operation and a lens production operation. In the metals operation, metal parts were machined and/or manufactured, cleaned, coated, and assembled. The production of optical lenses involved the shaping, grinding, polishing, and coating of glass lenses for use in ophthalmic instruments, microscopes, refractometers, and other optical instruments.

Numerous chemicals were stored and used at the facility for use in or as part of the manufacturing processes. These materials have included paints, solvents (such as acetone, xylene, methanol, methylene chloride, 2-butanone, and chloromethane), degreasers (such as trichloroethene, 1,1,1-trichloroethane), hydraulic oils, fuel oils, cutting oils, refraction oils, cyanide, acid based plating baths, and metals (cadmium, chromium, nickel, zinc, and copper).

The three dual-fuel boilers used to supply steam and heat for the facility currently operate with natural gas as a primary fuel and use #6 fuel oil as an alternate fuel. From 1972 to 1990, #6 fuel oil was the primary fuel. From sometime in the early 1960s to 1972, #5 fuel oil was burned. From 1938 to the early 1960s, the facility was heated with coal. Until about 1956 the ash resulting from the use of coal as a boiler fuel was landfilled on Site in a low area in the southeast corner of the Site as presented on Figure 2.2. After 1956, the ash was disposed of by the Town of Cheektowaga. This area was covered with soil and was subsequently paved over for use as an employee parking area in the late 1950s.

The refuse incinerator, located outside the Main Building immediately north of the boiler room, was built in 1971 for disposal of burnable refuse from the facility and was fired by natural gas. Ash from the incinerator was hauled away by the Town of Cheektowaga. Both the boilers and the incinerator discharged to the atmosphere through a common smokestack. An Air Discharge Permit was issued for this stack as Permit No. 143-000-075. The three boilers were designated emission point numbers 00001A, 00001B, and 00001C and the incinerator was emission point 00001D. The incinerator was operated by Leica until July 1993, when Leica moved from the facility.

NYSDEC records contain no reports of spills or releases at the Site. Leica personnel report a 6,000-gallon #6 fuel oil spill onto the ground in 1970 or 1971 due to a problem while filling a tank. This spill was cleaned up by the fuel delivery company using absorbents, shovels, and pumps.

According to Leica personnel, the only known on-Site disposal was the placement of coal ash in the low area in the southeast portion of the Site.

2.3 PREVIOUS INVESTIGATIONS

The principal investigations performed at the Site prior to the RI include the following activities:

July-August 1990	Phase I Environmental Audit Conducted by Recra Environmental, Inc.	• Site Inspection • Employee Interviews • Records Review
November 1990-January 1991	Phase II Site Assessment Conducted by Recra Environmental, Inc.	• Transformer Area Sampling • Plating Room Sampling • Matching Areas Sampling • Storm Sewer Sampling • Subsurface Soil Sampling - Underground Storage Tank Areas - Drum Staging Areas - Anomalous Areas • Geophysical Survey • Groundwater Well Installation • Groundwater Monitoring

July 1991	Confirmatory Sampling Conducted by CRA	• Groundwater Well Installation • Groundwater Monitoring
January 1992	Supplemental Site Investigation Petroleum Hydrocarbon Delineation VOC Delineation Conducted by CRA	• Borehole Installations • Shallow Soil Sampling • Groundwater Well Installation • Groundwater Monitoring

In July and August 1990, Recra Environmental, Inc. (Recra) conducted a Phase I Environmental Audit of the site in support of the sale of this property.

A Phase II Site Assessment was conducted by Recra between November 1990 and January 1991. The Phase II Site Assessment included subsurface soil sampling (boreholes TB1 to TB9 and well location MW4); installation and sampling of four overburden monitoring wells (MW1, MW2, MW3 and MW4) and a geophysical survey.

Subsurface soil samples were collected during the Phase II Site Assessment in the vicinity of the underground storage tanks, in the former drum storage area and to investigate anomalies identified during the geophysical survey.

Two rounds of groundwater sampling were conducted in November 1990 and January 1991 during the Phase II Site Assessment.

Confirmatory groundwater sampling was conducted in July 1991 by CRA. Three additional monitoring wells, MW5, MW6, and MW7, were installed followed by a sampling round for wells MW1 to MW7.

A Supplemental Site Investigation was conducted by CRA in January 1992 to further investigate conditions at the Site. During the Supplemental Site Investigation, subsurface soil was investigated by the installation of 18 boreholes (BH-A to BH-R). In addition, five groundwater monitoring wells (MW8, MW9, MW10, MW11 and MW12) were installed.

Groundwater monitoring was conducted at wells MW8 to MW12 and previously installed wells MW4, MW6 and MW7.

The results of these previous investigations are presented in the RI Report. Sample locations are presented on Figure 2.3.

2.4 RI SUMMARY

On November 4, 1992, based on the results of the previous investigations presented in Section 2.3, the NYSDEC notified Leica that the Site had been listed on the Registry of Inactive Hazardous Waste Disposal Sites as a Class 2 Site ("significant threat to the environment-action required"). The NYSDEC subsequently requested that a RI/FS be conducted, followed by a Remedial Design/Remedial Action (RD/RA) program.

During the period from November 1993 to August 1994, CRA conducted field activities at the Site in accordance with the approved RI/FS Work Plan. At the conclusion of the RI activities, the information generated by the investigation was correlated and evaluated. This task culminated in the completion of the RI Report which was submitted to the NYSDEC in October 1994.

The RI field investigation included the following activities:

- installation of ten overburden and nine bedrock groundwater monitoring wells;
- hydraulic conductivity testing (rising head tests) was conducted for eight of the nine bedrock wells and ten of the 23 overburden wells;
- five water level monitoring events were conducted during the period from July 1992 to August 1994;

- soil samples were collected from 52 boreholes and analyzed for the Site-specific Parameter List (SSPL) consisting of volatile organic compounds (VOCs), metals, and total petroleum hydrocarbons (TPH) or VOCs, metals, TPH, and semi-volatile organic compounds (SVOCs);

- geotechnical analyses including grain size distribution, Atterberg limits, permeability, and specific gravity were conducted for one Shelby tube sample from the lake sediment layer. Bulk samples collected from the lake sediment layer, sand layer, and till and were analyzed for grain size distribution;

- one sediment sample and one surface water sample were collected from the off-Site area and analyzed for Target Compound List (TCL) VOCs and SVOCs, Target Analyte List (TAL) metals, and TPH;

- three rounds of groundwater sampling were conducted as follows:

  - Round I - samples collected from 12 existing overburden wells were analyzed for TCL VOCs and TPH and samples collected from 4 wells installed during the RI and seven existing bedrock wells were analyzed for TCL VOCs, SVOCs, TAL metals, and TPH,

  - Round II - samples collected from eight overburden and six bedrock wells were analyzed for a revised SSPL consisting of TCL VOCs only, and

  - Round III - samples collected from six overburden and three bedrock wells (installed based on the results of Round I and Round II) were analyzed for the revised SSPL consisting of TCL VOCs only;

- a property boundary and topographical survey were completed for the Site and the adjacent off-Site areas to the east and south;

- a biota survey was conducted for the area east of the Site;

- an air pathways analysis was performed to evaluate potential air emission impacts resulting from the Site; and
- a field survey including the installation of six boreholes was conducted to confirm the location of underground utilities at the Site.

Upon completion of the field activities, all data were compiled with historical data, as appropriate, to define the hydrogeology and the distribution of chemicals at the Site. Based upon the available data, a Baseline Risk Assessment (RA) was conducted consistent with the current U.S. EPA guidance ("Risk Assessment Guidance for Superfund" Interim Final - EPA/540/1-89/002, December 1989 [RAGS, December 1989]).

A supplementary borehole investigation was conducted in March 1995 to investigate the subsurface soil conditions beneath the Plant. Soil samples were collected from three boreholes installed within the Plant building and analyzed for VOCs and TPH.

The results of the field investigation and RA are presented in the RI Report, October 1994. The results of the supplementary borehole investigation within the Plant building, conducted in March 1995, are presented in Appendix D. Sample locations including historical locations are presented on Figure 2.3.

2.5 SITE HYDROGEOLOGY

2.5.1 Site Geology

In general, five stratigraphic units have been identified on Site which consist of the following:

i) fill materials;
ii) native lake sediments, primarily clay and silt;
iii) saturated water-laid deposits, primarily silt and sand;
iv) basal till deposits, primarily compacted sand and gravel;

v) bedrock (Onondaga Formation limestone).

Stratigraphic cross-sections for the areas investigated during the RI are presented on Figures 2.4 to 2.6. These units are described further below.

The overburden at the Site consists of a thin layer of fill material overlying native soils consisting of lake sediments, sandy soils, and till. The total overburden thickness ranges from 8.1 feet to 16.0 feet. The overburden is generally thickest along the east side and southeast corner of the Main Building (13 to 15.5 feet) which appears to correspond with the higher ground elevations observed in these areas.

The fill encountered at the Site consists of disturbed native soils; imported topsoil in the grassed areas; sand, gravel, and asphalt in the parking lot areas; and assorted fill, including brick, glass, slag, ash, coal, clinkers, metal, gravel, wood, and other materials in the area southeast of the Main Building. The fill layer ranges in thickness from 0.5 feet to 6.2 feet and is thickest in the areas east and southeast of the southeast corner of the Main Building, where it is in excess of three feet thick. The fill thins toward the south and west. In the eastern parking lot area, the fill is generally less than one foot thick, with native soil occurring below a thin topsoil or asphalt layer. The moisture content of the fill zone varied from dry to wet across the Site. The water in the fill is a perched water table resting on the underlying lake sediment layer.

The native soils at the Site consist of a lake sediment layer overlying a gray silty-sand layer. The thickness of the native soil ranges from 5.4 feet to 12.9 feet. The overall thickness of the native soils averages 9.7 feet, and is thickest in the east parking area and the west part of the south parking area. The native soils are thinnest in the southeast portion of the Site; correlating to the thickest fill areas.

The lake sediment layer at the Site is a varved, red-brown clay and silt with minor amounts of sand and fine gravel. Results of grain size distribution analyses indicate clay and silt comprise from 78.6 to

97.4 percent of this unit. Laboratory analyses indicate that the permeability of the lake sediment layer is approximately 1×10^{-8} cm/sec, with a porosity of 0.37 and a moisture content of 19.5 percent. The lake sediment layer ranges in thickness from 2.4 feet to 9.4 feet, and averages 5.6 feet thick. The lake sediments were described as being dry to moist.

Beneath the lake sediments is a saturated silt and sand layer (sandy zone), which is primarily silt and sand with minor amounts of clay and gravel. Results of grain size distribution analyses indicate silt comprises from 40.2 to 49.3 percent and sand comprises from 31.4 to 46.3 percent of this unit. This sandy zone ranges in thickness from 1.9 feet to 9.7 feet and averages 4.1 feet thick.

A thin, densely compacted till layer lies below the sandy zone directly above the bedrock. Where noted to be present, this till layer ranged in thickness from 0.3 to 3.0 feet, with an average thickness of 1.1 feet. The till layer was notably drier than the overlying silt and sand deposits. The grain size distribution analysis conducted for the sample collected from the till layer at well MW-1A indicates the presence of silt at 34.2%, sand at 30.7%, clay at 17.7% and gravel at 17.4%. This thin sandy till unit has been included with the overlying sandy zone for the hydrogeologic assessment.

The bedrock encountered beneath the Site is the Onondaga Formation. The uppermost member encountered is the Moorehouse Member, a fine to medium grained, light to medium gray, massive limestone with nodular chart, tabular and rugose corals, and brachiopod fossils. This member is noted to be up to 55 feet thick in the Buffalo Area. The actual thickness under the Site is unknown as the bedrock wells penetrate a maximum of 32 feet of bedrock.

2.5.2 Site Hydrogeology

The following four hydrostratigraphic units have been identified at the Site:

i) Perched Water Table Unit;
ii) Overburden Silty Clay Aquitard Unit;
iii) Overburden Silt and Sand Water-Bearing Unit; and
iv) Onondaga Limestone Bedrock Aquifer Unit.

A hydrostratigraphic unit is comprised of one or more stratigraphic (geologic) units which have similar hydraulic properties. Hydrostratigraphic units are designated aquifers (waterbearing zones) if they transmit groundwater, or aquitards (confining layer) if they restrict groundwater flow.

The Perched Water Table Unit exists within limited areas of the fill zone at the Site as evidenced by the moisture content of the fill zone material encountered during subsurface investigations in the southeast portion of the Site. This perched water zone appears to coincide with the areas having the greatest amount of fill and is discontinuous at the Site. It is highly probable that the Perched Water Table Unit occurs only periodically following wet conditions in the spring (and possibly late fall) of the year since groundwater levels in the deeper sandy zone of the overburden were observed to drop significantly as discussed below.

The groundwater table within the Silt and Sand Unit has been monitored by periodic measurements of water levels at the Site over a period of 3 years. Seasonal fluctuations of the water table on the order of 4 to 6 feet occur, with a significant drop in water levels and/or drying up of some on-Site overburden wells observed during drier periods.

The estimated hydraulic conductivity for the Silt and Sand Water-Bearing Unit at the Site based on the results of the RI range from 1.1×10^{-5} cm/sec to 1.1×10^{-2} cm/sec.

The groundwater flow in the Overburden Silt and Sand Water-Bearing Unit occurs from the north, east and west toward the southeastern corner of the Site, i.e., the depressional area in the vicinity of MW-4, MW-8 and MW-11.

The overburden (sandy zone) groundwater elevation contours are presented for three sets of water levels:

i) April 11, 1994 representing the high water level season (see Figure 2.7);

ii) June 23, 1994 representing the nominal water level conditions and which will be generally used in this study (see Figure 2.8); and

iii) August 30, 1994 representing the low water levels of the late summer dry season (see Figure 2.9);

This description of the overburden groundwater flow is consistent with that expected due to elevated topography to the east (Pine Ridge) and to the north (the south slope of Cleveland Hill) of the Site. A large depressional area is located southwest of the Site. Regionally, the shallow groundwater flow is southward from the Site to the Squajaquada Creek which passes through this depressional area. A smaller localized depressional area trends south of the Site and up through the eastern side of the Site. The shallow groundwater flow on Site appears to be influenced by and directed towards this localized depressional area in the southeastern portion of the Site.

The groundwater flow within the Bedrock Aquifer Unit (Onondaga Formation limestone) occurs primarily along bedding plane fractures and vertical joints. Weathered horizontal fractures and partings in the rock cores were frequently observed. As bedrock is rather shallow, the groundwater flow pattern in the bedrock is expected to be similar to that of the overburden, i.e., influenced by the surrounding topographic features.

The bedrock groundwater elevation contours for June 23, 1994 data is presented in Figure 2.10 and is considered representative of the normal conditions. The Bedrock Unit groundwater flow across the eastern part of the Site appears to be from a high point at well MW-17A westward toward well MW-16A. This is consistent with the expected pattern due to recharge from Pine Ridge, east of the Site. On a Site scale, the Bedrock Unit groundwater appears to flow from the southwest and the northeast (and probably from the north also) toward the localized depressional area occurring between well MW-6A and well MW-14A in the southeastern part of the Site. The Bedrock Unit groundwater flow patterns appear to correlate well with the top of bedrock contours (i.e., sloping towards the southeastern corner).

The estimated hydraulic conductivity for the Bedrock Aquifer Unit based on the results of the RI, ranges from 9.3×10^{-5} cm/sec to 1.8×10^{-2} cm/sec.

2.6 CHEMICAL DISTRIBUTION

The analytical results for samples collected from the various environmental media during the Phase II Site Assessment (1990), Confirmatory Sampling (1991), Supplemental Site Investigation (1992), the RI (1993/1994) and the Supplementary Borehole Program (1995) have been used to define the chemical distribution at the Site. The following sections present discussions of the chemical distribution for each of the media investigated.

2.6.1 Soil

The chemical distribution in soils is based on analytical results for soil samples collected from boreholes installed in areas which were identified in previous investigations or during the RI as sources of contamination or potential sources of contamination. In the eastern area, soil samples were collected from boreholes installed in and adjacent to the former drum storage pad, near the location of the former aboveground storage tanks and a dry well sump, near the underground fuel oil storage area, and within the Plant building. In the southern area, boreholes were installed in the southeast part of the Site, and in the off-Site parcel. Boreholes were installed to collect soil samples of the shallow fill zone and/or the deeper silty-sand zone soils.

The discrete potential source areas are shown on Figure 2.2 and are discussed separately in the following subsections.

Compound concentrations exceeding NYSDEC cleanup soil objectives[1] in the shallow and deep soils are presented on Figures 2.11 and 2.12, respectively.

Inorganic concentrations detected in soils are summarized in Table 2.7 for the lake sediment layer and sand layer. As indicated on Table 2.7, the inorganic results are consistently higher in the lake sediment layer than the sand layer with the exception of calcium and magnesium. Calcium and magnesium are expected to be higher in the sandy layer which is in close proximity to the bedrock. The absence of a defined source area for inorganics coupled with the two distinct ranges for inorganics (including metals that have historically been used at the Site (cadmium, chromium, nickel, zinc and copper)) indicate that the inorganic concentrations in the overburden soils are naturally occurring and probably do not represent a Site-related impact.

2.6.1.1 Former Drum Storage Area

This area, located at the northeast corner of the Main Building, consists of a 40-foot by 70-foot concrete pad surrounded by asphalt parking areas. This area was used to stage drums of various chemicals and waste materials prior to off-Site disposal. The former drum storage pad area is no longer used for the storage or handling of drummed wastes and chemicals.

A summary of detected compounds is presented on Table 2.1 for the former drum storage area.

---

[1] Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels, HWR-94-4046, NYSDEC, January 24, 1994.

As presented on Figure 2.11, the reported concentration of 1,1,1-trichloroethane at BH-DS2-93 exceeds the soil cleanup objective of 800 µg/kg. The horizontal and vertical extent of 1,1,1-trichloroethane around borehole BH-DS2-93 is limited, as exhibited by the low concentrations detected in the adjacent boreholes (BH-DS-E1, BH-DS-E2, BH-DS-N1, BH-DS-N2, BH-DS3-93, and TB-1 and the deeper soil sample from TB-1), the closest which are only 20 to 30 feet away.

The portion of the former drum storage area that contains subsurface soils with organic chemical concentrations exceeding NYSDEC soil cleanup objectives is designated as Area A for the purposes of the FS. The volume of soil with chemicals that exceed cleanup objectives in Area A is estimated to be 110 yd^3 based on an areal extent of 990 ft^3 and a depth of 3 ft.

2.6.1.2 East Side Dry Well Area/Former Aboveground Storage Tank Area/Underground Fuel Oil Storage Tank Area/Plant Building

Multiple potential contaminant sources are present within close proximity of each other in this area, located east of the Main Building. A stone-filled pit (dry well) functioned as the drainage sump for the trench and floor drains in the former flammable liquids storage room. Outside this room, two aboveground solvent storage tanks (trichloroethene and 1,1,1-trichloroethane) were formerly located on an elevated concrete loading dock. To the southeast, two USTs were used to store #5 and #6 fuel oil and one AST stored diesel fuel. Each of these potential sources was investigated as described in the following subsections. Table 2.2 presents a summary of organic compounds detected in the samples collected from these areas.

2.6.1.2.1 Former Aboveground Storage Tank Area (AST)

This area was investigated through the collection of one shallow soil sample and one duplicate soil sample from borehole BH-AST1-93 located beneath the pavement at the foot of the elevated concrete loading dock area. Reported concentrations, as presented on Figure 2.11, for 1,2-dichloroethene of 570D and 660JD µg/kg and a trichloroethene concentration of 850JD µg/kg exceed the soil cleanup objectives of 300 µg/kg and 700 µg/kg, respectively.

2.6.1.2.2 East Side Dry Well Area

The east side dry well located approximately 25 feet east of the AST area, was the receiver for floor and trench drains from the former flammable storage room. This dry well consists of a 4-foot by 4-foot hole about 6 feet deep which was backfilled with stones, covered with soil, and paved over.

Analytical results, as presented on Figure 2.12, indicate the following compounds at concentrations exceeding soil cleanup objectives in the deeper sandy zone: 1,1,1-trichloroethane (21,000D µg/kg), trichloroethene (1,700JD µg/kg), toluene (1,800JD µg/kg), ethylbenzene (17,000D µg/kg), and xylene (92,000D µg/kg).

2.6.1.2.3 Underground Fuel Oil Storage Tank Area

Two USTs for the storage of heavy fuel oils (#5 and #6) are present in the area east of the Main Building. One AST for storage of diesel fuel was also located in this area.

Concentrations of chemicals exceeding soils cleanup objectives were reported for shallow soil samples and for the deep soil sample as presented on Figures 2.11 and 2.12, respectively. VOCs detected above the soil cleanup objectives in the shallow soils include 1,1,1-trichloroethane (1,200JD µg/kg), xylene (7,000 D µg/kg) and benzene (80 µg/kg). Benzene (140 µg/kg) exceeded the soil cleanup objective in the sample collected from the deeper soils.

2.6.1.2.4 Plant Building

Three boreholes were installed within the plant building during the supplementary investigation conducted in March 1995. The boreholes were located within 45 feet west of the flammable material storage room.

Analytical results, presented in Appendix D, indicate that compounds were not detected at concentrations exceeding soil cleanup objectives in the deeper sandy zone soil samples collected from beneath the Plant.

2.6.1.2.5 Summary

The portion of the multiple contaminant source area (east side dry well area, above ground storage tank area and the underground fuel oil storage tank area) that contains subsurface soil with organic chemical concentrations exceeding NYSDEC soil cleanup objectives is designated as Area B for the purposes of the FS. The volume of soil with chemical concentrations that exceed cleanup objectives in Area B is estimated to be 6,000 yd^3 based on an areal extent of 12,450 ft^2 and a depth of 13 ft.

2.6.1.3 Southern Area

The southern area includes the entire southern portion of the Site and the area between the Main Building and the storage building. Historical research has shown that a portion of this area was filled with coal ash prior to 1956. This filled area lies in the southeast part of the southern area as presented on Figure 2.2.

The results of analysis of the soil samples confirmed organic chemicals present in both the shallow and deep soils in the southeast part of the Site. These installations also defined the extent of elevated chemical presence as being limited to the ash-filled area. Summaries of detected compounds for samples collected from the shallow and deep soils in the southern area are presented in Tables 2.3 and 2.4, respectively.

The contamination in the shallow soils from the southeast part of the area, which correlates well with the area of ash placement (as shown on Figure 2.2), runs west to east from a point somewhere between MW-21 and MW-6A to the eastern property line. The north to south extent is from the TB-7/BH-8-94 area, where TPH was detected, to MW-9. The area of contamination corresponds with the areas in which the ash was placed in the southeast corner. The areal extent of higher chemical concentrations in the soil does not extend beyond the fill areas. The primary contaminants reported at concentrations exceeding soil cleanup objectives are 1,2-dichloroethene, trichloroethene, and xylenes.

As presented on Figure 2.11, VOCs detected in one or more samples collected from the shallow soils in the southern area with the highest reported concentrations exceeding soil cleanup objectives are as follows: acetone (1,800JB µg/kg), benzene (62 µg/kg), 1,2-dichloroethene (total) (9,100J µg/kg), methylene chloride (390J µg/kg), trichloroethene (320,000 µg/kg), vinyl chloride (840J) and xylenes (total) (29,000J).

As presented on Figure 2.11, three SVOCs, 2,4-dimethylphenol (750 µg/kg), 4-methylphenol (570 mg/kg) and phenol (270J µg/kg) were detected at concentrations exceeding soil cleanup objectives at borehole BH-G.

As presented on Figure 2.12, the deeper sandy zone soils in the southeast part of the southern area contain elevated organic contaminants in the part of the Site underlying the ash-filled area.

As presented on Figure 2.12, VOCs detected in one or more samples collected from the deeper sandy zone soil with the highest reported concentrations exceeding soil cleanup objectives are as follows: 1,2-dichloroethene (37,000J µg/kg), trichloroethene (2,000,000 µg/kg), and xylene (64,000J µg/kg). The highest levels of VOCs were detected where NAPL was present in the soil at locations MW-11 and BH-S. In the southern area, VOCs were not detected in the sandy zone soils above soil cleanup objectives outside the area defined by locations MW-11, MW-12 and BH-5.

Along the south edge of the southern area, closest to the adjoining residences, no organic compounds were detected above soil cleanup objectives in the deep soil samples from BH-6-93 and MW-5A.

The portion of the southern area that contains subsurface soil with organic chemical concentrations exceeding NYSDEC soil cleanup objectives is designated as Area C for the purposes of the FS. The volume of soil with chemical concentrations that exceed soil cleanup objectives in Area C is estimated to be 10,210 yd^3 based on an areal extent of 22,050 ft^2 and a depth of 12.5 ft.

Although exceedances of cleanup objectives were not evident for the limited number of samples collected from boreholes in the remainder of the fill area outside of Area C, it is possible that the maximum areal extent of soil with concentrations exceeding cleanup objectives may extend to the boundaries of the known fill area. The remainder of the fill material outside of Area C is designated as the secondary southeast area for the purposes of the FS and contains an estimated 11,870 yd^3 of material that may potentially exceed soil cleanup objectives. The estimated volume in the secondary southeast area is based on an areal extent of 22,900 ft^2 and a depth of 14 ft.

It will be necessary to determine the exact extent (limit) of contamination during design of the chosen remedial alternative so that exact soil quantity can be determined

2.6.1.4 Eastern Off-Site Parcel

The area referred to as the Eastern Off-Site Parcel is a 6-acre property owned by the St. Johns Cemetery Association. This area is located immediately east of the southern part of the Site. This area was investigated during the RI because data from an earlier program (1992 Site Investigation) indicated contaminants were present at the eastern property line.

Summaries of detected compounds for samples collected from the shallow and deep soils in the off-Site Parcel are presented in Tables 2.5 and 2.6, respectively.

The shallow and deep soils in the Off-Site Parcel exhibited only very low levels of organic compounds at concentrations below soil cleanup objectives.

2.6.1.5 West Side Dry Well Area

The west side dry well was the receiver for floor drains for the former plant storage area in the northwest part of the Main Building. This dry well was constructed by digging a 2 x 2 x 4-foot deep hole, filling it with stones and covering it with topsoil.

No VOCs or TPH were detected in this area.

2.6.2 Groundwater

Samples of overburden and bedrock groundwater were collected from existing wells and from wells installed during the RI. Three rounds of groundwater samples were collected during the RI from selected wells as described in Section 2.4. During the sampling conducted as part of the RI, the NYSDEC also collected split samples from selected wells during each of the three sample rounds.

The data from the analyses of the above samples and historical groundwater data have been used to characterize the groundwater chemistry at the Site.

As discussed in Section 2.6.1, there are two primary contaminant source areas at the Site; one in the vicinity of the east side dry well (northeast area) and one in the southeast portion of the Site (southeast area). The presence of these source areas has impacted both overburden and bedrock groundwater quality in the immediate vicinity of each source area.

This section provides a description of the groundwater quality as it pertains to the remedial evaluation. A more detailed description is provided in Section 6.0 of the RI report.

The overburden and bedrock groundwater has been impacted by Site-related chemicals in the northeastern and southeastern portions of the Site. The main area corresponds to the Fill Area in the southeastern portion of the Site. The second area is localized in the northeastern part of the Site in the vicinity of monitoring well MW-16, approximately 500 feet north (upgradient) of the main southeastern area. These two areas are considered to be the 'source areas'.

The majority of chemicals detected in the groundwater at the Site were organic chemicals, primarily VOCs which fall into three main chemical groups:

i) chlorinated ethenes;
ii) chlorinated ethanes; and
iii) benzene, toluene, ethylbenzene, and xylenes (BTEX).

Chlorinated ethene compounds include 1,1-dichloroethene, 1,2-dichloroethene (total), tetrachloroethene, trichloroethene and vinyl chloride. Chlorinated ethane compounds include chloroethane, 1,1-dichloroethane, 1,1,1-trichloroethane, and 1,1,2-trichloroethane. The BTEX compounds are grouped together as they are commonly associated with petroleum products.

The primary chemicals detected in the overburden groundwater are chlorinated ethenes, chlorinated ethanes and BTEX compounds in the northeast area of the Site and chlorinated ethenes and BTEX compounds in the southeast portion of the Site including the off-Site parcel. The exceedances of Class GA groundwater standards for the overburden is presented on Figure 2.13. Analytical results are summarized in

Tables 2.8, 2.9, and 2.10 and contaminant plumes are presented on Figures 2.14, 2.15, and 2.16.

The primary chemicals detected in the bedrock groundwater are chlorinated ethenes, chlorinated ethanes and BTEX compounds in the northeast area of the Site and chlorinated ethenes and BTEX compounds in the southeast part of the Site including the off-Site parcel. The exceedances of Class GA groundwater standards for the bedrock is presented on Figure 2.17. Analytical results are summarized in Tables 2.11, 2.12, and 2.13 and contaminant plumes are presented on Figures 2.18, 2.19, and 2.20.

LNAPL (Light Non-Aqueous Phase Liquid) was observed in wells MW-8 and MW-11. A sample of the LNAPL present in MW-11 was collected and analyzed for VOCs. The LNAPL in MW-22 is an oily matrix containing vinyl chloride (1,400,000 µg/L), total 1,2-dichloroethene (22,000,000 µg/L), trichloroethene (330,000,000 µg/L), tetrachloroethene (160,000J µg/L), ethylbenzene (920,000J µg/L), and total xylene (6,600,000 µg/L). The elevated chlorinated ethene concentrations in the center of the groundwater plume are attributable to the presence of LNAPL given the high concentrations of chlorinated ethenes in the LNAPL in MW-11.

Inorganic parameters have been detected in the overburden and bedrock groundwater at the Site at concentrations exceeding applicable groundwater standards or guidance values. These inorganics have been detected and measured at similar concentrations in the northeast area (well MW-16) and the southeast area including the off-Site parcel (MW-11, MW-13, and MW-14) which indicates that specific source areas contributing to inorganic concentrations in the overburden groundwater at the Site do not exist. This is further supported by the fact that the VOC plumes at the Site (which are more mobile than inorganic parameters) are limited to the vicinity of known source areas. The inorganics detected which exceed groundwater standards or guidance values are also naturally present within bedrock groundwater formations and do not indicate a Site-related impact. Therefore, the source of inorganics in the groundwater is considered to be naturally occurring and do not indicate a Site-related impact.

The following organic compounds were detected at concentrations exceeding Class GA groundwater standards or guidance values at one or more monitoring wells:

Parameter	*Southeastern Area*		*Northeastern Area*	
	Overburden	*Bedrock*	*Overburden*	*Bedrock*
Chlorinated Ethenes				
1,1-Dichloroethene	√ [1]	√	√	√
1,2-Dichloroethene (total)	√	√	√	√
Tetrachloroethene	√			√
Trichloroethene	√	√	√	√
Vinyl Chloride	√	√	√	√
1,1-Dichloroethane		√	√	√
1,1,1-Trichloroethane		√	√	√
1,1,2-Trichloroethane				√
Chloroethane				√
BTEX Compounds				
Benzene	√	√	√	√
Toluene	√	√	√	√
Ethylbenzene	√	√	√	√
Xylene	√	√	√	√
Aliphatic Ketones				
Acetone			√	
2-Butanone				√
SVOCs				
2-Methylphenol	NA [2]	√	√	
4-Methylphenol	NA	√	√	
2,4-Dimethylphenol	NA	√	√	
4-Chloro-3-Methylphenol	NA		√	
Naphthalene	NA		√	

---

[1] √ - Denotes exceedance of Class GA groundwater standards or guidance value.

[2] NA - Compound was not analyzed.

Parameter	*Southeastern Area*		*Northeastern Area*	
	Overburden	*Bedrock*	*Overburden*	*Bedrock*
Miscellaneous Organics				
Chloroform			√	√
Methylene Chloride	√			√
Chloromethane				√

2.6.3 Surface Water And Sediment

On-Site surface water is controlled through the use of grading and catchbasins, which minimize the amount of surface water runoff from the Site to off-Site areas. Further, the majority of the Site (65 percent or 15 acres) is covered by pavement, concrete, or buildings, which prevents contact of runoff with contaminated soil. On the off-Site parcel, low areas exhibit seasonal standing water. Heavy rains produce surface water flow across this parcel in a north to south direction. The majority of runoff channels into two stormwater receivers located just inside the fence north of Rowan Road at Preston Road. These receivers tie into the Town of Cheektowaga stormwater sewer system.

In November 1993, one sediment sample and one surface water sample were collected from the off-Site area at the location identified as Sed-1 and SW-1 on Figure 2.3. The sample location was a small pool (approximately 32 ft^2) with a few inches of standing water located in a shallow depressed area of the off-Site parcel. This pool of standing water was the only surface water present in the off-Site parcel at the time of sampling. Due to the intermittent nature of this surface water and the minimal amount of surface water present, the sediment sample is more appropriately considered a surface soil sample. The surface soil and surface water samples were analyzed for VOCs, SVOCs, inorganics, and TPH.

Compounds detected in the surface soil and surface water samples are presented in Table 2.14.

Organic Chemical Compounds

VOCs were not detected at concentrations exceeding soil cleanup objectives in the surface soil sample collected from the off-Site parcel.

Six SVOCs at elevated levels above soil cleanup objectives were detected in the surface soil sample. These compounds are benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and chrysene.

The source of the SVOCs in the surface soil sample is unknown. Five of the six SVOCs that were detected above soil cleanup objectives in the surface soil sample were also detected in subsurface soil samples collected from the southeast area of the Site (TB-7, TB-9, MW-4, BH-G and BH-5-93). However, the concentrations detected in the on-Site samples are one to two orders of magnitude less than the results for the off-Site surface soil sample. In addition, the six SVOCs were not detected in overburden or bedrock groundwater samples collected during the RI or in shallow soil samples collected in the off-Site parcel (BH-1-93 and BH-3-93).

Metals

In the surface water sample, aluminum, cadmium, copper, iron, lead, and zinc were detected at elevated levels above Class C surface water standards. The Class C surface water standards are based on aquatic risks and ensure that water quality is suitable for fish propagation and survival. However, the small amount of intermittent ponded water that was sampled does not support fish or benthic organisms. The exceedances of Class C surface water standards for these metals is, therefore, not considered significant.

In the surficial soil sample, four metals were detected at concentrations exceeding soil cleanup objectives. These metals and their detected concentrations are:

Metals	*Concentration Detected (mg/kg)*	*Soil Cleanup Objective (mg/kg)*
Arsenic	109	7.5
Cadmium	9.8	1.0
Lead	1830	500
Zinc	1500	300

The source of these elevated metals is unknown and does not necessarily indicate a Site-related impact.

2.7 BASELINE RISK ASSESSMENT

A baseline risk assessment (BRA) was completed during the RI to evaluate the present and future potential impact of Site activities on public health and the environment. The BRA assumed that the present land use and environmental conditions are unchanged in the future. The BRA did not consider any effects which will follow implementation of any interim remedial action (IRAs) or final remedial action.

The BRA evaluated the risks in four phases: identification of chemicals of potential concern (COCs), assessment of potentially exposed populations and exposure routes, toxicity assessment, and risk characterization.

Due to the Site layout and conditions, it was expected that different exposures would occur in different areas around the plant. Therefore, the BRA identified three separate sectors or units, as presented on Figure 2.2, to evaluate soil exposure:

Sector A - the undeveloped cemetery property;
Sector B - the grassed area in front of and along the sides of the plant; and
Sector C - the primarily paved areas to the south and east of the plant.

Groundwater was evaluated on the basis of potential use as potable water. The overburden and the bedrock groundwater were evaluated as separate units. The total data set for the bedrock, excluding background wells was used to calculate the exposure point concentrations. In addition, the perimeter downgradient wells were evaluated as a separate series of wells to characterize the potential risk from use of groundwater at the Site boundary as potable water.

Information on Site characteristics and analytical data for soils, sediments, groundwater, and surface water were examined to evaluate the chemicals present, their distribution and concentrations at the Site. Analytical data utilized in the BRA are summarized in Sections 5.0 and 6.0 and are discussed in Section 7.0 of the RI report.

2.7.1 Chemicals of Potential Concern

Two selection criteria were applied to identify COCs; the detection frequency and comparison to background levels. All chemicals with published toxicity factors which were determined to be present above background and in at least 5 percent of the total samples were evaluated in the quantitative health risk assessment.

For soils, reported chemicals were frequently present in only one sample in a sector and possibly at background levels. Therefore, all chemicals reported in a single sample were included for quantitative evaluation and risk characterization.

For sediments, one sample was collected from a shallow ponded area which was present in Sector A. This area was observed to be dry during other on-Site activities. The sample collected from this area is not considered representative of sediment. Therefore, the data for this sediment sample was included as a soil sample and evaluated with surface soil in Sector A.

For groundwater, all chemicals reported in a single sample were included for quantitative evaluation and risk characterization.

Surface water was not identified as a medium of concern in the BRA.

The COCs identified for soil and groundwater are summarized in Table 2.15.

2.7.2 Potential Exposure Pathways

Because the Site is presently an industrial site within an area zoned industrial, there is no reason to believe this land use will change. The Site is presently surrounded by a secure chain link fence. The potential populations which could enter the Site (Sectors B and C) would be company employees and visitors, contract workers (construction, maintenance, etc.), or trespassers. The undeveloped cemetery property (Sector A) is open to the east allowing access to passersby or residents of homes adjacent to this area. Cemetery workers would also be expected to enter Sector A for maintenance and development activities.

Populations which could be exposed to contaminated soils in Sectors B and C would be on-Site workers, visitors, or trespassers. Sector B, the grass/landscaped area near the plant, has only one surface soil sample. This sample was considered unaffected by plant activities and identified as a background sample. Since Sector B is covered by grass or other landscape planting, contact with surface soil would be very limited. Since the area is apparently unaffected by Site-related chemicals and contact is very limited, this area was not evaluated further.

Sector C is essentially a paved parking and operations area. Therefore, there is no direct contact with surface soil by the visitors, trespassers, or the employees during their regular activities. Only in case of construction activities involving excavation would soil beneath the pavement be exposed for worker contact. Therefore, workers involved in construction activities may be exposed to chemicals in the subsurface soils.

Surface soil in Sector A may be a source of exposure to cemetery workers or to residents that may enter the area from the adjacent residential area. Because of the close proximity of this area to the residential lots, small children could enter the area to play.

Although there are currently no active wells in the Site area, the bedrock could be a potential future source of potable groundwater and could supply adequate water for residential or business use. All residential water in the area is presently obtained from a municipal water system.

Because there are no wetlands, seeps, streams or ponds on Site or in the general area, exposure to contaminated sediment and surface water were not evaluated as exposure possibilities.

Exposure pathways which were evaluated in the BRA are summarized as follows:

Media	*Exposure Pathway*	*Receptor Population*
Cemetery Property (Sector A)		
Surface and Subsurface soil	Dermal Contact Incidental Ingestion	Workers Trespassers (residents from adjacent homes)
Plant Site (Sector C)		
Subsurface soil	Dermal Contact Incidental Ingestion	On-Site Workers Contractors
Bedrock		
Groundwater	Ingestion Dermal Contact Inhalation	Residential Use of Private Well[1] (home owners)

The BRA estimated carcinogenic and non-carcinogenic health risks posed by the various exposure pathways.

---

[1] The residential use of private wells for bedrock groundwater use is hypothetical. There are currently no bedrock groundwater users in the vicinity of the Site.

2.7.3 Exposure Point Concentrations

Soil samples evaluated in the exposure scenarios were from all sampling locations reported in each sector. In Sector A, the calculated means for all samples analyzed were used to represent the exposure point concentrations for exposure to chemicals in surface soil. In Sector C, the calculated means for all samples analyzed were used to represent the exposure point concentrations for exposure to chemicals in excavated soils.

To calculate the exposure point concentrations in bedrock groundwater, all on-Site bedrock groundwater data were included except MW-1A and MW-17A, the upgradient wells.

In addition, to evaluate the potential off-Site impact of bedrock groundwater, the means were calculated for the downgradient perimeter bedrock wells, MW-2A and MW-5A. These means were used to assess estimated health risks from potential off-Site wells which could be installed into the bedrock in the immediate area. This potential has a low probability because the area is serviced by a municipal water system.

2.7.4 Exposure Scenario Assumptions

2.7.4.1 Surface Soil

Sector A

In Sector A there were two potentially exposed populations, cemetery workers and local residents.

a) Cemetery Workers

Cemetery workers would be exposed during cleanup and maintenance activities, or in case the area is cleared and developed as additional cemetery plots.

The following scenario assumptions were applied to provide a conservative estimate of the chemical intake for cemetery worker exposures:

i) exposure point concentrations are the mean (Mean) and the 95th percentile of the mean (RME);

ii) ingestion rate is 50 mg of soil/day for both Mean and RME;

iii) surface area exposed to soiling is 5,300 cm^2;

iv) conversion factor is 0.000001 kg/mg;

v) the worker is exposed 1 work day per week (RME) or 1 day per month (Mean) for 5 months (May through September) or 20 days per year (RME) or 5 days per year (Mean). This is a conservative assumption and would cover work applied to future development of the area;

vi) the worker is assumed to spend 10 years (Mean) or 25 years (RME) at the same job for his work life;

vii) the average worker weighs 70 kg;

viii) averaging time:
Carcinogen - 25,550 days
Non-carcinogen - 365 days;

ix) 0.2 mg (Mean) or 1.0 mg (RME) of soil adheres to each cm^2 of skin;

x) a matrix factor of 0.15 represents the fact that only 15 percent of the chemical in the soil matrix on the skin actually contacts the skin and is available for absorption;

xi) the chemical-specific absorption factor represents the rate of absorption of the chemical through the skin; and

(Note: If the absorption factor is based on absorption data from tests on contaminated soil, the matrix factor does not apply);

xii) the PTF or part of exposure time the individual is exposed to the contaminated soil is 1 since the contamination generally extends over most of the Sector.

b) Local Residents

Local residents, including children, could play in the area and be potentially exposed to Site-related chemicals through contact with contaminated surface soil.

The following scenario assumptions were applied to provide a conservative estimate of the chemical intake for local residents that may enter Sector A:

i) exposure point concentrations are the mean (Mean) and the 95th percentile of the mean (RME);

ii) ingestion rate is:
Young child - 200 mg soil/day for both Mean and RME;
Older child - 100 mg soil/day for both Mean and RME;

iii) surface area exposed to soiling is:
Child - 1,325 cm^2;
Older child - 5,300 cm^2;

iv) conversion factor is 0.000001 kg/mg;

v) the receptor resident is exposed 2 days per week (RME) or 1 day per week (Mean) for 6 months (May through October) or 48 days per year (RME) or 24 days per year (Mean) as a child. A conservative assumption is made that younger children and older children (including teenagers) would play in this area at the same frequency. Adults would not be expected to recreate or trespass regularly in this area. Adult exposures in this area are evaluated as cemetery worker exposures.

vi) although the very young child (2 and 3 years old) is unlikely to play in this undeveloped area, the young child is assumed to play in the undeveloped cemetery property during years age 2, 3, 4, 5, and 6 (RME) or years age 4, 5, and 6 (Mean). The older child is assumed to play in the area each year from age 7 through 18 (12 years for RME and Mean).

vii) the average weight is:
Child - 16 kg
Older child - 45 kg;

viii) averaging time:
Carcinogen - 25,550 days
Non-carcinogen - 365 days;

ix) 0.2 mg (Mean) or 1.0 mg (RME) of soil adheres to each cm^2 of skin;

x) a matrix factor of 0.15 represents the fact that only 15 percent of the chemical in the soil matrix on the skin actually contacts the skin and is available for absorption;

xi) the chemical-specific absorption factor represents the rate of absorption of the chemical through the skin. This factor is chemical specific; and

xii) the PTF or part of exposure time the individual is exposed to the contaminated soil is 1 since the contamination generally extends over most of the Sector.

Sector C

In Sector C, there is only one potentially exposed population, construction workers. Because the area is essentially all paved, exposure to contaminated subsurface soil would only occur during periods of excavation.

Construction workers would be exposed during the limited time that excavated dirt is exposed. Two construction campaigns per year were assumed, one involving a 1-month excavation period and another involving a 3-month excavation period. The worker is assumed to be exposed daily during the 5 day work week for the entire excavation period.

The following scenario assumptions were applied to provide a conservative estimate of the chemical intake for construction worker exposures:

i) exposure point concentrations are the mean (Mean) and the 95th percentile of the mean (RME);

ii) ingestion rate is 50 mg of soil/day for both Mean and RME;

iii) surface area exposed to soiling is 5,300 cm^2;

iv) conversion factor is 0.000001 kg/mg;

v) the worker is exposed 5 work days per week for 3 months (RME) or 5 days per week for 1 month (Mean) 80 days per year (RME) or 20 days per year (Mean) for 1 year. This is a conservative assumption since the excavation portion of the construction jobs would generally cover a comparatively short part of the total construction period;

vi) the worker is assumed to be exposed during a single year during one construction campaign;

vii) the average worker's weight is 70 kg;

viii) averaging time:
Carcinogen - 25,550 days
Non-carcinogen - 365 days;

ix) 0.2 mg (Mean) or 1.0 mg (RME) of soil adheres to each cm^2 of skin;

x) a matrix factor of 0.15 represents the fact that only 15 percent of the chemical in the soil matrix on the skin actually contacts the skin and is available for absorption;

xi) the chemical-specific absorption factor represents the rate of absorption of the chemical through the skin; and

xii) the PTF or part of exposure time the individual is exposed to the contaminated soil is 1 since the contamination generally extends over most of the Sector.

2.7.4.2 Groundwater

Presently, there are no groundwater users on Site or in the general area of the Site. However, the bedrock groundwater is adequate to develop residential or commercial wells. The development of potable water supply wells is not likely in this area because of the availability of municipal water service, but a hypothetical scenario for the use of groundwater is provided to evaluate groundwater quality at the Site. Two evaluations were presented in the BRA covering the evaluation of the total groundwater under the Site and the evaluation of the groundwater at the downgradient perimeter of the Site.

a) Ingestion of Drinking Water - On-Site Wells

The scenario for the hypothetical future consumption of bedrock groundwater from an on-Site well for residential drinking water included the following assumptions:

i) exposure point concentrations are the average (Mean) and the 95th percentile of the mean (RME) concentrations for samples reported from all bedrock wells on Site;

ii) ingestion rates are:
Young child - 1 L/day (Mean and RME)
Adults - 2 L/day (Mean and RME);

iii) the exposure frequency is 350 days per year for both child and adult, this allows for 15 days spent away from home;

iv) the exposure duration is 5 years for child (Mean and RME) and 5 and 25 years for adults (Mean and RME). The duration's for child and adult are additive to account for 10 and 30-year residency at a single dwelling;

v) the average weight is:
Child - 16 kg
Adult - 70 kg; and

vi) averaging time:
Carcinogen - 25,550 days:
Non-carcinogen - 365 days.

b) Ingestion of Drinking Water - Perimeter Wells

The scenario for the hypothetical future consumption of bedrock groundwater from a well immediately downgradient of the Site for a residential drinking water included the following assumptions:

i) exposure point concentrations are the average (Mean) and the 95th percentile of the mean (RME) concentrations for samples reported from bedrock wells MW-2A and MW-5A, the perimeter wells at the downgradient perimeter of the Site;

ii) ingestion rates are:
Young child - 1 L/day (Mean and RME)
Adults - 2 L/day (Mean and RME);

iii) the exposure frequency is 350 days per year for both child and adult, this allows for 15 days spent away from home;

iv) the exposure duration is 5 years for child (Mean and RME) and 5 and 25 years for adults (Mean and RME). The duration's for child and adult are additive to account for 10 and 30-year residency at a single dwelling;

v) the average weight is:
Child - 16 kg
Adult - 70 kg; and

vi) averaging time:
Carcinogen - 25,550 days
Non-carcinogen - 365 days.

Showering/Bathing On-Site and Off-Site Wells

Because of the uncertainty related to existing models used for estimating exposures related to showering or bathing, the exposure and resulting risk from bathing will be assumed to be 1.5 times the exposure and resulting risk from ingestion by drinking the water.

2.7.5 Estimated Carcinogenic Risks and Non-Carcinogenic Hazard

The BRA used a combination of mid-range and upper-bound exposure assumption factors to calculate the average (Mean) and the reasonable maximum exposure (RME) expected to occur under exposure scenarios explicitly developed for the Site. The most likely exposure conditions or the Mean utilized the average or mean value for the assumption. The reasonable maximum exposure or the RME was based on the 90th or 95th percentile confidence level for the assumption and was intended to be a conservative (i.e., well above the average case) estimate of any potential exposure.

The chemical-specific cancer slope factor (CSF) was applied to estimate the potential risk of cancer from an exposure. The CSF is expressed in $(mg/kg\text{-}day)^{-1}$ and when multiplied by the lifetime average daily dose expressed as mg/kg-day will provide an estimate of the probability that the dose will cause cancer during the lifetime of the exposed individual. This increased cancer risk is expressed by terms such as 1E-06 (i.e., this means that for every 1 million people exposed to the Site contamination, the average incidence of cancer will increase by one). This is a hypothetical estimate of the upper limit of risk based on very conservative or health protective assumptions and statistical evaluations of data from animal experiments or from epidemiological studies. The National Contingency Plan (NCP) has adopted an excess cancer risk of 1E-06 to 1E-04 (i.e., one in a million to one in ten thousand) as an acceptable risk range for Superfund sites.

Non-carcinogenic risks are evaluated by comparing estimated intake to U.S. EPA derived chemical-specific Reference Doses (RfDs). RfDs are estimates of the daily exposure which can be experienced by a population, including sensitive sub-populations such as children and the elderly, for a lifetime without the likelihood of deleterious effects. The comparison between calculated exposure and the RfD is called the hazard quotient. Hazard quotients for all chemicals are added to derive a hazard index (HI).

The HI is used to determine if potential non-cancer effects may be of concern. It does not predict the incidence or severity of potential health effects. An HI less than one indicates that no adverse effects are expected to occur in the exposed population under review. An HI greater than one indicates only that an adverse effect may occur; it does not mean that an effect will occur. It is important to emphasize that the HI is not a statistical probability; the level of concern does not increase linearly as the HI approaches or exceeds one. The summing of hazard quotients to derive a hazard index provides a very conservative (i.e., health-protective) measure of non-cancer health risks.

The total excess cancer risks and hazard for the Site are summarized in Table 2.16.

The estimated cancer risks associated with all exposure pathways evaluated for soils were below or within the acceptable range of 1.0E-06 to 1.0E-04 established by the U.S. EPA. It appeared that approximately 80 percent of the total risk was attributable to PAHs reported in one "sediment" sample which was included as a surface soil sample. The remainder of the risk was attributable to arsenic and beryllium which were reported at levels at or slightly above background concentrations expected in soil.

The hazard indices associated with all exposure pathways evaluated for soils were below 1.0, the level of concern.

The use of groundwater from the bedrock below the Site for household use (drinking and bathing) resulted in estimated risks and hazards in excess of the acceptable range. Since this was a hypothetical use of this groundwater, the exceedance of acceptable risk and hazard levels was concluded to be of consequence only for remedial planning. Vinyl chloride contributed 99.4 percent of the estimated carcinogenic risk, while 1,2-dichloroethene was the primary source of potential non-carcinogenic hazard.

The consumption of groundwater by off-Site residents yielded estimated cancer risks that were above the 1.0E-04, the high end of the acceptable range of 1.0E-06 to 1.0E-04 prescribed by U.S. EPA. Arsenic contributed essentially 100 percent of the estimated carcinogenic risk while barium, arsenic and nickel accounted for 99.5 percent of the non-carcinogenic hazard. Although the inorganic constituents resulted in exceedances of the acceptable risk and hazard limits, the RME concentrations of arsenic, barium, and nickel were well below their respective MCLs.

It was concluded in the RI report that although the on-Site bedrock is contaminated, the movement off Site is limited and the present downgradient perimeter conditions do not exceed the MCL levels for the inorganic chemicals which are the primary contaminants in bedrock groundwater from the perimeter wells. Concentrations of metals reported in downgradient wells may be in part or totally a result of normal background conditions.

It was also concluded in the RI report that the overburden is not a productive unit, and therefore not a potential source of potable water. As for the bedrock groundwater, there is limited downgradient and off-Site movement of the Site-impacted groundwater in the overburden. This apparently is a result of the seasonal fluctuations of the gradient of the overburden groundwater in the southern and southeastern portion of the Site.

2.7.6 Ecological Evaluation

An ecological evaluation was not warranted due to the lack of any identified wildlife habitat on the Site. The Site is occupied by buildings, paved parking lots, and a grassed area across the west side (front) of the plant building. The eastern off-Site parcel contains a small wooded area at the southwest corner of the Site that is part of the adjacent habitat. This area is scheduled for clearing and filling, in preparation for future use as burial plots. However, a biotic survey was completed covering this area. This biotic survey is presented as Appendix I of the RI Report.

2.8 CONTAMINANT FATE AND TRANSPORT

Site related contaminants have been detected in the shallow soil, sandy zone soil, overburden groundwater, and bedrock groundwater. In addition, Site related contaminants have been detected in the surface soil and surface water samples collected from the off-Site eastern parcel. Therefore, the potential migration pathways which exist at the Site include:

i) atmospheric dispersion from surficial soils in the off-Site parcel;
ii) surface water transport;
iii) overburden groundwater flow; and
iv) bedrock groundwater flow.

Each of these potential migration pathways is discussed on the following pages.

2.8.1 Atmospheric Dispersion

Atmospheric dispersion of chemicals from the Site is restricted to chemicals present in or which migrate to the surface soils. The chemicals may be released to the atmosphere through volatilization and/or by atmospheric entrainment of chemicals adsorbed onto particulate matter. Once released, the chemicals may be transported by the wind.

The majority of the Site surface is covered by pavement, buildings, or grass, which minimizes the dispersion of chemicals by volatilization or entrainment. In areas of worn or broken pavement, the soil tends to be compacted rather than loose. The surface of the off-Site area is largely covered by established vegetation or by vegetative debris (fallen leaves, etc.). Areas of exposed soil are along a limited part of the former roadway road base and are gravelly and compacted.

The data from the air pathway analysis presented in the RI indicates the estimated air emission of Site contaminants is one or more orders of magnitude below the applicable guidance criteria and, therefore, air is not a significant migration pathway for Site related contaminants.

Additionally, the compounds which were present in the surface soil from the off-Site area were SVOCs and metals, which are not highly volatile. Therefore, the primary route of transport of these compounds in surface soils would be by airborne dispersion of soil particles or by surface water transport.

2.8.2 Surface Water Runoff

Surface water runoff or overland flow may carry particulate or dissolved contaminants from the surface soil. Surface water drainage on the Site is largely across paved areas and is controlled from exiting the Site via overland flow through the use of grading and catchbasins to conduct the flow to the Town of Cheektowaga storm sewer system. In a limited area along the east side of the southern area of the Site, surface water runoff can exit the Site onto the off-Site parcel. This occurs in the vicinity of BH-2-93. Overland flow of stormwater across the off-Site parcel is controlled by grading and topography which directs flow toward two stormwater receivers at the south end of the off-site area which are tied into the Town storm sewers.

The Cheektowaga storm sewer system transports the runoff from the Site to the City of Buffalo storm sewer system along Genesee Street. This sewer outfalls into the underground portion of Scajaquada Creek approximately two miles southwest of the Site. Scajaquada Creek in the area south of the Site is classified as a Class C water body, and receives heavy stormwater discharges from most of northern Cheektowaga, and the northern part of the Town of Clarence and Lancaster.

No sampling of storm event runoff or stormwater was conducted during the RI and there are no permanent surface water bodies on or adjacent to the Site. The one surface water sample collected was from seasonally ponded water in a low area on the off-Site parcel. This pool of water was the only water present on the off-Site parcel at the time of sample collection. Because of the low levels of chemicals (primarily metals) detected in the surface water sample, the effective use of control structures to collect overland stormwater flow from both the on-Site and off-Site areas, and the dilution of the residual chemicals that would occur by the mixture of a low concentration of these chemicals with a relatively large volume of stormwater, this mechanism of transport is not a significant pathway for the migration of contaminants from the Site.

2.8.3 Overburden Groundwater Flow

Site related contaminants are present in the overburden groundwater in the northeastern and in the southeastern area of the Site. Contaminated groundwater has not migrated off-Site from the northeastern area. It has migrated, to a limited extent, onto the adjacent off-Site parcel from the southeastern area.

A potential migration pathway to the off-Site area exists for shallow perched water through the bedding of the sewer line which cuts diagonally across the southeastern part of the Site. Contaminants have been detected in the bedding of this utility seven feet inside the eastern property line. It is possible that contaminants around the sewer line are the result of the adjacent fill being contaminated, and that the chemicals do not extend off the Site. However, utility bedding typically provides a preferential migration pathway as it is a disturbed native soil or engineered bedding material of higher permeability and the backfill material is often looser than the surrounding soil.

The primary potential migration pathway of groundwater in the deeper soil is laterally through the silty sand layer. Vertical migration of contaminants from the overburden into the bedrock has also occurred. This is most likely to occur where bedrock groundwater elevations are lower than those of the overlying overburden groundwater elevations.

2.8.4 Bedrock Groundwater

Site-related contaminants have been released into the bedrock groundwater below the Site in two distinct areas: the northeastern portion of the Site with a source area in the vicinity of MW-16A; and in the southeastern portion of the Site from the MW-6A area off-Site to the MW-14A and MW-13A area. The source of the southeastern area contaminants coincides with the ash-filled area in this part of the Site and the high contaminant levels detected in the MW-4, MW-6, MW-7, MW-8, MW-11, and MW-12 area. The areal limits of contaminants (predominately chloroethenes) in the bedrock groundwater in the southeastern part of the Site have not been fully defined in a southeastward direction. However, the highest bedrock groundwater chemistry is confined to the on-Site areas with only low level concentrations (<100 µg/L) detected in the off-Site area and at the southern Site boundary. The limits of bedrock groundwater contamination in the eastern part of the Site have been adequately defined to the north and to the east, and likely continue at very low concentrations into the southern part of the Site. The western limit extends beneath the Main Building, but is not expected to extend far because of the opposing gradient of the bedrock groundwater from the southwest corner of the Site.

The potential migration pathways of groundwater in the bedrock are laterally through horizontal and/or bedding plane fractures in the water-producing intervals and vertically along vertical fractures and joints.

3.0 DETERMINATION OF SCGS

Applicable or relevant and appropriate New York State Standards, Criteria, and Guidelines (SCGs) are used in determining the need for remedial action, to develop remedial action objectives and to scope, formulate and evaluate remedial action technologies and alternatives. SCGs are cleanup standards, control standards or other substantive environmental limitations promulgated under federal or New York State law. The consideration of SCGs is made in accordance with 6 NYCRR Section 375-1.10 (c) and with the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended, (CERCLA) §121, Y2 U.S.C. §9621.

SCGs are evaluated below.

Applicable Requirements

Applicable requirements are promulgated federal and state requirements such as cleanup standards, standards of control, and other environmental protection criteria or limitations that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site.

Relevant and Appropriate Requirements

Relevant and appropriate requirements are those promulgated federal and state requirements that, while not applicable as defined above to the circumstances at a site, address problems or situations sufficiently similar to those encountered at a site that their use is well suited. The regulations provide specific criteria for determining whether a requirement is relevant and appropriate.

During the feasibility study process, relevant and appropriate requirements are accorded the same weight and consideration as applicable requirements.

Other Requirements To Be Considered

This category contains other requirements and non-promulgated documents to be considered in the process of developing and screening remedial alternatives. The To Be Considered (TBC) category includes federal and state non-regulatory requirements, such as guidance documents, advisories, or criteria. Non-promulgated advisories or guidance documents do not have the status of standards. However, if no standards for a contaminant or situation exist, guidance or advisories would be consulted in evaluating whether a remedy is protective.

SCGs are categorized as follows:

1. chemical-specific requirements that define acceptable exposure limits and can therefore, be used in establishing preliminary remediation goals;
2. location-specific requirements that may restrict activities within specific locations such as floodplains or wetlands; and
3. action-specific requirements which may establish controls or restrictions for specific treatment and disposal activities.

Each of these SCG types are further discussed in the following subsections.

A master NYSDEC listing of SCGs that may potentially apply to the Site are provided in Appendix F.

3.1 CHEMICAL-SPECIFIC SCGS

Chemical-specific SCGs establish the acceptable amount or concentration of a particular chemical that may be either found in, or discharged to the ambient environment. Concentration limits provide protective site cleanup levels or may be used as a basis for estimating appropriate cleanup levels for the chemicals of concern in the various media. Chemical-specific SCGs may be used to determine treatment and disposal requirements for remedial activities and to assess the effectiveness or suitability of a remedial alternative. These values are usually based on health or risk considerations for the protection of either human health or the environment. If a chemical compound has more than one SCG, the most stringent is generally required to be met.

There are chemical-specific SCGs for the Site for groundwater and surface water. There are currently no chemical-specific standards for soils in New York State. However, soil cleanup objectives have been established in the State guidance document entitled "Determination of Soil Cleanup Objectives and Cleanup Levels" (TAGM HWR-94-4046, January 24, 1994). These soil cleanup objectives are used as TBCs in this FS.

3.1.1 Groundwater

Class GA groundwater is fresh groundwater found in the saturated zone of unconsolidated deposits and bedrock. The best usage of Class GA groundwater is as a potable water supply source. Groundwater in the area of the Site is not currently used as a drinking water source. However, unless specific deed restrictions exist, groundwater potentially could be used as a potable water source and, therefore, the appropriate groundwater quality standards apply.

Potential chemical-specific SCGs for Class GA groundwater are the most stringent of:

i) Maximum Contaminant Levels (MCLs) for drinking water promulgated in 10 NYCRR Subpart 5-1, Drinking Water Supplies;

ii) MCLs for drinking water promulgated under the Safe Drinking Water Act (SDWA);

iii) water quality standards promulgated in 10 NYCRR Part 170, Sources of Water Supply;

iv) water quality standards promulgated in 6 NYCRR Part 703, Water Quality Regulations; and

v) water quality standards and guidance values presented in Technical and Operations Guidance Series (TOGS) 1.1.1 (Oct. 1993), Ambient Water Quality Standards and Guidance Values.

Potential chemical-specific SCGs for groundwater at the Site are summarized in Table 3.1. The most stringent values from applicable sources pertaining to Class GA groundwater were used.

3.1.2 Surface Water

Surface water is present in the off-Site parcel on an intermittent basis in low-lying depressional areas. At the time of sample collection during the RI, surface water was present at one location. The areal extent of the surface water was approximately 32 ft^2 with an estimated depth of a few inches. The seasonal surface water located in the off-Site parcel does not support fish or benthic organisms. The surface water in the off-Site area is most likely subjected to evapotranspiration and infiltration to a larger degree than surface water runoff.

The section of Scajaquada Creek closest to the Site which potentially could receive surface water runoff from the Site area is classified as a Class C surface water body. Class C surface waters are waters that are suitable for fish propagation and survival. The water quality is suitable for primary and secondary contact recreation. The best usage of Class C waters is fishing. Scajaquada Creek is not used as a drinking water source, but is heavily used for stormwater drainage purposes and receives discharges from the Cheektowaga sewage treatment plant located 1.5 miles southeast of the Site.

Although the seasonal surface water in the off-Site parcel is not classified as a Class C surface water, chemical concentrations will be compared to Class C chemical-specific SCGs for comparative purposes.

Potential chemical-specific SCGs for Class C surface waters are the most stringent of:

i) 6 NYCRR Part 702, Water Quality Standards;
ii) TOGS 1.1.1 (Oct. 1993), Ambient Water Quality Standards and Guidance Values;
iii) Federal Clean Water Act (CWA), 33 U.S.C. ss1251-1376 and 40 CFR Part 129; and
iv) Federal Water Quality, 40 CFR Part 131.

Potential chemical-specific SCGs for surface waters at the Site have been summarized in Table 3.1. The most stringent values from applicable sources pertaining to Class C surface water were used.

3.1.3 Air

There are no chemical-specific SCGs for air for this Site. However, current draft ambient guideline concentrations as presented in the Draft New York State Air Guide 1, 1991 Edition are used as TBCs in this FS and are presented in Table 3.2. The concentrations are expressed as short-term guideline concentrations (SGCs) and long-term or annual guideline concentrations (AGCs) and are used by the NYSDEC to help establish control requirements in a Permit to Construct and a Certificate to Operate for sources of air contaminants regulated under 6 NYCRR Part 212. The SGCs and AGCs are based on occupational health-based values (eight-hour time-weighted averages or threshold limit values) and health risk-based values.

3.1.4 Soils

The NYSDEC has developed recommended soil cleanup objectives as presented in the "Technical and Administrative Guidance Memorandum (TAGM): Determination of Soil Cleanup Objectives and Cleanup Levels", dated January 24, 1994 (TAGM HWR-94-4046). These values are presented in Table 3.3. They are guidance values only, but will be considered (i.e., used as TBCs) since there are no officially promulgated soil cleanup standards.

3.2 LOCATION-SPECIFIC SCGS

Potential location-specific SCGs are requirements that set restrictions on activities depending on the physical and environmental characteristics of the Site or its immediate surroundings. The Site is bounded on the north and east by cemeteries; on the south by residential areas and by vacant open land to the west. The Site does not contain any significant agricultural lands, no modifications of any stream or water body is required for potential remedial action, no endangered species are believed to be present on the Site, the Site is not located within the 100-year floodplain and no wetlands exist on or adjacent to the Site. Therefore, there are no location-specific SCGs for the Site.

3.3 ACTION-SPECIFIC SCGS

Action-specific SCGs are determined by the particular remedial activities that are selected to address the Site cleanup. Action-specific requirements establish controls or restrictions on the design, implementation and performance of remedial activities. Following the development of the remedial alternatives, action-specific SCGs that specify performance levels, actions, technologies, or specific levels for discharged or residual chemicals provide a means for assessing the feasibility and effectiveness of the remedial activities.

The SCGs which may be applicable to potential Site remediation technologies are presented in Table 3.4.

4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

4.1 INTRODUCTION

Alternatives for Site remediation are developed by assembling the appropriate technologies for each medium of concern into alternatives that address Site-wide contamination. This process consists of the following steps:

i) develop remedial action objectives for each medium of interest based on risks to human health and the environment and chemical-specific SCGs;

ii) develop general response actions that are medium-specific and satisfy the remedial action objectives;

iii) identify and screen technologies applicable to each general response action;

iv) identify and evaluate technology process options to select a representative process for each technology type retained for alternative development; and

v) assemble the selected representative technologies and process options into viable alternatives for detailed evaluation.

Section 4.2 presents the remedial action objectives for the Site based on Site-associated chemical constituents and the media of interest. The preliminary remediation goals are established based upon risk-related factors and chemical-specific SCGs.

Section 4.3 presents the identification and screening of the general remedial response actions, technologies and process options for the media of concern at the Site. Each response action and technology for each medium is evaluated based on technical feasibility. Technology process options are then screened based upon effectiveness, implementability and cost to select a representative process(es) for each retained technology type.

4.2 REMEDIAL ACTION OBJECTIVES

This Section presents the development of remedial action objectives for each medium of interest at the Site. The overall goal of Site remedial action is to ensure the protection of human health and the environment. The general remedial objectives of the FS directed at achieving this goal are to:

1. minimize the discharge of hazardous constituents off Site via groundwater flow;

2. ensure that any hazardous constituents within the soil and groundwater meet acceptable risk levels consistent with the anticipated use of the property;

3. minimize potential human contact with waste constituents;

4. minimize potential human exposure to chemicals via air pathways;

5. avoid future remediation and operation and maintenance activities; and

6. prevent risks or adverse impacts to natural resources.

The U.S. EPA guidance document entitled "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," October 1988, states, *"remedial action objectives consist of medium-specific or operable unit-specific goals for protecting human health and the environment."* The objectives must not be so specific that the range of remedial alternatives which can be developed becomes overly limited. Remedial action objectives established to protect human health and the environment are to specify:

i) the chemicals of concern;
ii) the exposure routes and receptors; and
iii) an acceptable chemical concentration or range of concentrations for each exposure route.

Specifying remedial action objectives in this manner is deemed to be appropriate since protectiveness may be achieved by reducing exposure to receptors either separately or in conjunction with reducing chemical levels.

The guidance further states that *"because remedial action objectives for protecting environmental receptors typically seek to preserve or restore a resource, environmental objectives should be addressed in terms of the medium of interest and target cleanup levels, whenever possible."*

The remedial objectives themselves are not the motivation for initiating a remedial action. Rather, remedial objectives are a set of performance standards against which to compare remedial alternatives and aid in the selection of the preferred remedy.

The following subsections present, on a media-specific basis, a discussion of the chemicals of interest, allowable exposures based upon the results of the Baseline Risk Assessment (RA) and chemical-specific SCGs, and potential remedial goals. It is to be noted that the estimated cancer risks associated with all exposure pathways for both current and future land use are less than 10^{-4}, and the non-carcinogenic hazards are less than 1 with the exception of the potential future bedrock groundwater use scenario.

4.2.1 Subsurface Soils

The primary chemicals detected in subsurface soil samples collected from on-Site and the off-Site parcel are chlorinated ethenes, chlorinated ethanes and BTEX compounds. Additional VOCs detected at lower concentrations include aliphatic ketones (acetone, 2-butanone, 2-hexanone and 4-methyl-2-pentanone) and miscellaneous compounds (carbon disulfide, methylene chloride and chlorobenzene). SVOCs detected in subsurface soil samples at relatively low concentrations include polyaromatic hydrocarbons (PAHs), phthalates and phenolic compounds. Site-related inorganics including cadmium, chromium, nickel and zinc were also detected in subsurface soil samples but are probably attributable to naturally occurring conditions.

Potential risk scenarios were developed and evaluated in the BRA for exposure to subsurface soils beneath the cemetery property (Sector A) and the plant site (Sector C) for workers and trespassers.

The estimated lifetime cancer risks were calculated to be:

	Level 1	*Level 2*
Plant Site (Sector C)		
• On-Site Workers	1.33×10^{-8}	3.08×10^{-8}
Cemetery Property (Sector A)		
• Cemetery Worker	1.08×10^{-7}	6.0×10^{-6}
• Trespasser	5.75×10^{-6}	4.82×10^{-5}

These values are below or within the target cancer risks of 1×10^{-6} to 1×10^{-4} established by the U.S. EPA. The estimated non-carcinogenic hazard indices (3.64×10^{-3} to 0.645) were also calculated to be below the level of concern (1.0). It is to be noted that 80 percent of the estimated risk for cemetery workers and trespassers in Sector A is related to PAHs which were reported only once for the sediment sample (SED-1) which was included with the subsurface soil results for the Sector A evaluation.

Three areas of the Site have been identified that contain subsurface soils with organic chemical concentrations exceeding applicable NYSDEC soil cleanup objectives. The soil cleanup objectives are concentrations in soil that are considered to be protective of groundwater quality. The three areas, designated A, B and C on Figure 4.1, are associated with the former drum storage area, the northeastern source area (east side dry well area, former above ground storage tank area and the underground fuel oil storage tank area) and the southeastern fill area, respectively. Chemical compounds exceeding applicable soil cleanup objectives for the shallow and deep soil samples are presented on Figures 2.11 and 2.12, respectively.

In addition to these areas that have been determined to contain soils exceeding cleanup objectives, a secondary area consisting of the remainder of the fill area outside of Area C, may require remediation.

The following areas and volumes of soil have been estimated for each area with chemical concentrations exceeding soil cleanup objectives and the secondary southeastern area:

	Areal Extent (ft^2)	*Average Depth (ft)*	*Volume (yd^3)*
Area A	990	3	110
Area B	12,450	13	6,000
Area C	22,050	12.5	10,210
Secondary Southeast Area	22,900	14	11,870

Preliminary remedial objectives for subsurface soil at the Site will be to prevent or mitigate the migration of chemicals, to the maximum extent practicable, from areas A, B, and C and possibly the secondary southeast area that would result in groundwater contamination in excess of Class GA groundwater standards. The NYSDEC soil cleanup objectives are, therefore, remedial goals for the subsurface soils. Remedial objectives, designed to reduce human health risks, are not necessary based on the results of the BRA.

4.2.2 Surface Soils

The potential for contact with contaminated surface soils is limited. BRA Sector B, the grass/landscaped area near the plant, has historically been unaffected by Site-related chemicals and contact with surface soils is limited. BRA Sector C is a parking and operations area with an asphaltic cover, thereby, eliminating exposure to surface soil. The cemetery property (BRA Sector A) may potentially be an area where cemetery workers and trespassers are exposed to chemicals in the surface soil.

One surface soil sample was collected in the cemetery property. As discussed in Section 2.6.3, six SVOCs and four metals were detected at concentrations above applicable soil cleanup objectives. However, the source of these parameters may not be Site-related.

Risks associated with exposure to surface soil in the cemetery property were calculated in the BRA with subsurface soil as discussed in Section 4.2.1. Cancer risks and non-carcinogenic hazard indices were determined to be at acceptable levels.

Remedial goals for surface soil are not necessary due to the limited potential for exposure to chemicals in BRA Sectors B and C and the acceptable health risks for exposure to surface soils in BRA Sector A. Any potential for environmental impact from chemicals in the on-site surface soil would be eliminated or mitigated by the remedial measures implemented for subsurface soils at the Site.

4.2.3 Groundwater

4.2.3.1 Overburden Groundwater

The primary chemicals detected in the overburden groundwater are chlorinated ethenes, chlorinated ethanes and BTEX compounds in the northeast area of the Site and chlorinated ethenes and BTEX compounds in the southeast portion of the Site including the off-Site parcel. As presented in Section 2.6.2, exceedances of Class GA groundwater SCGs have occurred for these compounds in both the northeast and southeast areas. The VOCs detected most frequently at the highest concentrations include 1,1-dichloroethene, 1,2-dichloroethene, trichloroethene and vinyl chloride. In addition, minor exceedances of Class GA groundwater SCGs for several SVOCs (naphthalene and phenolic compounds) and metals (chromium, iron, lead, magnesium and manganese) have occurred for the overburden groundwater.

The exceedances of SCGs for the overburden groundwater is presented on Figure 2.13 and summarized in Tables 2.8, 2.9 and 2.10 for the northeast area, southeast area and off-Site parcel, respectively. Contaminant plumes are presented on Figures 2.14, 2.15 and 2.16.

A potential risk scenario for exposure to overburden groundwater was not evaluated in the BRA as the overburden at and in the vicinity of the Site is not a suitable source of potable water due the low yield of groundwater that could be obtained from this unit.

The remedial goals for the overburden groundwater at the Site are to restore groundwater quality, to the maximum extent practicable, to levels that are protective of human health and the environment. The Class GA groundwater SCGs are, therefore, remedial goals for the overburden groundwater. In addition, remedial goals for the overburden groundwater are to prevent the migration of contaminants, to the maximum extent practicable, to the bedrock aquifer for the protection of human health and the environment.

4.2.3.2 Bedrock Groundwater

The primary chemicals detected in the bedrock groundwater are chlorinated ethenes, chlorinated ethanes and BTEX compounds in the northeast area of the Site and chlorinated ethenes and BTEX compounds in the southeast part of the Site including the off-Site parcel. As presented in Section 2.6.2, exceedances of Class GA groundwater SCGs have occurred in these areas. The VOCs detected most frequently at concentrations exceeding SCGs include 1,2-dichloroethene and vinyl chloride in the northeast and southeast areas, and 1,1-dichloroethene, trichloroethene, and tetrachloroethene in the northeast area only. In addition, exceedances of Class GA groundwater SCGs for metals (iron and magnesium) have occurred for bedrock groundwater in both areas.

The exceedances of SCGs for the bedrock groundwater is presented on Figure 2.17 and summarized in Tables 2.11, 2.12 and 2.13 for the northeast area, southeast area and off-Site parcel, respectively. Contaminant plumes are presented on Figures 2.18, 2.19 and 2.20.

Although there are currently no groundwater users on Site or in the vicinity of the Site, the bedrock groundwater could potentially be developed as a potable water source in the future. Potential future risk scenarios were developed and evaluated in the BRA for exposure to bedrock groundwater under the Site and exposure to bedrock groundwater at the downgradient perimeter of the Site.

The estimated cumulative lifetime cancer risks were calculated to be:

	Level 1	*Level 2*
On-Site Bedrock Groundwater Use	0.944	4.77
Bedrock Groundwater Use at Site Perimeter	1.27×10^{-3}	1.02×10^{-2}

These values are above the established acceptable target cancer risks of 1×10^{-6} to 1×10^{-4}. In addition, the non-carcinogenic hazard indices (3,810 to 290,000) were calculated to be above the level of concern (1.0).

Remedial goals for the bedrock groundwater at the Site are to prevent the future ingestion and exposure, to the maximum extent practicable, to groundwater with chemicals that pose carcinogenic and non-carcinogenic risks in excess of the established acceptable levels. In addition, remedial goals for the Site bedrock groundwater are to reduce chemical concentrations, to the maximum extent practicable, to the applicable Class GA SCGs for the protection of human health and the environment.

4.2.4 NAPL

NAPL was detected in the overburden groundwater samples collected from wells MW-8 and MW-11. The NAPL, analyzed for the sample collected from well MW-11, was found to consist primarily of trichloroethene, 1,2-dichloroethene, xylene, vinyl chloride, ethylbenzene, and tetrachloroethene at concentrations ranging from 160,000 J µg/L to 330,000,000 µg/L.

The extent of NAPL presence is defined to the south, east and west by the absence of NAPL at downgradient overburden wells MW-4, MW-10 and MW-12, respectively.

The remedial goal for NAPL at the Site will be to prevent or mitigate, to the maximum extent practicable, the migration of chemicals from this source area to the groundwater and soil for the protection of human health and the environment.

4.2.5 Surface Water

Surface water is not a medium of concern at the Site due to the limited potential for contact with Site-related chemicals. The majority of the Site is covered by pavement, concrete or buildings which prevents contact of runoff with contaminated soils. In addition, the flow of on-Site surface water is controlled by grading and catch basins which minimizes the direct runoff to off-Site areas.

The minor exceedances of Class C surface water SCGs for metals in the surface water sample collected from the small pool of standing water located in the off-Site parcel are not considered significant as the intermittent ponded water does not support fish or benthic organisms. In addition, the presence of these metals does not indicate a Site-related impact, but may be the result of naturally occurring conditions or a source unrelated to the Site.

Remedial goals for surface water at the Site are not necessary. Any potential for environmental impact from chemicals in surface water would be eliminated or mitigated by remedial measures implemented for soils at the Site.

4.3 IDENTIFICATION AND SCREENING OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES AND PROCESS OPTIONS

This section presents the development and screening of general response actions, technologies and process options for the media of concern at the Site, soil, groundwater, and NAPL.

General response actions describe those actions that will satisfy the remedial action objectives presented in Section 4.2. Technologies are then identified that are applicable to each general response action. The technologies are screened based on technical implementability. Potential process options for each of the retained technologies are then screened using the criteria of effectiveness, implementability and cost.

NAPL is not evaluated separately in this section as the general response actions, technologies, and process options for soil and/or groundwater are also applicable to the remediation of NAPL.

4.3.1 Soil

4.3.1.1 Identification of General Soil Response Actions, Technologies and Process Options

Remedial action objectives for soils at the Site, as presented in Section 4.2.1, are to prevent or mitigate, to the maximum extent practicable, the potential migration of chemicals from areas with chemicals exceeding the NYSDEC soil cleanup objectives. Subsurface soils with chemicals exceeding the applicable cleanup objectives have been identified in Areas A, B, and C presented on Figure 4.1.

Exceedances of the cleanup objectives for these areas are presented on Figures 2.11 and 2.12. The volumes of soil potentially requiring remediation have been estimated to be 110 yd^3, 6,000 yd^3 and 10,210 yd^3 for Areas A, B and C, respectively. In addition, the soils in the remainder of the fill area outside of Area C may require remediation. The volume of soil in this secondary southeast area is estimated to be 11,870 yd^3. The following general remedial response actions have been identified for addressing these soils:

1) no action;
2) limited action;
3) physical containment action;
4) in situ treatment action;
5) removal/treatment action; and
6) removal/disposal action.

Potential remedial technologies and process options associated with each of these response actions are listed in Table 4.1. A general description of each of these response actions is presented below.

4.3.1.1.1 No Action

The NCP requires the evaluation of a no action alternative as a basis for comparison with other remedial alternatives. Under the no action response, no measures would be taken to improve environmental conditions with respect to the soils at the Site; however, groundwater monitoring would continue to be conducted to ensure that future conditions do not deteriorate significantly from existing conditions.

4.3.1.1.2 Limited Action

The limited action response involves restricting access to the property by the installation or maintenance of fences and implementing institutional controls to reduce potential human exposure to Site-related chemicals in the soils. The institutional controls may include initiation of deed restrictions (or institutional controls such as zoning changes) to maintain restricted access to the Site and to limit future uses of the Site. Many of these controls are already effectively in place at the Site.

4.3.1.1.3 Physical Containment Action

The physical containment response action involves the use of physical means to contain/stabilize or otherwise restrict the mobility and migration of chemicals associated with the Site soils. Potential containment technologies include:

- capping the areas with soil concentrations exceeding the potential soil cleanup goals; and
- chemical or physical fixation/stabilization in place.

Alternative capping options include a composite cap constructed to RCRA design standards, a soil cap meeting NYSDEC standards for a sanitary landfill, and an asphalt/clay cap.

The areas of the Site with soils containing chemicals exceeding soil cleanup objectives are currently covered with asphalt pavement.

4.3.1.1.4 In Situ Treatment Action

This response action involves in situ treatment of the soils to achieve the potential soil cleanup goals. The in situ treatment process could be conducted using either the following biological or physical treatment technologies:

1. biological;
2. soil vapor extraction;
3. soil flushing;

4. bioventing; and
5. passive adsorption.

Biological treatment involves the development of a bacterial colony within the soils. The bacteria are utilized to break down the chemicals to non-toxic components. Biodegradation of the chemical constituents depends on the Site soils and climatic conditions. Biological treatment may be enhanced by the process of bioventing which relies on forced air flow through contaminated soils at rates and configurations that will ensure adequate oxygenation for aerobic biodegradation.

Treatment by soil vapor extraction involves stripping the volatile organic parameters from the soil (vadose zone) by drawing a quantity of air through the soil by vacuum. In the in situ applications, either wells or trenches with horizontal perforated pipes are installed in the desired cleanup zones. Blowers are used to draw air from the wells, thereby moving air through the soils. The air removed is either reinjected into the soil or exhausted to the atmosphere. Treatment of the extracted air may be required prior to recirculation or exhaust to the atmosphere. The effectiveness of this system is dependent upon the type and characteristics of the soils, the chemicals present, and the rate at which the air is moved through the soil.

Soil flushing is very similar in principle to the soil vapor extraction process except that water or a water-surfactant is used as the flushing medium. Water is flushed through the soils solubilizing chemicals from the soil. The water is collected and treated to remove chemicals and then reinjected. Again, the effectiveness of the system is dependent upon the type of soils, and the chemicals present.

Passive adsorption is a method of placing adsorbent-filled canisters in monitoring wells in contaminated areas to gradually adsorb and concentrate the contaminants for removal and off-Site treatment or disposal. Typically, the canisters are filled with a hydrophobic polymer such as divinylbenzene. The canisters are suspended in the monitoring wells where they attract and adsorb contaminants. The canisters are replaced periodically and the contaminated canisters are regenerated off-Site for reuse.

4.3.1.1.5 Removal/Treatment Action

The removal/treatment action involves excavation of the soils with chemical concentrations exceeding the potential soil cleanup goals and treating the soils either on Site or at an off-Site facility. Potential treatment technologies include the following physical, chemical, or biological treatment options:

1. biological;
2. soil vapor extraction/bioremediation;
3. low temperature thermal desorption;
4. on-Site incineration;
5. off-Site incineration;
6. solvent extraction;
7. soil washing; and
8. mechanical volatilization

Potential on-Site treatment options include ex situ biological treatment, soil vapor extraction, low temperature thermal treatment, on-Site incineration, solvent extraction, soil washing, and mechanical volatilization.

Both biological treatment (which involves aeration of the soil by tilling and the addition of nutrients) and soil vapor extraction/bioremediation (which involves construction of soil piles with a forced aeration system) would be conducted on an engineered treatment pad. Excavated soils would be treated on the treatment pad to reach target cleanup levels.

Low temperature thermal desorption (LTTD) would involve excavating and placing the soils into a portable low temperature thermal stripping unit located on Site. Low temperature heat would be used to remove chemicals from the soil. The off-gases may require treatment prior to discharge to the atmosphere.

On-Site incineration would involve transporting a mobile incineration unit to the Site. The excavated soils would be placed into the incinerator and high temperatures would be used to break down the chemical constituents to non-toxic components.

Off-Site incineration would involve transporting the excavated materials to a permitted off-Site incinerator.

On-Site chemical treatment could be accomplished utilizing a solvent extraction treatment technology. The solvent extraction technology involves mixing the soils with an aliphatic solvent, such as triethylamine (TEA), at low temperatures in a mixing vessel. The first extraction of soil to be treated is conducted at temperatures below 40°F. At this low temperature, the TEA is miscible with water and solubilizes the hydrocarbons. The liquid phase (TEA, water, and hydrocarbons) separates from the soil and is pumped to a decanter. The solvent is then separated from the water by heating to temperatures above 130°F at which TEA becomes immiscible with water. The contaminants which remain with the solvent are then separated from the solvent using an evaporator or an evaporator combined with a distillation column. The solvent is reused and the contaminants sent off Site for treatment and disposal. Additional soil extractions, if required, are conducted at higher temperatures which increases the solubility of the organic compounds in TEA.

Soil washing is accomplished by contacting the excavated soil with water to partition the contaminants from the solid phase to the liquid phase. This technology can be enhanced by the use of surfactants which may increase the efficiency of the contaminant removal.

Mechanical volatilization would involve excavating and placing the soils into a portable treatment unit located on Site. The soils would be mechanically worked to enhance the volatilization of chemicals from the soil to the atmosphere. The treatment unit may require containment and the off-gases may require treatment prior to discharge to the atmosphere.

4.3.1.1.6 Removal/Disposal Action

The removal/disposal response action involves excavation of the soils with concentrations exceeding the potential soil cleanup goals. The excavated soil would be disposed of either on Site in an engineered cell or off Site at an approved disposal landfill facility.

4.3.1.2 Screening of Soil Remedial Response Actions, Technologies, and Process Options

This section presents an evaluation of the soil remedial response actions, technologies, and process options applicable to soil. The initial screening of response actions and technologies is based upon technical feasibility. Remedial response actions and technologies which are not technically feasible are thereby eliminated from further evaluation.

Following this screening, process options for the remaining response actions and technologies are evaluated based upon effectiveness, implementability, and cost considerations. The cost comparisons applied at this stage of evaluation are based primarily upon engineering judgment and are of sufficient detail and accuracy to allow comparison of the different technologies and process options. This initial screening is used to select those technologies and process options that are considered to be most appropriate to the remedial action objectives and conditions at the Site and to eliminate the less effective, less reliable or less cost effective technologies and process options.

4.3.1.2.1 Response Actions and Technologies

A summary of the initial screening of potential remedial response actions and technologies for soils is presented in Table 4.2. Based upon this screening, the following alternatives were eliminated from further evaluation:

- Physical Containment Action - chemical fixation/stabilization in place; and
- Removal/Disposal Action - on-Site disposal (soils) and off-Site disposal (soils).

A discussion of the reasons for elimination of each of these alternatives is presented in the following paragraphs:

Physical Containment Action - chemical fixation/stabilization in place

This alternative is eliminated from further evaluation due to its high cost and unreliability. Other, more reliable and cost-effective alternatives are retained for further evaluation.

Removal/Disposal Action - on-Site and off-Site disposal (soils)

This alternative is eliminated from further evaluation as land disposal restrictions may make this option very difficult to implement either off Site or on Site.

4.3.1.2.2 Process Options

The screening of process options is used to select the most cost-effective process options for the Site, considering Site-specific conditions such as Site geology, hydrogeology, and the chemicals of interest. The process options for the various technologies are evaluated based upon effectiveness, implementability, and cost considerations. The selected process options are retained for inclusion in the development of potential remedial alternatives to be further evaluated in the FS. The following sections present the evaluation of different capping, in situ soil treatment, and ex situ soil treatment options. Other general response actions and remedial technologies do not contain multiple process options and, therefore, are not evaluated at this time.

4.3.1.2.2.1 Capping

The capping objectives for this Site are to:

- minimize infiltration and hence reduce leaching of chemicals in the soils to the groundwater;
- eliminate the potential dermal contact by chemicals associated with surface soils;
- minimize volatilization of chemicals in the near-surface soils to the atmosphere; and
- minimize the potential transport of chemicals in surface water runoff by eliminating surface water runoff contact with chemicals in the surface soils.

Three capping options are considered for the Site. These include a RCRA cap, a clay cap meeting NYSDEC standards for solid waste landfill, and an asphalt cap. A description of each cap design is presented below:

RCRA Cap

- 24 inches of compacted clay;
- 6-inch bedding layer;
- high density polyethylene (HDPE) liner;
- 12-inch drainage layer;
- filter fabric;
- 24 inches of compacted fill;
- 6 inches of topsoil; and
- vegetative cover.

Clay Cap Meeting NYSDEC Solid Waste Landfill Standards

- 18 inches of compacted clay;
- 24 inches of compacted fill;
- 6 inches of topsoil; and
- vegetative cover.

Asphalt Cap (or Upgrading Existing Asphalt Pavement)

- 4 inches of bituminous paving material;
- 12-inch granular bedding layer; and

All three cap designs include a minimum 2 percent slope to promote positive surface water drainage off the capped area and a maximum 33 percent slope to minimize erosion.

Effectiveness

The construction of a cap would not significantly reduce the risk to human health and the environment associated with contaminated soils. The soils with concentrations of chemicals exceeding soil cleanup objectives are situated beneath asphalt pavement, thereby eliminating the potential for dermal contact.

The three capping options would minimize volatilization of chemicals in the near-surface soils to the atmosphere. However, the asphalt pavement currently overlying the contaminated soils already accomplishes this at the Site. Air emissions from near-surface soils have not been identified as a concern at the Site.

Surface water runoff is prevented from contacting surface soils at the Site, thereby eliminating the potential for chemical transport of chemicals in surface water. The three capping options would not significantly decrease the potential for the surface water migration pathway.

The three capping options would effectively minimize infiltration to the subsurface soils. However, the existing asphalt pavement and the surface water drainage controls at the Site already minimize infiltration. In addition, a significant portion of the groundwater flowing through contaminated soils at the Site originates off Site entering the Site laterally from the north and east.

Implementability

Construction of alternative cap designs would utilize common construction practices and locally available materials. Specialized equipment is required for the placement of the synthetic liner for the RCRA cap; however, contractors are readily available with this expertise.

Activities at the Site would be temporarily disrupted during construction of the cap in the northeast or southeast areas.

Costs

General capital costs for the capping alternatives are listed below:

RCRA Cap	- $300,000/acre
Clay Cap Meeting NYSDEC Standards	- $180,000/acre
Asphalt Cap	- $120,000/acre

Summary

Based upon this evaluation, it is determined that all three of the alternative cap designs will meet the capping objectives to eliminate potential dermal contact with chemicals associated with surface soils; minimize volatilization to the atmosphere of chemicals in the near surface soils; and minimize the potential transport of chemicals in the surface water runoff by preventing surface water runoff contact with chemicals in surface soils.

However, the capping options would not significantly increase the effectiveness of the existing asphalt pavement. The significant costs associated with cap construction are not warranted for the Site.

Therefore, capping is not retained for alternative development. However, the existing asphalt pavement may require upgrading and continued maintenance.

4.3.1.2.2.2 In Situ Soil Treatment

Six alternative process options were identified for in situ treatment of soils at the Site. These are:

1. biological;
2. soil vapor extraction;
3. soil vapor extraction with air sparging;
4. soil flushing;
5. bioventing; and
6. passive adsorption.

A detailed evaluation of the in situ treatment technologies is presented in Appendix A and a summary of the results of the evaluation is presented in this section.

Effectiveness

Each of the six treatment technologies have varying degrees of effectiveness for treatment of the different chemicals at the Site.

Biological treatment would not be effective for the chlorinated compounds at the Site. In addition, the low permeability of the native lake sediments within the shallow soils would severely limit transport of nutrients and oxygen to the impacted areas.

Process options such as soil vapor extraction, air sparging and bioventing would not be effective due to the low permeability shallow soils.

Soil flushing would not be effective due to the low permeability shallow soils. In addition, this process option would not be effective for the chlorinated compounds that have relatively low water solubilities.

Passive adsorption would not be effective for the low permeable shallow soils. In addition, soil cleanup objectives would not be achieved in a reasonable amount of time in the deep sandy zone soils.

Treatability and pilot tests would be required to fully evaluate the effectiveness of all in situ process options for the Site-specific conditions.

Implementability

All six of the alternative in situ treatment processes involve similar construction with installation of extraction and injection wells/trenches. Air permits may be required for discharge of treated vapors from a soil vapor extraction process. Treatment of the extracted water or vapors from the different systems prior to discharge or recirculation may be required.

Costs

Unit costs for each in situ treatment technology are as follows:

• biological treatment	$60 to $150/cubic yard
• vapor extraction	$20 to $70/cubic yard
• vapor extraction with air sparging	$40 to $100/cubic yard
• soil flushing	$60 to 150/cubic yard
• bioventing	$30 to $80/cubic yard

• passive adsorption	$50 to $100/cubic yard

Appendix A summarizes the treatment costs for each alternative.

Summary

Based upon the evaluation presented in Appendix A, it is concluded that in situ technologies and process options are not suitable for the treatment of soils at the Site. However, technologies such as soil flushing may be appropriate to enhance alternatives that include overburden groundwater containment or source removal.

4.3.1.2.2.3 Ex Situ Soil Treatment

A total of seven ex situ treatment process options were identified for potential soil remediation. These process options are listed below:

1. soil vapor extraction/bioremediation;
2. on-Site biological;
3. on-Site low temperature thermal desorption;
4. on-Site incineration;
5. off-Site incineration;
6. on-Site solvent extraction;
7. soil washing; and
8. mechanical volatilization.

Due to the relatively large number of alternative treatment process options to be evaluated, the detailed evaluation is presented in Appendix A and a summary of the results of the evaluation is presented in this section.

Effectiveness

All of the alternative process options, with the exception of solvent extraction, and soil washing are considered effective and reliable treatment technologies for the chemicals at the Site. The reliability and effectiveness of solvent extraction is questionable as it is not a widely used proven technology. Soil washing effectiveness is dependent upon the solubility of the chemicals of concern, some of which are relatively water insoluble (e.g., trichloroethene). The biological treatment technology has a higher potential for fugitive air emissions as a large surface area of soil is exposed during the treatment process.

Mechanical volatilization also has a high potential for air emissions as the soils are physically aerated using a hammermill shredder and pugmill to volatilize chemicals from the soil to the atmosphere. In addition, mechanical volatilization may not effectively treat phenolic compounds, NAPL containing soils, TPH and soils containing high concentrations of chemicals.

Treatability studies would be required to fully evaluate the effectiveness of all treatment options.

Implementability

All of the alternative process options are readily implemented with the exception of on-Site incineration and solvent extraction. On-Site incineration would require a trial burn and permitting period. In addition, a risk assessment would be required prior to implementation. The limited number of solvent extraction units that are available may cause lengthy delays before a unit can be mobilized to the Site.

Mechanical volatilization may be difficult to implement due to the potential for excessive air and fugitive dust emissions during treatment, thereby potentially increasing short-term risks to the community and workers. Community acceptance may limit the usefulness of this treatment option for soils with high chemical concentrations.

All of the ex situ treatment process options would require excavation of the soils to be treated. Excavation can be readily accomplished, although some temporary shoring and dewatering may be necessary. Due to potentially high emission rates from the soils, mitigation techniques may be required to control chemical emissions during excavation. In addition, excavation and backfilling operations would cause a disruption to the daily Plant activities in the northeast and southeast areas of the Site.

Cost

Unit costs for each ex situ technology are as follows:

• Soil Vapor Extraction/Bioremediation	$50 to $100/cubic yard	
• Biological Treatment	$70 to $150/cubic yard	$40 - $150 for unit
• Low Temperature Thermal Desorption	$150 to $300/cubic yard	
• On-Site Incineration	$200 to $400/cubic yard	
• Off-Site Incineration	$400 to $800/cubic yard	
• Solvent Extraction	$150 to $500/cubic yard	
• Soil Washing	$150 to $300/cubic yard	
• Mechanical Volatilization	$35 to $125/cubic yard	

Appendix A summarizes the treatment costs for each alternative. Soil vacuum extraction/bioremediation and mechanical volatilization have the lowest costs, followed by biological treatment, low temperature thermal desorption and soil washing. Solvent extraction and incineration (both on-Site and off-Site) are considerably higher in cost.

Summary

Based upon the evaluation presented in Appendix A, soil vapor extraction/bioremediation and mechanical volatilization are the most cost-effective process options for treating soils ex situ at the Site. Mechanical volatilization may be a cost-effective method of treating soils with low level contamination and/or as a pretreatment prior to ex situ soil vapor extraction/bioremediation.

4.3.1.2.3 Summary of Soil Screening Results

Based upon the results of the screening of soil remedial response actions, technologies, and process options, a total of three remedial response actions were retained for further evaluation. A listing of the retained response actions, technologies, and process options is presented in Table 4.3. These response actions, technologies and process options are assembled into remedial alternatives for detailed evaluation in Section 5.0.

4.3.2 Groundwater

4.3.2.1 Identification of General Groundwater Response Actions, Technologies, and Process Options

Remedial action objectives for groundwater at the Site, as presented in Section 4.2.3, are to prevent ingestion and exposure to bedrock groundwater with chemicals that pose carcinogenic and non-carcinogenic risks exceeding established levels of acceptability. In addition, remedial goals for the overburden and bedrock groundwater are to reduce chemical concentrations to applicable SCGs for the protection of human health and the environment.

Exceedances of Class GA groundwater SCGs are presented on Figures 2.13 and 2.17 for overburden and bedrock groundwater, respectively. Contaminant plumes are presented on Figures 2.14, 2.15, and 2.16 for overburden groundwater and Figures 2.18, 2.19, and 2.20 for bedrock groundwater. The following general remedial response actions have been identified for addressing the Site groundwater:

1. no action;
2. limited action;
3. in situ treatment action;
4. physical containment action;

5. hydraulic containment action;
6. source removal action;
7. collection/disposal action; and
8. collection/treatment action.

The potential remedial technologies and process options associated with each of these response actions are listed in Table 4.4. A general description of each of these response actions is presented below.

4.3.2.1.1 No Action

The NCP requires the evaluation of a no action alternative as a basis for comparison with other remedial alternatives. Under the no action response, no measures would be taken to improve environmental conditions with respect to the groundwater at the Site, however, groundwater monitoring would continue to be conducted to ensure that future conditions do not deteriorate significantly from existing conditions.

4.3.2.1.2 Limited Action

The limited action response involves implementing institutional controls to reduce the potential human exposure to Site-related chemicals in the groundwater. The institutional controls would include initiation of deed restrictions to restrict groundwater use on the Site. Groundwater monitoring would be conducted to ensure that future conditions do not deteriorate significantly from existing conditions. It should be noted that a variety of institutional controls are already in place at this Site to support ongoing operations.

4.3.2.1.3 In Situ Treatment Action

In situ treatment can be utilized to reduce chemical concentrations in the groundwater. An available technology currently used for in situ treatment of groundwater is biological treatment. Biological in situ treatment of groundwater would involve development and maintenance of a bacterial culture in the groundwater under controlled conditions. The bacteria would metabolize the chemical constituents to non-toxic components.

4.3.2.1.4 Physical Containment Action

The physical containment response action involves the use of physical means to contain and restrict the mobility and migration of chemicals in the groundwater. A potential physical containment technology involves construction of a barrier wall(s) either upgradient, downgradient, or around the source area to restrict the movement of chemicals from the Site via groundwater flow. Barrier walls can be constructed of soil/bentonite, cement/bentonite, or sheet piling.

4.3.2.1.5 Hydraulic Containment Action

The hydraulic containment action would involve groundwater extraction downgradient of the source area to reduce the migration of chemical constituents from the Site via groundwater flow. Hydraulic containment could be achieved by installing either groundwater extraction wells or horizontal groundwater collection drains. The collected groundwater would be either treated on Site or off Site using one of the treatment options presented in Section 4.3.2.1.7 and/or disposed of using one of the potential disposal options presented in Section 4.3.2.1.8.

4.3.2.1.6 Source Removal Action

The source removal response action would involve extracting groundwater throughout the source area utilizing either groundwater extraction wells or groundwater collection drains. The collected groundwater would be treated either on Site or off Site using one of the treatment options presented in Section 4.3.2.1.7 or disposed of using one of the potential disposal options presented in Section 4.3.2.1.8.

4.3.2.1.7 Collection/Treatment Action

The collection/treatment response action would involve treating collected groundwater to acceptable standards prior to discharge. Potential treatment technologies include on-Site treatment using physical, chemical, or biological treatment options or off-Site treatment.

Physical treatment could be accomplished on Site using liquid phase carbon adsorption, air stripping, air aeration, or incineration to remove contaminants from the groundwater (in addition, pretreatment and off-gas treatment, as required).

Activated carbon could be used to remove dissolved contaminants from the groundwater by physical adsorption. The spent carbon would be treated/recycled or disposed of as a hazardous waste.

Air stripping involves physically stripping contaminants from the groundwater by the counter current flow of air through a packed tower media. Monitoring and treatment of the off-gas may be required.

Aeration involves physically stripping the contaminants from the groundwater by utilization of an aeration basin. Monitoring and treatment of off-gas may be required.

Incineration involves breaking down the chemical constituents to non-toxic components utilizing an on-Site mobile incineration unit.

Chemical treatment of collected groundwater could be conducted using ultraviolet (UV) enhanced oxidation. The UV enhanced oxidation technology involves using chemical oxidizing agents such as hydrogen peroxide, or ozone combined with ultraviolet radiation to chemically oxidize organic compounds. The process decreases the toxicity of the waste by reducing contaminants to non-toxic components.

Biological treatment could be used to reduce organic concentrations in the collected groundwater. The principles of this process are essentially the same as described for the biological treatment of soils presented in Section 4.3.1.1.4.

Off-Site treatment technologies could include one or a combination of the identified on-Site treatment options.

4.3.2.1.8 Collection/Disposal Action

The collection/disposal response action would involve collection of groundwater using either the source removal and/or hydraulic containment response actions and disposal of the collected groundwater. Potential disposal technologies include off-Site disposal at a publicly owned treatment works (POTW). Treatment utilizing one of the treatment actions identified in Section 4.3.2.1.7 may be required prior to disposal.

4.3.2.2 Screening of Groundwater Remedial Response Actions, Technologies, and Process Options

This section presents an evaluation of the groundwater remedial response actions, technologies, and process options. The screening process parallels the process used for screening the soil remedial alternatives

(Section 4.3.1.2). The initial screening of response actions and technologies is based upon technical feasibility. Technologies which are not feasible are eliminated from further evaluation.

Following this screening, process options for the remaining response actions and technologies are evaluated based upon effectiveness, implementability, and cost considerations. The cost comparisons are based primarily upon engineering judgment and are of sufficient detail and accuracy to allow comparison of the different technologies and process options.

4.3.2.2.1 Response Actions and Technologies

A summary of the initial screening of potential remedial response actions and technologies for groundwater is presented in Table 4.5. A hydrogeologic evaluation of the Site relative to groundwater extraction alternatives is presented in Appendix C. Based upon the initial screening, the following alternatives were eliminated from further evaluation:

- Physical Containment Action - downgradient and upgradient;
- Hydraulic Containment Action/Source Removal Action - overburden groundwater extraction wells;
- Collection/Disposal Action - groundwater injection; and
- In Situ Treatment Action - biological.

A discussion of the reasons for elimination of each of these alternatives is presented in the following paragraphs.

Physical Containment Action - Barrier Wall

Full hydraulic containment will be provided to control the migration of contaminants at the Site. A downgradient barrier wall would not provide any additional benefit for the control of off-Site migration of groundwater. The barrier wall would not prevent the migration of contaminants to the bedrock aquifer.

A barrier wall may be installed upgradient to reduce the rate of groundwater entering the Site and consequently the amount of groundwater requiring treatment. However, since the anticipated flow rate in the overburden is predicted to be very low, the addition of an upgradient barrier is not considered necessary.

As a result, a barrier wall is not considered to be an effective component for hydraulic containment at the Site.

Hydraulic Containment Action/Source Removal Action - Overburden Groundwater Extraction Wells

Overburden extraction wells are not considered suitable due to the anticipated low yields. In addition, much of the overburden is seasonally dry. The silt and sand aquifer has low hydraulic conductivity and transmissivity so that effective pumping rates would not be achieved.

Therefore, extraction wells will not be considered as a remedial technology for hydraulic containment or source removal action for the overburden groundwater.

Collection/Disposal Action - Groundwater Injection

Groundwater injection would be appropriate for in situ soil treatment technologies involving biological treatment or soil flushing where the recirculation of groundwater is required for effective treatment. However, since these technologies have not been retained, groundwater injection is not considered an appropriate disposal action.

In Situ Treatment Action - Biological

In situ biological treatment would involve circulating nutrient enhanced water through the groundwater system to promote the development of bacteria cultures. Biological treatment would, therefore, not be effective for the low permeability soils. In addition, chlorinated compounds would be difficult to treat with in situ biological treatment.

Hence, the in situ biological treatment technology is eliminated from further evaluation.

4.3.2.2.2 Process Options

The screening of process options is used to select the most cost-effective process options for the Site, considering Site-specific conditions such as geology, hydrogeology, and the chemicals of interest. The process options of the various technologies are evaluated based upon effectiveness, implementability, and cost considerations. The selected process options are retained for inclusion in the development of potential remedial alternatives to be further evaluated in the FS. The following sections present the evaluation of the different groundwater treatment options.

4.3.2.2.2.1 Groundwater Treatment

A total of eight different process options were identified for potential groundwater treatment. The process options are listed below:

1. on-Site carbon adsorption;
2. on-Site air stripping;
3. on-Site air stripping/carbon adsorption;
4. on-Site aeration;
5. on-Site UV oxidation;
6. on-Site biological;
7. off-Site treatment at POTW; and
8. off-Site treatment at RCRA facility.

Due to the relatively large number of alternative treatment options to be evaluated, the detailed evaluation is presented in

Appendix B and a summary of the results of the evaluation is presented in this section.

Effectiveness

UV/oxidation, liquid phase carbon adsorption, air stripping, off-Site treatment at a POTW, and off-Site treatment at a RCRA facility are considered to be effective treatment technologies for the majority of the chemicals at the Site. Aeration is not considered effective, especially for SVOCs, due to its low efficiency in comparison to an air stripping system. Similarly, biological treatment would be ineffective for treating chlorinated compounds present at the Site, which would be expected to be present in the groundwater waste stream at relatively significant concentrations. Also, biological treatment would be less effective given the relatively low organic compound concentrations. Based upon the effectiveness criterion, biological treatment and aeration were eliminated from further evaluation.

Implementability

UV/oxidation and air stripping, are considered to be relatively easy to implement, however, pretreatment may be required to remove metals and suspended solids for these on-Site treatment options. Vapor phase carbon adsorption or catalytic oxidation may be required for treatment of the off-gas for an air stripping system.

Chemical concentrations in the collected groundwater may preclude the feasibility of utilizing a POTW for groundwater treatment without prior pretreatment.

Treatment at a RCRA facility is considered impractical due to the large volume of groundwater requiring transportation.

Liquid phase carbon adsorption would require a significant amount of carbon to treat the chemicals of concern at the Site.

Cost

Capital costs for the installation of carbon adsorption, air stripping with carbon adsorption off-gas treatment, air stripping with catalytic oxidation, and UV/oxidation systems are estimated to be $511,000, $418,000, $576,000, and $533,000, respectively. First year annual operation and maintenance costs are estimated to be $281,500 for carbon adsorption, $483,000 using air stripping/carbon adsorption, $78,000 using air stripping/catalytic oxidation, and $101,000 for UV/oxidation.

Summary

Based upon the evaluation presented in Appendix B, it is recommended that an air stripping/catalytic oxidation treatment system be included in alternatives which include groundwater collection and treatment. UV/oxidation and carbon adsorption may also be effective technologies for groundwater treatment. These processes are much more cost effective than treatment at an off-Site RCRA facility. Treatment at an off-Site POTW may be feasible if the chemical concentrations in the collected groundwater are below acceptance criteria. The suitability of these processes may only be determined during the detailed design/treatability study stage.

4.3.2.3 Summary of Groundwater Screening Results

Based upon the results of the screening of groundwater remedial response actions, technologies, and process options, a total of six remedial response actions were retained for further evaluation. A listing of the retained response actions, technologies, and process options is presented in Table 4.6. These alternatives represent a broad range of treatment, containment, and disposal technologies for groundwater remediation which can be assembled into complete remedial alternatives for the Site.

5.0 DEVELOPMENT AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

5.1 INTRODUCTION

The remedial alternatives for the Site are developed in Section 5.2 utilizing the general response actions, technologies, and process options retained from the initial screening conducted in Section 4.0.

The detailed analysis of alternatives, presented in Section 5.3, consists of the refinement of remedial alternatives and evaluation of each alternative against seven evaluation criteria which encompass technical, cost, and institutional considerations; and compliance with statutory requirements. The detailed analysis presented in this section follows the outline presented in the U.S. EPA RI/FS Guidance Document and 6 NYCRR Section 375-1.10 (c).

The results of the detailed analysis of alternatives is summarized in Section 5.4.

5.2 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The following four remedial alternatives for the Site have been assembled utilizing the general response actions, technologies and process options retained from the initial screening:

Alternative 1:
- No Action
- Groundwater Monitoring

Alternative 2:
- Institutional Controls
- Groundwater Monitoring

Alternative 3:

- Institutional Controls
- Groundwater Hydraulic Containment (Overburden and Bedrock)/Source Removal, On-Site Treatment
- NAPL Collection, Off-Site Treatment
- Groundwater Monitoring

Alternative 4:

- Institutional Controls
- Groundwater Hydraulic Containment (Bedrock)/Source Removal, On-Site Treatment
- Soil Source Removal, On-Site Treatment
- Groundwater Monitoring

5.3 DESCRIPTION AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The detailed analysis of alternatives consists of the evaluation of each alternative in terms of the seven evaluation criteria which encompass technical, cost, and institutional considerations; and compliance with statutory requirements.

The seven evaluation criteria used in the detailed analysis of remedial alternatives are summarized as follows:

i) overall protection of human health and the environment;
ii) compliance with applicable or appropriate and relevant requirements (ARARs);
iii) short-term impacts and effectiveness;
iv) long-term effectiveness and permanence;
v) reduction of toxicity, mobility, and volume;
vi) implementability; and
vii) cost.

A list of evaluation factors to be considered under each evaluation criteria is presented in Table 5.1.

The four alternatives have been scored in accordance with the seven evaluation criteria as outlined in TAGM HWR-90-4030[1]. The results of the scoring are presented in Appendix E.

A discussion of the remedial action components and requirements which are common to the various alternatives, or groups of alternatives, is presented in Section 5.3.1. These components or requirements include the following:

i) monitoring requirements;
ii) institutional controls; and
iii) pre-design studies.

The detailed analysis of each alternative is provided in Sections 5.3.2 to 5.3.5.

5.3.1 Components Common to Various Alternatives

A general Site monitoring program would be implemented with all remedial alternatives including the No Action alternative (Alternative 1). Institutional controls would be implemented for Alternatives 2 to 4 to restrict exposure to contaminated soil and groundwater. Finally, pre-design studies will be required to support the successful design and implementation of certain remedy components.

---

[1] Technical and Administrative Guidance Memorandum for the Selection of Remedial Actions at Inactive Hazardous Waste Sites, HWR-90-4030, NYSDEC, May 15, 1990.

5.3.1.1 Monitoring Programs

The objective of the monitoring program would be to provide data that would be used to assess the effectiveness of the remedial measures. The monitoring program would include on-Site and off-Site groundwater monitoring. The alternatives which include the collection and treatment of groundwater (Alternatives 3 and 4) would require additional monitoring of the treatment system(s). A summary of the anticipated monitoring program for each alternative is presented in Table 5.2. The monitoring program would be refined during the detailed design phase.

5.3.1.1.1 General Site Monitoring

A general Site groundwater monitoring program would be implemented with all remedial alternatives, including the No Action alternative (Alternative 1). The monitoring program would be designed to monitor the effectiveness of the remedial measures and to ensure that downgradient off-Site groundwater quality is not being adversely impacted.

The proposed monitoring program includes ten monitoring wells. The monitoring network is presented in Table 5.3. Groundwater would be monitored at the southern property boundary and downgradient of the southeastern source area at overburden and bedrock wells MW-3, MW-5/5A, MW-13/13A, and MW-14/14A. Groundwater would also be monitored downgradient of the northeastern source area at wells MW-18 and MW-15/15A. The actual monitoring well network would be determined in conjunction with the NYSDEC prior to implementation of the remedial action.

The monitoring program would be conducted semi-annually for five years and annually thereafter, and would include both hydraulic and chemical monitoring. All groundwater samples would be analyzed for VOCs. Results of the monitoring program would be submitted to the NYSDEC in an annual monitoring report. Following each monitoring event for the first five years, and for each subsequent five-year period, the monitoring program would be reviewed with the NYSDEC. Modifications to the monitoring program including frequency of monitoring and/or locations may be implemented as required based on the annual results or the 5-year review.

5.3.1.1.2 Treatment System Monitoring

Alternatives 3 and 4 involve extraction and treatment of groundwater. Monitoring of the influent and effluent concentrations for a selected list of parameters would be conducted to ensure the efficiency of the treatment system. For purposes of this evaluation, it is assumed that influent and effluent monitoring would be conducted on a weekly basis for the first two months and monthly thereafter. The expected duration of monitoring for each of these alternatives is 30 years. The treatment and monitoring of air emissions may be required for the groundwater treatment system.

Alternative 4 involves on Site soil treatment utilizing vapor extraction with biological treatment. Influent and effluent monitoring of the treatment system would be conducted on a weekly basis for the first two months and monthly thereafter.

5.3.1.1.3 Reporting

An annual report would be prepared which would document sampling activities, present analytical results, and provide an evaluation of the data. A mandatory review of the remedial action alternative would be conducted every five years after completion of the remedial construction.

5.3.1.2 Institutional Controls

All remedial alternatives, except the No Action alternative, would require institutional controls to restrict on-Site exposure to contaminated groundwater. Institutional controls would consist of deed restrictions.

Deed restrictions involve placing a notation on the property deed which makes the current and any prospective property owner aware of the property's history and the restricted land use. The deed restriction would restrict on-site groundwater use. The deed restriction would also limit on-Site property uses to industrial purposes, thereby limiting potential risks due to direct contact/ingestion of Site soil.

5.3.1.3 Pre-Design Studies

Pre-design studies are required in instances where there is a need to verify the effectiveness of treatment technologies (i.e., treatability studies) or verify quantity estimates for the activities associated with remedial action contractor procurement. The following pre-design studies would be required to provide supplemental data to support the detailed design requirements for the various components of Alternatives 3 and 4:

- groundwater treatability study (Alternatives 3 and 4);
- pre-design hydrogeologic investigation study (Alternatives 3 and 4):
  - aquifer properties testing,
  - groundwater extraction pumping test, and
  - groundwater extraction system influent chemistry evaluation; and
- soil treatability study (Alternative 4).

Additional soil sampling
to delineate soil contamination

The pre-design studies would be completed either before or during the preparation of the remedial design. The results of the pre-design studies would be incorporated in the final remedial design.

5.3.2 Alternative 1
- No Action
- Groundwater Monitoring

The No Action alternative does not include any remedial activities other than general Site monitoring following completion of the FS. The monitoring program is described in Section 5.3.1.1.1. The No Action Alternative is required by the NCP to serve as a basis for comparison with other remedial alternatives. Chemical concentrations in the soil and groundwater would be reduced with time through natural attenuation processes.

5.3.2.1 Alternative 1 - Overall Protection of Human Health and the Environment

The No Action alternative would not reduce risks to human health and the environment. Based upon the Baseline Risk Assessment, the cancer risks associated with all Level 2 exposure scenarios, with the exception of groundwater use as a future potable water source, range from 3.08 x 10^{-8} to 4.82 x 10^{-5}. The cumulative cancer risks for a potential future groundwater use scenario on Site and at the Site perimeter were calculated to be 4.77 and 1.02 x 10^{-2}, respectively for Level 2 exposure. The non-carcinogenic hazard indices for all exposure scenarios would continue to be less than the level of concern (1.0) with the exception of the potential future groundwater exposure scenario on Site and at the Site perimeter for which the hazard indices were estimated to be 290,000 and 149,000 respectively for Level 2 exposure. The existing conditions were determined to pose no potential risk to the natural environment.

5.3.2.2 Alternative 1 - Compliance With SCGs

It is expected that chemical-specific SCGs for Class GA groundwater would continue to be exceeded at and beyond the Site property boundary. The chemical concentrations in the groundwater would decrease with time due to natural attenuation processes. Calculations presented in

Appendix C indicate that it would take 570 to 4,235 years to reach SCGs in the overburden groundwater following source removal. Therefore, the chemical-specific SCGs for groundwater would not be achieved over an extended period of time with natural attenuation.

Soil cleanup objectives would continue to be exceeded for the on Site soils although soil concentrations would decrease with time due to natural attenuation.

5.3.2.3 Alternative 1 - Long-Term Effectiveness and Permanence

Potential health risks associated with chemicals at the Site, with the exception of the potential future groundwater use as a potable water supply, are low and would be reduced over time as the chemical concentrations decreased through natural attenuation. Implementation of Alternative 1 would not further reduce the long-term risks over what would occur through natural attenuation. A review of the remedial alternative would be conducted every five years to ensure that human health and the environment are being protected.

5.3.2.4 Alternative 1 - Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 1 provides no additional reduction in the toxicity, mobility, or volume of chemicals at the Site beyond what would be achieved through natural attenuation.

5.3.2.5 Alternative 1 - Short-Term Effectiveness

As Alternative 1 involves no remedial action, there would be no additional short-term impacts to the community, workers, or the environment as a result of implementation of this alternative.

5.3.2.6 Alternative 1 - Implementability

This alternative is easily implemented.

5.3.2.7 Alternative 1 - Cost

A detailed cost breakdown for Alternative 1 is presented in Table 5.4. This alternative has no capital cost or operational costs associated with it, except for groundwater monitoring and reporting. The annual costs for monitoring and reporting are estimated to be $56,500. The total present worth of this alternative is estimated to be $598,000 based upon a 7 percent discount rate over a 30-year period.

5.3.3 Alternative 2 - Institutional Controls - Groundwater Monitoring

Alternative 2 includes the implementation of institutional controls to minimize potential exposure to chemicals in the soil and groundwater. Details for the institutional controls for this alternative are presented in Section 5.3.1.2. A groundwater monitoring program would be implemented as described in Section 5.3.1.1.1.

5.3.3.1 Alternative 2 - Overall Protection of Human Health and the Environment

Alternative 2 would reduce the risks to human health for all exposure scenarios with the exception of the potential future off-Site groundwater use scenario. Potential contact to chemicals in the on-Site surface soils and groundwater would be reduced by maintaining limited access to the Site through the implementation of institutional controls. The resulting residual carcinogenic risk for all exposure scenarios would be less than 1.0×10^{-6} with the exception of off-Site groundwater use at the property perimeter for which the Level 2 risk was estimated to be 1.02×10^{-2}.

5.3.3.2 Alternative 2 - Compliance With SCGs

It is expected that chemical-specific SCGs for Class GA groundwater would continue to be exceeded at and beyond the Site property boundary. The chemical concentrations in the groundwater would decrease with time due to natural attenuation processes, however, the chemical-specific SCGs for groundwater would not be achieved over an extended period of time estimated to be greater than 570 to 4,235 years.

Soil cleanup objectives would continue to be exceeded for the on Site soils although soil concentrations would decrease with time through natural attenuation.

5.3.3.3 Alternative 2 - Long-Term Effectiveness and Permanence

Implementation of Alternative 2 would reduce the potential risks due to direct contact/ingestion of soil and on-Site groundwater ingestion for future uses through institutional controls. The continued maintenance of existing buildings and paved surfaces on-Site would also reduce potential risks due to direct contact/ingestion of soil throughout the majority of the Site. Institutional controls are considered to be reliable as a method to limit access and restrict future land uses at this Site. A review of the remedial alternative would be conducted every five years to ensure that human health and the environment are being protected.

5.3.3.4 Alternative 2 - Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 2 provides no additional reduction in the toxicity, mobility, or volume of chemicals at the Site beyond what would be achieved through natural attenuation.

5.3.3.5 Alternative 2 - Short-Term Effectiveness

As Alternative 2 involves no disturbance of any of the soils at the Site, there would be no additional short-term impacts to the community, workers, or the environment as a result of implementation of this alternative. The institutional controls could be implemented in a relatively short period of time (approximately one year).

5.3.3.6 Alternative 2 - Implementability

Institutional controls are generally easy to implement. The effectiveness of the remediation could be readily monitored by implementing the general Site monitoring program as described in Section 5.3.1.1.1. Additional remedial actions may be required at a later date dependent upon the results of the monitoring program.

5.3.3.7 Alternative 2 - Cost

A detailed cost breakdown for Alternative 2 is presented in Table 5.5. The total capital cost is estimated to be $16,300. The annual costs for monitoring and reporting are estimated to be $56,500. The total present worth of this alternative is estimated to be $614,000 based upon a 7 percent discount rate over a 30-year period.

5.3.4 Alternative 3

- Institutional Controls
- Groundwater Hydraulic Containment (Overburden and Bedrock)/Source Removal, On-Site Treatment
- NAPL Collection, Off-Site Treatment
- Groundwater Monitoring

Alternative 3 includes the remedy components of Alternatives 1 and 2 (i.e., groundwater monitoring and institutional controls) in addition to a groundwater extraction and on-Site treatment system and NAPL collection with off-Site treatment.

The remedial components for Alternative 3 are presented on Figure 5.1.

Alternative 3 includes overburden tile collection trenches and bedrock extraction wells in the southeastern and northeastern portions of the Site as presented on Figure 5.1. The overburden collection trenches and bedrock extraction wells would provide full groundwater hydraulic containment at the Site. In addition, as the combined system is located close to the source areas, Alternative 3 would provide source removal from these areas. The existing low level groundwater contamination southeast of the Site in the overburden and bedrock would be reduced through natural attenuating processes.

The overburden tile collection trenches would be positioned directly above the bedrock to provide a continuous line of containment in the overburden. The southeastern collection trench would be approximately 420 feet in length with an average depth of 12 feet. The northeastern trench would be approximately 100 feet in length with an average depth of 15 feet. Preliminary calculations presented in Appendix C indicate that the preferential pathways created by the collection trenches would capture approximately 0.02 gpm to 0.22 gpm of contaminated groundwater from the southeastern area and 0.004 gpm to 0.05 gpm from the northeastern area. The range in yields represent low and high water table conditions.

The following two process options are suitable for the excavation of the overburden collection trenches:

- conventional trenching; and
- "One-Pass" system.

Construction of the collection trench would involve excavation within areas of the Site with contaminated soils and groundwater. In order to minimize the disturbance and handling of contaminated soils and groundwater, it is proposed that the "One-Pass" system of trench installation be employed.

The "One-Pass" trenching system involves the simultaneous operations of excavating a narrow trench (approximately 10 to 14 inches wide), placing a flexible collector drain at the bottom of the trench and placing granular material on top of the collector drain. The entire trenching operation including installation of the collector drain is accomplished by a specially designed trench excavator. At the start of the trench, a vertical riser with the flexible collector drain attached is lowered into the trench. The vertical riser acts as a sump for groundwater collected by the drain. The trench is extended and the collector drain and granular material are installed as described above. At the end of the trench, the collector drain is brought up at an incline to the surface where it will serve as a cleanout for that section of collector trench. The maximum length of each collector trench is limited by the practical length for cleaning operations (typically 250 to 350 feet). If the practical length is exceeded, a new trench would be excavated immediately adjacent to the previous one. The new trench would begin roughly where the collector drain in the previous trench starts to incline towards the surface. The new trench would also include the installation of a vertical riser, a collector drain, and a cleanout. This process is continued until the total required length for groundwater collected is achieved.

The "One-Pass" system has several advantages over conventional trenching methods. The "One-Pass" system involves excavating a narrow trench which minimizes the volume of excavated soil and reduces the expense of soil handling. In addition, limited dewatering of

Jeff Degber
Watts Engineers
688-4827
FOIL

Rte 277 Dave Lacey

French to Como Park

(Sutton)
Greg Transit Valley Plaza Waste Site

NES

last thurs.

2wks

FS work-up

[redacted]

Has
Pre-design
report in hand
will give to
DEC this wk.

the trench would be required eliminating the expense of handling, transporting, and treating large volumes of contaminated groundwater. The system also precludes the need for laborers working in a trench, which eliminates trench shoring requirements. The "One-Pass" system is, therefore, less labor intensive and less costly than conventional trenching methods.

The "One-Pass" system would result in a trench approximately 10 to 14 inches wide with a 6-inch diameter collection drain installed to a maximum depth of approximately 15 feet as presented on Figure 5.2.

The collection trench would be sloped towards a "wet well" or pumping station from which the collected groundwater would be extracted. Collected groundwater would be pumped via forcemains to the on-Site treatment system.

Bedrock extraction wells would be installed in the center of the southeastern source area and in the northeastern source area near well MW-16A to provide hydraulic containment/source removal in these areas of the Site. The extraction wells would be installed in the fractured bedrock to an approximate depth of 35 feet. The pumping rate (see Appendix C) is estimated to be 10 gpm for each well.

The combined flow rate from the overburden collection trenches and bedrock extraction wells is estimated to be 20 gpm during high water table conditions.

The on-Site groundwater treatment system would be selected based on the results of the pre-design activities presented in Section 5.3.1.3. If discharge to a local POTW is not possible, the treatment system would most likely include either air stripping, UV oxidation, carbon adsorption or a combination of these options. If necessary, the treatment system would include a pretreatment solids removal system and off-gas treatment.

Based on the preliminary evaluation presented in Appendix B, air stripping with catalytic oxidation was determined to be the most cost-effective treatment method if direct discharge to a POTW is not possible. Therefore, for the purposes of the FS, the groundwater treatment system will consist of air stripping with catalytic oxidation, pretreatment for solids removal and off-gas treatment.

Air strippers typically consist of a stripping tower that utilizes a counter-current flow arrangement. The influent water stream is introduced at the top of the tower and allowed to flow downward through either packing media or a series of sieve trays while the air stream flows upward. The treated water exits at the bottom of the tower while the air stream exits at the top of the tower. The resulting residuals from an air stripping tower are the off gases and the stripped effluent. Where necessary, the off gas is directed through vapor phase treatment such as activated carbon or catalytic oxidation to control volatile emissions to the atmosphere.

The presence of suspended solids in the water stream may impact the treatment efficiency due to clogging. Also, the presence of metals such as iron, calcium and magnesium in the influent stream may cause additional scaling of air stripping due to changes in the water chemistry during the process. Pretreatment including filtration of particulates and addition of a sequestrate to inhibit scale formation will likely be necessary at the Site. Caustic precipitation may also be an appropriate pretreatment depending on Site conditions.

The removal efficiency of VOCs from the groundwater to the cross current air flow will depend on the influent flow rate, the specific VOC concentrations and the Henry's Law constant for the various VOCs. Appendix B provides a summary of the estimated maximum groundwater influent and treated effluent VOC concentrations at a conservatively estimated influent flow rate of 25 gpm. It is estimated that the VOCs of concern will be removed to a concentration of 1.0 μg/L.

Treated groundwater would be discharged to the on-Site storm sewer system. Monitoring of the treatment system as presented in Section 5.4.1.1.2 would ensure that applicable discharge criteria are met.

Alternative 3 includes NAPL collection and off-Site treatment. NAPL would be collected from wells MW-8 and MW-11 on an intermittent basis as required. The volume of NAPL and frequency of sampling would be determined during pre-design activities. The extracted NAPL would be directed to a separator in the on Site groundwater treatment facility to separate the aqueous phase from the non-aqueous phase (NAPL). The aqueous phase liquid would be treated on Site by the groundwater treatment system. NAPL would be accumulated on Site in a suitable containment area prior to being transported to an appropriate off Site treatment facility. The volume of NAPL that would be collected is expected to be low based on the distribution of NAPL and hydraulic characteristics of the overburden. For the purposes of the FS the volume of NAPL that would be collected is estimated to be 20 gallons per month for the first year.

Soil flushing may be added to Alternative 3 to enhance the remediation process by increasing the volume of groundwater flowing through the overburden. The feasibility of adding soil flushing to Alternative 3 would be evaluated during the pre-design stage.

5.3.4.1 Alternative 3 - Overall Protection of Human Health and the Environment

This alternative would reduce the risks to human health for all exposure scenarios. The groundwater containment system would prevent the off-Site migration of chemicals in the groundwater and hence reduce the associated potential risks with contact to groundwater. Potential contact to chemicals in the soils would be reduced by maintaining limited access to the Site through institutional controls.

5.3.4.2 Alternative 3 - Compliance With SCGs

Implementation of groundwater containment/source removal would decrease the time frame required to reach groundwater SCGs in the overburden and bedrock in comparison to Alternatives 1 and 2. Furthermore, the much greater pumping rate and volumetric flux rate through the bedrock aquifer will shorten the time required to reach groundwater SCGs in the bedrock aquifer.

The time required to reach soil cleanup objectives would also be reduced in comparison to Alternatives 1 and 2 by removal of NAPL and contaminated groundwater. The addition of soil flushing to Alternative 3 would enhance the flow of groundwater through the overburden and further reduce the time to reach soil and groundwater SCGs.

5.3.4.3 Alternative 3 - Long-Term Effectiveness and Permanence

Implementation of Alternative 3 would reduce potential risks due to direct contact/ingestion of soils through institutional controls. The existing building and paved surfaces on Site would also reduce potential risks due to direct contact/ingestion of the soils throughout the majority of the Site. Risks due to groundwater ingestion would be reduced through the groundwater containment and treatment system. A review of the remedial action would be required every five years.

5.3.4.4 Alternative 3 - Reduction of Toxicity, Mobility, or Volume Through Treatment

Implementation of this alternative provides a reduction in the mobility, and volume of chemicals contained in the soils and groundwater. It is assumed that the groundwater containment system would ultimately remove greater than 90 percent of the chemicals in the groundwater. The groundwater treatment action would result in irreversible treatment of the chemicals in the groundwater.

The removal and off-Site treatment of NAPL would also significantly reduce the volume of chemicals at the Site.

5.3.4.5 Alternative 3 - Short-Term Effectiveness

It is estimated that this alternative could be implemented in one year. The benefits of the groundwater collection system would be obtained immediately upon installation. This alternative involves minimal disturbance of soils on Site by using the "One-Pass" trenching system and there would be no additional short-term impacts to the community or the environment as a result of implementation of this alternative. Construction workers would wear proper protective equipment and adhere to safe construction practices to minimize potential hazards during the installation of the various remedy components.

5.3.4.6 Alternative 3 - Implementability

Implementation of this alternative would involve common construction procedures and the services and materials are readily available. There are several companies capable of implementing the "One-Pass" trenching method.

The effectiveness of this alternative could be easily monitored by implementation of the general Site monitoring program. Additional remedial action, such as extending the groundwater containment/extraction system, could be implemented at a later date (if required). This requirement would be determined based upon the analytical results obtained during implementation of the groundwater monitoring program.

Pre-design studies would be required for the design of the on-Site groundwater collection and treatment system and NAPL collection with off-Site treatment.

5.3.4.7 Alternative 3 - Cost

A detailed cost breakdown is presented in Table 5.6. The total capital cost is estimated to be \$1,190,000 and the annual operation and maintenance cost is estimated to be \$177,000. The total present worth of this alternative is estimated to be \$3,200,000 based upon a seven percent discount rate over a 30-year period.

5.3.5 Alternative 4

- Institutional Controls
- Bedrock Groundwater Hydraulic Containment (Bedrock)/Source Removal, On-Site Treatment
- Soil Source Removal, On Site Treatment
- Groundwater Monitoring

Alternative 4 includes the remedy components of Alternatives 1 and 2 (i.e., monitoring and institutional controls) in addition to a bedrock groundwater extraction system and soil source removal with on Site treatment.

The remedial components for Alternative 4 are presented on Figure 5.3.

Alternative 4 would involve excavation of the soils with concentrations exceeding the potential cleanup objectives and treatment of the soils on Site utilizing mechanical volatilization and/or vapor extraction supplemented by biological treatment. Excavation would be conducted to the areal limits presented on Figure 5.3. Confirmatory samples would be obtained from the sidewalls to ensure that all of the soils with concentrations exceeding the cleanup objectives are removed. A real time screening instrument such as an OVA meter would be used to guide the excavation with some additional laboratory analyses for verification. It is estimated that the following volumes of soil would be excavated.

Area A - 110 yd^3 requiring remediation, average depth of 3 feet

Area B - 6,000 yd^3 requiring remediation, average depth of 13 feet
Area C - 10,210 yd^3 requiring remediation, average depth of 12.5 feet

Total Volume to be excavated and treated - 16,320 yd^3

In addition, the soils in the Secondary Southeast Area may also require excavation and treatment. The volume of soil in this area is estimated to be 11,870 yd^3.

Treatment of the soils with mechanical volatilization could significantly reduce the time required to achieve soil cleanup objectives. The soils in Areas A and B contain lower concentrations (less than 25 mg/kg total average VOCs) compared to Area C soils (approximately 460 mg/kg total average VOCs) and are, therefore, more likely to be successfully treated using mechanical volatilization to acceptable levels for VOCs. Confirmatory samples would be collected following mechanical volatilization to determine the need for additional treatment with soil vapor extraction/bioremediation. Due to the fact that mechanical volatilization will not effectively treat the soils contaminated with phenolics and TPHs, it is likely that some soils will still require some form of treatment by bioremediation. Nonetheless, the aggressive mixing that occurs during the chemical volatilization process could be a valuable component of the bioremediation phase in that it homogenizes the soil mixture creating a mass that is more suitable for biological activity to occur.

Materials that have phenolics and TPH concentrations that are not of concern could be completely treated by mechanical volatilization.

Using a combination of these treatment methods would provide effective treatment of the Site material and the work could possibly be completed in one year. If soil vapor extraction/bioremediation was used for the entire soil mass, the remediation duration could be two to four years.

For the purposes of the FS, it has been assumed that the following volumes of soil would be treated by either mechanical volatilization or soil vapor extraction/bioremediation:

Treatment Method	Area	Volume (yd^3)
Mechanical Volatilization	Area A	110
	Area B	6,000
	Area C (1/3 total volume)	3,370
	Secondary Southeast Area (if treatment required)	11,870
Soil Vapor Extraction/ Bioremediation	Area C (2/3 total volume)	6,840

The existing asphalt parking area in the upper eastern area would be used as the treatment pad for soil vapor extraction/bioremediation. The treatment area would be approximately 90,000 $feet^2$. The soils would be treated by soil vapor extraction/bioremediation by constructing elongated piles within which perforated pipes would be installed. A typical layout for the treatment area is presented on Figure 5.4. The perforated pipes would be connected to a blower unit to draw air through the piles. The air would serve to volatize chemicals present in the water and on the soils and to add oxygen to the system to stimulate aerobic biodegradation. The air would be treated, if necessary, using carbon adsorption, prior to recirculation or exhaust to the atmosphere. Nutrients would be added to the treatment piles as required to further enhance biological degradation. Samples of the soil vapors would be analyzed as an indicator of residual chemical levels in the treated soils. Confirmatory soil samples may be required to be analyzed to ensure that the cleanup goals have been reached prior to backfilling the treated soils into the former excavation areas. Soil requiring remediation would be temporarily stockpiled, if necessary, and covered until space was available in the treatment facility.

The capacity of the treatment pad would be approximately 11,000 yd^3. It is estimated that the soils from Area C with higher levels of chemistry consisting of approximately 6,840 yd^3 could be treated in one year.

Soils from the southeastern area (Area C) would be excavated first and treated. Following treatment, soils would be excavated from Areas A and B. In order to minimize the disruption of Plant operations, the excavations in Areas A and B would be immediately backfilled with treated soil from Area C. Following the treatment of soils from Areas A and B, the excavation in Area C would be backfilled.

A treatability study would be conducted prior to implementation to evaluate the effectiveness of the treatment processes (mechanical volatilization and soil vapor extraction/bioremediation) and to refine the estimates for treatment duration.

As the deeper soils in the sandy zone potentially requiring remediation are below the water table, dewatering may be required during the excavation process. Additional water would be generated during the treatment of the excavated soils. Precipitation falling on the treatment pad would be collected and treated, if required, prior to discharge. Based upon an average precipitation from April to October of 20 inches, the total volume of water to be treated would be on the order of 1.1 million gal/year. Some of this water would be lost due to evaporation.

During the treatment process, the excavation in Area C would remain open and collect precipitation and groundwater infiltration. The precipitation and groundwater that collects in the open excavation would be used to flush the bedrock to further enhance treatment of the bedrock groundwater. The bedrock groundwater would be collected by the containment system and treated on-Site.

The excavation, handling and treatment of soils may result in emissions of chemicals to the atmosphere which may pose short-term risks to the workers or the community in the immediate vicinity of the Site. Air monitoring would be conducted on a regular basis to ensure that the air emissions do not exceed regulatory levels. If short-term measures are required to mitigate potential risks, any of the following actions may be taken:

- enclose the mechanical volatilization treatment unit and treat the off-gas;
- cover the soil treatment piles or excavation areas to reduce chemical and fugitive dust emissions;
- increase blower strength to maintain an inward gradient of air from the soils being treated by soil vapor extraction/bioremediation to the collection pipes;
- limit the size of the excavation and/or the volume of soil stockpiled for treatment; and
- reduce the volume and/or rate of soil being treated.

As the excavation areas generally coincide with the area of overburden groundwater contamination and NAPL presence in the southeastern area, the majority of the chemicals in the overburden groundwater would be removed. Overburden groundwater containment following soil remediation is, therefore, not considered necessary.

NAPL may be treated off-Site if the volume and/or chemical composition of the NAPL is unsuitable for the on-Site treatment process.

determined during treatability Study
what was results.

Bedrock extraction wells would be installed in the northeastern and southeastern areas of the Site following the excavation of soil to be treated in these areas. The bedrock groundwater containment measures would be similar in design and construction as proposed for Alternative 3. The existing low level groundwater contamination southeast of the Site in the overburden and bedrock would be reduced through natural attenuating processes.

The groundwater treatment system would be constructed prior to soil remediation for the treatment of bedrock groundwater. The on-Site groundwater treatment system would be selected based on the results of the pre-design activities presented in Section 5.3.1.3. Alternatively, direct discharge to a POTW may be feasible. However, for the purposes of the FS, the groundwater treatment system will consist of air stripping with catalytic oxidation, pretreatment of solids removal and off-gas treatment.

Groundwater monitoring would be conducted to ensure the protection of human health and the environment. Periodic monitoring of the effluent concentrations from both the vapor extraction system and the treated water would also be conducted. Institutional controls would be implemented to restrict groundwater usage beneath the Site until it is demonstrated through groundwater monitoring that unrestricted groundwater usage is appropriate.

5.3.5.1 Alternative 4 - Overall Protection of Human Health and the Environment

Alternative 4 would reduce the risks to human health for all exposure scenarios. the soil excavation and treatment process would remove chemicals from the soils and hence eliminate all potential exposures and associated risks for this medium.

The excavation of soils to bedrock would also remove the majority of the overburden groundwater with chemical concentrations exceeding Class GA groundwater SCGs. In addition, groundwater infiltrating into the excavations would also be collected and treated, as required, during soil treatment. Bedrock groundwater would be pumped and treated during and following soil remediation. These groundwater remedial measures would significantly reduce risks associated with exposure to both overburden and bedrock groundwater.

5.3.5.2 Alternative 4 - Compliance With SCGs

Chemical-specific SCGs would be met for the soils following the excavation and treatment of soils with chemical concentrations exceeding soil cleanup objectives.

Chemical concentrations in the overburden groundwater would be significantly reduced, thereby decreasing the time required to achieve Class GA groundwater SCGs in comparison to Alternatives 1,2 and 3.

It is expected that SCGs in the overburden groundwater downgradient of the treatment areas would be achieved in a shorter time period following remediation as the vast majority of the impacted groundwater is within the soil remediation zone.

By eliminating the source areas including NAPL overlying the bedrock, chemical-specific SCGs for the bedrock groundwater would also be achieved in a significantly shorter period of time in comparison to Alternatives 1,2 and 3.

5.3.5.3 Alternative 4 - Long-Term Effectiveness and Permanence

Implementation of Alternative 4 would eliminate all risks associated with chemicals in the soil at the Site as the source would be removed. The remaining risk of residual chemicals in the groundwater would be low and would be significantly reduced by groundwater extraction and treatment for the bedrock aquifer. A review of the remedial action would be required every five years.

5.3.5.4 Alternative 4 - Reduction of Toxicity, Mobility or Volume Through Treatment

It is estimated that Alternative 4 would remove and treat the majority of chemicals in the soils and groundwater within the overburden. The on-Site treatment processes for soils and groundwater are irreversible.

Low levels of chemicals, less than the soil cleanup objectives, would remain in the soils. Residual chemical concentrations in the bedrock groundwater would be reduced by the groundwater extraction and treatment system.

5.3.5.5 Alternative 4 - Short-Term Effectiveness

Alternative 4 involves extensive excavation, handling and treatment of soils with chemical concentrations exceeding the soil cleanup objectives. These processes may result in significant chemical emissions to the atmosphere. Workers would be required to wear proper protective equipment and adhere to safe construction practices to minimize potential hazards during the installation of the remedial components.

Engineering controls including flagging and barricades would be implemented to prevent access to the excavation and reduce short term risks. In addition, excavations would be conducted in accordance with 29 CFR Part 126 Subpart P to ensure employee protection and safe construction procedures.

It is estimated that Alternative 4 could be completed within a one year period.

5.3.5.6 Alternative 4 - Implementability

Implementation of Alternative 4 would involve common construction procedures and the services and materials are readily available.

Confirmatory sampling results of the excavation sidewalls may require that the excavations be extended laterally which may have a significant impact on the cost for this alternative. If the soils in the secondary southeast area require remediation, the volume of soil would increase by approximately 11,870 yd^3.

The effectiveness of this alternative could easily be monitored by implementation of the site monitoring program presented in

Section 5.3.1.1.1. Additional remedial action such as extending the bedrock groundwater containment and treatment system could be implemented at a later date if necessary. This requirement would be determined based upon the analytical results obtained during implementation of the groundwater monitoring program.

Predesign studies would be required for the design of the bedrock groundwater containment and treatment system, and the soil treatment system.

Compliance with RCRA and New York State air permits would be required for the operation of the treatment systems.

5.3.5.7 Alternative 4 - Cost

A detailed cost breakdown is presented in Table 5.7. The total capital cost is estimated to be $1,760,000 and the first year annual operation and maintenance cost is estimated to be $948,750. The total present worth of this alternative is estimated to be $4,658,000 based upon a seven percent discount rate over a 30-year period.

If the volume of soil requiring treatment expands to include the Secondary Southeast Area, the costs for Alternative 4 would increase as presented in Table 5.7. The total capital cost would increase to approximately $2,190,000 and the first year annual operation and maintenance costs is estimated to be $1,747,500. The total present worth of Alternative 4 including excavation and treatment of the Secondary Southeast Area is estimated to be $5,887,000.

It should be noted that the costs for Alternative 4 are based on the assumption that the soils exceeding cleanup objectives from Areas A and B, one-third of Area C and the Secondary Southeast Area would be amenable to treatment by mechanical volatilization. Soils with higher concentrations from Area C would be treated by pug milling followed by soil vapor extraction/bioremediation.

5.4 SUMMARY OF DETAILED ANALYSIS

The results of the detailed analysis of remedial alternatives presented in Section 5.3 is summarized in the following section. The summary is organized according to the seven evaluation criteria used for the detailed analysis of Alternatives 1 to 4. The TAGM 4030 scores for the seven evaluation criteria are presented in Appendix E and summarized in Table 5.8.

Overall Protection of Human Health and the Environment

The No Action Alternative (Alternative 1) would not reduce risks to human health associated with the potential future groundwater use scenario on Site and at the Site perimeter. The implementation of institutional controls for Alternative 2 would eliminate the risk associated with future on-Site groundwater use but the residual carcinogenic risk for future off-Site groundwater use at the Site perimeter would continue to exceed an acceptable risk level.

Alternative 3 would reduce all risks to human health by implementation of institutional controls and the construction of a groundwater containment system which would prevent the off-Site migration of chemicals.

Alternative 4 would be somewhat more effective than Alternatives 1, 2 and 3 in reducing all risks to human health by removing and treating soils and the majority of overburden groundwater with chemical concentrations exceeding applicable SCGs. In addition, bedrock groundwater residual chemistry would be contained on-Site by the bedrock groundwater containment system.

The TAGM 4030 scores for Alternatives 1 to 4 for the overall protection of human health and the environment are as follows:

Alternative 1	6
Alternative 2	6
Alternative 3	17
Alternative 4	20

Compliance With SCGs

Chemical-specific SCGs would continue to be exceeded for Alternatives 1 and 2.

Implementation of groundwater containment/source removal for Alternative 3 would decrease the time required to achieve SCGs in overburden and bedrock groundwater and soil.

Chemical-specific SCGs would immediately be achieved for Alternative 4 upon excavation and treatment of soils. Chemical-specific SCGs for overburden and bedrock groundwater would also be achieved in less time than Alternative 1, 2 and 3 by elimination of the source areas.

The TAGM 4030 scores for Alternatives 1 to 4 for compliance with SCGs are as follows:

Alternative 1	0
Alternative 2	0
Alternative 3	3
Alternative 4	7

Long-Term Effectiveness and Permanence

Alternative 1 would not reduce long-term risks beyond what would occur through natural attenuation. The implementation of institutional controls for Alternatives 2 and 3 is considered to be a reliable method to limit access and to restrict future land uses at the Site. Permanent long-term effectiveness would be achieved by groundwater containment and treatment for Alternative 3.

Long-term effectiveness and permanence would be greatest for Alternative 4 as the source would be removed by the removal and treatment of soil and the majority of groundwater with chemical concentrations exceeding SCGs.

A review of the selected remedial alternative would be conducted every 5 years to ensure that human health and the environment are being protected.

The TAGM 4030 scores for long-term effectiveness and permanence are as follows:

Alternative 1	6
Alternative 2	6
Alternative 3	9
Alternative 4	12

Reduction of Toxicity, Mobility or Volume Through Treatment

Alternatives 1 and 2 provide no additional reduction in the toxicity, mobility or volume of chemicals beyond what would be achieved beyond natural attenuation.

Implementation of Alternative 3 would provide a reduction in the mobility and volume of chemicals contained in both the soils and groundwater by groundwater containment and treatment and the removal and off-Site treatment of NAPL.

Alternative 4 would provide a greater reduction in the volume and mobility of chemicals than Alternatives 1, 2 and 3 by the removal and treatment of the majority of chemicals in both the soil and overburden groundwater.

The TAGM 4030 scores for reduction of toxicity, mobility or volume through treatment is as follows:

Alternative 1	0
Alternative 2	0
Alternative 3	8
Alternative 4	13

Short-Term Effectiveness

As Alternatives 1 and 2 do not involve the disturbance of any of the soils at the Site, there would be no additional short-term impacts to the community workers or the environment as a result of implementation of these alternatives.

The construction of the groundwater containment and collection systems for Alternative 3 could be completed within one year. Minimal disturbance of contaminated soils would be required, resulting in no additional short-term impacts.

The extensive excavation, handling and treatment of soils for Alternative 4 may result in significant chemical emissions to the atmosphere resulting in potential short-term risks to the community that may have to be addressed. It is estimated that Alternative 4 would be completed within one year.

The TAGM-4030 scores for short-term effectiveness are as follows:

Alternative 1	8
Alternative 2	10
Alternative 3	10
Alternative 4	6

Implementability

Alternatives 1 and 2 are easily implemented. Implementation of Alternatives 3 and 4 would involve common construction procedures, services and materials.

Predesign studies would be required for Alternatives 3 and 4 for the design of the groundwater containment and treatment system (Alternatives 3 and 4) and the soil treatment system (Alternative 4).

Excavation activities for Alternative 4 would have to be extended if the results of confirmatory sidewall sampling indicate that the area to be remediated is beyond original estimates.

The effectiveness of each remedial alternative would be assessed by implementing the Site monitoring program. The implementation of additional remedial measures would be dependent upon the results of the monitoring program.

The TAGM 4030 scores for implementability are as follows:

Alternative 1	3
Alternative 2	2
Alternative 3	13
Alternative 4	12

Cost

The estimated capital costs, annual operation and maintenance costs, and present worth costs for Alternatives 1 to 4 are as follows:

	Capital Cost	*Annual Cost*	*Present Worth Cost*
Alternative 1	$0	$56,500	$598,000
Alternative 2	$16,300	$56,500	$614,000
Alternative 3	$1,190,000	$177,000	$3,200,000
Alternative 4	$1,760,000 - $2,190,000	$948,750 - $1,747,500	$4,658,000 - $5,887,000

The present worth costs, based on a discount factor of 7 percent for a 30 year period may increase for Alternative 3 if the groundwater containment system is required for longer than 30 years. In addition, the present worth cost may increase for Alternative 4 if the volume of soil to be treated is greater than current estimates.

The TAGM 4030 scores for cost are as follows:

Alternative 1	15
Alternative 2	15
Alternative 3	5
Alternative 4	0

6.0 RECOMMENDED ALTERNATIVE

Based upon the evaluation presented in this FS, Alternative 4 is recommended as the preferred alternative to address the environmental and human health concerns at the Site. Alternative 4 involves the following remedial components:

- soil source removal with on-Site treatment;
- bedrock groundwater containment/source removal with on-Site treatment;
- institutional controls; and
- groundwater monitoring program.

The No Action alternative (Alternative 1) provides no reduction in risks to human health and the environment. The TAGM 4030 total score of 38 for Alternative 1 is the lowest of the 4 alternatives that were evaluated.

Alternative 2 would reduce the risks associated with all exposure scenarios with the exception of the potential off-Site future groundwater use scenario. However, chemical-specific SCGs would continue to be exceeded for Alternative 2. The TAGM 4030 total score of 39 for Alternative 2 is significantly less than Alternatives 3 and 4.

Alternative 3 would reduce the risks to human health for all exposure scenarios by providing overburden and bedrock groundwater containment and treatment. Alternative 3 has a TAGM 4030 total score of 65 which is significantly greater than Alternatives 1 and 2 but less than Alternative 4.

Alternative 4, which includes soil source removal and treatment, would also remove the majority of the chemicals in the overburden groundwater and would likely reduce the time required to achieve chemical-specific SCGs in the bedrock groundwater in comparison to Alternative 3. The residual chemicals remaining in the soil and groundwater following soil source removal and treatment for Alternative 4 would require bedrock groundwater containment and treatment for a much shorter duration than would be required for Alternative 3.

The total TAGM 4030 score of 70 for Alternative 4 is the highest of the alternatives evaluated in this FS.

The effectiveness of Alternative 4 would be monitored by implementation of the groundwater monitoring program. The bedrock groundwater containment and treatment system could be extended or reduced as required based upon the results of the monitoring program.

7.0 DESIGNATION OF CORRECTIVE ACTION MANAGEMENT UNIT

7.1 INTRODUCTION

A corrective action management unit (CAMU) would be designated for the implementation of Alternative 4, the preferred alternative. In accordance with 40 CFR 264, the designation of a CAMU for Alternative 4 would provide added flexibility to expedite and improve remedial decisions within the regulatory framework. Any remediation waste (i.e., soil and groundwater) generated as part of the corrective action would not be subject to RCRA regulatory disposal requirements. Placement of wastes to be remediated into or within a designated CAMU would not constitute land disposal of hazardous waste and would not create a unit subject to minimum technology requirements.

The following subsections present the description and management of the CAMU for Alternative 4.

7.2 CAMU DESCRIPTION

The CAMU designated for Alternative 4 would include the areas of the Site to be remediated, the soil treatment pad, and the groundwater and soil vapor treatment facility as presented on Figure 7.1.

The areas to be remediated include soil excavation Areas A, B, and C. These three non-contiguous areas contain soils with chemicals exceeding soil cleanup objectives and, therefore, require corrective action. The areal extent of Areas A, B and C is 990 ft^2, 12,450 ft^2 and 22,050 ft^2, respectively. In addition, the secondary southeast area, which includes all soils within the ash-filled area outside of Area C, may also require excavation and treatment. This area consists of approximately 22,900 ft^2.

The soil treatment pad, located in the eastern corner of the Site, would cover an area of approximately 90,000 ft^2. Although this area of the facility is uncontaminated, it is considered appropriate, in accordance with

40 CFR 264.552(c)(3), to include this area within the CAMU as remediation of the soils cannot be conducted effectively on or within the contaminated area itself. The treatment pad would have an asphalt base, thereby, eliminating the potential for contaminating the subsurface beneath it.

The total area of the CAMU for Alternative 4 would consist of approximately 5.5 acres as presented on Figure 7.1.

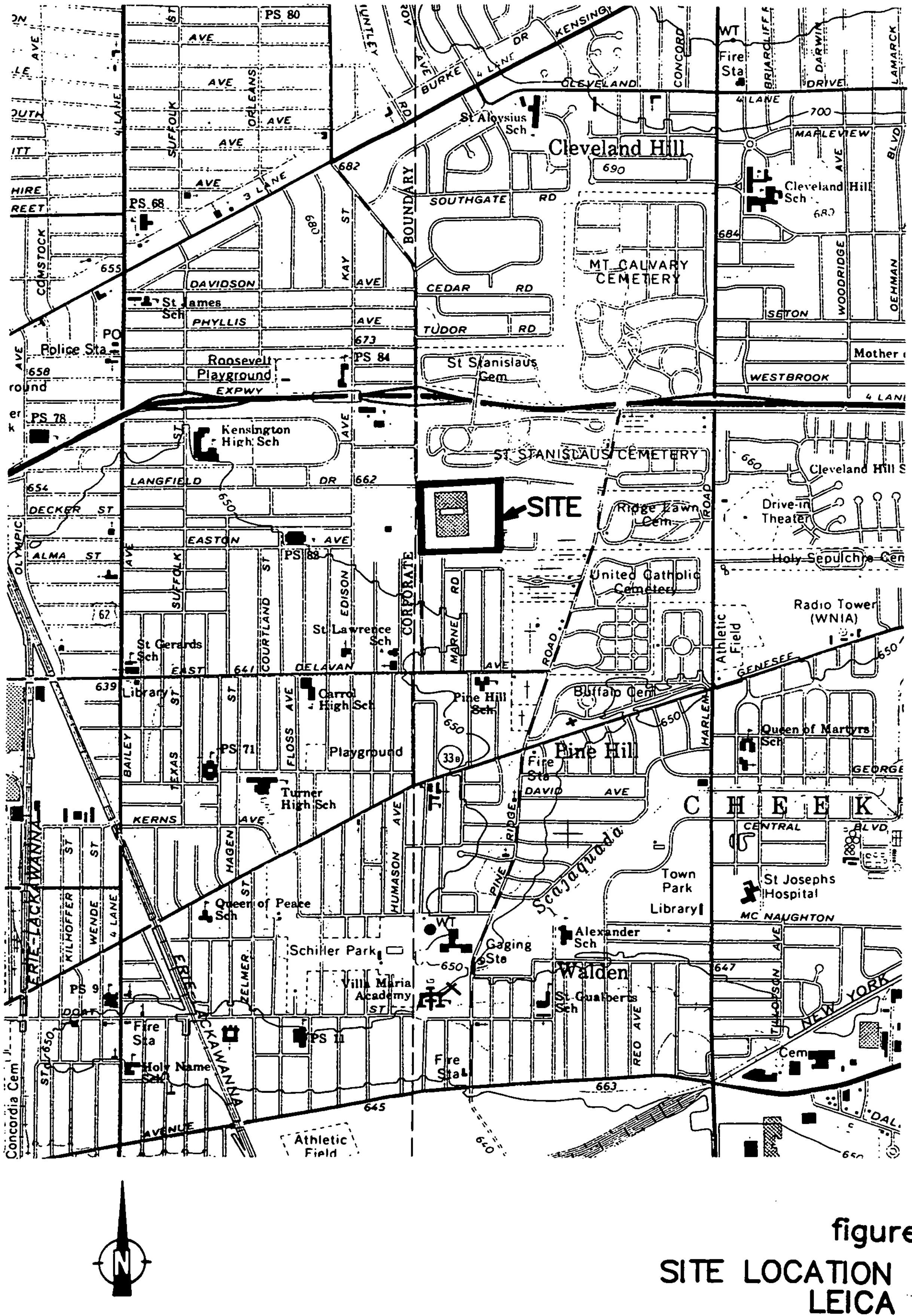
7.3 MANAGEMENT OF REMEDIATION WASTES

As presented in Section 5.3.5, Alternative 4 involves the excavation of soils in Areas A, B and C and treatment of the soils on Site utilizing mechanical volatilization and soil vapor extraction supplemented by biological treatment. Soils from Area C would be excavated and treated first. Following treatment of the soils from Area C, soils would be excavated from Areas A and B. The excavations in Areas A and B would immediately be backfilled with the treated soil from Area C to minimize the disruption of plant operations in the northeast area of the Site. The excavation in Area C would be backfilled with the treated soil from Areas A and B.

Water generated during the excavation process or during the treatment of excavated soils would be treated at the on-Site groundwater treatment facility, if necessary. Groundwater and precipitation that collects in Area C, which would remain open during treatment, would most likely be allowed to flush the bedrock, thereby enhancing treatment of the bedrock groundwater.

Bedrock extraction wells, installed in Areas B and C, would provide containment and collection of bedrock groundwater. Collected groundwater would be treated at the groundwater treatment facility prior to discharge to the sewer.

The general Site monitoring program presented in Section 5.3.1.1 would be conducted throughout the implementation of Alternative 4 and post-closure of the CAMU.



USGS BUFFALO NE 7.5' QUADRANGLE

figure 2.1

SITE LOCATION MAP
LEICA INC.
Cheektowaga, New York

CRA

3967 (8) APR 12/95(W) REV.0

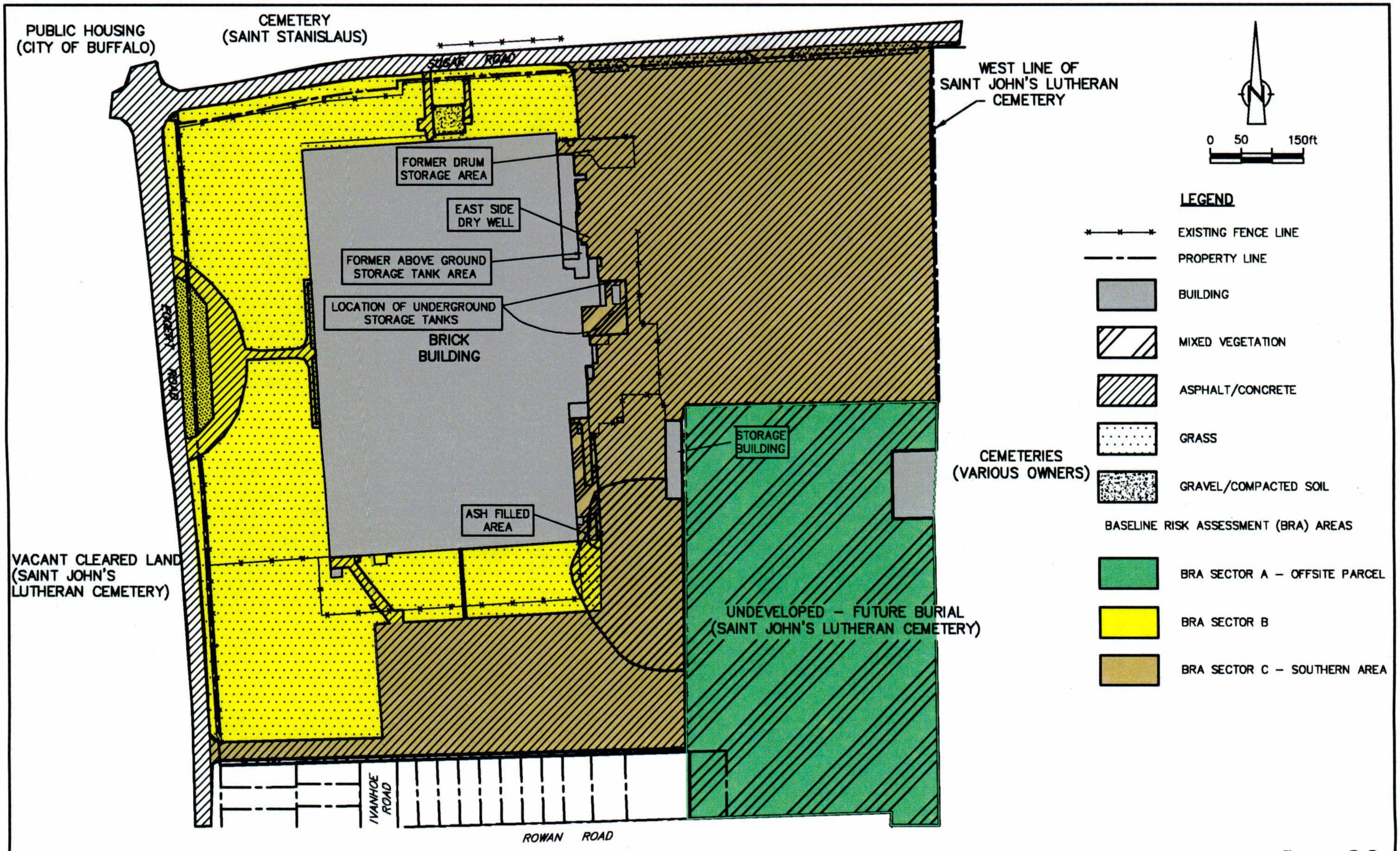
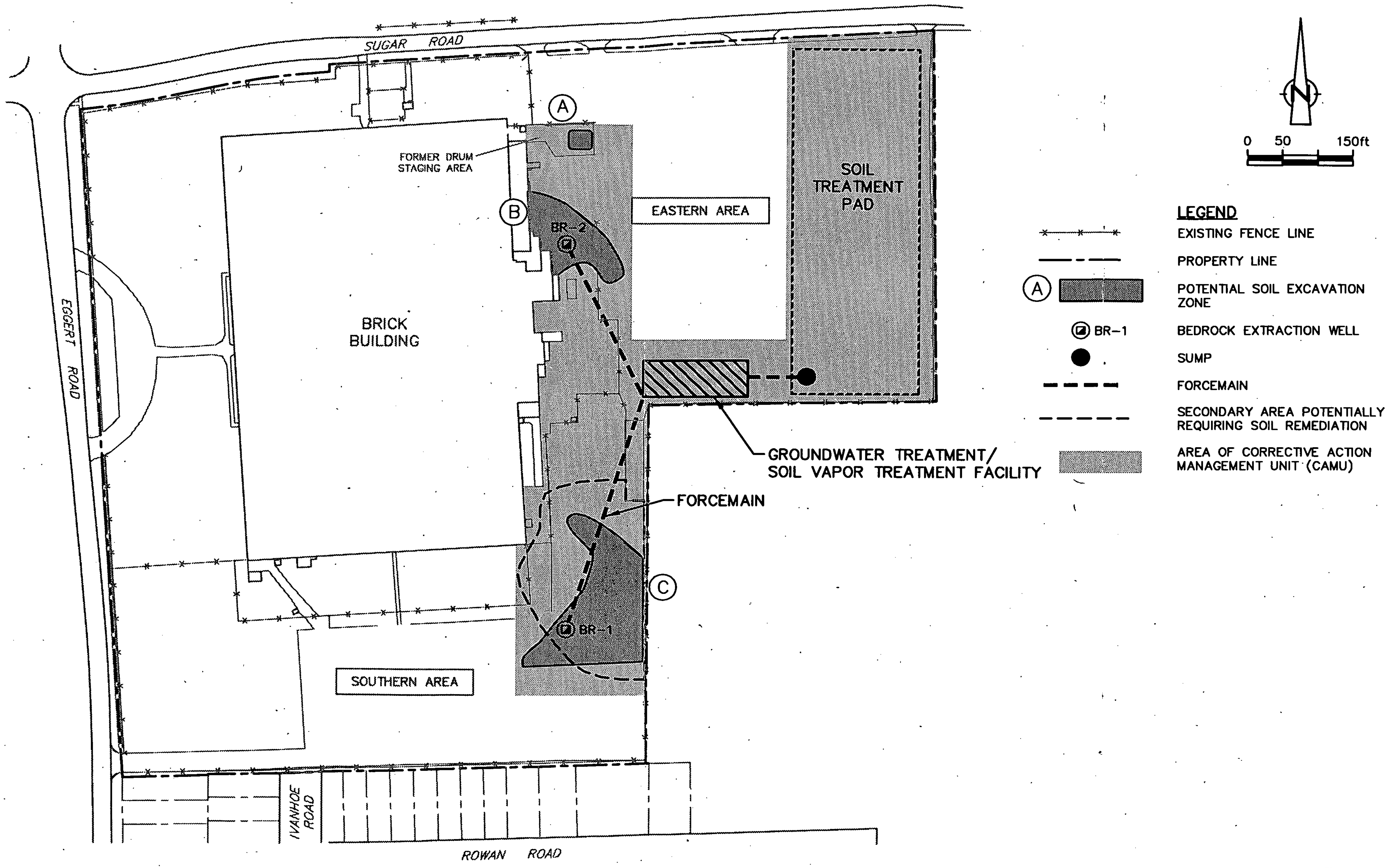


figure 2.2

SURFACE CHARACTERISTICS
LEICA INC.
Cheektowaga, New York

SOURCE: GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

CRA



SOURCE: GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

figure 7.1
CAMU DESIGNATION – ALTERNATIVE 4
LEICA INC.
Cheektowaga, New York

CRA

3967 (8) JULY 24/95(W) REV.0 (P-89)

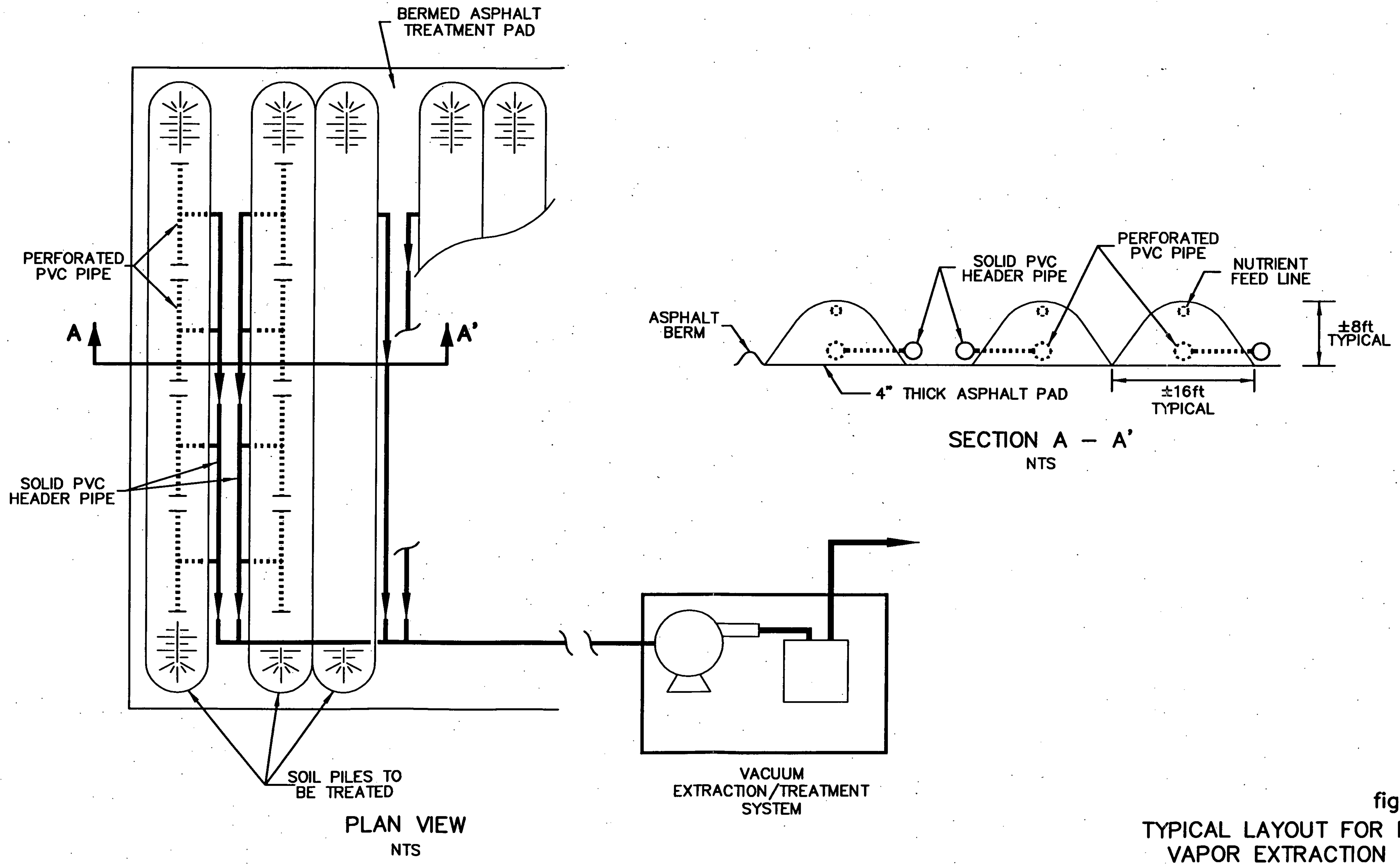
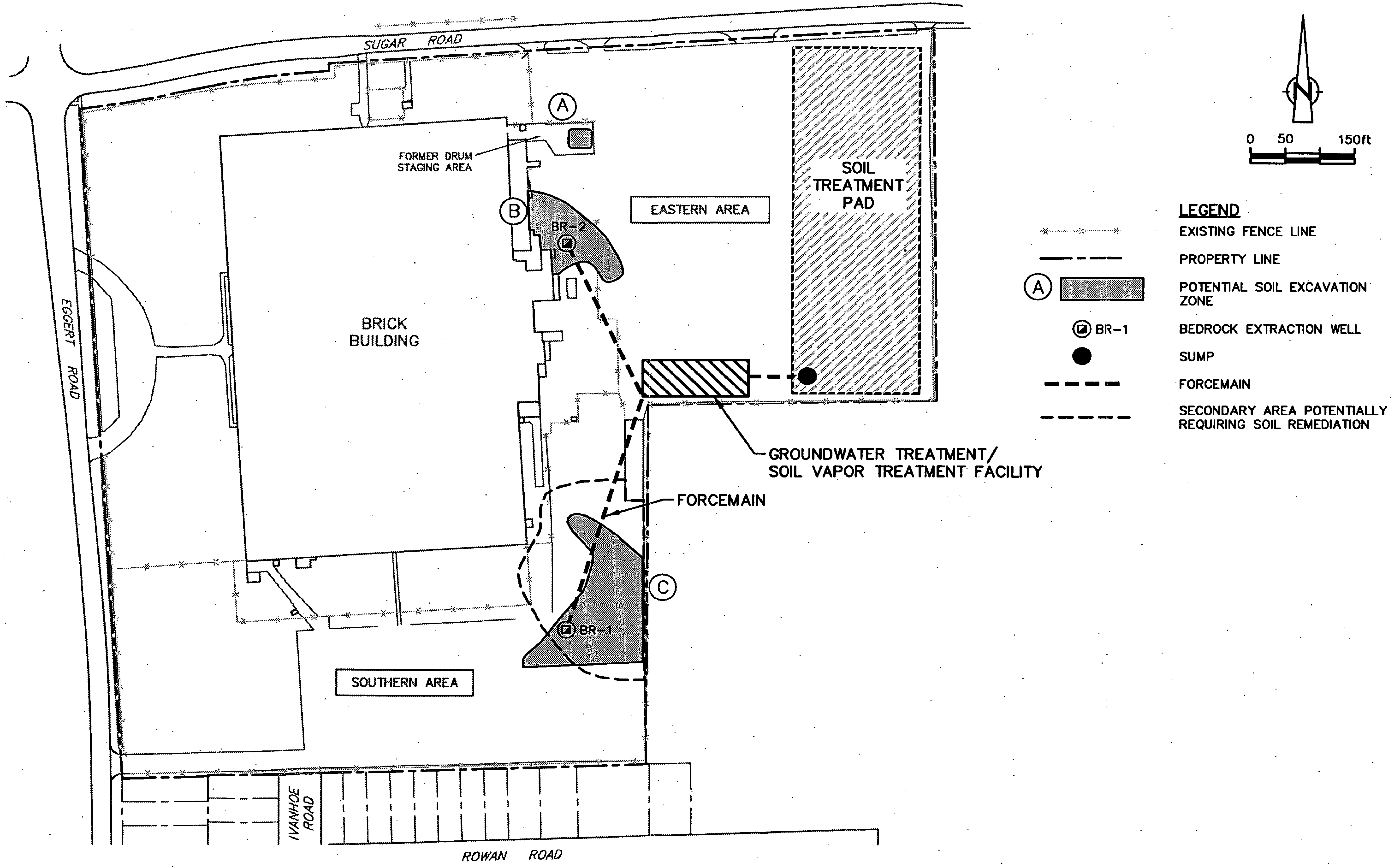


figure 5.4

TYPICAL LAYOUT FOR EX SITU VAPOR EXTRACTION SYSTEM
LEICA INC.
Cheektowaga, New York

CRA

3967 (8) APR 12/95(W) REV.0 (D-02)



SOURCE: GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

figure 5.3

ALTERNATIVE 4–SYSTEM COMPONENTS
LEICA INC.
Cheektowaga, New York

CRA

3967 (8) APR 11/95(W) REV.0 (P-82)

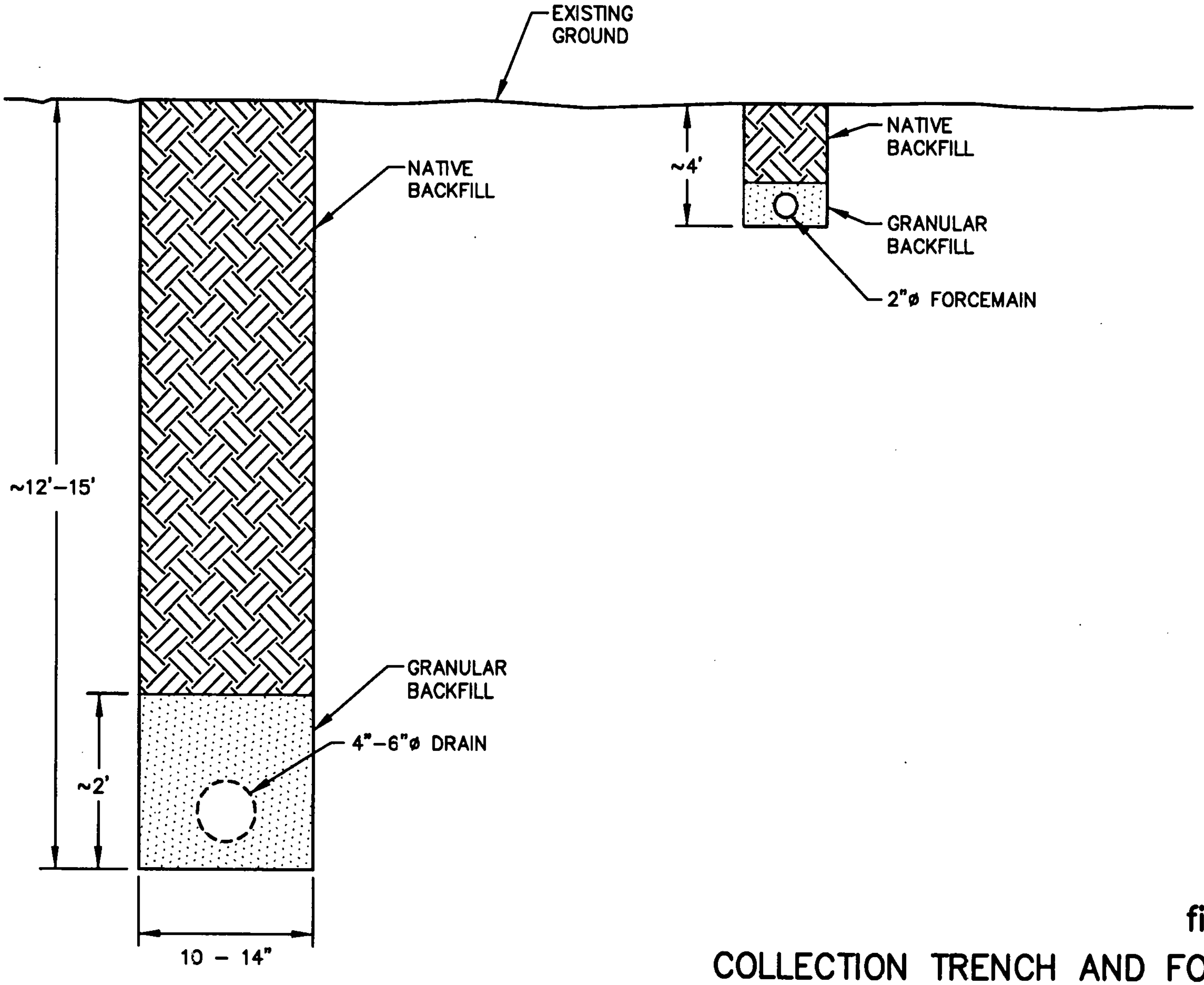


figure 5.2
COLLECTION TRENCH AND FORCEMAIN
TYPICAL CROSS–SECTION
LEICA INC.
Cheektowaga, New York

CRA

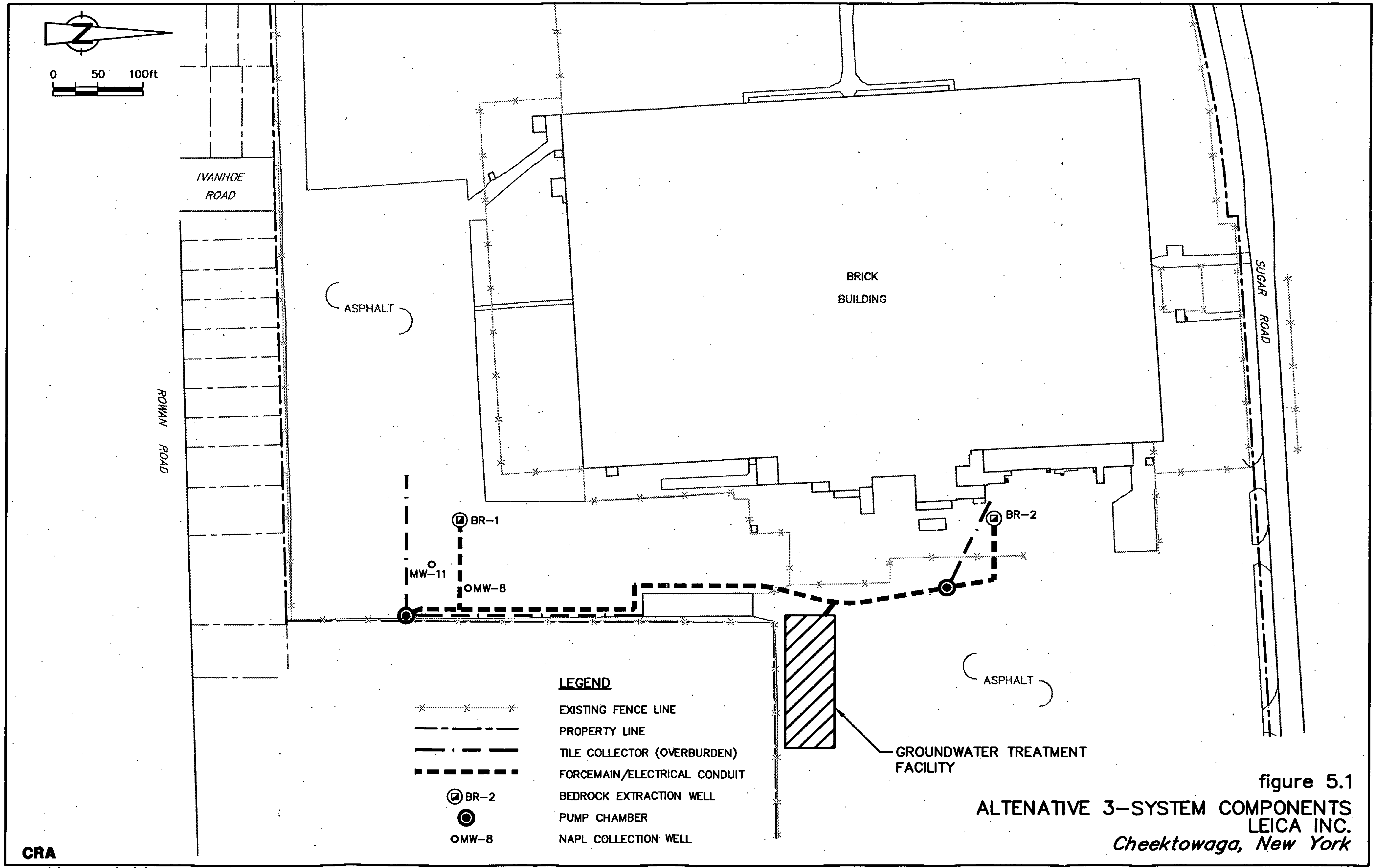
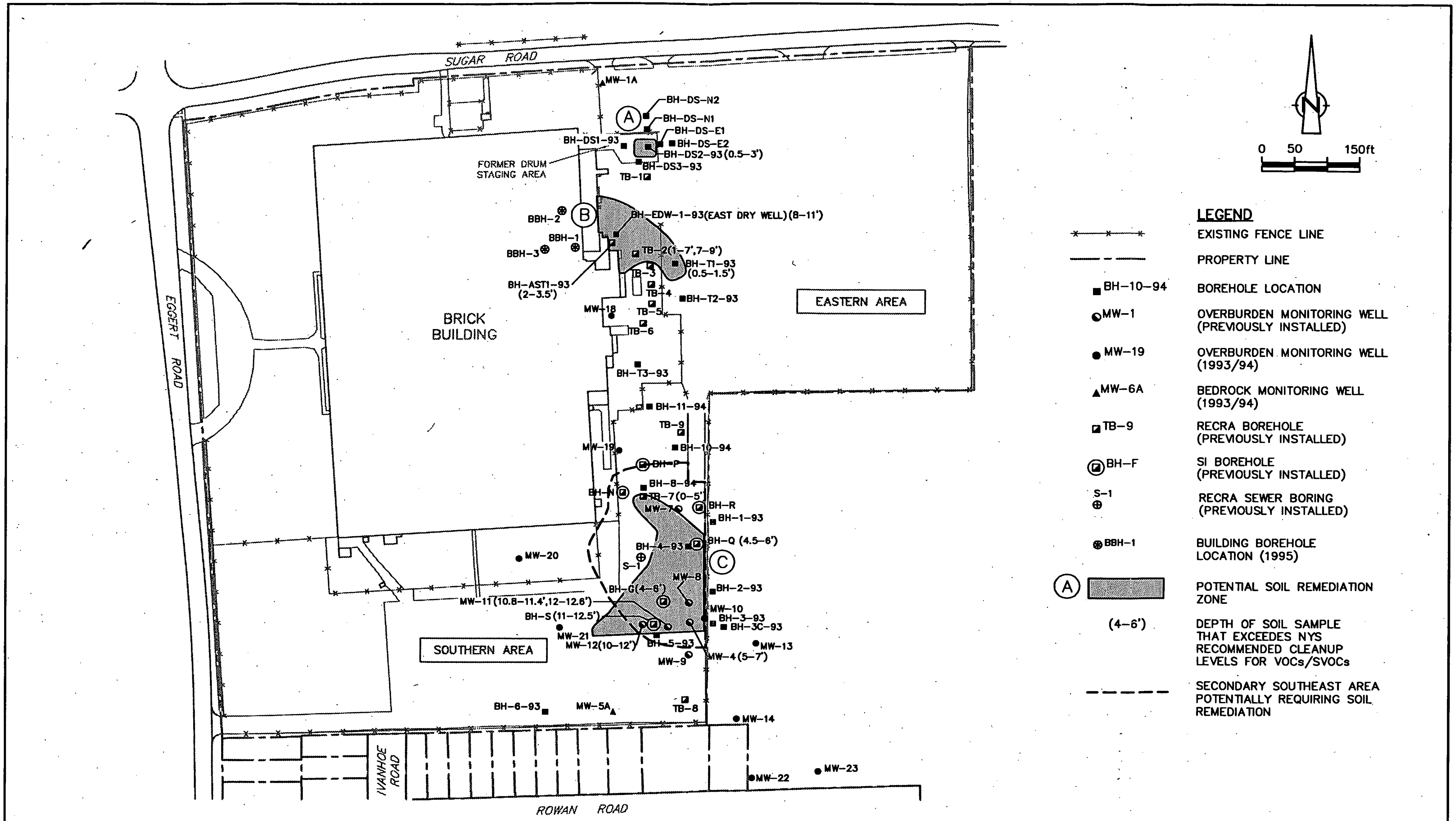


figure 5.1

ALTENATIVE 3–SYSTEM COMPONENTS
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P–83)



SOURCE: GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

CRA

figure 4.1

POTENTIAL SOIL REMEDIATION ZONES
LEICA INC.
Cheektowaga, New York

3967 (8) APR 18/95(W) REV.0 (P-70)

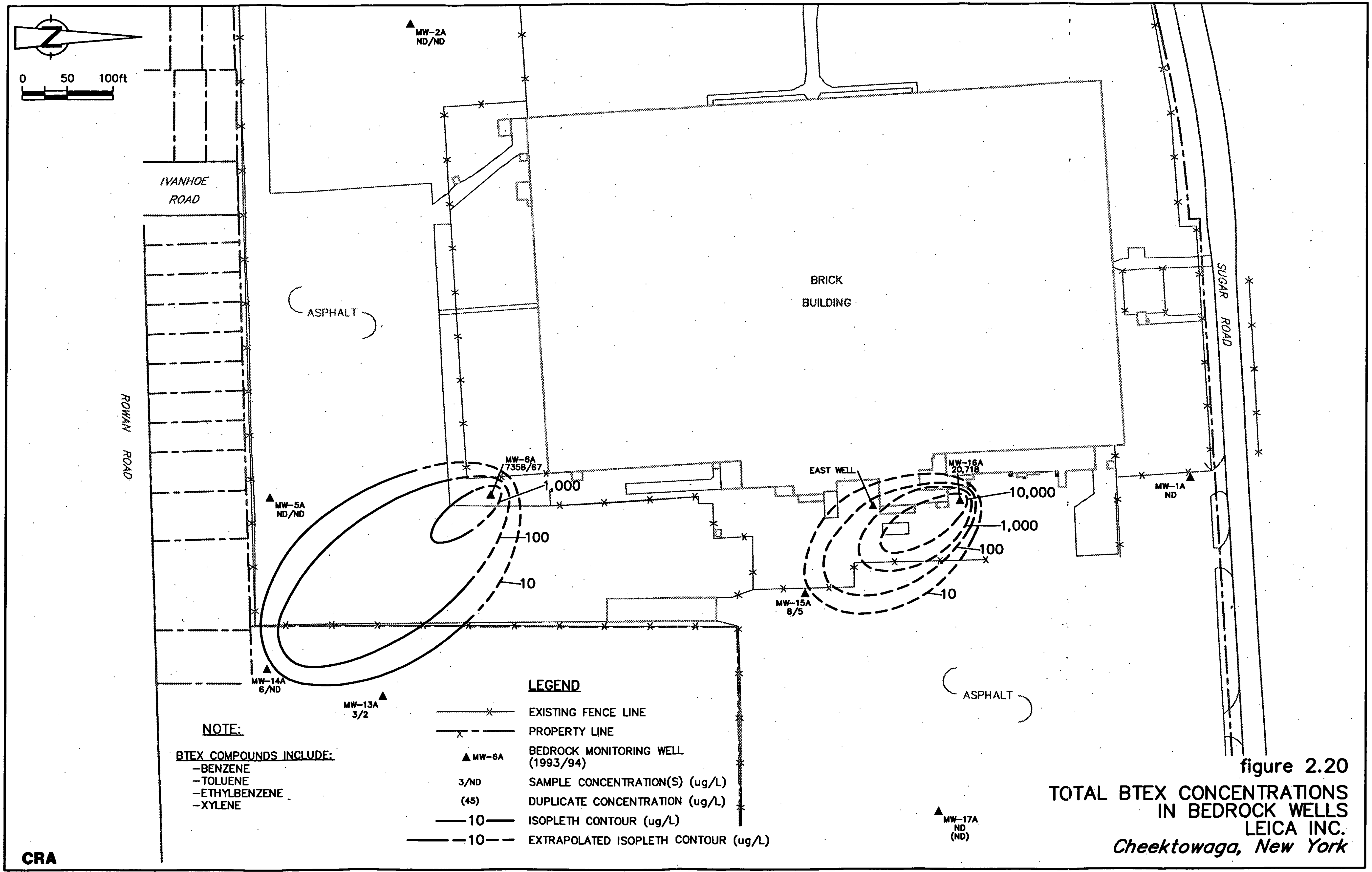
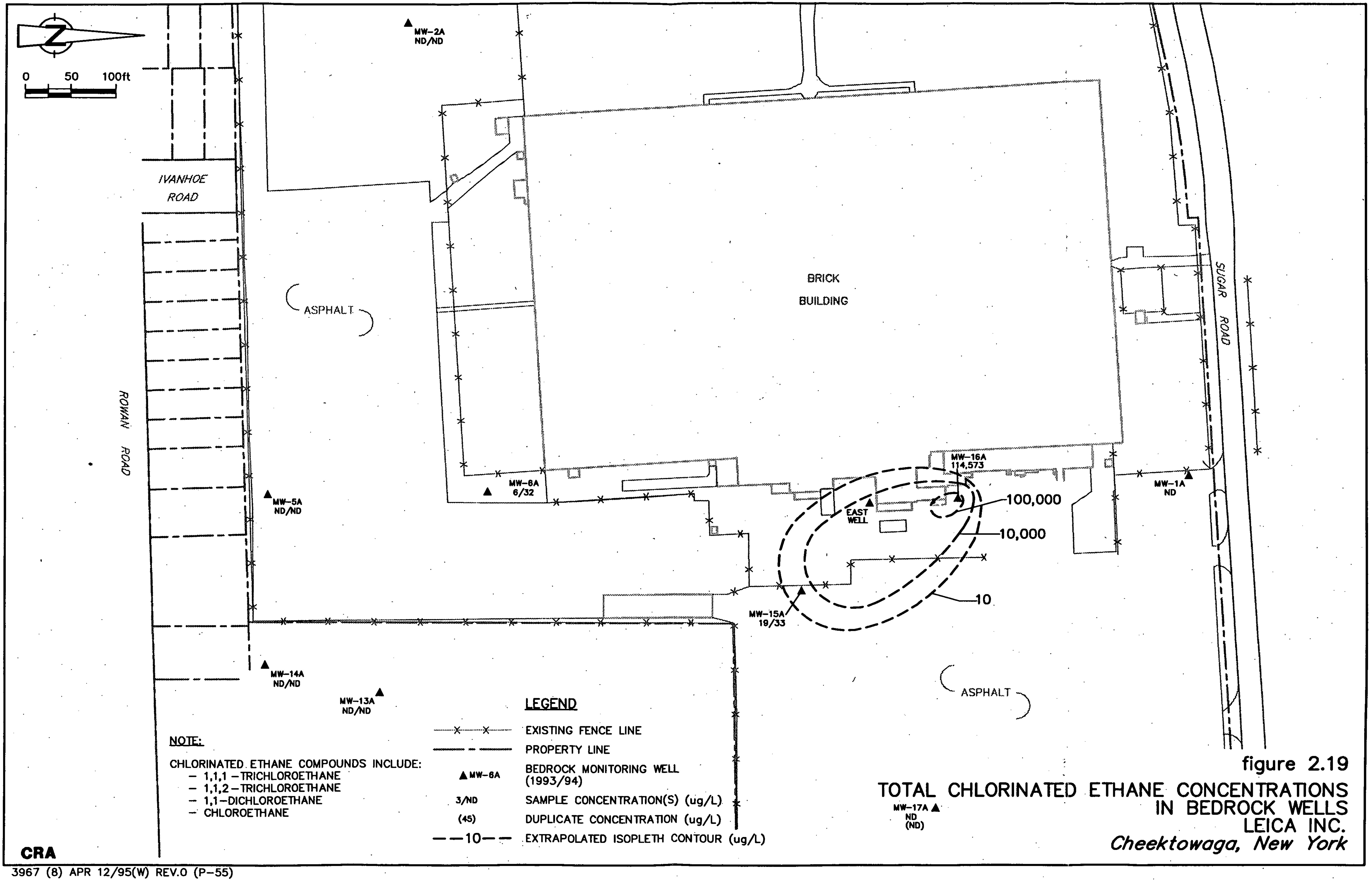


figure 2.20

TOTAL BTEX CONCENTRATIONS
IN BEDROCK WELLS
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-56)



NOTE:

CHLORINATED ETHANE COMPOUNDS INCLUDE:
- 1,1,1 –TRICHLOROETHANE
- 1,1,2 –TRICHLOROETHANE
- 1,1–DICHLOROETHANE
- CHLOROETHANE

LEGEND

—x—x—	EXISTING FENCE LINE
— - —	PROPERTY LINE
▲MW-6A	BEDROCK MONITORING WELL (1993/94)
3/ND	SAMPLE CONCENTRATION(S) (ug/L)
(45)	DUPLICATE CONCENTRATION (ug/L)
– –10– –	EXTRAPOLATED ISOPLETH CONTOUR (ug/L)

figure 2.19
TOTAL CHLORINATED ETHANE CONCENTRATIONS
IN BEDROCK WELLS
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-55)

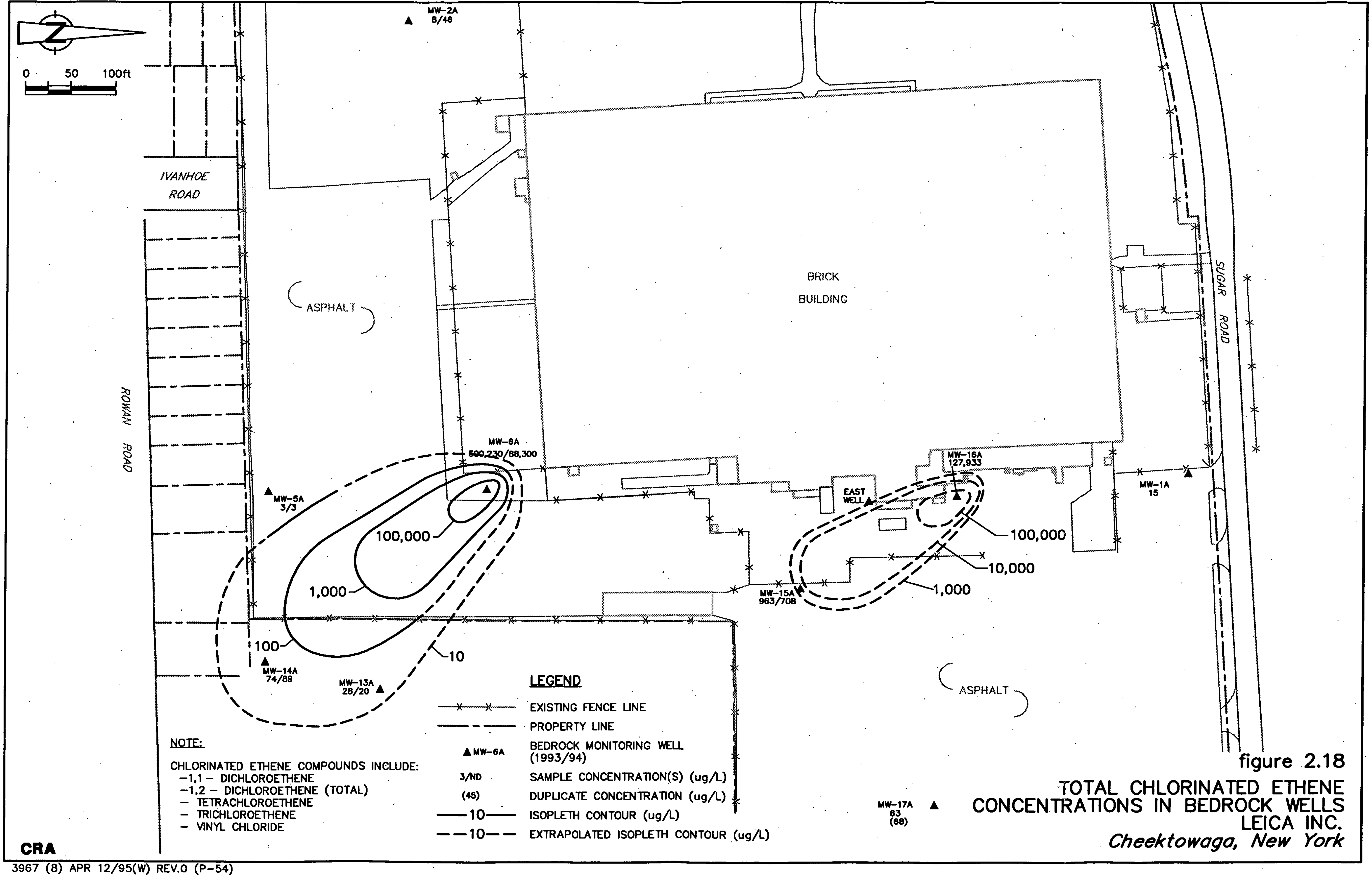
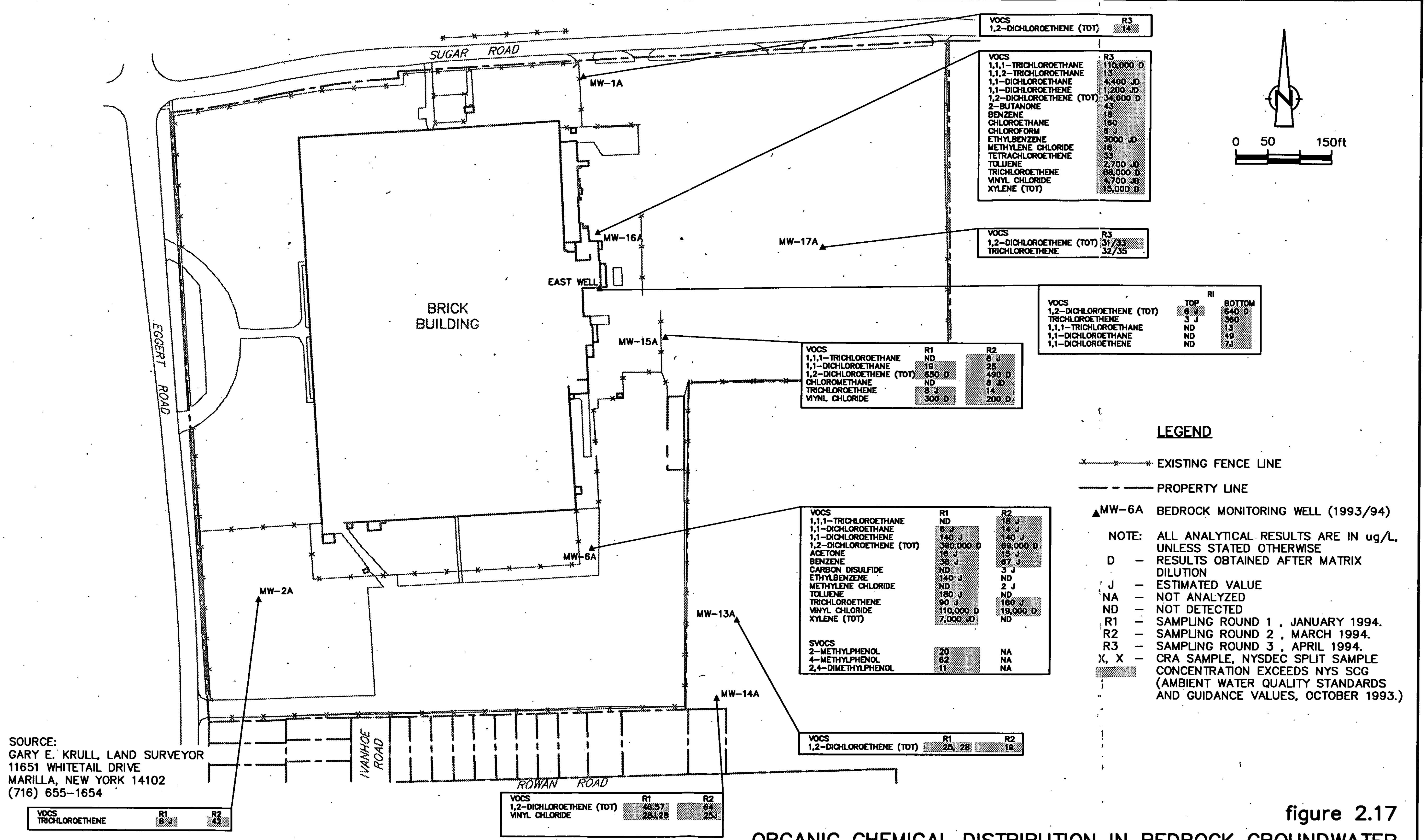


figure 2.18

TOTAL CHLORINATED ETHENE
CONCENTRATIONS IN BEDROCK WELLS
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-54)



VOCS	R3
1,2-DICHLOROETHENE (TOT)	14

VOCS	R3
1,1,1-TRICHLOROETHANE	110,000 D
1,1,2-TRICHLOROETHANE	13
1,1-DICHLOROETHANE	4,400 JD
1,1-DICHLOROETHENE	1,200 JD
1,2-DICHLOROETHENE (TOT)	34,000 D
2-BUTANONE	43
BENZENE	18
CHLOROETHANE	160
CHLOROFORM	8 J
ETHYLBENZENE	3000 JD
METHYLENE CHLORIDE	18
TETRACHLOROETHENE	33
TOLUENE	2,700 JD
TRICHLOROETHENE	88,000 D
VINYL CHLORIDE	4,700 JD
XYLENE (TOT)	15,000 D

VOCS	R3
1,2-DICHLOROETHENE (TOT)	31/33
TRICHLOROETHENE	32/35

	RI	
VOCS	TOP	BOTTOM
1,2-DICHLOROETHENE (TOT)	8 J	640 D
TRICHLOROETHENE	3 J	360
1,1,1-TRICHLOROETHANE	ND	13
1,1-DICHLOROETHANE	ND	49
1,1-DICHLOROETHENE	ND	7J

VOCS	R1	R2
1,1,1-TRICHLOROETHANE	ND	8 J
1,1-DICHLOROETHANE	19	25
1,2-DICHLOROETHENE (TOT)	650 D	490 D
CHLOROMETHANE	ND	8 JD
TRICHLOROETHENE	8 J	14
VIYNL CHLORIDE	300 D	200 D

VOCS	R1	R2
1,1,1-TRICHLOROETHANE	ND	18 J
1,1-DICHLOROETHANE	6 J	14 J
1,1-DICHLOROETHENE	140 J	140 J
1,2-DICHLOROETHENE (TOT)	380,000 D	69,000 D
ACETONE	16 J	15 J
BENZENE	38 J	67 J
CARBON DISULFIDE	ND	3 J
ETHYLBENZENE	140 J	ND
METHYLENE CHLORIDE	ND	2 J
TOLUENE	180 J	ND
TRICHLOROETHENE	90 J	160 J
VINYL CHLORIDE	110,000 D	19,000 D
XYLENE (TOT)	7,000 JD	ND
SVOCS		
2-METHYLPHENOL	20	NA
4-METHYLPHENOL	62	NA
2,4-DIMETHYLPHENOL	11	NA

VOCS	R1	R2
1,2-DICHLOROETHENE (TOT)	25, 28	19

VOCS	R1	R2
1,2-DICHLOROETHENE (TOT)	46,57	64
VINYL CHLORIDE	28J,28	25J

VOCS	R1	R2
TRICHLOROETHENE	8 J	42

LEGEND

- ×——×——× EXISTING FENCE LINE
- —— – —— PROPERTY LINE
- ▲MW-6A BEDROCK MONITORING WELL (1993/94)

NOTE: ALL ANALYTICAL RESULTS ARE IN ug/L, UNLESS STATED OTHERWISE

D	–	RESULTS OBTAINED AFTER MATRIX DILUTION
J	–	ESTIMATED VALUE
NA	–	NOT ANALYZED
ND	–	NOT DETECTED
R1	–	SAMPLING ROUND 1 , JANUARY 1994.
R2	–	SAMPLING ROUND 2 , MARCH 1994.
R3	–	SAMPLING ROUND 3 , APRIL 1994.
X, X	–	CRA SAMPLE, NYSDEC SPLIT SAMPLE
▨		CONCENTRATION EXCEEDS NYS SCG (AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES, OCTOBER 1993.)

SOURCE:
GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

figure 2.17

ORGANIC CHEMICAL DISTRIBUTION IN BEDROCK GROUNDWATER
LEICA INC.
Cheektowaga, New York

CRA

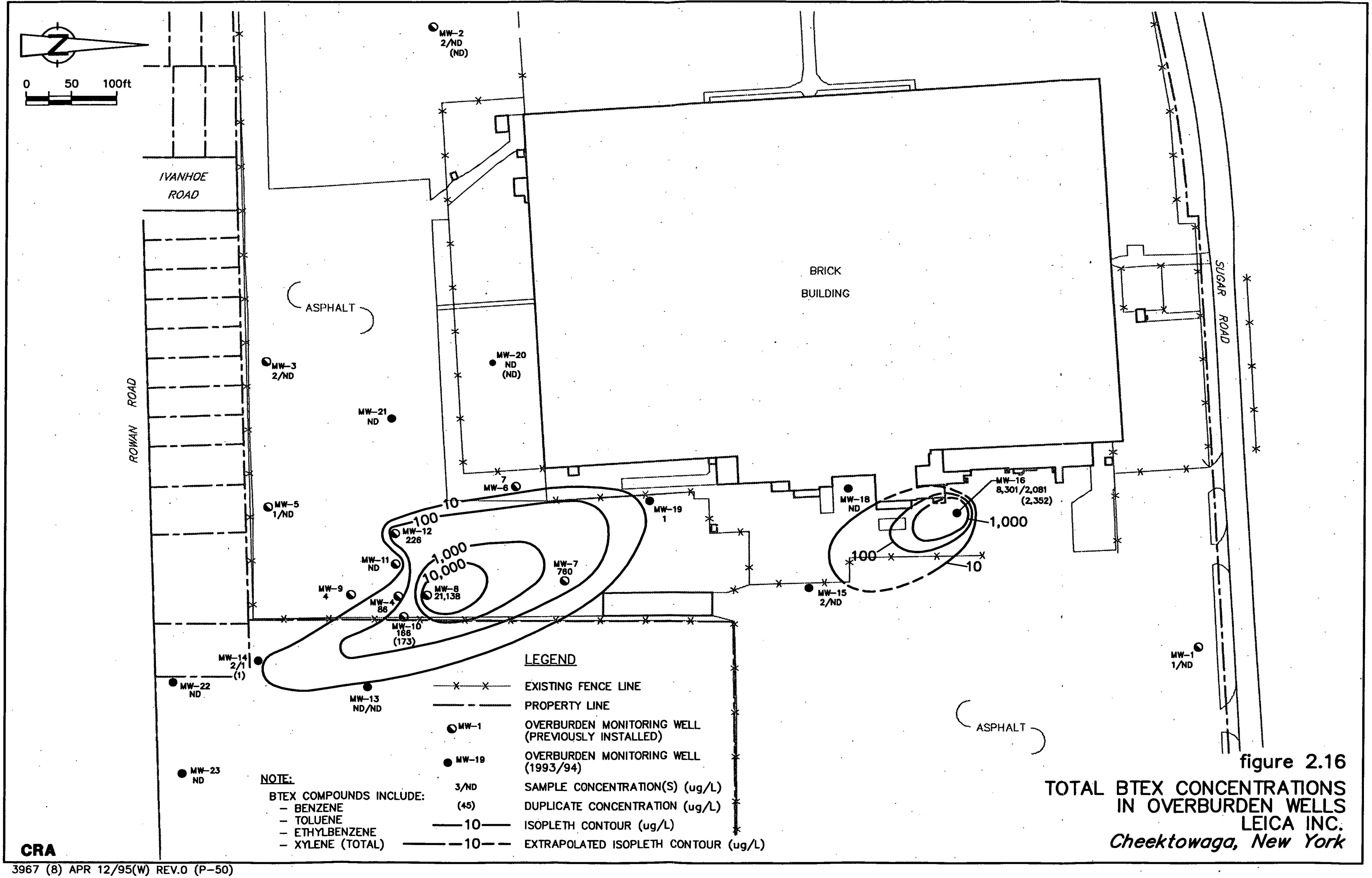
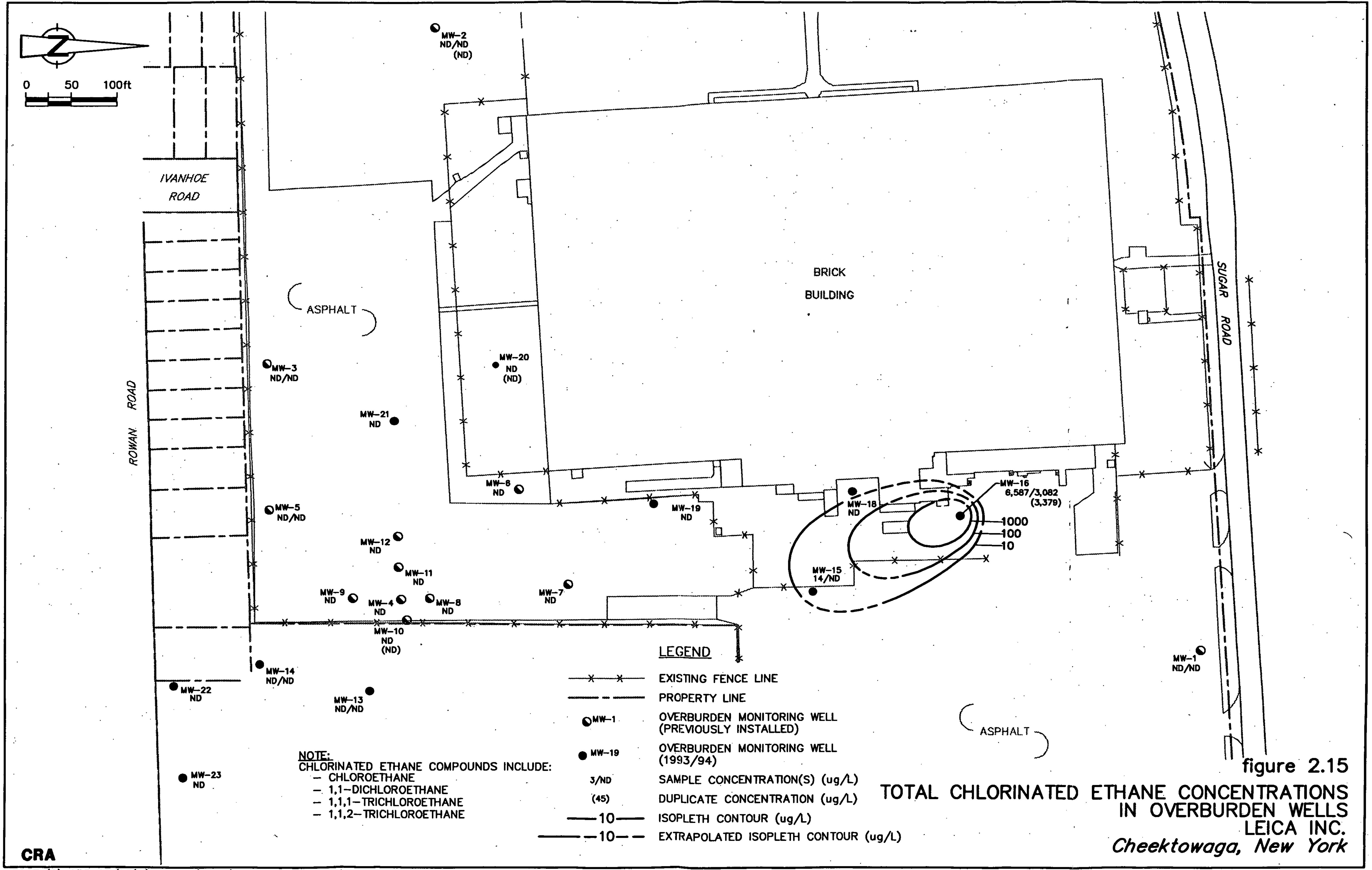


figure 2.16

TOTAL BTEX CONCENTRATIONS
IN OVERBURDEN WELLS
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-50)

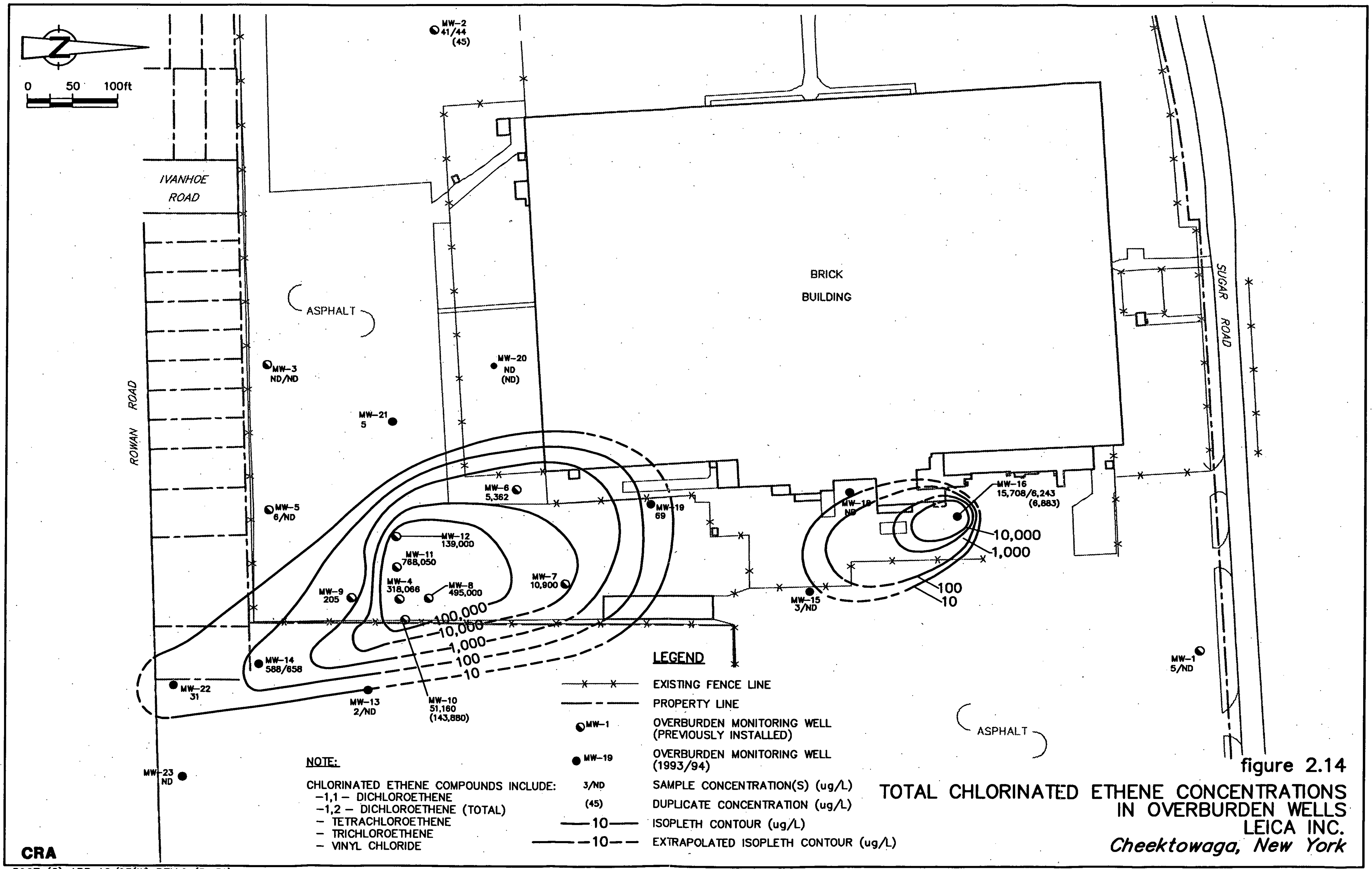


NOTE:
CHLORINATED ETHANE COMPOUNDS INCLUDE:
- CHLOROETHANE
- 1,1-DICHLOROETHANE
- 1,1,1-TRICHLOROETHANE
- 1,1,2-TRICHLOROETHANE

figure 2.15

TOTAL CHLORINATED ETHANE CONCENTRATIONS IN OVERBURDEN WELLS
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-52)



LEGEND

—x—x—	EXISTING FENCE LINE
— — - — —	PROPERTY LINE
◐ MW-1	OVERBURDEN MONITORING WELL (PREVIOUSLY INSTALLED)
● MW-19	OVERBURDEN MONITORING WELL (1993/94)
3/ND	SAMPLE CONCENTRATION(S) (ug/L)
(45)	DUPLICATE CONCENTRATION (ug/L)
——10——	ISOPLETH CONTOUR (ug/L)
— — —10— —	EXTRAPOLATED ISOPLETH CONTOUR (ug/L)

NOTE:

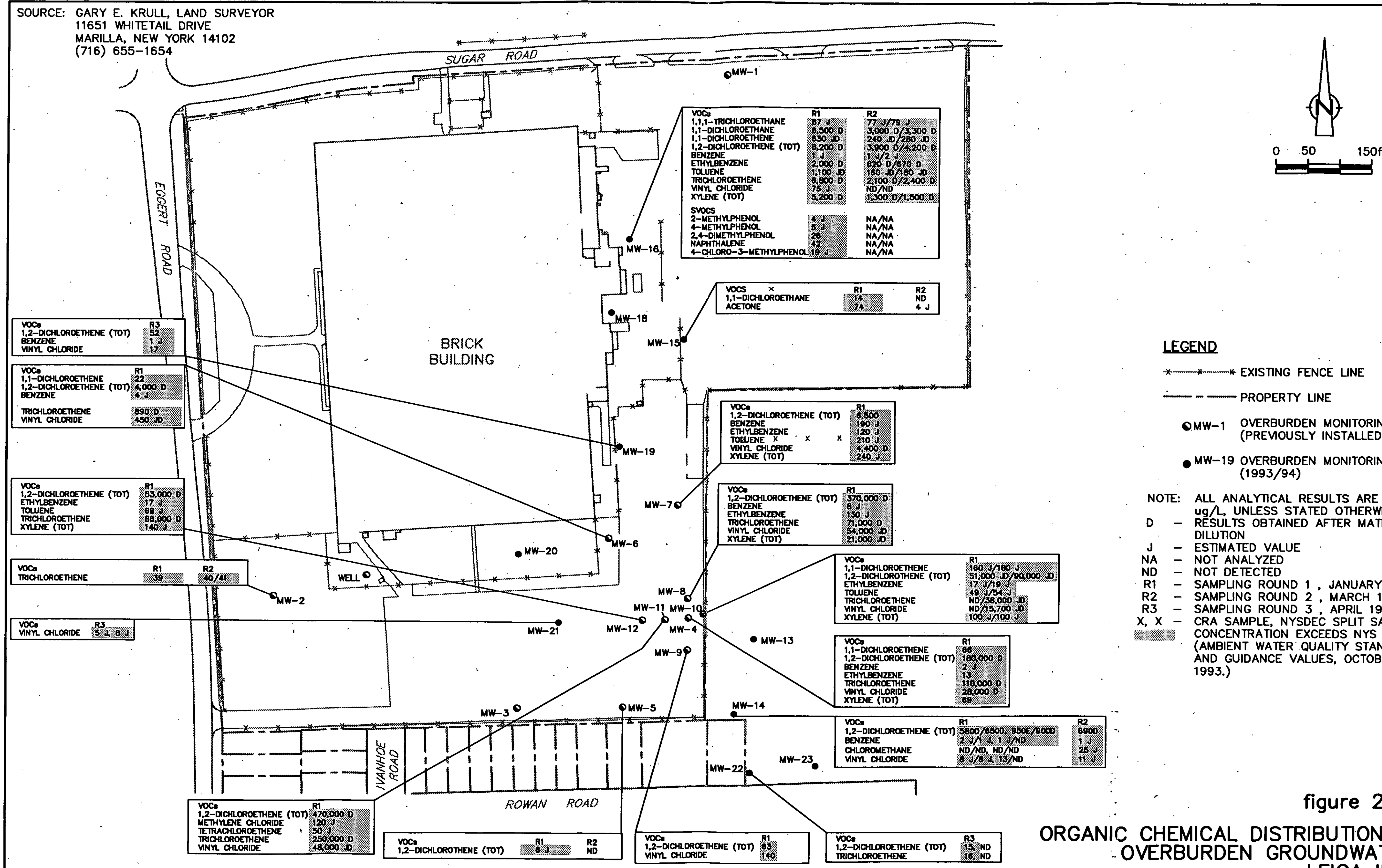
CHLORINATED ETHENE COMPOUNDS INCLUDE:
- -1,1 - DICHLOROETHENE
- -1,2 - DICHLOROETHENE (TOTAL)
- TETRACHLOROETHENE
- TRICHLOROETHENE
- VINYL CHLORIDE

figure 2.14

TOTAL CHLORINATED ETHENE CONCENTRATIONS
IN OVERBURDEN WELLS
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-51)

SOURCE: GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654



VOCs	R1	R2
1,1,1-TRICHLOROETHANE	87 J	77 J/79 J
1,1-DICHLOROETHANE	6,500 D	3,000 D/3,300 D
1,1-DICHLOROETHENE	630 JD	240 JD/280 JD
1,2-DICHLOROETHENE (TOT)	6,200 D	3,900 D/4,200 D
BENZENE	1 J	1 J/2 J
ETHYLBENZENE	2,000 D	620 D/670 D
TOLUENE	1,100 JD	160 JD/180 JD
TRICHLOROETHENE	6,800 D	2,100 D/2,400 D
VINYL CHLORIDE	75 J	ND/ND
XYLENE (TOT)	5,200 D	1,300 D/1,500 D
SVOCS		
2-METHYLPHENOL	4 J	NA/NA
4-METHYLPHENOL	5 J	NA/NA
2,4-DIMETHYLPHENOL	26	NA/NA
NAPHTHALENE	42	NA/NA
4-CHLORO-3-METHYLPHENOL	19 J	NA/NA

VOCS ×	R1	R2
1,1-DICHLOROETHANE	14	ND
ACETONE	74	4 J

VOCs	R3
1,2-DICHLOROETHENE (TOT)	52
BENZENE	1 J
VINYL CHLORIDE	17

VOCs	R1
1,1-DICHLOROETHENE	22
1,2-DICHLOROETHENE (TOT)	4,000 D
BENZENE	4 J
TRICHLOROETHENE	890 D
VINYL CHLORIDE	450 JD

VOCs	R1
1,2-DICHLOROETHENE (TOT)	6,500
BENZENE	190 J
ETHYLBENZENE	120 J
TOLUENE X X X	210 J
VINYL CHLORIDE	4,400 D
XYLENE (TOT)	240 J

VOCs	R1
1,2-DICHLOROETHENE (TOT)	53,000 D
ETHYLBENZENE	17 J
TOLUENE	69 J
TRICHLOROETHENE	88,000 D
XYLENE (TOT)	140 J

VOCs	R1
1,2-DICHLOROETHENE (TOT)	370,000 D
BENZENE	8 J
ETHYLBENZENE	130 J
TRICHLOROETHENE	71,000 D
VINYL CHLORIDE	54,000 JD
XYLENE (TOT)	21,000 JD

VOCs	R1	R2
TRICHLOROETHENE	39	40/41

VOCs	R1
1,1-DICHLOROETHENE	160 J/180 J
1,2-DICHLOROTHENE (TOT)	51,000 JD/90,000 JD
ETHYLBENZENE	17 J/19 J
TOLUENE	49 J/54 J
TRICHLOROETHENE	ND/38,000 JD
VINYL CHLORIDE	ND/15,700 JD
XYLENE (TOT)	100 J/100 J

VOCs	R3
VINYL CHLORIDE	5 J, 8 J

VOCs	R1
1,1-DICHLOROETHENE	66
1,2-DICHLOROETHENE (TOT)	180,000 D
BENZENE	2 J
ETHYLBENZENE	13
TRICHLOROETHENE	110,000 D
VINYL CHLORIDE	28,000 D
XYLENE (TOT)	69

VOCs	R1	R2
1,2-DICHLOROETHENE (TOT)	5800/6500, 950E/900D	6900
BENZENE	2 J/1 J, 1 J/ND	1 J
CHLOROMETHANE	ND/ND, ND/ND	25 J
VINYL CHLORIDE	8 J/8 J, 13/ND	11 J

VOCs	R1
1,2-DICHLOROETHENE (TOT)	470,000 D
METHYLENE CHLORIDE	120 J
TETRACHLOROETHENE	50 J
TRICHLOROETHENE	250,000 D
VINYL CHLORIDE	48,000 JD

VOCs	R1	R2
1,2-DICHLOROTHENE (TOT)	6 J	ND

VOCs	R1
1,2-DICHLOROETHENE (TOT)	63
VINYL CHLORIDE	140

VOCs	R3
1,2-DICHLOROETHENE (TOT)	15, ND
TRICHLOROETHENE	16, ND

LEGEND

-×-×- EXISTING FENCE LINE

— - — PROPERTY LINE

◐MW-1 OVERBURDEN MONITORING WELL (PREVIOUSLY INSTALLED)

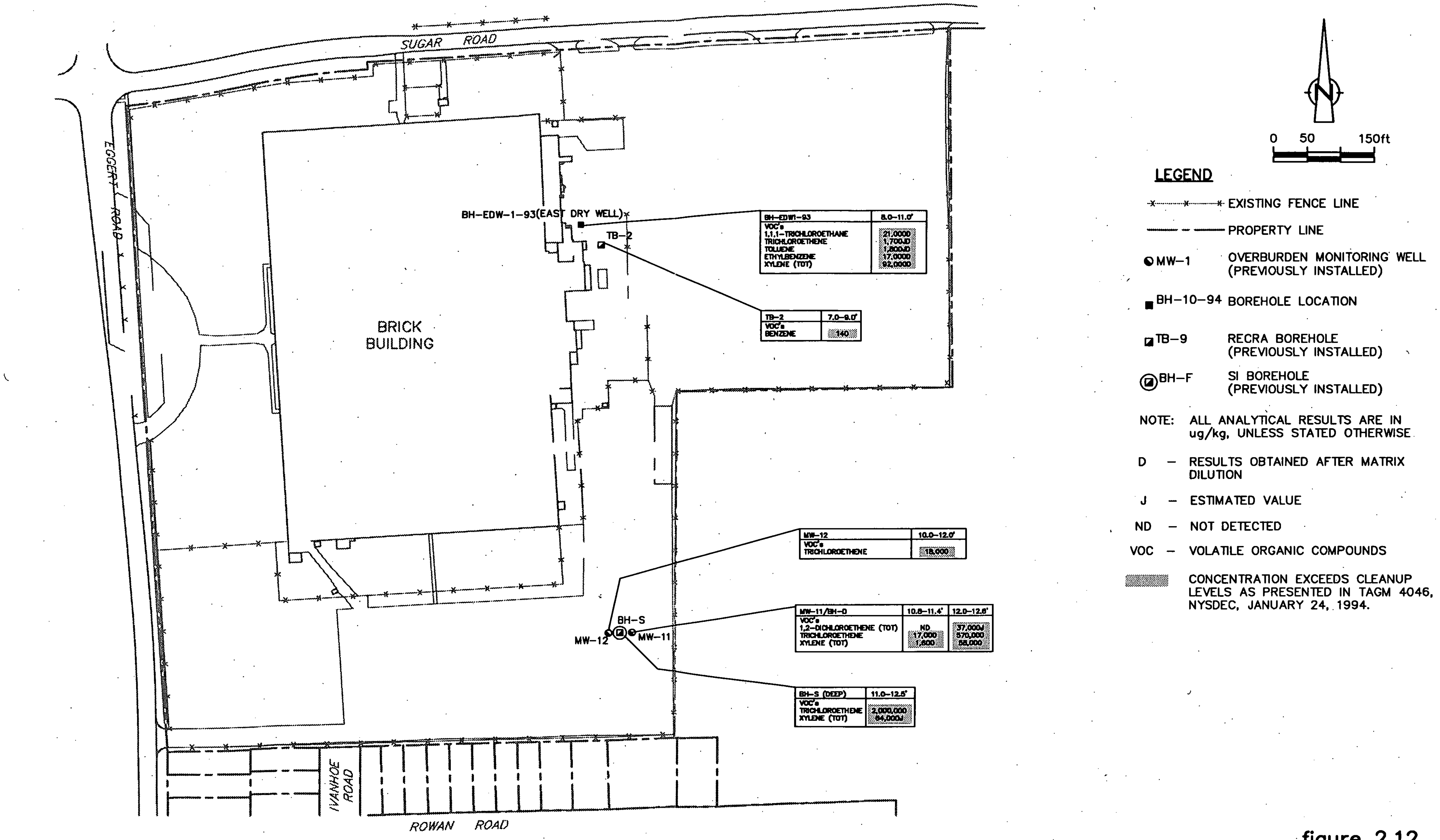
● MW-19 OVERBURDEN MONITORING WELL (1993/94)

NOTE: ALL ANALYTICAL RESULTS ARE IN ug/L, UNLESS STATED OTHERWISE
D – RESULTS OBTAINED AFTER MATRIX DILUTION
J – ESTIMATED VALUE
NA – NOT ANALYZED
ND – NOT DETECTED
R1 – SAMPLING ROUND 1 , JANUARY 1994.
R2 – SAMPLING ROUND 2 , MARCH 1994.
R3 – SAMPLING ROUND 3 , APRIL 1994.
X, X – CRA SAMPLE, NYSDEC SPLIT SAMPLE
▨ CONCENTRATION EXCEEDS NYS SCG (AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES, OCTOBER 1993.)

figure 2.13

ORGANIC CHEMICAL DISTRIBUTION IN OVERBURDEN GROUNDWATER
LEICA INC.
Cheektowaga, New York

CRA



BH-EDW1-93	8.0-11.0'
VOC's	
1,1,1-TRICHLOROETHANE	21,000D
TRICHLOROETHENE	1,700JD
TOLUENE	1,800JD
ETHYLBENZENE	17,000D
XYLENE (TOT)	92,000D

TB-2	7.0-9.0'
VOC's	
BENZENE	140

MW-12	10.0-12.0'
VOC's	
TRICHLOROETHENE	18,000

MW-11/BH-D	10.8-11.4'	12.0-12.6'
VOC's		
1,2-DICHLOROETHENE (TOT)	ND	37,000J
TRICHLOROETHENE	17,000	570,000
XYLENE (TOT)	1,600	58,000

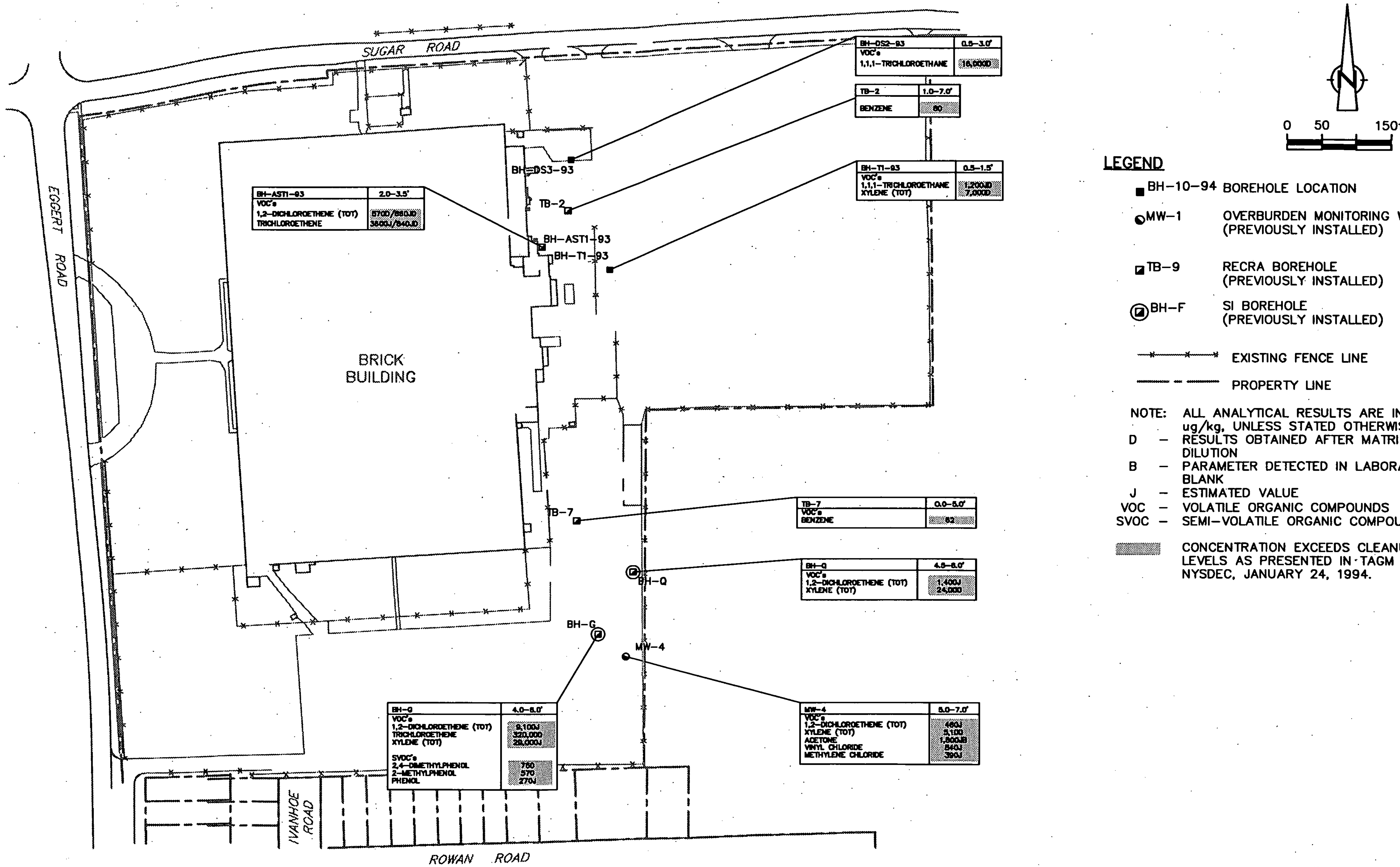
BH-S (DEEP)	11.0-12.5'
VOC's	
TRICHLOROETHENE	2,000,000
XYLENE (TOT)	64,000J

SOURCE: GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

figure 2.12

DEEP SOIL CHEMISTRY
LEICA INC.
Cheektowaga, New York

CRA



LEGEND

■ BH-10-94	BOREHOLE LOCATION
◐ MW-1	OVERBURDEN MONITORING WELL (PREVIOUSLY INSTALLED)
◪ TB-9	RECRA BOREHOLE (PREVIOUSLY INSTALLED)
◉ BH-F	SI BOREHOLE (PREVIOUSLY INSTALLED)
—×—×—	EXISTING FENCE LINE
—— — —	PROPERTY LINE

NOTE: ALL ANALYTICAL RESULTS ARE IN ug/kg, UNLESS STATED OTHERWISE
D – RESULTS OBTAINED AFTER MATRIX DILUTION
B – PARAMETER DETECTED IN LABORATORY BLANK
J – ESTIMATED VALUE
VOC – VOLATILE ORGANIC COMPOUNDS
SVOC – SEMI-VOLATILE ORGANIC COMPOUNDS
▨ CONCENTRATION EXCEEDS CLEANUP LEVELS AS PRESENTED IN TAGM 4046, NYSDEC, JANUARY 24, 1994.

SOURCE: GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

figure 2.11

SHALLOW SOIL CHEMISTRY
LEICA INC.
Cheektowaga, New York

CRA

3967 (8) JULY 21/95(W) REV.0 (P-88)

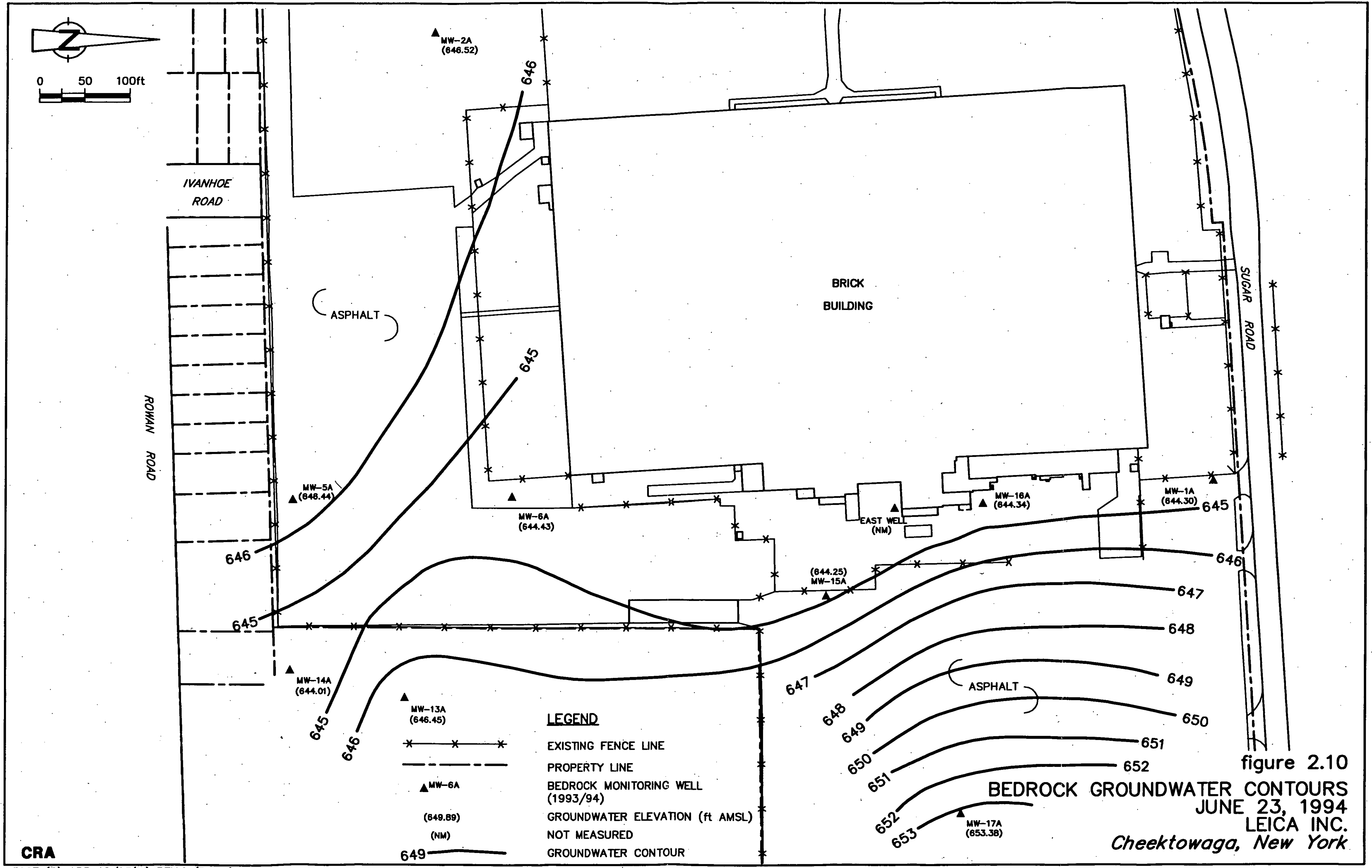


figure 2.10

BEDROCK GROUNDWATER CONTOURS
JUNE 23, 1994
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-74)

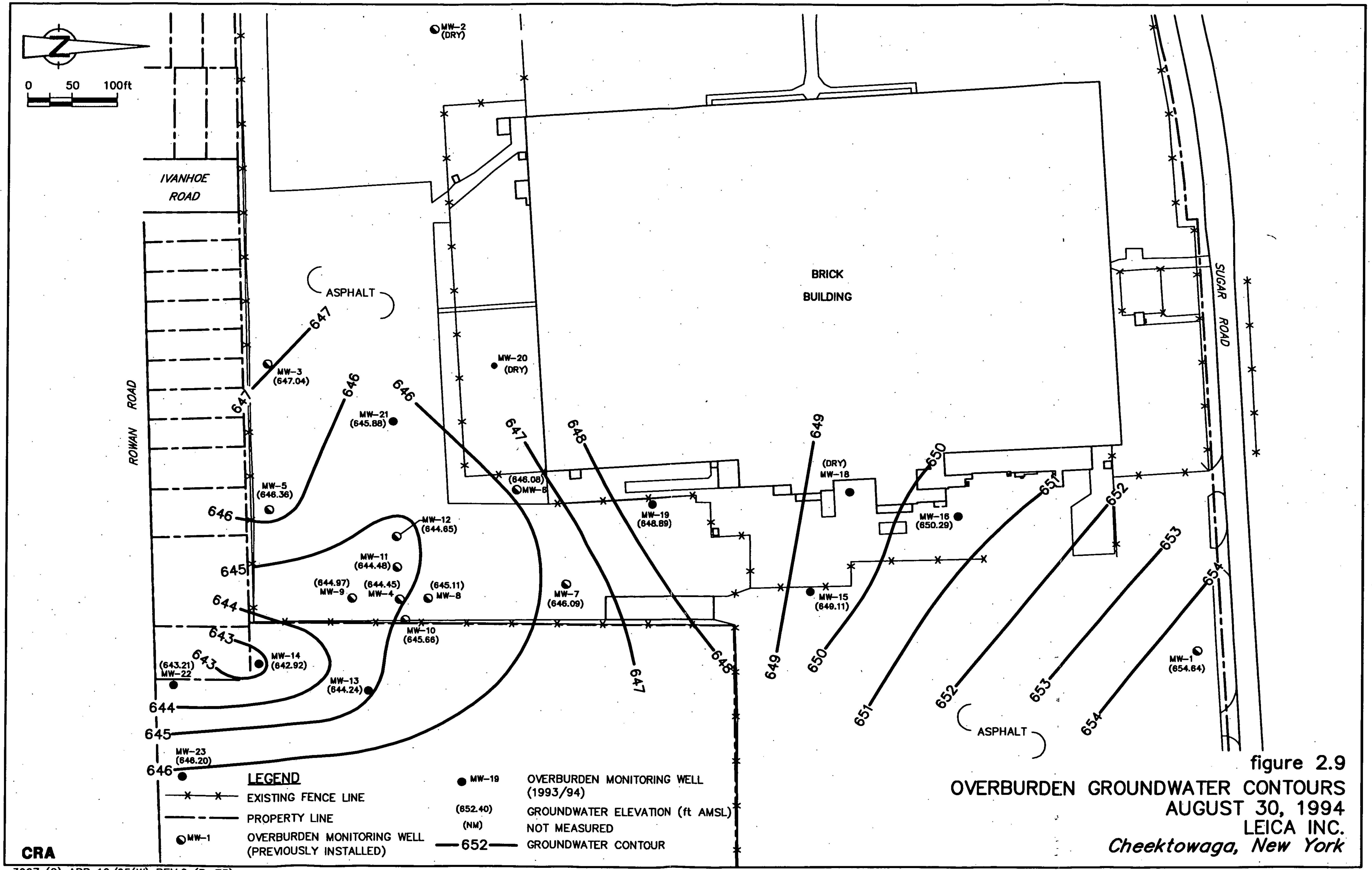


figure 2.9
OVERBURDEN GROUNDWATER CONTOURS
AUGUST 30, 1994
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-73)

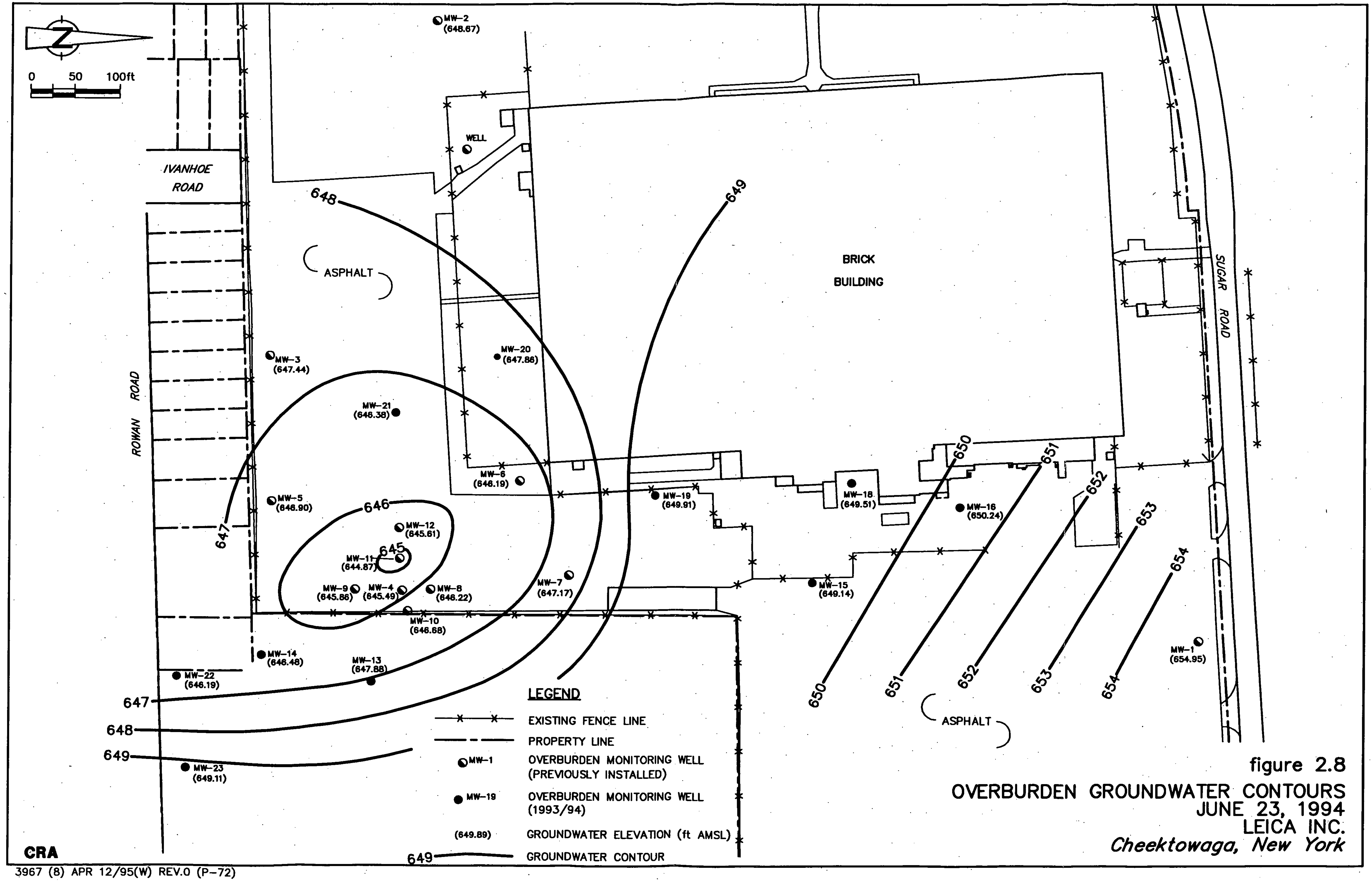


figure 2.8
OVERBURDEN GROUNDWATER CONTOURS
JUNE 23, 1994
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-72)

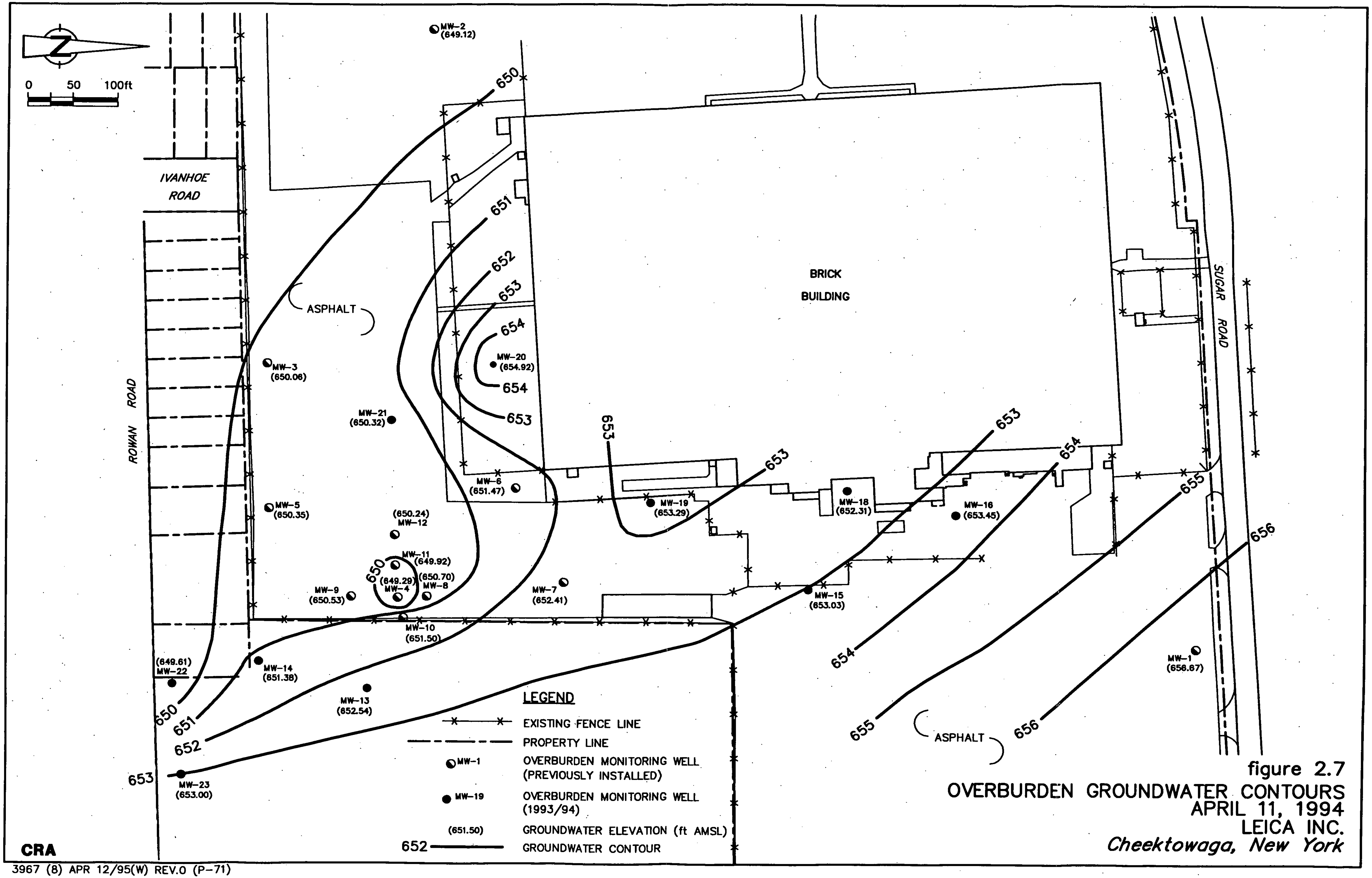
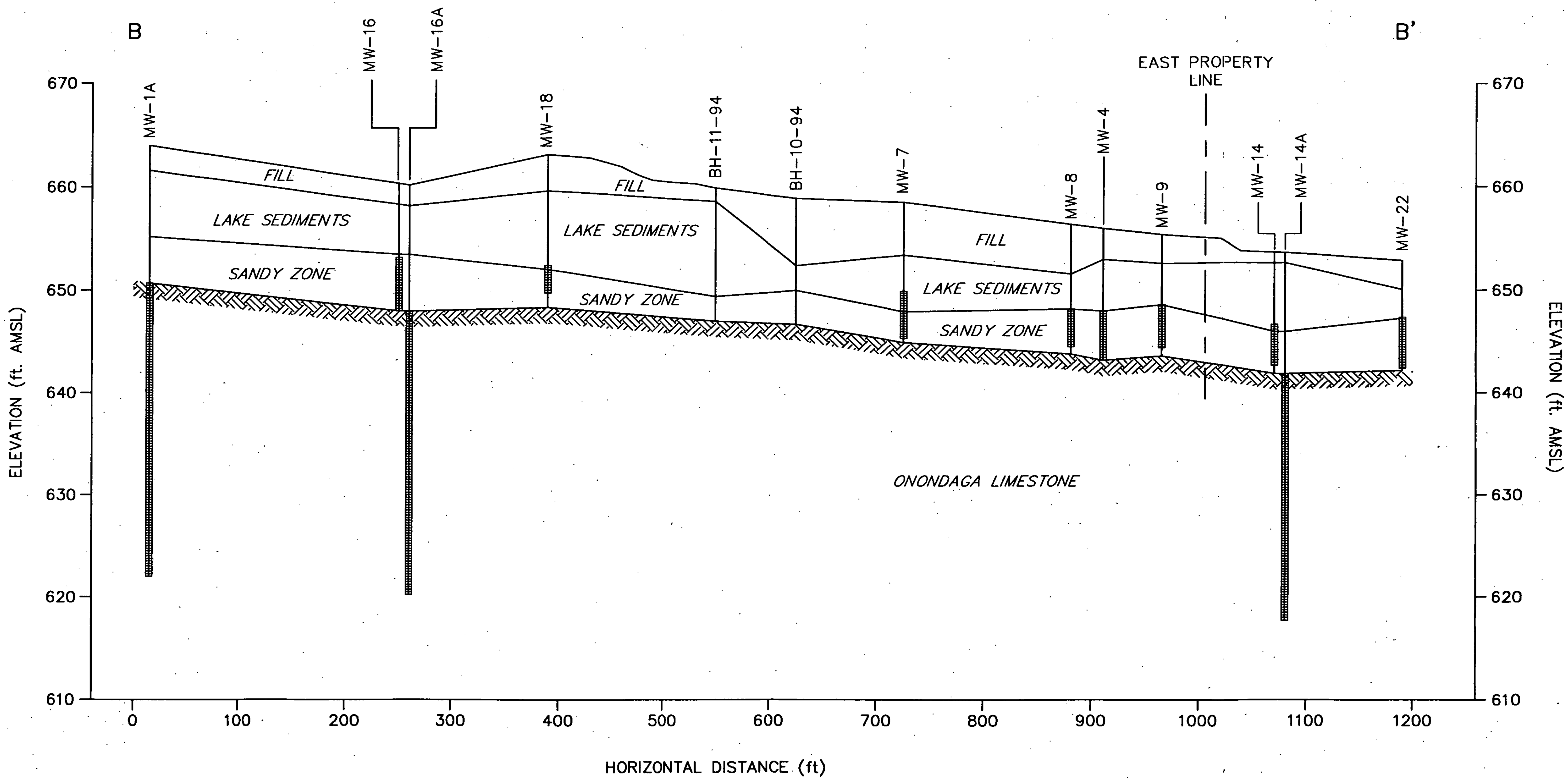


figure 2.7
OVERBURDEN GROUNDWATER CONTOURS
APRIL 11, 1994
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-71)



LEGEND

▥ MONITORED INTERVAL

CROSS SECTION B–B'

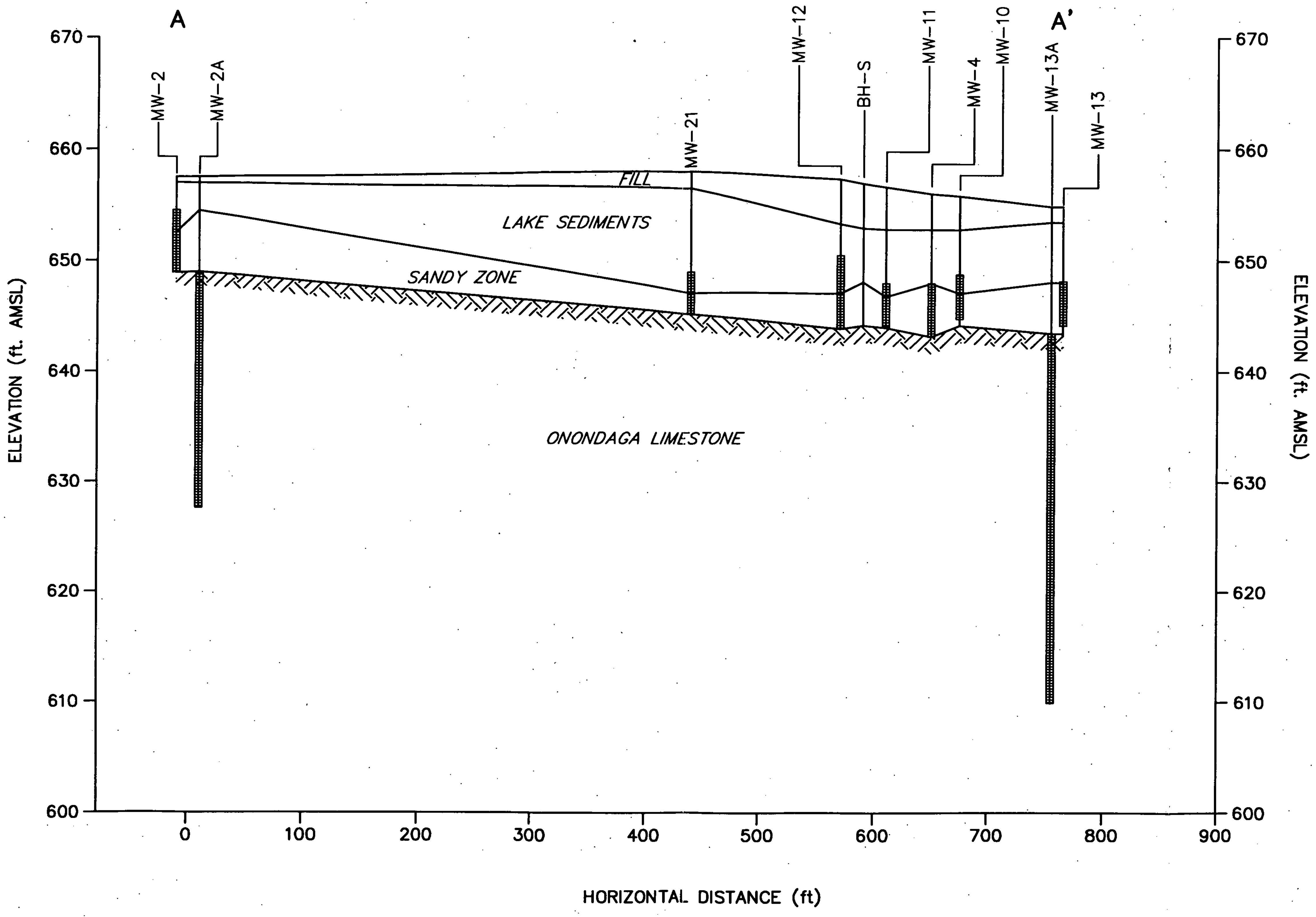
SCALE: HORIZ: 1"=100'
VERT: 1"=10'

figure 2.6

STRATIGRAPHIC CROSS SECTION B–B'
LEICA INC.
Cheektowaga, New York

CRA

3967 (8) APR 13/95(W) REV.1 (X-13)

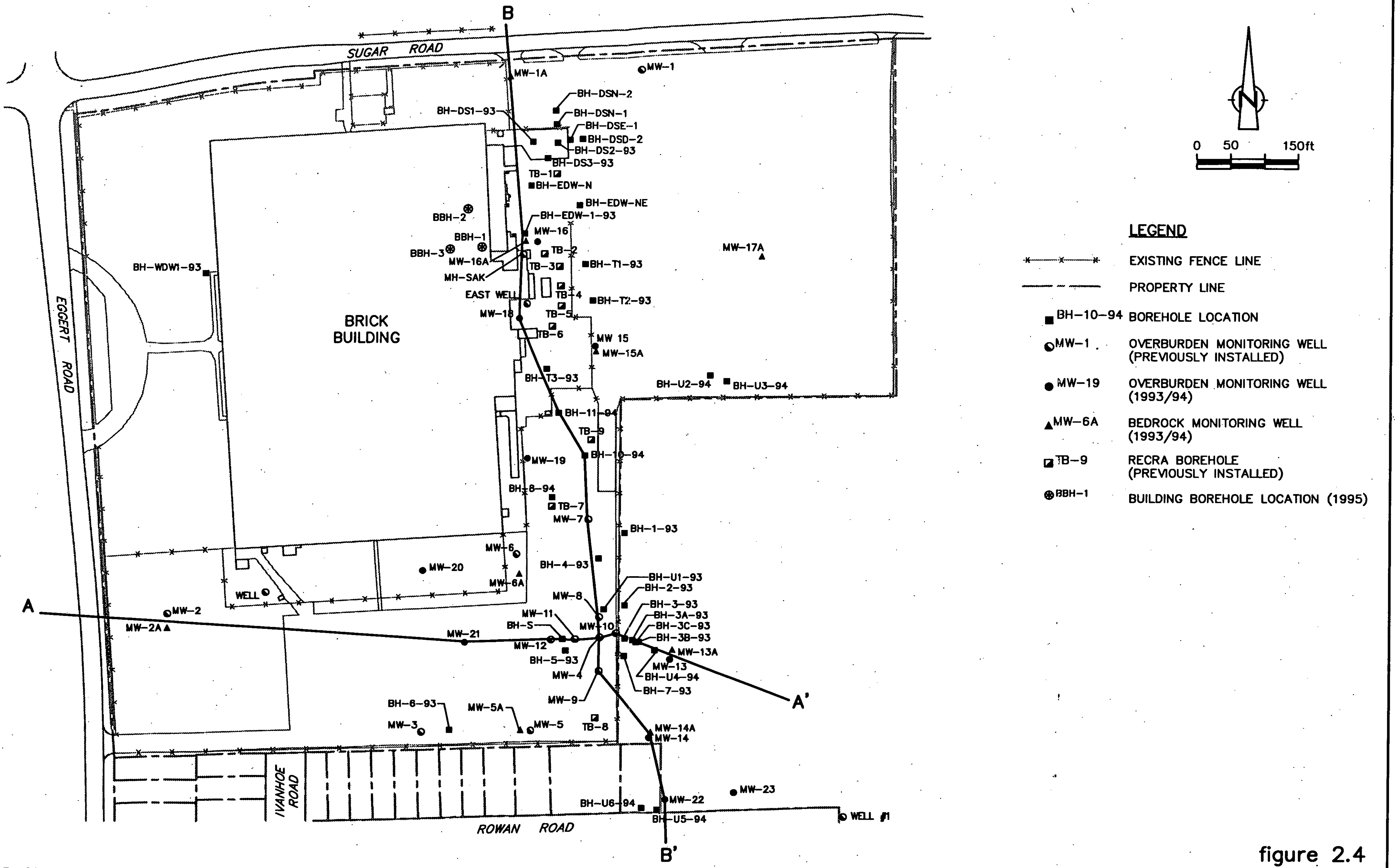


LEGEND

▥ MONITORED INTERVAL

CROSS SECTION A–A'
SCALE: HORIZ: 1"=100'
VERT: 1"=10'

figure 2.5
STRATIGRAPHIC CROSS SECTION A–A'
LEICA INC.
Cheektowaga, New York



LEGEND

—×——×—	EXISTING FENCE LINE
— — —	PROPERTY LINE
■ BH-10-94	BOREHOLE LOCATION
◐ MW-1	OVERBURDEN MONITORING WELL (PREVIOUSLY INSTALLED)
● MW-19	OVERBURDEN MONITORING WELL (1993/94)
▲ MW-6A	BEDROCK MONITORING WELL (1993/94)
◪ TB-9	RECRA BOREHOLE (PREVIOUSLY INSTALLED)
⊕ BBH-1	BUILDING BOREHOLE LOCATION (1995)

SOURCE: GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

figure 2.4
CROSS SECTION ALIGNMENTS
LEICA INC.
Cheektowaga, New York

CRA

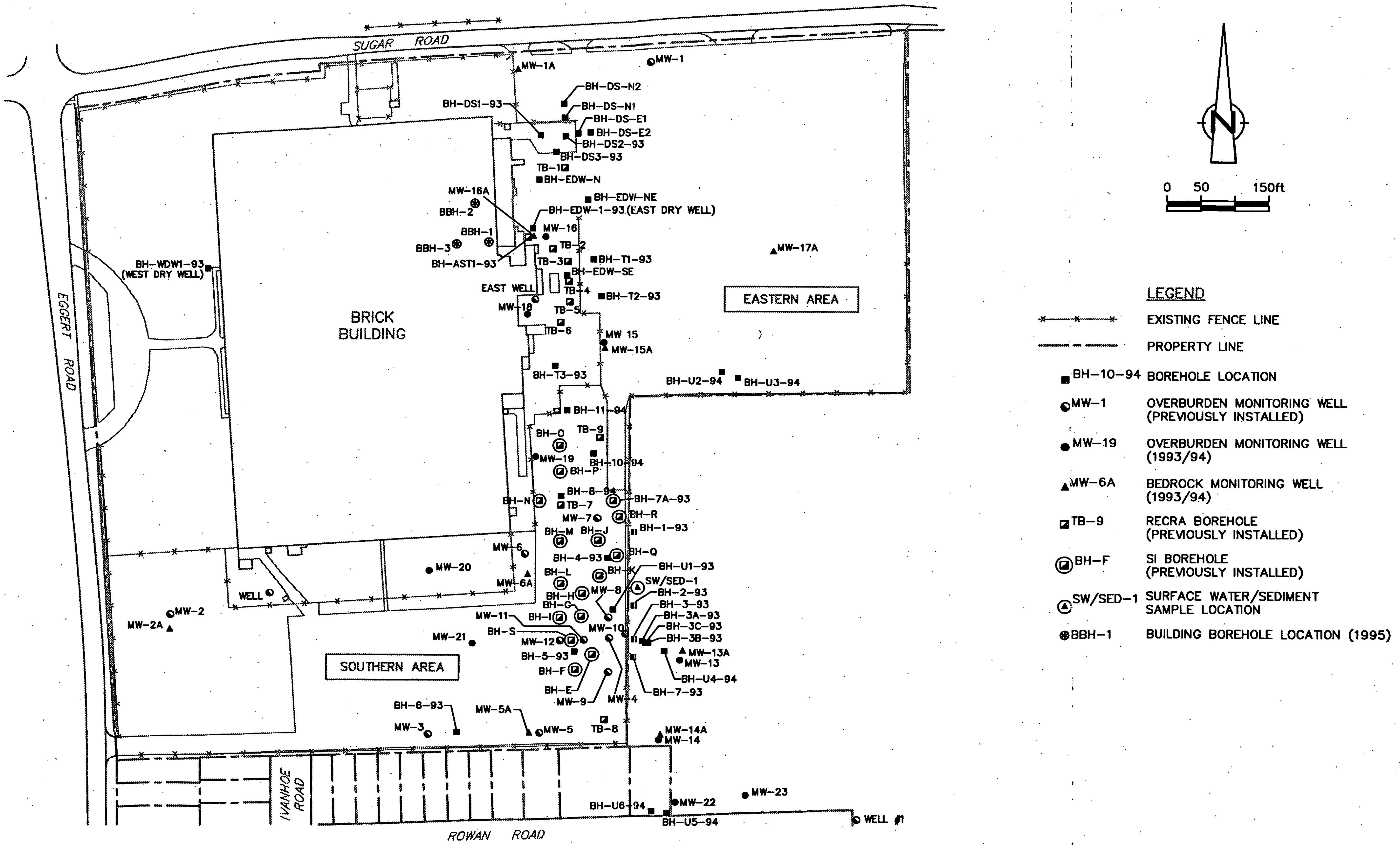


figure 2.3

GROUNDWATER MONITORING WELL AND SAMPLE LOCATIONS
LEICA INC.
Cheektowaga, New York

SOURCE: GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

CRA

3967 (8) APR 12/95(W) REV.0 (P-61)

TABLES

TABLE 1.1

RI/FS SCOPE OF WORK
LEICA INC.
CHEEKTOWAGA, NEW YORK

Remedial Investigation (RI)

Task 1	Preparation of Detailed Project Specific Plans
Task 2	Description of Current Conditions and Site Background
Task 3	Procurement of Contractors
Task 4	Site Investigation
Task 5	Sample Analyses
Task 6	Data Evaluation
Task 7	Risk Assessment
Task 8	Identification of Preliminary Remedial Action Objectives
Task 9	Preliminary Evaluation of Treatability Studies
Task 10	Remedial Investigation Report

Feasibility Study (FS)

Task 1	Identification of SCGs
Task 2	Remedial Alternatives Development and Screening
Task 3	Treatability Studies
Task 4	Remedial Alternatives Evaluation
Task 5	Feasibility Study Report

TABLE 2.1

REPRESENTATIVE DETECTED CONTAMINANT CONCENTRATIONS
FORMER DRUM STORAGE AREA - SOIL
LEICA INC.
CHEEKTOWAGA, NEW YORK

Parameter	*Units*	*Soil Cleanup Objective(1)(2)*	*Range of Detected Concentrations*			*Number of Detections/Number of Sample Locations*
			Minimum	*Maximum*	*Mean*	
VOCs						
Acetone	µg/kg	200	7J	29J	15J	4/9
Benzene	µg/kg	60	1J	1J	1J	1/9
2-Butanone	µg/kg	300	2J	15J	7J	3/9
Carbon Disulfide	µg/kg	2,700	18J	18J	18J	1/9
1,1-Dichloroethane	µg/kg	200	6	19	10J	4/9
1,1-Dichloroethene	µg/kg	400	1J	4J	3J	2/9
1,2-Dichloroethene (total)	µg/kg	300	1J	4J	3J	2/9
Ethylbenzene	µg/kg	5,500	7J	48J	28J	3/9
2-Hexanone	µg/kg	NA	4J	4J	4J	1/9
4-Methyl-2-Pentanone	µg/kg	1,000	11J	11J	11J	1/9
Methylene Chloride	µg/kg	100	1J	93	47J	4/9
Tetrachloroethene	µg/kg	1,400	8J	8J	8J	1/9
Toluene	µg/kg	1,500	2J	25J	15J	4/9
1,1,1-Trichloroethane	µg/kg	800	8	16,000D	3,250JD	5/9
Trichloroethene	µg/kg	700	2J	47	12.4J	5/9
Xylenes (Total)	µg/kg	1,200	2J	560JD	201JD	4/9
Metals						
Aluminum	mg/kg	100,000	11,700	17,800	14,467	3/3
Arsenic	mg/kg	93.2	1.8B	4.9	3.1	3/3
Barium	mg/kg	3,000	113	296	187	3/3
Beryllium	mg/kg	5	0.63	1.3	0.9	3/3
Cadmium	mg/kg	1.1	0.89	0.89	0.89	1/5
Calcium	mg/kg	35,000(3)	26,000J	120,000	74,233J	3/3
Chromium	mg/kg	1,500	8.5	20.6	16.6	4/4
Cobalt	mg/kg	60(3)	7.8	11.7	9.3	3/3
Copper	mg/kg	300	21.1	53.4J	33.2J	3/3
Iron	mg/kg	550,000(3)	17,300	27,200	21,300	3/3
Lead	mg/kg	500(1)	12.3	64.9J	30.1J	3/3
Magnesium	mg/kg	5,000(3)	6,770	19,500	15,123	3/3
Manganese	mg/kg	5,000(3)	509	1,200J	804J	3/3
Mercury	mg/kg	1.5	0.07	0.07	0.07	1/3
Nickel	mg/kg	150	22.8	208	90.8	5/5
Potassium	mg/kg	43,000(3)	1,540	2,250	1,803	3/3
Selenium	mg/kg	4	0.99J	0.99J	0.99J	1/3
Sodium	mg/kg	50,000(3)	1,010	1,010	1,010	1/3
Vanadium	mg/kg	300(3)	20.6	28.6	23.5	3/3
Zinc	mg/kg	300	74.9	115J	89.2J	5/5
TPH	mg/kg	NA	86	3,930	1,667J	8/9

Notes:

(1)	Soil Cleanup Objectives are based on "Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels", HWR-94-4046, NYSDEC, January 24, 1994.
(2)	Soil Cleanup Objectives for metals are the maximum of the concentration range for US published soil concentrations unless otherwise indicated.
(3)	Soil Cleanup Objective is the maximum of concentration range, NYSDEC published concentrations.
B	Parameter found in associated method blank.
D	Result obtained after matrix dilution.
J	Estimated value.
MDL	Method Detection Limit.
NA	Soil Cleanup Objective has not been established for indicated parameter.
TPH	Total Petroleum Hydrocarbon.
VOCs	Volatile Organic Compounds.
SVOCs	Semi-Volatile Organic Compounds.

TABLE 2.2

REPRESENTATIVE DETECTED CONTAMINANT CONCENTRATIONS
FORMER ABOVEGROUND STORAGE TANK AREA, EAST SIDE DRY WELL AREA, UNDERGROUND STORAGE TANK AREA AND PLANT BUILDING
LEICA INC.
CHEEKTOWAGA, NEW YORK

Parameter	*Units*	*Soil Cleanup Objective (1)(2)*	*Range of Detected Concentrations*			*Number of Detections/Number of Sample Locations*
			Minimum	*Maximum*	*Mean*	
VOCs						
Acetone	µg/kg	200	8J	58J	26J	3/9
Benzene	µg/kg	60	80	140	110	2/19
2-Butanone	µg/kg	300	15J	15J	15J	1/9
Carbon Disulfide	µg/kg	2,700	5J	5J	5J	1/9
Chlorobenzene	µg/kg	1,700	8J	8J	8J	1/9
1,1-Dichloroethane	µg/kg	200	3J	120	43	3/9
1,1-Dichloroethene	µg/kg	400	6J	132J	69J	2/9
1,2-Dichloroethene (total)	µg/kg	300	34	615JD	238JD	3/9
Ethylbenzene	µg/kg	5,500	3J	17,000D	3,070JD	6/19
Methylene Chloride	µg/kg	100	2J	2J	2J	1/9
Tetrachloroethene	µg/kg	1,400	4J	5J	5J	2/9
Toluene	µg/kg	1,500	2J	1,800JD	409JD	9/19
1,1,1-Trichloroethane	µg/kg	800	2J	21,000D	4,461JD	5/9
Trichloroethene	µg/kg	700	2J	1,700JD	577JD	5/9
Vinyl Chloride	µg/kg	200	1J	1J	1J	1/9
Xylenes (Total)	µg/kg	1,200	3J	92,000D	12,496JD	8/19
Metals						
Aluminum	mg/kg	100,000	1,600	13,100	7,350	2/2
Arsenic	mg/kg	93.2	0.98	3.5J	2.2J	2/2
Barium	mg/kg	3,000	15.9	139	77.5	2/2
Beryllium	mg/kg	5	0.77	0.77	0.77	2/2
Cadmium	mg/kg	1.1	ND	ND	ND	0/2
Calcium	mg/kg	35,000(3)	52,000	85,150	68,575	2/2
Chromium	mg/kg	1,500	19.4	19.4	19.4	1/2
Cobalt	mg/kg	60(3)	8.8	8.8	8.8	1/2
Copper	mg/kg	300	5.3	48.4J	26.9J	2/2
Iron	mg/kg	550,000(3)	4,150	21,050	12,600	2/2
Lead	mg/kg	500(1)	6.9	63J	35J	2/2
Magnesium	mg/kg	5,000(3)	19,850	22,100	20,975	2/2
Manganese	mg/kg	5,000(3)	213	695	454	2/2
Mercury	mg/kg	1.5	0.17J	0.17J	0.17J	1/2
Nickel	mg/kg	150	28.4	28.4	28.4	1/2
Potassium	mg/kg	43,000(3)	398	2,220	1,309	2/2
Sodium	mg/kg	50,000(3)	419	419	419	1/2
Vanadium	mg/kg	300(3)	5.6	25.8	15.7	2/2
Zinc	mg/kg	300	56.2	124.1J	90.2J	2/2
TPH	mg/kg	NA	42	7,370	806	13/15

Notes:

(1)	Soil Cleanup Objectives are based on "Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels", HWR-94-4046, NYSDEC, January 24, 1994.
(2)	Soil Cleanup Objectives for metals are the maximum of the concentration range for US published soil concentrations unless otherwise indicated.
(3)	Soil Cleanup Objective is the maximum of concentration range, NYSDEC published concentrations.
D	Result obtained after matrix dilution.
J	Estimated value.
MDL	Method Detection Limit.
NA	Soil Cleanup Objective has not been established for indicated parameter.
ND	Not Detected.
TPH	Total Petroleum Hydrocarbon.
VOCs	Volatile Organic Compounds.
SVOCs	Semi-Volatile Organic Compounds.

TABLE 2.3

REPRESENTATIVE DETECTED CONTAMINANT CONCENTRATIONS
SOUTHERN AREA - SHALLOW SOIL
LEICA INC.
CHEEKTOWAGA, NEW YORK

Parameter	*Units*	*Soil Cleanup Objective(1)(2)*	*Range of Detected Concentrations*			*Number of Detections/Number of Sample Locations*
			Minimum	*Maximum*	*Mean*	
VOCs						
Acetone	µg/kg	200	13B	1,800JB	349J	6/8
Benzene	µg/kg	60	62	62	62	1/8
2-Butanone	µg/kg	300	2J	2J	2J	1/8
Chlorobenzene	µg/kg	1,700	530	530	530	1/8
1,2-Dichloroethene (total)	µg/kg	300	7J	9,100J	1,846J	6/8
Ethylbenzene	µg/kg	5,500	450	1,200J	825J	2/8
2-Hexanone	µg/kg	6,750	570	570	570	1/8
4-Methyl-2-pentanone	µg/kg	1,000	100	100	100	1/8
Methylene Chloride	µg/kg	100	4J	8	6J	2/8
1,1,2,2-Tetrachloroethane	µg/kg	600	100	100	100	1/8
Tetrachloroethene	µg/kg	1,400	5J	5J	5J	1/8
Toluene	µg/kg	1,500	500J	5,100	2,800J	2/8
Trichloroethene	µg/kg	700	33	320,000	160,017	2/8
Vinyl Chloride	µg/kg	200	25	840J	302J	3/8
Xylenes (total)	µg/kg	1,200	510	29,000J	17,837J	3/8
SVOCs						
Benzo(a)anthracene	µg/kg	224 or MDL	22	220J	107J	3/5
Benzo(a)pyrene	µg/kg	61 or MDL	17	17	17	1/5
Benzo(b)fluoranthene	µg/kg	1,100	27	140J	84J	2/4
Benzo(g,h,i)perylene	µg/kg	50,000	130J	130J	130J	1/3
Benzo(k)fluoranthene	µg/kg	1,100	37J	37J	37J	1/4
Chrysene	µg/kg	400	1.7	130J	50J	3/4
Di-n-butylphthalate	µg/kg	8,100	1,700	1,700	1,700	1/3
2,4-Dimethylphenol	µg/kg	585	2.7	750	376	2/3
Fluoranthene	µg/kg	50,000	2.8	410	149J	4/5
Indeno(1,2,3-cd)pyrene	µg/kg	3,200	140J	140J	140J	1/3
2-Methylnapthalene	µg/kg	36,400	120J	120J	120J	1/3
2-Methylphenol	µg/kg	100 or MDL	1.3	570	286	2/3
4-Methylphenol	µg/kg	900	380	380	380	1/3
Napthalene	µg/kg	13,000	290J	290J	290J	1/3
Phenanthrene	µg/kg	50,000	50	190J	123J	3/5
Phenol	µg/kg	30 or MDL	270J	270J	270J	1/3
Pyrene	µg/kg	50,000	43	210J	124J	3/5
Metals						
Aluminum	mg/kg	100,000	8,600	15,500	10,760	4/4
Arsenic	mg/kg	93.2	1.4	5.9	3.3	4/4
Barium	mg/kg	3,000	40.4	110	82	4/4
Beryllium	mg/kg	5	0.4	0.6	0.5	2/4
Cadmium	mg/kg	1.1	0.77	2.5	1.7	4/6
Calcium	mg/kg	35,000(3)	12,500	63,000	48,125	4/4
Chromium	mg/kg	1,500	12.4	41.0	21.9	6/6
Cobalt	mg/kg	60(3)	6.2	10.3	7.8	4/4
Copper	mg/kg	300	16	29.6	20.6	4/4
Iron	mg/kg	550,000(3)	16,000	25,300	19,825	4/4
Lead	mg/kg	500(1)	9.0	14.3	11.0	4/4
Magnesium	mg/kg	5,000(3)	3,750	28,300	16,013	4/4
Manganese	mg/kg	5,000(3)	317	716	481	4/4
Nickel	mg/kg	150	14	54.0	26.2	5/6
Potassium	mg/kg	43,000(3)	911	1,800	1,373	4/4
Sodium	mg/kg	50,000(3)	380	410	395	2/4
Thallium	mg/kg	2.8	0.3J	0.39	0.35J	2/4
Vanadium	mg/kg	300(3)	20	31.6	23	4/4
Zinc	mg/kg	300	58	445	152	6/6

TABLE 2.3

REPRESENTATIVE DETECTED CONTAMINANT CONCENTRATIONS
SOUTHERN AREA - SHALLOW SOIL
LEICA INC.
CHEEKTOWAGA, NEW YORK

Parameter	*Units*	*Soil Cleanup Objective(1)(2)*	*Range of Detected Concentrations*			*Number of Detections/Number of Sample Locations*
			Minimum	*Maximum*	*Mean*	
TPH	mg/kg	NA	140	60,900	11,221	11/13

Notes:

(1)	Soil Cleanup Objectives are based on "Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels", HWR-94-4046, NYSDEC, January 24, 1994.
(2)	Soil Cleanup Objectives for metals are the maximum of the concentration range for US published soil concentrations unless otherwise indicated.
(3)	Soil Cleanup Objective is the maximum of concentration range, NYSDEC published concentrations.
B	Parameter found in associated method blank.
J	Estimated value.
MDL	Method Detection Limit.
NA	Soil Cleanup Objective has not been established for indicated parameter.
TPH	Total Petroleum Hydrocarbon.
VOCs	Volatile Organic Compounds.
SVOCs	Semi-Volatile Organic Compounds.

TABLE 2.4

REPRESENTATIVE DETECTED CONTAMINANT CONCENTRATIONS
SOUTHERN AREA - DEEP SOIL
LEICA INC.
CHEEKTOWAGA, NEW YORK

Parameter	*Units*	*Soil Cleanup Objective(1)(2)*	*Range of Detected Concentrations*			*Number of Detections/Number of Sample Locations*
			Minimum	*Maximum*	*Mean*	
VOCs						
Acetone	µg/kg	200	5J	90B	34J	3/14
Benzene	µg/kg	60	2J	20	11J	2/14
2-Butanone	µg/kg	300	1J	1J	1J	1/14
Carbon Disulfide	µg/kg	2,700	1J	3J	2J	3/14
Chlorobenzene	µg/kg	1,700	20	20	20	1/14
1,2-Dichloroethene (total)	µg/kg	300	1J	37,000J	4,716J	8/14
Ethylbenzene	µg/kg	5,500	35	35	35	1/14
Tetrachloroethene	µg/kg	1,400	10J	10J	10J	1/14
Toluene	µg/kg	1,500	10J	120	65J	2/14
Trichloroethene	µg/kg	700	410	2,000,000	434,602	6/14
Vinyl Chloride	µg/kg	200	3J	5J	4J	2/14
Xylene (total)	µg/kg	1,200	1J	64,000J	17,784	7/14
SVOCs						
Benzo(a)anthracene	µg/kg	224 of MDL	55J	55J	55J	1/1
Benzo(a)pyrene	µg/kg	61 or MDL	61J	61J	61J	1/1
Chrysene	µg/kg	400	73J	73J	73J	1/1
Di-n-butylphthalate	µg/kg	8,100	99J	99J	99J	1/1
Fluoranthene	µg/kg	50,000	190J	190J	190J	1/1
Phenanthrene	µg/kg	50,000	130J	130J	130J	1/1
Pyrene	µg/kg	50,000	110J	110J	110J	1/1
Metals						
Aluminum	mg/kg	100,000	3,810	5,800	4,640	3/3
Arsenic	mg/kg	93.2	1.3	2.0	1.6	3/3
Barium	mg/kg	3,000	35.0	43.3	39.3	3/3
Calcium	mg/kg	35,000(3)	71,000	81,800	75,633	3/3
Cobalt	mg/kg	60(3)	3.1	4.8	3.9	3/3
Chromium	mg/kg	1,500	6.7	9.7	8.7	3/3
Copper	mg/kg	300	8.4	10.9	9.6	3/3
Iron	mg/kg	550,000(3)	8,250	11,200	9,627	3/3
Lead	mg/kg	500(1)	6.8	12.4	8.7	3/3
Potassium	mg/kg	43,000(3)	1,040	1,530	1,250	3/3
Magnesium	mg/kg	5,000(3)	28,300	37,500	31,833	3/3
Manganese	mg/kg	5,000(3)	273	346	312	3/3
Vanadium	mg/kg	300(3)	10.4	71.1	31.7	3/3
Zinc	mg/kg	300	44.9	52.8	49.7	3/3
TPH	mg/kg	NA	83	9,000	3,496	4/11

Notes:

(1)	Soil Cleanup Objectives are based on "Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels", HWR-94-4046, NYSDEC, January 24, 1994.
(2)	Soil Cleanup Objectives for metals are the maximum of the concentration range for US published soil concentrations unless otherwise indicated.
(3)	Soil Cleanup Objective is the maximum of concentration range, NYSDEC published concentrations.
B	Parameter found in associated method blank.
J	Estimated value.
MDL	Method Detection Limit.
NA	Soil Cleanup Objective has not been established for indicated parameter.
TPH	Total Petroleum Hydrocarbon.
VOCs	Volatile Organic Compounds.
SVOCs	Semi-Volatile Organic Compounds.

TABLE 2.5

REPRESENTATIVE DETECTED CONTAMINANT CONCENTRATIONS
OFF-SITE PARCEL - SHALLOW SOIL
LEICA INC.
CHEEKTOWAGA, NEW YORK

Parameter	*Units*	*Soil Cleanup Objective(1)(2)*	*Range of Detected Concentrations*			*Number of Detections/Number of Sample Locations*
			Minimum	*Maximum*	*Mean*	
VOCs						
Acetone	µg/kg	200	2J	49J	22J	5/6
Bromomethane	µg/kg	415	3J	3J	3J	1/6
2-Butanone	µg/kg	300	9J	9J	9J	1/6
Carbon Disulfide	µg/kg	2,700	2J	2J	2J	1/6
1,2-Dichloroethene (total)	µg/kg	300	6J	160D	60JD	4/6
2-Hexanone	µg/kg	6,750	6J	6J	6J	1/6
Ethylbenzene	µg/kg	5,500	42	42	42	1/6
1,1,1-Trichloroethane	µg/kg	800	8J	8J	8J	1/6
Toluene	µg/kg	1,500	39	39	39	1/6
Trichloroethene	µg/kg	700	5J	150J	54J	3/6
Vinyl Chloride	µg/kg	200	42	42	42	1/6
Xylene (total)	µg/kg	1,200	190D	190D	190D	1/6
SVOCs						
Fluoranthene	µg/kg	50,000	100J	130J	115J	2/2
Pyrene	µg/kg	50,000	66J	150J	108J	2/2
Metals						
Aluminum	mg/kg	100,000	12,800	29,600	17,650	6/6
Arsenic	mg/kg	93.2	0.88	8.3	4.9	6/6
Barium	mg/kg	3,000	92.4	235	175	6/6
Beryllium	mg/kg	5	0.68	0.88	0.78	2/6
Cadmium	mg/kg	1.1	2.0	2.9	2.3	3/6
Calcium	mg/kg	35,000(3)	3,360	91,200	32,848	6/6
Chromium	mg/kg	1,500	18.8	35.4	25.6	6/6
Cobalt	mg/kg	60(3)	8.3	13.1	11.3	6/6
Copper	mg/kg	300	9.7	33.1	23.2	6/6
Iron	mg/kg	550,000(3)	19,600	32,000	25,717	6/6
Lead	mg/kg	500(1)	13.1	346	78.3J	6/6
Magnesium	mg/kg	5,000(3)	5,650	19,400	11,878	6/6
Manganese	mg/kg	5,000(3)	182	999	557	6/6
Mercury	mg/kg	1.5	0.37	0.37	0.37	1/6
Nickel	mg/kg	150	21.8	33.0	28.5	6/6
Potassium	mg/kg	43,000(3)	1,980	2,940	2,432	6/6
Sodium	mg/kg	50,000(3)	347	362J	355J	2/6
Thallium	mg/kg	2.8	0.35	0.62	0.49	2/6
Vanadium	mg/kg	300(3)	25.0	41.3	30.7	6/6
Zinc	mg/kg	300	69.2	193	115	6/6
TPH	mg/kg	NA	288	288	288	1/6
Total Organic Carbon	mg/kg	NA	15,900	15,900	15,900	1/6

Notes:

(1)	Soil Cleanup Objectives are based on "Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels", HWR-94-4046, NYSDEC, January 24, 1994.
(2)	Soil Cleanup Objectives for metals are the maximum of the concentration range for US published soil concentrations unless otherwise indicated.
(3)	Soil Cleanup Objective is the maximum of concentration range, NYSDEC published concentrations.
B	Parameter found in associated method blank.
J	Estimated value.
D	Result obtained after matrix dilution.
MDL	Method Detection Limit.
NA	Soil Cleanup Objective has not been established for indicated parameter.
TPH	Total Petroleum Hydrocarbon.
VOCs	Volatile Organic Compounds.
SVOCs	Semi-Volatile Organic Compounds.

TABLE 2.6

REPRESENTATIVE DETECTED CONTAMINANT CONCENTRATIONS
OFF-SITE PARCEL - DEEP SOIL
LEICA INC.
CHEEKTOWAGA, NEW YORK

Parameter	*Units*	*Soil Cleanup Objective(1)(2)*	*Range of Detected Concentrations*			*Number of Detections/Number of Sample Locations*
			Minimum	*Maximum*	*Mean*	
VOCs						
Acetone	µg/kg	200	4J	6J	5J	2/4
Bromomethane	µg/kg	415	2J	2J	2J	1/4
Carbon disulfide	µg/kg	2,700	1J	1J	1J	1/4
Methylene Chloride	µg/kg	100	2J	2J	2J	2/4
Toluene	µg/kg	1,500	1J	1J	1J	1/4
Trichloroethene	µg/kg	700	5J	5J	5J	1/4
Metals						
Aluminum	mg/kg	100,000	2,965	4,100	3,533	2/2
Arsenic	mg/kg	93.2	1.7	2J	1.9J	2/2
Barium	mg/kg	3,000	28.6	37.9	33.3	2/2
Calcium	mg/kg	35,000(3)	61,100	65,350	63,225	2/2
Chromium	mg/kg	1,500	7.2	7.4	7.3	2/2
Cobalt	mg/kg	60(3)	2.7	3.4	3.1	2/2
Copper	mg/kg	300	6.5	10.0	8.3	2/2
Iron	mg/kg	550,000(3)	8,040	9,240	8,640	2/2
Lead	mg/kg	500(1)	6.1	6.3	6.2	2/2
Magnesium	mg/kg	5,000(3)	25,300	26,750	26,025	2/2
Manganese	mg/kg	5,000(3)	243	285	264	2/2
Potassium	mg/kg	43,000(3)	795J	1,010	903J	2/2
Vanadium	mg/kg	300(3)	10.4	10.8	10.6	2/2
Zinc	mg/kg	300	48.4	57.0	52.7	2/2
TPH	mg/kg	NA	ND	ND	NV	0/2

Notes:

Results of investigative and duplicate samples were averaged prior to determining concentration range and mean. Averaging of investigative and duplicate results was not conducted if either result was non-detect.

(1) Soil Cleanup Objectives are based on "Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels", HWR-94-4046, NYSDEC, January 24, 1994.
(2) Soil Cleanup Objectives for metals are the maximum of the concentration range for US published soil concentrations unless otherwise indicated.
(3) Soil Cleanup Objective is the maximum of concentration range, NYSDEC published concentrations.
B Parameter found in associated method blank.
J Estimated value.
MDL Method Detection Limit.
NV No Value.
NA Soil Cleanup Objective has not been established for indicated parameter.
TPH Total Petroleum Hydrocarbon.
VOCs Volatile Organic Compounds.
SVOCs Semi-Volatile Organic Compounds.

TABLE 2.7

SUMMARY OF SUBSURFACE SOIL DETECTED INORGANIC PARAMETER RESULTS
LEICA INC.
CHEEKTOWAGA, NEW YORK

	Lake Sediments					*Sand Layer*				
	No. of Detections	*Range*		*Average*	*Standard Deviation*	*No. of Detections*	*Range*		*Average*	*Standard Deviation*
Parameter (mg/kg)		*Minimum*	*Maximum*				*Minimum*	*Maximum*		
Aluminum	16	4,310	29,600	14,591	6,022	5	1,600	5,800	3,732	1,509
Arsenic	16	0.88	8.3	4.1	2.5	5	0.98	2.8	1.8	0.7
Barium	16	39.5	357	156	89	5	15.9	43.3	32.6	10.4
Beryllium	9	0.4	2.6	1.0	0.7	ND	NA	NA	NA	NA
Cadmium	7	0.77	2.9	1.9	0.7	1	0.89	0.89	0.89	NA
Calcium	16	3,660	120,000	54,056	35,895	5	52,000	81,800	67,040	11,510
Chromium	19	9.1	41	21	8.2	5	6.7	9.6	7.9	1.1
Cobalt	16	3.9	13.1	9.1	2.7	4	2.8	4.8	3.5	0.9
Copper	16	9.4	71.8	27.8	16.2	5	5.3	10.9	8.3	2.3
Iron	16	9,430	32,000	21,558	6,129	5	4,150	11,200	8,268	2,577
Lead	16	6.8	346	47	83	5	6.3	12.4	7.8	2.6
Magnesium	16	3,750	28,300	14,437	6,806	5	22,100	37,500	28,460	5,794
Manganese	16	182	2,700	722	585	5	213	346	275	48
Mercury	3	0.07	0.37	0.23	0.15	ND	NA	NA	NA	NA
Nickel	18	12	54	26	9.9	1	7.8	7.8	7.8	NA
Potassium	16	911	2,940	2,007	561	5	398	1,530	980	403
Selenium	1	0.99J	0.99J	0.99J	NA	ND	NA	NA	NA	NA
Sodium	8	269	1,010	457	230	ND	NA	NA	NA	NA
Thallium	4	0.3	0.62	0.42	0.14	ND	NA	NA	NA	NA
Vanadium	16	11.1	41.3	25.1	7.5	5	5.6	13.6	10.2	2.9
Zinc	19	24	445	117	91	6	44.9	61	53.6	5.7

Notes:

ND - Not Detected
NA - Not Applicable
The higher parameter result of an investigative sample and its duplicate sample was used in calculations, except for the copper concentration at BH-ASTI-93. The copper concentration in the investigative sample (545 J mg/kg) was deemed anomalous, and the duplicate sample result (42.3 J mg/kg) was used.

TABLE 2.8

OVERBURDEN GROUNDWATER DETECTED COMPOUND SUMMARY
NORTHEAST AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or Guidance Values (1)	*MW-1*		*MW-15*		*MW-16*			*MW-18*	
		1/7/94	*3/24/94*	*1/6/94*	*3/24/94*	*1/7/94*	*3/24/94*	*03/24/94*	*4/15/94*	*4/15/94*
Volatiles (µg/L)										
1,1,1-Trichloroethane	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	87J	77J	79J	ND (10)	ND (10)
1,1-Dichloroethane	5 (S)	ND (10)	ND (10)	14	ND (10)	6,500D	3,000D	3,300D	ND (10)	ND (10)
1,1-Dichloroethene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	630JD	240JD	280JD	ND (10)	ND (10)
1,2-Dichloroethene (total)	5 (S)	2J	ND (10)	3J	ND (10)	8,200D	3,900D	4,200D	ND (10)	ND (10)
Acetone	50 (G)	ND (10)	ND (10)J	74	4J	ND (10)	ND (10)J	ND (10)J	ND (10)	ND (10)
Benzene	0.7 (S)	ND (10)	ND (10)	ND (10)	ND (10)	1J	1J	2J	ND (10)	ND (10)
Chloroethane	5 (S)	ND (10)	ND (10)J	ND (10)	ND (10)J	ND (10)	5J	ND (10)J	ND (10)	ND (10)
Chloroform	7 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	1J	2J
Ethylbenzene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	2,000D	620D	670D	ND (10)	ND (10)
Methylene chloride	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	9J	9J	ND (10)	ND (10)
Tetrachloroethene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	3J	3J	3J	ND (10)	ND (10)
Toluene	5 (S)	1J	ND (10)	1J	ND (10)	1,100JD	160JD	180JD	ND (10)	ND (10)
Trichloroethene	5 (S)	3J	ND (10)	ND (10)	ND (10)	6,800D	2,100D	2,400D	ND (10)	ND (10)
Vinyl chloride	5 (S)	ND (10)	ND (10)J	ND (10)	ND (10)J	75J	ND (500)D	ND (500)D	ND (10)	ND (10)
Xylene (total)	5 (S)	ND (10)	ND (10)	1J	ND (10)	5,200D	1,300D	1,500D	ND (10)	ND (10)
Semi-Volatiles (µg/L)										
2,4-Dimethylphenol	1 (S)	NA	NA	NA	NA	26	NA	NA	NA	NA
2-Methylphenol	1 (S)	NA	NA	NA	NA	4J	NA	NA	NA	NA
4-Chloro-3-methylphenol	1 (S)	NA	NA	NA	NA	19J	NA	NA	NA	NA
4-Methylphenol	1 (S)	NA	NA	NA	NA	5J	NA	NA	NA	NA
Naphthalene	10 (G)	NA	NA	NA	NA	42	NA	NA	NA	NA

TABLE 2.8

OVERBURDEN GROUNDWATER DETECTED COMPOUND SUMMARY
NORTHEAST AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or Guidance Values (1)	*MW-1*		*MW-15*		*MW-16*			*MW-18*	
		1/7/94	*3/24/94*	*1/6/94*	*3/24/94*	*1/7/94*	*3/24/94*	*03/24/94*	*4/15/94*	*4/15/94*
Metals (µg/L)										
Aluminum	NS/G	NA	NA	NA	NA	9,250	NA	NA	NA	NA
Arsenic	25 (S)	NA	NA	NA	NA	6	NA	NA	NA	NA
Barium	1,000 (S)	NA	NA	NA	NA	266	NA	NA	NA	NA
Calcium	NS/G	NA	NA	NA	NA	168,000	NA	NA	NA	NA
Chromium	50 (S)	NA	NA	NA	NA	83	NA	NA	NA	NA
Cobalt	NS/G	NA	NA	NA	NA	10	NA	NA	NA	NA
Copper	200 (S)	NA	NA	NA	NA	53.0	NA	NA	NA	NA
Iron	300 (S)	NA	NA	NA	NA	21,600	NA	NA	NA	NA
Lead	25 (S)	NA	NA	NA	NA	18	NA	NA	NA	NA
Magnesium	35,000 (G)	NA	NA	NA	NA	55,700	NA	NA	NA	NA
Manganese	300 (S)	NA	NA	NA	NA	599	NA	NA	NA	NA
Nickel	NS/G	NA	NA	NA	NA	175	NA	NA	NA	NA
Potassium	NS/G	NA	NA	NA	NA	6,850	NA	NA	NA	NA
Sodium	20,000 (S)	NA	NA	NA	NA	361,000	NA	NA	NA	NA
Vanadium	NS/G	NA	NA	NA	NA	12	NA	NA	NA	NA
Zinc	300 (S)	NA	NA	NA	NA	132J	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/L)										
Total Petroleum Hydrocarbons	NS/G	ND (2.5)	NA	ND (2.5)	NA	ND (2.5)	NA	NA	NA	NA

Notes:

(1)	NYS groundwater standards or guidance values are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
Dup	Field Duplicate
J	Associated value is estimated
NA	Not Analyzed
ND	Not-detected at or above the associated value
R	Rejected value
▨	Concentration exceeds NYS standards or guidance values for Class GA groundwater (Ambient Water Quality Standards and Guidance Values, October 1993).

TABLE 2.9

OVERBURDEN GROUNDWATER DETECTED COMPOUND SUMMARY
SOUTHEAST AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or Guidance Values (1)	*MW-2*			*MW-3*		*MW-4*	*MW-5*		*MW-6*	*MW-7*
		1/5/94	*3/22/94*	*3/22/94 Dup*	*1/5/94*	*3/22/94*	*1/10/94*	*1/5/94*	*3/22/94*	*1/5/94*	*1/7/94*
Volatiles (ug/L)											
1,1-Dichloroethene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	66	ND (10)	ND (10)	22	ND (1,000)
1,2-Dichloroethene (total)	5 (S)	2J	4J	4J	ND (10)	ND (10)	180,000D	6J	ND (10)	4,000D	6,500
Acetone	50 (G)	ND (10)J	ND (10)	ND (10)	ND (10)J	ND (10)	13	13J	ND (10)	ND (10)	ND (1,000)
Benzene	0.7 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	2J	ND (10)	ND (10)	4J	190J
Carbon disulfide	NS/G	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	3J	ND (10)	ND (10)	ND (10)	ND (1,000)
Ethylbenzene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	13	ND (10)	ND (10)	ND (10)	120J
Methylene chloride	5 (S)	ND (10)	ND (10)J	ND (10)J	ND (10)	ND (10)J	ND (10)	ND (10)	ND (10)J	ND (10)	ND (1,000)
Tetrachloroethene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (1,000)
Toluene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (22)	ND (10)	ND (10)	3J	210J
Trichloroethene	5 (S)	39	40	41	ND (10)	ND (10)	110,000D	ND (10)	ND (10)	890D	ND (1,000)
Vinyl chloride	5 (S)	ND (10)	ND (10)J	ND (10)J	ND (10)	ND (10)J	28,000D	ND (10)	ND (10)J	450JD	4,400D
Xylene (total)	5 (S)	2J	ND (10)	ND (10)	2J	ND (10)	69	1J	ND (10)	ND (10)	240J
Semi-Volatiles (ug/L)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals (ug/L)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/L)											
Total Petroleum Hydrocarbons	NS/G	ND (2.5)	NA	NA	ND (2.5)	NA	ND (2.5)	ND (2.5)	NA	ND (2.5)	ND (2.5)

Notes:

(1)	NYS groundwater standards or guidance values are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
Dup	Field Duplicate
J	Associated value is estimated
NA	Not Analyzed
ND	Not-detected at or above the associated value
R	Rejected value
▨	Concentration exceeds NYS standards or guidance values for Class GA groundwater (Ambient Water Quality Standards and Guidance Values, October 1993).

TABLE 2.9

OVERBURDEN GROUNDWATER DETECTED COMPOUND SUMMARY
SOUTHEAST AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or Guidance Values (1)	*MW-8*		*MW-9*	*MW-10*		*MW-11*	*MW-11-NAPL*	*MW-12*
		1/11/94	*1/11/94 NAPL*	*1/7/94*	*1/11/94*	*1/11/94 Dup*	*1/10/94*	*1/10/94*	*1/10/94*
Volatiles (ug/L)									
1,1-Dichloroethene	5 (S)	ND (50,000)D	ND (50,000)D	ND (10)	160J	180J	ND (50,000)D	ND (1,000,000)	ND (10)J
1,2-Dichloroethene (total)	5 (S)	370,000D	390,000D	63	51,000DJ	90,000DJ	470,000D	22,000,000	53,000D
Acetone	50 (G)	ND (50,000)DJ	ND (50,000)DJ	ND (10)	18U	ND (10)J	ND (50,000)DJ	ND (1,000,000)	ND (10)J
Benzene	0.7 (S)	8J	7J	ND (10)	ND (10)J	ND (10)J	R	ND (1,000,000)	ND (10)J
Carbon disulfide	NS/G	R	ND (10)J	ND (10)	ND (10)J	ND (10)J	R	ND (1,000,000)	ND (10)J
Ethylbenzene	5 (S)	130J	84J	ND (10)	17J	19J	ND (50,000)D	920,000J	17J
Methylene chloride	5 (S)	R	ND (10)J	ND (10)	ND (10)J	ND (10)J	120J	ND (1,000,000)	ND (10)J
Tetrachloroethene	5 (S)	R	23J	ND (10)	ND (10)J	ND (10)J	50J	160,000J	ND (10)J
Toluene	5 (S)	ND (50,000)D	ND (50,000)D	1J	49J	54J	ND (50,000)D	ND (1,000,000)	69J
Trichloroethene	5 (S)	71,000D	36,000DJ	2J	ND (50,000)DJ	38,000JD	250,000D	330,000,000D	86,000D
Vinyl chloride	5 (S)	54,000DJ	34,000DJ	140	ND (50,000)DJ	15,700JD	48,000JD	1,400,000	ND (10)J
Xylene (total)	5 (S)	21,000JD	ND (50,000)D	3J	100J	100J	ND (50,000)D	6,600,000	140J
Semi-Volatiles (ug/L)		NA	NA	NA	NA	NA	NA	NA	NA
Metals (ug/L)		NA	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/L)									
Total Petroleum Hydrocarbons	NS/G	67.4	NA	ND (2.5)	3.2	ND (2.5)J	192.0	NA	ND (2.5)J

Notes:

(1)	NYS groundwater standards or guidance values are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
Dup	Field Duplicate
J	Associated value is estimated
NA	Not Analyzed
ND	Not-detected at or above the associated value
R	Rejected value
▨	Concentration exceeds NYS standards or guidance values for Class GA groundwater (Ambient Water Quality Standards and Guidance Values, October 1993).

TABLE 2.9

OVERBURDEN GROUNDWATER DETECTED COMPOUND SUMMARY
SOUTHEAST AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or Guidance Values (1)	*MW-19*	*MW-20*			*MW-21*	
		4/14/94	*4/14/94*	*4/14/94 Dup*	*4/14/94 DEC Split*	*04/14/94*	*4/14/94 DEC Split*
Volatiles (ug/L)							
1,1-Dichloroethene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)
1,2-Dichloroethene (total)	5 (S)	▨ 52	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)
Acetone	50 (G)	ND (10)J	ND (10)J	ND (10)	ND (10)	ND (10)J	ND (10)
Benzene	0.7 (S)	▨ 1J	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)
Carbon disulfide	NS/G	ND (10)J	ND (10)J	ND (10)	ND (10)	ND (10)J	ND (10)
Ethylbenzene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)
Methylene chloride	5 (S)	ND (10)J	ND (10)J	ND (10)	ND (10)	ND (10)J	ND (10)
Tetrachloroethene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)
Toluene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)
Trichloroethene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)
Vinyl chloride	5 (S)	▨ 17	ND (10)	ND (10)	ND (10)	▨ 5J	▨ 6J
Xylene (total)	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)
Semi-Volatiles (ug/L)		NA	NA	NA	NA	NA	NA
Metals (ug/L)		NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/L)							
Total Petroleum Hydrocarbons	NS/G	NA	NA	NA	NA	NA	NA

Notes:

(1)	NYS groundwater standards or guidance values are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
Dup	Field Duplicate
J	Associated value is estimated
NA	Not Analyzed
ND	Not-detected at or above the associated value
R	Rejected value
▨	Concentration exceeds NYS standards or guidance values for Class GA groundwater (Ambient Water Quality Standards and Guidance Values, October 1

TABLE 2.10

OVERBURDEN GROUNDWATER DETECTED COMPOUND SUMMARY
OFF-SITE PARCEL
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or Guidance Values (1)	*MW-13*			*MW-14*					*MW-22*		*MW-23*	
		1/6/94	*1/6/94 DEC Split*	*3/23/94*	*1/6/94*	*1/6/94 Dup*	*1/6/94 DEC Split*	*1/6/94 DEC Split*	*3/23/94*	*04/14/94*	*4/14/94 DEC Split*	*4/14/94*	*4/14/94 DEC Split*
Volatiles (µg/L)													
1,1-Dichloroethene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	1J	ND (100)	2J	ND (10)	ND (10)	ND (10)	ND (10)
1,2-Dichloroethene (total)	5 (S)	2J	ND (10)	ND (10)	▨ 580D	▨ 650D	▨ 950 E	▨ 900D	▨ 690D	▨ 15	ND (10)	ND (10)	ND (10)
2-Butanone	50 (G)	ND (10)	ND (10)	ND (10)J	ND (10)J	ND (10)J	ND (10)	ND (100)	7JD	ND (10)	ND (10)	ND (10)	ND (10)
Acetone	50 (G)	ND (14)	ND (10)	ND (10)J	ND (10)	ND (10)	ND (10)	ND (100)	3J	ND (10)	ND (10)	ND (10)	ND (10)
Benzene	0.7 (S)	ND (10)	ND (10)	ND (10)	▨ 2J	▨ 1J	▨ 1J	ND (100)	▨ 1J	ND (10)	ND (10)	ND (10)	ND (10)
Bromomethane	5 (S)	ND (10)	ND (10)	ND (10)J	ND (10)	ND (10)	ND (10)	ND (100)	▨ 16JD	ND (10)	ND (10)	ND (10)	ND (10)
Chloromethane	5 (S)	ND (10)	ND (10)	ND (10)J	ND (10)	ND (10)	ND (10)	ND (100)	▨ 25JD	ND (10)	ND (10)	ND (10)	ND (10)
Methylene chloride	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (100)	ND (10)	1J	ND (10)	ND (10)	ND (10)
Trichloroethene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (100)	ND (10)	▨ 16	ND (10)	ND (10)	ND (10)
Vinyl chloride	5 (S)	ND (10)	2J	ND (10)J	▨ 8J	▨ 8J	▨ 13	ND (100)	▨ 11J	ND (10)	ND (10)	ND (10)	ND (10)
Semi-Volatiles (µg/L)		ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA

Notes:

(1)	NYS groundwater standards or guidance values are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
Dup	Field Duplicate
J	Associated value is estimated
NA	Not Analyzed
ND	Not-detected at or above the associated value
R	Rejected value
▨	Concentration exceeds NYS standards or guidance values for Class GA groundwater (Ambient Water Quality Standards and Guidance Values, October 1993).

TABLE 2.10

OVERBURDEN GROUNDWATER DETECTED COMPOUND SUMMARY
OFF-SITE PARCEL
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or <u>Guidance Values (1)</u>	*MW-13*			*MW-14*					*MW-22*		*MW-23*	
		1/6/94	*1/6/94 DEC Split*	*3/23/94*	*1/6/94*	*1/6/94 Dup*	*1/6/94 DEC Split*	*1/6/94 DEC Split*	*3/23/94*	*04/14/94*	*4/14/94 DEC Split*	*4/14/94*	*4/14/94 DEC Split*
<u>Metals (µg/L)</u>													
Aluminum	NS/G	6,970	NA	NA	27,200J	39,800J	NA	NA	NA	NA	NA	NA	NA
Arsenic	25 (S)	2	NA	NA	9	14	NA	NA	NA	NA	NA	NA	NA
Barium	1,000 (S)	245	NA	NA	251	352	NA	NA	NA	NA	NA	NA	NA
Calcium	NS/G	186,000	NA	NA	466,000	584,000	NA	NA	NA	NA	NA	NA	NA
Chromium	50 (S)	53	NA	NA	73	92	NA	NA	NA	NA	NA	NA	NA
Cobalt	NS/G	8	NA	NA	16	24	NA	NA	NA	NA	NA	NA	NA
Copper	200 (S)	22	NA	NA	75	88	NA	NA	NA	NA	NA	NA	NA
Iron	300 (S)	12,700	NA	NA	41,600J	60,900J	NA	NA	NA	NA	NA	NA	NA
Lead	25 (S)	ND (10.4)	NA	NA	65.6J	112J	NA	NA	NA	NA	NA	NA	NA
Magnesium	35,000 (G)	81,900	NA	NA	251,000	290,000	NA	NA	NA	NA	NA	NA	NA
Manganese	300 (S)	254	NA	NA	1,390	1,850	NA	NA	NA	NA	NA	NA	NA
Nickel	NS/G	70.0	NA	NA	128	138	NA	NA	NA	NA	NA	NA	NA
Potassium	NS/G	3,970	NA	NA	10,900	13,800	NA	NA	NA	NA	NA	NA	NA
Sodium	20,000 (S)	16,200	NA	NA	78,800	77,100	NA	NA	NA	NA	NA	NA	NA
Vanadium	NS/G	9.0B	NA	NA	38.3B	62	NA	NA	NA	NA	NA	NA	NA
Zinc	300 (S)	35.7J	NA	NA	207J	257J	NA	NA	NA	NA	NA	NA	NA
<u>Petroleum Hydrocarbons (mg/L)</u>													
Total Petroleum Hydrocarbons	NS/G	3.5	NA	NA	ND (2.5)	ND (2.5)	NA	NA	NA	NA	NA	NA	NA

<u>Notes:</u>

(1)	NYS groundwater standards or guidance values are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
Dup	Field Duplicate
J	Associated value is estimated
NA	Not Analyzed
ND	Not-detected at or above the associated value
R	Rejected value
▨	Concentration exceeds NYS standards or guidance values for Class GA groundwater (Ambient Water Quality Standards and Guidance Values, October 1993).

TABLE 2.11

BEDROCK GROUNDWATER DETECTED COMPOUND SUMMARY
NORTHEAST AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or Guidance Values (1)	*MW-E*	*MW-1A*	*MW-15A*		*MW-16A*	*MW-17A*	
		1/14/94	*4/15/94*	*1/14/94*	*3/24/94*	*04/18/94*	*4/15/94*	*4/15/94 Dup*
Volatiles (µg/L)								
1,1,1-Trichloroethane	5 (S)	ND (10)	ND (10)	ND (10)	8J	110,000D	ND (10)	ND (10)
1,1,2-Trichloroethane	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	13	ND (10)	ND (10)
1,1-Dichloroethane	5 (S)	ND (10)	ND (10)	19	23	4,400JD	ND (10)	ND (10)
1,1-Dichloroethene	5 (S)	ND (10)	ND (10)	5J	4J	1,200JD	ND (10)	ND (10)
1,2-Dichloroethene (total)	5 (S)	6J	14	650D	490D	34,000D	31	33
2-Butanone	50 (G)	ND (10)	ND (10)	ND (10)J	ND (10)J	43	ND (10)	ND (10)
4-Methyl-2-pentanone	NS/G	ND (10)	ND (10)	ND (10)	ND (10)	91	ND (10)	ND (10)
Acetone	50 (G)	ND (10)	ND (10)	4J	ND (10)J	ND (10000)D	ND (10)	ND (10)
Benzene	0.7 (S)	ND (10)	ND (10)	1J	ND (10)	18	ND (10)	ND (10)
Bromomethane	5 (S)	ND (10)	ND (10)	ND (10)	5JD	ND (10)	ND (10)	ND (10)
Carbon disulfide	NS/G	ND (10)	ND (10)	ND (10)	ND (10)	7J	9J	9J
Chlorobenzene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	2J	ND (10)	ND (10)
Chloroethane	5 (S)	ND (10)	ND (10)	ND (10)J	ND (10)J	160	ND (10)	ND (10)
Chloroform	7 (S)	ND (10)	ND (10)	ND (10)	ND (10)	8J	ND (10)	ND (10)
Chloromethane	5 (S)	ND (10)J	ND (10)	ND (10)J	8JD	ND (10)	ND (10)	ND (10)
Ethylbenzene	5 (S)	ND (10)	ND (10)	ND (10)	2J	3,000JD	ND (10)	ND (10)
Methylene chloride	5 (S)	ND (10)	ND (10)	ND (10)	1J	18	ND (10)	1J
Tetrachloroethene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	33	ND (10)	ND (10)
Toluene	5 (S)	ND (10)	ND (10)	3J	1J	2,700JD	ND (10)	ND (10)
Trichloroethene	5 (S)	3J	1J	8J	14	88,000D	32	25
Vinyl chloride	5 (S)	ND (10)	ND (10)	300D	200D	4,700JD	ND (10)	ND (10)
Xylene (total)	5 (S)	ND (10)	ND (10)	4J	2J	15,000D	ND (10)	ND (10)
Semi-Volatiles (µg/L)		ND	NA	ND	NA	NA	NA	NA

Notes:

(1)	NYS groundwater standards or guidance values are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
Dup	Field Duplicate
J	Associated value is estimated
NA	Not Analyzed
ND	Not-detected at or above the associated value
R	Rejected value
▨	Concentration exceeds NYS standards or guidance values for Class GA groundwater (Ambient Water Quality Standards and Guidance Values, October 1993).

TABLE 2.11

BEDROCK GROUNDWATER DETECTED COMPOUND SUMMARY
NORTHEAST AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or Guidance Values (1)	*MW-E*	*MW-1A*	*MW-15A*		*MW-16A*	*MW-17A*	
		1/14/94	*4/15/94*	*1/14/94*	*3/24/94*	*04/18/94*	*4/15/94*	*4/15/94 Dup*
Metals (ug/L)								
Aluminum	NS/G	ND (49.7)	NA	450	NA	NA	NA	NA
Arsenic	25 (S)	4.8J	NA	5	NA	NA	NA	NA
Barium	1,000 (S)	95	NA	139	NA	NA	NA	NA
Calcium	NS/G	80,500	NA	135,000	NA	NA	NA	NA
Copper	200 (S)	ND (3.6)	NA	17	NA	NA	NA	NA
Iron	300 (S)	5,620	NA	2,610	NA	NA	NA	NA
Magnesium	35,000 (G)	32,300	NA	60,800	NA	NA	NA	NA
Manganese	300 (S)	145	NA	66.0	NA	NA	NA	NA
Potassium	NS/G	1,630	NA	3,130	NA	NA	NA	NA
Sodium	20,000 (S)	133,000	NA	154,000	NA	NA	NA	NA
Zinc	300 (S)	91.1J	NA	ND (20.4)	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/L)								
Total Petroleum Hydrocarbons	NS/G	ND (2.5)	NA	ND (2.5)	NA	NA	NA	NA

Notes:

(1)	NYS groundwater standards or guidance values are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
Dup	Field Duplicate
J	Associated value is estimated
NA	Not Analyzed
ND	Not-detected at or above the associated value
R	Rejected value
▨	Concentration exceeds NYS standards or guidance values for Class GA groundwater (Ambient Water Quality Standards and Guidance Values, October 1993).

TABLE 2.12

BEDROCK GROUNDWATER DETECTED COMPOUND SUMMARY
SOUTHEAST AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or Guidance Values (1)	*MW-2A*		*MW-5A*		*MW-6A*	
		1/13/94	*3/22/94*	*1/13/94*	*3/24/94*	*1/12/94*	*03/24/94*
Volatiles (µg/L)							
1,1,1-Trichloroethane	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)J	18J
1,1-Dichloroethane	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	6J	14J
1,1-Dichloroethene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	140J	140J
1,2-Dichloroethene (total)	5 (S)	ND (10)	4J	ND (10)	3J	390,000D	69,000D
4-Methyl-2-pentanone	NS/G	ND (10)	ND (10)	ND (10)	ND (10)	7J	12J
Acetone	50 (G)	ND (10)J	ND (10)	3J	ND (10)J	16J	15J
Benzene	0.7 (S)	ND (10)	ND (10)	ND (10)	ND (10)	38J	67J
Carbon disulfide	NS/G	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)J	3J
Ethylbenzene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	140J	ND (5,000)D
Methylene chloride	5 (S)	ND (10)	ND (10)J	ND (10)	ND (10)	ND (10)J	2J
Toluene	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	180J	ND (5,000)D
Trichloroethene	5 (S)	8J	42	ND (10)	ND (10)	90J	160J
Vinyl chloride	5 (S)	ND (10)J	ND (10)J	ND (10)J	ND (10)J	110,000D	19,000D
Xylene (total)	5 (S)	ND (10)	ND (10)	ND (10)	ND (10)	7,000JD	ND (5,000)D
Semi-Volatiles (µg/L)							
1,2-Dichlorobenzene	4.7 (S)	ND (10)	NA	ND (10)	NA	4J	NA
2,4-Dimethylphenol	1 (S)	ND (10)	NA	ND (10)	NA	11	NA
2-Methylphenol	1 (S)	ND (10)	NA	ND (10)	NA	20	NA
4-Methylphenol	1 (S)	ND (10)	NA	ND (10)	NA	62	NA
bis(2-Ethylhexyl)phthalate	50 (S)	40	NA	3J	NA	2J	NA
Naphthalene	10 (G)	ND (10)	NA	ND (10)	NA	3J	NA

Notes:

(1)	NYS groundwater standards or guidance values are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
Dup	Field Duplicate
J	Associated value is estimated
NA	Not Analyzed
ND	Not-detected at or above the associated value
R	Rejected value
▨	Concentration exceeds NYS standards or guidance values for Class GA groundwater (Ambient Water Quality Standards and Guidance Values, October 1993).

TABLE 2.12

BEDROCK GROUNDWATER DETECTED COMPOUND SUMMARY
SOUTHEAST AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or Guidance Values (1)	*MW-2A*		*MW-5A*		*MW-6A*	
		1/13/94	*3/22/94*	*1/13/94*	*3/24/94*	*1/12/94*	*03/24/94*
Metals (µg/L)							
Aluminum	NS/G	732	NA	8,810	NA	231	NA
Arsenic	25 (S)	3.6J	NA	4	NA	2.0J	NA
Barium	1,000 (S)	59	NA	296	NA	458	NA
Calcium	NS/G	105,000	NA	179,000	NA	134,000	NA
Chromium	50 (S)	9	NA	14	NA	10	NA
Cobalt	NS/G	32	NA	4	NA	3	NA
Copper	200 (S)	ND (8.5)	NA	ND (12.3)	NA	25	NA
Iron	300 (S)	8,330	NA	13,800	NA	3,750	NA
Lead	25 (S)	ND (2.7)	NA	13	NA	ND (5.2)	NA
Magnesium	35,000 (G)	38,400	NA	147,000	NA	93,000	NA
Manganese	300 (S)	93	NA	414	NA	80	NA
Nickel	NS/G	7	NA	7	NA	18	NA
Potassium	NS/G	3,740	NA	10,500	NA	6,360	NA
Sodium	20,000 (S)	11,600	NA	82,700	NA	99,200	NA
Vanadium	NS/G	ND (2.0)	NA	7	NA	ND (2.0)	NA
Zinc	300 (S)	ND (22.3)	NA	66.8J	NA	596J	NA
Petroleum Hydrocarbons (mg/L)							
Total Petroleum Hydrocarbons	NS/G	ND (2.5)	NA	ND (2.5)	NA	ND (2.5)	NA

Notes:

(1)	NYS groundwater standards or guidance values are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
Dup	Field Duplicate
J	Associated value is estimated
NA	Not Analyzed
ND	Not-detected at or above the associated value
R	Rejected value
▨	Concentration exceeds NYS standards or guidance values for Class GA groundwater (Ambient Water Quality Standards and Guidance Values, October 1993).

TABLE 2.13

BEDROCK GROUNDWATER DETECTED COMPOUND SUMMARY
OFF-SITE PARCEL
LEICA INC.
CHEEKTOWAGA, NEW YORK

	NYS Groundwater Standards or Guidance Values (1)	*MW-13A*			*MW-14A*		
		1/13/94	*1/13/94 DEC Split*	*3/23/94*	*1/13/94*	*1/13/94 DEC Split*	*3/23/94*
Volatiles (µg/L)							
1,2-Dichloroethene (total)	5 (S)	25	28	19	46	57	64
Toluene	5 (S)	ND (10)	ND (10)	ND (10)	3J	ND (10)	ND (10)
Trichloroethene	5 (S)	3J	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)
Vinyl chloride	5 (S)	ND (10)	2J	1J	28J	28	25J
Xylene (total)	5 (S)	3J	2J	2J	3J	0.8J	ND (10)
Semi-Volatiles (µg/L)							
bis(2-Ethylhexyl)phthalate	50 (S)	1J	NA	NA	2J	NA	NA
Metals (µg/L)							
Aluminum	NS/G	480	NA	NA	636	NA	NA
Arsenic	25 (S)	2.0	NA	NA	3	NA	NA
Barium	1,000 (S)	230	NA	NA	214	NA	NA
Calcium	NS/G	436,000	NA	NA	165,000	NA	NA
Chromium	50 (S)	ND (6.4)	NA	NA	11	NA	NA
Copper	200 (S)	ND (9.3)	NA	NA	14	NA	NA
Iron	300 (S)	4,670	NA	NA	5,210	NA	NA
Magnesium	35,000 (G)	68,100	NA	NA	75,900	NA	NA
Manganese	300 (S)	173	NA	NA	102	NA	NA
Nickel	NS/G	6	NA	NA	6.0	NA	NA
Potassium	NS/G	2,150	NA	NA	3,450	NA	NA
Sodium	20,000 (S)	10,400	NA	NA	20,400	NA	NA
Zinc	300 (S)	ND (15.7)	NA	NA	24.6J	NA	NA
Petroleum Hydrocarbons (mg/L)							
Total Petroleum Hydrocarbons	NS/G	ND (2.5)	NA	NA	ND (2.5)	NA	NA

Notes:

(1)	NYS groundwater standards or guidance values are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
Dup	Field Duplicate
J	Associated value is estimated
NA	Not Analyzed
ND	Not-detected at or above the associated value
R	Rejected value
▨	Concentration exceeds NYS standards or guidance values for Class GA groundwater (Ambient Water Quality Standards and Guidance Values, October 1993).

TABLE 2.14

SURFACE SOIL AND SURFACE WATER DETECTED COMPOUND SUMMARY
LEICA INC.
CHEEKTOWAGA, NEW YORK

Surface Water Parameter	*Class C Surface Water Standard (1) (µg/L)*	*Surface Water Sample SW-1 11/10/93 (µg/L)*
VOCs		
Acetone	NS/G	5 J
SVOCs		
Bis (2-ethylhexyl) phthalate	0.6 (S)	1 J
Metals		
Aluminum	100 (S)	611
Arsenic	190 (S)	18.5
Barium	NS/G	233
Cadmium	2.1 (S)(2)	6.8
Calcium	NS/G	70,700
Copper	22.6 (S)(2)	27
Iron	300	899
Lead	8.5 (S)	56.2 J
Magnesium	NS/G	7,970
Manganese	NS/G	344
Potassium	NS/G	3,190
Sodium	NS/G	31,100
Zinc	158 (S)(2)	208

Notes:

(1) Class C surface water standards are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(2) Class C Surface Water Standard has been claculated consistent with TOGS 1.1.1 based on a calculated hardness of 215.422 mg/L as presented in the RI.
(3) Soil Cleanup Objectives are derived from "Technical and Administrative Guidance Memoradum: Determination of Soil Cleanup Objectives and Cleanup Levels", HWR-94-4046, January 24, 1994.
(4) Soil Cleanup Objectives for metals are maximum of published range for US or NYS soil with the exception of arsenic which is derived from HWR-94-4046.

(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
J	Associated value is estimated
NDx	Not-detected at or above the associated value
U	Data is unusable

TABLE 2.14

SURFACE SOIL AND SURFACE WATER DETECTED COMPOUND SUMMARY
LEICA INC.
CHEEKTOWAGA, NEW YORK

Surface Soil *Parameter*	*Soil Cleanup Objective (3)* *(µg/kg)*	*Surface Soil Sample* *SED-1* *11/10/93* *(µg/kg)*
VOCs		
Trichloroethene	700	8 J
SVOCs		
Naphthalene	13,000	2,700
2-Methylnaphthalene	36,400	3,500
Acenaphthylene	41,000	330 J
Acenaphthene	50,000	560 J
Dibenzofuran	6,200	1,200
Fluorene	50,000	660 J
Phenanthrene	50,000	13,000 D
Anthracene	50,000	1,500
Carbazole	50,000	5,200 J
Di-n-butylphthalate	8,100	320 J
Fluoranthene	50,000	25,000 D
Pyrene	50,000	18,000 D
Butylbenzylphthalate	50,000	600 J
Benzo(a)anthracene	224	8,400 JD
Chrysene	400	8,100
bis(2-Ethylhexyl)phthalate	50,000	ND (7,700) U
Benzo(b)fluoranthene	1,100	24,000 D
Benzo(a)pyrene	61	12,000 D
Ideno(1,2,3-cd)pyrene	3,200	47,000
Dibenzo(a,h)anthracene	4	2,100
Benzo(g,h,i)perylene	50,000	4,400

Notes:

(1)	Class C surface water standards are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.
(2)	Class C Surface Water Standard has been claculated consistent with TOGS 1.1.1 based on a calculated hardness of 215.422 mg/L as presented in the RI.
(3)	Soil Cleanup Objectives are derived from "Technical and Administrative Guidance Memoradum: Determination of Soil Cleanup Objectives and Cleanup Levels", HWR-94-4046, January 24, 1994.
(4)	Soil Cleanup Objectives for metals are maximum of published range for US or NYS soil with the exception of arsenic which is derived from HWR-94-4046.
(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
J	Associated value is estimated
NDx	Not-detected at or above the associated value
U	Data is unusable

TABLE 2.14

SURFACE SOIL AND SURFACE WATER DETECTED COMPOUND SUMMARY
LEICA INC.
CHEEKTOWAGA, NEW YORK

Surface Soil *Parameter*	*Soil Cleanup Objective (3)* *(μg/kg)*	*Surface Soil Sample* *SED-1* *11/10/93* *(μg/kg)*
Metals		
Aluminum	100,000	11,000
Arsenic	7.5	109
Barium	3,000	832
Beryllium	5	1.0
Cadmium	1.1	9.8
Calcium	35,000 (10)	14,700
Chromium	1,500	99
Cobalt	60 (10)	14.7
Copper	300	280
Iron	550,000 (10)	26,700
Lead	500 (11)	1,830
Magnesium	5,000 (10)	3,160
Manganese	5,000 (10)	838
Mercury	1.5	1.1
Nickel	150	102
Potassium	43,000 (10)	1,850
Selenium	4.0	2.0
Sodium	50,000 (10)	241
Vanadium	400 (10)	65.7
Zinc	300	1,500

Notes:

(1) Class C surface water standards are derived from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation, Albany, New York, October 1993.

(2) Class C Surface Water Standard has been claculated consistent with TOGS 1.1.1 based on a calculated hardness of 215.422 mg/L as presented in the RI.

(3) Soil Cleanup Objectives are derived from "Technical and Administrative Guidance Memoradum: Determination of Soil Cleanup Objectives and Cleanup Levels", HWR-94-4046, January 24, 1994.

(4) Soil Cleanup Objectives for metals are maximum of published range for US or NYS soil with the exception of arsenic which is derived from HWR-94-4046.

(S)	Standard
(G)	Guidance Value
NS/G	No standards or guidance values have been established
D	Result obtained after matrix dilution
J	Associated value is estimated
NDx	Not-detected at or above the associated value
U	Data is unusable

TABLE 2.15

SUMMARY OF CHEMICALS OF POTENTIAL CONCERN
LEICA INC.
CHEEKTOWAGA, NEW YORK

	Groundwater		*Soil*	
Parameter	***On-Site***	***Perimeter Wells***	***Sector A***	***Sector C***
VOCs				
Acetone	x	x	x	x
Benzene	x			x
Bromodichloromethane				
Bromoform				
Bromomethane			x	
2-Butanone			x	x
Carbon Disulfide			x	x
Carbon Tetrachloride				
Chlorobenzene				
Chloroethane				
Chloroform				
Chloromethane				
Dibromochloromethane				
1,1-Dichloroethane	x			x
1,2-Dichloroethane				
1,1-Dichloroethene	x			x
1,2-Dichloroethene (Total)	x	x	x	x
1,2-Dichloropropane				
cis-1,3-Dichloropropene				
trans-1,3-Dichloropropene				
Ethylbenzene	x		x	x
2-Hexanone			x	
Methylene Chloride	x		x	x
4-Methyl-2-Pentanone				
Styrene				
1,1,2,2-Tetrachloroethane				
Tetrachloroethene	x			x
Toluene	x		x	x
1,1,1-Trichloroethane	x			x
1,1,2-Trichloroethane				
Trichloroethene	x	x	x	x
Vinyl Acetate				
Vinyl Chloride	x		x	x
Xylenes (Total)	x		x	x

TABLE 2.15

SUMMARY OF CHEMICALS OF POTENTIAL CONCERN
LEICA INC.
CHEEKTOWAGA, NEW YORK

	Groundwater		*Soil*	
Parameter	***On-Site***	***Perimeter Wells***	***Sector A***	***Sector C***
SVOCs				
Acenaphthene			x	
Acenaphthylene			x	
Anthracene			x	
Benzo (a) anthracene			x	x
Benzo (b) fluoranthene			x	x
Benzo (k) fluoranthene			x	x
Benzo (g,h,i) perylene			x	x
Benzo (a) pyrene			x	x
Bis (2-chloroethoxy) methane				
Bis (2-chloroethyl) ether				
Bis (2-chloroisopropyl) ether				
Bis (2-ethylhexyl) phthalate	x	x	x	
4-Bromophenyl phenyl ether				
Butyl benzyl phthalate			x	
Carbazole			x	
4-Chloroaniline				
2-Chloronaphthalene				
4-Chlorophenyl phenyl ether				
1-Chloropropane				
Chrysene			x	x
Dibenzo (a,h) anthracene			x	
Dibenzofuran			x	
Di-n-butyl phthalate			x	x
1,2-Dichlorobenzene	x			
1,3-Dichlorobenzene				
1,4-Dichlorobenzene				
3,3'-Dichlorobenzidine				
Diethyl phthalate				
Dimethyl phthalate				
2,4-Dinitrotoluene				
2,6-Dinitrotoluene				
Di-n-octyl phthalate				
Fluoranthene			x	x
Fluorene			x	
Hexachlorobenzene				
Hexachlorobutadiene				
Hexachlorocyclopentadiene				
Hexachloroethane				
Indeno (1,2,3-cd) pyrene			x	x

TABLE 2.15

SUMMARY OF CHEMICALS OF POTENTIAL CONCERN
LEICA INC.
CHEEKTOWAGA, NEW YORK

	Groundwater		*Soil*	
Parameter	***On-Site***	***Perimeter Wells***	***Sector A***	***Sector C***
SVOCs				
Isophorone				
2-Methylnaphthalene			x	x
Naphthalene	x		x	x
Nitrobenzene				
2-Nitroaniline				
3-Nitroaniline				
4-Nitroaniline				
N-Nitrosodiphenylamine				
N-Nitroso-di-n-propylamine				
Phenanthrene			x	x
Pyrene			x	x
1,2,4-Trichlorobenzene				
Acid Extractables				
4-Chloro-3-methylphenol	x			
2-Chlorophenol				
2,4-Dichlorophenol				
2,4-Dimethylphenol	x			x
2,4-Dinitrophenol				
4,6-Dinitro-2-methylphenol				
2-Methylphenol	x			x
4-Methylphenol	x			x
2-Nitrophenol				
4-Nitrophenol				
Pentachlorophenol				
Phenol	x			x
2,4,5-Trichlorophenol				
2,4,6-Trichlorophenol				
Metals				
Aluminum	x	x	x	x
Antimony				
Arsenic	x	x	x	x
Barium	x	x	x	x
Beryllium			x	x
Cadmium			x	x
Calcium	x	x	x	x

TABLE 2.15

SUMMARY OF CHEMICALS OF POTENTIAL CONCERN
LEICA INC.
CHEEKTOWAGA, NEW YORK

	Groundwater		*Soil*	
Parameter	***On-Site***	***Perimeter Wells***	***Sector A***	***Sector C***
Metals				
Chromium	x	x	x	x
Cobalt	x	x	x	x
Copper	x		x	x
Iron	x	x	x	x
Lead	x	x		x
Magnesium	x	x	x	x
Manganese	x	x	x	x
Mercury			x	x
Nickel	x	x	x	x
Potassium	x	x	x	x
Selenium			x	x
Silver				
Sodium	x	x	x	x
Thallium			x	x
Vanadium	x	x	x	x
Zinc	x	x	x	x

TABLE 2.16

SUMMARY OF ADDITIONAL ESTIMATED CANCER RISKS AND HAZARD INDICES
LEICA INC.
CHEEKTOWAGA, NEW YORK

	Total Estimated Additional Cancer Risk		*Hazard Indices*	
Scenario	*Mean*	*RME*	*Mean*	*RME*
SECTOR A (SOIL) :				
Cemetery Worker	1.08E-07	6.01E-06	3.64E-03	3.82E-02
Trespasser - Child	3.86E-06	2.62E-05	1.46E-01	5.42E-01
Trespasser - Older Child	1.78E-06	1.60E-05	2.63E-02	1.03E-01
Trespasser - Lifetime	5.75E-06	4.82E-05	1.72E-01	6.45E-01
SECTOR C (SOIL) :				
Construction Worker	1.33E-08	3.08E-08	5.74E-03	3.61E-02
BEDROCK GROUNDWATER (ON-SITE) :				
Drinking Water - Child	3.24E-01	7.26E-01	3.31E+03	4.40E+04
Drinking Water - Older Child/Adult	1.48E-01	1.66E+00	1.51E+03	1.01E+05
Drinking Water - Lifetime	4.72E-01	2.39E+00	4.82E+03	1.45E+05
Drinking Water - Bathing/Showering	9.44E-01	4.77E+00	9.64E+03	2.90E+05
BEDROCK GROUNDWATER (OFF-SITE) :				
Drinking Water - Child	2.83E-05	2.94E-05	4.38E+00	3.37E+01
Drinking Water - Older Child/Adult	6.07E-04	5.07E-03	1.90E+03	7.47E+04
Drinking Water - Lifetime	6.35E-04	5.10E-03	1.90E+03	7.47E+04
Drinking Water - Bathing/Showering	1.27E-03	1.02E-02	3.81E+03	1.49E+05

TABLE 3.1

NEW YORK STATE GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDELINE CONCENTRATIONS (1)

LEICA INC.

CHEEKTOWAGA, NEW YORK

	Concentration (1) (µg/L)		
	Class GA Groundwater	*Class A Surface Water*	*Class C Surface Water*
Volatile Organic Compounds			
Chloromethane	5 (S)	5 (G)	NS/G
Bromomethane	5 (S)	5 (G)	NS/G
Vinyl chloride	2 (S)	0.3 (G)	NS/G
Chloroethane	5 (S)	5 (G)	NS/G
Methylene chloride	5 (S)	5 (G)	NS/G
Acetone	50 (G)	50 (G)	NS/G
Carbon disulfide	NS/G (2)	NS/G (2)	NS/G
1,1-Dichloroethene	5 (S)	0.07 (G)	NS/G
1,1-Dichloroethane	5 (S)	5 (G)	NS/G
1,2-Dichloroethene (Total)	5 (S) (3)	5 (G) (3)	NS/G
Chloroform	7 (S)	7 (S)	NS/G
1,2-Dichloroethane	5 (S)	0.8 (S)	NS/G
2-Butanone	50 (G)	50 (G)	NS/G
1,1,1-Trichloroethane	5 (S)	5 (G)	NS/G
Carbon tetrachloride	5 (S)	0.4 (G)	NS/G
Bromodichloromethane	50 (G)	50 (G)	NS/G
1,2-Dichloropropane	5 (S)	0.5 (G)	NS/G
cis-1,3-Dichloropropene	5 (S)	5 (G)	NS/G
Trichloroethene	5 (S)	3 (G)	11 (G)
Dibromochloromethane	50 (G)	50 (G)	NS/G
1,1,2-Trichloroethane	5 (S)	0.6 (S)	NS/G
Benzene	0.7 (S)	0.7 (S)	6 (G)
trans-1,3-Dichloropropene	5 (S)	5 (G)	NS/G
Bromoform	50 (G)	50 (G)	NS/G
4-Methyl-2-pentanone	NS/G	NS/G	NS/G
2-Hexanone	50 (G)	50 (G)	NS/G
Tetrachloroethene	5 (S)	0.7 (G)	1 (G)
1,1,2,2-Tetrachloroethane	5 (S)	0.2 (G)	NS/G
Toluene	5 (S)	5 (G)	NS/G
Chlorobenzene	5 (S)	20 (S)	5 (G)
Ethylbenzene	5 (S)	5 (G)	NS/G
Styrene	5 (S)	50 (S)	NS/G
Xylenes (Total)	5 (S) (4)	5 (G) (4)	NS/G

TABLE 3.1

NEW YORK STATE GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDELINE CONCENTRATIONS (1)
LEICA INC.
CHEEKTOWAGA, NEW YORK

		Concentration (1) (µg/L)	
	Class GA Groundwater	*Class A Surface Water*	*Class C Surface Water*
Semi-Volatile Organic Compounds	***(Compounds detected at the Site)***		
Phenol	1 (S) (5)	1 (S) (5)	1 (S) 5
2-Methylphenol	1 (S) (5)	NS/G (2)	NS/G (2)
4-Methylphenol	1 (S) (5)	NS/G	NS/G
2,4-Dimethylphenol	1 (S) (5)	NS/G	NS/G
4-Chloro-3-methylphenol	1 (S) (5)	NS/G	NS/G
1,2-Dichlorobenzene	4.7 (S)	5 (S)	5 (S)
Napthalene	10 (G)	10 (S)	NS/G
Phenanthrene	50 (G)	50 (G)	NS/G
Fluoranthene	50 (G)	50 (G)	NS/G
Pyrene	50 (G)	50 (G)	NS/G
Benzo(a)anthracene	0.002 (G)	0.002 (G)	NS/G
Chrysene	0.002 (G)	0.002 (G)	NS/G
Bis(2-Ethylhexyl)phthalate	50 (S)	4 (G)	0.6 (S)
Benzo(b)fluoranthene	0.002(G)	0.002 (G)	NS/G
Benzo(k)fluoranthene	0.002 (G)	0.002 (G)	NS/G
Benzo(a)pyrene	ND (S)	0.002 (G)	0.0012 (G)
Indeno(1,2,3-cd)pyrene	0.002 (G)	0.002 (G)	NS/G
Benzo(g,h,i)perylene	NS/G	NS/G	NS/G
Di-n-butylphthalate	50 (S)	50 (G)	NS/G
Metals			
Aluminum	NS/G	100 (S)	100 (S)
Antimony	3 (G)	3 (G)	NS/G
Arsenic	25 (S)	50 (S)	190 (S)
Barium	1000 (S)	1000 (S)	NS/G
Beryllium	3 (G)	3 (G)	11 (S)
Cadmium	10 (S) (6)	10 (S) (6)	(7) (S)
Calcium	NS/G	NS/G	NS/G
Chromium	50 (S)	11 (S)	(8) (S)
Cobalt	NS/G	5 (S)	5 (S)
Copper	200 (S)	200 (S)	(9) (S)
Iron	300 (S)	300 (S)	300 (S)
Lead	25 (S)	50 (S)	(10) (S)

TABLE 3.1

NEW YORK STATE GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDELINE CONCENTRATIONS (1)
LEICA INC.
CHEEKTOWAGA, NEW YORK

	Concentration (1) (µg/L)		
	Class GA Groundwater	*Class A Surface Water*	*Class C Surface Water*
Metals (con't)			
Magnesium	35,000 (G)	35,000 (S)	NS/G
Manganese	300 (S)	300 (S)	NS/G
Mercury	2 (S)	2 (S)	0.2 (G)
Nickel	NS/G	NS/G	(11) (S)
Potassium	NS/G	NS/G	NS/G
Selenium	10 (S)	10 (S)	1 (S)
Silver	50 (S)	50 (S)	0.1 (S)
Sodium	20,000 (S)	NS/G	NS/G
Thallium	4 (G)	4 (G)	8 (S)
Vanadium	NS/G	14 (S)	14 (S)
Zinc	300 (S)	300 (S)	(13) (S)

Notes:

(1) The noted concentrations are obtained from "Ambient Water Quality Standards and Guidance Values", Technical and Operations Guidance Series (TOGS) 1.1.1, Division of Water, New York State Department of Environmental Conservation Albany, New York, October 1993, which may be applicable or appropriate and relevant to the Site.
(S) - Standard
(G) - Guidance Value

(2) NS/G - No standard or guidance values have been established.
(3) Refers to cis or trans-1,2-dichloroethene.
(4) Refers to each isomer (1,2-, 1,3- and 1,4-) invididually.
(5) Refers to sum of all phenols (phenolic compounds).
(6) Value obtained from Federal regulations 40 CFR 141.32(e) is 5 µg/l.
(7) Value is equal to exp(0.7852[ln (ppm hardness)] - 3.490)
(8) Value is equal to exp(0.819[ln (ppm hardness)] + 1.561)
(9) Value is equal to exp(0.8545[ln (ppm hardness)] - 1.465)
(10) Value is equal to exp(1.266[ln (ppm hardness)] - 4.661)
(11) Value is equal to exp(0.76 [ln (ppm hardness)] + 1.06)
(12) Refers to total unchlorinated phenol
(13) Value is equal to exp(0.85)[ln(ppm hardness)] + 0.50)

TABLE 3.2

DRAFT NEW YORK STATE
AMBIENT AIR GUIDELINE CONCENTRATIONS (1)
LEICA INC.
CHEEKTOWAGA, NEW YORK

	SGC (2) *(μg/m3)*	*AGC (3)* *(μg/m3)*
Volatile Organic Compounds		
Chloromethane	22,000 (D)	770 (D)
Bromomethane	NGC	NGC
Vinyl chloride	1,300 (T)	0.02 (E,U)
Chloroethane	630,000 (T)	63,000 (T)
Methylene chloride	41,000 (T)	27 (D,U)
Acetone	140,000 (R)	14,000 (R)
Carbon disulfide	710 (R)	7.0 (D)
1,1-Dichloroethene	2000 (T)	0.02 (E,U)
1,1-Dichloroethane	190,000 (T)	500 (E)
1,2-Dichloroethene (Total)	190,000 (T)	1,900 (T)
Chloroform	980 (R)	23.0 (R)
1,2-Dichloroethane	950 (R)	0.039 (E,U)
2-Butanone	140,000 (T)	300 (E)
1,1,1-Trichloroethane	450,000 (T)	1,000 (E)
Carbon tetrachloride	1,300 (R)	0.07 (E,U)
Bromodichloromethane	NGC	0.02 (D)
1,2-Dichloropropane	83,000 (T)	0.15 (D)
cis-1,3-Dichloropropene	NGC	NGC
Trichloroethene	33,000 (R)	0.45 (D,U)
Dibromochloromethane	NGC	0.1 (D)
1,1,2-Trichloroethane	13,000 (T)	0.06 (E,U)
Benzene	30 (P)	0.12 (E,U)
trans-1,3-Dichloropropene	NGC	NGC
Bromoform	1,200 (T)	12 (T)
4-Methyl-2-pentanone	48,000 (R)	480 (R)
2-Hexanone	NGC	NGC
Tetrachloroethene	81,000 (T)	0.075 (D,U)
1,1,2,2-Tetrachloroethane	1,600 (T)	0.02 (E,U)
Toluene	89,000 (R)	2,000 (I)
Chlorobenzene	11,000 (P)	20.0 (E)
Ethylbenzene	100,000 (T)	1,000 (T)
Styrene	51,000 (T)	510 (T)
Xylenes (Total)	100,000 (T)	300 (I)

TABLE 3.2

DRAFT NEW YORK STATE
AMBIENT AIR GUIDELINE CONCENTRATIONS (1)
LEICA INC.
CHEEKTOWAGA, NEW YORK

	SGC (2) *(µg/m3)*	*AGC (3)* *(µg/m3)*
Semi-Volatile Compounds	(compounds detected at the site)	
Phenol	4,500 (T)	9.6 (H)
2-Methylphenol	2,400 (A)	24 (A)
4-Methylphenol	2,400 (A)	24 (A)
2,4-DiMethylphenol	NGC (1)	NGC (1)
4-Chloro-3- Methylphenol	NGC	NGC
1,2-Dichlorobenzene	30,000 (T)	200 (E)
Napthalene	12,000 (T)	120 (T)
Phenanthrene	NGC	NGC
Fluoranthene	NGC	NGC
Pyrene	NGC	NGC
Benzo(a)anthracene	NGC	NGC
Chrysene	NGC	NGC
Bis(2-Ethylhexyl)Phthalate	NGC	NGC
Benzo(b)Fluoranthene	NGC	NGC
Benzo(k)Fluoranthene	NGC	NGC
Benzo(a)Pyrene	NGC	0.002 (H,U)
Indeno(1,2,3-cd)pyrene	NGC	NGC
Benzo(g,h,i)perylene	NGC	NGC
Di-n-butylphthalate	NGC	NGC
Metals		
Aluminum	NGC	NGC
Antimony	120 (T)	1.2 (T)
Arsenic	0.20 (R)	0.00023 (E,U)
Barium	120 (T)	0.5 (E)
Beryllium	.05 (R)	0.0004 (E,U)
Cadmium	0.2 (P)	0.0005 (H,U)
Calcium	NGC	NGC
Chromium	NGC	NGC
Cobalt	12 (T)	0.12 (T)
Copper	48 (T)/240 (T)	0.48 (T)/2.4 (T)
Iron	NGC	NGC
Lead	NGC	NGC
Magnesium	NGC	NGC
Manganese	240 (T)	0.30 (H)
Mercury	12 (T)/1.0 (T)	0.3 (I)/0.024 (T)

Metals (Cont'd)

TABLE 3.2

DRAFT NEW YORK STATE
AMBIENT AIR GUIDELINE CONCENTRATIONS (1)
LEICA INC.
CHEEKTOWAGA, NEW YORK

	SGC (2) (μg/m3)	*AGC (3) (μg/m3)*
Nickel	1.5 (R)	0.02 (H)
Potassium	NGC	NGC
Selenium	48 (T)	0.48 (T)
Silver	NGC	NGC
Sodium	NGC	NGC
Thallium	24 (T)	0.24 (T)
Vanadium	100 (R)	0.2 (H)
Zinc	150 (4)	50 (S)

Notes:

(1) Draft New York State Air Guide-1, Division of Air Resources, NYSDEC 1991.
NGC - No guideline concentrations have been established for these substances.

(2) SGC "Short-Term Guideline Concentration", Source:
(D) - SGC derived from NYSDEC, Division of Air Resources
(T) - SGC derived from ACGIH TLV-TWA (1990-1991)
(R) - SGC derived from NIOSH REL-TWA (1988)
(P) - SGC derived from proposed ACGIH TLV-TWA (1990-1991)
(A) - SGC based on NYSDEC structure - activity analog

(3) AGC "Annual Guideline Concentration", source:
(R) - AGC derived from NIOSH REL-TWA (1988)
(T) - AGC derived from ACGIH TLV-TWA (1990-1991)
(D) - AGC derived from NYSDEC, Division of Air Resources
(E) - AGC based on derivation by USEPA
(I) - AGC based upon RFC developed by USEPA - Integrated Risk Information System (IRIS), input pending
(H) - AGC derived by NYSDOH, Division of Environmental Health
(U) - AGC is the ambient air concentration which corresponds to an excess cancer risk of 10-6 after lifetime exposure
(A) - AGC based on NYSDEC structure-activity analog
(S) - Based on Federal or NYS Standard

(4) SCG is Federal Particulate Standard; not to be exceeded more than once per year.

TABLE 3.3

POTENTIAL SOIL CLEANUP OBJECTIVES FOR DETECTED ORGANIC COMPOUNDS LEICA INC. CHEEKTOWAGA, NEW YORK

Parameter	*Potential Soil Cleanup Objective (1) (μg/kg)*
Volatile Organic Compounds	
Acetone	200
Benzene	60
Bromomethane	415
2-Butanone	300
Carbon disulfide	2,700
Chlorobenzene	1,700
1,1-Dichloroethane	200
1,2-Dichloroethane	100
1,1-Dichloroethene	400
1,2-Dichloroethene	300 (2)
Ethylbenzene	5,500
2-Hexanone	6,750
Methylene chloride	100
4-Methyl-2-pentanone	1,000
1,1,2,2-Tetrachloroethane	600
Tetrachloroethene	1,400
1,1,1-Trichloroethane	800
Trichloroethene	700
Toluene	1,500
Vinyl chloride	200
Xylenes (Total)	1,200
SVOCs	
Acenaphthene	50,000 (3)
Acenaphthylene	41,000
Anthracene	50,000 (3)
Benzo(a)anthracene	224 or MDL (4)
Benzo(a)pyrene	61 of MDL (4)
Benzo(b)fluoranthene	1,100
Benzo(g,h,i)perylene	50,000 (3)
Benzo(k)fluoranthene	1,100
Bis(2-ethylhexyl)phthalate	50,000 (5)
Butyl benzylphthalate	400
Carbozole	50,000 (3)
Chrysene	50,000 (3)
Dibenzo(a,h)anthracene	0.014 or MDL (4)
Dibenzofuran	6,200
2,4-Dimethylphenol	585
Di-n-butylphthalate	8,100
Fluoranthene	50,000 (3)
Fluorene	50,000 (3)
Indeno(1,2,3-cd)pyrene	3,200
2-Methylnaphthalene	36,400
2-Methylphenol	100 or MDL

TABLE 3.3

POTENTIAL SOIL CLEANUP OBJECTIVES FOR DETECTED ORGANIC COMPOUNDS
LEICA INC.
CHEEKTOWAGA, NEW YORK

Parameter	*Potential Soil Cleanup Objective (1) (µg/kg)*
<u>*SVOCs*</u>	
4-Methylphenol	900
Napthalene	13,000
Phenanthrene	50,000 (3)
Phenol	30 or MDL
Pyrene	50,000 (3)

Notes:

(1) Potential Soil Cleanup Objectives were derived in accordance with "Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels", HWR-94-4046, NYSDEC, January 24, 1994. Unless otherwise indicated, the potential soil cleanup objectives were calculated as follows:
Potential Soil Cleanup Objective = foc x Cw x koc x At where:
foc = soil organic carbon content (1.0%);
Cw = groundwater standard or guidance value (µg/L);
koc = partition coefficient between water and soil (mL/g);
At = attenuation factor (100).

(2) Potential soil cleanup objective is for trans isomer.

(3) The calculated soil cleanup objective exceeds the maximum value of 50,000 µg/kg for individual SVOCs (HWR-94-4046). The maximum value of 50,000 µg/kg was, therefore, used as the soil cleanup objective for these compounds.

(4) The calculated soil cleanup objective exceeds the USEPA health based level. The more stringent health based level was, therefore, used as the soil cleanup objective for these compounds.
MDL = Method Detection Limit

(5) Due to a lack of parameter information for this compound, the maximum value of 50,000 µg/kg for individual SVOCs was used as the soil cleanup objective in accordance with HWR-94-4046.

TABLE 3.4

POTENTIAL ACTION-SPECIFIC STANDARDS, CRITERIA AND GUIDELINES
LEICA INC.
CHEEKTOWAGA, NEW YORK

	FEDERAL SCGs			NEW YORK STATE SCGs		
Activity	*Title*	*Subtitle*	*Citation*	*Title*	*Subtitle*	*Citation*
Capping	Standards for owners and operators of hazardous waste treatment, storage and disposal facilities	Closure and post-closure care Post-closure care and use of property	40 CFR 264.310 40 CFR 264.117(c)	Hazardous waste treatment, storage and disposal facility permitting requirements	–	6 NYCRR Subpart 373-1
				Final status standards for owners and operators of hazardous waste treatment, storage and disposal facilities	–	6 NYCRR Subpart 373-2
Container Storage	Standards for owners and operators of hazardous waste treatment, storage and disposal facilities	Condition of containers Compatibility of waste with containers Management of containers Inspections Containment	40 CFR 264.171 40 CFR 264.172 40 CFR 264.173 40 CFR 264.174 40 CFR 264.175	Hazardous waste treatment, storage and disposal facility permitting requirements	–	6 NYCRR Subpart 373-1
Constuction of New Landfill on Site	Standards for owners and operators of hazardous waste treatment, storage and disposal facilities	Design and operating requirements Operation and maintenance Closure and post-closure care Groundwater protection	40 CFR 264.301 40 CFR 264.303-304 40 CFR 264.310 40 CFR 264.91-100	Hazardous waste treatment, storage and disposal facility permitting requirements	–	6 NYCRR Subpart 373-1
Discharge of Treatment System Effluent	Administered permit programs: The national pollutant discharge elimination system	Establishing limitations, standards and other permit conditions	40 CFR 122.44 and State regulations approved under 40 CFR 131 Sections 303 and 307	Implementation of NPDES program in New York State Technical and Operations Guidance Series Blending policy for use of sources of drinking water	– – –	6 NYCRR Parts 750-757 – NYSDOH PWS 68
	Criteria and standards for the national pollutant discharge elimination program	Best management practices Discharge to waters of the U.S.	40 CFR 125.100 40 CFR 125.104 Sections 301, 302, and 402	Drinking water supplies Use and protection of waters	– –	Part 5 of State Sanitary Code 6 NYCRR Part 608
	Guidelines establishing test procedures for the analysis of pollutants	Identification of test procedures and alternate test procedures	40 CFR 136.1-4			
	Effluent guidelines and standards	Organic chemicals plastics and synthetic fibres	40 CFR Part 414			
	General pretreatment regulations for existing and new sources of pollution	Industrial pretreatment program requirements	40 CFR 403			
Excavation	Land disposal restrictions (also see Closure)	Treatment standards	40 CFR 268 (Subpart C)	Hazardous waste treatment, storage and disposal facility permitting requirements	–	6 NYCRR Subpart 376
Incineration Off Site	Standards for owners and operators of hazardous waste treatment, storage and disposal facilities	Waste analysis	40 CFR 264.341			
Land Treatment	Standards for owners and operators of hazardous waste treatment, storage and disposal facilities	Treatment program Design and operating requirements Unsaturated zone monitoring Special requirements for ignitable or reactive waste	40 CFR 264.271 40 CFR 264.273 40 CFR 264.278 40 CFR 264.281	Hazardous waste treatment, storage and disposal facility permitting requirements	–	6 NYCRR Subpart 373-1
				New York air pollution control regulations	General provisions Permits and certificates General prohibitions General process emission sources Air Quality Standards	6 NYCRR Part 200 6 NYCRR Part 201 6 NYCRR Part 211 6 NYCRR Part 212 6 NYCRR Part 257
Placement of Waste in Land Disposal Unit	Land disposal restrictions	Treatment standards	40 CFR 268 (Subpart C)	Hazardous waste treatment, storage and disposal facility permitting requirements	–	6 NYCRR Subpart 373-1

TABLE 3.4

POTENTIAL ACTION-SPECIFIC STANDARDS, CRITERIA AND GUIDELINES
LEICA INC.
CHEEKTOWAGA, NEW YORK

	FEDERAL SCGs			*NEW YORK STATE SCGs*		
Activity	*Title*	*Subtitle*	*Citation*	*Title*	*Subtitle*	*Citation*
Surface Water Control	Standards for owners and operators of hazardous waste treatment, storage and disposal facilities	Design and operating requirements for waste piles	40 CFR 264.251(c),(d)	Hazardous waste treatment, storage and disposal facility permitting requirements	–	6 NYCRR Subpart 373-1 6 NYCRR Part 701 and Part 703
		Design and operating requirements for land treatment	40 CFR 264.273(c),(d)			
		Design and operating requirements for landfills	40 CFR 264.301(c),(d)			
Treatment (in a unit)	Standards for owners and operators of hazardous waste treatment, storage and disposal facilities	Design and operating requirements for waste piles	40 CFR 264.251	Hazardous waste treatment, storage and disposal facility permitting requirements	–	6 NYCRR Subpart 373-1
		Design and operating requirements for thermal treatment units	40 CFR 265.373	Interim status standards for owners and operators of hazardous waste facilities	–	6 NYCRR Subpart 373-3
		Design and operating requirements for miscellaneous treatment units	40 CFR 264.601	New York air pollution control regulations	General provisions Permits and certificates	6 NYCRR Part 200 6 NYCRR Part 201
		National Ambient Air Quality Standards	40 CFR 50		General prohibitions General process emission sources Air Quality Standards	6 NYCRR Part 211 6 NYCRR Part 212 6 NYCRR Part 257
Treatment (when waste will be land disposed)	Land disposal restrictions	Identification of waste Treatment Standards Waste	40 CFR 268.10-12 40 CFR 268 (Subpart C)	Hazardous waste treatment, storage and disposal facility permitting requirements	–	6 NYCRR Subpart 373-1
		Specific prohibitions - Solvent wastes	40 CFR 268.30 RCRA Sections 3004 (d) (3), (e) (3) 42 USC 6924 (d) (3), (e) (3)	Interim status standards for owners and operators of hazardous waste facilities	–	6 NYCRR Subpart 373-3
Waste Pile	Standards for owners and operators of hazardous waste treatment, storage and disposal facilities	Design and operating requirements	40 CFR 264.251	New York air pollution control regulations	General provisions Permits and certificates General prohibitions General process emission sources	6 NYCRR Part 200 6 NYCRR Part 201 6 NYCRR Part 211 6 NYCRR Part 212
				Hazardous waste treatment, storage and disposal facility permitting requirements	–	6 NYCRR Subpart 373-1
				Interim status standards for owners and operators of hazardous waste facilities	–	6 NYCRR Subpart 373-3
Closure with Waste in Place	Standards for owners and operators of hazardous waste treatment, storage and disposal facilities	Closure and post-closure care	40 CFR 264.258			
		Post-closure care and groundwater monitoring	40 CFR 264.310			
Closure of Land Treatment Units	Standards for owners and operators of hazardous waste treatment, storage and disposal facilities	Closure of land treatment units	40 CFR 264.280	Final status standards for owners and operators of hazardous waste facilities	–	6 NYCRR Subpart 373-2
Transporting Hazardous Waste Off Site	Standards applicable to transporters of hazardous waste	–	40 CFR 263	Waste transport permits	–	6 NYCRR Part 364
				Hazardous waste manifest system and related standards for generators, transporters and facilities	–	6 NYCRR Part 372
Project Requiring Permits				NYS Uniform Procedures	–	6 NYCRR Part 621

TABLE 4.1

IDENTIFICATION OF POTENTIAL
GENERAL REMEDIAL RESPONSE ACTIONS, TECHNOLOGIES AND PROCESS OPTIONS - SOILS
LEICA INC.
CHEEKTOWAGA, NEW YORK

	General Response Actions		*Remedial Technologies*	*Process Options*
1.	No Action		--	--
2.	Limited Action	a)	Institutional Controls	i) Restricted Site Access and Limit Future Land Use
3.	Physical Containment Action	a)	Capping	i) Soil Cap Meeting Standards for a Sanitary Landfill ii) RCRA Cap iii) Asphalt Cap
		b)	Chemical Fixation/Stabilization In-place	i) Chemical ii) Physical
4.	In situ Treatment Action	a)	Biological	i) Biological ii) Bioventing
		b)	Physical	i) Vapor Extraction ii) Vapor Extraction with Air Sparging iii) Soil Flushing iv) Passive Adsorption

TABLE 4.1

IDENTIFICATION OF POTENTIAL GENERAL REMEDIAL RESPONSE ACTIONS, TECHNOLOGIES AND PROCESS OPTIONS - SOILS LEICA INC. CHEEKTOWAGA, NEW YORK

General Response Actions	*Remedial Technologies*	*Process Options*
5. Removal/Treatment Action	a) On-Site Physical	i) Soil Vapor Extraction/Bioremediation ii) Low Temperature Thermal Desorption iii) Mobile Incineration iv) Soil Washing v) Mechanical Volatilization
	b) On-Site Chemical	i) Solvent Extraction
	c) On-Site Biological	i) Biological
	d) Off-Site Physical	i) Incineration
6. Removal/Disposal Action	a) On-Site Disposal	i) Landfilling
	b) Off-Site Disposal	i) Landfilling - Hazardous Waste Disposal Site - Non-Hazardous Waste Disposal Site

TABLE 4.2

PRELIMINARY SCREENING OF REMEDIAL RESPONSE ACTIONS AND TECHNOLOGIES - SOILS
LEICA INC.
CHEEKTOWAGA, NEW YORK

	General Response Actions	*Remedial Technology/Process Option*	*Screening Comments*	*Recommendations*
1.	No Action	---	- required by the NCP - acceptable risk identified in Risk Assessment for direct contact with soils - will not change existing conditions - soils with concentrations exceeding potential cleanup goals will remain at the Site.	- retained for further evaluation
2.	Limited Action	a) Restricted Access and Institutional Controls	- will minimize potential future contact with chemicals in soils - soils with concentrations exceeding potential cleanup goals will remain at the Site.	- retained for further evaluation
3.	Physical Containment Action	a) Capping	- will minimize potential contact with chemicals in surface soil (dermal contact and air pathways) - reduce infiltration and hence chemical loading to the groundwater - soils with concentrations exceeding potential cleanup goals will remain at the Site. - areas with subsurface soil concentrations exceeding cleanup criteria are currently covered by asphalt cover.	- retained for further evaluation

TABLE 4.2

PRELIMINARY SCREENING OF REMEDIAL RESPONSE ACTIONS AND TECHNOLOGIES - SOILS
LEICA INC.
CHEEKTOWAGA, NEW YORK

General Response Actions	*Remedial Technology/Process Option*	*Screening Comments*	*Recommendations*
3. Physical Containment Action (cont'd)	b) Chemical Fixation/Stabilization In-place	- will reduce mobility of some chemicals in soils - not suitable for some chemicals in soil - expensive and difficult to implement - benefits obtained do not warrant the high cost of this relatively unreliable technology.	- eliminated from further evaluation
4. In Situ Treatment Action	a) Biological - Biological Treatment	- chlorinated solvents such as trichloroethene are difficult to treat - will decrease time required to potentially achieve groundwater SCGs for some compounds. - technically feasible but may be difficult to implement due to low permeability of soils and heterogeneous distribution.	- retained for further evaluation
	- Bioventing	- will decrease time required to potentially achieve groundwater SCGs - technically feasible - readily implemented with vacuum extraction - more effective than simple biological treatment - not effective for low permeability soils (lake sediment layer) - not effective for saturated soils (sandy zone soils)	- retained for further evaluation

TABLE 4.2

PRELIMINARY SCREENING OF REMEDIAL RESPONSE ACTIONS AND TECHNOLOGIES - SOILS
LEICA INC.
CHEEKTOWAGA, NEW YORK

General Response Actions	*Remedial Technology/Process Option*	*Screening Comments*	*Recommendations*
4. In Situ Treatment Action (cont'd)	b) Physical - Vapor Extraction	- will reduce concentrations of chemicals present in permeable non-saturated soils only - not effective for lake sediment unit - not effective for seasonally saturated sandy zone soils - effective primarily for VOCs and to a lesser extent SVOCs - will decrease time required to potentially achieve groundwater SCGs - requires vapor phase treatment	- retained for further evaluation
	- Soil Flushing	- technically feasible for fill areas and deeper sandy zone soils but may be difficult to implement - not effective for low permeability shallow lake sediment soils - limited effectiveness for chlorinated compounds with low water solubility - requires hydraulic control - possible contamination due to surfactants if used - treatment of extracted water/ surfactant required	- retained for further evaluation

TABLE 4.2

PRELIMINARY SCREENING OF REMEDIAL RESPONSE ACTIONS AND TECHNOLOGIES - SOILS
LEICA INC.
CHEEKTOWAGA, NEW YORK

General Response Actions	*Remedial Technology/Process Option*	*Screening Comments*	*Recommendations*
4. In situ Treatment Action (cont'd)	- Passive Adsorption	- effective for deeper permeable sandy zone soils - not effective for low permeable shallow lake sediment soils - soil cleanup objectives would not be achieved in a reasonable amount of time	- retained for further evaluation
5. Removal/Treatment Action	a) On-Site Biological	- technically feasible - may be difficult to implement due to regulatory restrictions concerning on-Site treatment - potential for significant chemical emissions during excavating/ handling/treatment - not as effective as ex situ soil vapor extraction with biological treatment	- retained for further evaluation
	b) On-Site Physical - Soil Vapor Extraction/ Bioremediation	- technically feasible - may be difficult to implement due to regulatory restrictions concerning on-Site treatment - potential for significant air emissions during excavating/ handling - effective for VOCs and to a lesser extent SVOCs - longer treatment duration than low temperature thermal desorption	- retained for further evaluation

TABLE 4.2

PRELIMINARY SCREENING OF REMEDIAL RESPONSE ACTIONS AND TECHNOLOGIES - SOILS
LEICA INC.
CHEEKTOWAGA, NEW YORK

General Response Actions	*Remedial Technology/Process Option*	*Screening Comments*	*Recommendations*
5. Removal/Treatment Action (cont'd)	- Low Temperature Thermal Desorption	- technically feasible but may be difficult to implement due to limited availability of mobile units - may require treatment of off-gas - effective for Site-related chemicals - potential for significant air emissions during excavation/ handling - significantly more expensive than soil vapor extraction with biological treatment	- retained for further evaluation
	- Soil Washing	- limited effectiveness for chlorinated compounds with relatively low water solubilities - generates contaminated aqueous waste stream which must be treated and disposed - potential for significant air emissions during excavation/handling	- retained for further evaluation
	- Mechanical Volatilization	- effective for VOCs - less effective for phenolic compounds, TPH and NAPL-containing soils - potential for significant air emissions during excavating/handling/treatment - may not be suitable for soils with high concentrations - may be difficult to implement due to community acceptance - will reduce time required to achieve soil cleanup objectives	- retained for further evaluation

TABLE 4.2

PRELIMINARY SCREENING OF REMEDIAL RESPONSE ACTIONS AND TECHNOLOGIES - SOILS
LEICA INC.
CHEEKTOWAGA, NEW YORK

General Response Actions	*Remedial Technology/Process Option*	*Screening Comments*	*Recommendations*
5. Removal/Treatment Action (cont'd)	- On-Site Incineration	- technically feasible but may be difficult to implement due to permitting requirements and community perception - effective for Site-related chemicals - trial burns may delay implementation by approximately two years - potential for significant air emissions during excavation/ handling - Site-specific risk assessment would be required prior to implementation	- retained for further evaluation
	c) On-Site Chemical - Solvent Extraction	- technically feasible - reliability and effectiveness of solvent extraction is questionable - potential for significant air emissions during excavation/handling - limited number of mobile solvent extraction units available	- retained for further evaluation
	d) Off-Site Incineration	- technically feasible - effective for Site-related chemicals - potential for significant air emissions during excavation/ handling/transportation of soils - limited available capacity at off-Site incinerators - not cost effective in comparison to other ex situ technologies	- retained for further evaluation

TABLE 4.2

PRELIMINARY SCREENING OF REMEDIAL RESPONSE ACTIONS AND TECHNOLOGIES - SOILS
LEICA INC.
CHEEKTOWAGA, NEW YORK

General Response Actions	*Remedial Technology/Process Option*	*Screening Comments*	*Recommendations*
6. Disposal Action	a) On-Site Disposal	- decrease time required to potentially obtain groundwater SCGs - potential for significant chemical emissions during excavation/ handling of soils - pretreatment or exemption may be required to comply with land ban provisions - no reduction in soil contaminant levels - does not comply with CERCLA remedial action goals	- eliminated from further evaluation
	b) Off-Site Disposal	- will remove soils from the Site with chemical concentrations exceeding cleanup objectives - decrease time required to potentially achieve groundwater SCGs by source removal - potential for significant chemical emissions during excavation/ handling of soils - pretreatment may be required to comply with land ban provisions - no reduction in soil contaminant levels - may be difficult to land dispose	- eliminated from further evaluation

TABLE 4.3

POTENTIAL REMEDIAL RESPONSE ACTIONS, TECHNOLOGIES AND PROCESS OPTIONS RETAINED FOR ALTERNATIVE DEVELOPEMENT - SOILS`
LEICA INC.
CHEEKTOWAGA, NEW YORK

	General Response Actions		*Remedial Technologies*		*Process Options*
1.	No Action		--		--
2.	Limited Action	a)	Institutional Controls		--
3.	Removal/Treatment Action	a)	On-Site Physical	i)	Soil Vapor Extraction/Bioremediation
				ii)	Mechanical Volatilization

TABLE 4.4

IDENTIFICATION OF POTENTIAL GENERAL REMEDIAL RESPONSE ACTIONS, TECHNOLOGIES AND PROCESS OPTIONS - GROUNDWATER
LEICA INC.
CHEEKTOWAGA, NEW YORK

General Response Actions	*Remedial Technologies*	*Process Options*
1. No Action	--	--
2. Limited Action	a) Institutional Controls	i) Restricted Future Land Use
3. In Situ Treatment Action	a) Biological	--
4. Physical Containment Action	a) Barrier Wall	i) Soil/Bentonite ii) Cement/Bentonite iii) Sheet Piling
5. Hydraulic Containment Action	a) Groundwater Extraction Wells	--
	b) Groundwater Collection Drains (Overburden only)	--
6. Source Removal Action	a) Groundwater Extraction Wells	--
	b) Groundwater Collection Drains (Overburden only)	--
7. Collected Groundwater Treatment Action	a) Physical Treatment	i) Liquid Phase Carbon Adsorption ii) Air Stripping iii) Air Aeration
	b) Chemical Treatment	i) UV/Oxidation
	c) On-Site Biological Treatment	i) Biological
	d) Off-Site Treatment	i) POTW ii) RCRA Facility
8. Collected Groundwater Disposal Action	a) Groundwater Recirculation	--
	b) Disposal at POTW	--

TABLE 4.5

PRELIMINARY SCREENING OF REMEDIAL RESPONSE ACTIONS AND TECHNOLOGIES - GROUNDWATER
LEICA INC.
CHEEKTOWAGA, NEW YORK

General Response Actions	*Remedial Technologies*	*Comments*	*Recommendations*
1. No Action	---	- will not change existing conditions	- retained for further evaluation
2. Limited Action	a) Institutional Controls	- will restrict potential use of groundwater at the Site to non-potable uses - groundwater concentrations will continue to exceed SCGS beneath the Site - unacceptable risk identified by Risk Assessment for bedrock groundwater	- retained for further evaluation
3. Physical Containment Action	a) Barrier Wall	- effectiveness at the Site would be minimal if hydraulic containment or source removal is implemented for overburden groundwater	- eliminated from further evaluation
4. Hydraulic Containment Action	a) Groundwater Extraction Wells		
	- bedrock	- will prevent off-Site migration of chemicals via groundwater flow - would be effective for bedrock	- retained for further evaluation
	- overburden	- limited saturated thickness - low hydraulic conductivity - low transmissivity - not effective for overburden	- eliminated from further evaluation

TABLE 4.5

PRELIMINARY SCREENING OF REMEDIAL RESPONSE ACTIONS AND TECHNOLOGIES - GROUNDWATER
LEICA INC.
CHEEKTOWAGA, NEW YORK

	General Response Actions		*Remedial Technologies*	*Comments*	*Recommendations*
4.	Hydraulic Containment Action (cont'd)	b)	Groundwater Collection Tile Drains	- will prevent off-Site migration of chemicals via groundwater flow in the overburden	- retained for further evaluation
5.	Source Removal Action	a)	Groundwater Extraction Wells		
			- bedrock	- will remove groundwater from isolated source areas with high concentrations in bedrock	- retained for further evaluation
			- overburden	- limited saturated thickness - low hydraulic conductivity - low transmissivity - not effective for overburden	- eliminated from further evaluation
		b)	Groundwater Collection Drains	- will remove groundwater from isolated source areas with high concentrations in overburden	- retained for further evaluation
6.	Collected Groundwater Treatment Action	a)	Physical Treatment	- will reduce concentrations of chemicals in groundwater - decrease time required to potentially obtain groundwater SCGs	- retained for further evaluation
		b)	Chemical Treatment	- will reduce concentrations of chemicals in groundwater - decrease time required to potentially obtain groundwater SCGs	- retained for further evaluation

TABLE 4.5

PRELIMINARY SCREENING OF REMEDIAL RESPONSE ACTIONS AND TECHNOLOGIES - GROUNDWATER
LEICA INC.
CHEEKTOWAGA, NEW YORK

	General Response Actions		*Remedial Technologies*	*Comments*	*Recommendations*
6.	Collected Groundwater Treatment Action (cont'd)	c)	On-Site Biological Treatment	- will reduce concentrations of chemicals in groundwater - decrease time required to potentially obtain groundwater SCGs - not effective for low permeable soils - not effective for chlorinated compounds	- retained for further evaluation
		d)	Off-Site Treatment	- will reduce concentrations of chemicals in groundwater - decrease time required to potentially obtain groundwater SCGs	- retained for further evaluation
7.	Collected Groundwater Disposal Action	a)	Groundwater Recirculation	- appropriate for soil flushing and in situ biological treatment	- eliminated from further evaluation
		b)	Disposal at POTW	- potentially applicable - extracted groundwater treated and disposed at POTW	- retained for further evaluation

TABLE 4.5

PRELIMINARY SCREENING OF REMEDIAL RESPONSE ACTIONS AND TECHNOLOGIES - GROUNDWATER
LEICA INC.
CHEEKTOWAGA, NEW YORK

	General Response Actions		*Remedial Technologies*	*Comments*	*Recommendations*
8.	In-Situ Treatment Action	a)	Biological	- not effective for low permeable soils - not effective for chlorinated compounds - not effective for treatment of bedrock groundwater	- eliminated from further evaluation

TABLE 4.6

POTENTIAL REMEDIAL RESPONSE ACTIONS, TECHNOLOGIES AND PROCESS OPTIONS RETAINED FOR ALTERNATIVE DEVELOPMENT - GROUNDWATER
LEICA INC.
CHEEKTOWAGA, NEW YORK

General Response Actions		*Remedial Technologies*		*Process Options*	
1.	No Action	--		--	
2.	Limited Action	a)	Institutional Controls	--	
3.	Hydraulic Containment Action	a)	Bedrock Groundwater Extraction Wells	--	
		b)	Overburden Groundwater Collection Drain		
4.	Source Removal Action	a)	Bedrock Groundwater Extraction Wells	--	
		b)	Overburden Groundwater Collection Drain		
5.	Collected Groundwater Treatment Action	a)	On-Site Physical Treatment	i)	Air Stripping (other options including UV/oxidation and carbon adsorption may also be appropriate)
6.	Collected Groundwater Disposal Action	a)	Disposal at POTW	--	

TABLE 5.1

DETAILED ANALYSIS CRITERIA AND FACTORS
LEICA INC.
CHEEKTOWAGA, NEW YORK

Evaluation Criteria	*Evaluation Factors*
Overall Protection of Human Health and the Environment	• elimination, reduction or control of risks
Compliance with ARARs	• compliance with chemical specific ARARs • compliance with action specific ARARs • compliance with location specific ARARs
Short-Term Impacts and Effectiveness	• protection of human health and environment during implementation • time required to achieve remedial objectives • protection of workers during remedial actions
Long-Term Effectiveness and Permanence	• permanence of remedial alternatives • magnitude of residual risk • adequacy of controls imposed after remedial action • reliability of controls imposed after remedial action
Reduction of Toxicity, Mobility and Volume	• amount of hazardous material destroyed or treated • degree of expected reduction in toxicity, mobility or volume • degree to which treatment is irreversible • type and quantity of residuals remaining after treatment
Implementability	• technical feasibility • administrative feasibility • availability of services and materials
Cost	• total capital costs • operation and maintenance costs • total present worth cost

TABLE 5.2

REMEDIAL ALTERNATIVE MONITORING PROGRAM
LEICA INC.
CHEEKTOWAGA, NEW YORK

	ESTIMATED DURATION OF SAMPLING			
	Alternative 1	*Alternative 2*	*Alternative 3*	*Alternative 4*
GENERAL SITE MONITORING PROGRAM				
Groundwater				
- 10 monitoring wells	30 years	30 years	30 years	30 years
- frequency - semi-annual for 5 years - annual thereafter				
TREATMENT SYSTEM MONITORING				
Groundwater Treatment (influent/effluent)				
- frequency - weekly for first two months - monthly thereafter	NA	NA	30 years	30 years
Soil Treatment				
- frequency - once per week for first two months - monthly thereafter	NA	NA	NA	1 year

Footnotes:

NA Not Applicable

TABLE 5.3

PROPOSED GROUNDWATER MONITORING WELL NETWORK
LEICA INC.
CHEEKTOWAGA, NEW YORK

Overburden Monitoring Wells

MW-3
MW-5
MW-13
MW-14
MW-15
MW-18

Bedrock Monitoring Wells

MW-5A
MW-13A
MW-14A
MW-15A

TABLE 5.4

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 1
LEICA INC.
CHEEKTOWAGA, NEW YORK

A) GROUNDWATER MONITORING

1) CAPITAL COSTS	
No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Groundwater Hydraulic and Chemical Monitoring (1)	
a) hydraulic monitoring of all wells and groundwater sample collection and analysis of VOCs from 10 monitoring wells	$20,000
Contingency (25%)	$5,000
Total Estimated Annual Operation and Maintenance Cost	$25,000
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$206,365**

B) ANNUAL MONITORING REPORT

1) CAPITAL COSTS	
No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Preparation of Annual Monitoring Report	$20,000
Contingency (25%)	$5,000
Total Estimated Annual Operation and Maintenance Cost	$25,000
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$310,226**

C) SITE EVALUATION

1) CAPITAL COSTS	
No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Conduct Site Evaluation and Reporting (Every 5 Years)	$5,220
Contingency (25%)	$1,305
Total Estimated Annual Operation and Maintenance Cost	$6,525
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$80,969**

Note:

. Groundwater monitoring is for a 30-year period and is performed semi-annually for 5 years and annually thereafter.

TABLE 5.4

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 1
LEICA INC.
CHEEKTOWAGA, NEW YORK

SUMMARY OF COMPONENT COSTS

Component	*Capital Cost*	*Annual Operation and Maintenance Cost*	*Present Worth Cost*
A - Groundwater Monitoring	$0	$25,000	$206,365
B - Annual Monitoring Report	$0	$25,000	$310,226
C - Site Evaluation	$0	$6,525	$80,969
Total Cost (2)	$0	$56,500	$598,000

Note:

2. Total costs have been rounded to 3 significant figures.

TABLE 5.5

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 2
LEICA INC.
CHEEKTOWAGA, NEW YORK

A) INSTITUTIONAL CONTROLS	
1) CAPITAL COSTS	
i) Direct Capital Costs	
a) deed restrictions	$10,000
ii) Indirect Capital Costs	
a) administration and legal (5% of direct capital costs)	$500
b) engineering design (10% of direct capital cost)	$1,000
c) construction supervision (10% of direct capital cost)	$1,000
d) health and safety (5% of direct capital cost)	$500
Subtotal Indirect Capital Costs	$3,000
Subtotal Indirect and Direct Capital Costs	$13,000
Contingency (25%)	$3,250
Total Estimated Capital Cost	$16,250
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
No operation and maintenance costs associated with this component	
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$16,250**

TABLE 5.5

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 2
LEICA INC.
CHEEKTOWAGA, NEW YORK

B) GROUNDWATER MONITORING

1) CAPITAL COSTS	
No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Groundwater Hydraulic and Chemical Monitoring (1)	
a) hydraulic monitoring of all wells and groundwater sample collection and analysis of VOCs from 10 monitoring wells	$20,000
Contingency (25%)	$5,000
Total Estimated Annual Operation and Maintenance Cost	$25,000
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$206,365**

C) ANNUAL MONITORING REPORT

1) CAPITAL COSTS	
No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Preparation of Annual Monitoring Report	$20,000
Contingency (25%)	$5,000
Total Estimated Annual Operation and Maintenance Cost	$25,000
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$310,226**

D) SITE EVALUATION

1) CAPITAL COSTS	
No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Conduct Site Evaluation and Reporting (Every 5 Years)	$5,220
Contingency (25%)	$1,305
Total Estimated Annual Operation and Maintenance Cost	$6,525
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$80,969**

Note:

. Groundwater monitoring is for a 30-year period and is performed semi-annually for 5 years and annually thereafter.

TABLE 5.5

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 2
LEICA INC.
CHEEKTOWAGA, NEW YORK

SUMMARY OF COMPONENT COSTS

Component	*Capital Cost*	*Annual Operation and Maintenance Cost*	*Present Worth Cost*
A - Institutional Controls	$16,250	$0	$16,250
B - Groundwater Monitoring	$0	$25,000	$206,365
C - Annual Monitoring Report	$0	$25,000	$310,226
D - Site Evaluation	$0	$6,525	$80,969
Total Cost (2)	$16,300	$56,500	$614,000

Note:

2. Total costs have been rounded to 3 significant figures.

TABLE 5.6

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 3
LEICA INC.
CHEEKTOWAGA, NEW YORK

A) INSTITUTIONAL CONTROLS	
1) CAPITAL COSTS	
i) Direct Capital Costs	
a) deed restrictions	$10,000
ii) Indirect Capital Costs	
a) administration and legal (5% of direct capital costs)	$500
b) engineering design (10% of direct capital cost)	$1,000
c) construction supervision (10% of direct capital cost)	$1,000
d) health and safety (5% of direct capital cost)	$500
Subtotal Indirect Capital Costs	$3,000
Subtotal Indirect and Direct Capital Costs	$13,000
Contingency (25%)	$3,250
Total Estimated Capital Cost	$16,250
2) ANNUAL OPERATION AND MAINTENANCE COSTS No operation and maintenance costs associated with this component	
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$16,250**

TABLE 5.6

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 3
LEICA INC.
CHEEKTOWAGA, NEW YORK

B) BEDROCK GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

1) CAPITAL COSTS	
i) Direct Capital Costs	
a) extraction well system (system installation and pump testing)	$60,000
b) groundwater treatment system (treatability study and system installation)	$400,000
Subtotal Direct Capital Costs	$460,000
ii) Indirect Capital Costs	
a) administration and legal (5% of direct capital costs)	$23,000
b) engineering design (10% of direct capital cost)	$46,000
c) construction supervision (10% of direct capital cost)	$46,000
d) health and safety (5% of direct capital cost)	$23,000
Subtotal Indirect Capital Costs	$138,000
Subtotal Indirect and Direct Capital Costs	$598,000
Contingency (25%)	$149,500
Total Estimated Capital Cost	$747,500
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Groundwater Extraction and Treatment System Operation	
a) pretreatment	$2,900
b) electrical power consumption	$14,300
c) maintenance (parts, supplies and labor)	$47,500
d) fuel and catalyst (off-gas treatment)	$9,500
ii) Groundwater Treatment System Monitoring (1)	$17,100
Subtotal Operation and Maintenance Costs	$91,300
Contingency (25%)	$22,825
Total Estimated Annual Operation and Maintenance Cost	$114,125
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$2,083,324**

Note:

1. Groundwater treatment system monitoring is for a 30 year period and is performed weekly for the first two months and monthly thereafter.

TABLE 5.6

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 3
LEICA INC.
CHEEKTOWAGA, NEW YORK

C) OVERBURDEN GROUNDWATER COLLECTION AND TREATMENT SYSTEM

1) CAPITAL COSTS	
i) Direct Capital Costs	
a) installation of overburden collection trench and forcemain system	$220,000
b) construction of sanitary sewer cross-over	$15,000
c) groundwater treatment system	$0 (2)
Subtotal Direct Capital Costs	$235,000
ii) Indirect Capital Costs	
a) administration and legal (5% of direct capital costs)	$11,750
b) engineering design (10% of direct capital cost)	$23,500
c) construction supervision (10% of direct capital cost)	$23,500
d) health and safety (5% of direct capital cost)	$11,750
Subtotal Indirect Capital Costs	$70,500
Subtotal Indirect and Direct Capital Costs	$305,500
Contingency (25%)	$76,375
Total Estimated Capital Cost	$381,875
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Groundwater Extraction and Treatment System Operation	
a) pretreatment	$200
b) electrical power consumption	$800
c) maintenance (parts, supplies and labor)	$2,500
d) fuel and catalyst (off-gas treatment)	$500
ii) Groundwater Treatment System Monitoring (1)	$900
Subtotal Operation and Maintenance Costs	$4,900
Contingency (25%)	$1,225
Total Estimated Annual Operation and Maintenance Cost	$6,125
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$453,651**

Note:

1. Groundwater treatment system monitoring is for a 30 year period and is performed weekly for the first two months and monthly thereafter.
2. Costs for treatment system are included for the bedrock groundwater treatment system.

TABLE 5.6

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 3
LEICA INC.
CHEEKTOWAGA, NEW YORK

D) NAPL COLLECTION AND OFF-SITE TREATMENT	
1) CAPITAL COSTS	
i) Direct Capital Costs	
a) 12 rounds of NAPL collection from wells MW-8 and MW-11	$24,000
b) off-Site transportation and incineration of collected NAPL (assume 240 gallons)	$6,000
Subtotal Direct Capital Costs	$30,000
ii) Indirect Capital Costs	
a) administration and legal (5% of direct capital costs)	$1,500
b) engineering design (10% of direct capital cost)	$3,000
c) construction supervision (10% of direct capital cost)	$3,000
d) health and safety (5% of direct capital cost)	$1,500
Subtotal Indirect Capital Costs	$9,000
Subtotal Indirect and Direct Capital Costs	$39,000
Contingency (25%)	$9,750
Total Estimated Capital Cost	$48,750
2) ANNUAL OPERATION AND MAINTENANCE COSTS No operation and maintenance costs associated with this component	
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$48,750**
E) GROUNDWATER MONITORING	
1) CAPITAL COSTS No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Groundwater Hydraulic and Chemical Monitoring (3)	
a) hydraulic monitoring of all wells and groundwater sample collection and analysis of VOCs from 10 monitoring wells	$20,000
Contingency (25%)	$5,000
Total Estimated Annual Operation and Maintenance Cost	$25,000
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$206,365**

Note:

3. Groundwater monitoring is for a 30-year period and is performed semi-annually for 5 years and annually thereafter.

TABLE 5.6

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 3
LEICA INC.
CHEEKTOWAGA, NEW YORK

F) ANNUAL MONITORING REPORT

1) CAPITAL COSTS	
No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Preparation of Annual Monitoring Report	$20,000
Contingency (25%)	$5,000
Total Estimated Annual Operation and Maintenance Cost	$25,000
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$310,226**

G) SITE EVALUATION

1) CAPITAL COSTS	
No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Conduct Site Evaluation and Reporting (Every 5 Years)	$5,220
Contingency (25%)	$1,305
Total Estimated Annual Operation and Maintenance Cost	$6,525
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$80,969**

TABLE 5.6

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 3
LEICA INC.
CHEEKTOWAGA, NEW YORK

SUMMARY OF COMPONENT COSTS

Component	*Capital Cost*	*Annual Operation and Maintenance Cost*	*Present Worth Cost*
A - Institutional Controls	$16,250	$0	$16,250
B - Bedrock Groundwater Extraction and Treatment System	$747,500	$114,125	$2,083,324
C - Overburden Groundwater Collection and Treatment System	$381,875	$6,125	$453,651
D - NAPL Collection and Off-Site Treatment	$48,750	$0	$48,750
E - Groundwater Monitoring	$0	$25,000	$206,365
F - Annual Monitoring Report	$0	$25,000	$310,226
G - Site Evaluation	$0	$6,525	$80,969
Total Cost (4)	$1,190,000	$177,000	$3,200,000

Note:

4. Total costs have been rounded to 3 significant figures.

TABLE 5.7

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 4
LEICA INC.
CHEEKTOWAGA, NEW YORK

A) INSTITUTIONAL CONTROLS

1) CAPITAL COSTS	
i) Direct Capital Costs	
a) deed restrictions	$10,000
b) fence installation around treatment system	$10,000
Subtotal Direct Capital Costs	$20,000
ii) Indirect Capital Costs	
a) administration and legal (5% of direct capital costs)	$1,000
b) engineering design (10% of direct capital cost)	$2,000
c) construction supervision (10% of direct capital cost)	$2,000
d) health and safety (5% of direct capital cost)	$1,000
Subtotal Indirect Capital Costs	$6,000
Subtotal Indirect and Direct Capital Costs	$26,000
Contingency (25%)	$6,500
Total Estimated Capital Cost	$32,500
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Fence Maintenance	$1,000
Contingency (25%)	$250
Total Estimated Annual Operation and Maintenance Cost	$1,250
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$48,011**

TABLE 5.7

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 4
LEICA INC.
CHEEKTOWAGA, NEW YORK

B) BEDROCK GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

1) CAPITAL COSTS	
i) Direct Capital Costs	
a) extraction well system (system installation and pump testing)	$60,000
b) groundwater treatment system (treatability study and system installation)	$400,000
Subtotal Direct Capital Costs	$460,000
ii) Indirect Capital Costs	
a) administration and legal (5% of direct capital costs)	$23,000
b) engineering design (10% of direct capital cost)	$46,000
c) construction supervision (10% of direct capital cost)	$46,000
d) health and safety (5% of direct capital cost)	$23,000
Subtotal Indirect Capital Costs	$138,000
Subtotal Indirect and Direct Capital Costs	$598,000
Contingency (25%)	$149,500
Total Estimated Capital Cost	$747,500
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Direct Operation and Maintenance Costs	
a) pretreatment	$2,900
b) electrical power consumption	$14,300
c) maintenance (parts, supplies and labor)	$47,500
d) fuel and catalyst (off-gas treatment)	$9,500
ii) Groundwater Treatment System Monitoring (1)	$17,100
Subtotal Operation and Maintenance Costs	$91,300
Contingency (25%)	$22,825
Total Estimated Annual Operation and Maintenance Cost	$114,125
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$2,083,324**

C) SOIL EXCAVATION AND EX SITU TREATMENT

1) CAPITAL COSTS		
i) Direct Capital Costs		
a) soil vapor extraction treatment system (pilot test and system installation)	$250,000	
b) excavation and backfilling of soil		
i) excavation (16,320 - 28,190 cubic yards) (2)	$163,200	- $281,900
ii) backfilling treated soil (16,320 - 28,190 cubic yards)	$163,200	- $281,900
iii) confirmatory soil sampling [collection and analyses of samples (assume 30 - 60 samples)]	$27,000	- $54,000
Subtotal Direct Capital Costs	$603,400	- $867,800

Note:

1. Groundwater treatment system monitoring is for a 30 year period and is performed weekly for the first two months and monthly thereafter.

TABLE 5.7

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 4
LEICA INC.
CHEEKTOWAGA, NEW YORK

1) CAPITAL COSTS (Cont'd)			
ii) Indirect Capital Costs			
a) administration and legal (5% of direct capital costs)	$30,170	-	$43,390
b) engineering design (10% of direct capital cost)	$60,340	-	$86,780
c) construction supervision (10% of direct capital cost)	$60,340	-	$86,780
d) health and safety (5% of direct capital cost)	$30,170	-	$43,390
Subtotal Indirect Capital Costs	$181,020	-	$260,340
Subtotal Indirect and Direct Capital Costs	$784,420	-	$1,128,140
Contingency (25%)	$196,105	-	$282,035
Total Estimated Capital Cost	$980,525	-	$1,410,175
2) ANNUAL OPERATION AND MAINTENANCE COSTS			
i) Mechanical Volatilization Treatment			
a) treatment of Area A soil (110 cubic yards)	$5,500		
b) treatment of Area B soil(6,000 cubic yards)	$300,000		
c) treatment of Area C soil (3,370 to 15,240 cubic yards)	$168,500	-	$762,000
d) confirmatory sampling (assume 1 sample per 75 cubic yards) (3)	$40,000	-	$85,500
Item i) Subtotal	$514,000	-	$1,153,000
ii) Soil Vapor Extraction/Bioremediation System Operation			
a) transfer and place soil for treatment (6,840 cubic yards for Area C)	$70,000		
b) pile breakdown and confirmatory sampling (assume 1 sample per 75 cubic yards)	$75,000		
c) system operation	$80,000		
d) soil treatment system monitoring (4)	$20,000		
Item ii) Subtotal	$245,000		
Subtotal Operation and Maintenance Costs	$759,000	-	$1,398,000
Contingency (25%)	$189,750	-	$349,500
Total Estimated Annual Operation and Maintenance Cost	$948,750	-	$1,747,500
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS EXCEPT FOR THE SOIL TREATMENT SYSTEM WHICH OPERATES FOR ONE YEAR)	**$1,929,300**	**-**	**$3,157,700**

Note:

2. A range of costs is presented for the excavation and treatment of soils with chemical concentrations exceeding soil cleanup objectives (16,320 cubic yards) and soils exceeding cleanup objectives with the addition of the Secondary Southeast Area (28,190 cubic yards).
3. A range of costs is presented for the treatment of the soils with potential low level contamination exceeding soil cleanup objectives (estimated to be 3,370 cubic yards from Area C to 15,240 cubic yards from Area C with the addition of the Secondary Southeast Area.
4. Soil treatment system monitoring is for a one year period and is performed weekly for the first two months and monthly thereafter.

TABLE 5.7

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 4
LEICA INC.
CHEEKTOWAGA, NEW YORK

D) GROUNDWATER MONITORING

1) CAPITAL COSTS	
No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Groundwater Hydraulic and Chemical Monitoring (5)	
a) hydraulic monitoring of all wells and groundwater sample collection and analysis of VOCs from 10 monitoring wells	$20,000
Contingency (25%)	$5,000
Total Estimated Annual Operation and Maintenance Cost	$25,000
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$206,365**

E) ANNUAL MONITORING REPORT

1) CAPITAL COSTS	
No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Preparation of Annual Monitoring Report	$20,000
Contingency (25%)	$5,000
Total Estimated Annual Operation and Maintenance Cost	$25,000
3) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$310,226**

F) SITE EVALUATION (every 5 years)

1) CAPITAL COSTS	
No Capital Costs associated with this component	
2) ANNUAL OPERATION AND MAINTENANCE COSTS	
i) Conduct Site Evaluation and Reporting (Every 5 Years)	$5,220
Contingency (25%)	$1,305
Total Estimated Annual Operation and Maintenance Cost	$6,525
2) PRESENT WORTH (7% DISCOUNT FACTOR FOR 30 YEARS)	**$80,969**

Note:

5. Groundwater monitoring is for a 30 year period and is performed semi-annually for 5 years and annually thereafter.

TABLE 5.7

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 4
LEICA INC.
CHEEKTOWAGA, NEW YORK

SUMMARY OF COMPONENT COSTS

Component	*Capital Cost*	*Annual Operation and Maintenance Cost*	*Present Worth Cost*
A - Institutional Controls	$32,500	$1,250	$48,011
B - Bedrock Groundwater Extraction and Treatment System	$747,500	$114,125	$2,083,324
C - Soil Excavation and Ex Situ Treatment	$980,525 - $1,410,175	$948,750 - $1,747,500	$1,929,300 - $3,157,700
D - Groundwater Monitoring	$0	$25,000	$206,365
E - Annual Monitoring Report	$0	$25,000	$310,226
F - Site Evaluation	$0	$6,525	$80,969
Total Cost (5)	$1,760,000-$2,190,000	$172,000	$4,658,000 - $5,887,000

Note:

5. Total costs have been rounded to 3 significant figures.

TABLE 5.8
SUMMARY OF TAGM 4030 SCORES (1)
LEICA INC.
CHEEKTOWAGA, NEW YORK

Criteria	*Alternative 1*	*Alternative 2*	*Alternative 3*	*Alternative 4*
1. Overall Protection of Human Health and the Environment	6	6	17	20
2. Compliance with SCGs	0	0	3	7
3. Long-Term Effectiveness and Permanence	6	6	9	12
4. Reduction of Toxicity, Mobility or Volume through Treatment	0	0	8	13
5. Short-Term Effectiveness	8	10	10	6
6. Implementability	3	2	13	12
7. Cost	15	15	5	0
Total Score:	**38**	**39**	**65**	**70**

Notes:
(1) Detailed determinations of scores for each criteria are presented in Appendix E.

APPENDICES

A

APPENDIX A

ASSESSMENT OF SOIL TREATMENT TECHNOLOGIES

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

A.1.0 INTRODUCTION

This Appendix presents a description, evaluation and a summary of the potential soil remedial response actions, technologies and process options for the Leica Site (Site) located in the Town of Cheektowaga, Erie County, New York.

The areas of the Site potentially requiring remediation are described in Section A.2.

A description of various potential soil remedial response actions, technologies and process options are provided in Section A.3. In situ and ex situ soil treatment technology process options are presented in Sections A.3.1 and A.3.2, respectively.

An evaluation of the different process options is presented in Section A.4. The evaluation is based upon effectiveness, implementability and cost considerations for each of the two primary source areas; the northeast area and southeast area and the former drum storage area. In addition, each of these areas are subdivided into shallow soil and deep soil. Based upon this evaluation, one or more technologies and processes are selected to be considered throughout the FS.

A.2.0 POTENTIAL AREAS TO BE REMEDIATED

The areas to be remediated are presented on Figure A.2.1. The two primary source areas, designated B and C on Figure A.2.1, are the northeast source area and the southeast source area, respectively. In addition to the soils that have been determined to contain chemicals with concentrations exceeding cleanup objectives, soils potentially requiring remediation have been extended, in the southeast area, to include the entire ash-filled area. Based on the results of the RI and historical investigations, soils with chemical concentrations exceeding the NYSDEC soil cleanup objectives have been conservatively estimated to extend to bedrock. The volumes of soil potentially requiring remediation are presented in Table A.1. The soils have been divided into the shallow soils consisting of the fill and lake sediment layer and the deep soils consisting of the sandy zone and till layer.

In addition to the two primary source areas, it is estimated that approximately 100 yd^3 of soil located in the former drum storage area (designated Area A on Figure A.2.1) will require remedial action. Soils with chemical concentrations exceeding soil cleanup objectives extend to a depth of approximately three feet in this area. As these chemicals are in the unsaturated low permeable shallow soils, many of the in situ treatment technologies and process options are not suitable for the former drum storage area contaminated soils.

The shallow and deep soils have different hydrogeologic properties that affect the feasibility of treatment technologies. These properties which include permeability, homogeneity, degree of saturation, and soil type, are discussed in Section 2.5 of the Feasibility Study (FS) Report.

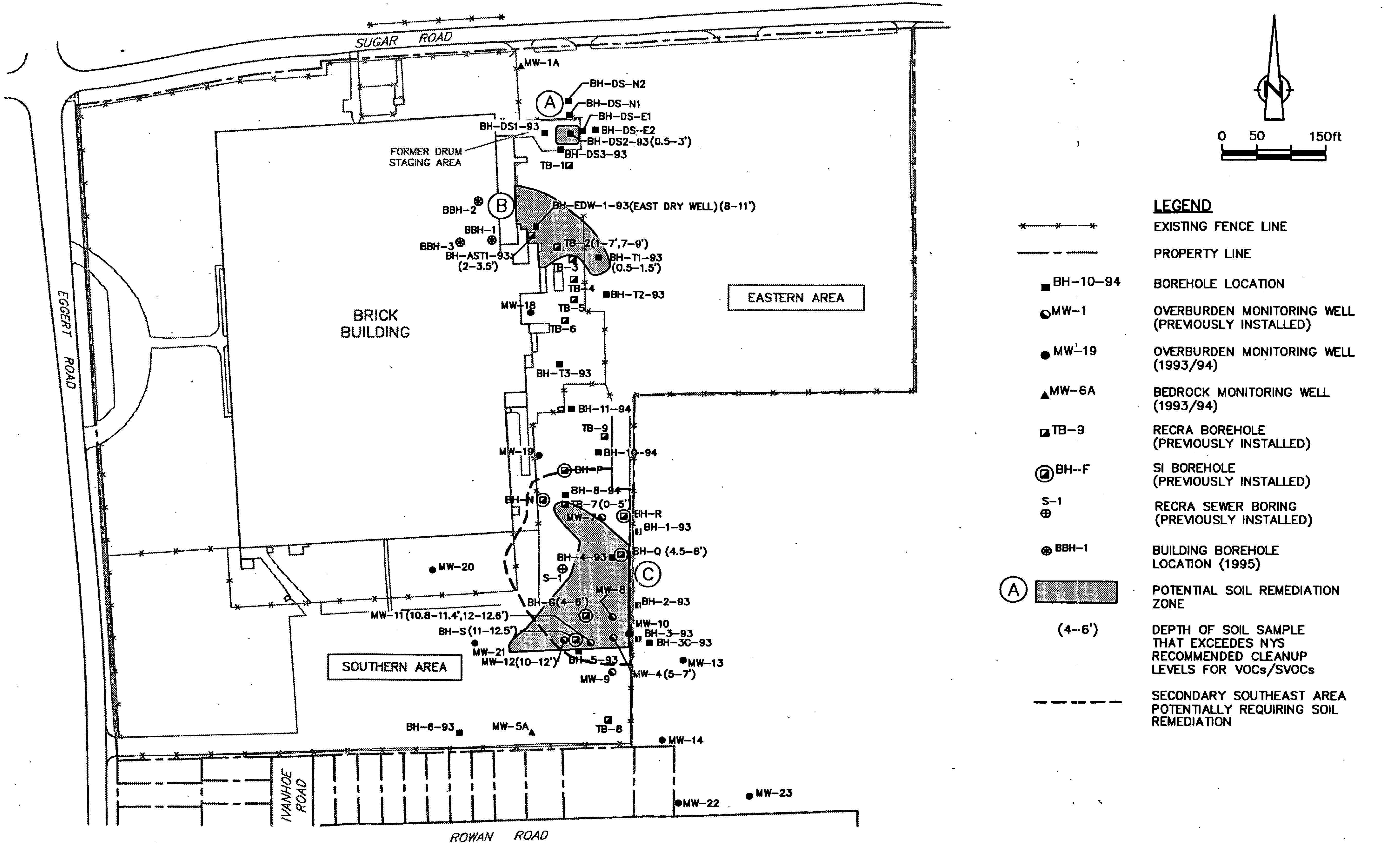
TABLE A.1

SUMMARY OF SOIL VOLUMES
POTENTIALLY REQUIRING REMEDIATION (1)
LEICA INC.
CHEEKTOWAGA, NEW YORK

	Area (ft^2)	Average Thickness (ft)		Volume (yd^3)
Northeast Area				
Shallow Soils (2)	12,450	7		3,230
Deep Soils (3)	12,450	6		2,770
	Northeast Area Subtotal		=	6,000
Southeast Area				
Shallow Soils	22,050	9.5		7,760
Deep Soils	22,050	3		2,450
	Southeast Area Subtotal		=	10,210
Secondary Southeast Area (5)				
Shallow Soils	22,900	11.5		9,750
Deep Soils	22,900	2.5		2,120
	Secondary Southeast Area Subtotal		=	11,870
Former Drum Storage Area				
Shallow Soils	990	3		110
Deep Soils	NA (4)	NA		NA
	Former Drum Storage Area Subtotal		=	110
	Total Estimated Volume		=	**28,190 yd^3**

Notes:

1. Soil volumes are based on extent of soil contamination with chemicals exceeding applicable soil cleanup objectives (TAGM HWR-94-4046).
2. Shallow soils refer to the combined fill and lake sediment layers.
3. Deep soils refer to the sandy zone and till layer.
4. NA - Not applicable, no deep soils with concentrations exceeding soil cleanup objectives.
5. The secondary southeast area includes all soils within the ash-filled area in addition to soils in the southeast area that exceed soil cleanup objectives.



SOURCE: GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

CRA

figure A.2.1

POTENTIAL SOIL REMEDIATION ZONES
LEICA INC.
Cheektowaga, New York

3967 (8) APR 11/95(W) REV.0 (P-80)

A.3.0 SOIL REMEDIAL RESPONSE ACTION, TECHNOLOGY AND PROCESS OPTION DESCRIPTION

There are two general response actions for the treatment of soils at the Site, in situ treatment action and ex situ treatment action. Both of these actions include biological, physical, and chemical remedial technologies and process options.

A.3.1 IN SITU SOIL TREATMENT ACTION

Five alternative process options were identified for consideration for in situ treatment of soils at the Site. These are:

Biological Treatment

1. Biological Treatment; and
2. Bioventing.

Physical Treatment

1. Soil Vapor Extraction and/or Air Injection;
2. Soil Flushing; and
3. Passive Adsorption.

A.3.1.1 In Situ Biological Treatment

In situ biological treatment is a process where soil conditions are manipulated to promote the breakdown of contaminants by naturally occurring microorganisms (usually bacteria). This is typically accomplished by adding nutrient-enhanced water to the system through infiltration basins at the ground surface or through recharge wells. The water is circulated through the soils to be remediated. The water used to transport the nutrients can also work to dissolve adsorbed contaminants. The extracted water would be treated on Site, if required, to remove dissolved chemicals prior to reinjection. This treatment technology can provide substantial reduction in organic contaminant levels in soils without the high cost of soil excavation.

Several factors influence the effectiveness of an in situ biological treatment process. These factors include:

- available oxygen concentration;
- appropriate levels of macronutrients and micronutrients;
- redox potential;
- soil pH;
- degree of water saturation;
- soil temperature;
- competition, predators, presence of toxins;
- chemicals to be treated and concentration; and
- hydraulic conductivity of soils.

In situ biodegradation is often used in conjunction with a groundwater pumping and reinjection system to circulate nutrients and oxygen through a contaminated zone. Under favorable conditions, introduced soil microorganisms are known to degrade many organic compounds. Microorganisms are capable of completely degrading organic compounds into water and carbon dioxide in the presence of sufficient oxygen and nutrients such as nitrogen and phosphorous, a near neutral pH, and warm soil temperatures. Anaerobic degradation of chlorinated organics is possible, although the rates of degradation are generally slow.

This technology is not suitable for soil contaminated with high concentrations of chlorinated compounds and metals present in inhibitory concentrations but is well suited for soil contaminated by petroleum by-products (e.g., aromatic hydrocarbons such as BTEX). Achievable levels of chemical reduction and length of time to accomplish maximum reduction vary from site to site. Bench scale and/or pilot-scale tests are required to ascertain the effectiveness of biological treatment at any particular site.

A.3.1.2 In Situ Soil Vapor Extraction

In Situ Soil Vapor Extraction (ISVE) is a technique used to remove VOC and, to a lesser extent, SVOC organic compounds from the vadose or unsaturated zone. ISVE is an in situ process that makes use of vapor extraction wells or trenches installed in the contaminated zone. The extraction wells/trenches can be used alone or in conjunction with air injection wells that either passively take in atmospheric air or actively use forced air injection. The air strips the volatile compounds from the soil and carries them to the vapor extraction well/trench.

The vacuum extraction process removes chemical vapors trapped in soil pore spaces, but also affects, to a limited extent, residual liquid contaminants and dissolved contaminants from the groundwater. Water in the collected air stream is condensed and separated from the air stream and is transferred to a water treatment system or to waste. The air stream is then treated, if required, prior to reinjection or exhausting to the atmosphere.

Several factors impact the effectiveness of in situ vacuum extraction at any particular site. These factors include:

- chemicals to be treated and concentrations;
- soil temperature;
- soil air permeability;
- moisture content;
- geological conditions; and
- soil sorption capacity.

The ISVE process is very site-specific. The process is best suited for use in permeable, well drained soils with low organic carbon content. Since ISVE works only in the vadose zone, it is sometimes plausible to lower the groundwater level to increase the volume of the unsaturated zone. One method of achieving this is by placing an impermeable cap over the treatment site to minimize surface water infiltration. An impermeable cap can also serve to increase the area of influence by preventing short circuiting of airflow directly to the surface. Factors such as stratigraphy and soil heterogeneities influence the flow of air as well as the location of contaminants. This will have a pronounced effect on the design of the ISVE facility but proper design of the vacuum extraction system may overcome these problems.

Once the area to be treated has been defined, the extraction wells/trenches can be strategically installed such that airflow within the area is maximized while airflow through other areas is minimized. The vapor extraction wells usually consist of screened pipe placed in a permeable packing. The top few feet of the well is grouted to prevent a short circuited airflow to the surface. Vacuum pumps or blowers reduce gas pressure in the extraction wells and induce subsurface airflow to the wells.

As the air travels through the soil, it passes through a series of pores providing the least resistance. Air that passes through pores containing vapor and liquids will strip the contaminants from the soil. Chemicals existing in a condensed phase will vaporize and this process will continue until the condensed phase organics are removed from the higher permeability soil. As cleanup progresses, contaminant removal, especially from areas of low permeability, may become diffusion limited.

The airflow draws chemical vapors and entrained water from the extraction wells to a vapor-liquid separator. In this unit, the liquid is separated and contained for treatment and vapor is advanced to a vapor treatment unit. Monitoring probes can be installed to measure the soil vapor concentrations and sampling ports can be installed at many stages after extraction from the well.

The vapors are typically treated using carbon adsorption, thermal destruction or condensation. Carbon adsorption is the most common method and can be used to accommodate a wide range of VOC concentrations and airflow rates. Thermal incineration and catalytic oxidation are also effective for a wide range of compounds. Condensation by refrigeration can be used to separate the VOCs from the air. This method is most effective for high concentrations of vapors but becomes less effective as the cleanup progresses and vapor concentrations drop. When properly operated, ISVE systems have demonstrated their ability for safe, continuous operation with minimal maintenance. Equipment used in the process can be either mobile or field constructed. Once the equipment has been mobilized, full-scale operations can usually be underway relatively rapidly.

A.3.1.3 In Situ Soil Vapor Extraction with Air Sparging

ISVE with air sparging (ISVE/AS) is a technique that injects pressurized, clean air into the groundwater to volatilize contaminants into the soil vapor for collection using standard ISVE methods. The air injection enhances ISVE in two ways:

i) treatment of groundwater and/or saturated soils can be achieved; and

ii) the clean air increases advective transport of contaminants in the lower unsaturated zone, typically difficult with ISVE alone (often groundwater depression is required to accomplish this).

The air sparging system uses air injection wells screened in the saturated zone below the area of contamination. Air channels upward through the groundwater and soil conveying VOCs into the unsaturated vapor space. From here, the contaminants are collected by the ISVE system for treatment or discharge.

A.3.1.4 Soil Flushing

Soil flushing is an in situ process using a groundwater extraction/reinjection system. The soil flushing process consists of injecting water or a water-surfactant solution throughout the affected soil to enhance the contaminant solubility, which results in increased recovery of contaminants in the leachate or groundwater.

The soil flushing system uses extraction wells or collection trenches installed in the contaminated zone, a reinjection system located upgradient of the contaminated zone, and a wastewater treatment system. Proper control measures must be employed to prevent migration of contaminants via groundwater flow from the area being treated. Sandy soils, for example, may give rise to uncontrolled migration whereas a clay confining layer can be used to inhibit migration. The process can be quickened by the use of ponds or sprinklers over the contaminated zone to accelerate the flushing of chemicals.

The degree to which soil flushing is effective is primarily dependent upon the following factors:

- soil hydraulic conductivity;
- soil organic carbon content; and
- chemical-specific properties such as water solubility, adsorption characteristics, vapor pressure, liquid viscosity and liquid density.

Surfactants can be added to the flushing water to help mobilize chemicals. Surfactants are natural or synthetic chemicals that have the ability to promote wetting, solubilization or emulsification of various organic chemicals.

The extracted water is treated using appropriate technology(ies) depending on the chemicals being removed. The soil flushing technology is chemical specific and has the greatest success when applied to soils containing only a limited number of chemicals to be treated.

A.3.1.5 Bioventing

Bioventing is an effective technology for biological degradation of volatile and, to a lesser extent, non-volatile fractions of hydrocarbons in contaminated soil. However, the presence of chlorinated compounds and certain metals could potentially inhibit the effectiveness of bioventing. This system, engineered to increase the rate of microbial biodegradation in the unsaturated zone using forced air as the oxygen source, is a potentially cost-effective alternative to conventional systems.

By using air as an oxygen source, more complete recovery of contaminants can be achieved due to higher diffusivity of gases over liquids. At many sites, geological heterogeneities create a problem with waterborne oxygen sources because fluid pumped through the formation is channeled into the more permeable pathways. In a gaseous system, this diffusion can take place at several orders of magnitude greater than a liquid system. Studies have shown that by using air as an oxygen source, the minimum ratio of air pumped per hydrocarbon degraded is approximately 13 to 1. This compares to more than 1,000 lb of water per one pound of hydrocarbon for a waterborne process.

The technology relies on air flow through contaminated soils, being at rates and configurations that will ensure adequate oxygenation for aerobic biodegradation. The addition of nutrients and moisture may be desirable to increase biodegradation rates. Gas monitoring points can be installed to sample short vertical sections of the soil. These points are necessary to determine local oxygen concentrations. Monitoring of airflow rates is also important to ensure against volatilization while maintaining adequate biodegradation conditions.

A.3.1.6 Passive Adsorption

Passive adsorption is a method of placing adsorbent-filled cannisters in monitoring wells in contaminated areas to gradually adsorb and concentrate the contaminants for removal and off-Site treatment or disposal. Typically, the cannisters are filled with a hydrophobic polymer such as divinylbenzene. The cannisters are suspended in the monitoring wells where they attract and adsorb contaminants. The cannisters are replaced periodically and the contaminated cannisters are regenerated off-Site for reuse.

Passive adsorption is most effective for compounds that have low polarity and low water solubility.

A.3.2 EX SITU SOIL TREATMENT ACTION

A total of six ex situ treatment process options were identified for potential soil remediation. These process options include:

Biological

1. On-Site biological treatment.

Physical

1. On-Site soil vapor extraction/bioremediation;
2. On-Site low temperature thermal desorption;
3. Incineration: On Site and Off Site;
4. On-Site soil washing; and
5. On-Site mechanical volatilization.

Chemical

1. On-Site solvent extraction.

A.3.2.1 On-Site Biological Treatment

This technology uses biodegradation techniques to degrade the contaminants in the soil or permit them to volatilize into the air. The basic concept involves providing a favorable environment to enhance microbial metabolism of organic contaminants resulting in the breakdown and detoxification of those contaminants.

The biological treatment technology involves aeration and biological degradation of the soils by tilling on an engineered treatment pad. The soils would be placed in a lift of approximately 1 foot thickness on the treatment pad. Tilling would be conducted on a regular basis to aerate the soil. Tilling also promotes volatilization of the contaminants to the surrounding air. Additives can be used to enhance the biodegradation process. This process continues until acceptable contaminant levels are achieved.

The implementation of a biological treatment remedy utilizes common construction techniques, however, depending on the volume and physical nature of the material requiring treatment as well as climatic conditions, the remedy may require a long treatment duration. Biological treatment commonly requires anywhere from three months up to two years for completion per lift. The length of treatment time can be confirmed in treatability studies. Remediation of each batch is confirmed by sampling and analysis.

The major organic (volatile and semi-volatile) chemicals detected in soils at the Site have a high or moderate potential for successful treatment under aeration and/or biological degradation.

Soils would be backfilled on-Site following treatment.

A.3.2.2 On-Site Soil Vapor Extraction/Bioremediation

This treatment technology is similar to biological treatment in that it involves providing a favorable environment to enhance the development of a bacteria culture in the soils. Likewise, this treatment usually involves the addition of nutrients and oxygen to the soil.

A soil vapor extraction/bioremediation system employs a forced aeration system which replaces the mechanical turning used to aerate the soil during biological treatment.

Oxygen is added by mechanically pulling (negative pressure) or pushing (positive pressure) of air through the static soil pile. The advantage of a soil pile is that a cover can be placed over the pile and volatile materials can be controlled and treated (i.e., carbon absorption).

One of the various designs for vapor extraction/bioremediation calls for constructing the soil pile upon an elevated, perforated base through which air is forced into the pile. Another approach involves embedding perforated ducts in a bottom layer of wood chips or other comparable material, upon which the soil is stacked.

For a soil vapor extraction/bioremediation operation to be successful:

- the soil should be granular;
- particle size should be relatively uniform;
- particles should be resistant to compaction;
- the soil pile should not be compacted; and
- the soil must not be excessively moist.

In operations in which forced aeration is used for moisture removal and temperature regulation as well as aeration, amounts and rates of air input will depend upon oxygen demand, moisture content, temperature and their interrelationship. Drying and destruction of volatile solids are greatest at high aeration rates and low process temperatures.

Soils would be backfilled on-Site following treatment.

A.3.2.3 On-Site Low Temperature Thermal Desorption

Thermal Desorption (LTTD) technology encompasses processes that are essentially physical separations based on the differences in vapor pressure between the organic contaminants and the affected matrix (i.e., soil). LTTD is a potential treatment technology for soils which have a high solid content with low to medium levels (<10%) of organic compounds. LTTD involves heating the soil to the appropriate temperature (200°F TO 1100°F) to cause volatilization of organic compounds into a carrier gas. The treatment process requires excavation of all contaminated soil with concentrations above soil chemical cleanup goals. Typical treatment rates for LTTD rotary kilns are approximately 75 to 150 tons of soil per day.

Excavated soils are placed into a desorber and are heated. Heating is used to increase the relative volatilities between the contaminants and the matrix enough to cause vaporization of the organics and moisture into a gas stream. Temperatures used for LTTD are related to the contaminants boiling points and generally range from 200 to 1100°F The carrier (purge) gas stream, usually an inert gas, is used to transport the volatilized compounds to a condenser where the gas stream is cooled in stages to low temperatures to condense the volatilized water and organics into liquids. An inert gas is used because it lowers the oxygen content in the desorber (heater) and results in the inhibition of combustion reactions.

The LTTD process has been successfully applied to solids, sludges, sediments and filter cakes which contain greater than 10 percent organics and less than 30 percent solids. Contaminants which have been successfully treated by LTTD in laboratory, pilot or full-scale processes include VOCs, SVOC, polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins and petroleum contaminated wastes.

Soils would be backfilled on Site following treatment.

A.3.2.4 Incineration - On-Site and Off-Site

Incineration is a treatment method for organic compounds which uses high temperature oxidation under controlled conditions to degrade a substance into carbon dioxide, water vapor, sulfur dioxide, nitrogen oxides, hydrogen chloride gases, and ash. Other emissions representing incomplete oxidation in the incinerator include carbon monoxide, unoxidized organic gases and products of incomplete combustion (PIC). The hazardous products of incineration, such as particulates, sulfur dioxide, nitrogen oxides, hydrogen chloride, unoxidized organic gases and

PICs require air emission control equipment. Incineration can be conducted either on Site or off Site.

The most common on- and off-Site system is the Rotary Kiln Incinerator (RKI). The contaminated soil is fed into the kiln at the top end and is passed through a combustion zone as the kiln rotates. The rotation creates turbulence which improves combustion. Incinerator residence times and temperatures are developed from the combustion characteristics and chemical properties of the waste. The units may be fueled by natural gas, propane or oil, and afterburners are often employed to ensure complete combustion.

When soil is incinerated, there is a small reduction in volume while the geologic nature of the soil remains the same, depending on the moisture and organic content of the soil. Inorganic contaminants (e.g., metals) are generally not destroyed by incineration but may be partially removed as a gaseous emission or adsorbed to particulates.

Incineration methods have demonstrated destruction and removal efficiencies greater than 99.99 percent and, in many cases, contaminants are not detectable in the remaining ash.

The remaining ash (i.e., soil) would be backfilled on Site following on-Site treatment.

A.3.2.5 On-Site Solvent Extraction

Solvent extraction is a process that is suitable for the treatment of materials with varying compositions of water, oil and solids. This technology has not been widely used for full-scale operations and, therefore, its effectiveness and reliability for the reduction of hazardous constituents in soils are questionable.

The solvent extraction process involves mixing potentially contaminated soils with an aliphatic solvent, such as triethylamine (TEA), at low temperatures in a vessel equipped with steel paddles or plows for mixing. The first extraction of the potentially contaminated soil is conducted at a temperature below 40°F. At low temperatures the solvent is miscible in water and solubilizes hydrocarbons. The homogeneous liquid phase separates from the soil and is pumped into a decanter. The remaining solids portion is "washed" again in the solvent at higher temperatures of about 130°F. At these temperatures, solubility of the organic compounds in the solvent increases which enhances their removal from the potentially contaminated soils. The required number of "washes" varies depending upon soil conditions and contaminants present. Once the liquid phase from the last "wash" is removed from the solids, the solids are dried by injecting steam in the jacket surrounding the vessel. Steam is also injected into the solids to strip any remaining solvent, which is later recovered.

The liquid phase from the initial extraction is heated to the temperature at which the solvent and water becomes immiscible (130°F for TEA). The chemicals, however, remain with the solvent. The solvent-chemical portion is pumped into a solvent recovery system along with the liquid phase from the subsequent extractions at higher temperatures. The solvent recovery system may consist of an evaporator or an evaporator combined with a distillation column. The solvent is condensed and reused, and the chemicals that are removed from the soil are sent off for disposal or treatment. The water portion is pumped to a stripping column to remove any traces of the solvent. The remaining water can be treated on Site through a carbon filter unit or collected and disposed of off Site.

Soils would be backfilled on-Site following treatment.

A.3.2.6 Soil Washing

Soil washing can be conducted on excavated soil and involves contacting the soils with water to partition the contaminants from the solid phase to the liquid phase. Excavated soil is slurried with water to remove contaminants from the soil and pumped through a filter press to separate the soil from the water. The contaminated water is then collected for treatment.

The effectiveness of soil washing with water is determined by the water solubility of the chemical compound, the tendency of a compound to adsorb to the soil, the porosity of waste and the contact time between waste and water. This technology can be enhanced by the use of surfactants to increase contaminant removal.

On entry into the washing unit, the soil passes into a soil scrubber, where it is sprayed with the washing fluid. Soil particles greater than two millimeters (mm) in diameter are sorted, rinsed, leave the scrubber and are dewatered. The remaining soil enters a chemical extractor where washing fluid is passed countercurrent to the soil flow, removing the contaminants.

The soil washing process is associated with the generation of a wastewater stream which must be collected and treated. This treatment can include such technologies as incineration and biological degradation.

Soils would be backfilled on-Site following treatment.

A.3.2.7 On-Site Mechanical Volatilization

Mechanical volatilization refers to the ex situ process of treating VOCs in soil by physical aeration methods. Excavated soil is placed in a mobile treatment unit and physically treated to enhance the volatilization of constituents within the soil.

The mobile treatment unit typically consists of a screening plant, pugmill and hammermill shredder. The process by which the soils are treated is as follows:

- excavated soils to be treated are screened to remove large, non-processable materials and debris;

- soils are then amended with additives, if necessary, utilizing a pugmill to reduce moisture content and/or reduce inhibiting treatment parameters;

- amended soils are then processed through a hammermill shredder to shred and work the soils, thereby reducing the particle size and volatilizing the VOCs within the soil to the atmosphere;

- processed soils are rescreened and/or reprocessed as necessary, until the soils meet the required cleanup objectives; and

- treated soils are backfilled.

Chemical constituents are typically allowed to volatilize directly to the atmosphere. However, air emission controls such as a treatment containment structure with off-gas treatment could be added to the mechanical volatilization process to reduce short-term risks to the community and workers.

Mechanical volatilization may be conducted separately or in conjunction with other ex situ treatment technologies such as soil vapor extraction/bioremediation.

A.4.0 EVALUATION OF SOIL TREATMENT TECHNOLOGIES

The biological, physical, and chemical technologies and process options presented in Section A.3 are all considered to be technically implementable for the soils at the Site. All of the technologies and process options are, therefore, retained for further evaluation in this section. The evaluation considers technical effectiveness, Site-specific implementability, and estimated cost. These terms are defined in the following paragraphs.

Effectiveness

This criterion addresses the ability for a technology process option to reduce the toxicity, mobility and volume of contaminants in soil and groundwater at the Site.

Table A.2 presents a comparative summary of the effectiveness of each technology process option.

Implementability

This criterion addresses the ability for an alternative to be constructed in a reasonable time frame using accepted technologies. The technical feasibility to construct and reliably operate a remedy is evaluated, and each alternative will be rated as either readily implemented, implemented with moderate concerns addressed or difficult to implement.

A summary of implementability for the soil treatment process options is presented in Table A.3.

Cost

This criterion provides an estimate of the total cost to implement each technology process option based on typical unit costs and estimated volumes. These comparative costs are based on engineering judgment rather than detailed estimates to assess the relative cost of each technology process option.

TABLE A.2

SUMMARY OF EFFECTIVENESS
OF SOIL TREATMENT TECHNOLOGIES
LEICA INC.
CHEEKTOWAGA, NEW YORK

IN SITU TECHNOLOGIES

Area	*In Situ Bio Treatment*	*In Situ Vapor Extraction*	*In Situ Vapor Extraction with Air Sparging*	*In Situ Soil Flushing*	*In Situ Bio Venting*	*Passive Adsorption*
Northeast						
• Shallow	3	3	3	3	3	3
• Deep	3	3	3	2	3	2
Southeast						
• Shallow	3	3	3	3	3	3
• Deep	3	3	3	2	3	2
SESA						
• Shallow	3	3	3	3	3	3
• Deep	3	3	3	2	3	2
FDSA						
• Shallow	3	3	3	3	3	3

EX SITU TECHNOLOGIES

Area	*Ex Situ Bio Treatment*	*Ex Situ Vapor Extraction*	*LTTD*	*On-Site Incineration*	*Off-Site Incineration*	*Ex Situ Solvent Extraction*	*Ex Situ Soil Washing*	*Ex Situ Mechanical Volatilization*
Northeast								
• Shallow	2	1	1	1	1	2	3	1
• Deep	2	1	1	1	1	2	3	1
Southeast								
• Shallow	2	1	1	1	1	2	3	2
• Deep	2	1	1	1	1	2	3	2
SESA								
• Shallow	2	1	1	1	1	2	3	1
• Deep	2	1	1	1	1	2	3	1
FDSA								
• Shallow	2	1	1	1	1	2	3	1

Notes:

1 Highly effective
2 Moderately effective
3 Low effectiveness

FDSA - Former Drum Storage Area
SESA - Southeast Secondary Area

TABLE A.3

SUMMARY OF IMPLEMENTABILITY
OF SOIL TREATMENT TECHNOLOGIES
LEICA INC.
CHEEKTOWAGA, NEW YORK

	IN SITU TECHNOLOGIES						*EX SITU TECHNOLOGIES*							
Area	*In Situ Bio Treatment*	*In Situ Vapor Extraction*	*In Situ Vapor Extraction with Air Sparging*	*In Situ Soil Flushing*	*In Situ Bio Venting*	*Passive Adsorption*	*Ex Situ Bio Treatment*	*Ex Situ Vapor Extraction*	*LTTD*	*On-Site Incineration*	*Off-Site Incineration*	*Ex Situ Solvent Extraction*	*Ex Situ Soil Washing*	*Ex Situ Mechanical Volatilization*
Northeast														
• Shallow	1	1	1	1	1	1	1	1	1	3	2	3	1	2
• Deep	1	1	1	1	1	1	1	1	1	3	2	3	1	2
Southeast														
• Shallow	1	1	1	1	1	1	1	1	1	3	2	3	1	3
• Deep	1	1	1	1	1	1	1	1	1	3	2	3	1	3
SESA														
• Shallow	1	1	1	1	1	1	1	1	1	3	2	3	1	2
• Deep	1	1	1	1	1	1	1	1	1	3	2	3	1	2
FDSA														
• Shallow	1	1	1	1	1	1	1	1	1	3	2	3	1	2

Notes:

1. Readily implementable
2. Implementable with moderate concerns
3. Difficult to implement

FDSA - Former Drum Storage Area
SESA - Southeast Secondary Area
Ex Situ treatment technologies typically have a high potential for fugitive air emission either during excavation and/or treatment.

Table A.4 presents a summary of costs for each technology process option.

A.4.1 IN SITU TREATMENT ACTION

A.4.1.1 In Situ Biological Treatment

Effectiveness

In situ biological treatment would not be an effective technology at the Leica Site. Chlorinated solvents, such as trichloroethene, are difficult to treat biologically under ideal conditions. At this site, the low permeability of the native lake sediments which underlie the fill within the shallow soils would severely limit the transport of nutrients and/or oxygen to the impacted areas. Additionally, contaminant levels are low and heterogenously distributed. Typically, higher concentrations are more amenable to treatment with biological methods. Table A.2 summarizes the effectiveness of in situ biological treatment on a comparative basis for each area.

Implementability

The construction components of this system are readily implementable using common construction techniques. Treatability analyses and pilot tests would be required to develop design parameters for the system. Table A.3 provides a comparative summary of the implementability of biological treatment for each area.

Costs

Typical costs for biological treatment range from $60 to $150/cubic yard. Table A.4 presents a summary of estimated costs for each area.

TABLE A.4

SUMMARY OF ESTIMATED COSTS
SOIL TREATMENT TECHNOLOGIES
(COST IN $1,000)
LEICA INC.
CHEEKTOWAGA, NEW YORK

	IN SITU TECHNOLOGIES						*EX SITU TECHNOLOGIES*							
Area	*In Situ Bio Treatment*	*In Situ Vapor Extraction*	*In Situ Vapor Extraction with Air Sparging*	*In Situ Soil Flushing*	*In Situ Bio Venting*	*Passive Adsorption*	*Ex Situ Bio Treatment*	*Ex Situ Vapor Extraction*	*LTTD*	*On-Site Incineration*	*Off-Site Incineration*	*Ex Situ Solvent Extraction*	*Ex Situ Soil Washing*	*Ex Situ Mechanical Volatilization*
Northeast														
• Shallow	194 - 485	65 - 226	129 - 323	194 - 485	97 - 258	163 - 323	226 - 485	162 - 323	485 - 969	646 - 1,292	1,712 - 3,004	485 - 1,615	485 - 969	113 - 404
• Deep	166 - 416	55 - 194	111 - 277	166 - 416	83 - 222	139 - 277	194 - 416	139 - 277	416 - 831	554 - 1,108	1,468 - 2,576	416 - 1,385	416 - 831	97 - 346
Southeast														
• Shallow	466 - 1,164	155 - 543	310 - 776	466 - 1,164	233 - 621	388 - 776	543 - 1,164	388 - 776	1,164 - 2,328	1,552 - 3,104	4,113 - 7,217	1,164 - 3,880	1,164 - 2,328	272 - 970
• Deep	147 - 368	49 - 172	98 - 245	147 - 368	74 - 196	123 - 245	172 - 368	123 - 245	368 - 735	490 - 980	1,299 - 2,279	368 - 1,225	368 - 735	86 - 306
SESA														
• Shallow	586 - 1463	195 - 683	390 - 975	586 - 1463	293 - 781	488 -975	683 - 1463	488 - 975	1,463 - 2,926	1,951 - 3,902	5,170 - 9,072	1,463 - 4,877	1,463 - 2,926	341 - 1219
• Deep	127 - 318	42 - 148	85 - 212	127 - 318	64 - 170	106 - 212	148 - 318	106 - 212	318 - 636	424 - 848	1,124 - 1,972	318 - 1,060	318 - 636	74 - 265
FDSA														
• Shallow	NA	NA	NA	NA	NA	NA	8 - 17	6 - 11	17 - 34	22 - 44	58 - 102	17 - 55	17 - 34	4 - 14
Total	1,687 - 4,213	561 - 1,965	1,122 - 2,808	1,687 - 4,213	843 - 2,247	1,404 - 2,808	1,973 - 4,229	1,410 - 2,819	4,229 - 8,458	5,639 - 11,278	14,944 - 26,222	4,229 - 14,097	4,229 - 8,458	987 - 3,524

Notes:

FDSA - Former Drum Storage Area
SESA - Southeast Secondary Area

A.4.1.2 In Situ Soil Vapor Extraction

Effectiveness

ISVE would be an effective means of treating primarily the volatile organic compounds present in permeable, non-saturated soils at the Site. However, this is a limited component at the Site; the deep areas are seasonally saturated, and the shallow areas include the low permeability lake sediments. Overall, this would be an ineffective technology. Table A.2 summarizes the effectiveness of ISVE on a comparative basis for each area.

Implementability

ISVE can be readily implemented and has been used effectively at many sites. A treatability analysis and pilot test would be required to develop the system design parameters. Table A.3 summarizes the implementability of ISVE on a comparative basis for each area.

Costs

Typical costs for an ISVE system range from $20 to $70/cubic yard. Table A.4 presents a summary of estimated costs for each area.

A.4.1.3 In Situ Soil Vapor Extraction With Air Sparging

Air sparging, in conjunction with ISVE, would not be an effective means of removing and collecting VOCs from the Site soils and groundwater. Air sparged into the deeper groundwater would volatilize organics; however, due to the impermeable overlying lake sediment layer, the contaminants would not be readily collected via ISVE, and they may migrate to other areas. Air sparging in the shallow soils would not be effective due to the low permeability at the Site. Table A.2 summarizes the effectiveness of ISVE on a comparative basis for each area.

Implementability

ISVE with air sparging can be readily implemented. A pilot test would be required to develop the system design parameters. Table A.3 summarizes the implementability of ISVE on a comparative basis for each area.

Costs

Typical costs for ISVE with air sparging range from $40 to $100/cubic yard. Table A.4 presents a summary of estimated costs for each area.

A.4.1.4 Soil Flushing

Effectiveness

In situ soil flushing is dependent on soil permeability, and would not be effective in the low permeability, shallow soils. This treatment would have limited effectiveness for the chlorinated compounds in the deeper soils which have a relatively low water solubility. Hence, the treatment time would be very lengthy. In addition, care would have to be taken to prevent migration of flushed chemicals via the groundwater flow system from the treatment area to the underlying bedrock aquifer. Table A.2 summarizes the effectiveness of soil flushing as treatment alternative for each area.

Implementability

The construction components of this system are readily implementable using common construction techniques. Treatability analyses and pilot tests would be required to develop design parameters for the system. Table A.3 summarizes the implementability of soil flushing on a comparative basis for each area.

Costs

Costs for soil flushing typically range from $60 to $150/cubic yard. Table A.4 presents a summary of estimated costs for each area.

A.4.1.5 Bioventing

Effectiveness

Bioventing combines biological and ISVE technologies. Due to the ineffectiveness of both of these technologies, as discussed in Sections A.4.1.1 and A.4.1.2, bioventing would not be effective at this Site. Table A.2 summarizes the effectiveness of bioventing as a treatment alternative for each area.

Implementability

Bioventing can be readily implemented. However, treatability analyses and pilot studies would be required to develop the design parameters. Table A.3 summarizes the implementability of bioventing on a comparative basis for each area.

Costs

Typical costs for bioventing range from $30 to $80/cubic yard. Table A.4 presents a summary of estimated costs for each area.

A.4.1.6 Passive Adsorption

Effectiveness

Passive adsorption would be an effective means of reducing the concentrations of contaminants in the deep permeable soils at the Site; however, it is unlikely that soil cleanup objectives would be achieved in a reasonable amount of time. Passive adsorption would not be effective in low permeability soils such as those found in the shallow zone. Table A.2 summarizes the effectiveness of passive adsorption as a treatment alternative in each area.

Implementability

Passive adsorption can be readily implemented using standard construction techniques. However, treatability testing may be required to select an appropriate polymer for the mix of chemistry at the Site. Table A.3 summarizes the implementability of passive adsorption on a comparative basis for each area.

Costs

Costs for passive adsorption are estimated at $50 to $100/cubic yard. Table A.4 presents a summary of estimated costs for each area.

A.4.1.7 Summary

The potential effectiveness of any of the identified in situ technologies and process options depend upon Site-specific parameters such as soil type, permeability, degree of homogeneity, and the nature and degree of chemical impact. In general, all of the identified process options have a documentable track record of laboratory and on-Site success. The layer of low permeability lake sediment at the Leica Site limits the potential effectiveness of many in situ process options due to the limited mobility of contaminants in this unit.

Many of the commercial vendors of these technologies and process options can provide documentation of cases where they were applied successfully. At a minimum, a laboratory-scale treatability study using impacted soil obtained from the Site would be required. However, treatment data obtained under laboratory-controlled conditions will likely only approximate the results achievable on Site. In many cases, a pilot-scale test, executed on Site, either in lieu of or in conjunction with a laboratory treatability study, would provide the data necessary for evaluating the effectiveness of a particular treatment technology or process option.

The estimated effectiveness of each process option in each area is presented in Table A.2. Process options such as soil vapor extraction and air sparging, which would be ideally suited for the low concentrations of VOCs at the Site, would not be effective due to the low permeability shallow soils.

Passive adsorption would have limited effectiveness in reducing contaminant levels over time.

Based upon this evaluation, in situ technologies and process options are not considered to be effective for the treatment of the soils at the Site in a reasonable amount of time. Technologies and process options such as soil flushing in conjunction with hydraulic containment may reduce the time required for the remediation of overburden soils at the Site.

A.4.2 EX SITU SOIL TREATMENT ACTION

All of the ex situ treatment process options would require excavation of the soils to be treated, and all are considered technically implementable. Excavation can be readily accomplished, although some temporary shoring and dewatering may be necessary. Due to potentially high emission rates from the soils, mitigation techniques may be required to control chemical emissions during excavation. In addition, excavation and backfilling operations would cause a disruption to the daily Plant activities in the northeast and southeast areas of the Site.

The cost estimates presented for ex situ treatment include excavation and backfilling costs.

A.4.2.1 <u>On-Site Biological Treatment</u>

<u>Effectiveness</u>

It is expected that this technology would be effective in reducing the chemical concentrations to acceptable levels, however, treatability tests would be required to assess the treatment duration and effectiveness in meeting potential soil cleanup goals. During the biological treatment process, some of the chemicals, especially the chlorinated compounds, would be more susceptible to volatilization (aeration) whereas other chemicals would be treated primarily by bioremediation. One of the disadvantages of this technology is the potential for excessive air emissions due to the volatilization of chemicals and fugitive dust emissions during the treatment process. If required, mitigative measures would be used to control emissions such as covering the treatment pad with a polyethylene cover, minimizing the area of soil tilled at any one time, or conducting the treatment process within an enclosed area(s). This technology would also result in a considerably longer treatment period than other technologies such as low temperature thermal desorption or incineration. Table A.2 summarizes the effectiveness of biological treatment as applied to each area.

<u>Implementability</u>

This technology process option would use common construction techniques. Due to the potential high emission rates from the soils, workers may be required to wear respiratory protection during the treatment process. Treatability studies would be required to develop the design parameters. A RCRA permit and a New York State air permit may be required for this treatment process. Table A.3 summarizes the implementability of biological treatment for each area.

Cost

Biological treatment costs would be approximately $70 to $150/cubic yard. Table A.4 presents a summary of estimated total costs for this technology process option as applied to each area.

A.4.2.2 Ex Situ Soil Vapor Extraction/Bioremediation

Effectiveness

Ex situ soil vapor extraction (ESVE) would be effective in reducing the chemicals to acceptable levels. A cover can be placed over the soil pile to reduce chemical emissions during treatment if required. One disadvantage of this technology is the increased volume of material requiring backfilling as a result of the addition of moisture retention material (e.g., wood chips). In addition, treatment duration would be considerably longer than for other processes such as low temperature thermal desorption or incineration. Table A.2 summarizes the effectiveness of this technology process option as applied to each area.

High exposure rate to excavated soil

Implementability

This alternative would use common construction techniques and, therefore, is readily implementable. Treatability analyses would be required to determine treatment duration. Table A.3 summarizes the implementability of this technology for each area.

Cost

The cost for treatment of the soils using ESVE technology is approximately $50 to $100/cubic yard. Table A.4 presents a summary of estimated total costs for this technology as applied to each area.

A.4.2.3 On-Site Low Temperature Thermal Desorption

Effectiveness

Low temperature thermal desorption (LTTD) is an effective means of removing organic compounds from contaminated soils. It is expected that low ppb concentrations can be obtained using this treatment technology, however, pilot tests would be required to optimize the treatment process and determine obtainable soil cleanup objectives. Table A.2 summarizes the effectiveness of low temperature thermal desorption as applied to each area.

Implementability

Mobile LTTD treatment units are available from several suppliers and, therefore, the technology can be readily implemented. A RCRA permit and a New York State air permit may be required for operation of the unit. As this treatment process is conducted in an enclosed unit, and exhaust gases are treated prior to discharge, chemical emissions to the atmosphere during treatment would be insignificant. Table A.3 summarizes the implementability of LTTD for each area.

Not if CAMU established

Cost

The cost for treatment of soil using LTTD is approximately $150 to $300/cubic yard. Table A.4 presents a summary of estimated total costs for this technology as applied to each area.

A.4.2.4 On-Site Incineration

Effectiveness

Incineration is a proven technology with a demonstrated removal efficiency greater than 99.99 percent. Trial burns are required to optimize the temperature and residence time for maximum efficiency. However, hazardous products of incineration such as particulates, sulfur dioxide, nitrogen oxides and hydrogen chloride in the off gas require air emission control equipment and disposal as a hazardous waste. This technology is not effective in treating inorganic parameters. Table A.2 summarizes the effectiveness of this technology as applied to each area.

Implementability

On-Site incineration would require a trial burn and permitting which translates to a Remedial Design/Remedial Action period of approximately two years for capital works. Soil remediation would take an additional 4 to 8 months. The necessity to comply with permitting requirements could present a significant obstacle to the implementation of on-Site incineration. Other concerns include recent guidance by the USEPA which requires a Site-specific risk assessment before an incinerator is brought to the Site. In addition, public acceptance of an on-Site incinerator may be a concern. Table A.3 summarizes the implementability of on-Site incineration for each area.

Cost

On-Site incineration costs are in the range of \$200 to \$400/yd^3. Table A.4 presents a summary of estimated total costs for this technology as applied to each area.

A.4.2.5 Off-Site Incineration

Effectiveness

The off-Site incineration option would have the same effectiveness as the on-Site incineration option discussed in Section A.4.2.4 (see Table A.2).

Implementability

Approvals would be required from the selected incineration facility to permit off-Site incineration. Obtaining these approvals could result in substantial delays in implementation. Table A.3 summarizes the implementability of off-Site incineration.

Costs

Off-Site incineration typically costs approximately \$400 to \$800/yd^3 plus an additional \$200/ton (\$130/yd^3) for transportation. This cost is considered very high in comparison to other treatment alternatives evaluated herein. Table A.4 presents estimated total costs for this technology as applied to each area.

A.4.2.6 On-Site Solvent Extraction

Effectiveness

Solvent extraction is a technology developed for removing organic chemicals. This technology is not widely used and, therefore, its effectiveness and reliability are questionable. A laboratory treatability and/or pilot test would be required to ascertain the effectiveness on a Site-specific/chemical-specific basis. Table A.2 summarizes the effectiveness of this technology as applied to each area.

As the solvent extraction treatment process is conducted in an enclosed unit, chemical emissions to the atmosphere would not occur from the treatment process. Compounds removed from the soil would be transported off-Site for permanent disposal.

Implementability

Due to the limited number of mobile solvent extraction units currently available, a lengthy delay may be incurred between the time at which a decision to utilize this technology is made and the time when a unit can be mobilized to the Site. Table A.3 summarizes the implementability of this technology for each area.

A RCRA permit and a New York State air permit may be required for operation of the treatment unit.

Cost

Costs for treatment of soil using a solvent extraction treatment unit is approximately $150 to $500/cubic yard. Table A.4 presents estimated total costs for this technology as applied to each area.

A.4.2.7 On-Site Soil Washing

Effectiveness

Soil washing would have limited effectiveness for some Site-related compounds which have a relatively low water solubility such as trichloroethene. This process generates an additional waste, contaminated water, which must then be treated and disposed. Table A.2 summarizes the effectiveness of this technology as applied to each area.

Implementability

Soil washing is readily implementable. A treatability study would be required to evaluate the effectiveness of this treatment process. Table A.3 summarizes the implementability of this technology as applied to each area.

Costs

The cost for treatment of soil using soil washing is approximately $150 to $300/cubic yard. Refer to Table A.4 for a summary of estimated total costs for this technology as applied to each area.

A.4.2.8 Mechanical Volatilization

Effectiveness

Mechanical volatilization is an effective technology for removing the VOCs from the contaminated soil at the Site. However, this process does not typically reduce or treat contaminants, but instead, transfers VOCs to the atmosphere where they are eventually photooxidized to non-toxic constituents. Alternatively, the treatment process could be contained in a temporary enclosure with off-gas treatment prior to discharge to the atmosphere.

Less volatile compounds that exceed cleanup objectives including phenol, 2-methylphenol and 2,4-dimethylphenol may be difficult to treat using mechanical volatilization. In addition, total petroleum hydrocarbons (TPH) may not be effectively treated by this technology.

Soils with higher concentrations of total VOCs and/or NAPL may not be suitable for treatment by mechanical volatilization due to the significantly higher rate of emissions that would be expected. According to the New York State Department of Environmental Conservation (NYSDEC), mechanical volatilization is typically applied to soils with concentrations in the 14 to 15 mg/kg range. The average total concentrations in Area C, which consists of approximately 22,000 yd^3 of soil, is estimated to be approximately 450 mg/kg. The average total VOC concentration in Areas A and B, which consist of a combined total of approximately 6,100 yd^3 of soil, is less than 22 mg/kg. Mechanical volatilization may, therefore, be an effective technology for the soils with lower concentrations in Areas A and B and any low level contaminated soil that can be segregated from Area C. In addition, if used in combination with other ex situ treatment options, mechanical volatilization would be an effective means of pretreatment.

Table A.2 summarizes the effectiveness of mechanical volatilization as applied to each area.

Implementability

Mechanical volatilization is technically readily implementable. The equipment required for mechanical volatilization is available from many suppliers. However, one of the disadvantages of this technology is the potential for excessive air and fugitive dust emissions. Chemical constituents are typically allowed to volatilize directly to the atmosphere, thereby potentially increasing short-term risks to the community and workers.

Air monitoring would be conducted to ensure that air emissions do not exceed allowable discharge limits (in accordance with Draft New York State Air Guide 1, 1991). If required, mitigative measures could be used to control emissions such as enclosing the treatment unit in a temporary structure or reducing the treatment rate.

Treatability studies would be required to develop the design parameters. A RCRA permit and a New York State air permit may be required for this treatment process. Table A.3 summarizes the implementability of mechanical volatilization for each area.

Cost

The cost for treatment of soil using mechanical volatilization is approximately $35 to $125/cubic yard. Table A.4 presents a summary of estimated total costs for this technology as applied to each area.

A.4.2.9 Summary

The most effective ex situ technologies for the treatment of contaminants in the soils are LTTD or on-Site or off-Site incineration. These technology processes would result in the permanent destruction of Site-related chemicals. However, these technologies are not considered to be cost-effective in comparison to ex situ vapor extraction/bioremediation and mechanical volatilization.

The costs for these technology process options to treat soils in the northeast, southeast and former drum storage areas are summarized below:

Low Temperature Thermal Extraction	$2,450,000	-	$ 4,897,000
On-Site Incineration	$3,264,000	-	$ 6,528,000
Off-Site Incineration	$8,120,000	-	$14,248,000
Ex Situ Soil Vapor Extraction/Bioremediation	$ 818,000	-	$ 1,632,000
Mechanical Volatilization	$ 572,000	-	$ 2,040,000

Mechanical volatilization may be effective for soils with low level contamination (i.e., less than 15 mg/kg) and/or as a pretreatment prior to ex situ soil vapor extraction/bioremediation. Although mechanical volatilization would be cost-effective for the treatment of the majority of the compounds at the Site, community acceptance may hinder the implementation of this treatment option.

Based upon this evaluation, it is concluded that ex situ soil vapor extraction/bioremediation is the most cost-effective ex situ treatment technology for the areas under consideration at this Site. ESVE will require a longer treatment period than the thermal alternatives, but this is not considered to be a significant disadvantage. ESVE may be supplemented by mechanical volatilization to reduce the contaminant reduction time frame.

B

APPENDIX B

ASSESSMENT OF GROUNDWATER TREATMENT TECHNOLOGIES

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF ATTACHMENTS

B.1.0 INTRODUCTION

This Appendix presents a description and evaluation of potential groundwater treatment technologies and process options that may be applicable for treating the chemicals in the groundwater at the Site.

Section B.2 provides an evaluation of the estimated concentrations of the chemicals in the extracted groundwater as well as a summary of the potential groundwater cleanup standards.

Section B.3 presents a description of the alternative groundwater treatment options.

Section B.4 presents an evaluation of the groundwater treatment alternatives with respect to effectiveness, implementability and cost.

Finally, Section B.5 presents a summary of the evaluation of the groundwater treatment technologies and process options presented in this Appendix.

B.2.0 ESTIMATED GROUNDWATER TREATMENT FACILITY (GTF) INFLUENT CONCENTRATIONS

A groundwater treatment facility (GTF) will be required to treat the groundwater extracted from the Leica site in order to reduce chemical concentrations to acceptable levels prior to discharge to the environment. Overburden groundwater will be collected by the southeast and northeast hydraulic containment and source removal trenches (see Appendix C). Bedrock groundwater will be collected by the southeast and northeast extraction wells (see Appendix C).

The southeast and northeast overburden trenches are projected to yield 0.22 and 0.05 gpm of groundwater, respectively. The southeast and northeast bedrock wells are projected to yield 10 gpm of groundwater each. Therefore, the total combined projected groundwater treatment system influent flowrate is estimated to be 20.3 gpm. A pump test will be necessary to confirm groundwater yields prior to detailed design of the groundwater treatment system. Allowing for a 20 percent safety factor, the groundwater treatment system design flowrate selected for this feasibility study is estimated to be 25 gpm.

Estimated groundwater contaminant concentrations for each overburden collection trench and each bedrock extraction well are summarized in Table B.1. Groundwater treatment system influent concentrations have also been projected in Table B.1. A pump test is recommended to confirm contaminant concentrations under dynamic conditions.

The combined groundwater flow will require volatile organic compound (VOC) removal prior to discharge. Semivolatile organic components will be present in trace quantities only and hence will not require treatment to meet acceptable criteria prior to discharge.

Metals concentrations will be comparable to background concentrations. Metal removal may not be necessary for compliance

TABLE B.1

GROUNDWATER TREATMENT FACILITY INFLUENT CONCENTRATIONS (1)
LEICA INC.
CHEEKTOWAGA, NEW YORK

Component	Overburden Groundwater Collection Trenches				Bedrock Groundwater Extraction wells				Groundwater Treatment System Influent	
	Southeast Trench		Northeast Trench		Southeast Well		Northeast Well			
	Flow(gpm)	Conc. (ppb)	Flow(gpm)	Conc. (ppb)	Flow(gpm)	Conc. (ppb)	Flow(gpm)	Conc. (ppb)	Flow(gpm)	Conc. (ppb)
Volatiles										
1,1,1,-Trichloroethane	0.26		0.08	87	10	18	10	3667	20.3	1812.0
1,1,2-Trichloroethane	0.26		0.08		10		10	13	20.3	6.4
1,1-Dichloroethane	0.26		0.08	6500	10	14	10	1491	20.3	765.5
1,1-Dichloroethene	0.26	1010	0.08	630	10	140	10	404	20.3	282.8
1,2-Dichloroethene (total)	0.26	149195	0.08	8200	10	17272	10	11710	20.3	16188.1
4-Methyl-2-pentanone	0.26		0.08		10	12	10	91	20.3	50.6
2-Butanone	0.26		0.08		10		10	43	20.3	21.1
Acetone	0.26		0.08		10	15	10		20.3	7.4
Benzene	0.26	31	0.08	2	10	67	10	18	20.3	42.2
Carbon disulfide	0.26		0.08		10	3	10	7	20.3	4.9
Chlorobenzene	0.26		0.08		10		10	2	20.3	1.0
Chloroethane	0.26		0.08		10		10	160	20.3	78.7
Chloroform	0.26		0.08		10		10	8	20.3	3.9
Ethylbenzene	0.26	74	0.08	2200	10	140	10	1001	20.3	570.6
Methylene Chloride	0.26		0.08		10	2	10	10	20.3	5.9
Tetrachloroethene	0.26	19	0.08	9	10		10	33	20.3	16.5
Toluene	0.26	230	0.08	1100	10	180	10	901	20.3	538.7
Trichloroethene	0.26	69549	0.08	6800	10	150	10	29458	20.3	15472.3
Vinyl chloride	0.26	18837	0.08	75	10	6342	10	2450	20.3	4563.6
Xylene (total)	0.26	2895	0.08	5200	10	3501	10	5002	20.3	4237.9
Semi-Volatiles										
2,4-Dimethylphenol	0.26		0.08	26	10		10		20.3	0.1
2-Methylphenol	0.26		0.08	4	10		10		20.3	0.0
4-Chloro-3-methylphenol	0.26		0.08	19	10		10		20.3	0.1
4-Methylphenol	0.26		0.08	5	10		10		20.3	0.0
Napthalene	0.26		0.08	42	10		10		20.3	0.2
Conventionals	0.26		0.08		10		10			
pH (standard units)	0.26		0.08		10		10		20.3	7.0
Conductivity (umho/cm)	0.26		0.08		10		10		20.3	1300.0
Temperature (Degrees C)	0.26		0.08		10		10		20.3	11.5
Calcium (mg/L)	0.26	380	0.08	168	10	156.5	10	80.5	20.3	122.0
Magnesium (mg/L)	0.26	310	0.08	55.7	10	120	10	32.3	20.3	79.1
Iron (mg/L)	0.26	10	0.08	21.6	10	8.775	10	5.62	20.3	7.3

Notes:

1. Concentrations are µg/L unless otherwise noted.

purposes. However, metals pretreatment will be essential to protect any VOC removal facilities selected.

B.3.0 ALTERNATIVE GROUNDWATER TREATMENT PROCESS OPTION DESCRIPTIONS

The core of the groundwater treatment facility (GTF) will be the VOC removal system. Seven VOC removal/treatment options were considered for the Leica site. Each VOC removal/treatment technology will require pretreatment and/or post-treatment to prevent maintenance problems. Three metals pretreatment/post-treatment options were considered for the selected VOC removal/treatment options. The response actions, groundwater remediation technologies and process options evaluated for this groundwater treatment system are listed below. Descriptions of VOC removal/treatment and their associated metals pretreatment/post-treatment processes are outlined in the following subsections.

Response Action	*Technology*	*Process Options*
1. VOC Removal/ Treatment	• On-Site Physical	• Liquid Phase Carbon Adsorption • Air Stripping • Air Aeration
	• On-Site Chemical	• UV/Oxidation
	• On-Site Biological	• Biological
	• Off-Site Treatment	• Discharge to POTW • Treatment at a RCRA Facility
2. Metals Pretreatment/ Post-treatment	• On-Site Chemical	• Sequestrant • Filtration • Caustic Precipitation

The Risk Reduction Engineering Laboratory (RREL) treatability database, computer simulations and CRA's experience with similar applications were utilized to assess the treatability of the compounds presented in Table B.1. The RREL treatability database results are presented in Attachment 1.

B.3.1 LIQUID PHASE CARBON ADSORPTION

A schematic representation of a typical carbon adsorption system is presented on Figure B.1. The process of adsorption onto activated carbon involves contacting the influent water stream with activated carbon, usually through a series of contactors. Activated carbon adsorbs organic constituents from the water by a surface/pore diffusion phenomenon whereby organic molecules get entrapped in the pores of the carbon granules. The adsorption process depends on the polarity and molecular weight of the adsorbate (organic contaminant), type and characteristics of the adsorbent (activated carbon), and pH of the solution, amongst other factors.

Once the carbon is saturated with organics, its adsorptive capacity becomes depleted and the carbon is said to be "spent". The carbon must, therefore, be replaced either with virgin carbon or regenerated carbon. Carbon is considered saturated when it reaches "breakthrough" or exhaustion. The time to reach breakthrough is the single most critical operating parameter. Limitations are usually economic and relate to the rate at which the carbon becomes spent.

Adsorption on activated carbon is used to treat single-phase aqueous organic wastes that contain organics with high molecular weights and boiling points, and low solubilities and polarities. It is also used to capture chemicals in the vapor phase such as those emitted from an air stripping process.

Suspended matter, oil and grease, and metals such as iron, calcium and manganese can greatly reduce the efficiency of the carbon adsorption process due to loss of hydraulic capacity. Based on the groundwater treatment system influent concentrations of metals presented in Table B.1, pretreatment such as caustic precipitation may be necessary. The groundwater pH is increased to produce metal complexes (such as calcium carbonate and iron hydroxides) of low solubility which are removed as a sludge in a clarifier. The water phase is neutralized and filtered prior to carbon adsorption. The sludge phase is typically dewatered in a filter press.

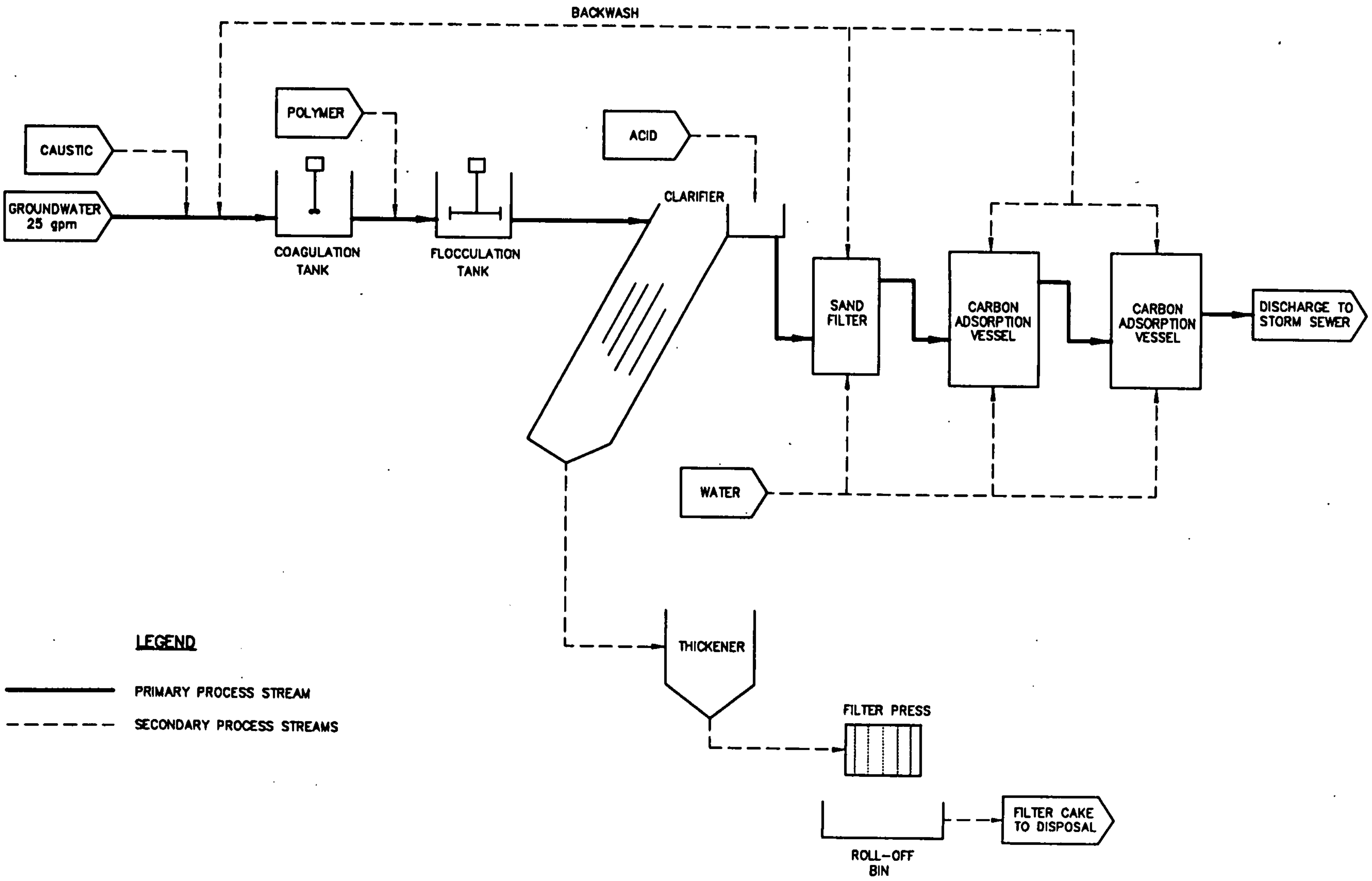


figure B.1

CARBON ADSORPTION SCHEMATIC
LEICA INC.
Cheektowaga, New York

CRA

3967 (8) APR 12/95(W) REV.0 (C-03)

B.3.2 AIR STRIPPING

A typical air stripping system is presented on Figure B.2. Air stripping is a method of aeration in which chemicals in the water are brought into intimate contact with an air stream. This is a mass transfer process which is impacted by several parameters such as temperature, pressure, air to water ratio and the presence of suspended matter (amongst other factors). The resulting residuals from an air stripping tower are the off gases and the stripped effluent.

Air strippers usually consist of a stripping tower that utilizes a counter-current flow arrangement. The influent water stream is introduced at the top of the tower and allowed to flow downward through either packing media or a series of sieve trays while the air stream flows upward. The treated water exits at the bottom of the tower while the air stream exits at the top of the tower. Where necessary, the off gas is directed through vapor phase treatment to control volatile emissions to the atmosphere such as activated carbon or catalytic oxidation.

The air stripping process is used to treat waters that contain organic chemicals that exhibit low water solubility and high volatility. Air to water ratios applied in stripping processes are usually much higher than those applied in simple aeration processes and, therefore, treatment efficiencies are usually much higher than those obtained from simple aeration. Since the process is temperature dependent, stripping efficiencies can be impacted by changes in ambient temperature. The presence of suspended solids in the water stream also impact the treatment efficiency due to clogging. Also, the presence of metals such as iron, calcium and magnesium in the influent stream may cause additional scaling due to changes in the water chemistry during the process. Pretreatment including filtration of particulates and addition of a sequestrant to inhibit scale formation may be necessary of the Leica Site. Caustic precipitation (see Section B.3.1) may also be an appropriate pretreatment depending on Site conditions.

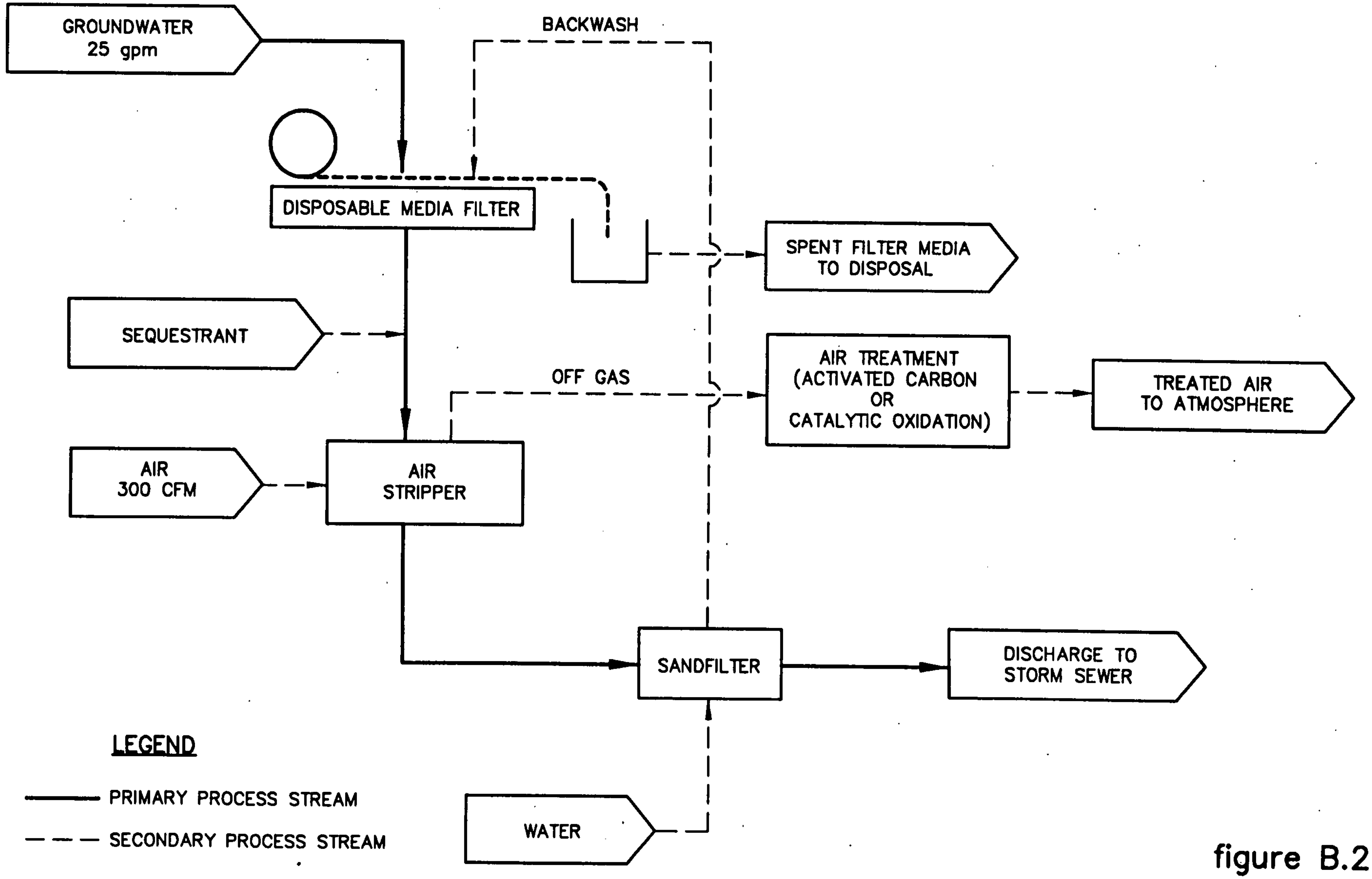


figure B.2

AIR STRIPPING SCHEMATIC
LEICA INC.
Cheektowaga, New York

CRA

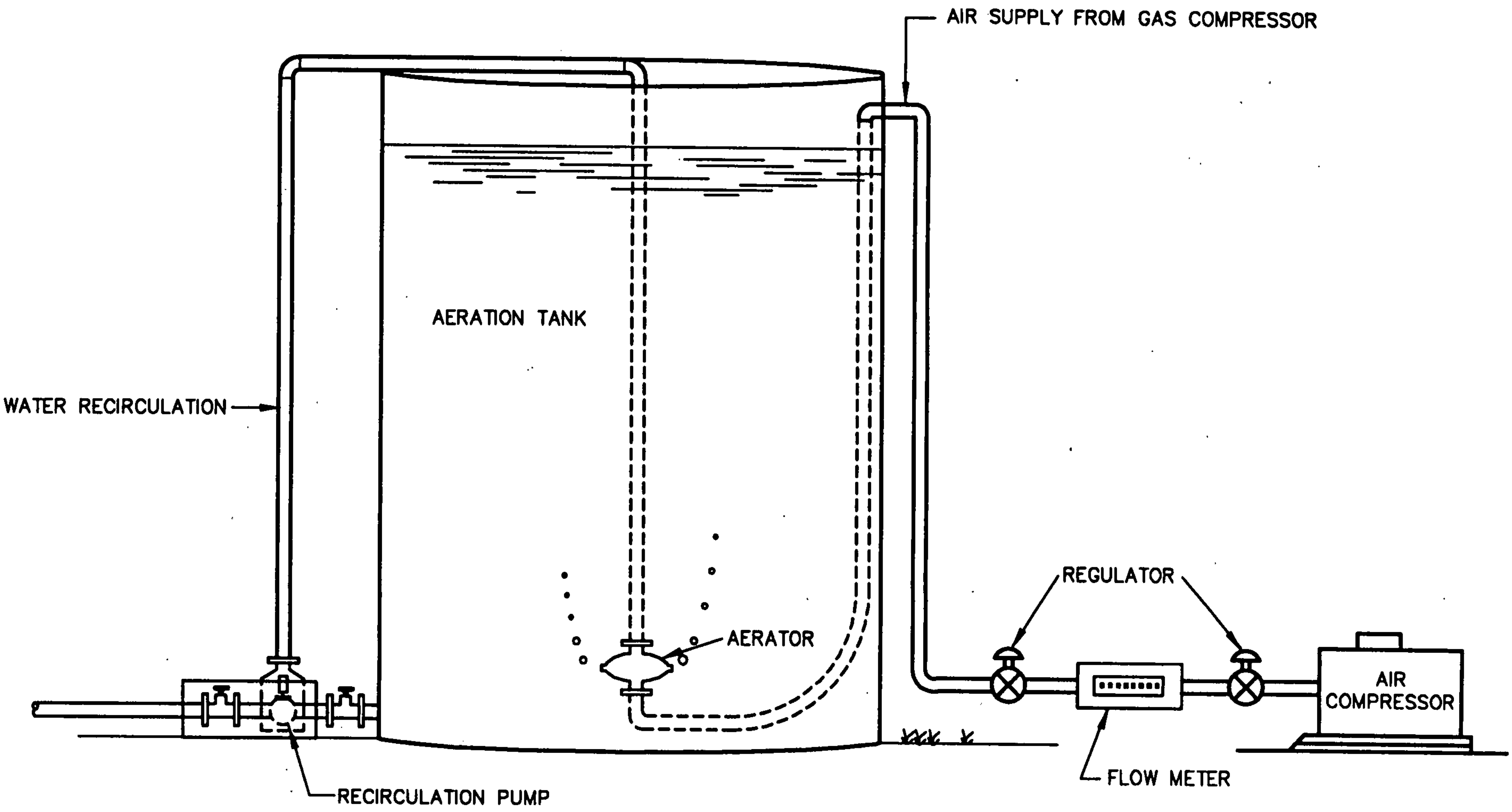
3967 (8) APR 12/95(W) REV.0 (C-01)

B.3.3 AIR AERATION

Figure B.3 presents a schematic representation of a typical aeration system. Aeration is a mass transfer process in which chemicals present in water are evaporated into the air. There are a number of factors that are important in the removal of organics via aeration from water. Temperature, pressure, air to water ratio, and surface area available for mass transfer are some of the parameters involved in an aeration process. Air to water ratios applied in simple aeration processes are usually low in comparison to other methods of aeration such as air stripping. Process efficiencies, therefore, tend to be low in comparison to treatment efficiencies obtained using other methods.

An aeration basin usually consists of an above or below ground tank fitted with an air distribution system that is typically located at the base of the tank. Air under pressure is pumped into the tank through a number of air diffusers which create fine bubbles. The VOCs diffuse into the air bubbles and are removed by the air bubbles which travel to the surface of the tank.

The process is used to treat groundwaters which contain organic compounds that exhibit high volatility and low water solubility (such as chlorinated hydrocarbons and aromatics). However, the process is limited by factors such as bubble surface area, bubble size, and contact time. The process is also impacted by changes in water temperature. The presence of suspended solids material may reduce the efficiency of the mass transfer process. Also, metals such as iron, calcium and magnesium may cause additional scaling and plugging of the diffuser system. However, aeration tanks and diffusers are less prone to clogging and scale formation than air stripping. Aeration basins may be expensive to operate because air has to be compressed and pumped against the static water head that is equal or greater than the depth of the tank.



N.T.S.

figure B.3

AERATION TANK SCHEMATIC
LEICA INC.
Cheektowaga, New York

CRA

3967 (8) APR 12/95(W) REV.0 (D-01)

B.3.4 ULTRAVIOLET/CHEMICAL OXIDATION

Figure B.4 presents a process flow diagram for an ultraviolet (UV)/chemical oxidation treatment system that could be used at the Site. The system entails pretreatment for solid contaminants and enhanced UV/oxidation using hydrogen peroxide. A filtration type pretreatment system would likely be appropriate for the Leica Site.

Ultraviolet/chemical oxidation is an enhanced chemical oxidation process whereby chemicals in the liquid stream are destroyed or detoxified upon the application of a high energy UV light in combination with a strong oxidant. Adsorption of energy in the UV spectrum results in a molecule's elevation to a higher energy state that increases the ease of bond cleavage and subsequent oxidation. Strong oxidants such as ozone and/or hydrogen peroxide are often applied throughout the process to enhance oxidation. The ultimate end products of the oxidation reaction are dependent on the particular chemicals in the waste stream.

A number of parameters can affect both performance and cost of such a process. Some of these include the amount of UV and oxidant applied, hydraulic retention time, temperature, pH, mixing efficiency and the usage of catalysts.

B.3.5 BIOLOGICAL

Figure B.5 illustrates a fixed film aerobic digester system and Figure B.6 illustrates the layout of an activated sludge treatment plant. A biological treatment system is a living bacteria system. Organics are put in contact with the bacteria and are metabolized by the bacteria along with nutrients to create additional bacteria cell mass. Excess cell mass must be removed from the system on an ongoing basis. The biological treatment systems require that toxic organics and/or inorganics, such as metals or refractory chemicals, be below inhibitory or toxic levels. The system must operate 24 hours per day, 7 days per week in a relatively balanced, toxic free environment. The biological system must have a constant source of food (an

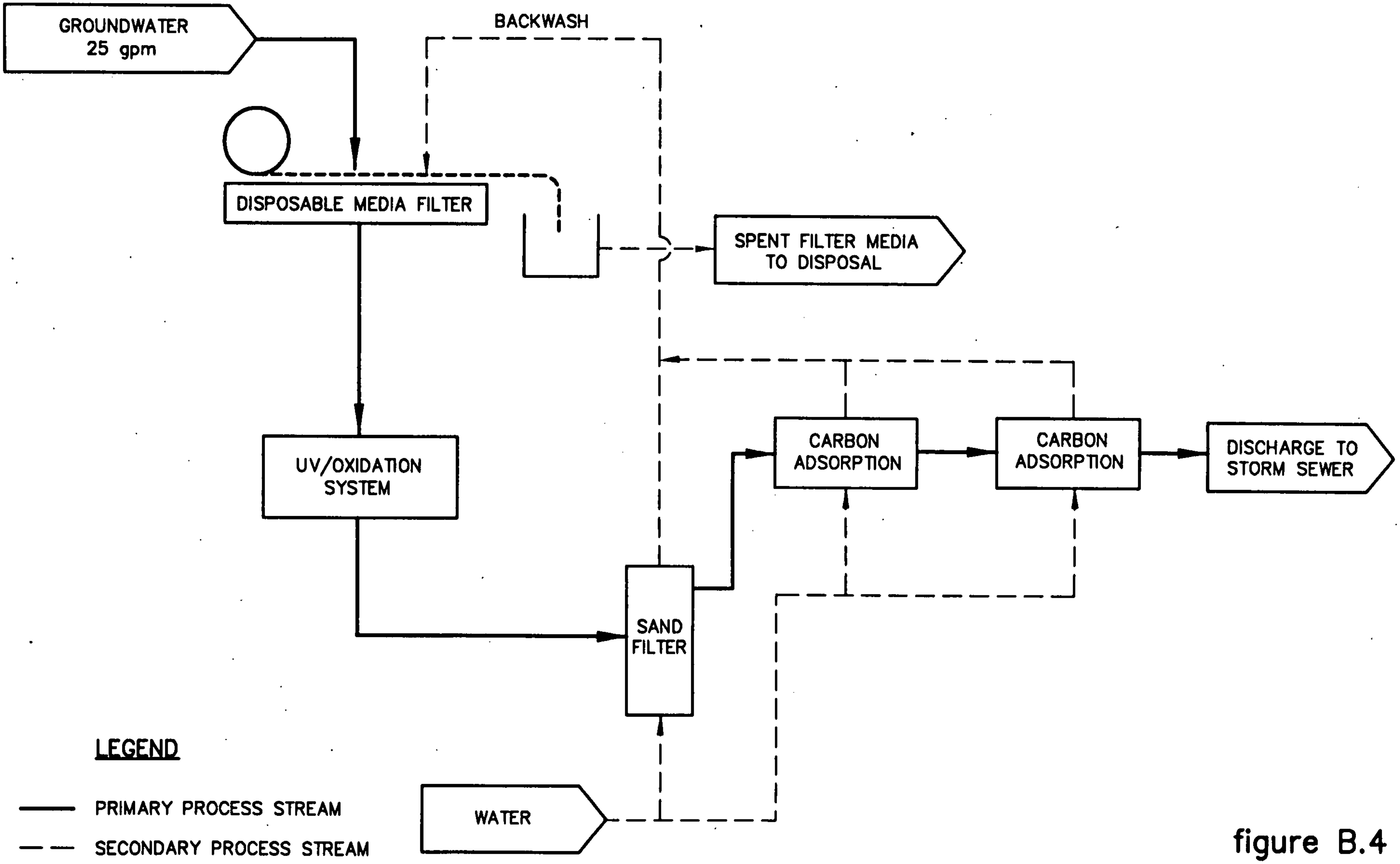
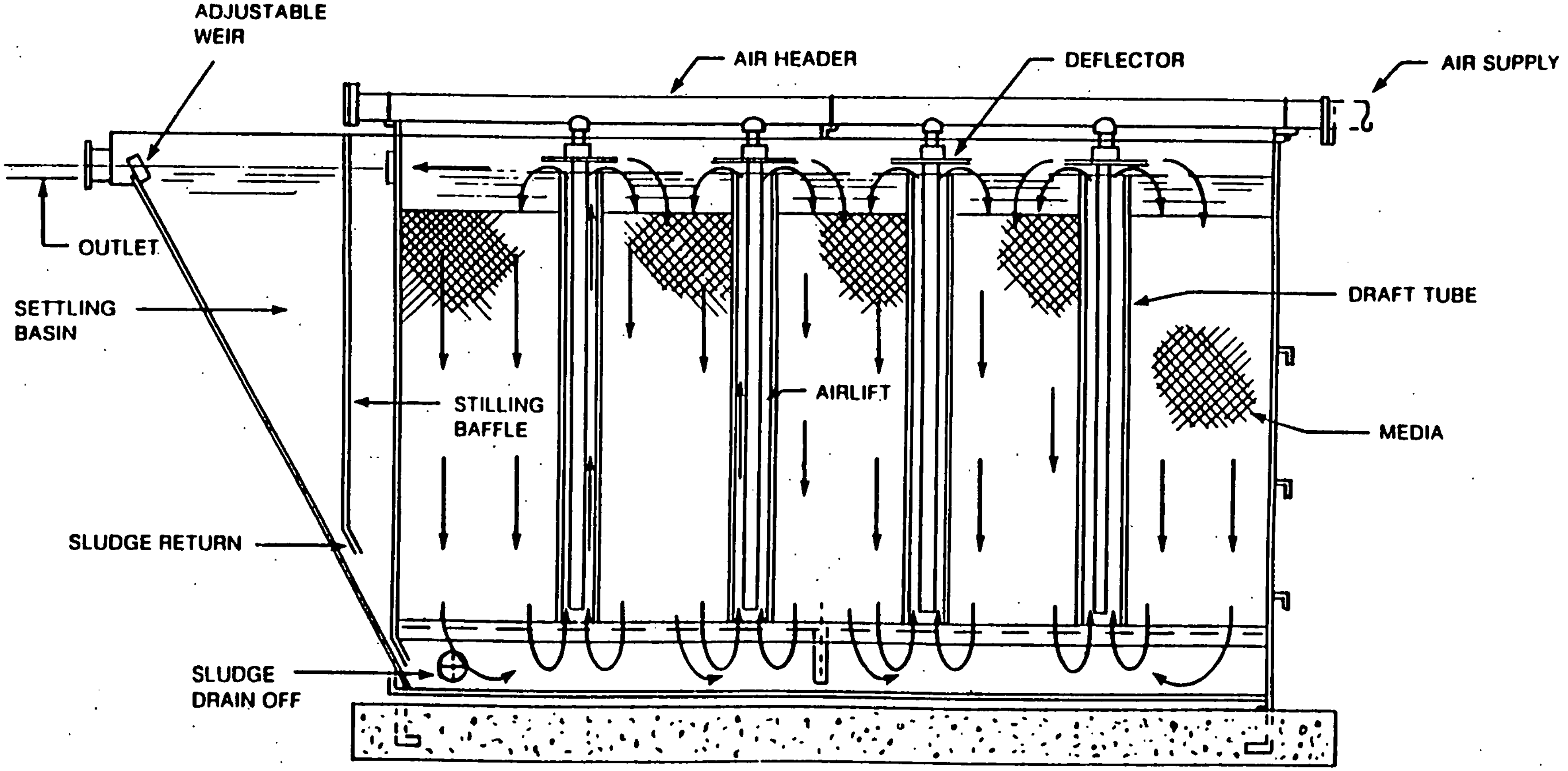


figure B.4

UV/OXIDATION SCHEMATIC
LEICA INC.
Cheektowaga, New York

CRA

3967 (8) APR 12/95(W) REV.0 (C-02)



SOURCE: NYER, 1985

figure B.5

FIXED FILM BIOLOGICAL
TREATMENT SYSTEM SCHEMATIC
LEICA INC.
Cheektowaga, New York

CRA

3967 (8) APR 12/95(W) REV.0

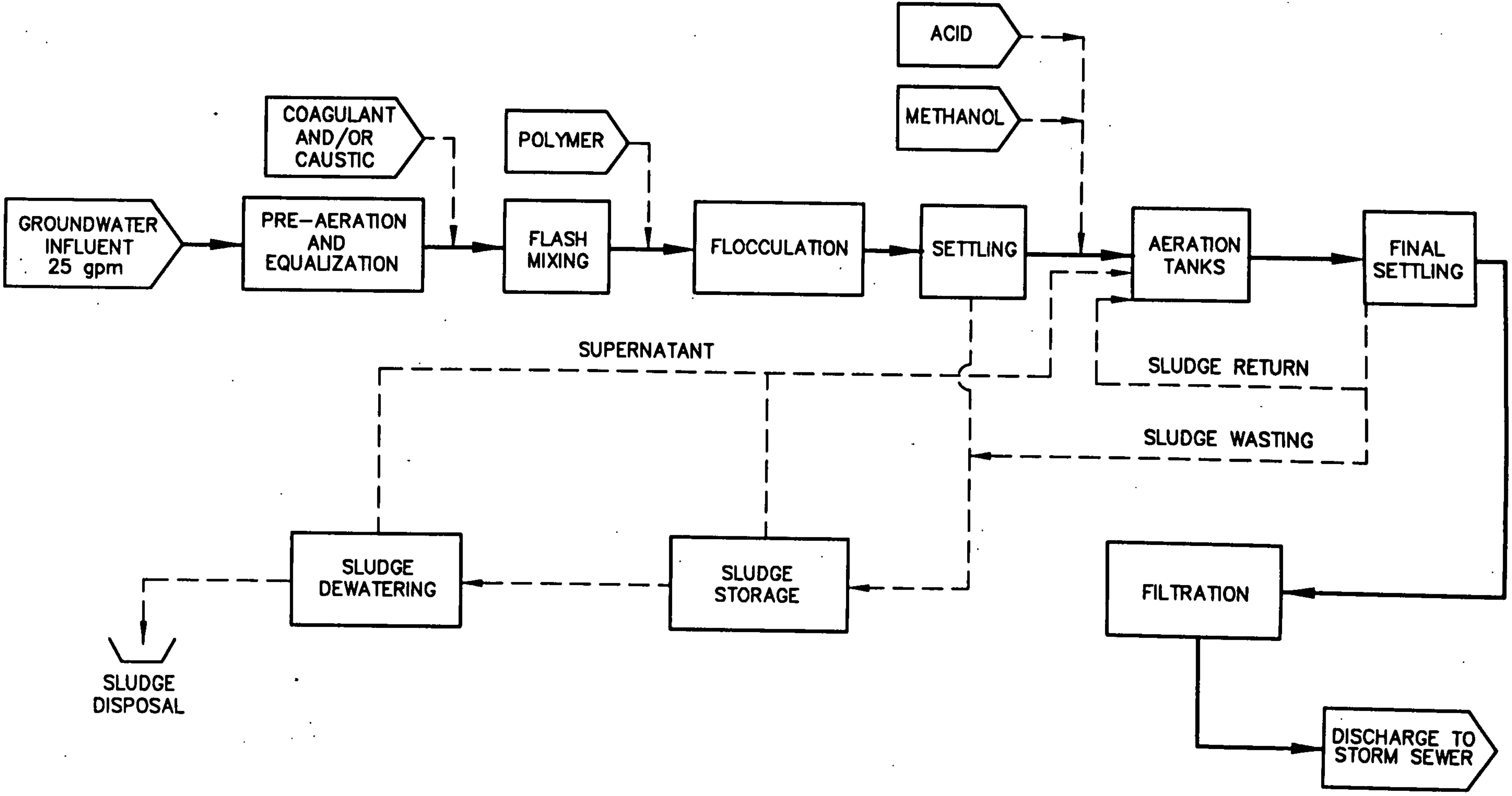


figure B.6

ACTIVATED SLUDGE SYSTEM SCHEMATIC

LEICA INC.
Cheektowaga, New York

CRA

3967 (8) APR 12/95(W) REV.0 (C-04)

organic contaminant) and sufficient available nutrients (nitrogen and phosphorus) to maintain a continuous life and growth cycle at sufficient concentrations to effectively remove and digest the compounds present. Biological technologies include anaerobic bacteria and aerobic bacteria systems. Anaerobic systems are generally suited for degrading high strength organics whereas aerobic systems are generally suited for degrading organics at concentrations typically below 4,000 mg/L.

Biological reactors may be further classified as suspended growth reactors and fixed film reactors. Suspended growth reactors mix organics with bacteria. In the fixed film reactor, the organics are passed over (through) a film of bacteria. Suspended growth reactors (aerated lagoons, activated sludge and sequence batch reactors) typically have long retention times and require the bacteria in a form that readily settles. Biological treatment systems typically achieve removal rates of 30 percent for lagoons to as much as 95 percent or more for activated sludge and sequence batch reactor systems.

B.3.6 OFF-SITE TREATMENT AT POTW

This treatment involves discharge of the collected groundwater to a publicly owned treatment works (POTW). The groundwater would be discharged directly to the treatment plant via the sanitary sewer. The groundwater would then undergo treatment and be discharged with other wastewater from the facility. Based upon an initial screening of the available data, it has been determined that the nearest POTW, located one mile south of the Site, may be suitable for treating collected groundwater at the Site. However, discharge of untreated groundwater to the sanitary sewer with either aromatic hydrocarbon or halogenated compound concentrations exceeding 5.3 mg/L would not be acceptable (telephone communication between CRA and James Kruszka of the Buffalo Sewer Authority). Preliminary influent calculations presented in Table B.1 indicate that aromatic hydrocarbon and halogenated compound concentrations may exceed 5.3 mg/L in the collected groundwater. Treatment at a POTW may be appropriate if these concentrations are determined, during the pre-design stage, to be below the required criteria.

B.3.7 OFF-SITE TREATMENT AT RCRA FACILITY

This treatment option would involve transporting the collected groundwater to an approved RCRA facility for treatment and/or disposal. A potential RCRA treatment facility is the Chemical Waste Management facility in Model City, New York located approximately 20 miles from the Site. This RCRA wastewater treatment facility utilizes a multi-component treatment process which could effectively treat the concentrations and flow rates expected at the Site.

B.4.0 EVALUATION OF GROUNDWATER TREATMENT OPTIONS

This section provides a preliminary analysis and evaluation of the groundwater treatment process options identified in Section B.3. The treatment process options are evaluated with respect to effectiveness, implementability and cost. The determination and design of the appropriate treatment system for groundwater will be completed based on pre-design studies.

B.4.1 LIQUID PHASE CARBON ADSORPTION

Effectiveness

Table B.2 summarizes the projected effluent qualities of several technologies that are effective and implementable with Leica groundwater. As indicated in Table B.2, compounds such as xylenes and ethylbenzene are readily removed utilizing liquid phase carbon adsorption. Carbon adsorption is an effective treatment technology for Site groundwater, and will treat all of the contaminants of concern to stringent discharge criteria.

A review of the information contained in Attachment 1 indicates that aliphatic ketones such as 2-butanone and acetone may not be readily removed utilizing carbon adsorption.

Typical adsorption capacities range from 1 mg/gram of carbon for benzene to approximately 85 mg/gram for xylene. Preliminary carbon consumption calculations indicate that approximately 360 lbs/day would be required to treat the groundwater to the discharge levels.

Implementability

Liquid phase carbon adsorption is an easily implemented treatment technology. A system of fixed tank carbon adsorbers could be designed to provide suitable hydraulic capacity and contact time for effective

TABLE B.2

GROUNDWATER TREATMENT FACILITY PROJECTED EFFLUENT CONCENTRATIONS
LEICA INC.
CHEEKTOWAGA, NEW YORK

Component	System Influent		Groundwater Treatment System Effluent (ppb)			
	Flow(gpm)	Conc. (ppb)	Activated Carbon	Air Stripping	UV/Oxidation	UV/Oxidation with Carbon
Volatiles						
1,1,1,-Trichloroethane	25	1790.3	<1	<1	447.0	<1
1,1,2-Trichloroethane	25	6.3	<1	<1	1.6	<1
1,1-Dichloroethane	25	837.9	<1	<1	210.0	<1
1,1-Dichloroethene	25	287.2	<1	<1	<1	<1
1,2-Dichloroethene (total)	25	16087.3	<1	2.0	<1	<1
4-Methyl-2-pentanone	25	50.0	<1	50.0	<1	<1
2-Butanone	25	20.9	<1	21.0	<1	<1
Acetone	25	7.3	<1	8.0	<1	<1
Benzene	25	41.7	<1	<1	<1	<1
Carbon disulfide	25	4.9	<1	<1	<1	<1
Chlorobenzene	25	1.0	<1	<1	<1	<1
Chloroethane	25	77.7	<1	<1	<1	<1
Chloroform	25	3.9	<1	<1	<1	<1
Ethylbenzene	25	591.1	<1	1.0	<1	<1
Methylene Chloride	25	5.8	<1	<1	<1	<1
Tetrachloroethene	25	16.4	<1	<1	<1	<1
Toluene	25	545.8	<1	1.0	<1	<1
Trichloroethene	25	15362.9	<1	1.0	<1	<1
Vinyl chloride	25	4506.9	<1	<1	<1	<1
Xylene (total)	25	4250.0	<1	3.0	<1	<1
Semi-Volatiles						
2,4-Dimethylphenol	25	0.4	<1	<1	<1	<1
2-Methylphenol	25	0.1	<1	<1	<1	<1
4-Chloro-3-methylphenol	25	0.3	<1	<1	<1	<1
4-Methylphenol	25	0.1	<1	<1	<1	<1
Napthalene	25	0.7	<1	<1	<1	<1

treatment. Both carbon adsorbers and activated carbon are commercially available. Carbon adsorbers could be easily operated and maintained and require minimum operator supervision. Based on the groundwater data available to date, a pretreatment system would be required to reduce the concentration of any solids and/or metals that would otherwise interfere with the performance of the carbon adsorbers by reducing their efficiency and, possibly, causing them to fail mechanically. A carbon adsorption groundwater treatment system could be designed and constructed in approximately one year.

Cost

A carbon adsorption system that would treat the anticipated groundwater flow at the Site (see Figure B.1) would cost approximately $511,000. The estimated first year annual operation and maintenance cost is $281,500. Table B.3 provides a breakdown of the costs.

B.4.2 AIR STRIPPING

Effectiveness

The results of a computer projection of removal efficiencies of various VOC/SVOC constituents are presented on Table B.2. Table B.2 indicates that the majority of the VOCs would be readily removed by air stripping. Removal rates for toluene, methylene chloride, 1,1,1-trichloroethane and xylenes may exceed 99 percent. Aliphatic ketones such as 2-butanone, acetone and 4-methyl-2-pentanone may be difficult to treat effectively with air stripping due to the high solubilities of these compounds in water.

Implementability

An air stripping system could be readily implemented. An air stripping unit is relatively easy to operate and maintain. A vapor phase carbon or catalytic oxidation air emission control system may be

TABLE B.3

COST ESTIMATE
LIQUID PHASE CARBON ADSORPTION
GROUNDWATER TREATMENT SYSTEM
LEICA INC.
CHEEKTOWAGA, NEW YORK

I. Capital Costs

1.	Mobilization and Demobilization	$30,000
2.	Pretreatment	$185,000
2.	Carbon Treatment System	$50,000
3.	Treatment Building	$60,000
4.	Electrical Services	$30,000
	Estimated Capital Costs	**$355,000**
	Engineering (20%)	$71,000
	Sub-Total	$426,000
	Contingency (20%)	$85,000
	Total Estimated Capital Costs	**$511,000**

II. Annual Operation and Maintenance Costs

1.	Pretreatment	$12,500
2.	Liquid Phase Carbon Replacement and Disposal (360 lb/day at $1.50/lb)	$197,000
3.	Power	$12,000
4.	Maintenance	$60,000
	Total Estimated Annual O&M Costs	**$281,500**

required for treatment of the off gas from the air stripping tower. A pretreatment system may be required for the removal of any solids and/or metals that may negatively impact the performance of the carbon units for off-gas treatment, if required. The design and construction of an air stripping system would take approximately one year.

Cost

An air stripping/vapor phase carbon adsorption system or an air stripping/vapor phase catalytic oxidizer that would treat the anticipated groundwater flow at the Site (see Figure B.2) would cost approximately $418,000 and $576,000, respectively. The estimated first year annual operation and maintenance costs are $483,000 and $78,000, respectively. Table B.4 provides a breakdown of these costs.

B.4.3 AIR AERATION

Effectiveness

The concentrations of the VOCs identified in Table B.1, with the exception of ketones such as acetone, are generally reduced by simple aeration techniques (as applied in aeration basins). However, to achieve acceptable effluent levels for discharge, high air to water ratios, along with long retention times would be required. This would require a high capacity (expensive) off-gas treatment process. The same levels of reduction could be achieved more effectively with lower air to water ratios using an air stripping tower. Therefore, simple aeration as a treatment alternative will not be evaluated any further.

TABLE B.4

COST ESTIMATE
AIR STRIPPING
GROUNDWATER TREATMENT SYSTEM
LEICA INC.
CHEEKTOWAGA, NEW YORK

I. Capital Costs	*Option 1A* *Activated Carbon* *Off-Gas Treatment*	*Option 1B* *Catalytic Oxidation* *Off-Gas Treatment*
1. Mobilization and Demobilization	$30,000	$30,000
2. Pretreatment	$35,000	$35,000
3. Air Stripping	$30,000	$30,000
4. Off-gas Treatment	$75,000	$185,000
5. Post Treatment (1)	$30,000	$30,000
6. Treatment Building	$60,000	$60,000
7. Electrical Services	$30,000	$30,000
Estimated Capital Costs	**$290,000**	**$400,000**
Engineering (20%)	$58,000	$80,000
Sub-Total	$348,000	$480,000
Contingency (20%)	$70,000	$96,000
Total Estimated Capital Costs	**$418,000**	**$576,000**
II. Annual Operation and Maintenance Costs		
1. Pretreatment	$3,000	$3,000
2. Off-gas Treatment		
- Option 1A - 455 lb/day of vapor carbon at $2.5/lb	$415,000	
- Option 1B - fuel and catalyst		$10,000
3. Power	$15,000	$15,000
4. Maintenance	$50,000	$50,000
Total Estimated Annual O&M Costs	**$483,000**	**$78,000**

(1) Includes a continuous backwash sand filter to remove particulates generated in the air stripper (such as $Fe(OH)_3$). Depending on treatability test results and discharge criteria, this process may not be necessary.

B.4.4 UV/OXIDATION

Effectiveness

UV light enhanced oxidation (an advanced oxidation process) is an effective method of treating organic chemicals in waters and wastewaters. Depending on the nature of the mixture, UV/oxidation treatment may be enhanced by adding additional chemicals to the waste stream. UV enhanced oxidation is effective in treating all of the organic compounds identified in Table B.1. However, chlorinated and non-chlorinated alkanes (i.e. trichloroethane and dichloroethane) are considered slow to oxidize by conventional enhanced oxidation processes. Therefore, a liquid phase activated carbon polishing process may be required.

Implementability

A UV/oxidation system as described is readily implementable. Pretreatment may be required for the removal of any solids and/or metals which would negatively impact the operation of the system. The detailed design and construction of a UV/oxidation treatment system would take approximately one year.

Cost

A UV/oxidation system which would treat the anticipated groundwater flow at the Site (see Figure B.4) would cost approximately $533,000. The estimated first year annual operation and maintenance cost is $101,000. Table B.5 provides a breakdown of these costs.

B.4.5 BIOLOGICAL

Effectiveness

The majority of contaminants identified in Table B.1 are treatable by biological technologies, however, the concentrations of these

TABLE B.5

COST ESTIMATE
UV/OXIDATION GROUNDWATER TREATMENT SYSTEM
LEICA INC.
CHEEKTOWAGA, NEW YORK

I. Capital Costs

1.	Mobilization/Demobilization	$30,000
2.	Pretreatment	$35,000
3.	UV/Oxidation System	$135,000
4.	Post-Treatment (Activated Carbon) (1)	$80,000
5.	Treatment Building	$60,000
6.	Electrical Services	$30,000
	Estimated Capital Costs	**$370,000**
	Engineering (20%)	$74,000
	Sub-Total	$444,000
	Contingency (20%)	$89,000
	Total Estimated Capital Costs	**$533,000**

II. Annual Operation and Maintenance Costs

1.	Pretreatment	$3,000
2.	UV/Oxidation System (2)	$40,000
3.	Post-Treatment liquid-phase carbon replacement and disposal (15 lb/day at $1.50/lb) (1)	$8,000
4.	Maintenance	$50,000
	Total Estimated O&M Costs	**$101,000**

(1) Includes liquid phase activated carbon polishing for alkanes and chlorinated alkanes. This process may not be necessary depending on discharge criteria.

(2) Includes cost for chemical addition, power consumption and lamp replacement.

chemicals are generally too low for a biological treatment system to be effective. The quantity of organic compounds in the extracted groundwater is insufficient to sustain the environment required by the biological organisms. A food source such as methanol could be added to the groundwater to address this problem. However, combining the groundwater with a municipal sewage food source (see Section B.4.6) would be more economical. Therefore, biological technologies as a treatment alternative will not be evaluated any further.

B.4.6 OFF-SITE TREATMENT AT POTW

Effectiveness

Off-Site treatment at a POTW would be an effective means of dealing with collected groundwater from the Site provided that the chemical loading will not adversely affect the treatment plant. The municipal wastewater combined with the collected groundwater would provide the food source lacking in on-Site biological treatment.

Implementability

A gravity sewer would be used to transport pumped groundwater from the Site to the sanitary sewer system used by the POTW. The estimated flowrate from the groundwater collection system is 25 gpm, or approximately 36,000 gallons per day. The utilization of the POTW may be effective for the chemicals at the Site.

Approval from the Buffalo Sewer Authority would be necessary for the discharge of collected groundwater to the sanitary sewer. The impact of the flow from the Site on the POTW's capacity and operation would be assessed prior to acceptance.

Cost

There would be a charge for discharging the collected groundwater to the sanitary sewer. These costs would be determined during the pre-design phase.

B.4.7 OFF-SITE TREATMENT AT RCRA FACILITY

Effectiveness

Off-Site treatment at a RCRA facility would be an effective means of treating collected groundwater from the Site.

Implementability

Due to the estimated volume of pumped groundwater (36,000 gallons per day), transport of the groundwater to a RCRA facility by tanker trucks would not be practical. Therefore, this alternative will not be evaluated any further.

B.5.0 SUMMARY OF EVALUATION

Liquid phase carbon adsorption, air stripping, UV/oxidation, off-Site treatment at a POTW and off-Site treatment at a RCRA facility are all considered to be effective treatment alternatives for the majority of the chemicals at the Site. Aeration and biological treatment were eliminated from further evaluation as they were determined to be ineffective for treating the groundwater at the Site.

Off-Site treatment of the groundwater at a RCRA facility was determined to be impractical due to the high volume of groundwater which would require transportation by tanker truck (approximately 36,000 gallons per day).

Liquid phase carbon adsorption would require a significant amount of carbon (360 lbs/day) to treat the chemicals of concern at the Site. In addition, aliphatic ketones may not be readily removed with carbon adsorption.

Air stripping and UV/oxidation are considered to be easy to implement. Pretreatment, however, may be required to remove metals and suspended solids for these on-Site treatment options. Vapor phase carbon adsorption or catalytic oxidation may be required for treatment of the off-gas for an air stripping system. Liquid phase carbon polishing may be required for a UV/oxidation system.

Capital costs for the installation of carbon adsorption, air stripping with carbon adsorption off-gas treatment, air stripping with catalytic oxidation and UV/oxidation systems are estimated to be $511,000, $418,000, $576,000, and $533,000, respectively. First year annual operation and maintenance costs are estimated to be $281,500 for carbon adsorption, $483,000 using air stripping/carbon adsorption, $78,000 using air stripping/catalytic oxidation, and $101,000 for UV/oxidation.

Based upon this preliminary evaluation, it is concluded that an air stripping/catalytic oxidation system based upon the design presented in Figure B.2 would be the most cost effective groundwater treatment technology. UV/Oxidation with activated carbon polishing would be slightly less cost effective due to its higher operating cost. Liquid phase carbon adsorption may be appropriate depending on the actual chemical concentrations in the collected groundwater determined during pre-design studies. Treatment at a local POTW may be feasible if the discharge criteria are not exceeded in the collected groundwater effluent. A more precise cost comparison and detailed analysis of these treatment alternatives would be conducted following a 48 hour pump test and treatability studies.

ATTACHMENT 1 TO APPENDIX B

RREL TREATABILITY DATABASE

ATTACHMENT 1

EVALUATION OF GROUNDWATER CONTAMINANTS USING USEPA'S TREATABILITY DATABASE

The Risk Reduction Engineering Laboratory (RREL) Treatability Database Version printouts are presented for the following compounds:

VOCs

1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2-Dichlorothene (total)
4-Methyl-2-pentanone
2-Butanone
Acetone
Benzene
Carbon disulfide
Chlorobenzene
Chloroethane
Chloroform
Ethylbenzene
Methylene Chloride
Tetrachloroethene
Toluene
Trichloroethene
Vinyl Chloride
Xylene (total)

SVOCs

2,4-Dimethylphenol
2-Methylphenol
4-Chloro-3-methylphenol
4-Methylphenol
Napthalene

The legend for matrix, Standard Industrial Classification (SIC) codes, and reference codes, is presented at the beginning of the appendix. The legend is constant throughout the database.

TREATMENT TECHNOLOGIES CODE AND ABBREVIATION TABLE

AQUEOUS DATA FILE

Treatment Technologies (Those with data)

AAS - Activated Alumina Sorption
AFF - Aerobic Fixed Film
AL - Aerobic Lagoons
API - API Oil/Water Separator
AS - Activated Sludge
AirS - Air Stripping
AlkHyd - Alkaline Hydrolysis
AlgIE - Algal Ion Exchange
AnFF - Anaerobic Fixed Film
BGAC - Biological Granular Activated Carbon
CAC - Chemically Assisted Clarification
ChOx - Chemical Oxidation (Parantheses shows oxidation chemical ie. ChOx(UV) is ultraviolet light, ChOx(Cl) is chlorine, ChOx(Oz) is ozone, ChOx(H2O2) is peroxide, ChOx(ClO2) is chlorine dioxide, and ChOx(Sur) is surfactant)
ChOx/Pt - Chemical Oxidation/Precipitation
ChPt - Chemical Precipitation
ChRed - Chemical Reduction
DAF - Dissolved Air Flotation
ED - Electrodialysis
Fil - Filtration
GAC - Activated Carbon (Granular)
IE - Ion Exchange (Parantheses shows resin type ie. (A) is anionic, (C) is cationic, and (M) is mixed)
KPEG - Dechlorination of Toxics using an Alkoxide (Formed by the reaction of potassium hydroxide with polyethylene glycol (PEG400))
PAC - Powdered Activated Carbon
PACT - Powdered Activated Carbon Addition to Activated Sludge
RA - Resin Adsorption
RBC - Rotating Biological Contactor
RO - Reverse Osmosis
SBR - Sequential Batch Reactor
SCOx - Super Critical Oxidation
Sed - Sedimentation
SExt - Solvent Extraction
Soft - Water Softening
SS - Steam Stripping
TF - Trickling Filter
UF - Ultrafiltration
WOx - Wet Air Oxidation

NOTES:

____ + ____ is the first process unit followed in process train by the second ie. AS + Fil - Activated Sludge followed by Filtration.

_____ w _____ is the two units together ie. UFwPAC - Ultrafiltration using Powdered Activated Carbon.

_____(B) is batch instead of continuous flow.

Scale

B - Bench Top P - Pilot Plant F - Full Scale

Number after letter refers to the plant number in a specific reference (ex. F7 - plant 7 is the seventh full scale plant in the indicated report).

Matrix

C - Clean water (ex. distilled)
D - Domestic wastewater
GW - Groundwater
HL - Hazardous leachate
I - Industrial wastewater
ML - Municipal leachate
RCRA - RCRA listed wastewater
S - Synthetic wastewater
SF - Superfund wastewater
SP - Spill
T - Tap water
TSDF - Commercial treatment, storage and disposal facility - liquids
W - Surface water

SIC (Standard Industrial Classification) Codes

For industrial wastewaters a 2 digit SIC code will be given following the letter designation, i.e. I 22 is a Textile Mill Products wastewater. If the SIC code is unknown a U will be shown, I U.

10 - Metal mining
12 - Coal mining
13 - Oil and gas extraction
20 - Food and kindered products
22 - Textile mill products
24 - Lumber and wood products
26 - Paper and allied products except computer equipment
27 - Printing and publishing
28 - Chemicals and allied products
29 - Petroleum refining and related
30 - Rubber and misc. plastic products
31 - Leather and leather products
33 - Primary metals industries
34 - Fabricated metal products except machinery & transportation equip.
36 - Electronic and electric equipment
37 - Transportation Equipment
39 - Misc. manufacturing industries
47 - Transportation services
49 - Electric, gas, and sanitary
99 - Nonclassifiable establishments/industries

Effluent Concentration

Effluent concentration will be given as a arithmetic mean to two significant figures. The number of samples used to calculate the mean is given after concentration as (n) (ex. 13 (5) - 13 is the mean of 5 sample values).

% Removal

Percent removal will be calculated on a concentration basis. If data are available, it will also be calculated on a mass basis for physical/chemical systems. Those values calculated on a mass basis will be noted by a (m). An example would be:

% Removal:	99.95	99.95 is based on concentration
	98(m)	98 is based on mass

$$\text{where \% Removal} = \frac{\text{Influent - Effluent}}{\text{Influent}}$$

Reference Quality Codes

A - Papers in a peer reviewed journal.
B - Government report or database.
C - Reports and/or papers other than in groups A or B not reviewed.
D - Group C papers and/or reports which have been given a "good" quality rating by a selected peer review.
E - Group C papers and /or reports which have been given a "poor" quality rating by a selected peer review. These data will only be used when no other data are available.

Additional Codes Following Reference Codes

V - Volatile emissions data available in Reference
S - Sludge data available in Reference
$ - Costs data available in Reference

Physical/Chemical Properties Data

(c) - Values presented are values that were reported calculated in the reference as is and are only used where measured are not available.
NA - Value for the particular property have not been found in literature to date.

SOLIDS DATA FILE

(Includes Thermal Destruction of Liquids)

Matrix

COMB - Combination (two or more of the following)
ASH
BLDG - Building (Asbestos Site)
DEBRIS
DRYWST - Dry Waste
LIQUID (both aqueous and organic liquids)
SED - Sediment
SLUDGE
SOIL

Technologies (Those with data)

Treatment systems are non in-situ unless specified.

AirS - Air Stripping
BD,AS - Biological Destruction, Aerobic, Slurry
BD,AnS - Biological Destruction, Anaerobic, Slurry
BD,asp - Biological Destruction, aerobic, solid phase
BDA-in - Biological Destruction, Aerobic, (in-situ)
BDN-in - Biological Destruction, aNaerobic, (in-situ)
CD - Chemical Destruction
CD,S - Chemical Destruction, Slurry
CD-in - Chemical Destruction, (in-situ)
CW - Classification/Washing
Comp - Composting, Aerobic
HTMR - High Temperature Metals Recovery
LTD - Low Temperature Desorption
PAP - Plasma Arc Pyrolysis
PD-in - Physical Destruction, (in-situ)
SE - Solvent Extraction
SE-in - Solvent Extraction, (in-situ)
Sol - Solidification
Sol-in - Solidification, (in-situ)
SS-in - Steam Stripping, (in-situ)
Stab - Stabilization
TD - Thermal Destruction
UV - UV Rad./Light/Solar
VE-in - Vacuum Extraction, (in-situ)
Vi-in - Vitrification, (in-situ)

Concentration

Number in "()" following "After" is number of tests/runs used to calculate average concentrations and "% Improvement".

Improvement,%

Change in % based upon "Analytical Method".

$$\text{DRE} = \frac{\text{Conc. in} - \text{Exhaust gas Conc.}}{\text{Conc. in}}$$

$$\text{TCA} = \frac{\text{Conc. at start} - \text{Conc. at end}}{\text{Conc. at start}}$$

$$\text{EPT \& TCLP} = \frac{\text{Conc. of Infl. leachate} - \text{Conc. of Effl. leachate}}{\text{Conc. of Infl. leachate}}$$

Scale

B - Bench Top, P - Pilot Plant, F - Full Scale

Number after letter refers to the test/run number or plant number in the specific reference. The test/run is a continuous flow process unless there is a "(B)" after scale, then it is a batch process (ex. P1 (B) - is first pilot test under batch conditions).

Reference

Quality codes same as for "Aqueous" data file. One extra field notes if cost data are available in reference.

Analytical Method

Lists anayltical test used to generated both the "Before" and "After" concentrations except for "(DRE)" which is the destruction/removal efficiency based upon feed mass per unit time and air emission mass per unit time.

(DRE) - Destruction and removal efficiency
EPT - Extraction procedure toxicity test
TCA - Total contaminant analysis
TCAsw - TCA analysis of a "surface wipe" test
TCLP - Toxicity characteristic leaching procedure test

Operating Parameters

Key operational parameters during test/run.

END

TRICHLOROETHANE,1,1,1-

CAS NO.: 71-55-6

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: C2 H3 CL3

CHEMICAL AND PHYSICAL PROPERTIES

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 133.40	333A
MELTING POINT (C): -30.4	333A
BOILING POINT (C): 74.1	333A
VAPOR PRESSURE @ T(C), TORR: 100 @ 20	333A
SOLUBILITY IN WATER @ T(C), MG/L: 4400 @ 20	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 2.47	1226A
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 4.08 E-3 @ 25	191D

ENVIRONMENTAL DATA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	4B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 300	C	2.48	0.34	mg/L	mg/gm	3B
FILTRASORB 400	C	1240	0.47	ug/L	ug/gm	73A
FILTRASORB 400	C	335	0.531	ug/L	ug/gm	79A

TRICHLOROETHANE,1,1,1-

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		F55	<10 (5)	>90.0	1B -S-
AS	D		F	21 (6)	79	201B -S-
AS	D		F12	10 (4)	89	1B -S-
AS	D		F17	<1 (5)	>98.4	1B -S-
AS	D		F3	<10 (4)	>84	1B -S-
AS	D		F14	<5 (4)	>95.0	1B -S-
AS	D		F57	<8 (3)	>84	1B -S-
AS	D		F25	10 (5)	81	1B -S-
AS	D		F4	<1 (7)	>92.3	375E -S-
AS	D		F1	2.9 (3)	77	238A ---
AS	D		F3	<1 (7)	>92.3	375E -S-
AS	D		F3	1.0 (7)	97.6	234A ---
AS	D		F6	<1.3 (7)	>73	234A ---
AS	D		F5	<1.3 (7)	>88	234A ---
AS	D		F2	2.2 (3)	85	238A ---
AS	D		F4	<1.3 (7)	>76	234A ---
[illegible]	D		F7	<9 (5)	>84	1B -S-
AS	D		F19	30 (6)	39	1B -S-
AS	D		F36	2 (3)	95.8	1B -S-
AS	D		F20	<2 (3)	>95.8	1B -S-
AS	D		F31	4 (3)	88	1B -S-
AS	D		F59	7 (3)	83	1B -S-
AS	D		F18	12 (4)	87	1B -S-
AS	D		F2	1.5 (10)	93.2	86B -S-
AS	D		F15	1.4 (10)	94.6	86B -S-
AS	D		F30	1.1 (10)	94.9	86B -S-
AS	D		F6	1.7 (10)	96.3	86B -S-
AS	D		F29	5.1 (12)	94.4	86B -S-
AS	D		P	<7.1 (17)	>83	156D -S-
AirS	D		F1	0.09 (7)	90.4	1682B ---
AirS	D		F2	0.43 (11)	90.9	1682B ---
CAC	D		F	17 (3)	19	15B ---
ChPt	D		F1	0.94 (7)	80	1682B ---
GAC	D		F	<0.24	>99.00	1421D ---
PACT	D		P	<1 (1)	>96.3	173E ---
RO	D		P	0.05	98.2	180A --$
Sed	D		F4	21 (10)	63	86B -S-
Sed	D		P	26 (14)	0	156D -S-
TF	D		F2	<1 (7)	>50	375E -S-
TF	D		F40	2 (5)	92.6	1B -S-
TF	D		F17	5 (5)	92.2	1B -S-
AirS	GW		P	<0.5 (1)	>96.7	219B --$
AirS	GW		P	<0.5 (1)	>97.5	207B ---
AirS	GW		P1	3.0	92.9	812E ---
AirS	GW		P	<0.3 (1)	>97.0	217B --$
AirS	GW		P	<1 (1)	>98.8	211B --$

AirS	GW		P2	0.59 (17)	88	134B	V-$
ChOx	GW		F	0.56 (18)	81	146B	V-$
GAC	GW		P	<1.0 (29)	>95.9	283A	---
GAC	GW		F	<1.0 (80)	>91.1	283A	---
AS	I	28	F5	<1 (1)	>97.8	32[illegible]	---
AS+AS	I	26	F	0.10 (6)	17	23A	---
PACT	I	28	F8	7 (1)	61	32B	---
SS+GAC	I	28	F27	<10 (3)	>76	87B	---
Sed	I	49	F1	1.4	0	638B	---
RO	S		P	2 (1)	97.8	323B	---
AirS	SF		F4	<10 (5)	>52	245B	---
ChOx(UVwH2O2)	SF		P1	14 (1)	21	92D	--$
ChOx(UVwH2O2)	SF		P2	<0.5 (1)	>97.8	92D	--$
ChOx(UVwH2O2)	SF		B3	<0.5 (1)	>96.9	92D	--$
ChOx(UVwH2O2)	SF		P3	24 (10)	47	92D	--$
ChOx(UV) (B)	T		B	30	40	1138E	---
Fil+GAC	TSDF		F4	<2 (1)	>94.1	28B	VS-

TRICHLOROETHANE,1,1,1-

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		P1	<8 (5)	>97.2	241B VS-
AS	D		F	0.27	99.73	1587E ---
AS	D		P	<0.3 (20)	>99.77	206B VS-
AS	D		F37	12 (6)	90.0	1B -S-
AS	D		F4	100 (5)	70	1B -S-
AS	D		F6	54 (5)	89	1B -S-
AS	D		F60	28 (6)	94.3	1B -S-
AS	D		F38	5 (6)	96.2	1B -S-
AS	D		P	12 (2)	94.9	187B SV-
TF	D		F37	2 (6)	98.3	1B -S-
TF	D		F11	13(6)	92.4	1B -S-
AirS	GW		P	1.7 (1)	99.50	211B --$
AirS	GW		P	1.1 (1)	99.75	222B --$
AirS	GW		P1	12	89	812E ---
AirS	GW		P	7 (1)	96.8	90D --$
GAC	GW		P	<1.0	>99.05	812E ---
[illegible]AC	GW		F3	<1.0	>96.6	1264B --$
GAC	GW		F2	<1.0	>99.35	1264B --$
RO	GW		F3	10	93.8	250B ---
AS	I	28	F1	<10 (3)	>98.9	6B ---
AS	I	28	F4	<4	>98.1	975B --$
AS	I	28	F13	<10 (1)	>97.3	87B ---
AirS	I	U	P	7	96.8	205E ---
ChOx(Cl)	I	28	F26	<10 (1)	>94.9	87B ---
Sed+AS	I	28	F28	<10 (3)	>92.8	87B ---
PACT	RCRA		B	25	93.8	242E ---
AS	SF		F6	<10 (1)	>93.3	245B ---
AS	SF		B2	<5 (6)	>98.6	143B VS-
AirS	SF		F6	<38 (5)	>93.7	245B ---
CAC (B)	SF		B1	590 (1)	12	143B VS-
ChPt	SF		F6	620 (5)	34	245B ---
Fil	SF		F6	600 (5)	2	245B ---
GAC	SF		F4	90 (5)	75	245B ---
RO	SF		F4	36	95.6	250B ---

TRICHLOROETHANE,1,1,1-

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F28	850 (6)	87	1B -S-
AS	D		F1	<1.3 (7)	>99.88	234A ---
AirS	GW		F	0.2	99.984	1344E ---
AirS	GW		P2	49	95.9	812E ---
AirS	GW		P	<5 (3)	>99.932	168E --$
RBC	I	36	B	34 (10)	97.2	272E ---
ChOx(Cl) (B)	S		B1	9,200 (1)	8.0	49E ---
ChOx(Oz) (B)	S		B2	9,200 (1)	8.0	49E ---
AirS	SF		P	130 (3)	97.8	1362E --$
Fil+GAC	TSDF		F3	<1,300 (2)	>36	28B VS-
PACT	TSDF		B1	<1	>99.980	46E ---

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
GAC	I	28	P4	<100 (4)	>99.15	159B --$
SS	I	28	F35	<10 (2)	>99.941	6B ---
SS	I	28	P3	42000 (1)	18	159B --$
GAC	SF		B	<1	>99.991	1362E --$

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
WOx	RCRA		F	0.40	99.955	242E ---
AS	S		B	1.6	98.6	202D VS-
AirS	SF		P1	7.6 (1)	94.9	182A ---
SS	SF		P2	<0.01 (1)	>99.993	182A ---

TRICHLOROETHANE,1,1,1-

INFLUENT CONCENTRATION - >1 g/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
SCOx	S		P1	<0.0001 (1)	>99.999	162E V--

DICHLOROETHANE,1,1-

CAS NO.: 75-34-3

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: $C_2H_4Cl_2$

CHEMICAL AND PHYSICAL PROPERTIES

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 98.96	333A
MELTING POINT (C): -97.0	333A
BOILING POINT (C): 57.3	333A
VAPOR PRESSURE @ T(C), TORR: 234 @ 25	463A
SOLUBILITY IN WATER @ T(C), MG/L: 5500 @ 20	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 1.79	338D
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 5.45 E-3 @ 25	191D

ENVIRONMENTAL DATA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 300	C	1.79	0.53	mg/L	mg/gm	3B
FILTRASORB 400	C	64.6	0.706	ug/L	ug/gm	79A

DICHLOROETHANE,1,1-

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		F55	<10 (2)	>88	1B -S-
AS	D		P	<2 (14)	>97.5	240A -S-
AS	D		P2	0.8 (1)	56	149B -S-
TF	D		P	7 (14)	91.3	240A -S-
AirS	GW		P	<0.3 (1)	>97.5	222B --$
AirS	GW		P	0.9 (1)	50	90D --$
AirS+GAC	GW		F1	<1 (19)	>97.4	229A ---
ChOx	GW		F	4.4 (18)	59	146B V-$
ChOx(Oz)	GW		P	2.7	4	133B ---
GAC	GW		F2	<1.0	>80	1264B --$
RO	GW		F2	3.0	95.4	250B ---
Soft	GW		P	2.8	0	133B ---
AnFFwGAC	HL		P1	20	80	154B ---
AnFF	S		P1	7.9 (1)	77	149B -S-
AS	SF		F6	<10 (1)	>78	245B ---
AirS+GAC	SF		F2	<1	>95.2	229A ---
ChOx(UVwH2O2)	SF		P1	9.5 (1)	42	92D --$
ChOx(UVwH2O2)	SF		P2	<0.5 (1)	>97.3	92D --$
ChOx(UVwH2O2)	SF		P3	2.7 (10)	87	92D --$
ChOx(UVwH2O2wOz)	SF		B2	<0.5 (1)	>96.2	92D --$
ChOx(UVwOz)(B)	SF		B1	<0.5 (1)	>96.2	92D --$

DICHLOROETHANE,1,1-

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		P2	19 (14)	87	203A -S-
AL	D		P1	45 (14)	69	203A -S-
AS	D		P	8 (14)	94.4	203A -S-
CAC	D		P	111 (14)	23	203A -S-
TF	D		P	94 (14)	35	203A -S-
AirS	GW		P	<5 (3)	>97.5	168E --$
RO	GW		F3	64	89	250B ---
AnFFwGAC	HL		P2	14	87	154B ---
SBRwPAC	HL		P2	<50 (1)	>64	278E ---
AS	SF		B2	<5 (6)	>98.4	143B VS-
AirS	SF		F6	<17 (5)	>92.0	245B ---
CAC (B)	SF		B1	640 (1)	8	143B VS-
ChOx(H2O2) (B)	SF		B3	600 (1)	0	143B VS-
ChOx(UVwH2O2)	SF		B4	29 (1)	86	143B VS-
ChPt	SF		F6	210 (5)	21	245B ---
Fil	SF		F6	210 (5)	0	245B [illegible]--
PACT	TSDF		B1	<1	>99.84	46[illegible] [illegible]--

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	F35	<10 (2)	>99.900	6B ---
ChOx(Cl) (B)	S		B1	9,000 (1)	10	49E ---
ChOx(Oz) (B)	S		B2	8,600 (1)	14	49E ---
AirS	SF		P	630 (3)	75	1362E --$
GAC	SF		B	<1	>99.967	1362E --$
RO	SF		F4	84	92.4	250B ---

DICHLOROETHANE,1,1-

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
GAC	I	28	P4	<100 (3)	>99.89	159B --$
SS	I	28	F1	<10 (10)	>99.909	251B V-$

DICHLOROETHYLENE,1,1-

CAS NO.: 75-35-4

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: C2 H2 CL2

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 96.94	333A
MELTING POINT (C): -122.6	462A
BOILING POINT (C): 31.6	462A
VAPOR PRESSURE @ T(C), TORR: 591 @ 25	463A
SOLUBILITY IN WATER @ T(C), MG/L: 210 @ 25	462A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 1.48	379B
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 1.49 E-2 @ 25	191D

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	4B
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	4B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 300	C	4.91	0.54	mg/L	mg/gm	3B
MLSS	C	0.150	0.71	mg/L	mg/gm	246B
FILTRASORB 400	C	470	0.515	ug/L	ug/gm	79A

DICHLOROETHYLENE,1,1-

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F14	<5 (2)	>86	1B -S-
AS	D		P	<0.2 (20)	>99.75	206B VS-
AS	D		F28	6 (2)	92.9	1B -S-
AS	D		F	<1 (2)	>97.5	201B -S-
AS	D		P	<1 (12)	>98.3	240A -S-
Sed	D		F4	3.9 (10)	87	86B -S-
TF	D		P	<1 (12)	>98.3	240A -S-
AirS	GW		P	<0.3 (1)	>95.6	217B --$
AirS	GW		P	<1 (1)	>92.3	222B --$
AirS	GW		P2	<1 (2)	>98.6	1139E ---
AirS	GW		P	0.9 (1)	91.8	90D --$
GAC	GW		P	<1	>97.0	1139E ---
GAC	GW		F2	<1.0	>70	1264B --$
GAC	GW		F	<1.0 (80)	>52	283A ---
RO	GW		F2	1.2	98.4	250B ---
RO	GW		F3	3.1	72	250B ---
AC	HL		F	<10 (1)	>64	237A ---
Sed+AS	I	28	F28	<10 (2)	>70	87B ---
AS	SF		B2	<5 (2)	>92.3	143B VS-
AirS+GAC	SF		F2	<1	>88	229A ---
ChOx(H2O2) (B)	SF		B3	81 (1)	0	143B VS-
ChOx(UVwH2O2)	SF		P1	<0.8 (1)	>98.0	92D --$
ChOx(UVwH2O2)	SF		B3	<0.5 (1)	>99.03	92D --$
ChOx(UVwH2O2)	SF		B4	<5 (1)	>74	143B VS-
ChOx(UVwH2O2wOz)	SF		B2	<0.5 (1)	>99.23	92D --$
ChOx(UVwOz)(B)	SF		B1	<0.5 (1)	>99.23	92D --$

DICHLOROETHYLENE,1,1-

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		P1	83 (14)	61	203A -S-
AL	D		P2	35 (14)	84	203A -S-
AS	D		P	14 (14)	93.4	203A -S-
CAC	D		P	150 (14)	29	203A -S-
TF	D		P	85 (14)	60	203A -S-
AirS	GW		P1	7.4 (6)	92.7	1139E ---
AS	I	28	F1	25 (3)	97.0	6B ---
AS	I	28	F3	<10 (22)	>97.0	6B ---
AS	I	28	F11	<10 (3)	>97.2	6B ---
CAC (B)	SF		B1	160 (1)	20	143B VS-
ChOx(UVwH2O2)	SF		P2	<0.5 (1)	>99.56	92D --$
ChOx(UVwH2O2)	SF		P3	<0.5 (10)	>99.61	92D --$

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AirS	GW		F	2.0	99.937	1344E ---
AirS	GW		P	<5 (3)	>99.81	168E --$
SS	I	28	F1	<10 (10)	>99.79	251B V-$
SS	I	28	F35	<10 (2)	>99.87	6B ---
SS	I	28	F32	<10 (15)	>99.77	6B ---
ChOx(Cl) (B)	S		B1	8,500 (1)	15	49E ---
AirS	SF		P	4 (3)	99.82	1362E --$
RO	SF		F4	240	78	250B ---

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
SExt (B)	I	28	B1	1000 (1)	92.3	159B --$
SExt (B)	I	28	B2	1000 (1)	92.3	159B --$
SS	I	28	P3	<100 (1)	>99.84	159B --$

DICHLOROETHYLENEs

CAS NO.: 25323-30-2

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: C2 H2 CL2

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 96.94	1035B
MELTING POINT (C):	SEE
BOILING POINT (C):	ISOMERS
VAPOR PRESSURE @ T(C), TORR:	NA
SOLUBILITY IN WATER @ T(C), MG/L:	NA
LOG OCTANOL/WATER PARTITION COEFFICIENT:	NA
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	NA

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME !

DICHLOROETHYLENEs

TREATMENT TECHNOLOGY DATA

TREATMENT TECHNOLOGY DATA NOT AVAILABLE AT THIS TIME!

DICHLOROETHYLENE,1,2-

CAS NO.: 540-59-0

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: C2 H2 CL2

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 96.94	333A
MELTING POINT (C):	NA
BOILING POINT (C): 55	1754A
VAPOR PRESSURE @ T(C), TORR:	SEE CIS
SOLUBILITY IN WATER @ T(C), MG/L:	& TRANS
LOG OCTANOL/WATER PARTITION COEFFICIENT:	NA
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	NA
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME !

DICHLOROETHYLENE,1,2-

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		P	<5 (7)	>69	156D -S-
Sed	D		P	14 (4)	0	156D -S-
ChOx(UVwH2O2)	SF		B3	<0.5 (1)	>99.21	92D --$
ChOx(UVwH2O2wOz)	SF		B2	<0.5 (1)	>99.28	92D --$
ChOx(UVwOz)(B)	SF		B1	<0.5 (1)	>99.28	92D --$

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
ChOx(UVwH2O2)	SF		P1	<1.6 (1)	>98.5	92D --$
ChOx(UVwH2O2)	SF		P2	<0.5 (1)	>99.53	92D --$

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	F1	<10 (10)	>99.89	251B V-$
ChOx(Oz) (B)	S		B2	4,200 (1)	58	49E ---

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
SExt (B)	I	28	B1	2000 (1)	95.9	159B --$
SExt (B)	I	28	B2	1000 (1)	98.0	159B --$

DICHLOROETHYLENE,1,2-

INFLUENT CONCENTRATION - >1 g/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	P3	<0.1 (1)	>99.994	159B --$

ACETONE

CAS NO.: 67-64-1

COMPOUND TYPE: KETONE,

FORMULA: C3 H6 O

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 58.08	333A
MELTING POINT (C): -95.35	333A
BOILING POINT (C): 56.2	333A
VAPOR PRESSURE @ T(C), TORR: 270 @ 30	463A
SOLUBILITY IN WATER @ T(C), MG/L: MISCIBLE	2028A
LOG OCTANOL/WATER PARTITION COEFFICIENT: -0.24	463A
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	NA
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME !

ACETONE

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
RA	I	28	F3	<50 (1)	>4	87B ---

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		P2	51 (1)	92.9	149B -S-
AS	D		P	<30 (21)	>85	156D -S-
Sed	D		P	140 (15)	0	156D -S-
AL	I	28	F3	<50 (2)	>64	261B ---
AS	I	28	F21	<500 (1)	>10	87B ---
AS	I	28	F30	<50 (3)	>67	87B ---
ChOx(Cl)	I	28	F26	<50 (1)	>81	87B ---
[illegible]hPt (B) + Fil	I	28	F19	480 (1)	42	87B ---
GAC	I	28	F14	<50 (3)	>72	87B ---
GAC	I	28	F3	52 (1)	92.5	87B ---
GAC	I	28	F1	<72 (2)	>83	261B ---
RA (B) + Fil	I	28	F20	<50 (1)	>90.0	87B ---
SS	I	28	F12	110 (2)	80	87B ---
SS+GAC	I	28	F27	<60 (1)	>93.9	87B ---
PACT	RCRA		B	<20	>91.4	242E ---
AS	SF		F6	<50 (5)	>66	245B ---
AirS	SF		F4	<50 (2)	>54	245B ---
AirS	SF		F6	150 (3)	77	245B ---
CAC (B)	SF		B1	580 (1)	0	143B VS-
ChOx(H2O2) (B)	SF		B3	550 (1)	8	143B VS-
ChPt	SF		F6	650 (1)	1	245B ---
Fil	SF		F5	<100 (3)	>25	245B ---
Fil	SF		F6	670 (2)	5	245B ---
GAC	SF		F5	120 (3)	2	245B ---
Fil+GAC	TSDF		F4	<50 (3)	>93.6	28B VS-

ACETONE

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		P1	28 (5)	98.5	241B VS-
AL	GW		F2	<50 (2)	>97.2	87B ---
GAC	GW		F2	850 (1)	88	87B ---
RO	GW		F2	200	81	250B ---
AnFFwGAC	HL		P1	190	98.1	154B ---
AS	I	28	F2	3,800 (1)	39	32B ---
AS	I	28	F5	<1 (1)	>99.938	32B ---
AS	I	28	F23	490 (3)	94.0	87B ---
AS	I	28	F31	<50 (3)	>99.00	87B ---
AlkHyd	I	28	F24	1300 (3)	0	87B ---
ChOx(Cl) (B)	I	28	F18	5700 (3)	0	87B ---
GAC	I	28	F9	1400 (2)	0	87B ---
GAC	I	28	F4	2200 (2)	28	87B ---
RA	I	28	F4	3000 (2)	0	87B ---
SExt (B)	I	28	F32	3600 (2)	0	87B ---
AnFF	S		P1	86 (1)	97.4	149B S-
API	SF		F3	2,900 (1)	10	245B --
AS	SF		B2	<100 (6)	>96.9	143B VS-
AirS	SF		P	270 (1)	94.7	91E ---
ChOx(UVwH2O2)	SF		B4	1800 (1)	0	143B VS-
ChPt	SF		F2	2,200 (1)	76	245B ---
ChPt	SF		F8	3,100 (5)	53	245B ---
DAF	SF		F3	2,400 (1)	17	245B ---
Fil	SF		F3	2,400 (1)	3	245B ---
Fil	SF		F8	5,000 (5)	0	245B ---
GAC	SF		F2	<50 (1)	>95.9	245B ---
GAC	SF		F3	2,600 (1)	0	245B ---
GAC	SF		F4	910 (5)	52	245B ---
GAC	SF		F8	<50 (5)	>97.2	245B ---

ACETONE

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	GW		F	1,100	97.1	1168E --$
AnFFwGAC	HL		P2	410	96.6	154B ---
SBR	HL		P1	470 (8)	96.5	278E ---
SBRwPAC	HL		P2	30 (8)	99.78	278E ---
AL	I	28	F11	<280 (3)	>99.57	87B ---
AS	I	28	F25	120 (3)	99.82	87B ---
AS	I	28	F13	3400 (3)	91.2	87B ---
AS	I	28	F17	<51 (3)	>99.84	87B ---
AS	I	28	F5	<500 (1)	>98.0	87B ---
ChOx(Cl)	I	28	F34	6800 (3)	55	87B ---
GAC	I	28	F1	25,000 (1)	11	87B ---
SS	I	49	P	10,000	80	1082E ---
SS	I	28	F33	15,000 (3)	5	87B ---
RO	SF		F4	5,800	78	250B ---

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
GAC	I	28	F15	830 (3)	0	87B ---
SS	I	U	P2	<5 (1)	>98.6	263E --$
Fil+GAC	TSDF		F3	120 (3)	0	28B VS-

INFLUENT CONCENTRATION - >1 g/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
Fil	I	28	F16	640 (3)	40	87B ---
SS	I	28	F6	<0.5 (1)	>99.994	87B ---
SS	I	28	F22	0.44 (2)	99.991	87B ---
WOx (B)	I	U	B2	<10 (1)	>99.40	78E ---
WOx	RCRA		F	0.23	99.992	242E ---

BENZENE

CAS NO.: 71-43-2

COMPOUND TYPE: AROMATIC,HYDROCARBON

FORMULA: C6 H6

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 78.11	333A
MELTING POINT (C): 5.5	333A
BOILING POINT (C): 80.1	333A
VAPOR PRESSURE @ T(C), TORR: 95 @ 25	462A
SOLUBILITY IN WATER @ T(C), MG/L: 1780 @ 20	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 2.13	379B
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 5.55 E-3 @ 25	191D

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	4B
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
NORIT PEAT CARBON	C	0.73	0.61	ug/L	mg/gm	764B
NUCHAR WV-G	C	1.07	0.48	ug/L	mg/gm	764B
FILTRASORB 400	C	1.12	0.39	ug/L	mg/gm	764B
HYDRODARCO 1030	C	1.18	0.36	ug/L	mg/gm	764B
FILTRASORB 300	C	1.0	1.6	mg/L	mg/gm	3B
FILTRASORB 400	C	0.036	0.48	mg/L	mg/mg	12A
FILTRASORB 400	C	1.26	0.533	ug/L	mg/gm	79A

BENZENE

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F5	<0.7 (7)	>97.4	234A ---
AS	D		F	6 (10)	81	201B -S-
AS	D		P	<0.2 (20)	>99.73	206B VS-
AS	D		F58	<16 (6)	>84	1B -S-
PACT	D		P	<1 (1)	>75	173E ---
TF	D		F11	1 (5)	97.5	1B -S-
AirS	GW		F	59 (14)	34	157B --$
AirS+GAC	GW		F1	<1 (19)	>90.9	229A ---
CAC+Fil	GW		F	53 (14)	10	157B --$
GAC	GW		F	78 (14)	0	157B --$
RO	GW		F2	3.8	95.1	250B ---
AL	I	28	F3	<10 (3)	>23	261B ---
AS	I	28	F4	<1 (1)	>92.3	32B ---
AS	I	28	F6	<1 (1)	>88	32B ---
AS	I	28	F2	<10 (28)	>89.6	6B ---
AS	I	28	F25	<10 (3)	>54	87B ---
[illegible]	I	U	P1	3	40	158E ---
AS	I	33	P2	<10	>87	158E ---
CAC	I	28	F2	<14 (2)	>18	261B ---
CAC (B)	I	49	B2	3.4 (1)	0	638B ---
ChOx(Cl)	I	33	F	4.6	94.3	9E --$
ChOx(Cl) (B)	I	28	F18	<10 (1)	>66	87B ---
GAC	I	28	F1	<5 (1)	>54	32B ---
GAC	I	28	F4	10 (1)	0	87B ---
GAC	I	28	F3	<10 (1)	>38	87B ---
GAC	I	28	F1	<10 (1)	>78	261B ---
RA	I	28	F4	10 (1)	0	87B ---
RA	I	26	F	3.1 (3)	3	177E --$
RA (B) + Fil	I	28	F20	12 (1)	86	87B ---
PACT	RCRA		B	<5	>83	242E ---
AS	S		B	0.5 (16)	97.8	200B VS-
RO	S		P	32 (1)	19	323B ---
AS	SF		F6	<10 (1)	>81	245B ---
CAC (B)	SF		B1	42 (1)	0	143B VS-
ChOx(UVwH2O2)	SF		P3	<0.5 (10)	>83	92D --$
ChOx(UVwOz)(B)	SF		B2	20 (1)	50	1975E --$
GAC	SF		F4	<10 (5)	>60	245B ---
Fil+GAC	TSDF		F4	<2 (1)	>90.5	28B VS-

BENZENE

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		F55	<10 (6)	>94.4	1B -S-
AS	D		F28	<1 (6)	>99.55	1B -S-
AS	D		F6	0.6 (7)	99.83	234A ---
AS	D		F38	2 (6)	98.9	1B -S-
AS	D		F30	<2 (6)	>99.00	1B -S-
AS	D		P	<1.0 (5)	>99.71	262D VS-
AL	GW		F2	<10 (2)	>96.6	87B ---
AirS	GW		P	<0.5 (1)	>99.67	224B --$
AirS	GW		F	<0.44 (22)	>99.74	322B --$
SBRwPAC	HL		P2	<50 (1)	>70	278E ---
AL	I	28	F24	<10 (2)	>92.3	6B ---
AL	I	28	F12	<10 (2)	>98.9	6B ---
AS	I	28	F5	<10 (7)	>98.8	6B ---
AS	I	28	F33	<10 (14)	>95.7	6B ---
AS	I	28	F1	11 (1)	98.0	32B ---
AS	I	28	F2	70 (1)	73	32B ---
AS	I	28	F7	<1 (1)	>99.58	32[illegible] --
AS	I	28	F3	<30 (22)	>91.7	6B ---
AS	I	28	F20	<10 (3)	>95.6	6B ---
CAC	I	28	F8	<5 (1)	>98.9	32B ---
ChPt (B) + Fil	I	28	F19	73 (1)	61	87B ---
GAC	I	28	F5	<56 (2)	>91.5	87B ---
PACT	I	29	P2	<10 (1)	>95.4	188A ---
SS	I	28	F1	<10 (10)	>96.3	251B V-$
Sed+AS	I	28	F28	<10 (3)	>96.3	87B ---
AS	S		B	0.8 (16)	99.30	200B VS-
AS	S		B	1.0 (8)	99.83	200B VS-
PACT	S		B	0.7 (12)	99.34	200B VS-
AirS	SF		P	1 (3)	99.09	1362E --$
AirS	SF		F6	<18 (5)	>92.7	245B ---
ChPt	SF		F6	240 (5)	23	245B ---
Fil	SF		F6	250 (5)	0	245B ---
RO	SF		F4	67	92.7	250B ---
RO	SP		P2	50	78	250B ---
PACT	TSDF		B1	<1	>99.66	46E ---

BENZENE

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AFFwGAC	GW		P	<1 (7)	>99.909	155D ---
AirS	GW		F	52 (19)	98.7	322B --$
RO	GW		F3	140	92.2	250B ---
GAC	HL		F1	<10 (1)	>99.28	245B ---
AL	I	28	F11	<40 (3)	>96.6	87B ---
API+DAF+AS	I	29	F	3.7 (4)	99.959	1482D ---
AS	I	28	F10	<10 (3)	>99.09	6B ---
AS	I	28	F11	<10 (3)	>99.71	6B ---
AS	I	28	F1	<11 (27)	>99.80	6B ---
AS	I	U	F	3	99.915	158E ---
AS	I	U	P4	<1	>99.981	158E ---
GAC	I	33	F	80	98.6	9E --$
WOx	RCRA		F	29	99.64	242E ---
AL	S		B	60	98.0	371D VS-
ChOx(Cl) (B)	S		B1	9,000 (1)	10	49E ---
ChOx(Oz) (B)	S		B2	9,200 (1)	8.0	49E ---
[illegible]x (B)	S		B3	500	53	1054E V--
CAC (B)	SF		B2	5500 (1)	19	1927B ---
ChPt (B)	SF		B5	9100 (1)	2	1927B ---
Sed (B)	SF		B1	6200 (1)	9	1927B ---
UF	SP		P2	230	78	250B ---

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL+AS	I	28	F	13 (21)	99.900	233D VS-
AS	I	28	F31	<10 (15)	>99.974	6B ---
SS	I	28	F32	10 (2)	99.971	6B ---
SS	I	28	F15	<10 (10)	>99.989	6B ---
TF+AS	I	28	F21	<10 (3)	>99.974	6B ---
AirS	S		B2	9,300 (5)	90.0	1328E ---
AirS	SF		P1	36,000 (1)	48	182A ---
DAF (B)	SF		B4	17000 (2)	10	1927B ---
GAC	SF		B6	4200 (8)	68	1927B ---
SS	SF		P2	<10 (1)	>99.985	182A ---

BENZENE

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
AS+Fil	I	28	F26	0.020 (3)	99.994	6B ---
SS	I	28	F17	0.048 (12)	99.994	6B ---
SS	I	28	F32	0.20 (3)	99.938	6B ---
AS	S		B	0.040	99.974	202D VS-
WOx (B)	S		B1	180	82	1054E V--

CHLOROETHANE

CAS NO.: 75-00-3

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: C2 H5 CL

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 64.51	333A
MELTING POINT (C): -136.4	333A
BOILING POINT (C): 12.3	333A
VAPOR PRESSURE @ T(C), TORR: 2660 @ 25	463A
SOLUBILITY IN WATER @ T(C), MG/L: 5740 @ 20	2028A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 1.43	338D
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 1.11 E-2 @ 24.8	1034A

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	NA

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 300	C	0.59	0.95	mg/L	mg/gm	3B

CHLOROETHANE

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	I	28	F5	<1 (1)	>94.4	32B ---
CAC (B)	SF		B1	52 (1)	0	143B VS

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		F55	260 (5)	30	1B -S-
AS	D		F51	640 (5)	0	1B -S-
AS	D		F58	250 (5)	0	1B -S-
AS	I	28	F1	<50 (4)	>87	6B ---
CAC	I	28	F8	340 (1)	42	32B ---
GAC	I	28	F3	<5 (1)	>99.50	32B ---
PACT	I	28	F8	33 (1)	90.3	32B ---

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
PACT	I	28	F40	<63 (3)	>96.8	6B ---
SExt (B)	I	28	B1	1000 (1)	67	159B --$
SExt (B)	I	28	B2	1000 (1)	67	159B --$
ChOx(Cl) (B)	S		B1	8,800 (1)	12	49E ---
ChOx(Oz) (B)	S		B2	8,900 (1)	11	49E ---

CHLOROETHANE

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
GAC	I	28	P4	<100 (3)	>99.84	159B --$
SS	I	28	F35	<50 (2)	>99.88	6B ---
SS	I	28	F32	<50 (15)	>99.75	6B ---

CHLOROFORM

CAS NO.: 67-66-3

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: C H CL3

CHEMICAL AND PHYSICAL PROPERTIES

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 119.38	333A
MELTING POINT (C): -63.5	333A
BOILING POINT (C): 61.7	333A
VAPOR PRESSURE @ T(C), TORR: 160 @ 20	463A
SOLUBILITY IN WATER @ T(C), MG/L: 9300 @ 25	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 1.97	163A
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 3.39 E-3 @ 25	191D

ENVIRONMENTAL DATA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 400	C	39.2	0.756	ug/L	ug/gm	73A
HYDRODARCO 3000	C	92.5	0.67	ug/L	ug/gm	73A
WESTVAC WV-W	C	55.7	0.738	ug/L	ug/gm	73A
FILTRASORB 300	C	2.6	0.73	mg/L	mg/gm	3B
FILTRASORB 300	T	15.1	0.914	ug/L	ug/gm	1318D
MLSS	C	0.094	0.90	mg/L	mg/gm	246B
HYDRODARCO 4000	C	14.5	0.68	ug/L	ug/mg	1334E
ICI HD 4000	C	7.8	0.69	mg/L	mg/gm	74B
AMBERSORB XE 340	C	18.2	0.81	mg/L	mg/gm	74B
FILTRASORB 400	C	92.5	0.669	ug/L	ug/gm	79A

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB F-400	C	285	0.532	ug/L	ug/gm	285A

CHLOROFORM

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F3	1.3 (7)	65	234A ---
AS	D		F	38 (29)	53	201B -S-
AS	D		F1	1.2 (7)	61	234A ---
AS	D		F6	0.5 (7)	98.4	234A ---
AS	D		F30	6 (5)	86	1B -S-
AS	D		F4	<1 (7)	>75	375E -S-
AS	D		F5	20 (7)	78	375E -S-
AS	D		F36	20 (3)	80	1B -S-
AS	D		F3	<1 (1)	>75	31B ---
AS	D		F	1.6	65	1587E ---
AS	D		F2	2.4 (3)	46	238A ---
AS	D		P	<2 (14)	>98.0	240A -S-
AS	D		F1	21 (6)	62	1B -S-
AS	D		F5	1.3 (7)	84	234A ---
AS	D		F4	2.3 (7)	72	234A ---
AS	D		F3	1.3 (10)	95.0	86B [illegible]S-
AS	D		F2	2.3 (10)	93.0	86B [illegible]S-
AS	D		F15	1.5 (10)	94.5	86B -S-
AS	D		F6	1.3 (10)	97.3	86B -S-
AS	D		F14	1.5 (11)	95.0	86B -S-
AS	D		F29	1.2 (12)	94.5	86B -S-
AS	D		F23	1.2 (10)	94.9	86B -S-
AS	D		F27	2.2 (5)	92.5	86B -S-
AS	D		P	0.5 (2)	88	187B SV-
AS	D		P	<7.2 (20)	>78	156D -S-
AirS	D		F1	0.18 (7)	84	1682B ---
AirS	D		F2	0.88 (11)	78	1682B ---
CAC+AirS	D		F	0.2 (25)	89	1833D ---
ChPt	D		F1	1.1 (7)	32	1682B ---
GAC	D		F	0.21	98.0	1421D ---
PACT	D		P	<1 (3)	>98.5	173E ---
RBC	D		F17	1.9 (10)	96.5	86B -S-
RO	D		P	0.89	71	180A --$
RO	D		P	1.0	0	144A ---
Sed	D		F3	4 (1)	0	31B ---
Sed	D		F4	3.8 (10)	88	86B -S-
Sed	D		P	9.8 (15)	0	156D -S-
TF	D		P	11 (14)	89	240A -S-
TF	D		F40	14 (4)	86	1B -S-
AirS	GW		B2	2.6	96.9	17A ---
AirS	GW		P	0.5 (1)	91.8	90D [illegible]-$
GAC	GW		F1	<1.0	>87	1264[illegible]$
AL	I	26	F10	9 (3)	90.1	1607B ---
AS	I	28	F2	<5 (1)	>50	32B ---
AS	I	28	F2	<2	>93.8	975B --$
AS	I	28	F1	<5 (1)	>88	32B ---

AS	I	28	F5	<1 (1)	>75	32B	---
AS	I	28	F9	<1 (1)	>96.2	32B	---
AS	I	28	F17	<10 (3)	>88	87B	---
CAC	I	28	F8	30 (1)	54	32B	---
[illegible]C (B)	I	49	B1	26 (1)	0	638B	---
ChPt (B) + Fil	I	28	F19	<10 (1)	>9	87B	---
PACT	I	28	F8	9 (1)	70	32B	---
PACT	I	29	P2	<10 (1)	>87	188A	---
Sed	I	49	F1	94	0	638B	---
PACT	RCRA		B	<20	>47	242E	---
AirS	S		P2	1.4	98.2	369A	---
AS	SF		F6	<10 (1)	>87	245B	---
AirS+GAC	SF		F2	<1	>90.0	229A	---
CAC (B)	SF		B1	21 (1)	4	143B	VS-
ChOx(UVwH2O2)	SF		P3	1.6 (10)	56	92D	--$
AirS	T		P	0.13 (1)	98.9	225B	---
AirS	T		B3	3.9	88	17A	---
AirS	T		P	13 (1)	77	213B	--$
ChOx(Oz)	T		P2	2.8	35	331D	--$
ChOx(Oz)	T		P1	46	37	331D	--$
ChOx(UV)	T		P	36	26	13E	---
ChOx(UVwH2O2)	T		P	22	50	13E	---
GAC	T		P1	<1	>98.6	331D	--$
GAC	W		F3a	55 (1)	28	189E	--$
GAC	W		F5	<1.0 (1)	>98.2	189E	--$

CHLOROFORM

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
ChOx(Oz) (B)	C		B1	7 (2)	96.0	640E ---
ChOx(UVwOz)(B)	C		B3	3 (1)	99.00	640E ---
AL	D		F55	<26 (6)	>96.8	1B -S-
AL	D		P2	31 (14)	77	203A -S-
AL	D		P1	53 (14)	61	203A -S-
AS	D		F28	59 (6)	51	1B -S-
AS	D		P	3.6 (20)	97.4	206B VS-
AS	D		P	18 (14)	87	203A -S-
AS	D		P1	44 (5)	85	241B VS-
CAC	D		P	106 (14)	22	203A -S-
TF	D		P	102 (14)	24	203A -S-
AirS	GW		B1	3.7	98.6	17A ---
RO	GW		F3	53	87	250B ---
RO	GW		F2	4.3	98.1	82A --$
GAC	HL		F1	<10 (1)	>97.6	245B ---
GAC	HL		F	<10 (1)	>98.1	237[illegible]--
AL	I	26	F	16	92.3	141A --
AL	I	26	F15	130 (3)	86	1607B ---
AL	I	26	F11	10 (2)	97.4	1607B ---
AS	I	28	F32	30 (7)	77	6B ---
AS	I	28	F11	<10 (3)	>98.2	6B ---
AS	I	26	F4	50 (3)	86	1607B ---
AS	I	28	F20	<10 (3)	>97.7	6B ---
AS	I	28	F31	<10 (3)	>96.0	87B ---
AS+AS	I	26	F	100 (6)	65	23A ---
AS+Fil	I	28	F9	<10 (14)	>95.8	6B ---
CAC	I	28	F2	150 (3)	40	261B ---
ChOx(Cl) (B)	I	28	F18	740 (3)	0	87B ---
GAC	I	28	F1	200 (1)	35	87B ---
SCOx	I	U	P1	<12 (1)	>98.8	164E V--
Sed+AS	I	28	F28	<10 (3)	>94.2	87B ---
AirS	S		P	<0.1	>99.988	10A ---
AirS	S		B1	34 (5)	84	1328E ---
SCOx	S		P	<1.7	>99.83	65D ---
AirS	SF		F6	<23 (5)	>93.8	245B ---
ChPt	SF		F6	360 (5)	18	245B ---
ChPt	SF		F8	520 (5)	9	245B ---
Fil	SF		F6	370 (5)	0	245B ---
Fil	SF		F8	490 (5)	6	245B ---
GAC	SF		F8	<10 (5)	>96.8	245B ---
GAC	SF		F2	<10 (1)	>96.3	245B --
AirS	T		B4	4.2	98.6	17A --
AirS	T		P	<1 (1)	>99.20	210B --$
GAC	W		F1	73 (1)	30	189E --$
GAC	W		F2	42 (1)	60	189E --$
GAC	W		F4	12 (1)	90.0	189E --$

GAC W F3b 68 (1) 74 189E --$

CHLOROFORM

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F	71 (31)	95.4	21E ---
RO	GW		F2	110	94.5	250B ---
AL	I	28	F3	<10 (3)	>99.58	261B ---
AS	I	26	F7	40 (2)	96.9	1607B ---
AS	I	26	F	150 (6)	86	75E V--
AS	I	28	F1	<19 (27)	>98.7	6B ---
AS	I	28	F25	92 (3)	98.6	87B ---
AS	I	28	F13	83 (2)	98.0	87B ---
AS	I	28	F	92	94.3	174E --$
AS	I	28	P	120	92.6	174E --$
AS+Fil	I	28	F9	<10 (3)	>99.41	6B ---
Fil	I	28	B1	4,800	0	63E ---
RA	I	26	F	4700 (3)	29	177E --$
AirS	S		P1	41 (4)	98.0	434B --$
ChOx(Cl) (B)	S		B1	9,300 (1)	7.0	49E ---
ChOx(Oz) (B)	S		B2	8,500 (1)	15	49E ---
AirS	T		B5	110	91.7	17[illegible]--
PACT	TSDF		B1	<1	>99.932	46E ---

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	F35	120 (2)	99.88	6B ---
SS	I	28	F1	5,500 (13)	90.2	28B VS-
AS	S		B	200	99.43	202D VS-
AirS	S		B2	4,400 (5)	83	1328E ---

CHLOROFORM

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	F1	9.6 (10)	96.4	251B V-$
SS	I	28	F32	<0.010 (15)	>99.998	6B ---
SS	I	28	P3	65 (1)	54	159B --$
WOx (B)	I	U	B2	<1 (1)	>99.63	78E ---
AirS	S		B2	16 (5)	93.1	1328E ---

INFLUENT CONCENTRATION - >1 g/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	F2	<0.006 (10)	>99.999	251B V-$
WOx (B)	S		B1	3 (1)	99.933	78E ---

ETHYLBENZENE

CAS NO.: 100-41-4

COMPOUND TYPE: AROMATIC,HYDROCARBON

FORMULA: C8 H10

CHEMICAL AND PHYSICAL PROPERTIES

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 106.17	333A
MELTING POINT (C): -95	333A
BOILING POINT (C): 136.2	333A
VAPOR PRESSURE @ T(C), TORR: 10 @ 25.9	333A
SOLUBILITY IN WATER @ T(C), MG/L: 152 @ 20	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 3.15	379B
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 6.44 E-3 @ 25	191D

ENVIRONMENTAL DATA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	4B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 300	C	53	0.79	mg/L	mg/gm	3B
FILTRASORB 400	C	0.100	0.40	mg/L	mg/mg	12A
FILTRASORB 400	C	9.27	0.415	ug/L	mg/gm	79A
MLSS	C	223	0.977	mg/L	ug/gm	275D

ETHYLBENZENE

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		F55	<10 (4)	>69	1B -S-
AS	D		F5	<0.2 (7)	>99.22	234A ---
AS	D		F3	<0.2 (7)	>99.14	234A ---
AS	D		P	<1 (14)	>98.4	240A -S-
AS	D		F4	<1 (5)	>98.1	1B -S-
AS	D		F59	<8 (4)	>89	1B -S-
AS	D		F17	<1 (4)	>97.7	1B -S-
AS	D		P	<0.2 (20)	>99.76	206B VS-
AS	D		F1	0.5 (3)	97.2	238A ---
AS	D		F14	<5 (3)	>89	1B -S-
AS	D		F7	<5 (5)	>79	1B -S-
AS	D		F19	3 (4)	89	1B -S-
AS	D		F1	3 (3)	95.4	1B -S-
AS	D		F38	9 (6)	90.7	1B -S-
AS	D		F	6 (16)	92.8	201B -S-
AS	D		F30	1.2 (10)	95.5	86B -S-
[illegible]	D		F51	<12 (4)	>60	1B -S-
AirS	D		F1	0.10 (3)	56	1682B ---
AirS	D		F2	0.041 (9)	39	1682B ---
ChPt	D		F1	0.23 (3)	84	1682B ---
GAC	D		F	0.10	37	1421D ---
RO	D		P	0.02	71	180A --$
Sed	D		F3	30 (1)	40	31B ---
TF	D		P	<1 (14)	>98.4	240A -S-
TF	D		F17	4 (4)	90.9	1B -S-
AirS	GW		P	<0.5 (1)	>91.9	224B --$
AirS	GW		F	<0.3	>94.1	69A --$
AirS+GAC	GW		F1	<1 (19)	>80	229A ---
AS	I	28	F4	<1 (1)	>95.0	32B ---
AS	I	28	F3	<5 (1)	>44	32B ---
AS	I	28	F4	<8	>87	975B --$
AS	I	28	F2	<5 (1)	>85	32B ---
AS	I	28	F25	<10 (3)	>88	87B ---
AS	I	28	F13	<10 (1)	>77	87B ---
AS+Fil	I	28	F29	<10 (15)	>90.0	6B ---
GAC	I	28	F3	9 (1)	40	32B ---
GAC	I	29	P1	<10 (1)	>52	188A ---
GAC	I	28	F1	<10 (1)	>52	261B ---
PACT	I	29	P2	<10 (1)	>75	188A ---
RA (B) + Fil	I	28	F20	<10 (1)	>54	87B ---
PACT	RCRA		B	<5	>76	242E ---
[illegible]	S		B	0.5 (9)	99.50	200B VS-
PACT	S		B	0.4 (11)	99.57	200B VS-
ChOx(H2O2) (B)	SF		B3	58 (1)	0	143B VS-
ChOx(UVwH2O2)	SF		B4	<5 (1)	>46	143B VS-
ChOx(UVwOz)(B)	SF		B2	<20 (1)	>10	1975E --$

Fil	SF	F8	31 (1)	6	245B	---
GAC	SF	F4	<10 (5)	>58	245B	---
RO	SP	P2	5	92.9	250B	---
Fil+GAC	TSDF	F4	<2 (1)	>82	28B	VS-

ETHYLBENZENE

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		P2	12 (14)	89	203A -S-
AL	D		P1	27 (14)	76	203A -S-
AS	D		F27	<1 (4)	>99.17	1B -S-
AS	D		F36	2 (3)	99.26	1B -S-
AS	D		P	6 (14)	94.6	203A -S-
AS	D		F28	4 (6)	97.5	1B -S-
AS	D		P1	<5 (5)	>97.6	241B VS-
AS	D		P2	2.8 (1)	97.4	149B -S-
AS	D		P	<5 (1)	>97.4	262D VS-
CAC	D		P	73 (14)	34	203A -S-
TF	D		F27	11 (4)	90.8	1B -S-
TF	D		P	31 (14)	72	203A -S-
AFFwGAC	GW		P	<1 (7)	>99.27	155D ---
AnFFwGAC	HL		P1	34	94.4	154B ---
AnFFwGAC	HL		P2	85	86	154B ---
AL	I	28	F3	<10 (3)	>95.3	261B ---
[illegible]	I	31	F5	32 (1)	82	31B ---
AS	I	28	F3	<10 (29)	>97.4	6B ---
AS	I	28	F1	<10 (24)	>94.4	6B ---
AS	I	28	F39	<10 (7)	>97.9	6B ---
AS	I	28	F11	<10 (3)	>98.2	6B ---
AS	I	28	F31	<10 (15)	>98.9	6B ---
AS	I	28	F1	<10	>96.4	975B --$
AS	I	28	F17	<10 (3)	>99.00	87B ---
CAC	I	28	F8	<5 (1)	>98.4	32B ---
ChPt (B) + Fil	I	28	F19	22 (1)	81	87B ---
GAC	I	28	F9	<10 (3)	>91.5	87B ---
GAC	I	28	F1	<10 (1)	>98.9	87B ---
Sed+AS	I	28	F28	<10 (3)	>90.4	87B ---
AS	S		B	0.6 (12)	99.50	200B VS-
AS	S		B	0.7 (6)	99.89	200B VS-
AnFF	S		P1	120 (1)	46	149B -S-
AirS	SF		F6	<10 (3)	>98.0	245B ---
CAC (B)	SF		B1	140 (1)	0	143B VS-
ChPt	SF		F6	590 (3)	0	245B ---
Fil	SF		F6	<410 (4)	>19	245B ---
UF	SP		P2	70	59	250B ---
PACT	TSDF		B1	<1	>99.46	46E ---

ETHYLBENZENE

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	GW		F2	<10 (3)	>99.88	87B ---
AL+AS	I	28	F	4 (21)	99.933	233D VS-
AS	I	28	F5	<1 (1)	>99.941	32B ---
AS	I	28	F1	<25 (3)	>98.7	6B ---
AS	I	28	F3	<8	>99.80	975B --$
AS	I	28	F28	<10 (4)	>99.47	6B ---
WOx	RCRA		F	21	99.65	242E ---
ChOx(Cl) (B)	S		B1	8,700 (1)	13	49E ---
ChOx(Oz) (B)	S		B2	9,500 (1)	5.0	49E ---
WOx (B)	S		B3	500	94.6	1054E V--
AirS	SF		P	16 (1)	98.8	91E ---
CAC (B)	SF		B2	3300 (1)	20	1927B ---
ChPt (B)	SF		B5	2300 (1)	28	1927B ---
DAF (B)	SF		B4	5200 (2)	0	1927B ---
GAC	SF		B6	390 (8)	86	1927B ---
RO	SF		F4	170	97.0	250[illegible]--
Sed (B)	SF		B1	3600 (1)	12	1927[illegible]--

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
API+DAF+AS	I	29	F	3.3 (4)	99.982	1482D ---
AS	I	28	F5	<10 (7)	>99.974	6B ---
AS	S		B	80	99.87	202D VS-
AirS	SF		P1	<10 (1)	>99.957	182A ---
SS	SF		P2	<10 (1)	>99.957	182A ---

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
WOx (B)	S		B1	30	97.0	1054E V--

METHYLENE CHLORIDE

CAS NO.: 75-09-2

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: C H2 CL2

CHEMICAL AND PHYSICAL PROPERTIES

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 84.93	333A
MELTING POINT (C): -95.1	333A
BOILING POINT (C): 40	333A
VAPOR PRESSURE @ T(C), TORR: 429 @ 25	462A
SOLUBILITY IN WATER @ T(C), MG/L: 1.67 E 4 @ 25	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 1.25	338D
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 3.19 E-3 @ 25	191D

ENVIRONMENTAL DATA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	4B
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	4B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 300	C	1.30	1.16	mg/L	mg/gm	3B
MLSS	C	0.056	1.28	mg/L	mg/gm	246B
FILTRASORB 400	C	6.25	0.801	ug/L	ug/gm	79A

METHYLENE CHLORIDE

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F3	4.9 (7)	56	234A ---
AS	D		F1	<2.0 (7)	>93.3	234A ---
AS	D		F6	10 (7)	69	375E -S-
AS	D		F4	<5 (7)	>80	375E -S-
AS	D		F18	23 (3)	74	1B -S-
AS	D		F2	11 (3)	78	238A ---
AS	D		F51	17 (4)	64	1B -S-
AS	D		F3	20 (7)	64	375E -S-
AS	D		F36	17 (3)	72	1B -S-
AS	D		F	45 (27)	51	201B -S-
AS	D		F19	61 (6)	34	1B -S-
AS	D		F38	17 (6)	77	1B -S-
AS	D		F12	23 (4)	57	1B -S-
AS	D		F17	9 (3)	75	1B -S-
AS	D		F6	31 (4)	31	1B -S-
AS	D		F10	62 (5)	35	1B [illegible]S-
AS	D		F59	61 (4)	34	1B [illegible]S-
AS	D		F7	23 (3)	64	1B -S-
AS	D		F20	16 (5)	72	1B -S-
AS	D		F3	12 (1)	12	31B ---
AS	D		P2	4.8 (1)	70	149B -S-
AS	D		P	3.4 (2)	95.2	187B SV-
AS	D		P	29 (21)	28	156D -S-
CAC	D		F	12 (2)	40	15B ---
CAC+AirS	D		F	2.4 (25)	92.3	1833D ---
Sed	D		F3	13 (1)	28	31B ---
Sed	D		P	16 (15)	19	156D -S-
TF	D		F2	12 (7)	8	375E -S-
TF	D		F10	58 (5)	40	1B -S-
TF	D		F21	20 (5)	67	1B -S-
TF	D		F39	21 (5)	77	1B -S-
TF	D		F17	23 (3)	36	1B -S-
AL	I	28	F3	<12 (3)	>43	261B ---
AL+Fil	I	28	F29	<10 (2)	>64	87B ---
AS	I	28	F1	<13 (10)	>79	6B ---
AS	I	28	F32	<10 (3)	>77	6B ---
AS	I	28	F2	0.43	92	975B --$
AS	I	31	F5	24 (1)	0	31B ---
AS	I	28	F2	<5 (1)	>88	32B ---
AS	I	31	F6	18 (1)	45	31B ---
AS	I	28	F25	<10 (3)	>88	87B ---
AS+Fil	I	28	F9	29 (9)	26	6B ---
CAC	I	31	F6	33 (1)	0	31B ---
CAC	I	28	F2	<11 (3)	>50	261B ---
CAC (B)	I	49	B1	21 (1)	4	638B ---
CAC (B)	I	49	B2	61 (1)	0	638B ---

ChOx(Cl)	I	28	F26	22 (2)	39	87B	---
GAC	I	28	F5	<10 (1)	>70	87B	---
SS+GAC	I	28	F27	<10 (3)	>89	87B	---
Sed	I	49	F1	67	0	638B	---
[illegible]CT	RCRA		B	<20	>76	242E	---
AS	SF		F6	<10 (1)	>88	245B	---
GAC	SF		F4	<14 (3)	>42	245B	---
Fil+GAC	TSDF		F4	<5 (2)	>79	28B	VS-
GAC	W		F5	<1.0 (1)	>64	189E	--$

METHYLENE CHLORIDE

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F37	46 (6)	69	1B -S-
AS	D		F5	0.8 (7)	99.54	234A ---
AS	D		F5	560 (5)	31	1B -S-
AS	D		F4	130 (6)	54	1B -S-
AS	D		P	<4 (20)	>96.6	206B VS-
AS	D		P1	110 (5)	78	241B VS-
TF	D		F37	16 (6)	89	1B -S-
TF	D		F29	120 (4)	56	1B -S-
TF	D		F1	21 (7)	88	375E -S-
TF	D		F11	37 (5)	66	1B -S-
AirS+GAC	GW		F1	<1 (19)	>99.80	229A ---
RO	GW		F2	80	66	250B ---
GAC	HL		F	<10 (1)	>94.4	237A ---
AL	I	28	F11	<40 (3)	>92.3	87B ---
AS	I	28	F1	<5 (1)	>98.4	32B ---
AS	I	28	F13	<10 (1)	>93.3	87[illegible]--
AS	I	28	F5	<62 (2)	>62	87[illegible]--
AirS	I	U	P	<3	>99.62	205E ---
GAC	I	28	F14	780 (2)	0	87B ---
GAC	I	28	F9	27 (3)	91.1	87B ---
GAC	I	28	F1	<60 (3)	>92.0	261B ---
RA (B) + Fil	I	28	F20	<10 (1)	>96.3	87B ---
SS	I	28	F35	<10 (2)	>99.00	6B ---
AnFF	S		P1	120 (1)	79	149B -S-
AS	SF		B2	<5.5 (6)	>99.39	143B VS-
AirS	SF		P	5.3 (3)	99.00	1362E --$
AirS	SF		F6	<25 (5)	>90.8	245B ---
AirS+GAC	SF		F2	<1	>99.43	229A ---
ChPt	SF		F6	250 (5)	23	245B ---
Fil	SF		F6	270 (5)	0	245B ---
GAC	SF		F2	<10 (1)	>99.00	245B ---
GAC	SF		F8	<11 (5)	>98.5	245B ---

METHYLENE CHLORIDE

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F5	55 (7)	99.33	375E -S-
AS	D		F14	56 (5)	97.8	1B -S-
AS	D		F31	2,000 (5)	5	1B -S-
AL	GW		F2	<13 (3)	>99.46	87B ---
AnFFwGAC	HL		P1	65	94.8	154B ---
AnFFwGAC	HL		P2	46	96.4	154B ---
AS	I	28	F4	54 (40)	98.6	6B ---
AS	I	28	F17	10 (3)	99.74	6B ---
AS	I	28	F42	<31 (10)	>99.53	6B ---
AlkHyd	I	28	F24	<10 (1)	>99.47	87B ---
ChPt (B) + Fil	I	28	F19	270 (1)	74	87B ---
SS	I	28	F1	<10 (10)	>99.17	251B V-$
SS	I	28	F9	<78 (9)	>95.1	6B ---
SS	I	28	F32	<10 (15)	>99.52	6B ---
Sed+AS	I	28	F28	<22 (3)	>99.68	87B ---
hOx(Cl) (B)	S		B1	8,300 (1)	17	49E ---
hOx(Oz) (B)	S		B2	9,600 (1)	4.0	49E ---
CAC (B)	SF		B1	3100 (1)	0	143B VS-
ChPt	SF		F2	2,700 (1)	0	245B ---
ChPt	SF		F8	1,200 (5)	18	245B ---
Fil	SF		F8	1,200 (5)	0	245B ---

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F32	12,000 (5)	14	1B -S-
PACT	D		P	72 (4)	99.75	173E ---
AS	GW		F	920	98.4	1168E --$
AS	I	28	F31	<10 (3)	>99.985	87B ---
WOx	I	U	P	10 (1)	99.983	78E ---
RO	SF		F4	15,000	44	250B ---
PACT	TSDF		B1	5.8	99.980	46E ---

METHYLENE CHLORIDE

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	P3	130 (1)	84	159B --$
WOx (B)	I	U	B2	<1 (1)	>99.60	78E ---
WOx	RCRA		F	0.084	99.989	242E ---
AS	S		B	0.51	99.72	202D VS-
Fil+GAC	TSDF		F3	<11 (3)	>91.6	28B VS-

INFLUENT CONCENTRATION - >1 g/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	F2	<0.011 (10)	>99.999	251B V-$
SS	I	28	F1	<0.20 (13)	>99.995	28B VS-

TETRACHLOROETHYLENE

CAS NO.: 127-18-4

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: C2 CL4

CHEMICAL AND PHYSICAL PROPERTIES

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 165.83	333A
MELTING POINT (C): -22.4	462A
BOILING POINT (C): 121.1	462A
VAPOR PRESSURE @ T(C), TORR: 19 @ 25	1006A
SOLUBILITY IN WATER @ T(C), MG/L: 150 @ 25	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 2.53	1226A
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 2.87 E-2 @ 25	191D

[illegible]VIRONMENTAL DATA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 400	C	10400	0.458	ug/L	ug/gm	73A
WESTVACO WV-G	C	7520	0.502	ug/L	ug/gm	73A
FILTRASORB 300	C	50.8	0.56	mg/L	mg/gm	3B
MLSS	C	0.897	1.12	mg/L	mg/gm	246B
FILTRASORB 400	C	4.05	0.516	ug/L	mg/gm	79A
FILTRASORB F-400	C	10,400	0.458	ug/L	ug/gm	285A

TETRACHLOROETHYLENE

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		F55	<10 (6)	>80	1B -S-
AS	D		F2	1.6 (3)	87	238A ---
AS	D		F3	<8 (4)	>85	1B -S-
AS	D		F1	2.1 (3)	87	238A ---
AS	D		F1	6 (4)	93.0	1B -S-
AS	D		F60	1 (4)	96.0	1B -S-
AS	D		F37	14 (5)	74	1B -S-
AS	D		F38	22 (3)	45	1B -S-
AS	D		F5	22 (7)	49	234A ---
AS	D		F57	<10 (3)	>83	1B -S-
AS	D		F12	9 (5)	75	1B -S-
AS	D		F	8 (22)	89.5	201B -S-
AS	D		F26	28 (6)	71	1B -S-
AS	D		F	0.87	97.8	1587E ---
AS	D		F31	8 (6)	85	1B -S-
AS	D		F36	2 (5)	97.5	1[illegible]S-
AS	D		F3	<0.6 (7)	>95.9	234A[illegible]--
AS	D		F	<10 (3)	>71	15B ---
AS	D		F4	4 (1)	95.0	31B ---
AS	D		F3	1.3 (10)	94.5	86B -S-
AS	D		F6	2.1 (10)	96.0	86B -S-
AS	D		F30	1.2 (10)	94.8	86B -S-
AS	D		F7	1.1 (10)	94.7	86B -S-
AS	D		P	0.06 (2)	94.5	187B SV-
AirS	D		F2	0.13 (11)	94.8	1682B ---
CAC	D		F	42 (2)	0	15B ---
CAC+AirS	D		F	<0.1 (7)	>89	1833D ---
ChPt	D		F1	0.16 (6)	73	1682B ---
GAC	D		F	<0.19	>99.00	1421D ---
PACT	D		P	<1 (1)	>75	173E ---
RO	D		P	0.25	81	180A --$
Sed	D		F20	6.0 (5)	76	86B -S-
TF	D		F24	<1 (4)	>96.9	1B -S-
TF	D		F11	12 (5)	81	1B -S-
TF	D		F29	18 (3)	54	1B -S-
TF	D		F37	3 (5)	94.3	1B -S-
TF	D		F40	<6 (6)	>92.7	1B -S-
AirS	GW		P	<0.2	>97.1	1363E ---
AirS	GW		F	0.96	98.4	69A --$
AirS	GW		P	<0.5 (1)	>98.3	207B ---
AirS	GW		P	<0.5 (1)	>95.8	221B[illegible]-$
AirS	GW		P	<0.2 (1)	>99.76	220B[illegible]-$
AirS	GW		P	0.2 (1)	99.17	208B --$
AirS	GW		P	<0.2 (1)	>94.3	222B --$
AirS	GW		P2	4.1 (46)	90.7	134B V-$
AirS	GW		F	<0.2	>97.9	282A V--

AirS	GW		F	41 (14)	54	157B	--$
CAC+Fil	GW		F	36 (14)	12	157B	--$
ChOx(H2O2wOz)	GW		P2	1.7 (4)	84	84A	--$
ChOx(H2O2wOz)	GW		P1	1.7 (1)	88	84A	--$
[illegible]AC	GW		F1	<1.0	>95.2	1264B	--$
GAC	GW		F	1 (14)	97.2	157B	--$
RA	GW		P1	0.22 (31)	99.40	134B	V-$
AL	I	31	F7	<1 (1)	>92.3	31B	---
AL	I	28	F3	<10 (3)	>78	261B	---
AS	I	31	F5	2 (1)	86	31B	---
AS+AS	I	26	F	0.05 (6)	50	23A	---
CAC	I	31	F6	16 (1)	0	31B	---
CAC	I	28	F2	27 (3)	40	261B	---
Fil	I	28	B1	30	61	63E	---
GAC	I	28	B3	0.1	99.68	63E	---
GAC	I	28	F5	<10 (2)	>84	87B	---
PACT	I	28	F8	11 (1)	83	32B	---
RA	I	28	B2	0.5	98.4	63E	---
RA+GAC	I	28	B4	0.1	99.68	63E	---
AirS	S		P	<0.2 (1)	>98.7	71D	--$
RO	S		P	30 (1)	68	323B	---
AS	SF		F6	<10 (1)	>78	245B	---
AirS	SF		F7	<10 (3)	>81	245B	---
ChOx(H2O2) (B)	SF		B3	56 (1)	0	143B	VS-
ChOx(UVwH2O2)	SF		P1	<0.8 (1)	>92.5	92D	--$
ChOx(UVwH2O2)	SF		P2	<0.5 (1)	>96.5	92D	--$
ChOx(UVwH2O2)	SF		P3	<0.5 (10)	>98.2	92D	--$
ChOx(UVwH2O2)	SF		B4	<5 (1)	>64	143B	VS-
Fil	SF		F8	65 (1)	7	245B	---
ChOx(UV) (B)	T		B	7.5 (1)	85	1138E	---
[illegible]il+GAC	TSDF		F4	<2 (1)	>69	28B	VS-

TETRACHLOROETHYLENE

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F59	48 (6)	79	1B -S-
AS	D		F6	3.9 (7)	96.7	234A ---
AS	D		F5	26 (6)	78	1B -S-
AS	D		P1	11 (5)	95.3	241B VS-
AS	D		F4	100 (4)	83	1B -S-
AS	D		F17	5 (5)	96.7	1B -S-
AS	D		F16	30 (5)	45	86B -S-
CAC	D		F4	80 (1)	38	31B ---
TF	D		F17	26 (5)	83	1B -S-
AirS	GW		F	0.8 (1)	99.43	223B --$
AirS	GW		P	0.3 (1)	99.73	217B --$
AirS	GW		F	1.2 (9)	99.75	322B --$
AirS	GW		P	0.9 (1)	99.31	214B --$
AirS	GW		F	0.5	99.71	1042E --$
AirS	GW		P	6 (1)	96.4	90D --$
GAC	GW		P	<1.0 (29)	>99.71	283[illegible] --
GAC	GW		F	<1.0 (80)	>99.48	283A --
GAC	HL		F	<10 (1)	>96.3	237A ---
AL+AS	I	31	F8	<1 (1)	>99.78	31B ---
AS	I	28	F1	<5 (1)	>96.9	32B ---
AS	I	28	F5	<75 (3)	>81	87B ---
AS+Fil	I	28	F9	<11 (15)	>97.7	6B ---
CAC	I	28	F8	65 (1)	74	32B ---
CAC	I	31	F7	13 (1)	97.2	31B ---
GAC	I	28	F1	52 (1)	82	261B ---
Sed	I	31	F8	450 (1)	0	31B ---
Sed+AS	I	28	F28	<10 (3)	>96.9	87B ---
PACT	RCRA		B	<10	>92.6	242E ---
AirS	SF		F6	<17 (5)	>88	245B ---
CAC (B)	SF		B1	140 (1)	0	143B VS-
ChPt	SF		F6	150 (5)	34	245B ---
Fil	SF		F6	150 (5)	3	245B ---
GAC	SF		F4	<10 (5)	>97.8	245B ---
PACT	TSDF		B1	<1	>99.67	46E ---

TETRACHLOROETHYLENE

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F28	440 (6)	85	1B -S-
GAC	HL		F1	<10 (1)	>99.13	245B ---
AS	I	31	F2	15 (1)	99.51	31B ---
CAC	I	31	F2	3,000 (1)	0	31B ---
CAC	I	31	F1	1,700 (1)	0	31B ---
ChOx(Cl)	I	28	F26	<10 (3)	>99.27	87B ---
PACT	I	31	F1	110 (1)	93.6	31B ---
SS	I	28	F1	<10 (10)	>99.29	251B V-$
ChOx(Cl) (B)	S		B1	9,100 (1)	9.0	49E ---
ChOx(Oz) (B)	S		B2	9,500 (1)	5.0	49E ---
AirS	SF		P	5 (3)	99.74	1362E --$

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS+Fil	I	28	F9	230 (3)	99.04	6B ---
SExt (B)	I	28	B1	2000 (1)	86	159B --$
SExt (B)	I	28	B2	1000 (1)	92.8	159B --$
SS	I	28	F35	<10 (2)	>99.952	6B ---
SS	I	28	F6	<550 (2)	>98.5	87B ---
SS+GAC	I	28	F27	72 (3)	99.67	87B ---
AnFF	S		B	4.4	99.978	724D ---

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	F7	<0.010 (1)	>99.998	87B ---

TETRACHLOROETHYLENE

INFLUENT CONCENTRATION - >1 g/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
WOx	I	U	P	0.9 (1)	99.978	78E ---

TETRACHLOROETHYLENE

CAS NO.: 127-18-4

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: C2 CL4

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 165.83	333A
MELTING POINT (C): -22.4	462A
BOILING POINT (C): 121.1	462A
VAPOR PRESSURE @ T(C), TORR: 19 @ 25	1006A
SOLUBILITY IN WATER @ T(C), MG/L: 150 @ 25	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 2.53	1226A
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 2.87 E-2 @ 25	191D

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 400	C	10400	0.458	ug/L	ug/gm	73A
WESTVACO WV-G	C	7520	0.502	ug/L	ug/gm	73A
FILTRASORB 300	C	50.8	0.56	mg/L	mg/gm	3B
MLSS	C	0.897	1.12	mg/L	mg/gm	246B
FILTRASORB 400	C	4.05	0.516	ug/L	mg/gm	79A
FILTRASORB F-400	C	10,400	0.458	ug/L	ug/gm	285A

TETRACHLOROETHYLENE

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		F55	<10 (6)	>80	1B -S-
AS	D		F2	1.6 (3)	87	238A ---
AS	D		F3	<8 (4)	>85	1B -S-
AS	D		F1	2.1 (3)	87	238A ---
AS	D		F1	6 (4)	93.0	1B -S-
AS	D		F60	1 (4)	96.0	1B -S-
AS	D		F37	14 (5)	74	1B -S-
AS	D		F38	22 (3)	45	1B -S-
AS	D		F5	22 (7)	49	234A ---
AS	D		F57	<10 (3)	>83	1B -S-
AS	D		F12	9 (5)	75	1B -S-
AS	D		F	8 (22)	89.5	201B -S-
AS	D		F26	28 (6)	71	1B -S-
AS	D		F	0.87	97.8	1587E ---
AS	D		F31	8 (6)	85	1B -S-
AS	D		F36	2 (5)	97.5	1[illegible]S-
AS	D		F3	<0.6 (7)	>95.9	234A[illegible]--
AS	D		F	<10 (3)	>71	15B ---
AS	D		F4	4 (1)	95.0	31B ---
AS	D		F3	1.3 (10)	94.5	86B -S-
AS	D		F6	2.1 (10)	96.0	86B -S-
AS	D		F30	1.2 (10)	94.8	86B -S-
AS	D		F7	1.1 (10)	94.7	86B -S-
AS	D		P	0.06 (2)	94.5	187B SV-
AirS	D		F2	0.13 (11)	94.8	1682B ---
CAC	D		F	42 (2)	0	15B ---
CAC+AirS	D		F	<0.1 (7)	>89	1833D ---
ChPt	D		F1	0.16 (6)	73	1682B ---
GAC	D		F	<0.19	>99.00	1421D ---
PACT	D		P	<1 (1)	>75	173E ---
RO	D		P	0.25	81	180A --$
Sed	D		F20	6.0 (5)	76	86B -S-
TF	D		F24	<1 (4)	>96.9	1B -S-
TF	D		F11	12 (5)	81	1B -S-
TF	D		F29	18 (3)	54	1B -S-
TF	D		F37	3 (5)	94.3	1B -S-
TF	D		F40	<6 (6)	>92.7	1B -S-
AirS	GW		P	<0.2	>97.1	1363E ---
AirS	GW		F	0.96	98.4	69A --$
AirS	GW		P	<0.5 (1)	>98.3	207B ---
AirS	GW		P	<0.5 (1)	>95.8	221B [illegible]-$
AirS	GW		P	<0.2 (1)	>99.76	220B [illegible]-$
AirS	GW		P	0.2 (1)	99.17	208B --$
AirS	GW		P	<0.2 (1)	>94.3	222B --$
AirS	GW		P2	4.1 (46)	90.7	134B V-$
AirS	GW		F	<0.2	>97.9	282A V--

AirS	GW		F	41 (14)	54	157B	--$
CAC+Fil	GW		F	36 (14)	12	157B	--$
ChOx(H2O2wOz)	GW		P2	1.7 (4)	84	84A	--$
ChOx(H2O2wOz)	GW		P1	1.7 (1)	88	84A	--$
[illegible]C	GW		F1	<1.0	>95.2	1264B	--$
GAC	GW		F	1 (14)	97.2	157B	--$
RA	GW		P1	0.22 (31)	99.40	134B	V-$
AL	I	31	F7	<1 (1)	>92.3	31B	---
AL	I	28	F3	<10 (3)	>78	261B	---
AS	I	31	F5	2 (1)	86	31B	---
AS+AS	I	26	F	0.05 (6)	50	23A	---
CAC	I	31	F6	16 (1)	0	31B	---
CAC	I	28	F2	27 (3)	40	261B	---
Fil	I	28	B1	30	61	63E	---
GAC	I	28	B3	0.1	99.68	63E	---
GAC	I	28	F5	<10 (2)	>84	87B	---
PACT	I	28	F8	11 (1)	83	32B	---
RA	I	28	B2	0.5	98.4	63E	---
RA+GAC	I	28	B4	0.1	99.68	63E	---
AirS	S		P	<0.2 (1)	>98.7	71D	--$
RO	S		P	30 (1)	68	323B	---
AS	SF		F6	<10 (1)	>78	245B	---
AirS	SF		F7	<10 (3)	>81	245B	---
ChOx(H2O2) (B)	SF		B3	56 (1)	0	143B	VS-
ChOx(UVwH2O2)	SF		P1	<0.8 (1)	>92.5	92D	--$
ChOx(UVwH2O2)	SF		P2	<0.5 (1)	>96.5	92D	--$
ChOx(UVwH2O2)	SF		P3	<0.5 (10)	>98.2	92D	--$
ChOx(UVwH2O2)	SF		B4	<5 (1)	>64	143B	VS-
Fil	SF		F8	65 (1)	7	245B	---
ChOx(UV) (B)	T		B	7.5 (1)	85	1138E	---
[illegible]l+GAC	TSDF		F4	<2 (1)	>69	28B	VS-

TETRACHLOROETHYLENE

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F59	48 (6)	79	1B -S-
AS	D		F6	3.9 (7)	96.7	234A ---
AS	D		F5	26 (6)	78	1B -S-
AS	D		P1	11 (5)	95.3	241B VS-
AS	D		F4	100 (4)	83	1B -S-
AS	D		F17	5 (5)	96.7	1B -S-
AS	D		F16	30 (5)	45	86B -S-
CAC	D		F4	80 (1)	38	31B ---
TF	D		F17	26 (5)	83	1B -S-
AirS	GW		F	0.8 (1)	99.43	223B --$
AirS	GW		P	0.3 (1)	99.73	217B --$
AirS	GW		F	1.2 (9)	99.75	322B --$
AirS	GW		P	0.9 (1)	99.31	214B --$
AirS	GW		F	0.5	99.71	1042E --$
AirS	GW		P	6 (1)	96.4	90D --$
GAC	GW		P	<1.0 (29)	>99.71	283[illegible]--
GAC	GW		F	<1.0 (80)	>99.48	283A[illegible]--
GAC	HL		F	<10 (1)	>96.3	237A ---
AL+AS	I	31	F8	<1 (1)	>99.78	31B ---
AS	I	28	F1	<5 (1)	>96.9	32B ---
AS	I	28	F5	<75 (3)	>81	87B ---
AS+Fil	I	28	F9	<11 (15)	>97.7	6B ---
CAC	I	28	F8	65 (1)	74	32B ---
CAC	I	31	F7	13 (1)	97.2	31B ---
GAC	I	28	F1	52 (1)	82	261B ---
Sed	I	31	F8	450 (1)	0	31B ---
Sed+AS	I	28	F28	<10 (3)	>96.9	87B ---
PACT	RCRA		B	<10	>92.6	242E ---
AirS	SF		F6	<17 (5)	>88	245B ---
CAC (B)	SF		B1	140 (1)	0	143B VS-
ChPt	SF		F6	150 (5)	34	245B ---
Fil	SF		F6	150 (5)	3	245B ---
GAC	SF		F4	<10 (5)	>97.8	245B ---
PACT	TSDF		B1	<1	>99.67	46E ---

TETRACHLOROETHYLENE

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F28	440 (6)	85	1B -S-
GAC	HL		F1	<10 (1)	>99.13	245B ---
AS	I	31	F2	15 (1)	99.51	31B ---
CAC	I	31	F2	3,000 (1)	0	31B ---
CAC	I	31	F1	1,700 (1)	0	31B ---
ChOx(Cl)	I	28	F26	<10 (3)	>99.27	87B ---
PACT	I	31	F1	110 (1)	93.6	31B ---
SS	I	28	F1	<10 (10)	>99.29	251B V-$
ChOx(Cl) (B)	S		B1	9,100 (1)	9.0	49E ---
ChOx(Oz) (B)	S		B2	9,500 (1)	5.0	49E ---
AirS	SF		P	5 (3)	99.74	1362E --$

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS+Fil	I	28	F9	230 (3)	99.04	6B ---
SExt (B)	I	28	B1	2000 (1)	86	159B --$
SExt (B)	I	28	B2	1000 (1)	92.8	159B --$
SS	I	28	F35	<10 (2)	>99.952	6B ---
SS	I	28	F6	<550 (2)	>98.5	87B ---
SS+GAC	I	28	F27	72 (3)	99.67	87B ---
AnFF	S		B	4.4	99.978	724D ---

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	F7	<0.010 (1)	>99.998	87B ---

TETRACHLOROETHYLENE

INFLUENT CONCENTRATION - >1 g/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
WOx	I	U	P	0.9 (1)	99.978	78E ---

TOLUENE

CAS NO.: 108-88-3

COMPOUND TYPE: AROMATIC,HYDROCARBON

FORMULA: C7 H8

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 92.14	333A
MELTING POINT (C): -95	333A
BOILING POINT (C): 110.6	333A
VAPOR PRESSURE @ T(C), TORR: 28 @ 25	462A
SOLUBILITY IN WATER @ T(C), MG/L: 515 @ 20	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 2.69	163A
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 5.92 E-3 @ 25	191B

VIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	4B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 300	C	26.1	0.44	mg/L	mg/gm	3B
HYDRODARCO	C	40.2	0.35	mg/L	mg/gm	780B
FILTRASORB 400	C	0.090	0.30	mg/L	mg/mg	12A
FILTRASORB 400	C	5.01	0.429	ug/L	mg/gm	79A

TOLUENE

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F19	2 (5)	97.1	1B -S-
AS	D		F31	4 (5)	88	1B -S-
AS	D		F4	<1 (4)	>98.0	1B -S-
AS	D		F12	3 (4)	90.6	1B -S-
AS	D		F1	6.2 (3)	92.7	238A ---
AS	D		F17	2 (5)	97.6	1B -S-
AS	D		F6	0.7 (7)	97.1	234A ---
AS	D		F1	4 (4)	86	1B -S-
AS	D		F4	<0.2 (7)	>96.2	234A ---
AS	D		F5	<1 (6)	>97.3	1B -S-
AS	D		F18	<1 (5)	>97.4	1B -S-
AS	D		F3	<0.2 (7)	>96.9	234A ---
AS	D		F1	<0.2 (7)	>97.7	234A ---
AS	D		F37	<2 (6)	>96.3	1B -S-
AS	D		F57	<3 (5)	>94.0	1B -S-
AS	D		F3	1 (1)	90.9	31[illegible] --
AS	D		F4	1 (1)	96.2	31B ---
AS	D		F	<0.1	>99.00	1587E ---
CAC	D		F4	26 (1)	0	31B ---
PACT	D		P	<1 (3)	>98.5	173E ---
Sed	D		F3	11 (1)	15	31B ---
TF	D		F37	<1 (6)	>98.2	1B -S-
TF	D		F17	10 (5)	88	1B -S-
TF	D		F11	7 (6)	86	1B -S-
TF	D		F21	2 (5)	97.2	1B -S-
AirS	GW		F	<2.0 (5)	>97.4	322B --$
AirS	GW		F	0.94	97.0	69A --$
AirS	GW		P	<0.5 (1)	>98.9	224B --$
AirS	GW		F	38 (14)	31	157B --$
AirS+GAC	GW		F1	<1 (19)	>90.0	229A ---
CAC+Fil	GW		F	36 (14)	5	157B --$
GAC	GW		F	<1 (14)	>97.2	157B --$
AL	I	28	F3	<10 (2)	>50	261B ---
AL+AS	I	31	F8	2 (1)	33	31B ---
AS	I	28	F7	<1 (1)	>93.3	32B ---
AS	I	28	F25	<10 (3)	>64	87B ---
AS	I	28	F31	<10 (1)	>72	87B ---
AS	I	33	P2	<10	>28	158E ---
CAC	I	31	F7	1 (1)	67	31B ---
CAC	I	31	F6	4 (1)	0	31B ---
CAC (B)	I	49	B1	1.5 (1)	17	638B ---
GAC	I	28	F4	<11 (2)	>66	87B ---
GAC	I	28	F3	<10 (1)	>33	87B ---
GAC	I	28	F1	<10 (1)	>85	87B ---
Sed	I	31	F8	3 (1)	83	31B ---
Sed	I	49	F1	1.9	0	638B ---

PACT	RCRA	B	<5	>91.2	242E ---
AirS	SF	P	1.7 (3)	95.3	1362E --$
AirS+GAC	SF	F2	<1	>98.8	229A ---
ChOx(UVwOz)(B)	SF	B2	<20 (1)	>74	1975E --$
[illegible]	SP	P2	12	86	250B ---
Fil+GAC	TSDF	F4	<2 (2)	>94.4	28B VS-

TOLUENE

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		F55	<32 (6)	>96.1	1B -S-
AS	D		P	<0.6 (20)	>99.76	206B VS-
AS	D		P1	<4 (5)	>98.6	241B VS-
AS	D		F59	<12 (5)	>96.8	1B -S-
AS	D		F5	<0.2 (7)	>99.900	234A ---
AS	D		F30	4 (6)	99.48	1B -S-
AS	D		F	57 (32)	87	201B -S-
AS	D		F14	<4 (4)	>96.4	1B -S-
AS	D		F51	<10 (6)	>96.4	1B -S-
AS	D		F6	20 (6)	89	1B -S-
AS	D		F36	56 (5)	93.8	1B -S-
AS	D		F38	31 (6)	95.4	1B -S-
AS	D		P2	2.0 (1)	98.8	149B -S-
AS	D		P	<0.1 (2)	>99.942	187B SV-
AS	D		P	<0.92 (5)	>99.44	262D VS-
TF	D		F39	7 (4)	97.8	1[illegible]S-
AL	GW		F2	<10 (3)	>98.8	87B ---
AirS	GW		F	<0.66 (24)	>99.77	322B --$
RO	GW		F3	20	92.5	250B ---
SBR	HL		P1	250 (1)	63	278E ---
SBRwPAC	HL		P2	<50 (1)	>92.6	278E ---
AL	I	28	F12	<10 (3)	>98.2	6B ---
AL	I	28	F11	<40 (3)	>85	87B ---
AS	I	31	F5	25 (1)	94.8	31B ---
AS	I	28	F10	<10 (3)	>94.4	6B ---
AS	I	28	F5	<1 (1)	>99.81	32B ---
AS	I	28	F2	300 (1)	0	32B ---
AS	I	28	F3	23	86	975B --$
AS	I	28	F28	<10 (4)	>97.6	6B ---
AS	I	28	F2	7.6	99.04	975B --$
AS	I	28	F33	<10 (14)	>97.8	6B ---
CAC	I	28	F8	480 (1)	59	32B ---
GAC	I	28	F1	230 (1)	44	32B ---
PACT	I	28	F8	<1 (1)	>99.79	32B ---
PACT	I	29	P2	<10 (1)	>91.7	188A ---
RA (B) + Fil	I	28	F20	<10 (1)	>98.3	87B ---
TF	I	28	F38	<10 (3)	>96.3	6B ---
WOx	RCRA		F	57	72	242E ---
AS	S		B	0.8 (10)	99.30	200B VS-
AnFF	S		P1	740 (1)	5	149B -S-
PACT	S		B	0.3 (13)	99.75	200B VS-
AS	SF		F6	<10 (4)	>97.0	245B ---
AS	SF		B2	<5 (6)	>98.3	143B VS-
ChOx(H2O2) (B)	SF		B3	530 (1)	0	143B VS-
ChOx(UVwH2O2)	SF		B4	<5 (1)	>98.1	143B VS-
ChPt	SF		F8	220 (5)	28	245B ---

Fil	SF	F8	210 (5)	8	245B	---
GAC	SF	F4	<10 (5)	>98.1	245B	---
GAC	SF	F8	<10 (4)	>92.8	245B	---
UF	SP	P2	84	35	250B	---

TOLUENE

INFLUENT CONCENTRATION - >1 - 10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F28	9 (6)	99.81	1B -S-
AFFwGAC	GW		P	1.3 (7)	99.88	155D ---
AirS	GW		F	34 (6)	99.18	322B --$
AnFFwGAC	HL		P1	440	94.5	154B ---
AnFFwGAC	HL		P2	1,100	87	154B ---
AL+AS	I	28	F	4 (21)	99.85	233D VS-
AS	I	28	F1	12	99.68	975B --$
AS	I	28	F3	<20 (33)	>99.80	6B ---
AS	I	28	F11	<10 (3)	>99.57	6B ---
AS	I	28	F4	<1 (1)	>99.971	32B ---
AS	I	28	F6	<1 (1)	>99.905	32B ---
AS	I	28	F1	410 (1)	86	32B ---
AS	I	28	F31	<10 (15)	>99.88	6B ---
AS	I	28	F1	24 (3)	99.76	6B ---
AS	I	28	F5	<10 (7)	>99.50	6B ---
AS	I	28	F1	<10 (24)	>99.73	6[illegible] ---
AS	I	28	F4	280	96.3	975B --$
AS	I	28	F13	23 (3)	99.00	87B ---
AS	I	28	F17	<10 (3)	>99.88	87B ---
AS	I	28	F5	<48 (3)	>99.10	87B ---
AS	I	U	F	8	99.88	158E ---
AS	I	U	P4	2	99.964	158E ---
ChPt (B) + Fil	I	28	F19	600 (1)	48	87B ---
Fil	I	28	B1	1,600	47	63E ---
GAC+ChOx(Cl)	I	33	F	<10	>99.51	9E --$
SS	I	28	F32	10 (2)	99.71	6B ---
SS	I	28	F6	<100 (1)	>98.0	87B ---
SS	I	28	F22	<11 (2)	>99.40	87B ---
Sed+AS	I	28	F28	<10 (3)	>99.55	87B ---
WOx (B)	I	U	B2	<500 (1)	>90.0	78E ---
AL	S		B	90	97.0	371D VS-
ChOx(Cl) (B)	S		B1	8,500 (1)	15	49E ---
ChOx(Oz) (B)	S		B2	9,400 (1)	6.0	49E ---
AirS	SF		F6	270 (5)	95.8	245B ---
CAC (B)	SF		B1	930 (1)	15	143B VS-
CAC (B)	SF		B2	5200 (1)	17	1927B ---
ChPt	SF		F6	7,000 (5)	26	245B ---
ChPt (B)	SF		B5	4900 (1)	18	1927B ---
DAF (B)	SF		B4	9900 (2)	1	1927B ---
Fil	SF		F6	6,400 (5)	9	245B ---
GAC	SF		B6	1200 (8)	83	1927B ---
RO	SF		F4	420	94.7	250B ---
Sed (B)	SF		B1	5600 (1)	7	1927B ---
Fil+GAC	TSDF		F3	<830 (3)	>90.0	28B VS-
PACT	TSDF		B1	<1	>99.963	46E ---

TOLUENE

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AirS	GW		F	114 (3)	99.33	322B --$
GAC	HL		F1	<10 (1)	>99.935	245B ---
API+DAF+AS	I	29	F	11 (4)	99.928	1482D ---
AS	I	28	F8	76 (3)	99.904	6B ---
AS	I	28	F20	73 (3)	99.84	6B ---
AS+Fil	I	28	F26	<10 (3)	>99.977	6B ---
SS	I	28	F32	12 (3)	99.948	6B ---
WOx	I	U	P	500 (1)	98.3	78E ---
WOx (B)	I	U	B2	<1,000 (1)	>98.8	78E ---
AS	S		B	<10	>99.983	202D VS-
AirS	S		B2	2,800 (5)	92.4	1328E ---
GAC	S		P	<10	>99.955	435B ---
WOx (B)	S		B3	500	98.9	1054E V--
AirS	SF		P	140 (1)	99.07	91E ---
AirS	SF		P1	6,600 (1)	92.8	182A ---
SS	SF		P2	<10 (1)	>99.989	182A ---

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
Fil	I	28	F16	120 (3)	42	87B ---
GAC	I	28	F15	210 (3)	0	87B ---
GAC	I	28	F1	5.2 (3)	96.7	261B ---
AS	S		P	<0.3 (7)	>99.85	226B VS-

INFLUENT CONCENTRATION - >1 g/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
WOx (B)	S		B1	220	95.7	1054E V--
WOx (B)	S		B1	12 (1)	99.72	78E ---

TRICHLOROETHYLENE

CAS NO.: 79-01-6

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: C2 H CL3

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 131.39	333A
MELTING POINT (C): -84.8	2028A
BOILING POINT (C): 86.7	2028A
VAPOR PRESSURE @ T(C), TORR: 77 @ 25	1006A
SOLUBILITY IN WATER @ T(C), MG/L: 1100 @ 25	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 2.53	1032A
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 1.17 E-2 @ 25	191D

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	4B
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	4B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 400	C	3390	0.416	ug/L	ug/gm	73A
WESTVACO WV-G	C	3260	0.407	ug/L	ug/gm	73A
WESTVACO WV-W	C	1060	0.500	ug/L	ug/gm	73A
HYDRODARCO 3000	C	713	0.470	ug/L	ug/gm	73A
FILTRASORB 300	C	28.0	0.62	mg/L	mg/gm	3B
FILTRASORB 400	C	36.3	0.592	mg/L	mg/gm	1028D
FILTRASORB 400	C	45	0.625	mg/L	mg/gm	681D
FILTRASORB 400	C	2.00	0.482	ug/L	mg/gm	79A
FILTRASORB 400	C	36.3	0.592	mg/L	mg/gm	81A
FILTRASORB F-400	C	3390	0.416	ug/L	ug/gm	285A

TRICHLOROETHYLENE

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F9	<5 (4)	>89	1B -S-
AS	D		F37	2 (6)	97.6	1B -S-
AS	D		F3	<0.7 (7)	>71	234A ---
AS	D		F2	2.1 (3)	90.6	238A ---
AS	D		F	13 (6)	87	201B -S-
AS	D		F5	<2.5 (7)	>58	375E -S-
AS	D		F5	16 (5)	72	1B -S-
AS	D		F5	<0.7 (7)	>92.3	234A ---
AS	D		F20	<1 (6)	>96.7	1B -S-
AS	D		F	<0.1	>95.7	1587E ---
AS	D		F10	<1 (5)	>98.5	1B -S-
AS	D		F1	0.5 (3)	94.8	238A ---
AS	D		F1	4 (4)	89.7	1B -S-
AS	D		F12	1.3 (10)	95.4	86B -S-
AS	D		F29	1.1 (12)	96.7	86B -S-
S	D		F22	4.5 (10)	76	86B -S-
S	D		P2	0.9 (1)	10	149B -S-
AirS	D		F2	<0.2 (4)	>77	1682B ---
AirS	D		F1	0.013 (7)	93.8	1682B ---
CAC+AirS	D		F	0.2 (20)	90.0	1833D ---
ChPt	D		F1	0.21 (7)	77	1682B ---
GAC	D		F	<0.02	>99.73	1421D ---
PACT	D		P	<1 (1)	>95.6	173E ---
TF	D		F10	<1 (5)	>98.5	1B -S-
TF	D		F24	<1 (5)	>98.4	1B -S-
TF	D		F11	5 (6)	93.2	1B -S-
TF	D		F37	<1 (6)	>98.8	1B -S-
AirS	GW		F	0.3	99.68	1042E --$
AirS	GW		P1	3.0	93.2	369A ---
AirS	GW		P	0.4 (1)	99.60	212B --$
AirS	GW		F	1.4	98.1	69A --$
AirS	GW		P	<0.3 (1)	>99.21	222B --$
AirS	GW		P	<0.5 (1)	>98.7	207B ---
AirS	GW		P1	4.3	87	1327E --$
AirS	GW		P	<0.5 (1)	>98.0	215B --$
AirS	GW		P	<0.5 (1)	>99.44	221B --$
AirS	GW		F	<0.5 (1)	>98.2	223B --$
AirS	GW		P	0.7 (1)	99.03	208B --$
AirS	GW		P1	4.3 (1)	87	1585E ---
AirS	GW		P1	0.96 (1)	98.9	81A ---
irS	GW		P	1.2 (1)	96.4	281A V-$
rS	GW		F	1.0	98.9	282A V--
CAC+Fil	GW		F	61 (14)	6	157B --$
ChOx	GW		F	0.79 (18)	98.6	146B V-$
ChOx(H2O2wOz)	GW		P2	3.7 (4)	96.2	84A --$
ChOx(Oz)	GW		P	0.2	71	133B ---

GAC	GW		F4	1.3	98.6	1264B	--$
GAC	GW		F1	<1.0	>98.8	1264B	--$
GAC	GW		P	<1.0 (29)	>41	283A	---
GAC	GW		F	11 (14)	82	157B	--$
RO	GW		F2	5.5	79	25[illegible]	---
Soft	GW		P	0.8	0	133B	---
AS	I	28	F1	<5 (1)	>90.7	32B	---
AS	I	28	F32	<10 (5)	>89	6B	---
AirS	I	U	P	<1	>97.2	205E	---
PACT	I	28	F8	5 (1)	75	32B	---
RA	I	26	F	5.3 (3)	0	177E	--$
SS+GAC	I	28	F27	<10 (1)	>20	87B	---
Sed+AS	I	28	F28	<10 (3)	>47	87B	---
PACT	RCRA		B	<10	>89	242E	---
AirS	S		P2	0.3	99.44	369A	---
RO	S		P	68 (1)	30	323B	---
AS	SF		F6	<10 (1)	>88	245B	---
AirS	SF		F7	<10 (5)	>52	245B	---
ChOx(UV) (B)	T		B	22	56	1138E	---
Fil+GAC	TSDF		F4	<2 (1)	>73	28B	VS-

TRICHLOROETHYLENE

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		P	<1.5 (20)	>98.6	206B VS-
AS	D		F14	<3 (4)	>97.3	1B -S-
AS	D		F6	64 (6)	87	1B -S-
AS	D		F4	37 (6)	92.6	1B -S-
AS	D		F38	2 (6)	99.23	1B -S-
AS	D		F28	87 (6)	87	1B -S-
AS	D		F12	31 (5)	74	1B -S-
AS	D		P1	7 (5)	96.7	241B VS-
Sed	D		F36	18 (5)	93.6	86B -S-
TF	D		F39	<1 (5)	>99.33	1B -S-
AirS	GW		P	0.8 (1)	99.58	209B --$
AirS	GW		P	3.1 (1)	98.6	211B --$
AirS	GW		P	2.1 (1)	98.9	216B ---
AirS	GW		F	<4	>99.38	199B --$
AirS	GW		P	0.5 (1)	99.58	219B --$
[illegible]irS	GW		P	<5	>97.1	1363E ---
[illegible]rS	GW		P	27	87	26A --$
AirS	GW		P	1.2 (1)	99.69	217B --$
AirS	GW		F	0.46 (10)	99.913	322B --$
AirS	GW		P	0.2 (1)	99.917	220B --$
AirS	GW		P2	0.96 (1)	99.32	81A ---
AirS	GW		P	16 (1)	95.5	90D --$
AirS	GW		P2	35 (45)	83	134B V-$
AirS	GW		F	1.0 (4)	99.27	281A V-$
AirS	GW		F	65 (14)	40	157B --$
ChOx(H2O2wOz)	GW		P1	5.6 (1)	95.9	84A --$
GAC	GW		F5	<1.0	>99.36	1264B --$
RA	GW		P1	0.61 (40)	99.71	134B V-$
RO	GW		F3	110	78	250B ---
AnFFwGAC	HL		P1	8	98.0	154B ---
AnFFwGAC	HL		P2	5	98.8	154B ---
GAC	HL		F	<10 (1)	>95.8	237A ---
GAC	HL		F1	<10 (1)	>97.8	245B ---
AS	I	31	F2	7 (1)	98.6	31B ---
AS	I	28	F20	<10 (3)	>94.1	6B ---
CAC	I	31	F2	500 (1)	0	31B ---
CAC	I	28	F8	20 (1)	88	32B ---
PACT	I	31	F1	5 (1)	95.2	31B ---
AirS	S		P	<5 (1)	>98.5	71D --$
AnFF	S		P1	3.5 (1)	97.5	149B -S-
AS	SF		B2	16 (6)	98.2	143B VS-
[illegible]rS	SF		F6	<25 (5)	>93.6	245B ---
ChOx(H2O2) (B)	SF		B3	920 (1)	0	143B VS-
ChOx(UVwH2O2)	SF		P2	<0.5 (1)	>99.87	92D --$
ChOx(UVwH2O2)	SF		P1	2.4 (1)	99.13	92D --$
ChOx(UVwH2O2)	SF		B3	<0.5 (1)	>99.65	92D --$

ChOx(UVwH2O2)	SF	P3	<0.6 (10)	>99.89	92D	--$
ChOx(UVwH2O2)	SF	B4	<5 (1)	>98.5	143B	VS-
ChOx(UVwH2O2wOz)	SF	B2	<0.5 (1)	>99.69	92D	--$
ChOx(UVwOz)(B)	SF	B1	<0.5 (1)	>99.69	92D	--$
ChPt	SF	F6	390 (5)	21	24[illegible]	---
Fil	SF	F6	390 (5)	1	245B	---
GAC	SF	F4	32 (5)	95.3	245B	---
PACT	TSDF	B1	<1	>99.69	46E	---

TRICHLOROETHYLENE

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	GW		F2	<12 (3)	>99.60	87B ---
AirS	GW		P2	170 (1)	84	1585E ---
AirS	GW		F	11 (7)	99.77	322B --$
AirS	GW		P2	190	91.3	1327E --$
AirS	GW		P	7.7 (1)	99.30	211B --$
SS	I	28	F1	<10 (10)	>99.79	251B V-$
SS	I	28	F32	<16 (14)	>99.20	6B ---
SS	I	28	F2	<5 (10)	>99.911	251B V-$
ChOx(Cl) (B)	S		B1	9,200 (1)	8.0	49E ---
ChOx(Oz) (B)	S		B2	9,500 (1)	5.0	49E ---
AirS	SF		P	<1 (3)	>99.936	1362E --$
CAC (B)	SF		B1	1800 (1)	0	143B VS-
ChPt	SF		F2	5,400 (1)	0	245B ---
ChPt	SF		F8	3,700 (5)	30	245B ---
Fil	SF		F8	3,400 (5)	8	245B ---
[illegible]AC	SF		F2	<10 (1)	>99.46	245B ---
[illegible]AC	SF		F8	<10 (5)	>99.54	245B ---
Fil+GAC	TSDF		F3	<750 (2)	>73	28B VS-

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
PACT	HL		B8	<5	>99.985	46E ---
SExt (B)	I	28	B1	6000 (1)	75	159B --$
SExt (B)	I	28	B2	5000 (1)	79	159B --$
SS	I	28	F35	<10 (2)	>99.974	6B ---
AS	S		B	210	99.78	202D VS-

TRICHLOROETHYLENE

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
WOx (B)	I	U	B2	2 (1)	99.33	78E ---
WOx (B)	I	U	B2	1.7 (1)	99.66	78E ---
AirS	SF		P1	190 (1)	44	182A ---
SS	SF		P2	<10 (1)	>99.997	182A ---

VINYL CHLORIDE

CAS NO.: 75-01-4

COMPOUND TYPE: HYDROCARBON,HALOGENATED

FORMULA: C2 H3 CL

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 62.50	333A
MELTING POINT (C): -159.7	462A
BOILING POINT (C): -13.9	462A
VAPOR PRESSURE @ T(C), TORR: 2580 @ 20	463A
SOLUBILITY IN WATER @ T(C), MG/L: 1.1 @ 25	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 0.60	379B
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 2.78 E-2 @ 25	1034A

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME !

VINYL CHLORIDE

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F30	<20 (4)	>80	1B -S-
AirS	GW		P	<0.5 (1)	>93.1	217B --$
AirS	GW		F	<0.3	>96.4	69A --$
ChOx(Oz)	GW		P	0.6	90.8	133B ---
Soft	GW		P	8.3	15	133B ---
Sed+AS	I	28	F28	<10 (1)	>17	87B ---
CAC (B)	SF		B1	39 (1)	44	143B VS-
ChOx(H2O2) (B)	SF		B3	29 (1)	0	143B VS-
ChOx(UVwH2O2)	SF		P2	<0.5 (1)	>98.6	92D --$
ChOx(UVwH2O2)	SF		P1	<0.8 (1)	>98.0	92D --$
ChOx(UVwH2O2)	SF		B3	<0.5 (1)	>96.6	92D --$
ChOx(UVwH2O2)	SF		P3	<0.5 (10)	>97.8	92D --$
ChOx(UVwH2O2)	SF		B4	<10 (1)	>52	143B VS-
ChOx(UVwH2O2wOz)	SF		B2	<0.5 (1)	>97.5	92D --$
ChOx(UVwOz) (B)	SF		B1	<0.5 (1)	>97.5	92B --$

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AirS	GW		F	<0.1	>99.985	1344E ---
AS	I	28	F16	<50 (3)	>94.9	6B ---
AS	I	28	F5	<62 (2)	>89	87B ---
SExt (B)	I	28	B1	1000 (1)	0	159B --$
SExt (B)	I	28	B2	1000 (1)	0	159B --$

VINYL CHLORIDE

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F6	100 (6)	94.1	1B -S-
AS+Fil	I	28	F9	<50 (14)	>98.3	6B ---
GAC	I	28	P4	<100 (3)	>97.9	159B --$
SS	I	28	F1	<10 (10)	>99.88	251B V-$
SS	I	28	F7	<10 (3)	>99.78	87B ---
SS	I	28	F6	<100 (1)	>98.0	87B ---
ChOx(Cl) (B)	S		B1	8,600 (1)	14	49E ---
ChOx(Oz) (B)	S		B2	<10 (1)	>99.9	49E ---

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
[illegible]	D		F57	3,900 (6)	92.9	1B -S-

INFLUENT CONCENTRATION - >1 g/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	F9	<0.12 (11)	>99.990	6B ---

XYLENEs

CAS NO.: 1330-20-7

COMPOUND TYPE: HYDROCARBON,AROMATIC

FORMULA: C_8H_{10}

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 106.16	2028A
MELTING POINT (C):	SEE
BOILING POINT (C):	ISOMERS
VAPOR PRESSURE @ T(C), TORR:	NA
SOLUBILITY IN WATER @ T(C), MG/L:	NA
LOG OCTANOL/WATER PARTITION COEFFICIENT:	NA
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	346B
WATER QUALITY CRITERIA	4B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME !

XYLENEs

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AirS	GW		F	0.60	96.4	69A --$
Fil+GAC	TSDF		F4	<2 (1)	>92.3	28B VS-

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		P1	<4 (5)	>98.0	241B VS-
AS	D		P	<1.4 (5)	>99.18	262D VS-
AS	D		P	<5 (7)	>97.0	156D -S-
Sed	D		P	210 (4)	47	156D -S-
CAC (B)	SF		B1	620 (1)	0	143B VS-
Ox(UVwOz)(B)	SF		B2	<30 (1)	>82	1975E --$

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	I	U	F	57	99.42	158E ---
CAC	I	28	F2	540 (1)	76	261B ---
AirS	SF		P	67 (1)	98.8	91E ---
CAC (B)	SF		B2	2500 (1)	17	1927B ---
ChPt (B)	SF		B5	1900 (1)	21	1927B ---
DAF (B)	SF		B4	3600 (2)	0	1927B ---
GAC	SF		B6	320 (8)	85	1927B ---
Sed (B)	SF		B1	3100 (1)	0	1927B ---
RO	SP		P2	40	96.2	250B ---
UF	SP		P2	1,100	66	250B ---
Fil+GAC	TSDF		F3	<1,000 (1)	>88	28B VS-

XYLENEs

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
API+DAF+AS	I	29	F	33 (4)	99.947	1482D ---
AS	I	U	P4	12	99.89	158E ---

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
WOx (B)	S		B3	0.5	99.60	1054E V--

INFLUENT CONCENTRATION - >1 g/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFE[illegible]CE
WOx	I	U	P	<20 (1)	>99.76	78E ---

DIMETHYLPHENOL,2,4-

CAS NO.: 105-67-9

COMPOUND TYPE: PHENOLIC,

FORMULA: C8 H10 O

CHEMICAL AND PHYSICAL PROPERTIES

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 122.17	333A
MELTING POINT (C): 27	462A
BOILING POINT (C): 210	333A
VAPOR PRESSURE @ T(C), TORR: 98 @ 104	463A
SOLUBILITY IN WATER @ T(C), MG/L:	NA
LOG OCTANOL/WATER PARTITION COEFFICIENT: 2.42	1226A
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 1.7 E-5 @ 25	2034B

VIRONMENTAL DATA

VIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 300	C	70	0.44	mg/L	mg/gm	3B
FILTRASORB 300	C	184	0.09	mg/L	mg/gm	780B

DIMETHYLPHENOL,2,4-

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		P	<0.9 (8)	>99.06	204A -S-
CAC	D		F4	28 (1)	0	31B ---
TF	D		F52	<25 (2)	>38	1B -S-
AS	I	31	F5	6 (1)	45	31B ---
CAC	I	31	F2	6 (1)	45	31B ---
CAC	I	28	F8	<10 (1)	>33	32B ---
AS	SF		F6	<10 (5)	>69	245B ---
AirS	SF		F7	<18 (5)	>42	245B ---
AirS	SF		F6	32 (5)	18	245B ---
ChPt	SF		F6	<34 (5)	>0	245B ---
Fil	SF		F3	24 (1)	68	245B ---
Fil	SF		F6	37 (4)	8	245B ---
GAC	SF		F3	15 (1)	6	245B ---
SBR	SF		P1	<5 (1)	>94.5	1906E -S-
SBR	SF		P2	<5 (1)	>94.5	1906E -S-
SBRwPAC	SF		P3	<5 (1)	>94.5	1906[illegible]S-
SS	SF		P2	<1 (1)	>95.0	182A ---

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F	<20 (1)	>82	21E ---
AS	D		P	1.4 (5)	99.00	262D VS-
AS	I	28	F5	<13 (7)	>98.1	6B ---
AS	I	28	F23	<10 (2)	>96.7	87B ---
ChPt (B) + Fil	I	28	F19	280 (1)	31	87B ---
RA (B) + Fil	I	28	F20	<10 (1)	>96.5	87B ---
API	SF		F3	110 (1)	0	245B ---
DAF	SF		F3	74 (1)	33	245B ---
RO	SF		F4	16	98.4	250B ---

DIMETHYLPHENOL,2,4-

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
SBR	HL		P1	<5 (1)	>99.54	278E ---
SBRwPAC	HL		P2	<5 (1)	>99.54	278E ---
AS	I	28	F2	26 (1)	99.24	32B ---
AS+Fil	I	28	F26	<10 (3)	>99.900	6B ---
SS	I	28	F22	3400 (1)	0	87B ---
AnFF	S		P	<0.4	>99.990	235D ---
AL	SF		P	<10	>99.81	192D ---
AS	SF		P	<10	>99.81	192D ---
RBC	SF		P	<10	>99.81	192D ---

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AFF+AnFF	I	99	P	<10 (2)	>99.948	186B ---
AS	I	28	F33	<10 (14)	>99.967	6B ---
AnFFwGAC	I	49	P	50	99.925	249D ---

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
ChOx(Cl) (B)	S		B1	<6.7 (1)	>99.00	49E ---
ChOx(Oz) (B)	S		B2	<6.7 (1)	>99.00	49E ---

INFLUENT CONCENTRATION - >1 g/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
WOx (B)	C		B	0.82 (1)	99.99	236A ---

CRESOL,2-

CAS NO.: 95-48-7

COMPOUND TYPE: PHENOLIC,

FORMULA: C7 H8 O

CHEMICAL AND PHYSICAL PROPERTIES

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 108.14	333A
MELTING POINT (C): 30.9	333A
BOILING POINT (C): 191	333A
VAPOR PRESSURE @ T(C), TORR: 0.24 @ 25	463A
SOLUBILITY IN WATER @ T(C), MG/L: 3.1 E 4 @ 40	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 1.95	163A
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	NA
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 400	C	73.4	0.188	mg/L	mg/gm	1576B
FILTRASORB 400	C	162	0.066	ug/L	mg/gm	50D
HYDRODARCO 3000	C	25.9	0.199	ug/L	mg/gm	48B

CRESOL,2-

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		F31	1.8 (10)	82	86B -S-
AS	I	28	F23	<10 (1)	>23	87B ---
GAC	I	28	F1	<10 (1)	>50	261B ---
AS	SF		F6	<10 (1)	>44	245B ---
AirS	SF		F6	<14 (2)	>7	245B ---
AirS	SF		F7	12 (1)	37	245B ---
ChPt	SF		F6	14 (2)	30	245B ---
Fil	SF		F6	<10 (2)	>29	245B ---
SBR	SF		P1	<5 (1)	>64	1906E -S-
SBR	SF		P2	<5 (1)	>64	1906E -S-
SBRwPAC	SF		P3	<5 (1)	>64	1906E -S-

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		P	<10 (1)	>94.7	262D VS-
RO	SF		F4	14	98.5	250B ---

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AFF+AnFF	I	99	P	<27 (2)	>99.946	186B ---
ChPt (B) + Fil	I	28	F19	29,000 (1)	0	87B ---
RA (B) + Fil	I	28	F20	6300 (1)	78	87B ---
AnFF	S		P	7,800	85	235D ---

CRESOL,2-

INFLUENT CONCENTRATION - >100 1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
AnFFwGAC	I	49	P	8.8	98.7	249D ---
AnFF	S		B	26	78	230A ---

CRESOL,4-

CAS NO.: 106-44-5

COMPOUND TYPE: PHENOLIC,

FORMULA: C7 H8 O

CHEMICAL AND PHYSICAL PROPERTIES

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 108.14	333A
MELTING POINT (C): 34.8	333A
BOILING POINT (C): 201.9	333A
VAPOR PRESSURE @ T(C), TORR: 0.11 @ 25	463A
SOLUBILITY IN WATER @ T(C), MG/L: 2.4 E 4 @ 40	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT:	NA
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	NA
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
POLYBENZIMIDAZOLE	C	0.11	0.935	mg/L	mg/gm	381D
POLY(4-VINYL PYRIDINE)	C	0.324	0.948	mg/L	mg/gm	381D
XAD-7	C	2.98	0.59	mg/L	mg/gm	8E
XAD-16	C	9.97	0.42	mg/L	mg/gm	8E

CRESOL,4-

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	I	28	F30	<10 (3)	>66	87B ---
API	SF		F3	66 (1)	8	245B ---
AS	SF		F6	<10 (5)	>76	245B ---
AirS	SF		F6	42 (5)	19	245B ---
ChPt	SF		F6	48 (5)	0	245B ---
DAF	SF		F3	36 (1)	45	245B ---
Fil	SF		F6	52 (5)	0	245B ---
Fil	SF		F3	44 (1)	0	245B ---
GAC	SF		F3	<10 (1)	>63	245B ---
SBR	SF		P1	<5 (1)	>90.7	1906E -S-
SBR	SF		P2	<5 (1)	>90.7	1906E -S-
SBRwPAC	SF		P3	<5 (1)	>90.7	1906E -S-

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFE NCE
AS	D		P2	170 (9)	68	241B VS-
AS	D		P	<10 (1)	>97.7	262D VS-
AS	I	28	F17	<100 (1)	>81	87B ---

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
API+DAF+AS	I	29	F	160 (4)	87	1482D ---
RO	SF		F4	72	97.7	250B ---

CRESOL,4-

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
ChPt (B) + Fil	I	28	F19	53,000 (1)	0	87B ---
RA (B) + Fil	I	28	F20	7800 (1)	85	87B ---

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
SExt	I	49	P	3	99.66	1082E ---
AnFF	S		B	<17	>90.7	230A ---

CHLORO-3-METHYLPHENOL,4-

CAS NO.: 59-50-7

COMPOUND TYPE: ,

FORMULA: C7 H7 Cl O

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 142.58	2028A
MELTING POINT (C): 66	2028A
BOILING POINT (C): 235	2028A
VAPOR PRESSURE @ T(C), TORR: NA	NA
SOLUBILITY IN WATER @ T(C), MG/L: 3846 @ 20	2028A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 3.10	463A
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: NA	NA

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	NA
AQUATIC TOXICITY DATABASE	NA

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME !

CHLORO-3-METHYLPHENOL,4-

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		P	<1.2 (5)	>37	262D VS-

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
SS	I	28	F22	2500 (1)	77	87B ---

NAPHTHALENE

CAS NO.: 91-20-3

COMPOUND TYPE: PAH,

FORMULA: C10 H8

CHEMICAL AND PHYSICAL PROPERTIES	REFERENCE
MOLECULAR WEIGHT: 128.17	333A
MELTING POINT (C): 80.5	333A
BOILING POINT (C): 218	333A
VAPOR PRESSURE @ T(C), TORR: 0.082 @ 25	1006A
SOLUBILITY IN WATER @ T(C), MG/L: 30 @ 25	463A
LOG OCTANOL/WATER PARTITION COEFFICIENT: 3.37	163A
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1: 4.83 E-4 @ 25	419A

ENVIRONMENTAL DATA	REFERENCE
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

ADSORBENT	MATRIX	K	1/N	Ce UNITS	X/M UNITS	REF.
FILTRASORB 300	C	132	0.42	mg/L	mg/gm	3B
FILTRASORB 300	C	123	0.41	mg/L	mg/gm	780B
FILTRASORB 400	C	277	0.43	mg/L	mg/gm	1056B
HYDRODARCO KB	C	58	0.276	mg/L	mg/gm	315B

NAPHTHALENE

INFLUENT CONCENTRATION - 0-100 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	D		P	<0.7 (8)	>99.09	204A -S-
AS	D		F38	<3 (4)	>91.9	1B -S-
AS	D		F36	9 (5)	86	1B -S-
AS	D		F	5 (11)	89	201B -S-
AS	D		F31	1.1 (10)	84	86B -S-
AirS	D		F1	0.18 (4)	14	1682B ---
AirS	D		F2	0.037 (10)	10	1682B ---
ChPt	D		F1	0.21 (4)	63	1682B ---
PACT	D		P	<1 (4)	>50	173E ---
RO	D		P	0.02	80	180A --$
Sed	D		F3	14 (1)	7	31B ---
Sed	D		F25	1.4 (5)	78	86B -S-
TF	D		F21	<3 (6)	>89	1B -S-
SBR	HL		P1	<5 (1)	>90.0	278E ---
SBRwPAC	HL		P2	<5 (1)	>90.0	278E ---
[illegible]FF+AnFF	I	99	P	<1 (2)	>83	186B ---
[illegible]L+AS	I	31	F8	<2 (1)	>50	31B ---
AS	I	28	F1	42 (1)	35	32B ---
AS	I	28	F7	<1 (1)	>75	32B ---
AS	I	31	F5	2 (1)	50	31B ---
AS	I	28	F4	<1 (1)	>86	32B ---
AS	I	31	F6	<1 (1)	>60	31B ---
AS	I	U	P1	0.20	99.39	158E ---
CAC	I	28	F8	20 (1)	0	32B ---
CAC	I	31	F6	2 (1)	78	31B ---
ChOx(Oz) (B)	I	28	B4	<2	>88	975B --$
GAC	I	28	F1	12 (1)	71	32B ---
GAC	I	29	P1	<10 (1)	>17	188A ---
PACT	I	28	F8	<2 (1)	>90.0	32B ---
Sed	I	31	F8	4 (1)	67	31B ---
AL	SF		P	<10	>82	192D ---
AS	SF		P	<10	>82	192D ---
AirS	SF		F6	<10 (5)	>58	245B ---
ChOx(Cl) (B)	SF		B5	0.063 (1)	42	286A ---
ChOx(Cl) (B)	SF		B6	0.054 (1)	50	286A ---
ChOx(H2O2) (B)	SF		B4	0.055 (1)	0	286A ---
ChOx(Oz) (B)	SF		B2	0.012 (1)	74	286A ---
ChOx(UVwH2O2)	SF		B3	<0.001 (1)	>97.8	286A ---
ChOx(UVwOz)(B)	SF		B2	<2 (1)	>96.3	1975E --$
ChOx(UVwOz)(B)	SF		B1	0.0043 (1)	90.8	286A ---
ChPt	SF		F6	24 (5)	8	245B ---
[illegible]l	SF		F6	24 (5)	0	245B ---
Fil	SF		F8	60 (5)	8	245B ---
GAC	SF		F8	<10 (5)	>73	245B ---
GAC	SF		P1	0.0047 (3)	85	286A ---
RBC	SF		P	<10	>82	192D ---

NAPHTHALENE

INFLUENT CONCENTRATION - >100-1000 ug/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AL	D		P2	13 (11)	88	203A -S-
AL	D		P1	36 (11)	67	203A -S-
AS	D		P1	<10 (5)	>93.0	241B VS-
AS	D		P	4 (11)	96.3	203A -S-
AS	D		P	6 (12)	95.0	240A -S-
AS	D		F60	<10 (5)	>95.4	1B -S-
AS	D		P2	8.9 (11)	97.9	241B VS-
CAC	D		P	79 (11)	27	203A -S-
TF	D		P	74 (11)	32	203A -S-
TF	D		P	14 (11)	88	240A -S-
GAC	GW		F2	<10 (1)	>91.2	87B ---
AL+AS	I	28	F	16 (21)	98.3	233D VS-
AS	I	28	F1	<14 (2)	>95.9	6B ---
AS	I	28	F31	<10 (13)	>99.00	6B ---
AS	I	28	F4	<1	>99.17	975B --$
AS	I	28	F11	<10 (3)	>96.0	6[illegible]--
AS	I	33	P2	1.2	99.52	158[illegible]--
AS	I	24	B1	0.40	99.86	158E ---
AlkHyd	I	28	F24	<100 (2)	>85	87B ---
ChPt (B) + Fil	I	28	F19	<10 (1)	>90.6	87B ---
Fil	I	28	B1	630	0	63E ---
PACT	I	29	P2	<10 (1)	>97.8	188A ---
SS+GAC	I	28	F27	<10 (1)	>92.1	87B ---
Sed+AS	I	28	F28	<10 (1)	>91.5	87B ---
AL	S		B	23	97.7	371D VS-
AS	S		B	2 (5)	99.5	1050E VS-
AL	SF		P	25	96.5	192D ---
AS	SF		P	25	96.5	192D ---
ChPt	SF		F8	64 (2)	38	245B ---
GAC	SF		B3	<2 (3)	>99.40	1980D ---
GAC	SF		B6	11 (1)	98.7	1927B ---
PACT	TSDF		B1	<1	>99.48	46E ---

NAPHTHALENE

INFLUENT CONCENTRATION - >1-10 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
ChOx(Oz) (B)	C		B	1200 (1)	84	315B ---
AS	D		P	<2 (5)	>99.88	262D VS-
CAC	D		F4	1,100 (1)	29	31B ---
AS	I	28	F5	<10 (7)	>99.56	6B ---
AS	I	28	F25	<10 (2)	>99.08	87B ---
AS	I	24	B2	1.8	99.87	158E ---
GAC	I	33	F	1.1	99.970	9E --$
AS	S		B	<10	>99.86	202D VS-
RBC	SF		B7	<2.0 (4)	>99.966	1927B ---
SBR	SF		P1	<2.5 (1)	>99.936	1906E -S-
SBR	SF		P2	<2.5 (1)	>99.936	1906E -S-
SBRwPAC	SF		P3	31 (1)	99.20	1906E -S-

INFLUENT CONCENTRATION - >10-100 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (ug/L)	PERCENT REMOVAL	REFERENCE
AS	I	28	F33	<10 (14)	>99.952	6B ---
AS	I	U	F	1	99.990	158E ---
AirS	S		B2	6,200 (5)	74	1328E ---
CAC (B)	SF		B1	8,000 (1)	46	1975E --$
CAC+ChPt (B)	SF		B3	820 (1)	92.5	1927B ---
Sed (B)	SF		B1	7800 (1)	33	1980D ---

INFLUENT CONCENTRATION - >100-1000 mg/L

TECHNOLOGY	MATRIX	SIC CODE	SCALE	EFFLUENT CONCENTRATION (mg/L)	PERCENT REMOVAL	REFERENCE
ChOx(Cl) (B)	S		B1	86 (1)	22	49E ---
ChOx(Oz) (B)	S		B2	<1.1 (1)	>99.00	49E ---

C

APPENDIX C

HYDROGEOLOGIC EVALUATION OF ALTERNATIVES

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF ATTACHMENTS

C.1 INTRODUCTION

This Appendix describes and evaluates alternative groundwater remedial systems for the Site. In Section 4.0 of the FS, the following three general response actions were identified for the remediation of groundwater at the Site:

- physical containment;
- hydraulic containment; and
- source (mass) removal.

This Appendix presents a description and evaluation of the technologies and process options associated with these response actions in order to select the optimal groundwater remedial option to be retained for inclusion in alternatives involving groundwater remediation.

Section C.2 provides the Site conceptualization, including a brief description of the geologic and hydrogeologic setting.

Section C.3 provides a discussion of the numerical calculations performed to address the effects of natural attenuation/degradation of the chemicals of potential concern beneath the Site. A description of the Batch Flushing Model employed in the analysis of the natural attenuation of the chemicals in the groundwater is also presented.

Section C.4 presents a brief description of the applicable groundwater remedial technologies used to develop the remedial alternatives for the Site.

The identification and evaluation of remedial technologies is presented in Section C.5. Technologies for the remediation of groundwater are evaluated on the basis of technical implementability.

C.2 SITE CONCEPTUALIZATION

A brief summary of the Site's physical characteristics is presented in Section 1.2.7 of the FS. A more detailed assessment is presented in the Remedial Investigation (RI) report (CRA, 1994). The main geologic and hydrogeologic units identified on Site and the groundwater chemistry are summarized in the following subsections.

C.2.1 SITE GEOLOGY

The Site geology encountered during the RI, in descending order, are as follows:

1. Overburden:
   - fill materials;
   - native silty clay lake sediments;
   - silt and sand (with some till) deposits; and

2. Bedrock:
   - Onondaga Formation limestone.

C.2.2 SITE HYDROGEOLOGY

Four hydrostratigraphic units, in descending order, have been identified on Site, as follows:

1. the Perched Water Table Unit (PWTU);
2. the Overburden Silty Clay Aquitard Unit;
3. the Overburden Silt and Sand Water-Bearing Unit; and
4. the Bedrock Aquifer Unit.

The PWTU occurs discontinuously atop the Overburden Aquitard Unit and is presumed to be intermittently present throughout the year.

The Overburden Silt and Sand Water-Bearing Unit (the sandy zone) is typically about 3 to 5 feet thick. The water level fluctuates from a confined (artesian) condition following wet periods to being dry in portions of the Site during the dry season in late summer. Single well response test results indicate the hydraulic conductivity of this unit to be variable over the Site ranging from 1.08×10^{-5} cm/s to 1.05×10^{-2} cm/s.

The Bedrock Aquifer Unit occurs within the shallow (typically 10 to 15 feet below ground surface) limestone bedrock. The bedrock groundwater flow occurs primarily within fractures along bedding planes and within subvertical jointing. As the bedrock permeability relates to this secondary porosity, the hydraulic conductivity values are quite variable depending on the size and number of fractures penetrated by the drillhole. The measured hydraulic conductivity ranged from 1.05×10^{-4} cm/s to 2.73×10^{-2} cm/s. As the bedrock aquifer is at least 33 feet thick (thickest penetration by on-Site monitoring wells), the transmissivity is relatively high.

Groundwater flow in the Overburden Water-Bearing Unit and Bedrock Aquifer Unit is directed towards a depressional area in the southeastern part of the Site from the east, west and north. Regionally, the groundwater flow is southward from the Site to the Squajaquada Creek.

C.3 NATURAL ATTENUATION OF CHEMICALS IN GROUNDWATER

This section presents a description of the natural attenuation/degradation of the chemicals of concern in the groundwater beneath the Site. The primary chemicals of concern for groundwater at the Site are the VOCs presented in Section C.2.3. The following sections provide a description and evaluation of the attenuation/degradation mechanisms which may affect the concentrations of the chemicals in the groundwater environment.

C.3.1 ATTENUATION/DEGRADATION MECHANISMS

The mobility of a contaminant depends upon the physical and chemical properties of the contaminant and the subsurface environment in which it resides. The contaminant-related properties include aqueous solubility, liquid density, vapor pressure, and the affinity of the contaminants for organic matter and fine grained soils. The physical and chemical properties of the Site-related contaminants are summarized in Table C.1. A description of these physical and chemical properties and their effect on the chemicals' environmental fate is provided in Table C.2.

Possible attenuation/degradation mechanisms within the groundwater environment include the following:

i) volatilization;
ii) leaching/desorption;
iii) degradation;
iv) precipitation;
v) advection; and
vi) diffusion/dispersion.

A brief discussion of each of these attenuation/degradation mechanisms is presented in the following paragraphs.

TABLE C-1

CHEMICAL AND PHYSICAL PROPERTIES
OF SITE-RELATED PARAMETERS
LEICA INC.
CHEEKTOWAGA, NEW YORK

	Molecular Weight (g/mol)	*Aqueous Solubility @ 25°C (mg/L)*	*Vapor Pressure @ 25°C (mm Hg)*	*Henry's Law Constant @ 25°C (atm-m3/mol)*	*Koc (ml/g)*	*Specific Density*
Chlorinated Ethenes						
1,1-Dichloroethene	96.94	5,000	591	2.10×10^{-2}	65	1.22
1,2-Dichloroethene (total)	96.95	3,500/6,300	208/324	$7.58 \times 10^{-3}/6.56 \times 10^{-3}$	59	1.28
Tetrachloroethene	165.83	2,900	5.0	3.81×10^{-4}	277	1.63
Trichloroethene	131.39	1,470	74	9.10×10^{-3}	126	1.46
Vinyl Chloride	62.50	2,670	2,660	8.19×10^{-2}	57	0.91
BTEXs						
Benzene	78.11	1,770	95.2	5.48×10^{-3}	83	0.877
Toluene	92.14	826	28.1	6.74×10^{-3}	300	0.862
Ethylbenzene	106.17	174	10	7.24×10^{-3}	1100	0.867
Xylene (total)	106.17	198	10	7.04×10^{-3}	240	0.864

Notes:

(1) Chemical property values are based on data presented in "Handbook of Environmental Data on Organic Chemicals", second edition, K. Verschueran, Van Nostrand Reinhold, N.Y., 1983.

(2) Chemical property values are based on data presented in "Superfund Public Health Evaluation Manual", EPA/540/1-86/060 (OSWER Directive 9285.4-1). United States Environmental Protection Agency, October 1986.

TABLE C-2

DESCRIPTION OF PHYSICAL AND CHEMICAL PROPERTIES OF SITE-RELATED CHEMICALS
LEICA INC.
CHEEKTOWAGA, NEW YORK

Property	*Description*	*Units*	*Descriptive Ranges*	*Examples of Site Contaminants*
Liquid density	The density of a chemical in its pure liquid form, relative to water.	D (g/cm^3)	<1 -- less dense than water	BTEX, vinyl chloride
			> 1 -- more dense than water	most chlorinated ethenes and ethanes
Aqueous solubility	The amount of a chemical at equilibrium that will be dissolved in pure water.	mg/L	high -- soluble in water	1,1-dichloroethene, 1,2-dichloroethene
			low -- less soluble in water	ethylbenzene, xylene
Vapor Pressure	The partial pressure of a vapor at equilibrium with the chemical in its pure state; describes the tendency of a chemical to evaporate.	Vp (mm Hg)	high -- highly volatile	vinyl chloride
			low -- moderate volatility	tetrachloroethene
Partitioning between air and water	The proportion of a chemical at equilibrium in the vapor phase in the space above an aqueous solution of the chemical; describes the tendency of a chemical to transfer between air and water.	Henry's law constant, H (atm m^3/mol)	10^{-5} to 10^{-3} -- moderate volatility	tetrachloroethene
			$>10^{-3}$ -- high volatility	BTEX, vinyl chloride

TABLE C-2

DESCRIPTION OF PHYSICAL AND CHEMICAL PROPERTIES OF SITE-RELATED CHEMICALS
LEICA INC.
CHEEKTOWAGA, NEW YORK

Property	*Description*	*Units*	*Descriptive Ranges*	*Examples of Site Contaminants*
Partitioning between organic matter and water	The proportion of a chemical at equilibrium sorbed to organic material in a water-soil or water-sediment system; more strongly sorbed chemicals tend to be less mobile	K_{oc} (ml/g)	50 to 100 -- high mobility	vinyl chloride, benzene, 1,1-dichloroethene, 1,2-dichloroethene
			100 to 500 -- moderate mobility	xylene, trichloroethene, tetrachloroethene, toluene
			500 to 2,000 -- low mobility	ethylbenzene

Volatilization

Volatilization refers to the change of a chemical from a liquid to a vapor phase with subsequent dispersion of the vapor into the atmosphere or soil pore spaces. The rate at which volatilization occurs depends on both the vapor pressure of the contaminant and the environmental conditions. The vapor pressures of VOCs are generally relatively high (see Tables C.1 and C.2) in comparison to other compounds such as SVOCs and metals.

Leaching/Adsorption

Leaching refers to the migration of a contaminant as a dissolved constituent in a liquid as this liquid passes through contaminated material. Adsorption refers to the process of a contaminant dissolved in an aqueous phase and sorbing to subsurface material, thereby reducing the concentration of the dissolved contaminant in the aqueous phase. Both of these processes are dependent on the partitioning of the contaminant between the solid and aqueous phases. This soil-water partitioning is predicted by an adsorption isotherm. Generally, a simplified isotherm of the following form is employed:

$$S = K_d C$$

where:

S = sorbed concentration (μg/kg of soil);
C = aqueous phase concentration (mg/L); and
K_d = distribution coefficient (L/kg).

The distribution coefficient (K_d) is directly related to the organic content of the subsurface material as follows:

$$K_d = K_{oc} F_{oc}$$

where:
K_{OC} = organic carbon partitioning coefficient (L/kg); and
F_{OC} = fraction of organic carbon.

The organic carbon partitioning coefficient is a measure of the tendency for organics to be adsorbed by the subsurface media. K_{OC} is chemical specific and is largely independent of soil properties. The fraction of organic carbon is the amount of organic carbon in the media.

The K_{OC} of the VOCs are generally low in comparison to other compounds such as SVOCs and metals and thus these compounds have a low tendency to be adsorbed by the subsurface material. In general, VOCs are considered to be relatively mobile in a groundwater environment.

Degradation

Degradation refers to the chemical and biological transformation of a contaminant. These processes ultimately will reduce the concentration of the contaminant in the aquifer. During these processes however, degradation products will be produced. The degradation products may be far less toxic than the parent compound.

For biodegradation to occur, microorganisms that are able to metabolize the VOCs are required.

Precipitation

The precipitation mechanism refers to the transformation of a chemical from an aqueous phase to a crystalline and/or solid phase when the concentration of the chemical exceeds its aqueous solubility. Although free product (i.e., non aqueous phase liquids (NAPL)) was noted at wells MW-8 and MW-11, precipitation was not evident.

Advection

Advection refers to the process of contaminant transport by the bulk motion of the flowing groundwater. Nonreactive chemical solutes are transported at an average rate equal to the average linear velocity of the groundwater.

Diffusion/Dispersion

Diffusion is the process whereby contaminants move in the groundwater under the influence of their kinetic activity and in the direction of their concentration gradients. Hydrodynamic dispersion is due to mechanical mixing during fluid advection. Both diffusion and dispersion result in dilution of the contaminants. Diffusion is dominant at low groundwater flow velocities while dispersion plays a major role at higher groundwater flow velocities. The mechanism of diffusion/dispersion is an important process along the entire conceptualized migration pathway.

In summary, the dominant mechanisms that should be considered in the analysis of natural attenuation/degradation of the contaminants in the groundwater are advection, dispersion, and adsorption. It is believed that the other attenuation/degradation mechanisms play a smaller role (although important) in the natural attenuation/degradation of the contaminants of potential concern in the groundwater at and in the vicinity of the Site.

C.3.2 BATCH FLUSHING MODEL

In order to address the natural attenuation/degradation of Site-related chemicals in groundwater, a Batch Flushing Model was used. This model is presented and described in Appendix D of the document entitled "Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites" (U.S. EPA, Office of Emergency Response, Hazardous Site Control Division, OSWER Directive No. 9283.1-2, December 1988). This model assumes that the source of the Site-related chemicals detected in the groundwater has been removed and that the only mechanisms that affect the concentrations of the chemicals along their migration pathway are advection, dispersion and adsorption.

The batch flushing model is based on the equilibrium condition:

$$K_d = \frac{S}{C} \qquad \text{Equation (1)}$$

where
K_d = distribution coefficient (L/kg);
S = concentration of the contaminant in the soil of the aquifer matrix (µg/kg); and
C = concentration of the contaminant in the groundwater (mg/L).

A series of discrete flushing periods (called steps) are used to model the transport of the contaminant through a delineated control volume. Each discrete flushing period contains enough water to completely fill the voids of the aquifer body within the control volume. After each discrete period, the concentrations of the contaminant are calculated for the aquifer matrix and groundwater using Equation (1). Thus, knowing the initial concentrations of the contaminant in the soil and groundwater, the mass of soil and the mass of groundwater, the final concentrations of contaminants in the soil and groundwater may be calculated.

The time for the groundwater to pass through each control volume (time step) is dependent on the natural flow rate of the groundwater. The volume of the voids in the control volume is divided by the flow rate to determine the time step. The following discussion summarizes other model assumptions which are utilized in the batch flushing approach.

Model Assumptions

The following assumptions were used to develop the model:

i) during the initial step, the aquifer matrix and groundwater were assumed to be in equilibrium and only the concentrations of contaminants in the groundwater were input to the model;

ii) equilibrium concentrations of the contaminants in the aquifer matrix and groundwater represent the total mass of the contaminants in the control volume;

iii) the adsorption/desorption isotherms were assumed to be linear;

iv) the dominant attenuation/degradation processes were advection and adsorption/desorption; and

v) the density of the groundwater was assumed to be 1 kg/L.

Site-Specific Model Setup

The batch flushing model was used to estimate the period required for natural attenuation of the overburden aquifer to an acceptable state of groundwater quality in the main area of contamination in the southeastern portion of the Site. A control volume (CV2) was delineated to encompass the main area of contamination. A second control volume (CV1) was located immediately upgradient of the main area of contamination since the groundwater quality there was marginally impacted. Therefore, the groundwater flows through CV1 into CV2. These CVs correspond to the groundwater extraction system strategies presented in Section C.5.

The batch flushing model was conducted for the Overburden Water-Bearing Unit since the contamination is most prevalent in the overburden. Due to the nature of fracture flow within the bedrock it is assumed that contaminant levels within the bedrock will decrease due to natural attenuation processes as the overburden source is eliminated. The time frame for the bedrock aquifer to naturally attenuate the existing contamination would be less than the cleanup times predicted for the

Overburden Water-Bearing Unit . Therefore, the batch flushing model is applied to the Overburden Water-Bearing Unit only.

Each time step consisted of calculating the initial contaminant masses in both the soil matrix and the groundwater. The final groundwater concentration was then calculated from these values. The final soil matrix concentration was calculated using a mass balance equation.

The final contaminant concentration in the soil matrix at the end of each time step was used as the initial soil matrix concentration for the next time step in the same control volume. The final contaminant concentration in the groundwater of CV1 at the end of each time step was used as the initial groundwater concentration in CV2 for the next time step. Unimpacted groundwater was assumed to enter CV1 at the start of each time step. The contaminant concentrations of the soil matrix and groundwater were then allowed to equilibrate prior to flushing out that control volume of water.

Model Input

The batch flushing model input parameters are summarized in Table C.3 including the organic carbon partitioning coefficient (K_{OC}) assigned to each chemical. Associated data and calculations are contained in Tables 1A through 1G of Attachment 1.

The fraction of organic carbon (F_{OC}) in the material comprising the Overburden Water-Bearing Unit was estimated and entered into the model. Total organic carbon analysis of the silt and sand deposits indicated an F_{OC} value of 0.010 (i.e., 1.0 percent) was appropriate. The model itself calculates the distribution coefficient (K_d) from the K_{OC} and F_{OC} data.

The Batch Flushing Model requires that the bulk control volume of each area be specified. The model then calculates the water mass, based on an input porosity of 32 percent (0.32) considered to be representative of the overburden water-bearing unit.

TABLE C-3

SUMMARY OF BATCH FLUSHING MODEL INPUT PARAMETERS - SOUTHEAST AERA
LEICA INC.
CHEEKTOWAGA, NEW YORK

CONTROL VOLUME (bulk):

High Water Table Conditions (April 11, 1994): 211,975 ft^3 = 6,002.5 m^3

Nominal Water Table Conditions (June 23, 1994): 120,930 ft^3 = 3,424.4 m^3

BULK SOIL DENSITY = 1530 kg/m^3

EFFECTIVE POROSITY = 0.32

FRACTION OF ORGANIC CARBON (foc) = 0.010 (1.0%)

INITIAL GROUNDWATER QUALITY OF TWO CONTROL VOLUMES (CV1 and CV2):

		Chemical Concentrations (mg/L)		
Chemical	K_{oc}	*CV1*	*CV2*	*NYS SCG*
1,1-Dichloroethene	64.6	0.005	1.010	0.005
1,2-Dichloroethene (total)	58.9	0.0207	149.195	0.005
Benzene	83	0.005	0.031	0.0007
Ethylbenzene	1,100	0.005	0.074	0.005
Tetrachloroethene	277	0.005	0.019	0.005
Toluene	300	0.005	0.230	0.005
Trichloroethene	125.9	0.005	69.549	0.005
Vinyl Chloride	57	0.009	18.837	0.002
Xylene (total)	240	0.005	2.895	0.005

TIME STEPS:

High Water Table Conditions: 3.7 years

Nominal Water Table Conditions: 27.5 years

The model also requires an estimate of the dry bulk density of the Overburden Water-Bearing Unit materials. A density of 1,530 kg/m^3 was assumed for the silt and sand material of the Overburden Water-Bearing Unit.

The initial average chemical concentrations from overburden monitoring wells of each control volume were entered into the model as summarized in Table C.3. Only contaminants with average concentrations above the respective SCGs were evaluated using the Batch Flushing Model.

C.3.3 PREDICTIVE SIMULATIONS

An example of the output from the Batch Flushing Model is provided in Attachment 2 to this Appendix. The results are summarized in Table C.4.

The flux occurring through the overburden within CV1 and CV2 (identical) was determined to range from 0.02 to 0.26 gpm based on the June and April 1994 water levels, respectively (see Attachment 1). These datasets represent nominal water level conditions (June) and seasonally high water table conditions (April). This indicates respective times of 27.5 and 3.7 years to flush one pore volume of groundwater (i.e., one time step), as calculated in Attachment 1.

As presented on Table C.4, it would take approximately 570 to 4,235 years to reduce all contaminant concentrations to below the applicable SCGs in the main southeastern area of contamination based on an F_{OC} value of 1.0 percent assuming no additional source is input from the unsaturated portion of the Site. These results assume no additional contaminants are introduced into the sandy zone and that concentrations are reduced by natural groundwater flux through the Overburden Water-Bearing Unit. The range in remediation periods reflects the two water table conditions.

TABLE C-4

SUMMARY OF BATCH FLUSHING MODEL OUTPUT RESULTS - CONTROL VOLUME TWO
LEICA INC.
CHEEKTOWAGA, NEW YORK

Chemical	*NYS SCG (µg/L)*	*Number of Control Volumes Flushed Through (i.e., Time Steps) to Reach NYS SCG*	*Final Concentration (µg/L)*	*Time to Reach NYS SCG (years)*	
				High Water Table Conditions	*Nominal Water Table Conditions*
1,1-Dichloroethene	5	21	3.93	50	386
1,2-Dichloroethene (total)	5	35	4.94	84	644
Benzene	0.7	24	0.63	50	386
Ethylbenzene	5	36	4.96	370	2834
Tetrachloroethene	5	32	4.89	60	460
Toluene	5	49	4.70	144	1104
Trichloroethene	5	64	4.37	154	1178
Vinyl Chloride	2	6	7.64	62	478
Xylene (total)	5	487	4.70	187	1435

Notes:

NYS SCG = New York State Standards Criteria and Guidance values.
Time Steps are 3.7 years for high water table condition and 27.5 years for nominal water table condition.
High water table conditions based on April 11, 1994 data.
Nominal water table conditions based on June 23, 1994 data.

C.4 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER CONTAINMENT AND EXTRACTION

This section introduces and provides a brief description of the applicable technologies which may be used for the general response actions of physical containment, hydraulic containment and source removal. The identified technologies are then screened for technical feasibility.

C.4.1 PHYSICAL CONTAINMENT ACTION

C.4.1.1 Barrier Wall

This technology involves the construction of a low permeability barrier that impedes groundwater flow. A barrier wall is usually constructed by excavating a trench (under a slurry) and mixing the excavated soil with local clay, soil-bentonite, or cement-soil-bentonite to form the trench backfill. Upon completion, the barrier wall has a much lower permeability than the surrounding soil which provides protection against groundwater and contaminant migration. Barrier walls may be applicable to the overburden groundwater at the Site.

If used, a barrier wall would probably be located downgradient of a groundwater extraction system to reduce the volume of water drawn back into the extraction system from the downgradient side. Alternatively, the wall may be used to physically contain contaminants in a source area if it can be "keyed" into a low permeability underlying unit. If deemed necessary, a barrier wall may be located at the upgradient side of a contaminated area to reduce the groundwater flux and the groundwater extraction rate required for hydraulic containment downgradient of the barrier wall.

C.4.2 HYDRAULIC CONTAINMENT/SOURCE REMOVAL ACTION

C.4.2.1 Groundwater Extraction Wells

This technology utilizes a series of groundwater extraction wells (normally ranging between 4 and 8 inches in diameter) equipped with pumps to extract groundwater. The collected water would subsequently be treated and disposed on or off Site. Pumping of an extraction well provides hydraulic containment of groundwater in a zone around the well. The limits of the capture zone associated with an extraction well would be a function of the pumping rate and the hydraulic properties of the aquifer or water-bearing unit (i.e., transmissivity and horizontal hydraulic gradient). Alternately, extraction wells may be used as a means of source removal. Extraction wells are best suited to withdrawing groundwater from relatively transmissive units (aquifers). In general, extraction wells may be applied to both overburden and bedrock aquifers.

C.4.2.1.1 Overburden Extraction Wells

Overburden extraction wells are considered inappropriate at this Site due to anticipated extremely low yields. The overburden silt and sand deposits are of very limited thickness in the range of 2.5 to 9.5 feet, and have a saturated thickness of five feet or less in the main area of contamination. Furthermore, the Overburden Water-Bearing Unit becomes seasonally dry over much of the Site. Data for wells in the main (southern) area of contamination (see Tables 1A and 1B of Attachment 1) indicate that this silt and sand water-bearing unit has quite low hydraulic conductivity (8.36×10^{-5} cm/s or 2.74×10^{-6} ft/sec) and transmissivity (4.77×10^{-6} to 8.36×10^{-6} ft^2/sec based on nominal and high water conditions, respectively). The low transmissivity of the Overburden Water-Bearing Unit and the very limited available drawdown (three feet or less) would preclude effective pumping rates from drilled overburden extraction wells.

Based on the Theis equation, it is estimated that an overburden extraction well would yield approximately 0.02 gpm during nominal (June) water level conditions. These values are considered to be theoretical upside estimates and would likely be less in field conditions. As such, steady pumping is not feasible and an effective line of groundwater capture could not be confidently maintained. Also, it would be possible for groundwater to flow along a linear depression in the bedrock surface at an elevation below the bottom of an adjacent overburden extraction well.

Therefore, extraction wells will not be considered as a remedial technology for the overburden groundwater at the Site.

C.4.2.1.2 Bedrock Extraction Wells

Conventional drilled extraction wells are considered to be a feasible remedial technology for the bedrock aquifer since the limestone bedrock aquifer is hydraulically transmissive. Yields in the range of 10 to 25 gpm are anticipated from the upper 35 feet of the limestone bedrock aquifer. Due to the variable nature of fractured bedrock aquifers, it may be necessary to construct and test more than one well to obtain the desired pumping rate.

One (or more) bedrock extraction well(s) may be located in the center of the main (southeastern) area of contamination. Bedrock extraction well(s) located in the center of the main zone of contamination are anticipated to provide hydraulic containment, as well as effective source removal, since (a) the bedrock groundwater flow is radially inward to the southeastern corner from the north, west and east, (b) the main zone of bedrock groundwater contamination is close to the downgradient property boundary, (c) bedrock groundwater contamination does not appear to have migrated off-Site, and (d) reasonably high yields and broad capture zones are anticipated for bedrock extraction wells.

A single bedrock extraction well located near MW-16A is expected to provide effective source removal for this secondary area of bedrock groundwater contamination.

C.4.2.1.3 Overburden Tile Collection System

This technology involves the construction of a tile collection system which would intercept contaminated groundwater in the overburden at the Site. Water collected by the tile system would be treated prior to discharge. Construction of the tile system would involve excavation of a trench. A perforated high density polyethylene (HDPE) pipe, installed in the bottom of the trench, would then be sloped to a "wet well" or pumping station from which the collected water would be extracted. The trench would then be backfilled with granular material to the top of the water table aquifer to provide a preferential pathway for the groundwater. A HDPE liner may be placed against the exterior (unimpacted) wall of the trench to reduce the influx of uncontaminated groundwater from that side.

This technology is only suitable for collection of overburden groundwater at relatively shallow depths (≤20 feet). Relative to extraction wells, tile collection systems are best suited to removing groundwater from poorly transmissive units. Tile collection systems are generally unsuitable for bedrock aquifers due to the physical complications of excavating a trench into bedrock.

The bedrock and overlying Overburden Water-Bearing Unit occur at shallow depths, typically less than 15 feet. This attribute suggests that a tile collection trench system designed to extract impacted groundwater from the overburden would be feasible.

The volumetric flux of groundwater which would flow through the impacted zone of groundwater and enter a collection trench is estimated to be quite low (i.e., approximately 50 to 500 gal/day). As such, efforts to restrict the flux of groundwater entering the upgradient side of the Site and flowing into a collector trench (i.e., the volume of extracted groundwater to treat and dispose) are not warranted. This indicates that an upgradient barrier wall would not be required.

Since the main zone of groundwater contamination is located in the downgradient corner of the Site, close to the Site limits, a tile collector system downgradient of this zone would act to provide effective hydraulic containment, as well as, contaminant source removal for the overburden. A liner may be placed in the collector trench on the downgradient side to minimize the influx of uncontaminated groundwater from the downgradient side. However, the liner is not considered necessary due to the anticipated low flows into the collector from the Overburden Water-Bearing Unit.

A second smaller tile collector system located downgradient of the secondary (northeastern) zone of groundwater contamination at MW-16 would be effective as a source removal system from this localized zone of overburden groundwater contamination. This second collector is recommended as it would improve the bulk removal of contaminants in concentrated form, rather than allow the contaminants to disperse as would be the case with a longer groundwater flow path toward a single collector system in the southeastern corner of the Site.

C.5 DEVELOPMENT AND SCREENING OF GROUNDWATER REMEDIAL ALTERNATIVES

The main objectives of groundwater remediation at the Leica Site are to reduce the concentrations of groundwater contaminants to levels below applicable SCGs and, to prevent the migration or potential migration of, the Site-related contaminants from the Site via groundwater flow. Containment of the groundwater contamination may be accomplished through the use of physical containment systems or groundwater extraction systems downgradient of the impacted areas (hydraulic containment). Based on hydrogeologic parameters, the hydraulic containment systems are designed to produce a continuous, composite pattern of groundwater capture so that contaminants do not flow off Site. Additionally, a source removal groundwater extraction system may be incorporated to remove groundwater from areas showing high concentrations of contaminants in the groundwater. This method is termed source or mass removal.

The containment and source removal technologies screened in Section C.4 form the basis for developing various alternatives for a groundwater remediation system. The physical containment alternative is evaluated in Section C.5.1. The hydraulic containment alternatives are evaluated in Section C.5.2. The alternatives for hydraulic containment coupled with source removal are evaluated in Section C.5.3.

C.5.1 PHYSICAL CONTAINMENT ALTERNATIVE

The objective of on-Site physical containment is to prevent the off-Site migration of contaminants via groundwater flow through the use of a physical barrier. The following alternative considers physical containment in the overburden.

C.5.1.1 Alternative 1A - Perimeter Barrier Wall

A low permeability barrier wall could be constructed through the overburden section to surround each of the two areas (southeastern and northeastern) of contamination. The barrier wall system would contain the overburden groundwater contamination, however, it would not remove the contaminants. Through time, the overburden contamination would continue to migrate into the bedrock aquifer. This would increase the impact on the bedrock groundwater quality. Also, the source of contamination (the overburden) would persist indefinitely.

The cost of a barrier wall would be slightly less than a collector trench per unit length, however, the barrier wall would have to surround the impacted area on four sides versus the downgradient side(s) for the collector trench. Also, a collector trench provides positive, continuous containment and removes contaminants through collected groundwater.

For these reasons, the physical containment alternative is considered less effective than the tile collector trench technology.

C.5.2 HYDRAULIC CONTAINMENT ALTERNATIVES

The objective of on-Site hydraulic containment is to minimize the potential for migration of the chemicals off Site via contaminant transport in groundwater. The following alternatives consider hydraulic containment:

Alternative 2A	Overburden Tile Collector and Bedrock Extraction Wells
Alternative 2B	Overburden Tile Collector, Bedrock Extraction Wells, and Upgradient Barrier (Diversion) Wall

The following subsections provide an evaluation of hydraulic containment alternatives 2A and 2B.

C.5.2.1 Alternative 2A - Overburden Tile Collector and Bedrock Extraction Well

The implementation of an overburden tile collector and a bedrock extraction well in the southeastern portion of the Site, as presented on Figures C.1 (overburden component) and C.2 (bedrock component), would provide hydraulic containment in the Overburden Water-Bearing Unit and the bedrock aquifer. As this combined system is close to the main (southeastern) area of contamination, the system would also provide the added benefit of source removal (discussed in Section C.5.3) from that area.

The tile collector would be positioned directly above the bedrock to provide a continuous line of containment in the overburden. The groundwater influx to the trench from the contaminated area is estimated to be in the range of 0.02 gal/min (nominal June conditions) to 0.22 gal/min (high water table April conditions), as detailed in Tables 1C through 1E of Attachment 1.

The bedrock extraction well would provide the capture zone indicated on Figure C.2 based on a pumping rate of 10 gpm. It is assumed that bedrock groundwater flow occurs naturally toward that location from the north, east and west, i.e., radially inward from three sides. The capture zone calculation is presented in Table 1F (Attachment 1) and Table C.5.

C.5.2.2 Alternative 2B - Overburden Tile Collector, Bedrock Extraction Well and Upgradient Barrier (Diversion) Wall

The addition of an upgradient barrier wall to Alternative 2A may be considered to reduce the rate of groundwater entering the tile collector and thereby the rate of groundwater requiring treatment. Since the anticipated flow rate into the tile collector is predicted to be very low under natural conditions, the addition of an upgradient barrier wall is not required. The effectiveness of the collection system would not be enhanced by the upgradient barrier wall. In addition, the barrier wall would limit the

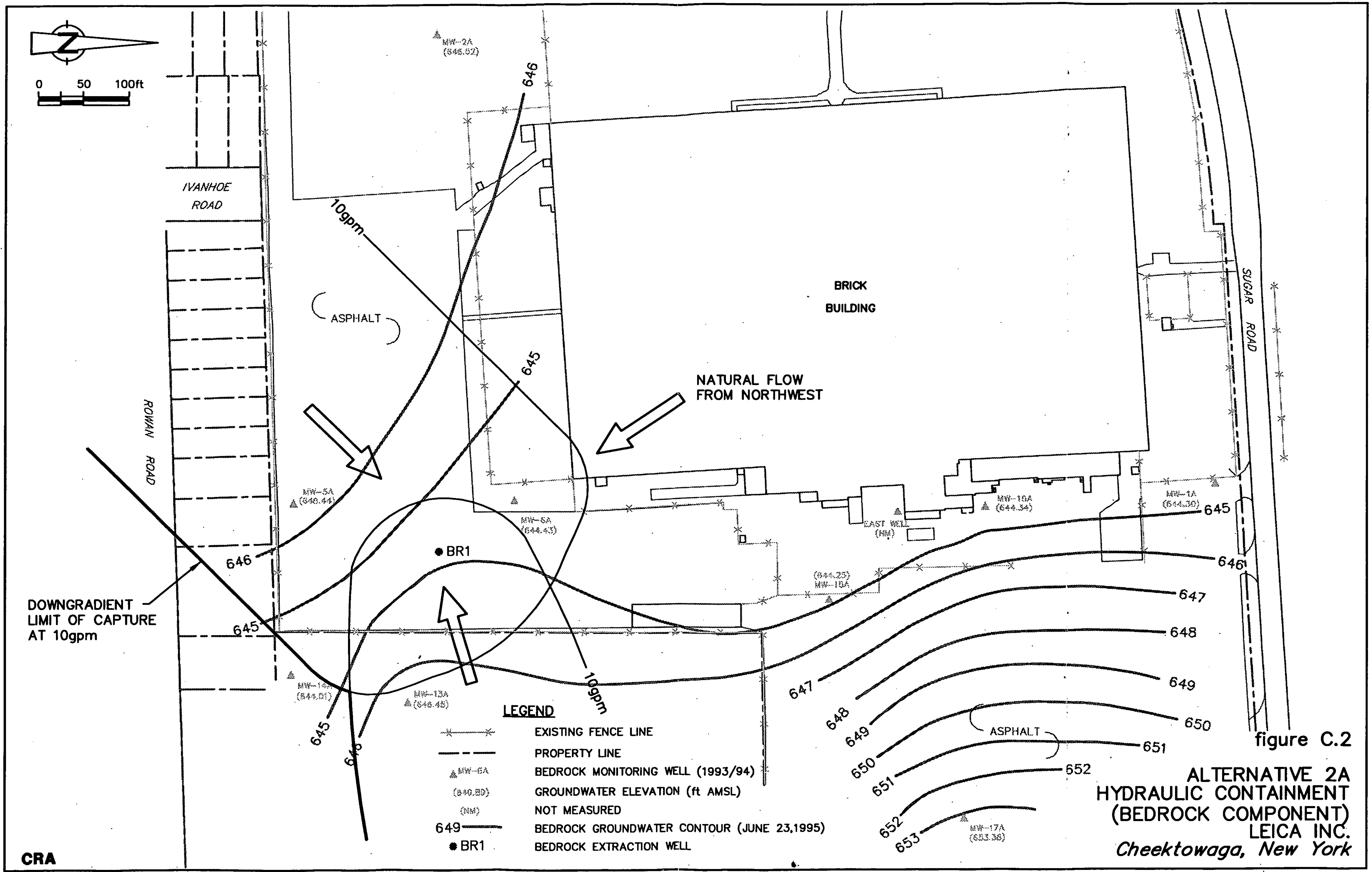


figure C.2

ALTERNATIVE 2A
HYDRAULIC CONTAINMENT
(BEDROCK COMPONENT)
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-79)

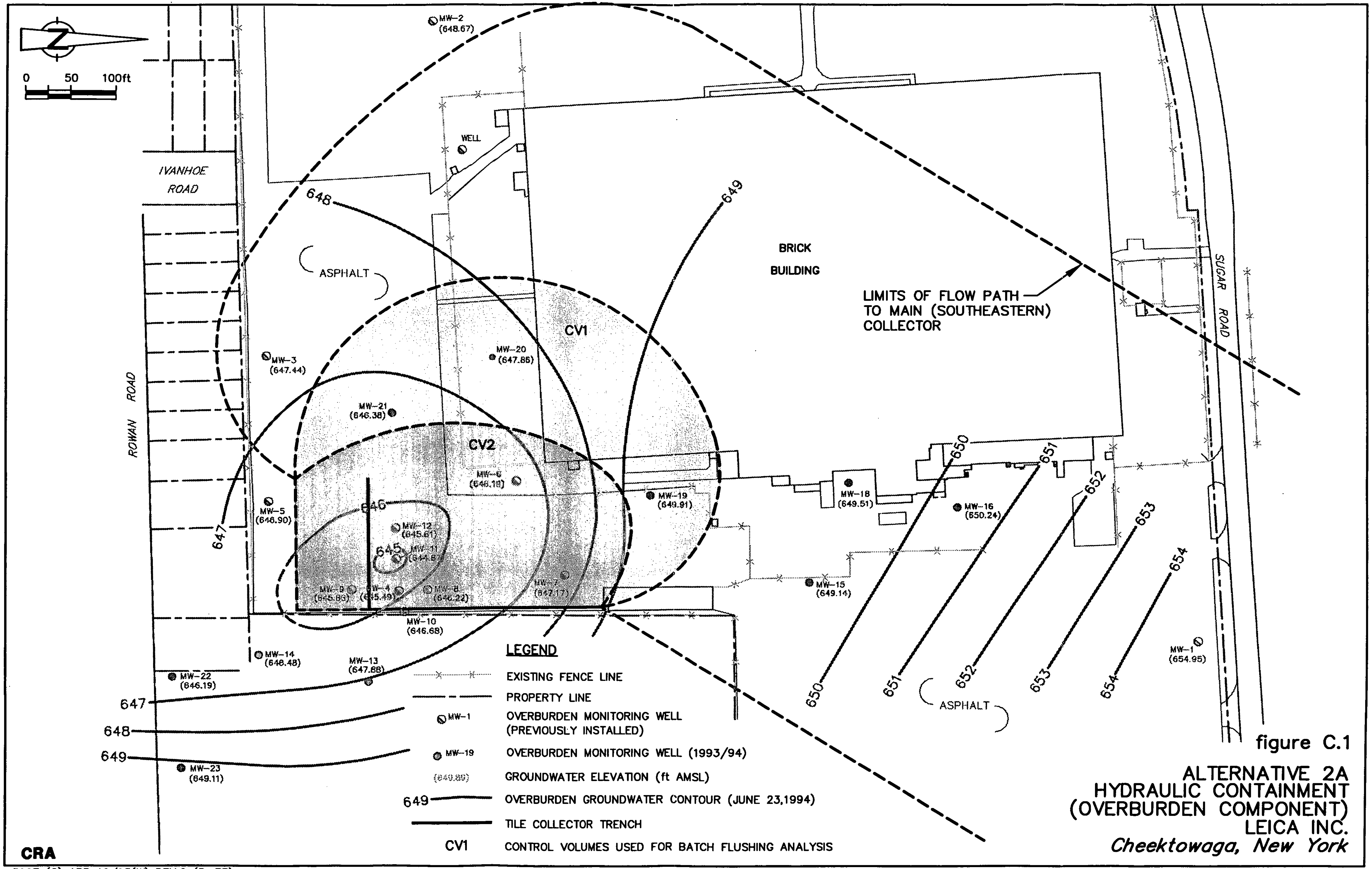


figure C.1

ALTERNATIVE 2A
HYDRAULIC CONTAINMENT
(OVERBURDEN COMPONENT)
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-77)

TABLE C-5

BEDROCK EXTRACTION WELL CAPTURE ZONE CALCULATIONS
LEICA INC.
CHEEKTOWAGA, NEW YORK

Analysis of Southeastern Bedrock Extraction Well, BR1:

Bedrock Aquifer Transmissivity (from Table 1F),

$T = 1.93 \times 10^{-3}\ \text{ft}^2/\text{sec} \times 86{,}400\ \text{sec/day} = 166.75\ \text{ft}^2/\text{day}$

Capture Zone Calculation (Todd, 1980)

$$r_c = \frac{Q}{2\pi Ti}$$

where,
r_c = distance to downgradient stagnation point,
Q = extraction well pumping rate, and
i = horizontal hydraulic gradient.

The width of the capture zone at the extraction well is estimated to be $\pi \bullet r_c$.

a) Eastward:

hydraulic gradient, $i = \dfrac{653\text{-}645\ \text{ft}}{270\ \text{ft}} = 0.030$

based on gradient across 653 to 645 contours between MW-17A and MW-15A (June 1994)

Q (*gpm*)	*Q* (*ft³/day*)	r_c (*ft*)	$\pi \bullet r_c$ (*ft*)
10	1925	61	193
20	3850	122	385

b) Westward:

hydraulic gradient, $i = \dfrac{646\text{-}645\ \text{ft}}{65\ \text{ft}} = 0.015$

based on gradient across 646 to 645 contours southwest of BR1 (June 1994)

Q (*gpm*)	*Q* (*ft³/day*)	r_c (*ft*)	$\pi \bullet r_c$ (*ft*)
10	1925	122	385
20	3850	245	770

c) Northward:

Groundwater will flow to BR1 from areas to the north under the natural southerly flow direction.

d) Southward:

The downgradient (southern) limit of capture by BR1 will be the intersection of the eastward and westward capture zones as indicated on Figures C.2 and C.4.

flow of groundwater through the contaminated overburden, thereby increasing the time for remediation.

C.5.3 HYDRAULIC CONTAINMENT AND SOURCE (MASS) REMOVAL ALTERNATIVES

By adding source removal measures to the hydraulic containment alternatives, groundwater contaminants may be extracted in more concentrated form. This reduces the overall volumes of groundwater to be managed, reduces the contaminant dispersion effects, and reduces the remediation period. The following alternatives consist of hydraulic containment with source removal:

Alternative 3A	Overburden Tile Collectors, and Bedrock Extraction Wells
Alternative 3B	Overburden Tile Collectors, Bedrock Extraction Wells, and Upgradient Barrier (Diversion) Wall

The following subsections provide a hydrogeologic evaluation of the above identified containment and source removal alternatives.

C.5.3.1 Alternative 3A - Overburden Tile Collectors and Bedrock Extraction Wells

This alternative builds upon the hydraulic containment Alternative 2A which consists of an overburden tile collector and a bedrock extraction well in the southeastern (downgradient) portion of the Site. As an added benefit, the Alternative 2A systems provide source (mass) removal from the main (southeastern) area of contamination due to their close proximity to that source area.

Alternative 3A includes a second overburden tile collector and a second bedrock extraction well to provide source removal from the secondary (northeastern) area of contamination in the area of wells

MW-16/16A. The layout of this system is provided on Figures C.3 and C.4. The length of the northeastern tile collector is 100 ft or approximately 25 percent of the southeastern tile collector (420 ft.). As such, flow into this second tile collector is expected to be approximately 25 percent of the southeastern collector.

The second bedrock extraction well may be pumped at a lower rate since the impacted area is much smaller. The capture zone for the northeastern bedrock extraction well, BR2, is indicated on Figure C.4 for a pumping rate of 10 gpm.

C.5.3.2 Alternative 3B - Overburden Tile Collectors, Bedrock Extraction Wells and Upgradient Barrier (Diversion) Wall

For those reasons discussed in the evaluation of Alternative 2B (Section C.5.2.2), the addition of an upgradient barrier wall to Alternative 3A is not considered necessary.

C.5.4 SUMMARY OF GROUNDWATER REMEDIAL ALTERNATIVES EVALUATION

Based on the evaluation presented in this Appendix, a combination of overburden tile collector trench systems and bedrock extraction well systems at both the main (southeastern) and secondary (northeastern) areas of contamination is considered to be the optimal groundwater remediation alternative. The layout of this system with the predicted capture zones is presented on Figures C.3 (overburden component) and C.4 (bedrock component). The bedrock capture zones are based on a transmissivity of 1.93×10^{-3} ft/sec (the geometric mean of the transmissivity results from the seven bedrock monitoring wells analyzed) and a pumping rate of 10 gpm, as indicated in Table C.5. Due to the complex overburden and bedrock flow patterns, it is assumed that groundwater flow occurs naturally from the north toward the bedrock extraction wells. The capture zones are also based on the gradients toward the wells from both the east and west

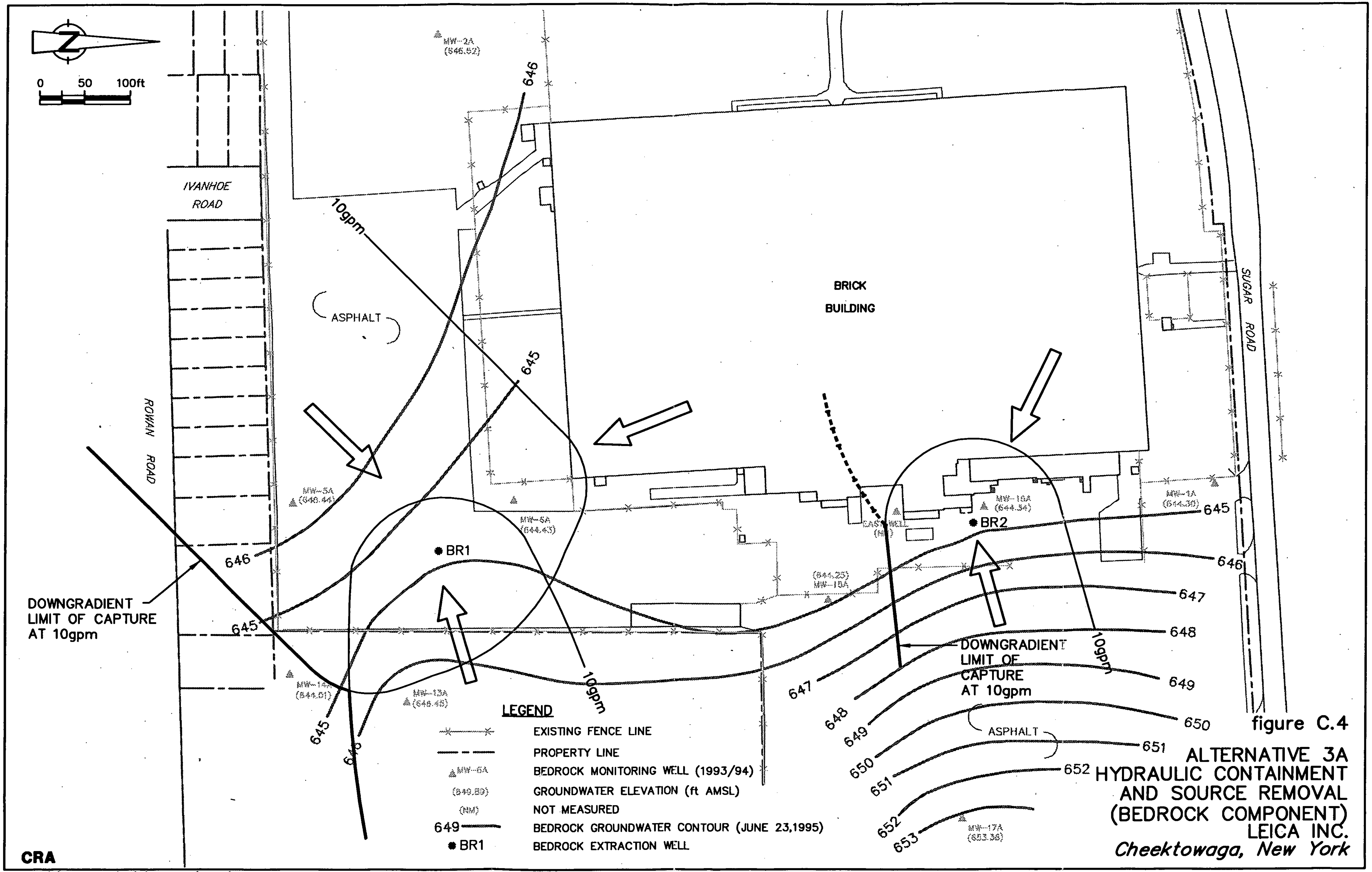


figure C.4

ALTERNATIVE 3A
HYDRAULIC CONTAINMENT
AND SOURCE REMOVAL
(BEDROCK COMPONENT)
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-76)

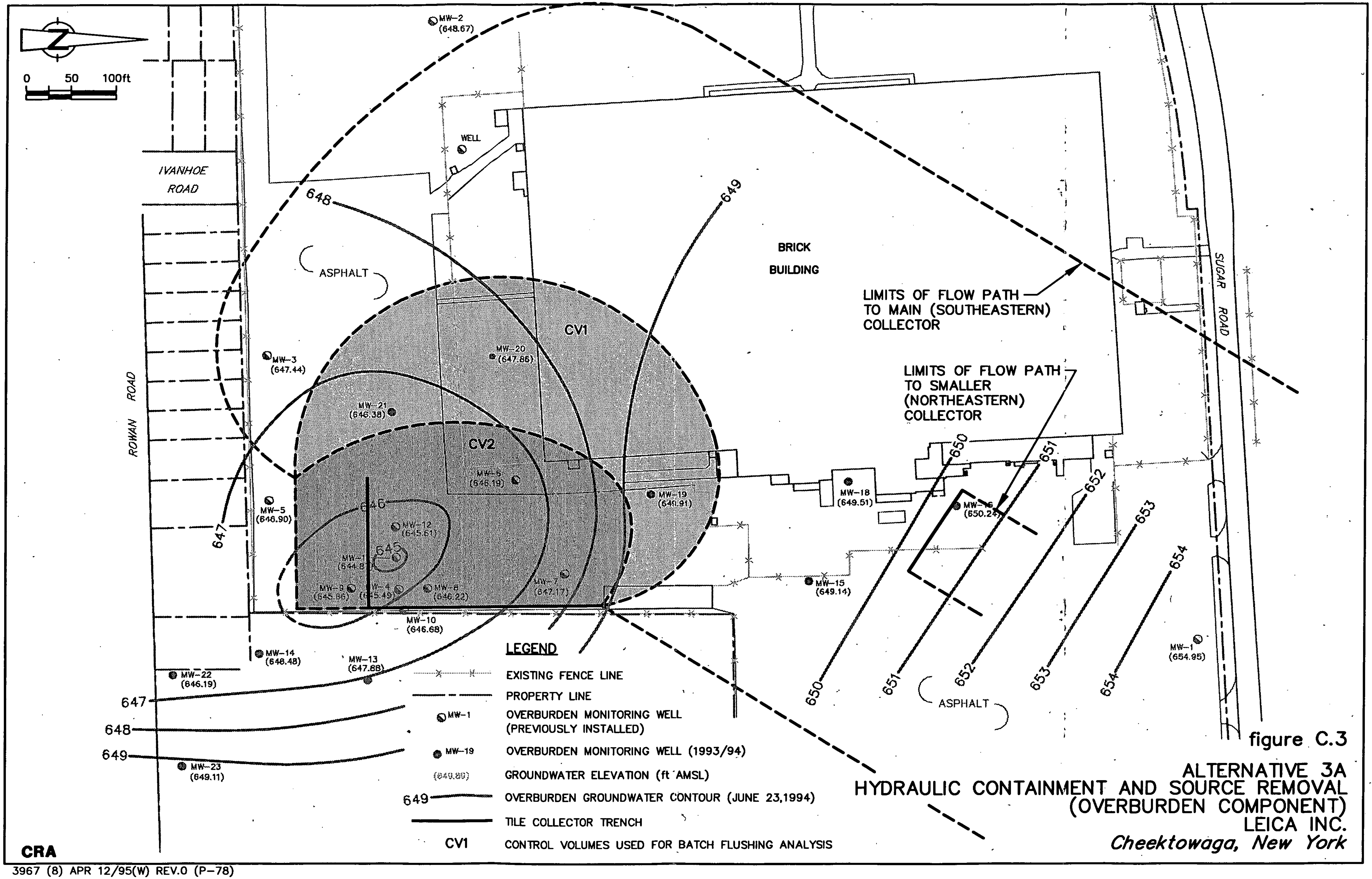


figure C.3

ALTERNATIVE 3A
HYDRAULIC CONTAINMENT AND SOURCE REMOVAL
(OVERBURDEN COMPONENT)
LEICA INC.
Cheektowaga, New York

3967 (8) APR 12/95(W) REV.0 (P-78)

(i.e., radially inward flow to the southeastern corner of the Site from three sides).

A borehole program would be required to obtain an accurate detailed profile of the bedrock surface along the overburden tile collector trench alignments with which the details of the system may be designed, i.e., the slopes of the collector tiles and wet well locations.

Due to the variability of well yields from a fractured bedrock aquifer, more than one well may have to be drilled and tested in order to intersect sufficient transmissive fractures to obtain the desired capture zones.

Based on the batch flushing model results, it is estimated that the remediation of the overburden groundwater to an acceptable state will require in the range of 570 to 4,235 years with ethylbenzene as the critical contaminant. The range reflects the results for high and nominal water table conditions, respectively.

Remediation of the bedrock aquifer is anticipated to require less time due to the lower contaminant concentrations and the nature of fractured bedrock aquifers (i.e., fracture porosity produces faster groundwater flow velocities and has less surface area requiring the desorption of contaminants). Furthermore, the much greater pumping rate and volumetric flux rate through the bedrock aquifer will shorten the remediation period of the bedrock aquifer.

Groundwater collection in the overburden may be enhanced by soil flushing. Soil flushing may increase the flow through the overburden, thereby increasing the recovery of contaminants by the collection system. Soil flushing would require the injection of water into the overburden upgradient of the contaminated areas. Soil flushing would be limited by the low transmissivity and low hydraulic conductivity of the overburden. However, it is expected that soil flushing would increase flow through the overburden during seasonally dry periods.

C.6.0 REFERENCES

1. Freeze, R.A. and Cherry, J.A., Groundwater. Prentice-Hall Inc. (1979).
2. Todd, D.K., Groundwater Hydrology, 2nd Edition. John Wiley & Sons, (1980).

ATTACHMENT 1

HYDROGEOLOGIC CALCULATIONS

TABLE 1A

SINGLE WELL RESPONSE TEST RESULTS
LEICA INC.
CHEEKTOWAGA, NEW YORK

Well Designation	*Static Water Elevation (ft AMSL)*	*Test Type*	*Analysis Method*	*Transmissivity* (ft^2/sec)	*Saturated Aquifer Thickness (ft)*	*Hydraulic Conductivity (ft/sec)*	*Hydraulic Conductivity (cm/sec) (3)*	*Generalized Lithological Description of Screened Material*
<u>Overburden</u>								
MW-1	654.64	Rising Head	Bouwer & Rice (1)	–	4.10	4.56E-06	1.39E-04	Sandy Zone
MW-2	650.45	Rising Head	Bouwer & Rice	–	1.50	2.28E-04	6.95E-03	Sandy Zone
	650.43	Rising Head	Bouwer & Rice	–	1.50	3.44E-04	1.05E-02	
MW-3	650.09	Rising Head	Cooper et al (2)	2.74E-05	3.50	7.83E-06	2.39E-04	Sandy Zone
MW-5	650.52	Rising Head	Bouwer & Rice	–	3.00	3.55E-07	1.08E-05	Sandy Zone
MW-13	652.27	Rising Head	Cooper et al	6.30E-06	4.60	1.37E-06	4.18E-05	Sandy Zone
MW-14	651.50	Rising Head	Cooper et al	3.63 E-06	4.10	8.85E-07	2.70E-05	Sandy Zone
MW-15	653.03	Rising Head	Cooper et al	2.41E-05	4.40	5.48E-06	1.67E-04	Sandy Zone
MW-19	648.89	Rising Head	Bouwer & Rice	–	1.29	8.76E-05	2.67E-03	Sandy Zone
	648.84	Rising Head	Bouwer & Rice	–	1.24	2.42E-05	7.38E-04	
MW-22	643.21	Rising Head	Bouwer & Rice	–	1.01	2.03E-06	6.19E-05	Sandy Zone
MW-23	646.20	Rising Head	Bouwer & Rice	–	6.02	2.26E-05	6.89E-04	Sandy Zone

TABLE 1A

SINGLE WELL RESPONSE TEST RESULTS
LEICA INC.
CHEEKTOWAGA, NEW YORK

Well Designation	*Static Water Elevation (ft AMSL)*	*Test Type*	*Analysis Method*	*Transmissivity (ft^2/sec)*	*Saturated Aquifer Thickness (ft)*	*Hydraulic Conductivity (ft/sec)*	*Hydraulic Conductivity (cm/sec) (3)*	*Generalized Lithological Description of Screened Material*
<u>Bedrock</u>								
MW-1A	643.34	Rising Head	Bouwer & Rice	–	18.74	1.62E-04	4.94E-03	Limestone Bedrock
	643.34	Rising Head	Bouwer & Rice	–	18.74	8.02E-05	2.44E-03	
MW-2A	650.34	Rising Head	Cooper et al	9.41E-04	21.9	4.30E-05	1.31E-03	Limestone Bedrock
	650.34	Rising Head	Cooper et al	5.40E-03	21.9	2.47E-04	7.52E-03	
	650.34	Rising Head	Cooper et al	3.91E-03	21.9	1.79E-04	5.44E-03	
MW-5A	650.05	Rising Head	Cooper et al	1.07E-04	30.9	3.46E-06	1.05E-04	Limestone Bedrock
MW-6A	643.32	Rising Head	Bouwer & Rice	–	19.52	6.54E-05	1.99E-03	Limestone Bedrock
MW-13A	649.06	Rising Head	Cooper et al	1.21E-04	33.1	3.66E-06	1.11E-04	Limestone Bedrock
MW-14A	648.69	Rising Head	Cooper et al	1.75E-02	23.1	7.58E-04	2.31E-02	Limestone Bedrock
	648.69	Rising Head	Cooper et al	2.07E-02	23.1	8.96E-04	2.73E-02	
MW-15A	649.31	Rising Head	Cooper et al	3.77E-03	23.2	1.63E-04	4.95E-03	Limestone Bedrock
	649.30	Rising Head	Insufficient Data to Perform Analysis					
	649.31	Rising Head	Insufficient Data to Perform Analysis					
MW-17A	652.72	Rising Head	Insufficient Data to Perform Analysis					Limestone Bedrock
	652.72	Rising Head	Insufficient Data to Perform Analysis					

Notes:

(1) Bouwer & Rice solution generally used for unconfined aquifer situations, where the screen straddle the water table - solution yields hydraulic conductivity value.
(2) Cooper et al. solution generally used for confined aquifer situations - solution yields transmissivity value.
(3) Hydraulic Conductivity for Cooper et al. solutions calculated as transmissivity divided by the saturated aquifer thickness. In the case of the bedrock monitoring wells, the length of saturated open bedrock corehole is used.

TABLE 1B

OVERBURDEN SANDY ZONE HYDRAULIC CONDUCTIVITY - SOUTHEASTERN AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

Well Number	*Hydraulic Conductivity (cm/sec)*
MW-3	2.39 E-04
MW-5	1.08 E-05
MW-13	4.18 E-05
MW-14	2.70 E-05
MW-19	1.40 E-03(1)
Geometric Mean:	8.36 E-05 cm/sec = 2.74 E-06 ft/sec

Note:

(1) Geometric mean of two SWRT runs at MW-19.

TABLE 1C

CALCULATION OF OVERBURDEN AQUIFER THICKNESSES
LEICA INC.
CHEEKTOWAGA, NEW YORK

Well Number	*Thickness of Sandy Zone (ft)*	*Height of Water Above Bedrock (ft)* (1)		*Saturated Thickness of Sandy Zone (ft)* (2)	
		April 11, 1994	*June 23, 1994*	*April 11, 1994*	*June 23, 1994*
MW-4	4.8	6.72	2.29	4.8	2.29
MW-6	2.8	5.81	0.53	2.8	0.53
MW-7	3.0	7.50	2.23	3.0	2.23
MW-8	3.4	6.87	2.39	3.4	2.39
MW-9	4.5	6.97	2.30	4.5	2.30
MW-10	2.9	7.28	2.46	2.9	2.46
MW-11	2.8	5.31	0.89	2.8	0.89
MW-12	3.2	6.34	1.71	3.2	1.71
MW-19	2.1	5.74	2.36	2.1	2.10
MW-20	2.2	8.13	1.07	2.2	1.07
MW-21	1.9	5.14	1.20	1.9	1.20
AVERAGES:	3.05	6.53	1.77	3.05	1.74

Notes:

(1) Static height of water is used to calculate the influx rate of groundwater into collection trench.
(2) Saturated thickness of sandy zone is used to calculate Bulk Control Volume of Aquifer (Area of Control Volume = 69,500 ft^2)

TABLE 1D

BATCH FLUSHING MODEL
CALCULATION OF GROUNDWATER FLUX INTO THE SOUTHEASTERN COLLECTOR TRENCH
(ALTERNATIVES 2A AND 3A)
LEICA INC.
CHEEKTOWAGA, NEW YORK

GROUNDWATER FLUX INTO THE TRENCH FROM ONE SIDE

$$Q = \frac{K * (H^2 - h^2) * x}{2 * L_o} \ ;$$

from: Fletcher G. Driscoll, Groundwater and Wells, Second Edition, P. 741, 1986.

where:

Q = groundwater flux (ft^3/sec)
K = hydraulic conductivity of aquifer material (ft/sec)
H = static height of water outside trench (ft)
h = height of water in trench (ft)
L_o = distance of trench influence (ft)
x = length of trench (ft)

For High Water Table (April) Conditions:

K = 8.36E-05 cm/sec (average of MW-3, MW-5, MW-13, MW-14 and MW-19)
= 2.74E-06 ft/sec
H = 6.53 ft (based on April 11, 1994 Hydraulic Data)
h = 0.3 ft (assumed)
L_o = 50 ft (assumed)
x = 420 ft (total length)

$\therefore Q$ = 5.68E-04 ft^3/sec
= 0.22 gal/min

For Nominal Water Table (June) Conditions:

K = 8.36E-05 cm/sec (average of MW-3, MW-5, MW-13, MW14 and MW-19)
= 2.74E-06 ft/sec
H = 1.77 ft (based on June 23, 1994 Hydraulic Data)
h = 0.1 ft (assumed)
L_o = 50 ft (assumed)
x = 420 ft (total length)

$\therefore Q$ = 4.17E-05 ft^3/sec
= 0.02 gal/min

TABLE 1E

BATCH FLUSHING MODEL
CALCULATION OF TIME STEP
LEICA INC.
CHEEKTOWAGA, NEW YORK

TIME STEP

$$\text{Time Step} = \frac{\text{CV (bulk)} * \text{n}}{\text{Q}} = \frac{\text{CV (GW)}}{\text{Q}}$$

where:

CV (bulk) = Bulk Control Volume
n = porosity
CV(GW) = Volume of Groundwater in Control Volume
Q = Groundwater influx to trench (gpm)

For High Water Table Conditions (April 1994):

CV (bulk) = 211,975 ft^3 = 6,002 m^3
n = 0.32
CV(GW) = 67,832 ft^3 = 1,921 m^3
= 507,417 gallons = 1,920,787 L
Q = 0.26 gpm

∴ Time Step = 1,355 days
= 3.7 years

For Nominal Water Table Conditions (June 1994):

CV (bulk) = 120,930 ft^3 = 3,424 m^3
n = 0.32
CV(GW) = 38,698 ft^3 = 1,096 m^3
= 289,480 gallons = 1,095,799 L
Q = 0.02 gpm

∴ Time Step = 10,051 days
= 27.5 years

TABLE 1F

CALCULATION OF BEDROCK AQUIFER TRANSMISSIVITY
LEICA INC.
CHEEKTOWAGA, NEW YORK

Well Designation	*Hydraulic Conductivity (ft/sec)*	*Bedrock Aquifer Transmissivity (ft^2/sec)*
MW-1A	1.14×10^{-4}	3.99×10^{-3}
MW-2A	1.24×10^{-4}	4.34×10^{-3}
MW-5A	3.46×10^{-6}	1.21×10^{-4}
MW-6A	6.54×10^{-5}	2.29×10^{-3}
MW-13A	3.66×10^{-6}	1.28×10^{-4}
MW-14A	8.24×10^{-4}	2.88×10^{-2}
MW-15A	1.63×10^{-4}	5.71×10^{-3}
MW-17A	insufficient data to analyze	

Geometric Mean of Transmissivity Values: 1.93×10^{-3} ft^2/sec

Notes:

(1) Hydraulic conductivity values from SWRT results of Table 1A. If more than one result per well, the geometric mean was used.

(2) Bedrock Aquifer transmissivity values were calculated as the hydraulic conductivity value at each well (using saturated corehole length) multiplied by an assumed bedrock aquifer thickness of 35 feet.

(3) The geometric mean transmissivity value was used in the bedrock extraction well capture zone calculations in Table C.5.

TABLE 1G

CALCULATION OF AVERAGE CONTAMINANT CONCENTRATIONS (1) IN THE OVERBURDEN GROUNDWATER - SOUTHEASTERN AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

A) Control Volume One (CV1) - Upgradient

Well Designation	*1,1-DCE*	*1,2-DCE*	*Benzene*	*Ethylbenzene*	*Tetrachloroethene*
MW-19	5 (2)	52	5 (2)	5 (2)	5 (2)
MW-20	5 (2)	5 (2)	5 (2)	5 (2)	5 (2)
MW-21	5 (2)	5 (2)	5 (2)	5 (2)	5 (2)
Average:	5	20.7	5	5	5

	Toluene	*TCE*	*Vinyl Chloride*	*Xylene*
MW-19	5 (2)	5 (2)	17	5
MW-20	5 (2)	5 (2)	5 (2)	5
MW-21	5 (2)	5 (2)	5	5
Average:	5	5	9	5

Notes:

(1) Concentrations are in µg/L.
(2) Compound was not detected at method detection limit (MDL). The concentration was assumed to be 1/2 (MDL) for the determination of the compound average.
(3) Compound was not detected at an elevated MDL. The concentration was assumed to be equal to the highest concentration for the other wells in the same control volume.
(4) Compound was detected but exceeded calibration range. Reanalysis of diluted sample indicated that compound was not detected at an elevated detection limit. The original value was used in the determination of the compound average.
(5) Concentration is highest value for the investigative and duplicate samples.

TABLE 1G

CALCULATION OF AVERAGE CONTAMINANT CONCENTRATIONS (1)
IN THE OVERBURDEN GROUNDWATER - SOUTHEASTERN AREA
LEICA INC.
CHEEKTOWAGA, NEW YORK

B) Control Volume Two (CV2) - Source Area

Well Designation	*1,1-DCE*	*1,2-DCE*	*Benzene*	*Ethylbenzene*	*Tetrachloroethene*
MW-4	66	180,000	2	13	5 (2)
MW-6	22	4,000	4	5 (2)	5 (2)
MW-7	500 (2)	6,500	190	120	50 (3)
MW-8	3,000 est.	390,000	8	130	23
MW-9	5	63	5 (2)	5 (2)	5 (2)
MW-10	180 (4)	90000 (4)	5 (2)	19 (4)	5 (2)
MW-11	4,300 (3)	470,000	-	280 (3)	50
MW-12	5 (2)	53,000	5 (2)	17	5 (2)
Average:	1,009.8	149,195.4	31.3	73.6	18.5

	Toluene	*TCE*	*Vinyl Chloride*	*Xylene*
MW-4	11 (2)	110,000	28,000	69
MW-6	3	890	450	5 (2)
MW-7	210	500 (2)	4,400	240
MW-8	780 (3)	71,000	54,000	21,000
MW-9	1	2	140	3
MW-10	54 (4)	38,000 (4)	15,700 (4)	100 (4)
MW-11	710 (3)	250,000	48,000	1,600 (3)
MW-12	67	86,000	5 (2)	140
Average:	229.8	69,549	18,836.9	2,894.6

Notes:

(1) Concentrations are in µg/L.
(2) Compound was not detected at method detection limit (MDL). The concentration was assumed to be 1/2 (MDL) for the determination of the compound average.
(3) Compound was not detected at an elevated MDL. The concentration was assumed to be equal to the highest concentration for the other wells in the same control volume.
(4) Compound was detected but exceeded calibration range. Reanalysis of diluted sample indicated that compound was not detected at an elevated detection limit. The original value was used in the determination of the compound average.
(5) Concentration is highest value for the investigative and duplicate samples.

ATTACHMENT 2

EXAMPLE BATCH FLUSHING MODEL RESULTS

Ref. [illegible]67
Chemical: 1,1-Dichloroethene
Conditions: High Water Table

SEQUENTIAL B[illegible]H FLUSHING MODEL

2/27/95

1) Chemical Parameters

Chemical Name	1,1-Dichloroethene	
foc	0.0100	
Koc	65.0	
Kd	0.6500	mL/g

2) Physical Parameters

Control Volume (bulk)	6002	m3
Control Volume (soil)	4,082	m3
Control Volume (GW)	1,920,787	L
Bulk Soil Density	1530	kg/m3
Porosity	0.32	
Soil Mass (CV)	9,183,764	kg
Water Mass	1,920,787	kg
Chemical Mass Distrib. Constant	7,890,234	kg

3) Initial Conditions

Control Volume	Soil Conc (mg/kg)	GW Conc (mg/L)
1	0.003	0.0050
2	0.657	1.0100
3	0.000	0.0000
4	0.000	0.0000
5	0.000	0.0000

Control Volume 1 (Upgradient Boundary)

	Initial Conditions				*Final Conditions*			
Step	GW Conc into CV (mg/L)	Chemical Mass in GW (mg)	Soil Conc in CV (mg/kg)	Chemical Mass in Soil (mg)	GW Conc Out (mg/L)	Chemical Mass in GW (mg)	Soil Conc in CV (mg/kg)	Chemical Mass in Soil (mg)
1	5.00E-03	9.60E+03	3.25E-03	2.98E+04	5.00E-03	9.60E+03	3.25E-03	2.98E+04
2	0.00E+00	0.00E+00	3.25E-03	2.98E+04	3.78E-03	7.27E+03	2.46E-03	2.26E+04
3	0.00E+00	0.00E+00	2.46E-03	2.26E+04	2.86E-03	5.50E+03	1.86E-03	1.71E+04
4	0.00E+00	0.00E+00	1.86E-03	1.71E+04	2.17E-03	4.16E+03	1.41E-03	1.29E+04
5	0.00E+00	0.00E+00	1.41E-03	1.29E+04	1.64E-03	3.15E+03	1.06E-03	9.78E+03
6	0.00E+00	0.00E+00	1.06E-03	9.78E+03	1.24E-03	2.38E+03	8.06E-04	7.40E+03
7	0.00E+00	0.00E+00	8.06E-04	7.40E+03	9.38E-04	1.80E+03	6.09E-04	5.60E+03
8	0.00E+00	0.00E+00	6.09E-04	5.60E+03	7.09E-04	1.36E+03	4.61E-04	4.23E+03
9	0.00E+00	0.00E+00	4.61E-04	4.23E+03	5.37E-04	1.03E+03	3.49E-04	3.20E+03
10	0.00E+00	0.00E+00	3.49E-04	3.20E+03	4.06E-04	7.80E+02	2.64E-04	2.42E+03
11	0.00E+00	0.00E+00	2.64E-04	2.42E+03	3.07E-04	5.90E+02	2.00E-04	1.83E+03
12	0.00E+00	0.00E+00	2.00E-04	1.83E+03	2.32E-04	4.46E+02	1.51E-04	1.39E+03
13	0.00E+00	0.00E+00	1.51E-04	1.39E+03	1.76E-04	3.38E+02	1.14E-04	1.05E+03

Ref. No. [illegible]967
Chemical: 1,1-Dichloroethene
Conditions: High Water Table

SEQUENTIAL BATCH FLUSHING MODEL

14	0.00E+00	0.00E+00	1.14E-04	1.05E+03	1.33E-04	2.56E+02	8.65E-05	7.94E+02
15	0.00E+00	0.00E+00	8.65E-05	7.94E+02	1.01E-04	1.93E+02	6.54E-05	6.01E+02
16	0.00E+00	0.00E+00	6.54E-05	6.01E+02	7.61E-05	1.46E+02	4.95E-05	4.55E+02
17	0.00E+00	0.00E+00	4.95E-05	4.55E+02	5.76E-05	1.11E+02	3.74E-05	3.44E+02
18	0.00E+00	0.00E+00	3.74E-05	3.44E+02	4.36E-05	8.37E+01	2.83E-05	2.60E+02
19	0.00E+00	0.00E+00	2.83E-05	2.60E+02	3.30E-05	6.33E+01	2.14E-05	1.97E+02
20	0.00E+00	0.00E+00	2.14E-05	1.97E+02	2.49E-05	4.79E+01	1.62E-05	1.49E+02
21	0.00E+00	0.00E+00	1.62E-05	1.49E+02	1.89E-05	3.63E+01	1.23E-05	1.13E+02
22	0.00E+00	0.00E+00	1.23E-05	1.13E+02	1.43E-05	2.74E+01	9.28E-06	8.52E+01

Ref. N[illegible]67
Chemical: 1,1-Dichloroethene
Conditions: High Water Table

SEQUENTIAL BA[illegible]H FLUSHING MODEL

1) Chemical Parameters

Chemical Name	1,1-Dichloroethene	
foc	0.0100	
Koc	65.0	
Kd	0.6500	mL/g

2) Physical Parameters

Control Volume (bulk)	6,002	m3
Control Volume (soil)	4,082	m3
Control Volume (GW)	1,920,787	L
Bulk Soil Density	1530	kg/m3
Porosity	0.32	
Soil Mass (CV)	9,183,764	kg
Water Mass	1,920,787	kg
Chemical Mass Distrib. Constant	7,890,234	kg

3) Initial Conditions

Control Volume	Soil Conc (mg/kg)	GW Conc (mg/L)
1	0.003	0.0050
2	0.657	1.0100
3	0.000	0.0000
4	0.000	0.0000
5	0.000	0.0000

Control Volume 2

	Initial Conditions				*Final Conditions*			
Step	GW Conc into CV (mg/L)	Chemical Mass in GW (mg)	Soil Conc in CV (mg/kg)	Chemical Mass in Soil (mg)	GW Conc Out (mg/L)	Chemical Mass in GW (mg)	Soil Conc in CV (mg/kg)	Chemical Mass in Soil (mg)
1	1.01E+00	1.94E+06	6.57E-01	6.03E+06	1.01E+00	1.94E+06	6.57E-01	6.03E+06
2	5.00E-03	9.60E+03	6.57E-01	6.03E+06	7.65E-01	1.47E+06	4.97E-01	4.57E+06
3	3.78E-03	7.27E+03	4.97E-01	4.57E+06	5.80E-01	1.11E+06	3.77E-01	3.46E+06
4	2.86E-03	5.50E+03	3.77E-01	3.46E+06	4.39E-01	8.44E+05	2.86E-01	2.62E+06
5	2.17E-03	4.16E+03	2.86E-01	2.62E+06	3.33E-01	6.40E+05	2.16E-01	1.99E+06
6	1.64E-03	3.15E+03	2.16E-01	1.99E+06	2.52E-01	4.85E+05	1.64E-01	1.51E+06
7	1.24E-03	2.38E+03	1.64E-01	1.51E+06	1.91E-01	3.67E+05	1.24E-01	1.14E+06
8	9.38E-04	1.80E+03	1.24E-01	1.14E+06	1.45E-01	2.78E+05	9.42E-02	8.65E+05
9	7.09E-04	1.36E+03	9.42E-02	8.65E+05	1.10E-01	2.11E+05	7.14E-02	6.55E+05
10	5.37E-04	1.03E+03	7.14E-02	6.55E+05	8.32E-02	1.60E+05	5.41E-02	4.97E+05
11	4.06E-04	7.80E+02	5.41E-02	4.97E+05	6.30E-02	1.21E+05	4.10E-02	3.76E+05
12	3.07E-04	5.90E+02	4.10E-02	3.76E+05	4.78E-02	9.18E+04	3.11E-02	2.85E+05
13	2.32E-04	4.46E+02	3.11E-02	2.85E+05	3.62E-02	6.95E+04	2.35E-02	2.16E+05

Ref. No. 967
Chemical: 1,1-Dichloroethene
Conditions: High Water Table

SEQUENTIAL BATCH FLUSHING MODEL

14	1.76E-04	3.38E+02	2.35E-02	2.16E+05	2.74E-02	5.27E+04	1.78E-02	1.64E+05
15	1.33E-04	2.56E+02	1.78E-02	1.64E+05	2.08E-02	3.99E+04	1.35E-02	1.24E+05
16	1.01E-04	1.93E+02	1.35E-02	1.24E+05	1.57E-02	3.02E+04	1.02E-02	9.40E+04
17	7.61E-05	1.46E+02	1.02E-02	9.40E+04	1.19E-02	2.29E+04	7.76E-03	7.12E+04
18	5.76E-05	1.11E+02	7.76E-03	7.12E+04	9.04E-03	1.74E+04	5.88E-03	5.40E+04
19	4.36E-05	8.37E+01	5.88E-03	5.40E+04	6.85E-03	1.32E+04	4.45E-03	4.09E+04
20	3.30E-05	6.33E+01	4.45E-03	4.09E+04	5.19E-03	9.97E+03	3.37E-03	3.10E+04
21	2.49E-05	4.79E+01	3.37E-03	3.10E+04	3.93E-03	7.56E+03	2.56E-03	2.35E+04
22	1.89E-05	3.63E+01	2.56E-03	2.35E+04	2.98E-03	5.73E+03	1.94E-03	1.78E+04

Ref. [illegible]967
Chemical: 1,1-Dichloroethene
Conditions: Low Water Table

SEQUENTIAL BATCH FLUSHING MODEL

1) Chemical Parameters

Chemical Name	1,1-Dichloroethene	
foc	0.0100	
Koc	65.0	
Kd	0.6500	mL/g

2) Physical Parameters

Control Volume (bulk)	3,422	m3
Control Volume (soil)	2,327	m3
Control Volume (GW)	1,095,142	L
Bulk Soil Density	1530	kg/m3
Porosity	0.32	
Soil Mass (CV)	5,236,150	kg
Water Mass	1,095,142	kg
Chemical Mass Distrib. Constant	4,498,640	kg

3) Initial Conditions

Control Volume	Soil Conc (mg/kg)	GW Conc (mg/L)
1	0.003	0.0050
2	0.657	1.0100
3	0.000	0.0000
4	0.000	0.0000
5	0.000	0.0000

Control Volume 1 (Upgradient Boundary)

Step	*Initial Conditions*				*Final Conditions*			
	GW Conc into CV (mg/L)	Chemical Mass in GW (mg)	Soil Conc in CV (mg/kg)	Chemical Mass in Soil (mg)	GW Conc Out (mg/L)	Chemical Mass in GW (mg)	Soil Conc in CV (mg/kg)	Chemical Mass in Soil (mg)
1	5.00E-03	5.48E+03	3.25E-03	1.70E+04	5.00E-03	5.48E+03	3.25E-03	1.70E+04
2	0.00E+00	0.00E+00	3.25E-03	1.70E+04	3.78E-03	4.14E+03	2.46E-03	1.29E+04
3	0.00E+00	0.00E+00	2.46E-03	1.29E+04	2.86E-03	3.13E+03	1.86E-03	9.74E+03
4	0.00E+00	0.00E+00	1.86E-03	9.74E+03	2.17E-03	2.37E+03	1.41E-03	7.37E+03
5	0.00E+00	0.00E+00	1.41E-03	7.37E+03	1.64E-03	1.79E+03	1.06E-03	5.58E+03
6	0.00E+00	0.00E+00	1.06E-03	5.58E+03	1.24E-03	1.36E+03	8.06E-04	4.22E+03
7	0.00E+00	0.00E+00	8.06E-04	4.22E+03	9.38E-04	1.03E+03	6.09E-04	3.19E+03
8	0.00E+00	0.00E+00	6.09E-04	3.19E+03	7.09E-04	7.77E+02	4.61E-04	2.41E+03
9	0.00E+00	0.00E+00	4.61E-04	2.41E+03	5.37E-04	5.88E+02	3.49E-04	1.83E+03
10	0.00E+00	0.00E+00	3.49E-04	1.83E+03	4.06E-04	4.45E+02	2.64E-04	1.38E+03
11	0.00E+00	0.00E+00	2.64E-04	1.38E+03	3.07E-04	3.36E+02	2.00E-04	1.05E+03
12	0.00E+00	0.00E+00	2.00E-04	1.05E+03	2.32E-04	2.55E+02	1.51E-04	7.91E+02
13	0.00E+00	0.00E+00	1.51E-04	7.91E+02	1.76E-04	1.93E+02	1.14E-04	5.98E+02

Ref. N[illegible]967
Chemical: 1,1-Dichloroethene
Conditions: Low Water Table

SEQUENTIAL BATCH FLUSHING MODEL

14	0.00E+00	0.00E+00	1.14E-04	5.98E+02	1.33E-04	1.46E+02	8.65E-05	4.53E+02
15	0.00E+00	0.00E+00	8.65E-05	4.53E+02	1.01E-04	1.10E+02	6.54E-05	3.43E+02
16	0.00E+00	0.00E+00	6.54E-05	3.43E+02	7.61E-05	8.34E+01	4.95E-05	2.59E+02
17	0.00E+00	0.00E+00	4.95E-05	2.59E+02	5.76E-05	6.31E+01	3.74E-05	1.96E+02
18	0.00E+00	0.00E+00	3.74E-05	1.96E+02	4.36E-05	4.77E+01	2.83E-05	1.48E+02
19	0.00E+00	0.00E+00	2.83E-05	1.48E+02	3.30E-05	3.61E+01	2.14E-05	1.12E+02
20	0.00E+00	0.00E+00	2.14E-05	1.12E+02	2.49E-05	2.73E+01	1.62E-05	8.49E+01
21	0.00E+00	0.00E+00	1.62E-05	8.49E+01	1.89E-05	2.07E+01	1.23E-05	6.42E+01
22	0.00E+00	0.00E+00	1.23E-05	6.42E+01	1.43E-05	1.56E+01	9.28E-06	4.86E+01

Ref. No. 5967
Chemical: 1,1-Dichloroethene
Conditions: Low Water Table

SEQUENTIAL BATCH FLUSHING MODEL

1) Chemical Parameters

Chemical Name	1,1-Dichloroethene	
foc	0.0100	
Koc	65.0	
Kd	0.6500	mL/g

2) Physical Parameters

Control Volume (bulk)	3,422	m3
Control Volume (soil)	2,327	m3
Control Volume (GW)	1,095,142	L
Bulk Soil Density	1530	kg/m3
Porosity	0.32	
Soil Mass (CV)	5,236,150	kg
Water Mass	1,095,142	kg
Chemical Mass Distrib. Constant	4,498,640	kg

3) Initial Conditions

Control Volume	Soil Conc (mg/kg)	GW Conc (mg/L)
1	0.003	0.0050
2	0.657	1.0100
3	0.000	0.0000
4	0.000	0.0000
5	0.000	0.0000

Control Volume 2

	Initial Conditions				*Final Conditions*			
Step	GW Conc into CV (mg/L)	Chemical Mass in GW (mg)	Soil Conc in CV (mg/kg)	Chemical Mass in Soil (mg)	GW Conc Out (mg/L)	Chemical Mass in GW (mg)	Soil Conc in CV (mg/kg)	Chemical Mass in Soil (mg)
1	1.01E+00	1.11E+06	6.57E-01	3.44E+06	1.01E+00	1.11E+06	6.57E-01	3.44E+06
2	5.00E-03	5.48E+03	6.57E-01	3.44E+06	7.65E-01	8.38E+05	4.97E-01	2.60E+06
3	3.78E-03	4.14E+03	4.97E-01	2.60E+06	5.80E-01	6.35E+05	3.77E-01	1.97E+06
4	2.86E-03	3.13E+03	3.77E-01	1.97E+06	4.39E-01	4.81E+05	2.86E-01	1.50E+06
5	2.17E-03	2.37E+03	2.86E-01	1.50E+06	3.33E-01	3.65E+05	2.16E-01	1.13E+06
6	1.64E-03	1.79E+03	2.16E-01	1.13E+06	2.52E-01	2.76E+05	1.64E-01	8.59E+05
7	1.24E-03	1.36E+03	1.64E-01	8.59E+05	1.91E-01	2.09E+05	1.24E-01	6.51E+05
8	9.38E-04	1.03E+03	1.24E-01	6.51E+05	1.45E-01	1.59E+05	9.42E-02	4.93E+05
9	7.09E-04	7.77E+02	9.42E-02	4.93E+05	1.10E-01	1.20E+05	7.14E-02	3.74E+05
10	5.37E-04	5.88E+02	7.14E-02	3.74E+05	8.32E-02	9.11E+04	5.41E-02	2.83E+05
11	4.06E-04	4.45E+02	5.41E-02	2.83E+05	6.30E-02	6.90E+04	4.10E-02	2.15E+05
12	3.07E-04	3.36E+02	4.10E-02	2.15E+05	4.78E-02	5.23E+04	3.11E-02	1.63E+05
13	2.32E-04	2.55E+02	3.11E-02	1.63E+05	3.62E-02	3.96E+04	2.35E-02	1.23E+05

14	1.76E-04	1.93E+02	2.35E-02	1.23E+05	2.74E-02	3.00E+04	1.78E-02	9.34E+04
15	1.33E-04	1.46E+02	1.78E-02	9.34E+04	2.08E-02	2.28E+04	1.35E-02	7.07E+04
16	1.01E-04	1.10E+02	1.35E-02	7.07E+04	1.57E-02	1.72E+04	1.02E-02	5.36E+04
17	7.61E-05	8.34E+01	1.02E-02	5.36E+04	1.19E-02	1.31E+04	7.76E-03	4.06E+04
18	5.76E-05	6.31E+01	7.76E-03	4.06E+04	9.04E-03	9.90E+03	5.88E-03	3.08E+04
19	4.36E-05	4.77E+01	5.88E-03	3.08E+04	6.85E-03	7.50E+03	4.45E-03	2.33E+04
20	3.30E-05	3.61E+01	4.45E-03	2.33E+04	5.19E-03	5.69E+03	3.37E-03	1.77E+04
21	2.49E-05	2.73E+01	3.37E-03	1.77E+04	3.93E-03	4.31E+03	2.56E-03	1.34E+04
22	1.89E-05	2.07E+01	2.56E-03	1.34E+04	2.98E-03	3.26E+03	1.94E-03	1.01E+04

D

APPENDIX D

RESULTS OF THE PLANT BOREHOLE PROGRAM - MARCH 1995

SUMMARY OF PLANT BOREHOLE PROGRAM
MARCH 1995
LEICA INC.

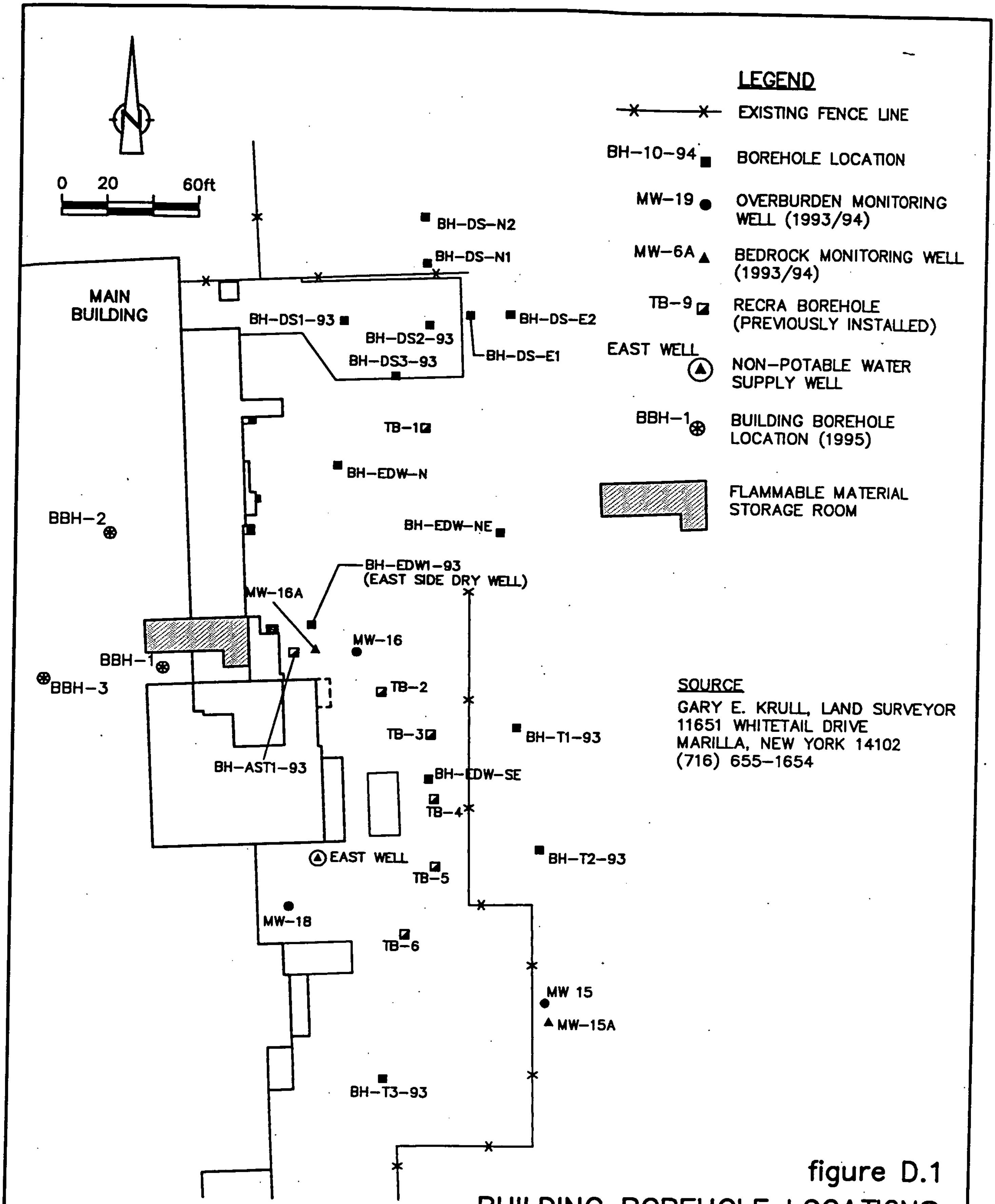
On March 22 and 23, 1995, three overburden boreholes (BBH-1 BBH-2, and BBH-3) were installed within the Main Building at the former Leica Inc. facility on Eggert Road in Cheektowaga, New York. This work was completed in accordance with the Supplemental Work Plan submitted March 6, 1995 and approved by the New York State Department of Environmental Conservation (NYSDEC) on March 13, 1995.

The boreholes were installed by continuous split-spoon sampling in advance of hollow-stem augering. Each split spoon sample was screened using a photoionization detector (PID) and the soils were logged using Unified Soil Classification System (USCS) methods. One soil sample was collected from each borehole for chemical analysis of Target Compound List Volatile Organic Compounds (TCL VOCs) and Total Petroleum Hydrocarbons (TPH) from the split spoon interval exhibiting the highest PID reading except at BBH-3 where the sample was collected from the last split spoon sample interval due to split spoon and auger refusal occurring at a shallower depth than expected.

The BBH-1 and BBH-2 boreholes were completed to 13.0 feet below ground surface (BGS) and 12.1 feet BGS, respectively. Both ended in the sandy till layer which occurs above bedrock at the Site and were not completed to bedrock. BBH-3 ended at split spoon and auger refusal at 12.0 feet BGS. No till was observed at this location. All boreholes were backfilled using soil cuttings to 2.0 feet below finished floor; with the concrete rubble to 1.0 feet below finished floor and gravel-mix concrete to flush with the finished floor. A minimum one foot thick bentonite pellet seal was placed within the lake sediment interval at each borehole.

The analytical results show the presence of VOCs beneath the building, however, all concentrations detected were well below the NYSDEC Technical and Administrative Guidance Memoranda (TAGM) 4046 recommended soil cleanup objectives.

Attached are a figure showing the location of the boreholes, copies of the borehole logs, and a copy of the data validation for the soil samples collected.



SOURCE
GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

figure D.1

BUILDING BOREHOLE LOCATIONS
LEICA INC.
Cheektowaga, New York

CRA

3967 (8) APR 17/95(W) REV.0 (P-86)

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(WL-93)
Page 1 of 1

PROJECT NAME: LEICA INC. RI/FS
PROJECT NUMBER: 3967
CLIENT: LEICA INC.
LOCATION: CHEEKTOWAGA, NY

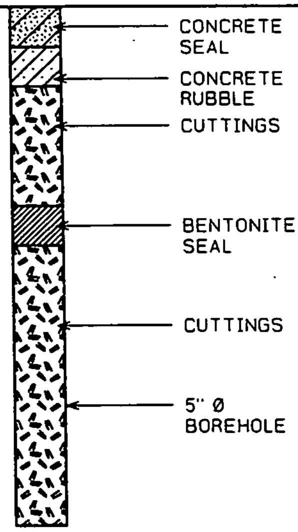
HOLE DESIGNATION: BBH-1
DATE COMPLETED: MARCH 23, 1995
DRILLING METHOD: 2 5/8" ID HSA
CRA SUPERVISOR: K. LYNCH

DEPTH ft. BGS: -2.5, -5.0, -7.5, -10.0, -12.5, -15.0, -17.5, -20.0, -22.5, -25.0, -27.5, -30.0, -32.5

STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. ft. BGS
Concrete floor, 6" thick, wood block floor, 3" thick, sub-base gravel	-1.00
ML-SILT (FILL), little clay and sand, trace fine rounded gravel, stiff, fine grained, brown and red-brown, dry to moist, reworked native	-3.90
SM-SAND, little silt, loose, dark brown, moist	-4.70
ML-SILT, little sand and clay, medium stiff, red brown, dry to moist, reworked native	-5.00 -5.30
SM-SAND (NATIVE), little silt, trace clay, loose, dark brown, dry to moist	
ML-SILT, little to some sand, little clay, hard, laminated, red-brown, dry to moist - very thin sandy lenses	-8.80
SM-SAND, some to little silt, trace fine to medium subrounded gravel, brown, moist to wet - gray - moderate solvent odor	-12.20
SP-SAND (TILL), some fine to medium subangular to subrounded gravel, little silt, little clay, very dense, gray-brown, dry to moist	-13.00

END OF HOLE @ 13.0ft BGS
NOTES:
1. Soil sample collected from 11.0 to 12.5ft BGS for analysis of TCL VOCs and TPH.

MONITOR INSTALLATION



SAMPLE

NUMBER	STATE	'N' VALUE	HNu (ppm)
1SS	☒	10	0
2SS	☒	15	0
3SS	☒	39	0-0.3
4SS	☒	36	4.2
5SS	☒	24	2.0
(6SS)	☒	55	12-25

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ⊻ STATIC WATER LEVEL ▼
CHEMICAL ANALYSIS ⬭

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

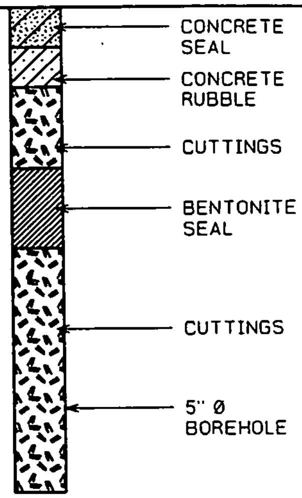
(WL-94)
Page 1 of 1

PROJECT NAME: LEICA INC. RI/FS
PROJECT NUMBER: 3967
CLIENT: LEICA INC.
LOCATION: CHEEKTOWAGA, NY

HOLE DESIGNATION: BBH-2
DATE COMPLETED: MARCH 23, 1995
DRILLING METHOD: 2 5/8" ID HSA
CRA SUPERVISOR: K. LYNCH

DEPTH ft. BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. ft. BGS
	Concrete floor, 8" thick, sub-base gravel	-1.00
2.5	ML-SILT (FILL), some clay, trace sand, trace red-brick, medium stiff, red brown, dry to moist, reworked native	-2.60
5.0	ML-SILT (NATIVE), little sand, some clay, trace rootlets, dark brown to brown, loose, moist	-5.00
7.5	CL-CLAY, little silt, trace sand and fine subrounded gravel, stiff, low to medium plasticity, laminated, red-brown with gray mottling, moist	-7.30
10.0	SM-SAND, little silt and clay, trace fine gravel, medium dense, fine to medium grained, brown, red-brown and gray, moist, alternating thin lenses	-8.20
	SM-SAND, medium dense, fine to medium grained, brown, moist to wet - slight musty odor - gray	-11.30
12.5	SP-SAND (TILL), some fine to medium subrounded gravel, very stiff, gray, dry to moist	-12.10
15.0	END OF HOLE @ 12.1ft BGS NOTES: 1. Soil sample collected from 11.0 to 12.1ft BGS for analysis of TCL VOCs and TPH.	
17.5		
20.0		
22.5		
25.0		
27.5		
30.0		
32.5		

MONITOR INSTALLATION



SAMPLE

NUMBER	STATE	'N' VALUE	HNu (ppm)
1SS	☒	16	0
2SS	☒	39	0.2-0.6
3SS	☒	31	0.4
4SS	☒	34	0.5
5SS	☒	31	2.5
6SS	☒	>100	3.0-5.1

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ⊽ STATIC WATER LEVEL ▼
CHEMICAL ANALYSIS ⬭

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

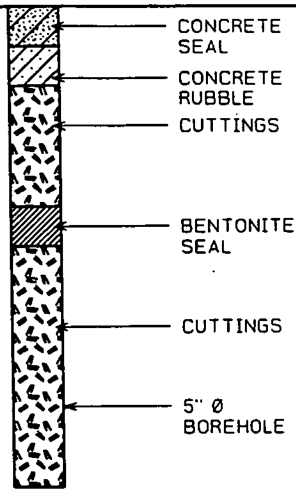
(WL-95)
Page 1 of 1

PROJECT NAME: LEICA INC. RI/FS
PROJECT NUMBER: 3967
CLIENT: LEICA INC.
LOCATION: CHEEKTOWAGA, NY

HOLE DESIGNATION: BBH-3
DATE COMPLETED: MARCH 23, 1995
DRILLING METHOD: 2 5/8" ID HSA
CRA SUPERVISOR: K. LYNCH

DEPTH ft. BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. ft. BGS
	Concrete floor, 6" thick, sub-base gravel	-1.00
-2.5	ML-SILT (FILL), some clay, trace subangular gravel, stiff, brown and red brown, dry to moist, reworked native	-2.80
-5.0	SM-SAND (NATIVE), some silt, little fine rounded gravel, trace rootlets, loose, dark and red brown, former topsoil layer, dry to moist	-3.80
-7.5	ML-SILT, some clay, little sand, trace fine subrounded gravel, stiff, laminated, red-brown with gray along seams, dry to moist	-7.50
	ML-SILT, some sand, little clay, sand present in thin lenses, laminated, red-brown and gray, dry to moist	-8.00
-10.0	SM-SAND, trace to little silt, trace clay and fine rounded gravel, medium dense, brown grading to gray, moist to wet	-12.00
-12.5	END OF HOLE @ 12.0ft BGS NOTES: 1. Soil sample collected from 11.0 to 12.0ft BGS for analysis of TCL VOCs and TPH.	
-15.0		
-17.5		
-20.0		
-22.5		
-25.0		
-27.5		
-30.0		
-32.5		

MONITOR INSTALLATION



SAMPLE			
NUMBER	STATE	'N' VALUE	HNu (ppm)
1SS	☒	18	0
2SS	☒	18	0
3SS	☒	45	0
4SS	☒	33	0.4-1.0
5SS	☒	39	1.2
6SS	☒	>100	0.3

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ▽ STATIC WATER LEVEL ▼
CHEMICAL ANALYSIS ○

ANALYTICAL DATA ASSESSMENT AND VALIDATION
SOIL SAMPLES
LEICA, INC.
CHEEKTOWAGA, NEW YORK
MARCH 1995

TABLE OF CONTENTS

LIST OF TABLES
(Following Report)

1.0 INTRODUCTION

The following details an assessment and validation of analytical results reported by H2M Labs, Inc. (H2M) for four soil samples (including one field duplicate) and one rinse blank collected in March 1995 at the Leica Inc. Site located in Cheektowaga, New York.

The samples were submitted for Target Compound List (TCL) Volatile Organic Compound (VOC) analysis and Total Petroleum Hydrocarbon (TPH) analysis. A sample key is presented in Table 1, and a summary of the analytical results is presented in Table 2.

Evaluation of the data was based on information obtained from the raw data, Chain of Custody forms, blank data, duplicate data, and recovery data for matrix and surrogate spikes. The assessment of analytical and in-house data included checks for: data consistency (by observing comparability of duplicate analyses); adherence to accuracy and precision criteria; transmittal errors; and anomalously high and low parameter values.

The Quality Assurance/Quality Control (QA/QC) criteria by which these data have been assessed are outlined in the analytical methods referenced in Table 3 and the documents entitled:

i) "National Functional Guidelines for Organic Data Review, USEPA Office of Emergency and Remedial Response, February 1994; and

ii) Quality Assurance Project Plan (QAPP), Appendix C of the RI/FS Work Plan, Leica, Inc., Cheektowaga, New York, June 1993.

Hereinafter, item i) will be referred to as the "Guidelines".

2.0 SAMPLE HOLDING TIMES

According to the QAPP, the following sample holding time requirements have been established.

Parameter	*Matrix*	*Holding Time*
TCL VOCs	Soil	10 days from VTSR to analysis
TPH	Soil	26 days from VTSR to analysis

Notes:

TCL VOCs	Target Compound List Volatile Organic Compounds.
TPH	Total Petroleum Hydrocarbons.
VTSR	Verified Time of Sample Receipt.

By comparing the VTSR of all samples (from the laboratory receipt date appearing on the Chain of Custody documents) with the sample analysis dates, it was noted that all samples were analyzed within the established holding times.

The rinse blank collected for TCL VOCs was not acid preserved as specified in the QAPP. Qualification of the data was not necessary since the analysis was performed within seven days of collection.

In accordance with the QAPP, all samples were transported and stored at 4°C (±2°C) after collection.

3.0 GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS) - TUNING AND MASS CALIBRATION - VOLATILES

Prior to analysis, GC/MS instrumentation is tuned to ensure optimization over the mass range of interest. To evaluate instrument tuning, Method 91-1 requires the analysis of the tuning compound bromofluorobenzene (BFB). The resulting spectras must meet the criteria cited in the method before analysis is initiated. Analysis of the tuning compound must then be repeated every 12 hours throughout the sample analysis to ensure the continued optimization of the instrument.

The tuning compound was analyzed at the required frequency throughout volatile analysis. All tuning criteria were met, indicating that proper optimization of the instrument was achieved.

4.0 INSTRUCTION CALIBRATION

4.1 VOLATILES

4.1.1 Initial Calibration

To quantify compounds of interest in samples, calibration of the GC/MS over a specific concentration range must be performed. Initially, a five point calibration curve containing all compounds of interest is analyzed and must meet specific sensitivity and linearity criteria as specified in Method 91-1.

For QA/QC purposes, the initial calibration data is evaluated based on the following criteria specified in the "Guidelines":

i) all Relative Response Factors (RRFs) must be greater than or equal to 0.050; and

ii) Percent Relative Standard Deviation (%RSD) values must not exceed 30.0 percent.

The %RSD values for acetone and 2-butanone exceeded the 30 percent criteria. All associated detected sample results were qualified as estimated (see Table 4). Non-detect results would not be affected by the variability in the calibration, so no qualification of the non-detect 2-butanone data was necessary.

The analysis of all remaining VOC compounds met the requirements specified in the "Guidelines".

4.1.2 Continuing Calibration

To ensure that instrument calibration is acceptable throughout the sample analysis period, continuing calibration standards must be analyzed and compared to the initial calibration curve every

12 hours. As specified in Method 91-1, RRF and Percent Difference (%D) values are then used to evaluate instrument stability.

For QA/QC purposes, the continuing calibration data is evaluated based on the following criteria specified in the "Guidelines":

i) all RRF values must be greater than or equal to 0.050; and
ii) %D values must not exceed 25.0 percent.

Continuing calibration standard analyses yielded %D values greater than 25.0 percent for several compounds. Associated sample results were qualified as estimated (see Table 5). All remaining continuing calibration results met the above requirements, indicating acceptable instrument calibration.

4.2 TPH

As specified in the method, the infrared spectrophotometer is calibrated by analyzing a series of working standards. A calibration plot of absorbance versus milligrams (mg) petroleum hydrocarbons per 100 milliliters (ML) solution is then established and used to calculate the TPH content in samples. The correlation coefficient of the calibration curve must be 0.995 or greater.

Upon review of the data, it was noted that a six-point calibration curve ranging from 2.5 to 40 mg/100 mL was analyzed and employed for sample TPH calculations. A correlation coefficient of 0.999 was achieved. Prior to sample analysis, a 20 mg/L standard was analyzed and yielded a 94 percent recovery indicating acceptable instrument calibration.

5.0 INTERNAL STANDARD ANALYSES - VOLATILES

In order to ensure that changes in GC/MS response and sensitivity do not affect sample analysis results, internal standards are added to each sample prior to analysis. All results are then calculated as a ratio of the internal standard response. The criteria by which the internal standard results are assessed is as follows:

i) internal standard area counts must not vary by more than a factor of two (-50 percent to +100 percent) from the associated calibration standard; and

ii) the retention time of the internal standard must not vary more than ±30 seconds from the associated calibration standard.

Low chlorobenzene-d_5 recoveries were reported for samples BBH-1, BBH-2 BBH-5, and the dilution analysis of BBH-5. All associated sample results were qualified as estimated (see Table 6). The ethylbenzene and xylene results for BBH-1 did not require qualification, as the data were obtained from a dilution analysis of the sample which had acceptable internal standard recoveries. No qualification of the data from the dilution analysis of BBH-5 was necessary, as the outlying internal standard was not associated with the trichloroethene result obtained.

All remaining internal standard recoveries were acceptable.

6.0 SURROGATE SPIKE RECOVERIES - VOLATILES

All samples and blanks analyzed for VOCs were spiked with the surrogate compounds 1,2-dichloroethane-d4, bromofluorobenzene, and toluene-d8 prior to sample analysis. Surrogate recoveries provide a means to evaluate the effects of individual sample matrices on analytical efficiency. Control limits for acceptable surrogate recoveries are specified in Method 91-1.

All surrogate recoveries were within the method control limits, indicating acceptable analytical efficiency for all sample analyses.

7.0 LABORATORY BLANK ANALYSES

The purpose of assessing the results of laboratory blank analyses is to determine the existence and magnitude of contamination introduced during analysis. Laboratory blanks were analyzed at a minimum frequency of one per 20 investigative samples and/or one per analytical sequence.

7.1 VOLATILES

VOC laboratory blanks analyzed on March 28, 1995 and March 29, 1995 yielded low level concentrations of methylene chloride, acetone, 2-butanone, 2-hexanone, and 1,1,2,2-tetrachloroethane. Per the "Guidelines", all associated positive sample results less than ten times (methylene chloride, acetone, 2-butanone) or five times (2-hexanone, 1,1,2,2-tetrachloroethane) the laboratory blank concentrations were qualified as non-detect (see Table 7).

All remaining VOCs were not detected in the laboratory blanks.

7.2 TPH

The laboratory blank analyzed for TPH was non-detect, indicating that contamination from the laboratory was not a factor in this analysis.

8.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE MS/MSD) ANALYSES - VOLATILES

The recoveries of MS/MSD analyses are used to assess the analytical accuracy achieved on individual sample matrices. The Relative Percent Difference (RPD) between the MS and MSD are used to assess analytical precision. MS/MSD analyses were performed at a minimum frequency of one per 20 investigative samples.

The MS/MSD analysis was performed on sample BBH-1. All spike recoveries and RPD values were within the method control limits, indicating that acceptable analytical accuracy and precision were achieved by the laboratory.

9.0 BLANK SPIKE ANALYSES - VOLATILES

The recoveries of blank spike analyses are used to assess the analytical accuracy achieved by the laboratory. As the blank spike analyses are independent of potential matrix effects, they give a true indication of the analytical accuracy achieved by the laboratory for the respective analyses performed. Blank spike analyses were performed at a frequency of one per 20 investigative samples.

For this study, one blank spike was analyzed and all recoveries reported were within the laboratory control limits. On the basis of these results, analytical accuracy for Method 91-1 was deemed acceptable.

10.0 MATRIX SPIKE (MS) ANALYSES - TPH

In order to evaluate the effects that the sample matrix may have on the accuracy of a particular analysis, samples are spiked with a known concentration of the analyte of concern and analyzed as MS samples. MS analyses are performed at a frequency of one per 20 investigative samples.

Sample BBH-1 was analyzed as the MS sample for TPH. The MS recovery was within the general control limits of 75 to 125 percent, indicating acceptable analytical accuracy.

11.0 DUPLICATE SAMPLE ANALYSIS - TPH

A duplicate sample is analyzed to assess analytical precision. A sample is prepared and analyzed in duplicate at a minimum frequency of one per 20 investigative samples. The RPD value between the original and duplicate analysis results is then assessed against a general control limit of 35 percent for soils.

For this study, sample BBH-1 was analyzed in duplicate. Both results were non-detect indicating acceptable analytical precision for this parameter.

12.0 TENTATIVELY IDENTIFIED COMPOUNDS (TICS) - VOLATILES

Chromatographic peaks recorded during volatile sample analysis which are not target compounds, surrogates, or internal standards, are potential TICs. The ten largest TICs that exhibit areas greater than 10 percent of the area of the nearest internal standard are tentatively identified and quantified.

All samples exhibited either low concentration levels or no presence of TICs. A summary of the results follows.

No TICs were observed in samples BBH-2, BBH-3, and BBH-5.

Low level concentrations of ethylbenzene and methylbenzene isomers ranging from 8 to 14 micrograms per kilogram (μg/kg) were reported for sample BBH-1.

Isopropyl alcohol was detected in the rinse blank, but was not present in any of the samples.

13.0 FIELD QA/QC

13.1 FIELD DUPLICATES

One field duplicate was collected and submitted "blind" to the laboratory for analysis to assess the overall analytical and sampling protocol precision as follows:

Sample I.D.	*Field Duplicate I.D.*	*Parameter*
BBH-2	BBH-5	TCL VOCs TPH

All field duplicate results showed adequate reproducibility, indicating that acceptable sampling and analytical precision was achieved.

13.2 RINSE BLANKS

In order to assess the efficiency of the sampling device cleansing protocols performed in the field, one rinse blank was collected on March 23, 1995 and submitted to the laboratory for TCL VOCs and TPH.

Acetone was detected at 22 μg/L in the rinse blank. All associated sample results up to ten times the level detected in the blank were qualified as non-detect in Table 8.

The rinse blank yielded non-detect concentrations for all remaining analytes of interest.

14.0 CONCLUSION

Based on the assessment detailed in the foregoing, the data produced by H2M are acceptable for use with the specific qualifications noted herein.

TABLE 1

SAMPLE SUMMARY KEY
SOIL SAMPLES
LEICA INC.
CHEEKTOWAGA, NEW YORK
MARCH 1995

Sample Number	*Sample Date*	*Sample Type*	*Sample Depths (ft. BGS)*	*Parameter*	*Notes*
BBH-1	03/23/95	Soil	(11'-12.5')	TCL VOCs, TPH	MS/MSD
BBH-2	03/23/95	Soil	(11'-12.1')	TCL VOCs, TPH	
BBH-3	03/23/95	Soil	(11'-12.0')	TCL VOCs, TPH	
BBH-5	03/23/95	Soil	(11'-12.1')	TCL VOCs, TPH	Dup. of BBH-2
Rinse Blank	03/23/95	Water	-	TCL VOCs, TPH	

Notes:

MS/MSD	Matrix Spike / Matrix Spike Duplicate
Dup.	Field Duplicate
VOCs	Volatile Organic Compounds
TPH	Total Petroleum Hydrocarbons
BGS	Below Ground Surface
TCL	Target Compound List

TABLE 2

ANALYTICAL RESULTS SUMMARY
SOIL SAMPLES
LEICA INC.
CHEEKTOWAGA, NEW YORK
MARCH 1995

Sample ID:	*BBH-1*	*BBH-2*	*BBH-5*	*BBH-3*
	(11'-12.5')	*(11'-12.1')*	*(Duplicate of BBH-2)*	*(11'-12.0')*
Collection Date:	*03/23/95*	*03/23/95*	*03/23/95*	*03/23/95*
TCL Volatiles (µg/kg)				
Chloromethane	11 U	11 U	12 U	12 U
Bromomethane	11 U	11 U	12 U	12 U
Vinyl Chloride	1 J	11 U	12 U	12 U
Chloroethane	11 U	11 U	12 U	12 U
Methylene Chloride	11 U	11 U	12 U	12 U
Acetone	11 U	11 U	13 U	15 U
Carbon Disulfide	11 U	11 U	12 U	12 U
1,1-Dichloroethene	11 U	11 U	12 U	12 U
1,1-Dichloroethane	5 J	3 J	3 J	12 U
1,2-Dichloroethene (total)	64	35	33	12 U
Chloroform	11 U	11 U	12 U	12 U
1,2-Dichloroethane	11 U	11 U	12 U	12 U
2-Butanone	11 UJ	11 UJ	12 U	12 UJ
1,1,1-Trichloroethane	11 U	11 U	12 U	12 U
Carbon Tetrachloride	11 U	11 U	12 U	12 U
Bromodichloromethane	11 U	11 U	12 U	12 U
1,2-Dichloropropane	11 U	11 U	12 U	12 U
cis-1,3-Dichloropropene	11 U	11 U	12 U	12 U
Trichloroethene	11 U	430	460	140
Dibromochloromethane	11 U	11 U	12 U	12 U
1,1,2-Trichloroethane	11 U	11 U	12 U	12 U
Benzene	11 U	11 U	12 U	12 U
trans-1,3-Dichloropropene	11 U	11 U	12 U	12 U
Bromoform	11 U	11 U	12 U	12 U
4-Methyl-2-Pentanone	11 UJ	11 UJ	12 UJ	12 UJ
2-Hexanone	11 UJ	11 UJ	12 UJ	12 UJ
Tetrachloroethene	11 UJ	11 UJ	5 J	12 U
1,1,2,2-Tetrachloroethane	11 UJ	11 UJ	12 UJ	12 U
Toluene	28 J	2 J	3 J	12 U
Chlorobenzene	8 J	11 UJ	12 UJ	12 U
Ethylbenzene	97	3 J	12 UJ	12 U
Styrene	11 UJ	11 UJ	12 UJ	12 U
Xylene (total)	410	13 J	12 UJ	12 U
TPH (mg/kg)	35.4 U	35.0 U	37.0 U	38.5 U

Notes:

U	Non-detect at the associated value.
J	Associated value is estimated.
TCL	Target Compound List.
TPH	Total Petroleum Hydrocarbons.

TABLE 3

METHODS OF ANALYSIS
SOIL SAMPLES
LEICA INC.
CHEEKTOWAGA, NEW YORK
MARCH 1995

Parameter	*Methodology*
TCL VOCs	91-1 (1)
TPH	EPA 418.1 (2)

Notes:

(1)	Method referenced from New York State Department of Environmental Conservation (NYSDEC), September 1989 Analytical Services Protocol (ASP) (12/91 Revision).
(2)	Method referenced from "Methods for Chemical Analysis of Water and Wastes", EPA-600 4-79-020, United States Environmental Protection Agency, March 1983.
TPH	Total Petroleum Hydrocarbons.
TCL VOCs	Target Compound List Volatile Organic Compounds.

TABLE 4

QUALIFIED ANALYTICAL RESULTS DUE TO OUTLYING INITIAL CALIBRATION RESULTS
SOIL SAMPLES
LEICA INC.
CHEEKTOWAGA, NEW YORK
MARCH 1995

Parameter	*Standard Analysis Date*	*Compound*	*%RSD*	*Associated Samples*	*Sample Results (µg/kg)*	*Qualifier*
TCL Volatiles	03/24/95	Acetone	47.7	BBH-1	8J	*
				BBH-2	11J	*
				BBH-3	15	J
				BBH-5	13	J
		2-Butanone	33.5	BBH-5	6J	*

Notes:

[illegible]SD	Relative Standard Deviation
[illegible]CL	Target Compound List
*	Result previously qualified as estimated.
J	Associated value is estimated.

TABLE 5

QUALIFIED ANALYTICAL RESULTS DUE TO CONTINUING CALIBRATION RESULTS
SOIL SAMPLES
LEICA INC.
CHEEKTOWAGA, NEW YORK
MARCH 1995

Parameter	*Standard Analysis Date*	*Compound*	*%D*	*Associated Samples*	*Sample Results (µg/kg)*	*Qualifier*
TCL Volatiles	03/28/95	Acetone	37.7	BBH-1	8J	*
				BBH-2	11J	*
				BBH-5	13	J
		2-Butanone	30.2	BBH-1	11U	J
				BBH-2	11U	J
				BBH-5	6J	*
	03/29/95	Acetone	50.5	BBH-3	15	J
		2-Butanone	42.6	BBH-3	12U	J
		4-Methyl-2-pentanone	26.5	BBH-3	12U	J
		2-Hexanone	33.4	BBH-3	12U	J

Notes:

TCL	Target Compound List
%D	Percent Difference
U	Non-detect at the associated value.
J	Associated value is estimated.
*	Result previously qualified as estimated.

TABLE 6

QUALIFIED ANALYTICAL RESULTS DUE TO OUTLYING INTERNAL STANDARD RECOVERIES
SOIL SAMPLES
LEICA INC.
CHEEKTOWAGA, NEW YORK
MARCH 1995

Parameter	*Sample ID*	*Internal Standard*	*Internal Standard Recovery (percent)*	*Associated Compounds*	*Sample Results*	*Qualifier*
TCL Volatiles	BBH-1	Chlorobenzene-d5	49	2-Hexanone	11U	J
				4-Methyl-2-Pentanone	11U	J
				Tetrachloroethene	11U	J
				1,1,2,2-Tetrachloroethane	11U	J
				Toluene	28	J
				Chlorobenzene	8J	*
				Styrene	11U	J
TCL Volatiles	BBH-2	Chlorobenzene-d5	45	2-Hexanone	11U	J
				4-Methyl-2-Pentanone	11U	J
				Tetrachloroethene	11U	J
				1,1,2,2-Tetrachloroethane	11U	J
				Toluene	2J	*
				Chlorobenzene	11U	J
				Ethylbenzene	3J	*
				Styrene	11U	J
				Xylene (Total)	13	J

TABLE 6

QUALIFIED ANALYTICAL RESULTS DUE TO OUTLYING INTERNAL STANDARD RECOVERIES
SOIL SAMPLES
LEICA INC.
CHEEKTOWAGA, NEW YORK
MARCH 1995

Parameter	*Sample ID*	*Internal Standard*	*Internal Standard Recovery (percent)*	*Associated Compounds*	*Sample Results*	*Qualifier*
TCL Volatiles	BBH-5	Chlorobenzene-d5	40	2-Hexanone	12U	J
				4-Methyl-2-Pentanone	12U	J
				Tetrachloroethene	5J	*
				1,1,2,2-Tetrachloroethane	12U	J
				Toluene	3J	*
				Chlorobenzene	12U	J
				Ethylbenzene	12U	J
				Styrene	12U	J
				Xylene (Total)	12U	J

Notes:

U	Non-detect at the associated value.
J	Associated value is estimated.
*	Result previously qualified as estimated.
TCL	Target Compound List

TABLE 7

QUALIFIED ANALYTICAL RESULTS DUE TO METHOD BLANK CONTAMINATION
SOIL SAMPLES
LEICA INC.
CHEEKTOWAGA, NEW YORK
MARCH 1995

Parameter	*Blank ID*	*Analysis Date*	*Compound*	*Blank Result (1) (µg/kg)*	*Sample ID*	*Sample Results*	*Qualified Sample Results*
TCL Volatiles	VBLK03	03/28/95	Acetone	5	BBH-1	8J	11U
				4	BBH-2	11J	11U
				5	BBH-5	13	13U
			Methylene Chloride	2	BBH-1	2J	11U
				2	BBH-2	3J	11U
				2	BBH-5	2J	12U
			2-Butanone	4	BBH-5	6J	12U
	VBLK04	03/29/95	Acetone	7	BBH-3	15	15U

Notes:

(1)	Blank results adjusted to reflect individual sample weights and % moistures.
J	Associated value is estimated.
U	Non-detect at the associated value.
TCL	Target Compound List

TABLE 8

QUALIFIED ANALYTICAL RESULTS DUE TO RINSATE BLANK CONTAMINATION
SOIL SAMPLES
LEICA INC.
CHEEKTOWAGA, NEW YORK
MARCH 1995

Parameter	*Compound*	*Blank Result*(1) *(µg/kg)*	*Sample ID*	*Sample Results (µg/kg)*	*Qualified Sample Results (µg/kg)*
TCL Volatiles	Acetone	25	BBH-1	8 J	11 U
		25	BBH-2	11 J	11 U
		27	BBH-3	15	15 U
		26	BBH-5	13	13 U

Notes:

U	Non-detect at the associated value.
J	Associated value is estimated.
(1)	Blank results adjusted to reflect individual sample weights and percent moisture.
[illegible]CL	Target Compound List

E

APPENDIX E

TAGM 4030 REMEDIAL ALTERNATIVE SCORE SHEETS

TABLE E.1

COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE NEW YORK STATE STANDARDS CRITERIA AND GUIDELINES (SCGS)

(Relative Weight = 10)

Analysis Factor	*Basis for Evaluation During Detailed Analysis*	*Score*	*Alternative 1*	*Alternative 2*	*Alternative 3*	*Alternative 4*
1. Compliance with chemical-specific SCGs	Meets chemical-specific SCGs such as groundwater standards	Yes __ 4	–	–	–	4
		No __ 0	0	0	0	--
2. Compliance with action-specific SCGs	Meets SCGs such as technology standards for incineration or landfill	Yes __ 3	NA	NA	3	3
		No __ 0	NA	NA	–	--
3. Compliance with location-specific SCGs (1)	Meets location-specific SCGs such as Freshwater Wetlands Act	Yes __ 3	NA	NA	NA	NA
		No __ 0	NA	NA	NA	NA
TOTAL (Maximum = 10)			0	0	3	7

Notes:

NA - not applicable.
1) There are no applicable location-specific SCGs for the Site.

TABLE E.2

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	*Basis for Evaluation During Detailed Analysis*	*Score*	*Alternative 1*	*Alternative 2*	*Alternative 3*	*Alternative 4*
1. Use of the site after remediation	Unrestricted use of the land and water (If answer is yes, go to the end of the Table.)	Yes __ 20	–	–	–	20
		No __ 0	0	0	0	0
2. Human health and the environment exposure after the remediation. (1)	i) Is the exposure to contaminants via air route acceptable?	Yes __ 3	3	3	3	–
		No __ 0	–	–	–	–
	ii) Is the exposure to contaminants via groundwater/surface water acceptable? (2)	Yes __ 4	–	–	4	–
		No __ 0	0	0	–	–
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes __ 3	3	3	3	–
		No __ 0	–	–	–	–
3. Magnitude of residual public health risks after the remediation.	i) Health risk	≤ 1 in 1,000,000 __ 5	–	–	–	–
	ii) Health risk	≤ 1 in 100,000 __ 2	–	–	2	–
4. Magnitude of residual environmental risks after the remediation.	i) Less than acceptable	__ 5	–	–	5	–
	ii) Slightly greater than acceptable	__ 3	–	–	–	–
	iii) Significant risk still exists	__ 0	0	0	–	–
TOTAL (Maximum = 20)			6	6	17	20

Notes:

(1) Exposures are based on the assumption that the present land use and environmental conditons are unchanged in the future.
(2) Health risks to bedrock groundwater are based on hypothetical future groundwater use. There are currently no groundwater users in the vicinity of the Site.

TABLE E.3

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	*Basis for Evaluation During Detailed Analysis*	*Score*	*Alternative 1*	*Alternative 2*	*Alternative 3*	*Alternative 4*
1. Protection of community during remedial actions.	° Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes _ 0	–	–	–	0
		No _ 4	4	4	4	–
	° Can the risk be easily controlled?	Yes _ 1	–	–	–	1
		No _ 0	–	–	–	–
	° Does the mitigative effort to control risk impact the community lifestyle?	Yes _ 0	–	–	–	–
		No _ 2	–	–	–	2
2. Environmental Impacts	° Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes _ 0	–	–	–	0
		No _ 4	4	4	4	–
	° Are the available mitigative measures reliable to minimize potential impacts?	Yes _ 3	–	–	–	3
		No _ 0	–	–	–	–
3. Time to implement the remedy.	° What is the required time to implement the remedy?	≤ 2yr. _ 1	NA	1	1	–
		> 2yr. _ 0	NA	–	–	0
	° Required duration of the mitigative effort to control short-term risk.	≤ 2yr. _ 1	NA	1	1	–
		> 2yr. _ 0	NA	–	–	0
TOTAL (Maximum = 10)			8	10	10	6

Notes:

NA - not applicable

TABLE E.4

LONG TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	*Basis for Evaluation During Detailed Analysis*	*Score*	*Alternative 1*	*Alternative 2*	*Alternative 3*	*Alternative 4*
1. On-site or off-site treatment or land disposal	° On-site treatment *	3	NA	NA	3	3
	° Off-site treatment *	1	NA	NA	--	--
	° On-site or off-site land disposal	0	NA	NA	--	--
* treatment is defined as destruction or separation/treatment or solidification/chemical fixation of inorganic wastes.						
2. Permanence of the remedial alternative after the remediation.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b) or (c). (If answer is yes, go to Factor 4.)	Yes __ 3	--	--	--	3
		No __ 0	0	0	0	--
3. Lifetime of remedial actions.	° Expected lifetime or duration of effectiveness of the remedy.	25-30yr. __ 3	3	3	3	--
		20-25yr. __ 2	--	--	--	--
		15-20yr. __ 1	--	--	--	--
		< 15yr. __ 0	--	--	--	--
4. Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site.	None __ 3	--	--	--	--
		<25% __ 2	--	--	--	2
		25-50% __ 1	--	--	--	--
		>50% __ 0	0	0	0	--
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 5.)	Yes __ 0	--	--	--	--
		No __ 2	2	2	2	2
	iii) Is the treated residual toxic?	Yes __ 0	--	--	--	--
		No __ 1	--	--	--	--
	iv) Is the treated residual mobile?	Yes __ 0	--	--	--	--
		No __ 1	--	--	--	--
5. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. __ 1	NA	--	--	--
		> 5yr. __ 0	NA	0	0	0
	ii) Are environmental controls required as part of the remedy to handle potential problems? (If answer is no, go to "iv".)	Yes __ 0	--	0	0	0
		No __ 1	1	--	--	--
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident __ 1	--	1	1	1
		Somewhat to not confident __ 1	--	--	--	--
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum __ 2	--	--	--	--
		Moderate __ 1	--	--	--	1
		Extensive __ 0	0	0	0	--
TOTAL (Maximum = 15)			6	6	9	12

Notes:

NA - not applicable

TABLE E.5

REDUCTION OF TOXICITY, MOBILITY OR VOLUME
(Relative Weight = 15)

Analysis Factor	*Basis for Evaluation During Detailed Analysis*		*Score*	*Alternative 1*	*Alternative 2*	*Alternative 3*	*Alternative 4*
1. Volume of hazardous waste reduced (reduction in volume or toxicity). If Factor 1 is not applicable, go to Factor 2.	i) Quantity of hazardous waste destroyed or treated. Immobilization technologies do not score under Factor 1.	99-100%	8	NA	NA	–	–
		90-99%	7	NA	NA	–	–
		80-90%	6	NA	NA	–	6
		60-80%	4	NA	NA	–	–
		40-60%	2	NA	NA	–	–
		20-40%	1	NA	NA	1	–
		<20%	0	NA	NA	–	–
	ii) Are there untreated or concentrated hazardous waste produced as a result of (i)? If answer is no, go to Factor 2.	Yes	0	NA	NA	–	–
		No	2	NA	NA	2	2
If subtotal = 10, go to Factor 3	iii) After remediation, how is the untreated, residual hazardous waste material disposed?	Off-site land disposal	0	–	–	–	–
		On-site land disposal	1	–	–	–	–
		Off-site destruction or treatment	2	–	–	–	–
2. Reduction in mobility of hazardous waste. If Factor 2 is not applicable, go to Factor 3.	i) Quantity of Available Wastes Immobilized After Destruction/Treatment	90-100%	2	–	–	–	–
		60-90%	1	–	–	–	–
		<60%	0	–	–	–	–
	ii) Method of Immobilization						
	-Reduced mobility by containment		0	–	–	0	0
	-Reduced mobility by alternative treatment technologies		3	–	–	–	–
3. Irreversibility of the destruction or treatment or immobilization of hazardous waste.	° Completely irreversible.		5	NA	NA	5	5
	° Irreversible for most of the hazardous waste constituents.		3	NA	NA	–	–
	° Irreversible for only some of the hazardous waste constituents.		2	NA	NA	–	–
	° Reversible for most of the hazardous waste constituents.		0	NA	NA	0	–
TOTAL (maximum = 15)				0	0	8	13

Notes:

NA - not applicable

TABLE E.6

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	*Basis for Evaluation During Detailed Analysis*		*Score*	*Alternative 1*	*Alternative 2*	*Alternative 3*	*Alternative 4*
1. Technical Feasibility							
Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.		___ 3	NA	NA	3	--
	ii) Somewhat difficult to construct. No uncertainties in construction.		___ 2	NA	NA	--	2
	iii) Very difficult to construct and/or significant uncertainties in construction.		___ 1	NA	NA	--	--
Reliability of technology.	i) Very reliable in meeting the specified process efficiencies or performance goals.		___ 3	NA	NA	3	3
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.		___ 2	NA	NA	--	--
Schedule of delays due to technical problems.	i) Unlikely		___ 2	NA	NA	2	2
	ii) Somewhat unlikely		___ 1	NA	NA	--	--
Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.		___ 2	--	--	--	2
	ii) Some future remedial actions may be necessary.		___ 1	1	1	1	--
2. Administrative Feasibility							
Coordination with other agencies.	i) Minimal coordination is required.		___ 2	2	--	--	--
	ii) Required coordination is normal.		___ 1	--	1	1	--
	iii) Extensive coordination is required.		___ 0	--	--	--	0
3. Availability of Services and Materials							
Availability of prospective technologies.	i) Are technologies under consideration generally commercially available for the site-specific application?	Yes	___ 1	NA	NA	1	1
		No	___ 0	NA	NA	--	--
	ii) Will more than one vendor be available to provide competitive bid?	Yes	___ 1	NA	NA	1	1
		No	___ 0	NA	NA	--	--
Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes	___ 1	NA	NA	1	1
		No	___ 0	NA	NA	--	--
TOTAL (maximum = 15)				3	2	13	12

Notes:

NA - not applicable

TABLE E.7

PROPOSED COST RANKING
(Relative Weight = 15)

Total Present Worth	*Score*	*Alternative 1*	*Alternative 2*	*Alternative 3*	*Alternative 4*
$0 - $1,100,000	15	15	15		
$1,100,000 - $2,200,000	10				
$2,200,000 - $3,300,000	5			5	
$3,300,000 - $4,400,000	0				0
		15	15	5	0
TOTAL SCORES (Tables E.1 to E.7)		38	39	65	70

F

APPENDIX F

NYSDEC MASTER LIST OF STANDARDS, CRITERIA AND GUIDANCE

STANDARDS, CRITERIA, & GUIDANCE
Master List

iv./ Agcy.*	Title	Std./ Guid.	Requirements
BMHP	6 NYCRR Part 661 (Cp. 10) - Tidal Wetlands Land Use Regulations	S	▸ limit/preclude excavation, filling, regrading in vegetated tidal wetlands or portions of adjacent areas
DAM	1 NYCRR Part 371 - Notice of Intent	S	▸ filing necessary if impact > 10 acres within an agricultural district
DAR	Air Guide 1 - Guidelines for the Control of Toxic Ambient Air Contaminants	G	▸ control of toxic air contaminants ▸ screening analysis for ambient air impacts ▸ toxicity classifications ▸ ambient standards - short term/annual
DAR	6 NYCRR Part 200 (200.6) - General Provisions; 1/29/93	S	▸ prohibits contravention of AAQS or causes air pollution
DAR	6 NYCRR Part 201 - Permits & Certificates; 3/31/93	S	▸ prohibits construction/operation w/o permit/certificate
DAR	6 NYCRR Part 211 (211.1) - General Prohibitions	S	▸ prohibits emissions which are injurious to human, plant, or animal life or causes a nuisance
DAR	6 NYCRR Part 212 - General Process Emission Sources	S	▸ establishes control requirements
AR	6 NYCRR Part 257 - Air Quality Standards	S	▸ applicable air quality standards
DFW	Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites (FWIA); 10/94	G	▸ habitat assessments ▸ contaminant impact assessments ▸ ecological effects of remedies ▸ remedial requirements ▸ monitoring ▸ checklist
DFW	ECL Article 24 & Article 71, Title 23 - Freshwater Wetlands Act	S	▸ preserve, protect, and conserve freshwater wetlands ▸ regulate use and development
DFW	6 NYCRR Part 182 - Endangered & Threatened Species of Fish & Wildlife	S	▸ lists endangered, threatened species and species of special concern and prohibits taking except under permit
DFW	6 NYCRR Part 608 - Use and Protection of Waters	S	▸ protect certain classified streams ▸ permits for impoundments, structures, dredge, and fill
DFW	6 NYCRR Part 662 - Freshwater Wetlands - Interim Permits	S	▸ interim permits in areas prior to DECs filing of a final freshwater wetlands map
DFW	6 NYCRR Part 663 - Freshwater Wetlands Permit Requirements	S	▸ procedural requirements for various activities in wetlands and adjacent areas and standards for permit issuance

DFW	6 NYCRR Part 664 - Freshwater Wetlands Maps & Classifications	S	▸ establishes the classification system for various types of wetlands
DFW	6 NYCRR Part 665 - Local Government Implementation of the Freshwater Wetlands Act & Statewide Minimum Land - Use Regulations for Freshwater Wetlands	S	▸ provides for optional local regulatory authority regarding use and development of freshwater wetlands
DHSR	Description of Difference - EPA State Regulations	G	▸ Summary
DHSR	6 NYCRR Part 364 - Waste Transporter Permits; 1/12/90	S	▸ regulates collection, transport, and delivery of regulated waste
DHSR	6 NYCRR Part 370 - Hazardous Waste Management System: General; 1/31/92	S	▸ definitions of terms and general standards applicable to Parts 370-374 & 376
DHSR	6 NYCRR Part 371 - Identification and Listing of Hazardous Wastes; 1/31/92	S	▸ haz. waste determinations
DHSR	6 NYCRR Part 372 - Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities; 1/31/92	S	▸ manifest system and recordkeeping, certain management standards
DHSR	6 NYCRR Part 374 - Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities - 1/31/92	S	▸ requirements for recyclable materials, hazardous waste burned for energy recovery, used oil burned for energy recovery, precious metal recovery, spent lead acid battery reclamation
DHSR	6 NYCRR Part 376 - Land Disposal Restrictions - 1/31/92	S	▸ identifies hazardous waste restricted from land disposal ▸ defines land disposal
DHSR	6 NYCRR Subpart 373-1 - Hazardous Waste Treatment, Storage and Disposal Facility Permitting Requirements; 1/31/92	S	▸ hazardous waste permitting requirements: includes substantive requirements
DHSR	6 NYCRR Subpart 373-2 - Final Status Standards for Owners and Operators of Hazardous Waste Treatment Storage and Disposal Facilities; 1/31/92	S	▸ hazardous waste management standards ▸ e.g., contingency plan; releases from SWMUs; closure/post-closure; container/management; tank management; surface impoundments; waste piles; ▸ landfills; incinerators; etc.
DHSR	6 NYCRR Subpart 373-3 - Interim Status Standards for Owners and Operators of Hazardous Waste Facilities - 1/31/92	S	▸ similar to 373-2
DHWR	TAGM HWR-92-4046 Determination of Soil Cleanup Objectives and Cleanup Levels; 1/24/94	G	▸ soil cleanup goals

DHWR	TAGM HWR-92-4030 Selection of Remedial Actions at Inactive Hazardous Waste Sites; 5/90	G	▸ remedy selection criteria/evaluations
HWR	TAGM HWR-94-4027 - Assistance for Contaminated Private and Public Water Supplies; 4/18/94	G	▸ when DEC can supply potable water
DHWR	TAGM HWR-89-4031 Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites; 10/27/89	G	▸ dust suppression during IRM/RA
DHWR	TAGM HWR-92-4042 Interim Remedial Measures; 6/1/92	G	▸ define and track IRMs
DHWR	TAGM HWR-92-4048 Interim Remedial Measures - Procedures; 12/9/92	G	▸ identifying and implementing IRMs
DHWR	6 NYCRR Part 375 - Inactive Hazardous Waste Disposal Site Remedial Program; 5/92	S	▸ requirements regarding remedial programs ▸ private party programs, state funded programs, state assistance to municipalities
DMR	Title 27 - NYS Mined Land Reclamation Law	S	▸ permit required for mining > 1000 tons in < 12 months (e.g. clay for cover)
DMR	6 NYCRR Part 420 - General	S	▸ definitions and scope
DMR	6 NYCRR - Part 421 - Permits	S	▸ requirements for mining permits
DMR	6 NYCRR Part 422 - Mined Land - Use Plan	S	▸ mining and reclamation plans
DMR	6 NYCRR Part 423 - Reclamation Bond	S	▸ requirements for reclamation bonds
DMR	6 NYCRR Part 424 - Enforcement	S	▸ violations of mining regulations
DMR	6 NYCRR Part 425 - Civil Penalties	S	▸ assessing penalties
DMR	6 NYCRR Part 426 - Hearings	S	▸ hearings regarding mining permits/penalties
DOH	Appendix 5-B of Part 5 of the State Sanitary Code (Rural Water Supply)	S	▸ requirements for wells, springs, cisterns, etc. in rural areas
DOH	The Binghamton State Office Building cleanup criteria for PCDDs, PCDFS & PCBs	G	▸ building cleanup criteria
DOH	The 10 ppt criterion for 2,3,7,8-TCDD in fish flesh	C	▸ <10 ppt in fish flesh
DOH	Tolerance levels for EDB in food	G	▸ possible use in risk assessments
DOH	Criteria for the development of health advisories for sport fish consumption	G	▸ for use in risk assessments and for known problems

DOH	Part 16 draft limits on the disposal of radioactive materials into sewer systems	G	▸ discharge to sewers of radioactive materials
[illegible]H	NYSDOH Interim Report on Point-of-Use Activated Carbon Treatment Systems	G	▸ guidance on the use of activated carbon treatment systems for drinking water
DOH	Appendix 5-A of Part 5 of the State Sanitary code (Recommended Standards for Water Works)	S	▸ standards for construction/operation of public water systems
DOH	Part 170 of title 10 of the NYCRR, Water Supply Sources	S	▸ protecting public water supplies
DOH	Part 5 of the State Sanitary Code, Drinking Water Supplies; 3/11/92	S	▸ drinking water standards
DOH	NYSDOH PWS 68 - Blending Policy for Use of Sources of Drinking Water	G	▸ conditions under which blending is allowed
DOH	NYSDOH PWS 69 - Organic Chemical Action Steps for Drinking Water	G	▸ actions to take when the concentration of organic contaminants exceed specified levels in a public water system
DOH	NYSDOH PWS 152 - Procedure for Handling Community Water System Emergencies	G	▸ identifies emergencies and what steps to take at public water systems
DOH	NYSDOH PWS 159 - Responding to Organic Chemical Concerns at Public Water Systems	G	▸ steps to take when organic chemical concentrations exceed action levels
DOH	NYSDOH PWS 160 - Public Notification of Organic Chemical Incidents Regarding Public Water Supplies	G	▸ requirements for notifying users
DOL	12 NYCRR 38 - Ionizing Radiation Protection	S	▸ protection and licensing requirements for handling materials that produce ionizing radiation
DOL	12 NYCRR 50 - Lasers	S	▸ laser users must have a certificate of competence ▸ licensed land surveyors excepted
DOS	Federal Consistency Process	G	▸ federal "actions" must be consistent with the NYS coastal management program
DOS	State Consistency Process	G	▸ proposed "actions" in the coastal area must be evaluated to determine consistency with NYS coastal policies. If action may have a significant effect, must prepare an EIS. Dept. of State must approve a Certificate of Consistency.
DOS	State Costal Policies	G	▸ 44 policies regarding development, fish & wildlife, recreation, energy & ice management, water/air resources, etc.

DOS	Federal Register - Part V - Department of Commerce - Federal Consistency Regulation; 6/25/79	G	▸ impacts federal actions (e.g. NPL sites) in the coastal zone
DOS	Part 600 - Department of State, Waterfront Revitalization and Coastal Resources Act	S	▸ "Coastal Area" includes Lakes Erie and Ontario, the St. Lawrence and Niagara rivers, the Hudson river south of the federal dam at Troy, the East river, the Harlem river, the Kill van Kull and Arthur Kill, Long Island sound, and the Atlantic ocean, etc.
DOS	NYS Costal Management Program	G	▸ program summary: promote the use of coastal resources; protect coastal resources; control major activities.
DOW	Analytical Services Protocols (ASP); 11/91	G	▸ analytical procedures
DOW	TOGS 2.1.2 - Underground Injection/Recirculation (UIR) at Groundwater Remediation Sites; 7/90	G	▸ guidance of the applicability of SPDES permits and groundwater effluent standards to the use of UIR as a remediation measure
DOW	TOGS 1.3.8 - New Discharges to Publicly Owned Treatment Works; 10/26/94	G	▸ limits on new or changed discharges to POTWs ▸ strict requirements regarding bioaccumulative and persistent substances plus other considerations
DOW	TOGS 1.3.7 - Analytical Detectability & Quantitation Guidelines for Selected Environmental Parameters; 7/90	G	▸ guidance on selection of analytical detection limits and quantitation limits in SPDES permits
DOW	TOGS 1.3.4.a - BPJ Methodologies/Amendments; 11/3/88	G	▸ amends TOGS 1.3.4 regarding BPJ for PCBs.
DOW	TOGS 1.3.4 - BPJ Methodologies;	G	▸ guidance for the application of BPJ to the determination of effluent limits
DOW	TOGS 1.3.2 - Toxicity Testing in the SPDES Permit Program; 5/90	G	▸ procedures for when effluent toxicity testing is required
DOW	TOGS 1.1.1 - Ambient Water Quality Standards & Guidance Values; 10/93	G	▸ compilation of ambient water quality stds. and guidance values
DOW	TOGS 1.3.1C - Development of Water Quality Based Effluent Limits for Metals Amendment; 8/91	G	▸ as stated
DOW	TOGS 1.3.1 - Waste Assimilative Capacity Analysis & Allocation for Setting Water Quality Based Effluent Limits; 5/90	G	▸ guidance for determining maximum allowable loadings and corresponding effluent limitations for point sources to surface water
DOW	TOGS 1.2.1 -Industrial SPDES Permit Drafting Strategy for Surface Waters; 4/90	G	▸ guidance for developing effluent and monitoring limits for point source releases to surface water
DOW	TOGS 2.1.3 - Primary & Principal Aquifer Determinations; 10/90	G	▸ clarifies the meaning of "primary water supply aquifer" and "principal aquifer."

DOW	6 NYCRR Part 702(a), (b), (c), (d) & (e) -	S	▸ Empowers DEC to Apply and Enforce Guidance where there is no Promulgated Standard
DOW	6 NYCRR Part 700-705 - NYSDEC Water Quality Regulations for Surface Waters and Groundwater; 9/1/91	S	▸ 700 - Definitions, Samples and Tests; 701 - Classifications Surface Waters and Groundwaters; 702 - Derivation and Use of Standards and Guidance Values; 703 - Surface Water and Groundwater Quality Standards and Groundwater Effluent Standards;
DOW	6 NYCRR Part 750-757 - Implementation of NPDES Program in NYS	S	▸ regulations regarding the SPDES program
DRA	Article 27, Title II of the ECL - Industrial Siting Hazardous Waste Facilities	S	▸ enabling statute; must be used with Part 361
DRA	6 NYCRR Part 361 - Siting of Industrial Hazardous Waste Facilities	S	▸ requirements for siting hazardous waste facilities; does not apply when permits are not required.
DRA	6 NYCRR Part 621 - Uniform Procedures	S	▸ permit processing requirements
DRA	6 NYCRR Part 624 - Permit Hearing Procedures	S	▸ procedures for hearings to resolve permit issues
DSM	STARS #1 - Petroleum-Contaminated Soil Guidance Policy; 8/92	G	▸ remedial guidance for petroleum spill cleanups
DSW	6 NYCRR Part 360 - Solid Waste Management Facilities; 10/9/93	S	▸ solid waste management facility requirements ▸ landfill closures; C&D landfill requirements; used oil; medical waste; etc.
OSHA/ PESH	29 CFR Part 1910.120; Hazardous Waste Operations and Emergency Response	S	▸ health and safety
US	16 USC 470 - National Historic Preservation Act	S	▸ determine if site may have significance ▸ mitigate impacts
USACE	Executive Order 11990 - Protection of Wetlands; 5/24/77	G	▸ minimize destruction, loss, or degradation of wetlands
USACE	33 USC 466 Section 404- Clean Water Act	S	▸ control disturbances in wetlands
USACE	33 CFR Parts 320-330; Regulatory Programs of the Corps of Engineers	S	▸ wetlands permits
USEPA	Hydrologic Evaluation of Landfill Performance (HELP) Model Hydrologic Simulation of Solid Wast Disposal Sites	G	▸ cover system performance/hydrology
USEPA	Solidification/Stabilization and its Application to Waste Materials; 6/93	G	▸ soil treatment

USEPA	16 USC 661 - Fish and Wildlife Coordination Act	S	▸ mitigate impacts to wetlands
USEPA	Integrated Risk Information System (IRIS)	G	▸ verified RfDs and cancer slope factors
USEPA	Risk Assessment Guidance for Superfund - Volume 1 - Human Health Evaluation Manual; 12/89	G	▸ human health risk assessments
USEPA	40 CFR Part 60 Subpart WWW: Standards of Performance for Municipal Solid Waste Landfills; 12/94	S	▸ landfill gas collection/treatment
USEPA	40 CFR Part 280; Guidelines for Specifications of Disposal Sites for Dredged or Fill Material	G	▸ restoration of wetlands

*

BMHP: Division of Marine Resources, Bureau of Marine Habitat Protection
DAM: Department of Agriculture and Markets
DAR: Division of Air Resources
DFW: Division of Fish and Wildlife
DHSR: Division of Hazardous Substances Regulation
DHWR: Division of Hazardous Waste Remediation
DMR: Division of Mineral Resources
DOH: Department of Health
DOL: Department of Labor
DOS: Department of State
[illegible]W: Division of Water
DRA: Division of Regulatory Affairs
DSM: Division of Spills Management
DSW: Division of Solid Waste
USEPA: US Environmental Protection Agency
USACE: US Army Corps of Engineers

The Following Image(s) are the Best Copies Available

BIEL'S

FEASIBILITY STUDY ADDENDUM

LEICA OPTICAL SITE
CHEEKTOWAGA, NEW YORK

Prepared for:

Leica

LEICA, INC.
OPTICAL PRODUCTS DIVISION
PO BOX 123
BUFFALO, NY 14240-0123

Prepared by:

NES in conjunction with TERRA VAC

NES, INC.
44 SE[illegible] ROAD

4

FEASIBILITY STUDY ADDENDUM

LEICA OPTICAL SITE
CHEEKTOWAGA, NEW YORK

Prepared for:

Leica, Inc.
Optical Products Division
PO Box 123
Buffalo, NY 14240-0123

Prepared by:

NES, Inc.
44 Shelter Rock Road
Danbury, Connecticut 06810

Terra Vac
9030 Secor Road, Suite A,
Temperance, MI 48182-9494

JANUARY, 1996

Table of Contents

1. INTRODUCTION

NES, Inc. and Terra Vac (the NES Team) were contracted by Leica, Inc., Optical Products Division, to prepare an addendum to the Feasibility Study which was prepared May, 1995 by Conestoga-Rover & Associates for the former Leica Optical Site in Cheektowaga, New York (Feasibility Study). This addendum has been prepared to include the Integrated Dual Vacuum Extraction/Pneumatic Fracturing technology as a feasible and preferable alternative to address the contamination at the site. The format of this report emulates the Feasibility Study. Sections and Subsections with no additions and/or corrections will have the statement, "No additions or corrections to this (Sub)Section" printed below the (Sub)Section title.

1.1 BASIS FOR REMEDIAL ACTION

No additions or corrections to this Subsection.

1.2 FS SCOPE

No additions or corrections to this Subsection.

1.3 BASIS FOR REMEDIAL ACTION

No additions or corrections to this Subsection.

2. SITE BACKGROUND

No additions or corrections to this Section.

3. DETERMINATION OF SCGS

No additions or corrections to this Section.

4. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

4.1 INTRODUCTION

No additions or corrections to this Subsection

4.2 REMEDIAL ACTION OBJECTIVES

No additions or corrections to this Subsection

4.3 IDENTIFICATION AND SCREENING OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES AND PROCESS OPTIONS

No additions or corrections to this Subsection.

4.3.1 SOIL

4.3.1.1 Identification of General Soil Response Actions, Technologies and Process Options

No additions or corrections to this Subsection.

4.3.1.1.1 No Action

No additions or corrections to this Subsection.

4.3.1.1.2 Limited Action

No additions or corrections to this Subsection.

4.3.1.1.3 Physical Containment Action

No additions or corrections to this Subsection.

4.3.1.1.4 In-Situ Treatment Action

Add Integrated Dual Vacuum Extraction/Pneumatic Fracturing to the list of In-situ treatment technologies.

6. Integrated Dual Vacuum Extraction/Pneumatic Fracturing

Insert following paragraph at the end of the subsection.

Integrated Dual Vapor Extraction/Pneumatic Soil Fracturing Remedial System depresses the groundwater table by removing groundwater and then extracts vapors from the unsaturated zone which removes the VOCs. The pneumatic soil fracturing portion of this system involves the injection of air at high pressures to create fractures in the clay-like soil around the injection point. The injected air provides additional airflow paths which increases the transfer of VOCs by diffusion. As air continues to flow through the fractures the clay material becomes dryer and more fractures are produced which provides more surface area for remediation of the contamination within the clay.

4.3.1.1.5 Removal Treatment Action

No additions or corrections to this Subsection.

4.3.1.1.6 Removal Disposal Action

No additions or corrections to this Subsection.

4.3.1.2 Screening of General Soil Response Actions, Technologies and Process Options

No additions or corrections to this Subsection.

4.3.1.2.1 Response Actions and Technologies

No additions or corrections to this Subsection.

4.3.1.2.2 Process Options

No additions or corrections to this Subsection.

4.3.1.2.2.1 Capping

No additions or corrections to this Subsection.

4.3.1.2.2.2 In-Situ Soil Treatment

Add the Integrated Dual Vacuum Extraction/Pneumatic Fracturing technology to the list of process options for in situ treatment of soils at the site.

7. Integrated Dual Vacuum Extraction/Pneumatic Fracturing

Effectiveness

Remove the last paragraph and replace with the following.

Integrated Dual Vacuum Extraction/Pneumatic Fracturing is considered a viable remedial technology due to the pneumatic fracturing and subsequent air injection to address the low permeable shallow soils.

A field pilot study has been conducted at the site. The pilot study demonstrated the effectiveness of this technology on the low permeable soil present at the site. The final report for the pilot study was previously submitted to the NYSDEC on December 4, 1996.

Implementability

No additions or corrections to this Subsection, except that there seven in situ treatment processes evaluated.

Costs

Add an additional bullet to read.

Integrated Dual Vacuum Extraction/Pneumatic Fracturing	$55 to $70/ cubic yard*

* The price assumes a more accurate volume calculation of the soil which needs to be remediated. The volume of soil from each area is described in Subsection 5.3.6, Alternative 5.

Summary

Remove paragraph and replace with the following.

Based on the pilot study and preliminary cost estimate, the Integrated Dual Vacuum Extraction/Pneumatic Fracturing technology option is suitable for the treatment of the contaminated soils at the site.

4.3.1.2.2.3 Ex-Situ Soil Treatment

No additions or corrections to this Subsection

Effectiveness

No additions or corrections to this Subsection

Implementability

Add the following to the end of this subsection.

Several site-specific disadvantages to excavation exist. These include:

- An unknown, but presumably large volume of soils contain contaminant concentrations above the limits for disposal to a non-hazardous or municipal landfill, and it is possible that free product is present. This material would therefore have to be shipped to a hazardous waste landfill, or be treated on site prior to disposal.
- For soil removal to be effective, the excavation would have to reach the bedrock. Because saturated soils would be encountered, collapsing soil conditions would likely occur and dewatering will be required, making this process more difficult.
- There is a high potential for direct contact with contamination or air dispersion of contaminants to adjacent properties.
- Excavation would not address the remaining contaminated groundwater. Contaminated groundwater often recontaminates the clean fill materials that are placed in the excavation, increasing the volume of contaminated materials.
- Contaminated groundwater within the bedrock would not be addressed by excavation.
- Excavation will cause disruptions to the operations at the facility.
- On-site SVE remediation of excavated clayey soil can be extremely difficult.

Costs

No additions or corrections to this Subsection

Summary

Remove paragraph and replace with the following.

Based on the above disadvantages, excavation of the soils represents a costly, difficult, and potentially ineffective means of remediation for soils and groundwater at the site. These disadvantages are utilized to determine the most feasible alternative to remediate the site.

4.3.1.2.3 Summary of Soil Screening results

Remove paragraph and replace with the following.

Based upon the results of the screening of soil remedial response actions and technologies, and process options, a total of four (4) remedial response actions were retained for further evaluation. A listing of the retained response actions, technologies, and process options is presented in Table 4.3. These response actions, technologies, and process options are assembled into remedial alternatives for detailed evaluation in Section 5.0.

4.3.2 GROUNDWATER

No additions or corrections to this Subsection

5. DEVELOPMENT AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

5.1 INTRODUCTION

No additions or corrections to this Subsection

5.2 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Delete Subsection and replace with the following.

The following five remedial alternatives for the site have been assembled utilizing the general response actions, technologies, and process options retained from the initial screening:

Alternative 1:

- No Action
- Groundwater Monitoring

Alternative 2:

- Institutional Controls
- Groundwater Monitoring

Alternative 3:

- Institutional Controls
- Groundwater Hydraulic Containment (Overburden and Bedrock)/ Source Removal, On-site Treatment
- NAPL Collection, Off-Site treatment
- Groundwater Monitoring

Alternative 4:

- Institutional Controls
- Groundwater Hydraulic Containment (Bedrock)
- Source Removal, On-site Treatment
- Groundwater Monitoring

Alternative 5:

- Institutional Controls
- Groundwater Hydraulic Containment (Overburden and Bedrock)
- In-Situ Treatment utilizing the Integrated Dual Vacuum Extraction/Pneumatic Fracturing technology
- Groundwater Monitoring

5.3 DESCRIPTION AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

No additions or corrections to this Subsection

5.3.1 COMPONENTS COMMON TO VARIOUS ALTERNATIVES

No additions or corrections to this Subsection

5.3.2 ALTERNATIVE 1

No additions or corrections to this Subsection

5.3.3 ALTERNATIVE 2

No additions or corrections to this Subsection

5.3.4 ALTERNATIVE 3

No additions or corrections to this Subsection

5.3.5 ALTERNATIVE 4

No additions or corrections to this Subsection

5.3.6 ALTERNATIVE 5

This entire subsection to the report.

- Institutional Controls
- Groundwater Hydraulic Containment (Overburden and Bedrock)
- In-Situ Treatment utilizing the Integrated Dual Vacuum Extraction/Pneumatic Fracturing technology
- Groundwater Monitoring

Alternative 5 includes the remedy components of Alternatives 1 and 2 (i.e., monitoring and institutional controls) in addition to a bedrock groundwater extraction system and soil source removal with on Site treatment on **Figure 5.3.**

The remedial components for Alternative 5 are presented below.

The technology of dual vacuum extraction enhanced with pneumatic fracturing and air injection has been proposed for the remediation of VOC contamination within the soils at the Leica Optical Site. The integration of these remedial technologies represents the most cost-effective in-situ treatment of the soils, while minimizing disruptions to normal facility activities. This remedial program will address VOC contamination in the soils and groundwater and eliminate spreading of contaminants through subsurface transport pathways and/or cross contamination of fill material associated with excavation activities. Each of the remedial options proposed are discussed in greater detail below.

Vacuum Extraction

The VE process enhances the volatilization of VOCs in the soils by the application of a vacuum to the subsurface through specially designed extraction wells. The resulting subsurface negative pressure gradient volatilizes contaminants and induces the migration of the vaporized VOCs towards the vacuum extraction wells, where they are drawn to the surface by a vacuum unit. Emission control devices, such as vapor phase activated carbon or catalytic oxidation units, can be installed in-line to remove extracted VOCs from the air stream prior to atmospheric discharge.

Dual Vacuum Extraction

DVE is the simultaneous extraction of both soil vapor and groundwater from a single extraction well. This technology causes drawdown of the watertable within the zone of influence of the DVE well, creating additional unsaturated soils which are then remediated by the VE process. The groundwater recovery rates observed using the DVE technology are significantly greater when compared to typical atmospheric pumping, due to the vacuum enhanced groundwater recovery. The increased groundwater recovery rates result in larger groundwater capture zones, greater drawdowns, and increased VOC extraction rates.

Pneumatic Fracturing/Air injection

In low permeability soil conditions the technological enhancements of PF and AI are used to assist the DVE process in inducing airflow through the subsurface. A source of compressed air, black iron driving rods, and metal injection points are used as the major system components. PF involves the injection of air at high pressures into the subsurface, which creates fractures in the soils. These flow pathways improve the effectiveness of DVE by increasing VOC recovery in both the vapor and dissolved phase, increasing groundwater recovery rates, and expanding the subsurface zones of influence for the extraction wells. AI involves continuous injection of air through the subsurface pathways created during PF operations. This approach combines to drive vapor phase VOCs and soil moisture towards the DVE wells, while increasing the number and volume of subsurface air paths.

It has been estimated that the following volumes of soil require remediation.

Area A - 250 yd^3 requiring remediation, average depth of 3 feet (1,250 square feet)
Area B - 8,500 yd^3 requiring remediation, average depth of 13 feet (17,500 square feet)
Area C - 16,250 yd^3 requiring remediation, average depth of 12.5 feet (33,750 square feet)

Total Volume to be treated - 25,000 yd^3 (52,500 square feet)

In addition, the soils in the secondary southeast area may also require treatment. The volume of soil in this area is estimated to be 12,000 yd^3.

Air monitoring would be conducted on a regular basis.

A treatability study has been conducted and has demonstrated the effectiveness of the treatment process and refined the estimates for treatment duration.

Bedrock extraction wells would be installed in the northeastern and southeastern areas of the Site concurrent with the installation of the DVE/PF System. The bedrock groundwater containment measures would be similar in design and construction as proposed for Alternative 3.

Groundwater monitoring would be conducted to ensure the protection of human health and the environment. Periodic monitoring of the effluent concentrations from both the vapor extraction system and the treated water would also be conducted. Institutional controls would be implemented to restrict groundwater usage beneath the Site until it is demonstrated through groundwater monitoring that unrestricted groundwater usage is appropriate.

A cost analysis is required to determine the feasibility of installing Vapor Extraction wells in Area A. The other alternative is to excavate the area and backfill with clean fill. The excavated material would be treated as described in Alternative 4. After treatment the material would be handled as non-contaminated material. Alternative 4 is a feasible alternative option for this area because only the fill zone is contaminated which can be treated ex-situ easily. Also, since only the fill material will be treated (overturned), the difficulty with handling and treating the wet clay material is eliminated.

5.3.6.1 Alternative 5 - Overall Protection of Human Health and the Environment

Alternative 5 would reduce the risks to human health for all exposure scenarios. the soil treatment process would remove chemicals from the soils and hence eliminate all potential exposures and associated risks for this medium.

The treatment of soils would also remove the majority of the overburden groundwater with chemical concentrations exceeding Class GA groundwater SCGs.

In-situ remediation would allow the remediation to take place without attracting neighbors from visiting the area and potentially exposing themselves to the contaminated material. In-situ remediation treats the contaminated material beneath the surface which minimizes exposure to the environment and human contact.

Bedrock groundwater would be pumped and treated during and following soil remediation. These groundwater remedial measures would significantly reduce risks associated with exposure to both overburden and bedrock groundwater.

5.3.6.2 Alternative 5 - Compliance With SCGs

Chemical-specific SCGs would be met for the soils following the treatment of soils with chemical concentrations exceeding soil cleanup objectives.

Chemical concentrations in the overburden groundwater would be significantly reduced, thereby decreasing the time required to achieve Class GA groundwater SCGs in comparison to Alternatives 1,2 and 3.

It is expected that SCGs in the overburden groundwater downgradient of the treatment areas would be achieved in a shorter time period following remediation as the vast majority of the impacted groundwater is within the soil remediation zone.

By remediating the source areas including NAPL overlying the bedrock, chemical-specific SCGs for the bedrock groundwater would also be achieved in a significantly shorter period of time in comparison to Alternatives 1,2 and 3.

5.3.6.3 Alternative 5 - Long-Term Effectiveness and Permanence

Implementation of Alternative 5 would eliminate all risks associated with chemicals in the soil at the Site as the source would be removed. The remaining risk of residual chemicals in the groundwater would be low and would be significantly reduced by groundwater extraction and treatment for the bedrock aquifer. A review of the remedial action would be required every five years.

5.3.6.4 Alternative 5 - Reduction of Toxicity, Mobility or Volume Through Treatment

It is estimated that Alternative 5 would remove and treat the majority of chemicals in the soils and groundwater within the overburden. The on-Site treatment processes for soils and groundwater are irreversible.

Low levels of chemicals, less than the soil cleanup objectives, would remain in the soils. Residual chemical concentrations in the bedrock groundwater would be reduced by the groundwater extraction and treatment system.

5.3.6.5 Alternative 5 - Short-Term Effectiveness

Alternative 5 involves the installation of dual vapor extraction wells (4 inch diameter PVC wells), piezometer nests, air injection probes, a building, wiring, and piping. Workers would be required to wear proper protective equipment and adhere to safe construction practices to minimize potential hazards during the installation of the well and piezometer components. After the installation of the wells and piezometers the remaining activity, including the on-going operations and maintenance of the system, the workers (noor curious visitors) will not be exposed to the contaminated material since it remains in the subsurface.

During system operation, groundwater removed will be treated with air treatment and activated carbon. The treated groundwater will be discharged into the local sanitary sewer system under a discharge permit. The extracted vapor will be treated with activated carbon prior to its discharge into the atmosphere. An air permit will be applied for if required. Exposure to workers and local residents are minimal. Contaminated soil remains below ground. Contaminated water is treated and discharged (through closed piping) to the local sanitary sewer system. The contaminated vapors are treated prior to its discharge into the atmosphere, through a pipe which extends 8 to 10 feet above ground level.

It is estimated that Alternative 5 could be completed within a two year period. However, if the secondary southeast area (an additional 12,000 yd^3) is determined to require treatment, four years may be required for the completion of Alternative 5.

5.3.6.6 Alternative 5 - Implementability

Implementation of Alternative 5 would involve common construction procedures and the services and materials are readily available.

The effectiveness of this alternative could easily be monitored by implementation of the site monitoring program presented in Section 5.3.1.1.1. Additional remedial action such as extending the bedrock groundwater containment and treatment system could be implemented at a later date if necessary. This requirement would be determined based upon the analytical results obtained during implementation of the groundwater monitoring program.

A bedrock aquifer pumping test has been performed and the results of this test will be available in the near future.

5.3.6.7 Alternative 5 - Cost

The total capitol cost to design, install and test the system is estimated to be ____________ and the annual operation and maintenance cost is estimated to be __________for the first two years with groundwater monitoring ,_________ for the remaining 28 years. The total present worth of this alternative is estimated to be $3,450,000 based upon an eleven percent return rate and three percent inflation rate over the 30-year period.

NES FAX

To: Grey Sutton

Company : NYSDEC

Fax Number : 716-851-7226

From : Mark Cambra

Company : NES

Fax Number : 203-792-3168

Subject : @U Feasibility Study Addendum

Pages including cover page: 14

Date : 1/10/97 Time : 3:15

MESSAGE

Following is a DRAFT Copy w/o Prices -

We are currently placing our Prices into Their format.

Please Note:

TAGM 4030 Score for Alt 5 => 74-79

please Call w/Comments -

WinFax PRO Cover Page

Department of Environmental Conservation

Division of Hazardous Waste Remediation

PROPOSED REMEDIAL ACTION PLAN

Leica, Incorporated Site

Town of Cheektowaga, Erie County
Registry Number 915156

April 1996

New York State Department of Environmental Conservation
GEORGE E. PATAKI, ***Govenor*** **MICHAEL D. ZAGATA,** ***Commisioner***

TABLE OF CONTENTS

SECTION ***PAGE***

PROPOSED REMEDIAL ACTION PLAN

LEICA INC. SITE
Town of Cheektowaga, Erie County, New York
Site No. 915156
April 1996

SECTION 1: PURPOSE OF THE PROPOSED PLAN

The New York State Department of Environmental Conservation (NYSDEC), in consultation with the New York State Department of Health (NYSDOH), is proposing that **ex-situ Soil Vapor Extraction (SVE), ex-situ Mechanical Volatile System (MVS) be used to treat contaminated soil and groundwater extraction and treatment be used to treat bedrock ground water** at the Leica Site. This remedy is proposed to address the threat to human health and the environment created by the presence of soil and ground water contamination at the site.

This Proposed Remedial Action Plan (PRAP) identifies the preferred remedy, summarizes the other alternatives considered, and discusses the rationale for this preference. The NYSDEC will select a final remedy for the site only after careful consideration of all comments submitted during the public comment period.

This PRAP is issued by the NYSDEC as an integral component of the citizen participation plan responsibilities provided by the New York State Environmental Conservation Law (ECL), and 6 NYCRR Part 375 (a State regulation). This document is a summary of the information that can be found in greater detail in the Remedial Investigation (RI) and Feasibility Study (FS) reports (described below) on file at the document repositories.

The NYSDEC may modify the preferred alternative or select another response action presented in this PRAP and the RI/FS Reports based on new information or public comments. Therefore, the public is encouraged to review and comment on all of the alternatives identified here.

To better understand the site and the investigations conducted there, you are encouraged to review the documents at the following repositories:

Reinstein Branch Library
2580 Harlem Road
Cheektowaga, New York 14227

New York State Department of Environmental Conservation
270 Michigan Avenue
Buffalo, New York 14203-2999
(716)851-7220
(Appointment Only)

Written comments on the PRAP can be submitted to Mr. Gregory P. Sutton, P.E., Project Manager, at the address given above.

DATES TO REMEMBER:

Comment Period to be Scheduled

Public comment period on the RI/FS Report, PRAP, and preferred alternative.

Date to be Scheduled, 7:00 PM
Public meeting at the

-

SECTION 2: SITE LOCATION AND DESCRIPTION

The Leica Inc. Site is located on approximately 24 acres at the intersection of Eggert Road and Sugar Road in the Town of Cheektowaga, Erie County, New York. The west boundary of the Site abuts the eastern boundary of the City of Buffalo.(Figure 1) The site is located in a generally commercial/residential area and is bounded by open land and public housing to the west, Cemetery property to the north and east and residential property to the south. There are no surface water bodies in the general vicinity of the site. Stormwater water run-off is collected by the municipal storm water system and conveyed to Scajaquada Creek approximately one mile south of the site. Groundwater is not used for a source of drinking water. Drinking water is supplied by the Erie County Water Authority and is supplied from the Niagara River. The manufacturing facility was built on the Site in 1938 by the Spencer Lens Company for the manufacture of scientific instruments and high quality optical devices. The property has been owned and operated by various other firms manufacturing similar optical related products. There are three permanent buildings on-Site, including the brick multi-story Main Building of approximately 360,000 square feet, a single story metal storage building of approximately 3,100 square feet, and a one story brick fire protection system pump house of 325 square feet. The Main Building was constructed in segments from 1938 to 1967. The remainder of the Site is either paved for parking use or landscaped. The buildings are all constructed with concrete slab on grade foundations. The site is listed on the New York Registry of Inactive Hazardous Waste Sites (#915156) as a Class 2 site. A class 2 designation indicates the property poses a significant threat to public health and/or the environment.

SECTION 3: SITE HISTORY

3.1: Operational/Disposal History

The manufacturing facility was built on the Site in 1938 by the Spencer Lens Company for the manufacture of scientific instruments and high quality optical devices. Spencer Lens operated at the Site from 1938 to 1945. American Optical Corporation owned and operated the Site from 1945 to 1986, manufacturing the same type of products. From 1986 to 1990, Cambridge Instruments Inc. owned and occupied the Site for the manufacture of similar optical products. In 1990, Cambridge Instruments Inc. merged with Leica Inc. and operated under the Leica name at this Site until 1993. In July 1993, Leica Inc. ceased manufacturing operations at the Site. In October 1993 the facility and most of the land was sold to Samson Distribution Corporation/Calypso Development Corporation for use as a distribution warehouse. Leica retained title to a 100 x 390 foot area in the southeast corner of the property which contains the majority of the contamination. Until about 1956, ash, resulting from the use of coal as a boiler fuel, was landfilled on Site in a low area in the southeast corner of the Site. After 1956, the ash was disposed by the Town of Cheektowaga. This area was covered with soil and was subsequently paved over for use as an employee parking area in the late 1950s. The buildings and asphalt parking areas occupy approximately 65 percent of the Plant Site (Figure 2).

Prior to 1993, the owners and operators of the facility had all been involved in the manufacture of scientific instruments and optical devices. This involved two primary production processes: a metals operation and a lens production operation. In the metals operation, metal parts were machined and/or manufactured, cleaned, coated, and assembled. The production of optical lenses involved the shaping, grinding, polishing, and coating of glass lenses for use in ophthalmic instruments, microscopes, refractometers, and other optical instruments.

Numerous chemicals were stored and used at the facility for use in or as part of the manufacturing processes. These materials have included paints, solvents (such as acetone, xylene, methanol, methylene chloride, 2-butanone, and chloromethane), degreasers (such as trichloroethene [TCE] and 1,1,1-trichloroethane [1,1,1-TCA]), hydraulic oils, fuel oils, cutting oils, refraction oils, cyanide, acid based plating baths, and metals (cadmium, chromium, nickel, zinc, and copper).

A paint storage room and a flammable storage room were both tributary to a subsurface dry wells which acted as receivers for the floor drains installed in these rooms.

Six storage tanks are or were present on-Site as follows: i) one 110-gallon steel aboveground diesel fuel tank located inside the fire protection system pump house to fuel the diesel pump motor; ii) one 100-gallon steel aboveground diesel fuel tank formerly located south of the boiler room. The tank was closed and removed in July 1993; iii) two aboveground steel solvent storage tanks, (one 750-gallon and one 250-gallon, for storage of TCE and 1,1,1-TCA) formerly located on the concrete dock area north of the boiler room. The two tanks were removed from service in 1987 and removed from the Site in July 1991. No documentation exists of the disposal of the above noted chemicals at the site. However, based on the proximity of the dry well to the paint room and the disposal of ash in the southwest area of the property, it is likely that these two areas were the most convenient areas for disposal to occur.

3.2: Remedial History

The following is a summary of the investigations completed or in progress at the Leica Site. Several environmental studies of the property have been previously conducted to determine if hazardous waste was present and if the site posed a significant threat to public health and/or the environment. The major investigative activity conducted at an inactive hazardous waste site is a Remedial Investigation/Feasibility Study (RI/FS). During the RI, the nature and extent of the contamination at the site is determined. This information is then used during the FS to determine an appropriate remedial action that effectively eliminates any threat posed by the site.

- July 1990: Leica contracted with Recra Environmental to complete a Environmental Audit of the property. The audit consisted of a site inspection, staff interview, records search etc. The results of the audit is contained in the report entitled **"Real Property Environmental Assessment Report"**, dated August 14, 1990.

- November 1990: Leica implemented a Phase II Site Investigation at the site. The investigation consisted of limited soil and groundwater samples.

- July 1991: Leica's consultant Conestoga-Rovers & Associates, conducted additional investigative activities at the site with the installation of additional groundwater monitoring wells and the collection of additional groundwater and soil samples. The results of the investigation are presented in the report entitled, **"Site Investigation Work Plan"**, dated October 25, 1991.

- November 4, 1992: Site listed on the New York State Registry of Inactive Hazardous Waste Site as a Class 2 site.

- October 8, 1993: Leica entered into Consent Order (legal agreement) with NYSDEC to conduct a Remedial Investigation/Feasibility Study and also the Remedial Design/Remedial Action at site. This order required the company to: investigate the site, propose a clean-up method, prepare design specifications, build, and construct the appropriate clean-up method at the site.

- October 1994: Leica submitted the completed **"Remedial Investigation Report"**, dated October 3, 1994 and revised February 16, 1995.

- May 1995: Leica submitted a draft **"Final Feasibility Study Report"** dated May 1, 1995. Subsequent revisions to the report were submitted dated July 25, 1995 and March 1996.

3.3 Enforcement Status

Potentially Responsible Parties (PRPs) are those who may be legally liable for contamination at a site. This may include past or present owners and operators, waste generators, and haulers.

The NYSDEC and Leica, Inc. entered into a Consent Order on October 8, 1994. The Order obligates the responsible parties to carry out a full remedial program, which includes an investigation to determine the extent and location of site contaminants, determine the appropriate remedial method, prepare design document and implement that design.

The following is a chronological enforcement history of this site.

Date	**Index No.**	**Subject of Order**
10/8/94	B9-0396-92-01	RI/FS-RD/RA

SECTION 4: CURRENT STATUS

Leica Inc., under the supervision of the NYSDEC, initiated a Remedial Investigation/Feasibility Study (RI/FS) in November 1993 to address the contamination at the site. The RI was completed in October 1994. A FS was submitted in May 1995 with subsequent revisions in July 1995 and March 1996. Upon issuance of a Record of Decision (ROD), the NYSDEC will authorize Leica to begin design activities necessary to implement the chosen remedial alternative at the site.

4.1: Summary of the Remedial Investigation

The purpose of the RI was to define the nature and extent of any contamination resulting from previous activities at the site.

The RI was completed in three phases. The first phase was completed between November 1993 and December 1993. The second phase was carried out between March 1994 and May 1994. A third phase of work was conducted in March 1995. A report entitled **"Remedial Investigation Report, Leica, Inc., Cheektowaga, New York"** dated October 3, 1994 and revised February 16, 1995 has been prepared describing the field activities and findings of the RI in detail.

The RI activities consisted of the following:

- Site mapping, including a review of aerial photos, topographic maps, property boundary surveys and the delineation of all structures on site.
- Investigation of underground utilities and storage tanks.
- Installation of soil borings and monitoring wells on site to delineate the extent of contamination in site soils and groundwater.
- Surface water and sediment sampling in the Cemetery property adjacent to the site.
- Conducted a Air Pathways Analysis through the monitoring of air around the plant site.
- Performed a biota (vegetation, fish and wildlife) survey.
- A Health Risk Assessment.

The analytical data obtained from the RI was compared to applicable Standards, Criteria, and Guidance (SCGs) in determining remedial alternatives. Groundwater, drinking water and surface water SCGs identified for the VacAir site were based on NYSDEC Ambient Water Quality Standards and Guidance Values and Part V of the NYS Sanitary Code. For the evaluation and interpretation of soil and sediment analytical results, NYSDEC soil cleanup guidelines for the protection of groundwater, background conditions, and risk-based remediation criteria, were used to develop remediation goals for soil.

Based upon the results of the RI, in comparison to the SCGs and potential public health and environmental exposure rates, certain areas and media (ie. soil, groundwater, air, sediments, etc.) of the site have been determined to require remediation. The following discussions summarize the extent of the contamination at the site.

Site Geology and Hydrology

The general geology consists of the following five specific geologic units beneath the site:

i) fill material overlying;

ii) native lake sediments, primarily silts and clays, overlying;

iii) saturated silty-sand zone soils, primarily sands and silts, overlying;

iv) till, primarily compacted sand and gravel, overlying;

v) bedrock (Onondaga Formation limestone).

Overburden Geology

The overburden soil (soil above bedrock) at the Site consists of a thin layer of fill material (0.5 to 6.2 feet thick) overlying native soils. The total overburden thickness ranges from 8.1 to 16.0 feet. The overburden is generally thickest along the east side and southeast corner of the Main Building (13 to 15.5 feet) which appears to correspond with the higher ground elevations observed in these areas. The fill encountered at the Site consists of disturbed native soils; imported topsoil in the grassed areas; sand, gravel and asphalt underlying the parking lot areas; and assorted fill, including brick, glass, slag, ash, coal, clinkers, metal, gravel, wood and other materials in the area southeast of the Main Building. This area was a low area which was filled with coal ash. The fill layer ranges in thickness from 0.5 feet to 6.2 feet. The fill layer is thickest in the areas east and southeast of the southeast corner of the Main Building, where it is in excess of three feet deep. The fill thins toward the south and west. The water in the fill is a perched water table resting on the underlying lake sediment layer.

The native soils at the Site consist of a lake sediment layer overlying a gray silty-sand layer overlying a thin till overlying bedrock. The thickness of the native soil ranges from 5.4 feet to 12.9 feet. The overall thickness of the native soils averages 9.7 feet, and is thickest in the east parking area and the west part of the south parking area. The native soils are thinnest in the southeast portion of the Site; correlating to the thickest fill areas.

The lake sediment layer is the result of deposition of fine grained soils by preglacial lakes which preceded present-day Lake Erie. The lake sediment layer at the Site is a varied, red-brown clay, and silt with minor amounts of sand and fine gravel. This layer would act as a aquitard (groundwater barrier), unless disturbed or breached. The lake sediment layer ranges in thickness from 2.4 feet to 9.4 feet and averages 5.6 feet thick. This layer was present in all borings completed at the Site. The lake sediments were described as being dry to moist.

Beneath the lake sediments is a saturated silty-sand layer (sandy zone), which is primarily sand and silt with minor amounts of clay and gravel. This sandy zone ranges in thickness from 1.9 feet to 9.7 feet and averages 4.1 feet thick. Included with this sandy zone is a thin densely compacted till layer which lies directly above the bedrock. This till layer ranged in thickness from 0.3 to 3.0 feet, with an average thickness of 1.1 feet. The till layer was notably drier than the overlying silty sands. The sandy zone is the only overburden water-producing interval. The 22 overburden wells at the Site were installed to monitor this zone. The direction of ground water flow in this zone varies across the site but is generally in a southeast direction (Figure 3).

Bedrock Geology

The bedrock encountered beneath the Site is the Onondaga Formation. The uppermost member encountered is the Moorehouse Member, a fine to medium grained, light to medium gray, massive limestone with corals, and brachiopod fossils. This member is noted to be up to 55 feet thick in the Buffalo Area. The actual thickness under the Site is unknown as the bedrock wells penetrate a maximum of 32 feet of bedrock. In general, the bedrock surface is highest toward the northwest corner of the Site and drops toward the southeast. A total relief of 10.1 feet was observed across the Site, with highest elevations observed to the east and the lowest elevations occurring at the southwest end of the site. Bedrock groundwater flow varies across the site but is generally in the direction to the southwest (Figure 4).

The five classes of media sampled during the various investigations at the site are: groundwater; surface water; sediment; surface soils and subsurface soil. Selected results of the organic and inorganic analyses are summarized below for each media. A detailed discussion of the analytical results for each area can be found in the Remedial Investigation Report.

In addition to the various medias investigated the site was broken into five areas. These areas were designated based on information provided by the company that showed that they may have been the site of chemical disposal or usage and thus may be contaminated to some degree. The following areas are:

Eastern Off-Site Parcel

The area referred to as the Eastern Off-Site Parcel is a six acre property owned by the St. Johns Cemetery Association. This area is located immediately east of the southern part of the Site and was at one time intended as a northward extension of Preston Road from Rowan Road to Sugar Road. A gravel road base and sanitary and storm sewers were installed, however, the roadway was never completed.

East Side Dry Well Area Multiple potential contaminant sources are present within close proximity of each other in this area, located east of the Main Building. A stone-filled pit (dry well) functioned as the drainage sump for the trench and floor drains in the former flammable liquids storage room. Outside this room, two aboveground solvent storage tanks (TCE and 1,1,1-TCA) were formerly located on an elevated concrete loading dock. To the southeast, two USTs were used to store #5 and #6 fuel oil and one AST stored diesel fuel. The east side dry well is located on the east side of the main plant building, approximately 25 feet east of the Above Ground Storage Tanks (AST) area. This dry well consists of a 4 foot by 4 foot hole about six feet deep which was backfilled with stones, covered with soil, and paved over.

West Side Dry Well

The west side dry well is located west of the Main Building and north of the building entrance. It received drainage from floor drains in the former paint storage room that was located in the northwest part of the Main Building. This dry well consists of a 2 ft. x 2 ft. x 4 ft. dug hole, filled with stone and covered with topsoil.

Southern Area

The southern area includes the entire southern portion of the Site and the area between the Main Building and the storage building. Historical research has shown that a portion of this area was filled with coal ash prior to 1956. T~~his filled~~ area ~~lies in the southeast part of the this area and~~ is ~~shown in the aerial photograph on Figure 2.3 and as outlined on Figure 6.1.~~

Former Drum Storage Area

This area, located at the northeast corner of the Main Building, consists of a 40 foot by 70 foot concrete pad surrounded by asphalt parking areas. This area was used to stage drums of various chemicals and waste materials prior to off-Site disposal. The pad is no longer used for the storage or handling of drummed wastes and chemicals, eliminating a future source of the detected residual contaminants in this area.

GROUNDWATER

Two specific groundwater zones below the site, were evaluated during the investigations. The two zones are the Overburden Aquifer, located in the silty-sand zone, and the Bedrock Aquifer located in the Onondaga Limestone formation.

Overburden Ground water

Groundwater samples collected and analyzed from the Overburden Aquifer were found to be contaminated with several volatile organic compounds (VOCs). These VOCs primarily consisted of trichloroethene, 1,2-dichloroethene, ethylbezene, xylene, and vinyl chloride. Several other VOCs, which are degradation (breakdown) products of TCE, Semi-volatile compounds (SVOCs) and metals were detected in low concentration. The primary contaminants detected in the Overburden Aquifer are:

Contaminant	Concentration Range (ppb)	Groundwater Stds.(1)
trichloroethene	ND-250,000	5
1,2-dichloroethene	ND-470,000	5
vinyl chloride	ND-110,000	2
toluene	ND-2,700	5
xylenes	ND-7,000	5
ethylbenzene	ND-2,000	5

ND-Non-detectable
(1)- Clean-up Goals from NYSDEC TOGS 1.1.1 (10/22/93)

The highest concentrations of contaminants were detected in two separate areas of the property. In an area of the "East Dry Well", the primary contaminant, trichloroethylene, was detected in MW-16A at 6,800 parts per billion (ppb). 1,2-dichloroethene, 1,1-dichloroethene and 1,1-dichloroethane were also detected at maximum concentrations of 4,200ppb, 630ppb and 6,500ppb respectively. The groundwater standard for these volatile organic compounds (VOCs) is 5ppb. In addition to the above chlorinated VOCs, several non-chlorinated chemicals were detected. Ethylbenzene, toluene and xylenes were also detected at maximum concentrations of 2,000ppb, 1,100ppb and 5,200ppb, respectively, These compounds are generally associated with the spillage of petroleum products such as fuel oils or gasoline. The general flow of the groundwater from the site is to the southwest. Analysis of samples from MW-15, which is located approximately 300 feet downgradient of MW-16, did not detect any of the above VOCs above the analytical detection limit of 10 ppb.

In the Southeast Area contamination was considerable higher than the dry well area, with TCE detected at concentrations of 250,000ppb(MW-11), 71,000ppb(MW-8) and 110,000ppb(MW-4). Non-Aqueous Phased Liquid (NAPL) was also detected in MW-11 with a TCE concentration of 330,000,000ppb or 33%.. Several other compounds were also detected in the NAPL, 1,2-dichloroethene (22,000,000ppb), vinyl chloride (1,400,000ppb) and xylenes(6,600,000ppb) as well as in the groundwater itself. Ground water contamination was determined to extend approximately 250 feet to the Southeast from the ash fill area. A visual representation of the extent of groundwater contamination can be found in Figure 5.

Bedrock Aquifier

The general areas of bedrock contamination correspond to the areas of overburden contamination noted above. Groundwater samples collected and analyzed from the Bedrock Aquifer were found to be contaminated with several volatile organic compounds (VOCs). These VOCs primarily consisted of trichloroethene, 1,2-dichloroethene, 1,1,1-trichloroethane, ethylbezene, xylene, and vinyl chloride. Several other VOCs, which are degradation (breakdown) products of TCE, Semi-volatile compounds (SVOCs) and metals were detected in low concentration. The primary contaminants detected in the Bedrock Aquifer are:

Contaminant	Concentration Range (ppb)	Groundwater Stds.(1)
trichloroethene	ND-88,000	5
1,2-dichloroethene	ND-390,000	5
1,1,1-trichloroethane	ND-110,000	5
vinyl chloride	ND-110,000	2
xylenes	ND-15,000	5
ethylbenzene	ND-3,000	5

ND-Non-detectable
(1)- Clean-up Goals from NYSDEC TOGS 1.1.1 (10/22/93)

The highest concentrations of contaminants were detected in two separate areas of the property. In an area of the "East Dry Well", the primary contaminants, trichloroethylene and 1,2-dichloroethene were detected in MW-16A at

88,000 ppb and 34,000 ppb, respectively. 1,1,1-trichloroethane (110,000 ppb) and xylenes (15,000 ppb) were also detected in the bedrock groundwater. It was noted that the bedrock contamination was higher than the contamination in the overburden aquifer. This may due to the fact that the "Dry Well" allowed for the direct discharge of contaminants to the top of the bedrock. Analysis of samples from MW-15A, which is located approximately 300 feet from MW-16A, detected trichloroethene (14 ppb), 1,2-dichloroethene (490 ppb) and vinyl chloride (200 ppb) at concentration substantially lower than in the suspected disposal area.

In the "Southeast Area" contamination in the bedrock was also consistent with the overburden area overlying it. Bedrock monitoring wells were not installed directly through the waste during the Remedial Investigation due to the high concentration of contaminants in the overburden soils. Bedrock wells were placed within the contaminant plume. The results of the sampling of these wells showed that 1,2-dichloroethene and vinyl chloride were the most predominant chemical detected at a maximum concentrations of 390,000 ppb and 110,000ppb at monitoring well, MW-6A. Only low concentrations of TCE and other VOCs found in the overburden soils were detected in the bedrock. Ground water contamination was determined to extend approximately 250 feet to the Southeast from the ash fill area. Monitoring wells MW-13A and MW-14A, downgradient of the fill area, show significant decrease of contaminants such as 1,2-dichloroethene of 25 ppb and 46 ppb, respectively. Vinyl chloride was detected at concentrations of non-detectable and 28ppb. A visual representation of the extent of groundwater contamination can be found in Figure 6.

SOIL

Eastern Off-Site Parcel

Several soil samples were collected of shallow soil and sediment directly adjacent to the plant site. The largest number of detected compounds and the highest reported concentration of these compounds from the this area (545 ppb total VOCS) were from the shallow sample collected at BH-3-93. The primary contaminants of this sample was xylenes and 1,2-DCE. This location is closest to the on-Site area near MW-4/MW-8/MW-12, which exhibits elevated contaminant levels on the site. The remainder of the soil samples showed very low or non-detectable levels of contaminants that did not exceed clean-up goals for the site.

Contaminant	Concentration Range (ppb)	Clean-up Goal(1)
acetone	ND-49J	200
trichloroethene	ND-150J	700
1,2-dichloroethane	ND-160J	200
xylenes	ND-190D	1,200
toluene	ND-39	1,500
ethylbenzene	ND-42	5,500
vinyl chloride	ND-42	200

ND-Non-detectable
D-Result after sample dilution
J- Result is estimated
(1)- Clean-up Goals from NYSDEC TAGM 4046 (1/24/94)

East Side Dry Well Area

This area was investigated through the collection of shallow (silt and clay) and deep (sandy soils) samples from beneath the pavement at the foot of the elevated concrete loading dock area and in the area of the former dry well. The shallow soils samples showed 1,2-DCE and TCE at maximum concentrations of 660 ppm and 859 ppm respectively. TPHs were detected in the samples at a maximum level 522 ppb.

Deep Soil samples showed 1,1,1-TCA (21,OOOD ppb), TCE (1,70OJD ppb), toluene (1,80OJD ppb), ethylbenzene (17,OOOD ppb), and xylene (92,OOOD). No SVOCs were detected.

Soil Contaminant	Concentration Range (ppb)	Clean-up Goal(1)
1,1,1-trichloroethane	ND-21,000D	800
1,2-dichloroethene	ND-570D	300
trichloroethene	ND-1,700JD	700
ethylbenzene	ND-17,000D	5,500
toluene	ND-1,800JD	1,500
xylenes	ND-92,000D	1,200

ND-Non-detectable
D-Result after sample dilution
J- Result is estimated
(1)- Clean-up Goals from NYSDEC TAGM 4046 (1/24/94)

TPHs were detected in all the majority of all soil samples from this area. TPH concentrations detected ranged from 54.4 ppb to 7,370 ppb. TPH levels are higher to the north and east of the USTs., and lower to the south.

West Side Dry Well

One borehole was completed to 4.0 feet BGS in native lake sediment soils approximately one foot west of the dry well location and an additional soil boring was located within the well material. No visible signs of contaminants were observed (e.g., discoloration). A low PID reading of up to 1.0 ppm was observed at the 1.0 to 1.5 foot interval, no other PID readings were recorded above background levels. A soil sample was collected and analyzed. No VOCs were detected in the sample. Beryllium, calcium, copper, magnesium, and zinc exceeded typical clean-up goals but were detected within the range of US soil background concentration ranges. No TPHs were detected at this location.

Southern Area

In shallow soil, 14 volatile organic chemicals were detected. Soil cleanup objectives were exceeded for six of these compounds: vinyl chloride (840J ppb); acetone (18OOJB ppb); toluene (5100 ppb); 1,2-DCE (9100J ppb); TCE (320,000 ppb); and xylenes (29,OOOJ ppb). The contaminants were generally found in the area of MWs-4,8 &11 in the area where document ash disposal had occurred.

Analysis of two shallow soil samples collected during the RI at MW-5A and BH-6-93, near the residences to the south did not show nay site related contaminants in the soil. Low concentrations of acetone were detected at concentrations of 73J ppb and 14J ppb.

Seventeen SVOCs were detected in shallow soil samples from the southern area. The compounds detected and their reported concentrations can be found in the RI. Of the 17 parameters detected, only 2-methylphenol (570 ppb) exceeded the soil cleanup objective (100 ppb) at one location.

In the deeper sandy zone soil samples, 12 VOC compounds were detected. Of these 12 compounds, three exceeded soil cleanup objectives.

TCE was detected in the sandy zone soil in the vicinity of MW-8, MW-11, and MW-12 at concentrations of 410 ppb (at MW-8) to 18,000 ppb (at MW-12). Higher levels of TCE were detected in soil from BH-S (deep- 12') (2,000,000 ppb) and MW-11(570,000 ppb), where NAPL was present in the soil. Additionally, high levels of total 1,2-DCE (up to 37,OOOJ ppb) and total xylenes (up to 64,OOOJ ppb) were detected in this area. Away from this area, the concentration of contaminants decline rapidly, reaching non-detect levels within the distance of 150 feet. The area along the south property line is not filled and exhibits low levels (e.g, less than 75 ppb total VOCS) of Site related contaminants in MW-5A and BH-6-93 soil samples.

Soil Contaminant	Concentration Range (ppb)	Clean-up Goal(1)
vinyl chloride	ND-840J	200
1,2-dichloroethene	ND-37,000J	300
trichloroethene	ND-2,000,000	700
benzene	ND-62	60
toluene	ND-5,100	1,500
xylenes	ND-64,000J	1,200

ND-Non-detectable
J- Result is estimated
(1)- Clean-up Goals from NYSDEC TAGM 4046 (1/24/94)

Former Drum Storage Area

Soil samples were collected from beneath the pad and along it's edges. In general only trace or low levels of VOC contaminants were detected the levels shown below. Of the compounds detected, 1,1,1-trichloroethane was the most predominant, at a maximum concentration of 16,000 ppb, in a shallow soil samples (0.5-3.0 ft.) collected from below the pad. No other compounds detected exceeded the clean-up goals. Total Petroleum

Hydrocarbons (TPHs) concentrations reported ranged from ND(37) to 4,170 ppb. Associated benzene, toluene, ethylbenzene, and xylene concentrations do not exceed the TAGM 4046 soil cleanup objectives. The deep soil sample, also showed only a trace organic chemical presence.

Soil Contaminant	Concentration Range (ppb)	Clean-up Goal(1)
1,1,1-trichloroethane	ND-16,000	800
trichloroethene	ND-47	700
1,1-dichloroethane	ND-19	200
methylene chloride	ND-93	100
xylenes	ND-560	1,200

ND-Non-detectable
(1)- Clean-up Goals from NYSDEC TAGM 4046 (1/24/94)

The horizontal and vertical extent of contaminants around the pad is very limited, as exhibited by the low concentration of 1,1,1-TCA detected in the adjacent boreholes and the deeper soil sample.

SURFACE WATER AND SEDIMENT

One surface water and one sediment sample were collected from a small low area on the eastern off-site parcel. This area contained seasonal standing water that was evident only during periods of precipitation and snow melt. No VOCs were detected above the clean-up goals for the site in sediment samples. Several SVOCs (shown below) were detected at in the sediment.

Sediment Contaminant	Concentration (ppb)	Clean-up Goal(1)
Naphthalene	ND-2,700	13,000
2-Methylnapthalene	ND-3,500	36,400
Dibenzofuran	ND-1,200	6,200
Phenanthrene	ND-13,000D	50,000
Anthracene	ND-1,500	50,000
Fluoranthene	ND-25,000D	50,000
Pyrene	ND-18,000D	50,000
Benzo(a)anthracene	ND-8,400JD	224
Crysene	ND-8,100	400
Benzo(b)fluoranthene	ND-24,000D	1,100
Benzo(a)pyrene	ND-12,000D	61
Ideno(1,2,3-cd)pyrene	ND-4,700	3,200
Benzo(g,h,i)perylene	ND-4,400	50,000

D-Result after sample dilution
J-Result is estimated
(1)- Clean-up Goals from NYSDEC TAGM 4046 (1/24/94)

No VOCs or SVOCs were detected in the surface water above the quantifiable detection limit.

Air Pathway Analysis

The concentrations of ~~these parameters~~ VOCs in soil were assumed to have one hundred percent volatilization from the soil to the air, and were compared to the ambient guideline concentration (AGC) established in the **NYSDEC Air Cleanup Criteria**. The results of modeling of the potential air discharge concluded that all VOCs identified at the site are below the ambient guideline concentration established in the **NYSDEC Air Cleanup Criteria** and do not pose a threat to air quality. Air monitoring that was conducted during the investigation activities also did not detect any exceedances of air standards that were established for the site.

4.2 Summary of Human Exposure Pathways:

This section describes the types of human exposure that may present added health risks to persons at or around the site. A more detailed discussion of the health risks associated with the site can be found in the section of the Remedial Investigation Report, dated February 16, 1995, entitled "Risk Assessment". An exposure pathway is the process by which an individual comes into contact with a contaminant. The five elements of an exposure pathways are 1) the source of contamination; 2) the environmental media and transport mechanism (e.g. air); 3) the point of exposure and uptake mechanism; 4) the route of exposure (e.g. inhalation, ingestion, etc.); and 5) the receptor population. These elements of an exposure pathway may be based on past, present, or future events.

Completed pathways (ie. ways in which people come in contact with contaminants) which are known to, or may, exist at the site include:

- Dermal (skin) contact or ingestion (eating) of surface soil,

- Dermal contact or ingestion of sediments in the lowland areas,

- Ingestion or dermal contact of surface water in the lowlands area,

- Ingesting (drinking) of groundwater in the Water Table Aquifer,

- Ingestion or dermal contact of excavated subsurface soils,

- Inhalation (breathing) of contaminants by on-site workers during excavation of subsurface soils.

The Risk Assessment selected 60 chemicals of concern (COCs) to be evaluated as part if the Risk Assessment for the Site. These chemical included 16 volatile organic compounds (VOCs), 23 semi-volatile organic compounds (SVOCs), 5 Acid Extractable compounds, and 16 metal parameters in the various medias (groundwater, soil, sediment and surface water). A summary of the COCs is found on Table 1.

The results of the Risk Assessment concluded that the current risks associated with exposure to soils, groundwater, sediments and surface water for current and future land uses and the exposure pathways previous discussed, are below the accepted 1 x 10^{-6} to 1 x 10^{-4} range as established by USEPA. The hazard indices associated with exposures to surficial soils, sediment and surface water are also all below the level of concern of 1.0. This risk assessment was based on the premise that there is limited or no routes of exposure to contamination on the site because the contamination is beneath the ground surface. Groundwater is also not used as a potable water source because the area is supplied with potable water by the local municipality. Future risk could be associated with the off-site migration of contaminated groundwater into the residential area to southeast of the site. Exposure pathways could be produced from the ingestion of contaminated groundwater or the inhalation of volatile compounds through exposure from basements or other below grade structures. However, since the area is served by a public drinking water supply, ingestion of groundwater is highly unlikely. Risk calculations for the various medias can be found in the Remedial Investigation Report.

4.3 <u>Summary of Environmental Exposure Pathways</u>:

This section summarizes the types of environmental exposure which may be presented by the site. The Ecological Assessment included in the RI was performed in accordance with requirements of the NYSDEC guidance document, "Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites", dated June 18, 1991, and presents a more detailed discussion of the potential impacts from the site to fish and wildlife resources.

The general area surrounding the site is urban. There are no major natural resources within two miles of the plant site.

SECTION 6: <u>SUMMARY OF THE REMEDIATION GOALS</u>

Goals for the remedial program have been established through the remedy selection process stated in 6NYCRR 375-1.10. These goals are established under the guideline of meeting all standard, criteria, and guidance (SCGs) and protecting human health and the environment.

At a minimum, the remedy selected should eliminate or mitigate all significant threats to the public health and to the environment presented by the hazardous waste disposed at the site through the proper application of scientific and engineering principles.

The goals selected for this site are:

General:

- Provide for the attainment of Remedial Action Objectives (RAOs) (Table 2) for groundwater, surface and subsurface soil, surface water and sediment.

Groundwater:

- To restore groundwater to the maximum extent practicable, in the Overburden and Bedrock Aquifers to applicable standards and/or guidance values (Table 2).
- To eliminate the near-term and future exposure of human receptors to contaminated groundwater.
- To eliminate contaminant migration via the groundwater so that potential releases of contaminated groundwater do not present a human or environmental threat.

Soil:

- To prevent or mitigate the leaching and /or migration of contaminants in the soil (Table 2) that would cause groundwater and/or surface water contamination above standards.
- Eliminate, to the maximum extent practicable, the potential for direct human or animal contact with contaminated soil.

Air:

- To prevent or mitigate the release and inhalation of airborne contaminants above acceptable standards.

SECTION 7: SUMMARY OF THE EVALUATION OF ALTERNATIVES

Potential remedial alternatives for the Leica Inc. Site were identified, screened and evaluated in a Feasibility Study. This evaluation is presented in the report entitled Feasibility Study, Leica Inc. Cheektowaga, New York, Site No.915156, dated May 1, 1995 and revised dated March, 1996. A summary of the detailed analysis follows.

7.1: Description of Alternatives

Alternative 1

No Action

Present Worth:	$ 0
Capital Cost:	$ 0
Annual O&M:	$ 0
Time to Construct	0 years

The "No Action" alternative would provide no active remedial measures to improve the environmental conditions at the site be taken.

This is an unacceptable alternative as the site would remain in its present condition, and human health and the environment would not be adequately protected. Natural attenuation (dilution) and biodegradation would be the only action that would reduce VOC levels in site soil and groundwater.

Alternative 2

Institutional Controls and Monitoring

Present Worth:	$ 200
Capital Cost:	$ 200
Annual O&M:	$ 90
Time to Construct	0.25 year

Alternative 2 is the **Institutional Controls and Monitoring** alternative. This alternative includes the implementation of institutional controls to restrict exposure to contaminated soil and groundwater. Institutional controls may consist of fencing, deed restrictions, and paving of exposed soil areas. This alternative would also require implementation of a groundwater monitoring program. This program would be used to monitor groundwater conditions and provide a data base for periodically reevaluating the risks and assessing whether future remedial actions may be required. However, contaminated groundwater would continue to impact the lowland area and off-site groundwater.

Alternative 3

Present Worth:	$ 60
Capital Cost:	$ 90
Annual O&M:	$ 90
Time to Construct	0 year

Alternative 4

Present Worth:	$ 00
Capital Cost:	$ 00
Annual O&M:	$ 00
Time to Construct	0 year

6.2 EVALUATION OF REMEDIAL ALTERNATIVES

The criteria used to compare the potential remedial alternatives are defined in the inactive hazardous waste sites in New York State Regulation (6NYCRR Part 375). For each of the criteria, a brief description is provided followed by an evaluation of the alternatives against that criterion. A detailed discussion of the evaluation criteria and comparative analysis is contained in the Feasibility Study.

1. COMPLIANCE WITH NEW YORK STATE STANDARDS, CRITERIA AND GUIDANCES (SCGs. Compliance with SCGs addresses whether or not a remedy will meet applicable environmental laws, regulations, standards, and guidance.

2. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT This criterion is an overall evaluation of the health and environmental impacts to assess whether each alternative is protective.

The range of protectiveness of the seven alternatives range from no protection provided by Alternative 1, to maximum protection provided by Alternative 5.

3. SHORT-TERM IMPACTS AND EFFECTIVENESS The potential short-term adverse impacts of the remedial action upon the community, the workers, and the environment during the construction and implementation are evaluated. The length of time needed to achieve the remedial objectives is also estimated and compared with the other alternatives.

4. LONG-TERM EFFECTIVENESS AND PERMANENCE This criterion evaluates the long-term effectiveness of alternatives after implementation of the response actions. If wastes or treated residuals remain on site after the selected remedy has been implemented, the following items are evaluated: 1) the magnitude of the remaining risks, 2) the adequacy of the controls intended to limit the risk, and 3) the reliability of these controls.

5. REDUCTION OF TOXICITY, MOBILITY AND VOLUME Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility or volume of the wastes at the site.

6. IMPLEMENTABILITY The technical and administrative feasibility of implementing each alternative is evaluated. Technically, this includes the difficulties associated with the construction, the reliability of the technology, and the ability to monitor the effectiveness of the remedy. Administratively, the availability of the necessary personnel and material is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, etc..

7. COSTS Capital and operation and maintenance costs are estimated for each alternative and compared on a present worth basis. Although cost is the last balancing criterion evaluated, where two or more alternatives have met the requirements of the remaining criteria, cost effectiveness can be used as the basis for the final decision.

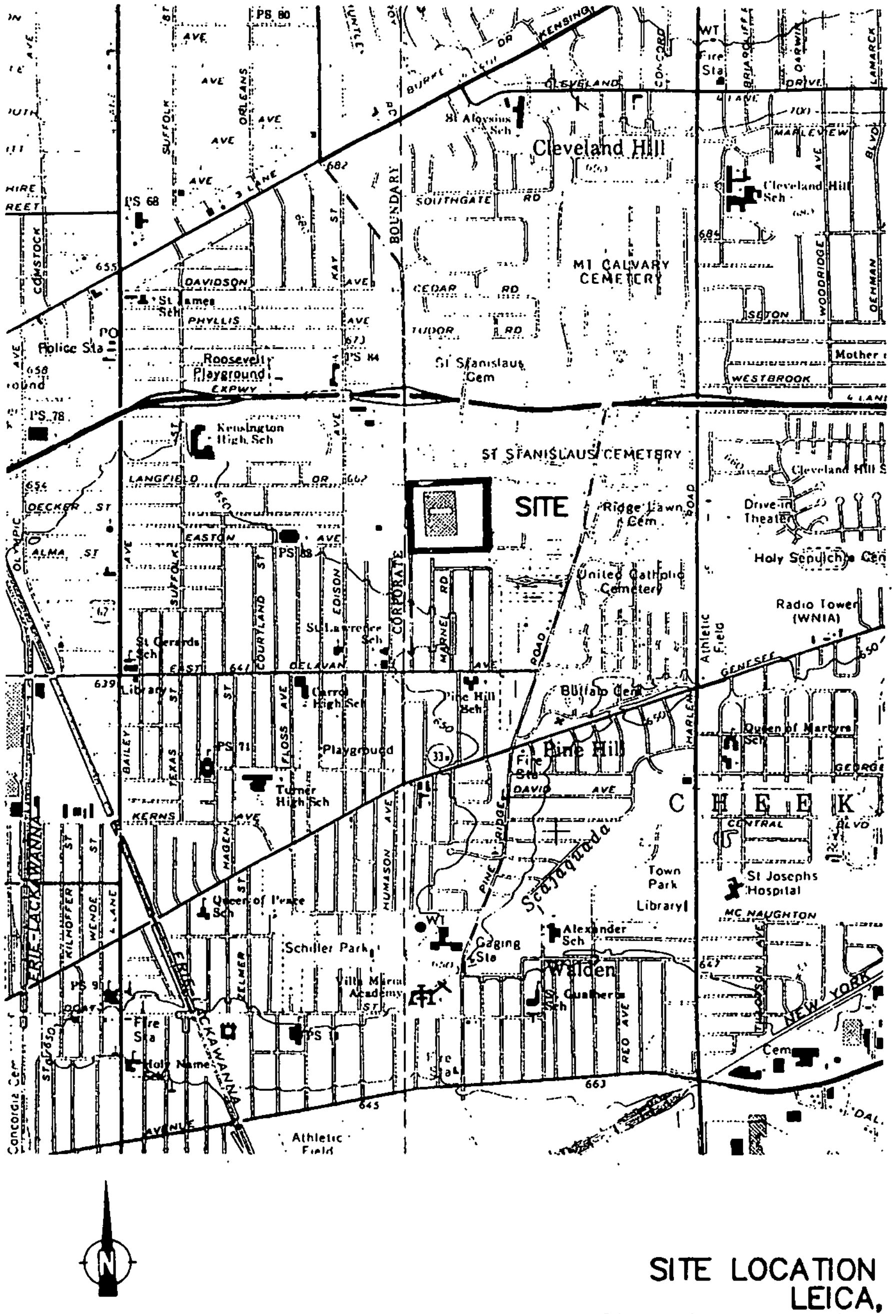
8. COMMUNITY ACCEPTANCE Concerns of the community regarding the RI/FS report and the Proposed Remedial Action Plan (PRAP) would be evaluated. A "Responsiveness Summary" would be prepared that describes public comments received and how the Department would address the concerns raised. If the final remedy selected differs significantly from the proposed remedy, notices to the public would be issued describing the differences and the reason for the changes.

7.0 PREFERRED REMEDIAL ALTERNATIVE

Based upon the results of the RI/FS, and the evaluation presented in Section 7, **the NYSDEC is proposing**

Selection of the Recommended Remedial Alternative

Figure 1
Site Location Map

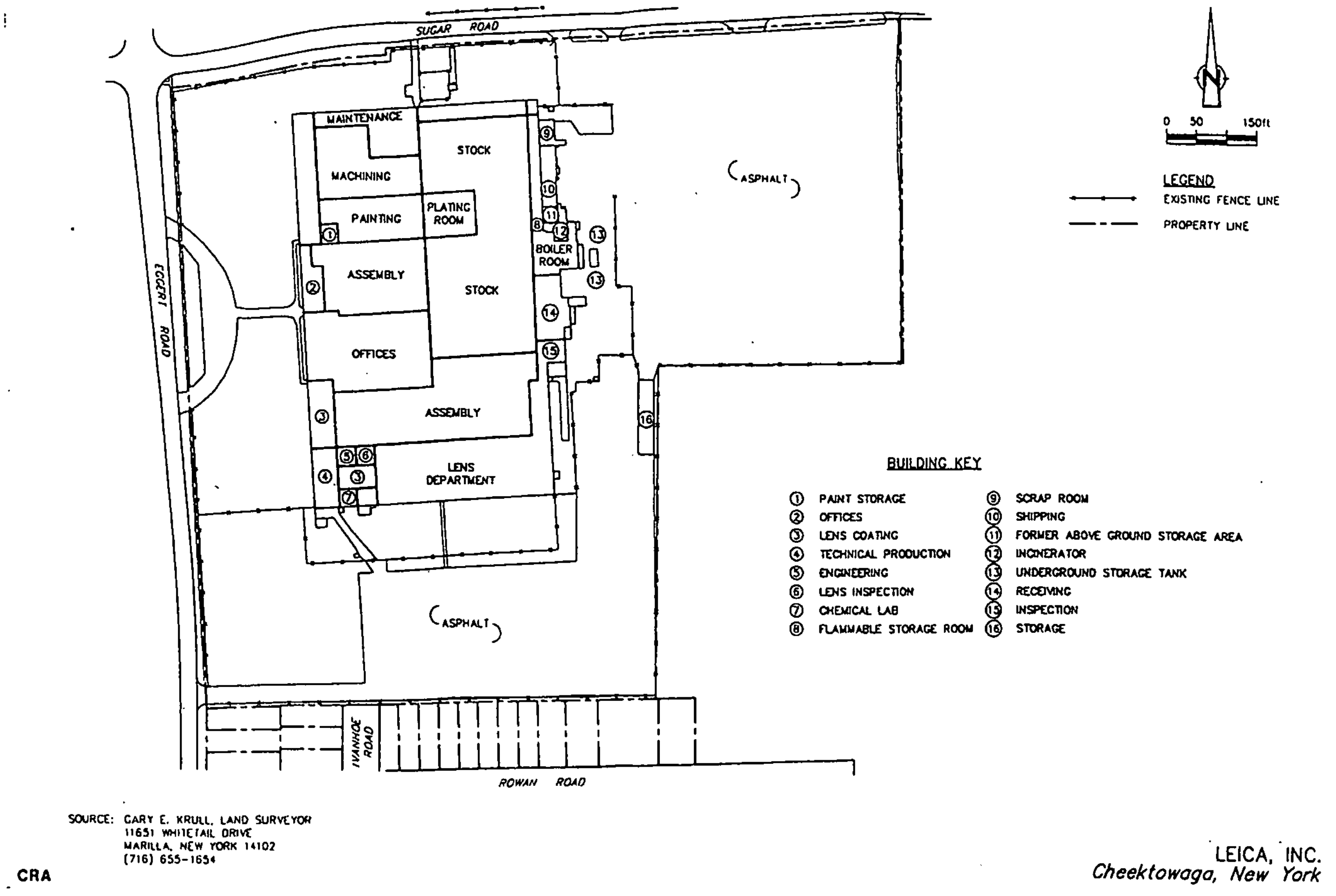


SITE LOCATION MAP
LEICA, INC.
Cheektowaga, New York

USGS BUFFALO NE 7.5' QUADRANGLE

CRA

Figure 2
Site Map



SOURCE: GARY E. KRULL, LAND SURVEYOR
11651 WHITETAIL DRIVE
MARILLA, NEW YORK 14102
(716) 655-1654

Figure 3
Overburden Ground Water Monitoring Well Locations and Flow Direction

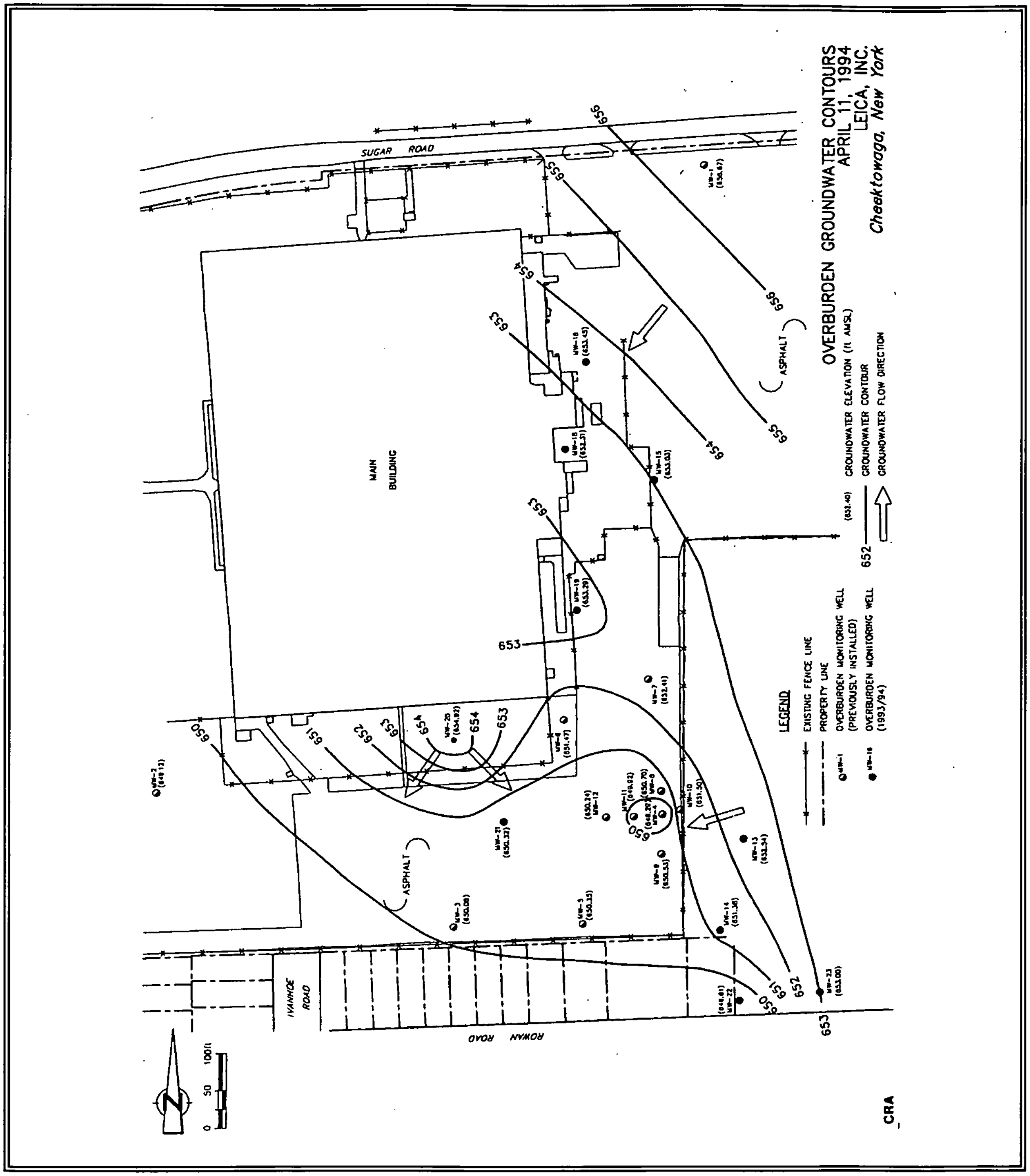


Figure 4
Bedrock Ground Water Monitoring Well Locations and Flow Direction

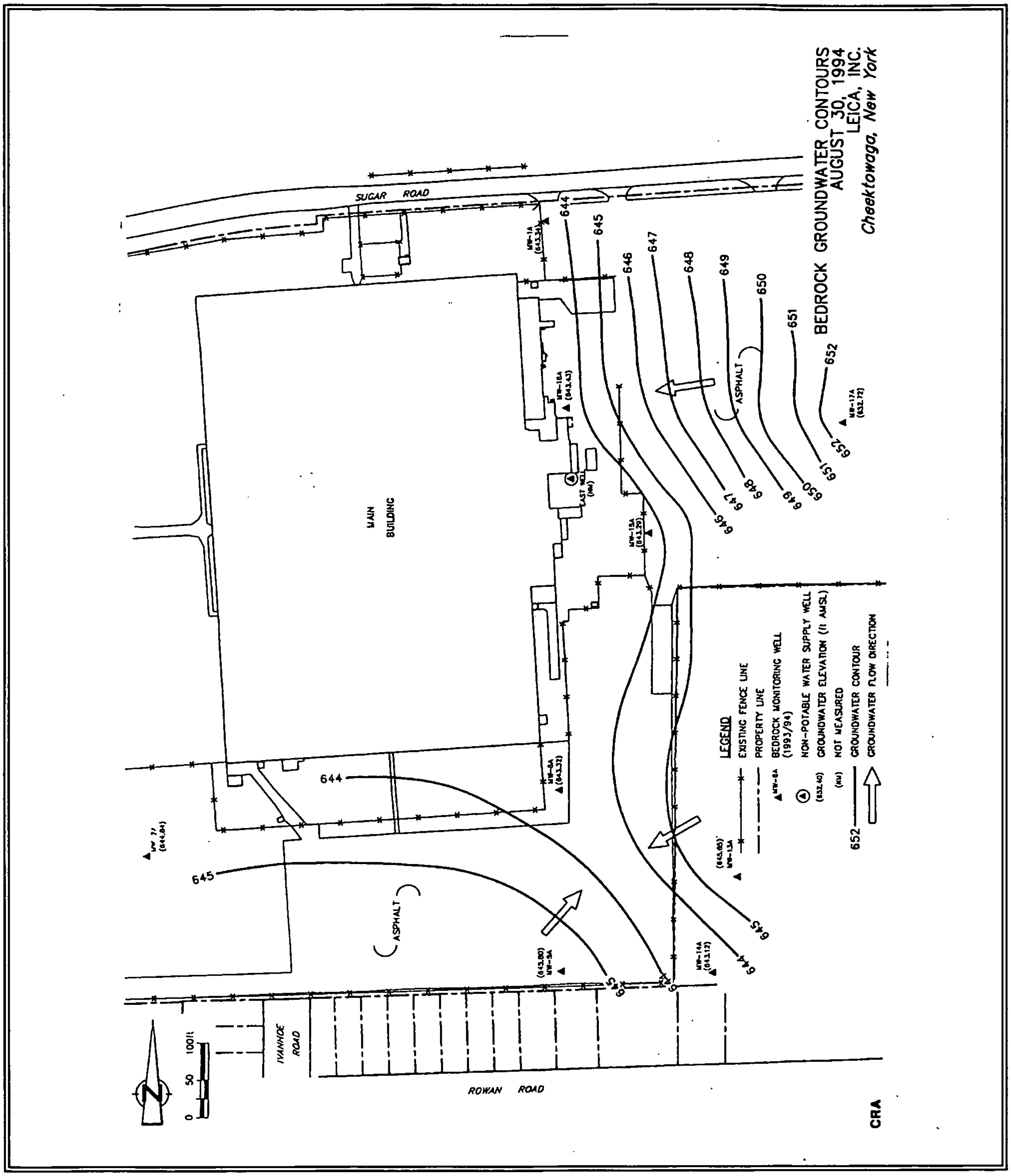


Figure 5
Overburden Chloroethene Contamination Contours

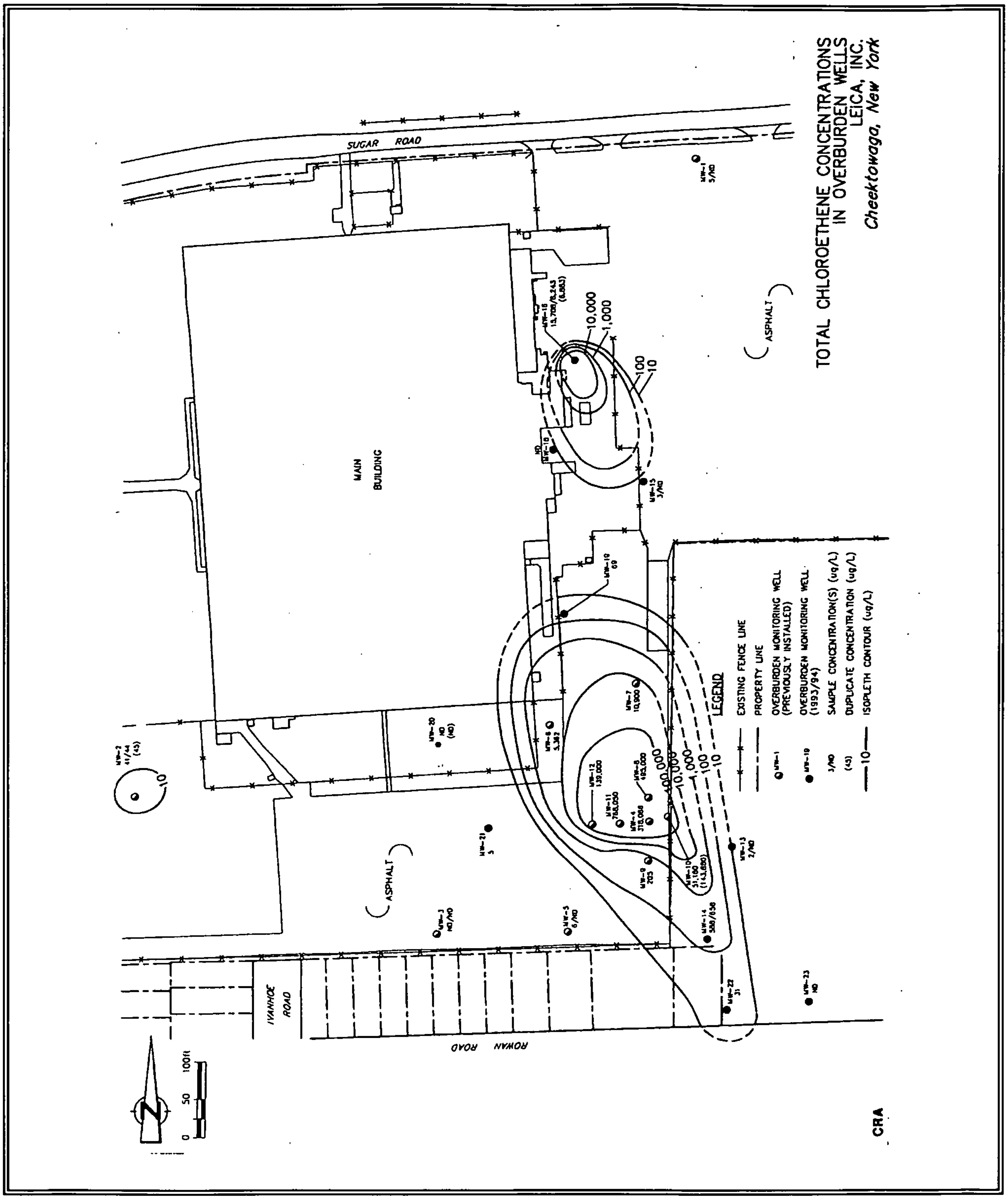


Figure 6
Bedrock Chloroethene Contamination Contours

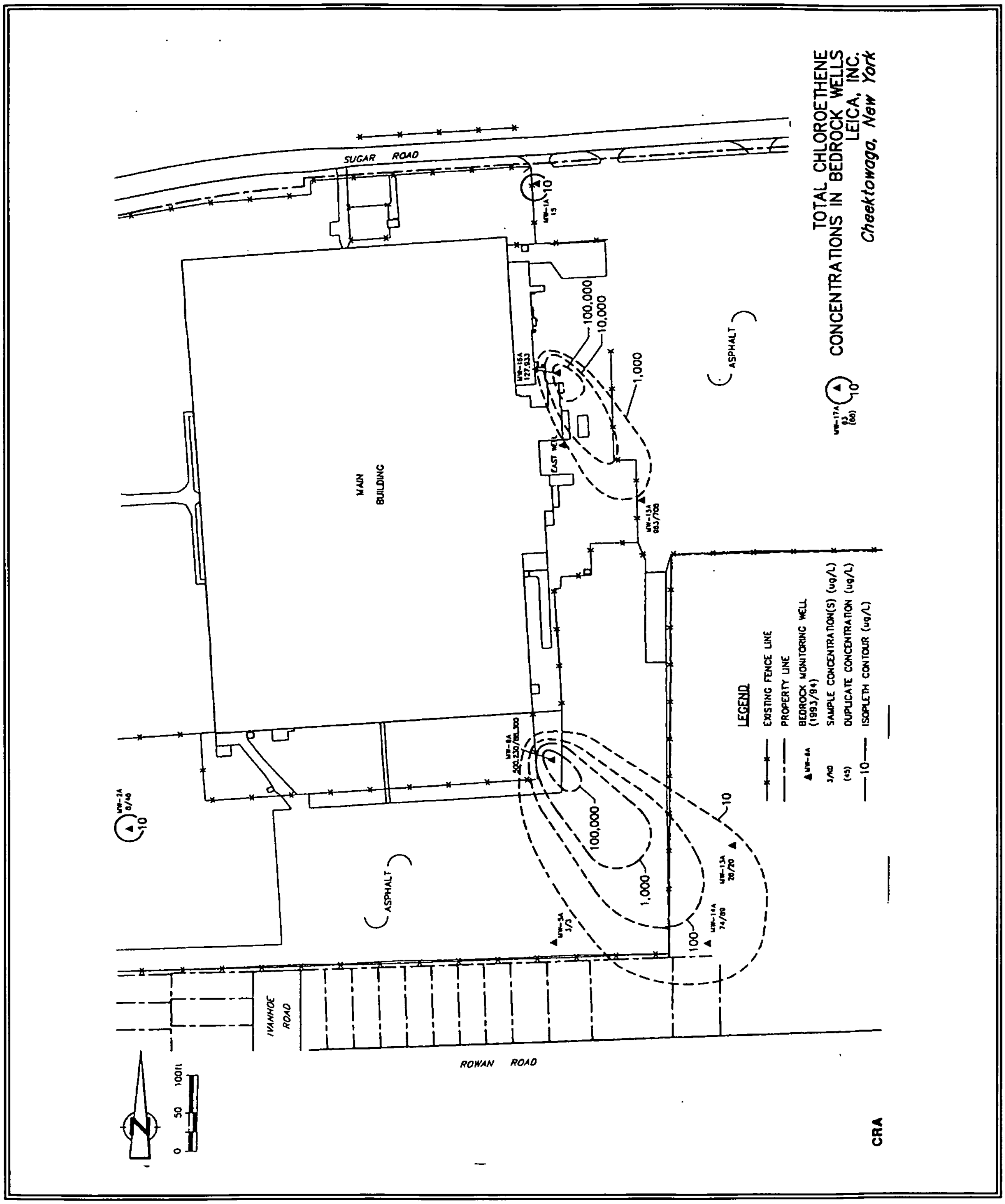


TABLE 1

Chemicals of Concern
Leica Site

Volatile Organic Compounds(VOCs)

Acetone
Benzene
Bromomethane
2-Butanone
Carbon Disulfide
1,1-Dichloroethane
1,1-Dichloroethene
1,2-Dichloroethene(total)
Ethylbenzene
Methylene Chloride
Tetrachloroethene
Toluene
1,1,1-Trichloroethane
Trichloroethene
Vinyl Chloride
Xylenes(total)

Semi-Volatile Organic Compounds(SVOCs)

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluorathene
Benzo(g,h,i)perylene
Benzo(a)pyrene
Bis(2-ethylehexyl)phthalate
Butyl benzyl phthalene
Carbazole
Chrysene
Dibenzo(a,h)anthracene
Dibenzofuran
Di-n-butyl phthalate
1,2-Dichlorobenzene
Di-n-octyl-phthalate
Fluoranthene
Hexachloroethane
2-Methylnaphthalene
Naphthalene
Phenanthrene
Pyrene

Acid Extractables

4-Chloro-3-methylphenol
2,4-Dimethylphenol
2-Methylphenol
4-Methylphenol
Phenol

Metals

Aluminum
Arsenic
Barium
Cadmium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Nickel
Potassium
Sodium
Vanadium
Zinc

TABLE 2

REMEDIAL ACTION OBJECTIVES

Media	Remedial Goal
Groundwater	**Concentration Range (ppb)**
trichloroethene	5
1,2-dichloroethene	5
vinyl chloride	5
1,1,1-trichloroethane	5
toluene	5
xylene	5
ethylbenzene	5
Soil	**Concentration Range (ppm)**
trichloroethene	1.0
1,1,1-trichloroethane	0.8
1,1-dichloroethane	0.2
1,2-dichloroethene	0.1
methylene chloride	0.2
vinyl chloride	0.2
xylene	1.2
benzene	0.06
ethylbenzene	5.5
toluene	1.5

TABLE 3

SUMMARY OF PRELIMINARY COST ESTIMATES

Alternative No.	Description	Capital Cost	Annual O&M Cost	Estimated Present Worth
1	- No Action	$0	$0	$0
2	- Institutional Controls - Long Term Monitoring			

APPENDIX A

ADMINISTRATIVE RECORD

1. **"Real Property Environmental Assessment Report", Leica Inc.,**dated August 14, 1990,

2. **"Site Investigation, Leica, Inc."**, dated November 1990.

3. **"Site Investigation Work Plan", Leica, Inc.** dated October 25, 1991, Conestoga-Rovers & Associates.

4. Leica entered into **Order onConsent** (legal agreement) with NYSDEC on October 8, 1993 to conduct a Remedial Investigation/Feasibility Study and Remedial Design and Remedial .

5. **"RI/FS Work Plan", Leica, Inc.** dated June 1993

6. **"Remedial Investigation Report", Leica, Inc.,** dated October 1994 (revised dated February 16, 1995), Conestoga-Rovers & Assoc.

7. **"RI/FS Preliminary Remedial Action Objectives", Leica, Inc.** dated January 6, 1995

8. "Final **Feasibility Study Report", Leica, Inc., dated** March 1996.

9. **"Remedial Predesign Work Plan", Leica, Inc.,** dated August 1995.

10. "**Pre-Design Investigation Report**", Leica Inc., dated 1996.

11. "**Supplemental Soil Vapor Extraction Evaluation**", Leica Inc., dated 1996.

12. "**Proposed Remedial Action Plan**", dated April 1996

APPENDIX B

GLOSSARY OF TERMS

AST:	Above Ground Storage Tank
COCs:	Chemicals of Concern
CAMU:	Corrective Action Management Unit
DCE:	Dichloroethylene
ECL:	Environmental Conservation Law
IRM:	Interim Remedial Measure
NAPL:	Non-Aqueous Phase Liquid
NYCRR:	New York Codes, Rules, and Regulations
NYSDEC:	New York State Department of Environmental Conservation
NYSDOH:	New York State Department of Health
O&M:	Operation and Maintenance
ppb:	Parts per billion (equivalent to 1 second in 31.7 years) also can be represented as ug/l (as measured in a liquid) and ug/kg (as measured in a soild)
ppm:	Parts per million (equivalent to 1 second in 11.6 days) also be represented as mg/l (as measured in a liquid) and mg/kg (as measured in a soild)
PRAP:	Proposed Remedial Action Plan
PRP:	Potential Responsible Party
RAOs:	Remedial Action Objectives
RCRA:	Resource, Conservation, Recovery Act
RI/FS:	Remedial Investigation/Feasibility Study
ROD:	Record of Decision
SCG:	Standards, Criteria and Guidances
SVE:	Soil Vapor Extraction
SVOCs:	Semi-Volatile Organic Compounds
TCE:	Trichloroethylene or Trichloroethene
UST:	Underground Storage Tank
USEPA:	United States Environmental Protection Agency
VC:	Vinyl Chloride
VOCs:	Volatile Organic Compounds