FINAL PHASE I
REMEDIAL INVESTIGATION

OLIN CHEMICALS
ROCHESTER PLANT SITE
ROCHESTER, NEW YORK

VOLUME I

Submitted to:

Division of Hazardous Waste Remediation
New York State Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233-4011

Prepared by:

ABB Environmental Services, Inc.
110 Free Street
Portland, Maine 04101

AUGUST 1995

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This report presents the findings of the Phase I Remedial Investigation (RI) conducted at the Olin Corporation Chemicals Division (Olin) manufacturing plant in Rochester, New York, between September 1993 and February 1994. The Phase I RI was performed to fulfill part of the requirements of the Consent Agreement between the New York State Department of Environmental Conservation (NYSDEC) and Olin (Index No. B8-0343-90-08). The Phase I RI report includes discussions of the purpose of the RI and site history; the technical program; physical characteristics of the site; nature and distribution of contamination; fate and transport; and the baseline risk assessment.

Introduction

The purpose of the RI was to 1) characterize the nature and distribution of site-related contaminants beyond the Olin Plant boundary, 2) refine characterization of known or suspected source areas, 3) support a Feasibility Study, and 4) provide data to develop a baseline risk assessment.

The Olin Plant is located on McKee Road, a private road in southwestern Rochester. The plant property is approximately 15.3 acres. The surrounding area is industrialized and the nearest residential areas are 1,500 to 4,000 feet from the site. The present Olin Plant operations consist of organic and inorganic chemical manufacturing facilities. The predominant products are specialty organic chemicals, including chloropyridines.

The original Rochester plant site has been used for commercial activity since 1948. Mathieson Chemical Corporation, a predecessor of Olin, acquired the original plant in 1954 and subsequently purchased additional property to the north and south. The production of chloropyridine at the Rochester plant was started in 1963.

Chemical releases on-site have resulted from past operating procedures and waste management practices. The operational sources include leakage from underground sewers and infiltration of building washdown water. Several on-site waste management operations have also been identified and specifically investigated as possible sources, including an acid neutralizing pond, a lab sample disposal area, the tank farm area, the sodamide area, and a building washdown area (Well B-17 Area). Site-related groundwater contamination is related to residual soil concentrations resulting from the past releases to the environment. There is no evidence of active leaks from current plant processes.

Remedial Investigation Program

The technical approach for this Phase I RI was designed to meet the objectives for the RI/FS process associated with the Consent Agreement. Investigations were conducted both on the Olin Plant property (on-site) and in areas outside the plant property (off-site). These investigations included:

- surface and borehole geophysical surveys
- soil-gas, surface-soil, subsurface soil, and groundwater sampling
- monitoring well and piezometer installations
- packer sampling and testing
- hydraulic conductivity testing
- water level measurements
- surveying
- field laboratory and off-site laboratory sample analysis

Site Physical Characteristics

Results of investigations undertaken during the Phase I RI at the Olin Study Area have corroborated previous conclusions regarding the geology and hydrogeology of the site, and the direction of groundwater flow. The Phase I RI identified the following physical characteristics of the Olin Plant and surrounding area:

- study area geology consists of 10 to 20 feet of overburden, consisting of stratified silt, sand, and gravel, overlying Lockport Dolomite bedrock;

- primary groundwater flow occurs in the saturated parts of the overburden and the uppermost 11 to 40 feet of bedrock, which is generally more fractured and weathered than the deeper bedrock;

- a deeper water-bearing zone was identified within the more competent deep rock, between 73 and 75 feet below ground surface (bgs);

- groundwater beneath the Olin Plant flows primarily to the south, southwest, and west, with a smaller component toward the southeast;

- hydraulic conductivity estimates range from 1.9×10^{-5} to 7.7×10^{-3} centimeters per second (cm/sec) in the overburden and from 4.0×10^{-5} to 1.7×10^{-3} cm/sec in the shallow bedrock; deeper bedrock hydraulic conductivities were estimated to be approximately 10^{-6} cm/sec in the competent rock and 2.4×10^{-4} cm/sec in the water-bearing zone between 73 and 75 feet bgs; and

- groundwater capture is evident in some areas of the Olin Plant, but evidence of capture is inconclusive in other areas.

Nature and Distribution of Contamination

Site-related contaminants were detected in soil gas, surface and subsurface soil, and groundwater in the study area. No new source areas were identified during the investigation, and the limits of on-site soil contamination were identified.

Soil Gas. Selected volatile organic compounds (VOCs) were detected in soil gas on-site and, at lower concentrations, off-site. The primary on-site areas of VOCs in soil gas were the Well B-17 Area and the Lab Sample Area.

Surface Soil. Chloroform was the only VOC detected in surface soils samples, which were collected from on-site areas. All surface soil samples contained polynuclear aromatic hydrocarbons (PAHs) and one or more chloropyridine isomers.

Subsurface Soil. Results of analyses of subsurface soil showed no significant areas of soil contamination that could be considered contaminant sources in four of the five potential contaminant source areas investigated on-site. The highest concentrations of VOCs, pyridines, and other semivolatile organic compounds (SVOCs) were detected in samples from one area: the Well B-17 Area.

Groundwater. Pyridines, other SVOCs, VOCs, and inorganic analytes were detected in overburden and bedrock groundwater, beneath both the Olin Plant and the off-site portion of the study area.

Pyridines were the most frequently-detected organic chemicals in both overburden and bedrock groundwater, and the distribution of pyridines is believed to represent the greatest extent of site-derived groundwater contamination. Two primary lobes of pyridines in overburden groundwater are present, one extending west and northwest of the Olin Plant, and the other extending south of the Plant. Total pyridine concentrations were lower in deep bedrock than in adjacent shallow bedrock wells.

In overburden groundwater, total pyridine concentrations were delineated to 10 μg/L in all directions except the southeast, where they were delineated to 4,600 μg/L. In shallow bedrock, the extent of total pyridine concentrations above 10 μg/L was delineated in all directions except south and southwest of the Olin Plant, where concentrations up to 3,000 and 23,000 μg/L, respectively, were detected at the limit of explorations.

Several VOCs were detected in overburden and bedrock groundwater, including carbon tetrachloride, chloroform, methylene chloride, chlorinated ethenes, and benzene, toluene, ethylbenzene, and xylenes (BTEX compounds). The highest overburden concentrations of VOCs were detected beneath the Well B-17, Tank Farm, and Well BR-5 areas. VOCs detected in off-site overburden groundwater include PCE, TCE, and BTEX. Overburden groundwater VOC concentrations were delineated to 56 μg/L (total BTEX) to the southeast of the site and to 10 μg/L in other directions. Overburden becomes unsaturated to the west of the Olin Plant. The highest bedrock concentrations were detected south of the Well B-17 Area. Bedrock VOC concentrations were detected west and south of the Olin Plant, where they were delineated to 920 and 9 μg/L (total selected VOCs), respectively.

Inorganic concentrations in groundwater were higher in the overburden than in the bedrock, perhaps due to suspended solids concentrations in unfiltered overburden samples. Maximum inorganic concentrations in overburden were detected primarily along the western and southern plant property boundaries. Maximum inorganic concentrations in bedrock were detected in wells showing high site-related organic constituent concentrations. Most inorganics detected in groundwater are believed to be naturally occurring elements unrelated to operations at the Olin Plant.

Pyridines and VOCs were detected in the single deep bedrock well installed during the Phase I RI. The extent of site-related contaminants in the deep bedrock was not delineated.

No DNAPL was detected in any well installed during the Phase I RI.

Fate and Transport

The fate and transport analysis concentrated on site-related VOCs, pyridines and other SVOCs, and inorganics migrating from on-site sources to overburden and bedrock groundwater. Dissolved-phase transport in groundwater is considered the most important contaminant migration pathway. Other less significant pathways that were investigated include atmospheric migration of VOCs from the subsurface into neighboring buildings and surface water transport of constituents potentially discharged via groundwater flow to the Erie Barge Canal.

Dissolution and degradation of VOCs from past releases to groundwater are believed to be the most significant fate processes for VOCs at the study area. Adsorption to soil was identified as the most important fate process controlling the distribution of PAHs and pesticides. Biodegradation was identified as the most important fate process for pyridines, however photo-oxidation and volatilization also control the fate.

Groundwater in the vicinity of the Olin Plant is naturally high in sulfur, and would be expected to be high in calcium and magnesium because of the carbonate bedrock.

A conceptual model was developed which illustrates that chemicals leach from soil by infiltrating precipitation, or formerly percolated through the unsaturated overburden to the groundwater. Once in the groundwater, contamination migrates in the dissolved phase in the saturated overburden and bedrock. Groundwater may discharge from bedrock to the Erie Barge Canal, or it may flow beneath the canal in fractures. Oxidation/reduction processes, dissolution, degradation, volatilization, and adsorption processes act to reduce concentrations of chemicals in groundwater during migration.

Baseline Risk Assessment

The human health risk assessment identified no significant risks associated with exposures to soil gas or surface soil. Although potential noncancer risks from Chemicals of Potential Concern (CPCs) in subsurface soil exceed USEPA acceptable values, these risks may be a result of naturally occurring elements at ambient concentrations and may not be related to the Olin Plant.

Potential risks characterized for exposures to the overburden groundwater, predominantly the on-site overburden groundwater, exceed USEPA acceptable risk levels. The exposure parameters used in the evaluation are conservative and most likely over-estimate anticipated actual exposures. Reducing or eliminating exposure to groundwater during potential future excavation activities would mitigate the level of risk. Use of personal protective equipment would greatly reduce the level of exposure and is expected to reduce the risk to acceptable levels.

No toxicological impacts or bioaccumulation hazards associated with the discharge of groundwater into the Erie Barge Canal are anticipated. Ecological wildlife receptors that may occur in the study area are unlikely to be adversely impacted as a result of exposures associated with foraging activities, as well.

Screening toxicological benchmarks for terrestrial plants and invertebrates were exceeded by surface soil concentrations of several inorganic CPCs. There is considerable uncertainty involved in the interpretation of the benchmark exceedances which were derived from a number of studies where environmental conditions varied considerably. Moreover, the selection of the lowest reported toxicological values for each surface soil CPC assumes that the most sensitive receptors would occur at the Olin Plant. Although this assumption is appropriate for a baseline assessment, actual risks to the plants and invertebrates that occur at the plant were most likely over-estimated in this ecological risk assessment.

Recommendations for Future Work

Based on the information collected during the Phase I RI and previous investigations, general recommendations for additional work are as follows:

- Further delineate the overburden groundwater plume, particularly to the southeast of the Phase I investigation locations.
- Further delineate the shallow bedrock groundwater plume west and south of the Phase I investigation locations.

- Further characterize groundwater flow and quality in deeper bedrock fractures.
- More completely characterize background soil concentrations.
- Develop more realistic assumptions for potential exposures to groundwater for risk assessment purposes.
- Assess potential impacts of site-related contaminants on the Erie Barge Canal.

1.0 INTRODUCTION

This report presents results of a Phase I Remedial Investigation (RI) conducted at the Olin Corporation Chemicals Division (Olin) manufacturing plant in Rochester, New York, between September 1993 and February 1994. Also presented herein are interpretations and recommendations based on the these results and previous investigations at the plant. This Phase I RI was performed under a Consent Agreement between the New York State Department of Environmental Conservation (NYSDEC) and Olin (Index No. B8-0343-90-08).

1.1 REPORT ORGANIZATION

This report is organized into seven sections. Section 1 is the introduction presenting the purpose and scope of work, a description of previous work at the Olin Plant, and the overall study area and regional description. Section 2 presents the technical approach for the field program, an assessment of the analytical program, identification of state and federal requirements and guidelines, and a discussion of remedial actions already in place. Section 3 provides a description of the physical characteristics of the study area including the geologic and hydrogeologic environments. The nature and distribution of contamination is discussed in Section 4, and Section 5 discusses contaminant fate and transport including the site conceptual model. The baseline risk assessment is presented in Section 6. Section 7 provides a summary and conclusions of the RI. Figures and Tables are shown separately from text in separately labeled sections.

1.2 PURPOSE AND SCOPE OF WORK

The purpose of this RI was to 1) characterize the nature and distribution of site-related contaminants beyond the Olin Plant boundary, 2) refine characterization of known or suspected contaminant source areas, 3) support a Feasibility Study (FS) for potential remedial actions to be implemented within the plant boundary, and 4) provide additional data to support development of an updated baseline risk assessment, originally conducted in 1990. To achieve these objectives the following tasks were performed:

- Geophysical surveys to determine the presence or absence of potential subsurface source areas and further assess the depth to bedrock south and west of the Olin Plant.
- Collection and analysis of soil gas samples from identified source areas, a site-wide grid, and adjacent to off-site buildings.
- Collection and analysis of surface and subsurface soil samples from previously identified and potential source areas.
- Collection and analysis of groundwater samples from new and existing monitoring wells, piezometers, and ground probes.

1.3 SITE DESCRIPTION AND HISTORY

Site Description. The Olin manufacturing plant site, hereinafter referred to as the Olin Plant, is located in the southwestern section of Rochester, New York, on McKee Road, a private industrial road (Figure 1-1). The plant property occupies approximately 15.3 acres. Areas identified as being within the Olin Plant property boundary are also identified as being "On-Site", while areas outside the Olin Plant boundary are referred to as being "Off-Site". The area covered by the Phase I RI is herein after referred to as the study area and includes the Olin Plant and surrounding properties.

The Olin Plant is at an elevation of approximately 540 feet above mean sea level (MSL). The Olin Plant property and surrounding terrain are relatively flat, with a maximum relief of about 12 feet. There is no surface water at the Olin Plant, but an open drainage ditch runs west from near the northwest corner of the plant property. Drainage from the Olin Plant is collected in storm drains and discharged to the local publicly- owned treatment works (POTW).

The major surface water features in the area are the Erie Barge Canal, located approximately 1,500 feet west of the plant, and the Genessee River, which is approximately 3 miles to the south. The shores of Lake Ontario lie approximately 7 miles to the northwest of the plant.

The present Olin Plant operations consist of organic and inorganic chemical manufacturing. The primary products are specialty organic chemicals, many produced in small quantities. Due to the changing nature of the operation at Rochester, a large number of organic raw materials, intermediates, and products have been handled at the plant.

Site History. The original Rochester plant site has been used for commercial activity since 1948. During that year, Genessee Research, a fully-owned subsidiary of Puritan Company, established a manufacturing facility for automotive specialty products such as brake fluids, polishes, antifreeze and specialty organic chemicals (Olin, 1990). In 1954, Mathieson Chemical Corporation, a predecessor of Olin, acquired Puritan. Mathieson continued the brake fluid and antifreeze operations for a time, but in 1962 stepped up the production of specialty organic chemicals including the production of Zinc Omadine™. In 1963, the production of chloropyridine was begun, and Olin is now the world's largest producer of this specialty chemical (Olin, 1990).

Olin acquired the Rochester plant in 1954 (as Mathieson Chemical Corporation). Since that time, Olin has purchased additional property to the north and south. When the northern parcel was acquired in 1963, disposal of asphalt and concrete debris had occurred over a number of years by the Asphaltic Concrete Company that operated in the facility to the north of the Olin Plant. After it acquired the property, Olin sued Asphaltic to remove the debris. The anticipated cost of litigation eventually caused Olin to remove the debris itself. After removal, the land surface was uneven and lower in elevation than the adjacent areas of the Olin Plant property. The northern parcel was graded to bring it up to approximately the same grade as the plant site. The southern parcel was purchased as undeveloped flat ground and remains in this condition.

Several areas along McKee Road have been used as landfill or dump sites over the years. NYSDEC lists two areas west of McKee Road on its site registry. These sites are registry numbers 8-28-018a, between Firth Rixson (formerly Monroe Forging) and Aid to Hospitals, and 8-28-018b, an area north of Firth Rixson which is currently occupied by Griffith Oil Co. A third site, registry number 8-28-018c, is now the northern part of the Olin property, acquired in 1963 as noted above. Olin has never used any of these areas for solid or hazardous waste disposal. However, site number 8-28-018c is now considered by NYSDEC to be the Olin Plant property.

The northern part of McKee Road was also the site of a waste incinerator that stored up to 1,000 drums of oil, gasoline, solvent liquids and sodium cyanide. Miljo Liquid Waste Processing Corporation was closed in April 1974 by the Monroe County Air Resources Department for incinerating certain chemicals without a permit. Its term of operation is unknown.

1.3.1 Previous Investigations

Olin has reported on-site waste management activities to various agencies in the past (Olin, 1990). These reports were developed from file searches and employee interviews, and indicated that these activities were relatively limited. These activities are likely sources of contamination. Investigations at the Olin Plant indicate that historic plant operations, rather than waste storage or disposal activities, were the source of contamination found in the groundwater. The manufacturing operations at Rochester have traditionally been carried out in buildings with concrete floors, with floor drains leading to underground sewers that eventually discharge to off-site sewers routed to the Monroe County POTW. The wastewater discharged to the underground sewers contained organic chemicals.

Prior to the inception of this RI, the primary sources of soil and groundwater contamination were thought to be:

1) former in-plant floor drains and sewers,
2) building washdown that was too large a volume for the floor drains to handle and that consequently overflowed to open ground areas outside the buildings, and
3) possible leakage from tank farm dikes that at one time were unlined.

Principal areas of contamination at the Olin Plant have been identified in the south central part of the plant, near the operating areas. This is the area known to have had leaking sewers and the area where washdown water from the chlorinator building is reported to have been discharged onto the ground surface before this operating practice was stopped in the mid-1970's (Olin, 1990).

1.3.1.1 1982 Report. During 1981 and 1982, Olin conducted a geohydrological study of the Rochester plant site. The purposes of the study were to evaluate the direction of groundwater movement and its controlling factors; the type and quantity of potential Olin-generated contaminants in groundwater; and to develop a remedial action plan to address significant contamination problems indicated by the study results.

Available regional geological information was augmented by site-specific geological data to complete the hydrogeological description and analysis of the study area. The presence of any nearby pumping wells and their depth, pumping rate, and seasonal pumping schedule, were reviewed to see if they exerted an influence on localized groundwater movement. A network of 22 monitoring wells was installed on the plant property. Seventeen wells were located on the plant perimeter to detect any off-site contaminant movement and to measure the water table gradient. Five wells were installed around the plant operating area to define the area of any contaminants and to aid in measuring the water table gradient.

Groundwater table levels were measured monthly, and in-situ permeability tests were performed at selected wells to measure the aquifer permeability. Groundwater samples were taken from all wells in January 1982 and April 1982. The findings and conclusions of the 1982 report are summarized below. Some of these have changed since that report was issued, based on more recent and complete information developed in later studies.

The main contaminants found in the groundwater were chloropyridines and dichloropyridines. Lesser contaminants were fluoraniline, tetrachloroethene, trichloroethene, methylene chloride, carbon tetrachloride, chloroform and toluene. All of these contaminants except tetrachloroethene could be associated with present or past Olin operations.

The sources of chloropyridines were an apparent leak from the plant process sewer system (repaired in 1982) and past leaks and spills. Other contaminants came from similar sources. There was no significant evidence of any waste buried onsite.

A computer simulation model was used to select locations and pumping rates for an interceptor well system. A pumping system to intercept contaminated groundwater and contain contaminants on Olin Plant property was recommended (and eventually installed), using ten existing wells to accomplish the objective. The intercepted water was conveyed by pipeline to the pretreatment plant for discharge to the POTW. The addition of the intercepted groundwater to the existing plant discharge increased the daily flow volume and mass loading to the POTW by less than 3 percent (Olin, 1990).

1.3.1.2 1984 EPA Site Inspection. In 1983, NUS Corporation, acting as a consultant to the U.S. Environmental Protection Agency (USEPA), conducted a Preliminary Assessment (PA) of the Rochester plant based on a file review. Subsequent to the PA, NUS conducted a site inspection on June 14, 1984. The inspection team consisted of a chemical engineer, a civil engineer, a geologist, and biologist. Using Olin's 1982 report (described above) as a basis, NUS collected four groundwater, one runoff, and three soil samples for analysis (Olin, 1990). NUS concluded:

- Groundwater discharges to the Barge Canal
- Groundwater in vicinity is unusable as drinking water (because of background constituents).
- No potential for worker exposure (contamination underground).
- Deep production well west (sic - Ness well is south) of site is contaminated by site.
- No potential exists for air exposure (HNU & OVA readings nil).

1.3.1.3 1987/1989 Groundwater Investigation. In May 1987, Olin entered into a Consent Agreement with NYSDEC to continue the investigation at the Rochester plant to evaluate the nature of the bedrock and the distribution of groundwater contamination. The field work for this program was started in July 1987, and a phased program was implemented to optimize information gathering activities, ending in 1989.

The focus of the 1987-1989 groundwater investigation was groundwater in the bedrock aquifer, but soil sampling to detect potentially entrapped contaminant sources and overburden piezometer installations to monitor interceptor system performance were also included in the program. In addition, a baseline risk assessment was performed by Sirrine Environmental Consultants (Olin, 1990).

Eight shallow bedrock and two deep bedrock monitoring wells were installed at the Olin Plant and sampled to characterize the bedrock groundwater. Chemicals present in the shallow bedrock aquifer, which were similar to those detected in the overburden, were found to have migrated to the south and west from the main production area, where the highest concentrations were detected. Based on these results, two shallow bedrock wells (BR-2 and BR-3) were converted to pumping wells to prevent further migration. Extremely low yields from the two deep bedrock wells suggested that vertical migration of contaminants was prevented by the competent rock underlying the upper fractured bedrock.

Ten soil borings were drilled in an open area adjacent to the plant's loading dock to assess the potential presence of continuing sources of contaminants to groundwater. Soil samples from the borings were screened using an organic vapor analyzer (OVA), and the boring with the highest OVA readings was converted to an overburden monitoring well (B-17).

Five overburden piezometers were installed just off Olin Plant property to the west and south to assess the performance of the overburden groundwater interceptor system. Two additional overburden monitoring wells were also installed adjacent to the canal, but these wells found unsaturated conditions in the overburden. An evaluation of overburden water levels indicated the interceptor system was preventing Olin Plant-related chemicals in the overburden groundwater from migrating off-site.

The risk assessment identified no adverse impacts to either human or ecological health from site-derived contaminants.

1.3.1.4 Systematic Monitoring. Since its installation in July 1983, the interception well system has been monitored under two programs. First, plant preventative maintenance personnel check the wells weekly to insure that the pumped volume remains up to specification. Second, quarterly water elevation readings are taken in the pumping wells and their associated piezometers. These data are sent to Olin Environmental Affairs where a hydrogeologist reviews them. This allows fine tuning of the system to address changing conditions.

Since 1989, all bedrock monitoring wells and selected overburden monitoring wells have been sampled quarterly and the samples analyzed for volatile organic compounds (VOCs), pyridine, and selected chloropyridines. Results of these analyses have been maintained in a computer database and reported quarterly to the NYSDEC.

1.3.2 Identified Sources

There have been some waste management operations on-site that utilized land disposal. Solid waste management units (SWMUs) used in the past were described in a submission to NYSDEC dated July 27, 1988 (Olin, 1990). An additional minor unit, involving small quantity toluene diamine (TDA) releases, is described below. Figure 1-2 shows the SWMU locations. An aerial photography review was completed to assist in identifying past sources (Olin, 1990). The units are discussed individually below, based on available knowledge and interviews with Olin Plant personnel at Rochester (Olin, 1990). Groundwater contamination from these areas is related to residual soil concentrations which have resulted from past releases to the environment. There is no evidence of active leaks from current plant processes.

Nitrating Acid Neutralization Pond referred to as the Well BR-5 Area - The pond was an excavated pit approximately 30 feet by 100 feet by 4 feet deep located beneath the current Tank Farm, and used from 1966 until 1971 to neutralize nitrating acid from the manufacture of benzotrifluoride using limestone. An ammonium hydroxide spent scrubber solution was also discharged to the pond. The pond discharged into a low area, thought to be immediately north in the area of the current well BR-5. Accumulated water in the low area evaporated or percolated into soils.

Although analytical results from monitoring wells in the vicinity indicate that seepage from this pond has not significantly affected groundwater beneath the plant site, high concentrations of VOCs detected in Well BR-5 suggests that the low area where this well is located may have been a source (Olin, 1990).

Lab Sample Disposal Area - Quality control samples from the on-site laboratory were disposed of in a pit north of the laboratory from the 1950s until 1970. The quantity buried was small due to the small volumes associated with sampling. When the present boiler house was being constructed, this pit was uncovered. All visible sample bottles were excavated from the area of the pit, as well as all surrounding soil, and disposed of properly offsite in a commercial landfill (Olin, 1990).

Also occurring in this area was a one-time disposal of a batch (of off-specification trichlorobutylene oxide (TCBO), believed to be about 1,000 gallons, in a pit in the vicinity of the lab sample pit. This disposal was reported to have occurred in late

1968. If this was the case, then soils that may have become contaminated were also removed during the boiler construction as noted above (Olin, 1990).

Tank Farm Area - The Tank Farm Area is an active chemical storage area in the central eastern portion of the Olin Plant property. There are no documented leaks or spills in this area. However, land covering the eastern-most section of the Tank Farm Area has been used for this purpose since 1948 and was not originally bermed to contain leaks or spills that may have occurred. Currently the Tank Farm Area is bermed or sloped to contain possible leaks or spills.

Sodamide Area - Discussions with employees raised the possibility that one to three drums of sodamide had been buried in the southeastern corner of the property in the early 1960s, near the present firewater tank. One letter from Olin the files refers to a burial of elemental sodium in this same area. These are believed to be the same episode and that the correct reference is to sodamide (Olin, 1990).

TDA Area - During 1969, ortho- and meta-TDA were processed by the Olin Plant in a one-time, short campaign. Soils beneath the rail car unloading area were potentially contaminated by drippage during unloading. The soils were spread south of the railroad tracks and covered (Olin, 1990)

Former Building Washdown and Well B-17 Area Building washdown water that was too large a volume for the floor drains to handle is reported to have been discharged to the formerly unpaved ground off the southeast end of the Main Plant Building (Olin, 1990). This area currently is the location of a paved loading dock area and also contains structures including piping and containment vessels that have been built up around the loading dock. Analytical results from the systematic monitoring of wells showed some of the highest VOC and semivolatile organic compound (SVOC) concentrations in monitoring well B-17. These results further suggested this area is a likely source of groundwater contamination.

1.4 POPULATION CHARACTERISTICS/LAND USE

The Olin Plant lies within the central portion of Monroe county in the northwest region of New York State. According to the 1990 census, the City of Rochester population is approximately 230,000. The Olin Plant is in the westernmost section of Rochester. The Erie Barge Canal, to the west of the Olin Plant, defines the boundary between the town of Gates on the west side and the City of Rochester on the eastern side (see Figure 1-1). The area surrounding the Olin Plant is industrialized, with businesses ranging from light commercial to heavy manufacturing. The nearest downgradient residential area is on Chili Avenue in the city of Rochester to the south, approximately 4,000 feet from the plant.

1.5 NATURAL RESOURCES

The natural resources of the area surrounding the Olin Plant include the Erie Barge Canal located 1,500 feet to the west.

The Erie Barge Canal is designated a New York State Class B stream. The canal flows from west to east in the Rochester area into the Genessee River.

The dolomite bedrock has been quarried for use as crushed stone and aggregate. The nearest quarry operation is west of the Olin Plant, approximately 4,000 feet away, on the opposite side of the Erie Barge Canal. This quarry is operated by Dolomite Products Company and covers approximately 70 acres.

1.6 CLIMATE

Rochester is in the Great Lakes Plain physiographic province, which is a lowland region comprising a large part of northwest New York. The climate is characterized by lengthy periods of either cold or warm weather that result from the movement of high pressure systems into the eastern United States. Based on climatological data from 1951 through 1980, the average daily minimum and maximum temperatures for January range from 16.3°F to 30.8°F, respectively. Daily minimum and maximums for July range from 60.3°F to 82.3°F. Average yearly precipitation, including water equivalents for snowfall, from 1951 through 1980, is 31.27 inches. Monthly prevailing wind direction ranges from the west southwest to southwest, with average speeds ranging from 8.1 to 11.9 miles per hour (NOAA, 1985).

2.0 REMEDIAL INVESTIGATION PROGRAM

2.1 TECHNICAL APPROACH

The technical approach for this Phase I RI was designed to meet objectives for the RI/FS process listed in Subsection 1.2. Components of the Phase I program included:

- surface geophysical surveys
- TerraProbe^{SM} soil gas, soil and groundwater sampling
- surface soil sampling
- monitoring well and piezometer installations
- borehole geophysics
- packer sampling and testing
- groundwater sampling
- hydraulic conductivity testing
- water and separate phase liquid level measurements
- surveying
- sample analyses

The following subsections describe the field activities undertaken to meet the RI/FS objectives, including methods used to collect data. Analytical methods used for this RI are described in Subsection 2.2.

2.1.1 Surface Geophysical Surveys

Geophysical surveys were conducted to 1) look for indications of buried drums or waste at the reported sodamide disposal area and the decommissioned equipment lay-down area in the northern portion of the Olin Plant property and 2) provide information about the depth to bedrock at areas within the southern part of the plant property and off-site to the south and west of the Olin Plant. To meet the first objective, a ground penetrating radar (GPR) survey was conducted, and to characterize the depth to bedrock, a seismic refraction survey was performed. A detailed discussion of the geophysical survey techniques and results is provided in Appendix A. Each survey is described in more detail in the following subsections.

2.1.1.1 Ground Penetrating Radar.

Sodamide Area. A total of 1,500 linear feet was surveyed by GPR in the purported sodamide disposal area adjacent to the firewater tank. The GPR survey focused on detecting the presence of drums that were reported to have been disposed in this area. Figure 2-1 shows the locations of this and the other geophysical surveys.

Northern Portion (Decommissioned Equipment Lay-Down Area). A total of 6,600 linear feet was surveyed by GPR in the decommissioned equipment lay-down area. This survey also focused on detecting buried containers, such as drums, that would be indicative of waste disposal in the area. Small portions of the area were inaccessible to the instrumentation because of the presence of objects such as former containment vessels. Results of the two GPR surveys are discussed in Section 4, and are presented in detail in Appendix A.

2.1.1.2 Seismic Survey. Seismic surveys were performed along five traverses totaling 2,765 feet (see Figure 2-1). The fifth traverse, measuring 800 feet along McKee Road, provided no usable data due to excessive seismic noise from vehicular traffic and industrial operations in the surrounding area. Results of the seismic surveys are discussed in Section 3 and presented in detail in Appendix A.

2.1.2 TerraProbe^{SM} Sampling

The TerraProbe^{SM} system was used to collect soil gas, groundwater, and soil samples. Groundwater and soil sampling were completed at known and potential Olin Plant source areas to provide a broader understanding of contaminant distribution. Soil gas samples were collected on-site to provide information about potential unknown source areas. Off-site soil gas samples were collected to assess the potential for VOCs from groundwater to enter basements in neighboring buildings and to assist in locating monitoring wells in areas where the TerraProbe^{SM} encountered no groundwater in the overburden. Groundwater samples were collected off-site using the TerraProbe^{SM} system to optimize locations for additional monitoring wells. A description of the TerraProbe^{SM} sampling methods is provided in the Quality Assurance Project Plan (QAPP) for this RI (ABB Environmental Services, Inc. [ABB-ES], 1993).

Soil Gas Sampling. The TerraProbe^{SM} system was used to collect 87 soil gas samples at approximately 3 feet below ground surface (bgs). Samples were collected on site at locations shown on Figure 2-2. Four on-site soil gas sampling locations (SG-184 through SG-187) were added to the program presented in the Work Plan (ABB-ES, 1993). These locations were added to assure coverage at the Lab Sample Disposal Area. Table 2-1 provides a breakdown of the number and type of completed explorations as compared to the planned totals in the Work Plan. Areas investigated were as follows:

- Each of the five potential source areas of concern, plus the perimeter of the main plant building.
- Across the remaining accessible areas of the facility.
- Adjacent to three nearby off-site buildings to evaluate potential migration through basements.

In addition, off-site samples, which were collected where no overburden groundwater was present, were collected at locations shown on Figure 2-53. These samples were collected at the base of the overburden.

Soil gas samples were analyzed for selected VOCs by using an on-site gas chromatography (GC) technique. The soil gas analytical program is discussed in Subsection 2.2.2.1.

Soil Sampling. The TerraProbe^{SM} system was used to collect subsurface soil samples from the five areas at the Olin Plant identified in the Work Plan as known or suspected contaminant sources (Figure 2-4). Table 2-2 shows the number of borings drilled for soil sample collection at each area. Soil samples were collected at continuous two-foot intervals until probe refusal at each of these boring locations. Where possible, two samples from each location were selected for field analysis, one from the unsaturated and one from the saturated zone.

Seven soil sampling locations were added to those specified in the Work Plan, based on the results of field analyses. All seven locations were in the vicinity of the Well B-17 area behind the main production building and were added to attempt to bracket soil contamination in this area.

Soil samples were analyzed on-site for selected VOCs and chloropyridines by field GC. In addition, a minimum of 25 percent of all soil samples were split for analysis by the off-site laboratory. Details of the field and off-site analytical program are discussed in Subsection 2.2.2.

Groundwater Sampling. Groundwater sampling was conducted using the TerraProbe^{SM} at both on-site and off-site locations (see Figures 2-4 and 2-5). On-site groundwater samples were collected at each location where TerraProbe^{SM} soil samples were collected, to provide additional information about potential source areas. Off-site samples were collected to characterize the distribution of potential constituents of concern in overburden groundwater and provide a basis for locating off-site monitoring well pairs. Table 2-3 summarizes the TerraProbe^{SM} groundwater sampling program. TerraProbe^{SM} groundwater samples were collected at nine locations that were not specified in the Work Plan, and seven of the specified off-site groundwater samples were replaced by soil gas samples due to unsaturated conditions in the overburden. Groundwater locations were added in an effort to bracket the shallow contaminant plume in the following areas:

- on Kodak property east of the Olin Plant;
- south and southeast of planned investigations;
- in the northwest part of Olin's property; and
- on Firth Rixson (formerly Monroe Forging) property west of the Olin Plant.

At each TerraProbe^{SM} sampling point, one groundwater sample was collected for analysis. Temporary sample probes were drilled exposing a machine slotted stainless steel tip or a 0.75-inch inside diameter (ID) polyvinyl chloride (PVC) screen to the overburden groundwater. At some locations, samples could not be collected because of the absence of overburden groundwater. Soil gas samples were collected in lieu of groundwater samples at locations where overburden groundwater was absent.

Groundwater samples were analyzed on-site for selected VOCs and chloropyridines by field GC. In addition, a minimum of 25 percent of the samples were split for analysis by the off-site laboratory. Details of the field and off-site analytical programs are discussed in Subsection 2.2.2.

2.1.3 Surface Soil Sampling

Surface soil samples were collected on-site to evaluate potential direct contact exposures to site-related chemicals and potential off-site transport of contaminated soil and dust.

Surface soil samples were collected from within 2 inches of the ground surface at 15 locations throughout the Olin Plant (Figure 2-3). Table 2-4 provides a description of each location. Locations for surface soil sampling were limited to 1) areas inside the Olin Plant fence which are not accessible to the general public and 2) areas where no pavement or fixed structures prevented manual sampling access. One sample was collected at each of the five potential source areas (Tank Farm, Sodamide, BR-5, Lab Sample and TDA areas). Eight additional samples were collected from within the fenced area of the Olin Plant property away from the identified source areas but near operations areas. Finally, two background surface soil samples were collected on Olin property away from operations areas. All surface soil samples were submitted to the off-site laboratory for analysis for VOCs, SVOCs with selected pyridines, and Target Analyte List (TAL) inorganics.

2.1.4 Monitoring Wells and Piezometers

As part of the Phase I RI, fifteen monitoring wells and eight piezometers were installed to further characterize the following:

- overburden, bedrock, and deep bedrock groundwater quality,
- groundwater response to extraction well pumping, and
- piezometric gradients within and between the saturated overburden and deep or shallow bedrock zones.

These wells and piezometers, each assigned 100-series location name (e.g., MW-105, BR-101, or PZ-101) were installed to augment the existing network of 54 wells and piezometers previously installed at the study area. Figure 2-6 shows the locations of all wells and piezometers. Two overburden and six shallow bedrock piezometers were installed to provide piezometric data to help further evaluate aquifer responses to interceptor system pumping. Two on-site bedrock wells (BR-101 and BR-102) were installed to provide groundwater quality and piezometric data for previously unmonitored areas in the central part of the plant property. Off-site overburden and bedrock monitoring wells were installed at six locations to evaluate contaminant distribution beyond the Olin property boundary.

Off-site well locations were selected based on the results of TerraProbe^{SM} groundwater and soil gas sampling, and the seismic surveys. The rationale for locating each of the off-site monitoring wells is as follows:

Wells	Location/Rationale
MW-103/ BR-103	East of the Olin Plant property and Well BR-5. Positioned to monitor for potential eastward off-site contaminant migration. Easternmost well pair installed.
MW-104 / BR-104	South of the Olin Plant property and Kodak's McKee Road property. Positioned to monitor groundwater downgradient of the Olin Plant where a southerly flow component exists.
MW-105/BR-105/ BR-105D	Southwest of the Olin Plant near Aid to Hospitals. Located in an area where bedrock was interpreted to have a lower seismic velocity, indicating less competency (i.e., potentially greater hydraulic conductivity) in the shallow zone.
MW-106/BR-106	On Aid to Hospitals property west of the Olin Plant, in area interpreted from the seismic survey to be a bedrock low. The bedrock surface is believed to control, in part, overburden groundwater flow.

MW-107/BR-107	At Firth Rixson (formerly Monroe Forging), north and west of the Olin Plant. The northernmost well pair west of the Olin Plant, to delineate the northern extent of a contaminant plume located south of the drainage ditch that runs west from McKee Road to the Erie Barge Canal.
MW-108/BR-108	Between Firth Rixson (formerly Monroe Forging) and Aid to Hospitals buildings. Located approximately half way between the MW/BR-107 and MW/BR-106 well pairs to further characterize potential contamination west of and downgradient from the Olin Plant.

Both MW-108 and BR-108 were added to the RI program per field judgement after the other well locations were selected, to monitor area between the MW/BR-106 and MW/BR-107 pairs. They were not included in the original RI Work Plan scope.

Monitoring well and piezometer construction is described in further detail in the QAPP (ABB-ES, 1993). Descriptions of all wells utilized for this RI, and boring and well installation logs for those installed during the Phase I RI, are presented in Appendix A.

2.1.5.1 Overburden Piezometer and Monitoring Well Construction. Borings for the construction of overburden monitoring wells and piezometers were drilled using 4.25-inch ID hollow stem augers. With the exception of three monitoring wells, each boring was advanced to the top of bedrock or refusal for the purpose of installing the overburden well or piezometer. For MW-105, MW-106, and MW-108, borings were advanced approximately 5 feet into bedrock, using a 3 7/8-inch diameter rotary (roller) bit after auger refusal. This was done to place the well screen in the uppermost bedrock and lowermost overburden in areas where little or no overburden groundwater was expected, and provide monitoring of the shallowest groundwater present.

Soil samples were collected at two-foot continuous intervals until refusal at each well location. Each soil sample was screened with a photoionization detector (PID) and flame ionization detector (FID). One soil sample from each of four borings was collected for grain size analysis. Each was collected within the depth interval of the well screen to confirm appropriate selection of screen slot size. Grain size analysis results are provided in Appendix A.

Overburden wells and piezometers were installed using 2-inch nominal ID schedule 40 PVC riser and 0.010 inch slot size screen. With some exceptions, each monitoring well and piezometer was constructed with a 10-foot long screen. Several shorter well screen lengths were used because of shallow bedrock.

2.1.5.2 Shallow Bedrock Piezometer and Monitoring Well Construction. Shallow bedrock monitoring well and piezometer borings were to be drilled in overburden using 16-inch ID temporary steel casings and 12-inch ID permanent casings. The QAPP describes the bedrock drilling techniques that were employed for this project. With NYSDEC approval, casing sizes in overburden were downsized, using 10-inch ID temporary and 6-inch ID permanent casings. This was done to minimize the volume of cuttings which needed to be containerized and disposed of for all borings. As the temporary casing was advanced, a rotary bit and wash method was used to extend a rock socket approximately 2 feet into bedrock to seat the permanent six-inch casing. At BR-105, BR-106, and BR-108, a five-foot-deep rock socket was drilled to provide a separation from the adjacent overburden wells (MW-105, MW-106, and MW-108) which were advanced 5 feet into rock. Permanent casings were seated into each rock socket and sealed with a cement/bentonite grout mixture placed inside and outside the casing.

Once the grout had hardened, drilling was performed using an "HQ" (3.8-inch outside diameter [OD]) size rotary core bit and barrel inside the six-inch casing. After coring through the grout and beginning from the bottom of the rock socket, rock core samples were collected in 5- or 10-foot continuous intervals. Rock core samples were also screened with a PID and FID. Shallow bedrock monitoring wells were installed as open core holes with the bottom of each hole ending between 5 and 10 feet below the interpreted competent bedrock surface. Piezometer core holes were advanced approximately 15 feet into rock to allow space for sandpack and bentonite above the screen. A ten-foot length of 2-inch ID schedule 40 PVC was installed in each piezometer.

2.1.5.3 Deep Bedrock Well Construction. A single deep bedrock well (BR-105D) was installed adjacent to wells BR-105 and MW-105. The purpose of this installation was to evaluate groundwater quality and piezometric gradients in the first significant water bearing zone below the upper, less-competent bedrock. Drilling for this well was done in three additional steps to prevent possible cross- contamination from shallower groundwater. Once the permanent 6-inch ID casing was seated into bedrock and rock was cored to a depth just below the bottom of BR-105, the following was done:

1) The 3.8-inch core hole was reamed with a 5 7/8-inch diameter rotary bit inside the 6-inch casing to a depth 5 feet below the bottom of BR-105 to seat a 4-inch ID steel casing.

2) After seating the 4-inch casing into grout, coring was continued until 110 feet bgs.

3) Based on results of borehole geophysical and packer tests (see Subsections 2.1.6 and 2.1.7), a 2-inch ID schedule 40 PVC screen was installed inside the 3.8-inch core hole, extending from 70 to 80 feet bgs. The borehole below the screened interval was backfilled with a cement bentonite grout. The annulus around the screen was backfilled with filter sand and the screened zone was then isolated from the rock above by placing a bentonite seal and grout above the sand pack.

2.1.5.4 Well Development. Monitoring wells and piezometers were developed by overpumping, bailing, or surging. Attempts were made to remove a minimum of five well volumes in overburden wells and piezometers and at least 1.5 times the volume of water lost while drilling and coring for bedrock installations. All development water was containerized and turned over to Olin for discharge to the on-site treatment system. Temperature, pH, specific conductance, and turbidity were monitored during development of each well. For some of the bedrock wells it was not practical to remove 1.5 times the amount of water lost during coring. A summary of the development for each well and piezometer is provided in Appendix A.

2.1.6 Borehole Geophysics

Borehole geophysical testing was conducted in wells BR-105 and BR-105D. The purpose of the testing was to provide data that would be used to 1) select a screen depth for BR-105D and 2) correlate with data from possible future boreholes. A technical memorandum containing the geophysical logs and interpretations is provided in Appendix A.

In accordance with the Work Plan, the following geophysical logs were run:

- Fluid temperature
- Single point resistance (SPR)
- Fluid conductivity
- Video
- Caliper (hole diameter)

In addition, natural gamma and spontaneous potential (SP) tests were run while obtaining the SPR data. For each type log, at least two passes were made along the length of each borehole to verify responses: once down and once up. Test intervals were run from 25 to 45 feet bgs in BR-105 and from 50.5 to 107 feet bgs in BR-105D. These intervals represent the depth range of exposed bedrock in each borehole. The video log in BR-105D was of poor interpretive quality because of numerous gas bubbles moving up through the water column in the hole. Based on high explosimeter readings at the borehole mouth, the gas bubbles are believed to contain naturally occurring methane that either entered the borehole near its bottom or came out of solution in the water in the borehole. Video logging was not done in BR-105.

In BR-105, notable geophysical log features included:

1) A distinct decrease in fluid temperature beginning at 34.5 feet bgs.

2) A low excursion on the SPR log at 40 feet bgs, suggesting a possible fracture or fractures.

In addition, several prominent features were observed in the logs run for BR-105D, including:

1) Variations in caliper (borehole diameter) and natural gamma logs indicating possible fracturing from 56 to 60 feet bgs.

2) Excursions in the SPR and SP logs between 71 and 86 feet that suggest a fracture zone between 73 and 75 feet.

2.1.7 Packer Sampling and Testing

Packer sampling and testing was conducted in the corehole for BR-105D prior to final well installation. The purpose of this testing was to augment the borehole geophysical results as an aid in selecting a screen depth in a significant water bearing zone. Sampling and testing were conducted in continuous 5.5-foot intervals from 50.5 to 106.5 feet bgs. In all, nine samples were collected for analysis. All intervals were sampled except between 85.5 and 91 feet bgs, where not enough water could be pumped for sample collection. Each packer sample was shipped to an off-site laboratory and analyzed for VOCs, SVOCs, and five selected pyridines. The results of these analyses are presented and discussed in Section 4.3.

Following the packer sampling of the entire borehole, packer testing was conducted in each of the sampled depth intervals to provide a measurement of hydraulic conductivity. In total, ten intervals were packer tested. The interval from 77 to 80 feet bgs, was not tested because the packers were adjusted to avoid leakage across a possible major fracture zone between 73 and 75 feet. This zone was identified in the borehole geophysical testing. As specified in the QAPP, hydraulic conductivities were measured three times for each interval using variable packer and gauge pressures. A summary of the testing data is presented in Appendix A. Packer test results are also discussed in Subsection 3.2.1.

2.1.8 Groundwater Sampling

Comprehensive groundwater sampling was performed between January 18 and February 4, 1994. Monitoring wells, pumping wells, and piezometers were all sampled to provide a broader understanding of groundwater contaminant distributions. All previously installed on- and off-site wells and piezometers were included in the sampling. Seventy-four wells were sampled; five wells (B-13, E-5, EC-2, MW-105, and W-6) were dry at the time of sampling. Groundwater samples were analyzed for VOCs, SVOCs, with selected pyridines, and TAL inorganics.

Samples from six wells, in the area of BR-3 and BR-5, were analyzed for pesticides and polychlorinated biphenyls (PCBs). In addition, two wells (B-3 and MW-108) provided only enough volume for a VOCs analysis. Appendix B-4 contains the sample collection data sheets which include field parameter samples from measurements.

2.1.9 Hydraulic Conductivity Testing

Hydraulic conductivity tests were conducted on three new overburden and nine new bedrock wells installed at the study area. Both falling and rising head tests were run. Hydraulic head was measured for each test using pressure transducers connected to a Hermit 2000 datalogger. Transducer measurements were checked with an electronic water level meter. Hydraulic conductivity values were estimated from the test data using the Bouwer-Rice (1976) method in AQTESOLV (Geraghty & Miller Modeling Group, 1989). Test data plots and calculations are presented in Appendix A.

2.1.10 Water and Separate Phase Liquid Level Measurements

Prior to the start of the January/February 1994 groundwater sampling event, groundwater and separate-phase liquid levels were measured. Measurements were made to the nearest 0.01-foot from the top of protective well casings using electronic water and product level indicators. Subsequently, groundwater elevations were measured on both March 14 and June 24, 1994. A tabulation of the groundwater elevation data is presented in Appendix A.

In addition to the product meter measurements, a specially designed sampler was installed at the base of several new bedrock wells and piezometers for the purpose of detecting and/or sampling dense nonaqueous phase liquid (DNAPL).

No DNAPLs or light nonaqueous phase liquids (LNAPL) were detected in any of the wells and piezometers measured.

2.1.11 Exploration and Photogrammetric Survey

Om Popli, P.E., Inc. (Popli), ABB-ES' subcontractor, surveyed all new explorations and geophysical survey lines during December 1993 and January 1994. Horizontal positions were established to the nearest foot and groundwater surface elevations at each location were established to the nearest 0.1 feet. Vertical positions for newly installed monitoring wells and piezometers were also established to the nearest 0.01 foot for both the rim of the protective casing and the top of the uncapped well riser. Horizontal positions were tied into the New York State Plane Coordinate System and vertical positions were tied to MSL as determined by the 1929 General Adjustment. The Plane System Coordinates for the Olin RI explorations are listed in Appendix A.

A photogrammetric survey was completed by Abrams Aerial Survey, Inc. (Abrams) from aerial photography of the study area. The photography was performed in May 1993. This mapping was used in development of the habitat-based risk assessment and topographic survey. The photogrammetric database deliverable from Abrams was used in combination with the exploration survey from Popli to create site and area base maps using AutoCAD™ Release 12.0 software.

2.2 ANALYTICAL PROGRAM

Data Quality Objectives (DQOs), on-site and off-site chemical analysis, analytical data quality evaluation, and data usability for the Olin Phase I RI/FS field program are discussed below.

2.2.1 Data Quality Objectives

The data produced during the RI were compared with the defined quality assurance (QA) objectives and criteria for precision, accuracy, and completeness, as defined in the QAPP (ABB-ES, 1993). The data were also evaluated with respect to internal consistency between sampling points and to existing data from previous investigations. The primary goal of the evaluation procedures is to ensure that the data reported as a result of the investigation are representative of actual conditions at the study area and acceptable for use in subsequent evaluations. Both laboratory-related and field-related blank samples were used to evaluate whether or not the laboratory- or field-related activities represented a possible source of sample contamination. Duplicate sample results were used to evaluate data precision.

DQOs are based on the premise that different data uses require different levels of data quality. Data quality refers to a degree of uncertainty with respect to precision, accuracy, representativeness, completeness, and comparability. Specific objectives were established to develop sampling protocols and identify applicable documentation, sample handling procedures, and measurement system procedures. These DQOs were established based on site conditions, objectives of the project, and knowledge of available measurement systems.

Data obtained during this RI are intended to be used for study area characterization and determination of the vertical and horizontal distribution of chemicals in soil and groundwater. The subsequent use of measurements in calculations and evaluations is described in the following subsections.

The following four levels of data quality were used in the RI field program:

- Level I: Qualitative information for identification of sampling locations and health and safety monitoring [e.g., PID or FID meter screening of soil samples].

- Level II: Field analysis data based on qualitative/quantitative methods performed on-site [e.g., field GC analysis). These analyses provided quantitative chemical-specific information measured under similar conditions as that of an off-site laboratory, and included analysis of quality control (QC) samples (e.g., matrix spikes, duplicates, and surrogate standards).

- Level III: Laboratory-generated data obtained using USEPA- or NYSDEC-approved methods other than the NYSDEC Analytical Services Protocols (ASP) or Contract Laboratory Program (CLP) Routine Analytical Services Protocols. These data may be used for engineering studies (e.g., treatability testing), risk assessment, and site investigations, and are both qualitative and quantitative.

- Level IV: These data are generated using NYSDEC ASP methods and supported by a rigorous QA program, supporting documentation, and data review procedures. These data are suitable for use in site characterizations, risk assessments, enforcement/litigation activities, and design of remedial alternatives.

The Data Quality Levels that were followed for field and laboratory analysis are summarized in Table 2-5.

2.2.1.1 Precision and Accuracy. Precision is defined as the agreement among individual measurements of the same chemical constituent in a sample, obtained under similar conditions. Accuracy is defined as the degree to which the analytical measurement reflects the true concentration present.

Precision objectives for off-site laboratory analysis are shown in Table 2-6. The relative percent difference (RPD) of laboratory and field duplicates were calculated in order to evaluate the analytical and sampling precision. Precision of chemical data from both the field GC and off-site chemical analysis results were expressed as the RPD between duplicate analyses where:

$$RPD = \frac{|X1 - X2|}{(X1 + X2)/2} \times 100$$

where: X1 and X2 = results of duplicate analyses
$|X1 - X2|$ = absolute difference between duplicates X1 and X2

During the Phase I sampling program, field duplicates were collected at a frequency of 10 percent (i.e., one in ten samples were duplicated) and matrix spike/matrix spike duplicates (MS/MSD) were collected at a frequency of 20 percent (i.e., one in five samples were scheduled for MS/MSD analysis). Precision objectives apply to both field and laboratory duplicates. However, field duplicate results take into account the level of error introduced by field sampling techniques, field conditions, and analytical variability.

Accuracy was measured as percent recovery for matrix spikes and percent recovery of the surrogate spikes for gas chromatography/mass spectrometry (GC/MS) analyses. Accuracy objectives for off-site laboratory analysis are shown in Tables 2-7 and 2-8.

A matrix spike is a sample (of a particular matrix) to which predetermined quantities of standard solutions of certain target analytes are added prior to sample extraction/digestion and analysis. Samples are split into replicates, one replicate spiked and both aliquots analyzed.

Accuracy can also be evaluated using the recovery of surrogate spikes in the organic analyses. These spikes consist of organic compounds which are similar to the analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, and samples prior to analysis.

Percent recoveries of the surrogate and matrix spikes were reported by the laboratory for all analyses associated with the samples. Variations from 100 percent recovery may be due to matrix interferences, laboratory spike handling procedures, or sample heterogeneities between replicates. The percent recovery of the spikes was calculated from the following equation:

$$\% \text{ Recovery} = \frac{X - B}{T} \times 100$$

where:
X = measured amount in sample after spiking
B = measured amount in unspiked sample
T = amount of spike added

Accuracy of analyses of tentatively identified compounds (TICs) from GC/MS analyses was estimated by the use of internal standards. Internal standards are organic compounds similar to surrogates which are spiked into samples. The responses of the instrumentation to these spiked compounds are used to provide a qualitative estimate of non-target compounds that are identified by the use of a GC/MS library search.

2.2.1.2 Representativeness. Representativeness is defined as the degree to which the data accurately and precisely represents the true environmental conditions existing at the study area. Representativeness measurement for samples was achieved to the greatest degree possible by adhering to the Work Plan and the sampling procedures described in the QAPP. Representativeness was also achieved by evaluating analytical results for possible laboratory or sampling contamination.

2.2.1.3 Completeness and Comparability. Completeness is a measure of all information necessary for a valid study. It is defined as the percentage of measurements made which are determined to be valid measurements (i.e., amount of acceptable results divided by the total number of results multiplied by 100). As stated in EPA/540/G-87/003, Data Quality Objectives for Remedial Response Activities, 1987, "CLP data has been found to be 80-85 percent complete on a nationwide basis." This can be extrapolated to indicate that Level III and IV analytical techniques will generate data that are approximately 80 percent complete. The QA objective for this project was to obtain acceptable data for 85 percent of the laboratory data collected. Completeness was evaluated by comparing project objectives with the proposed data acquisition and was found to be 99 percent complete. This level of completeness exceeds the objectives for this program.

Comparability is a measure of the confidence with which one data set can be compared to another. Following the procedures and Standard Operating Procedures (SOPs) contained within the Phase I QAPP helped to ensure comparability of the data.

2.2.2 Chemical Analysis

Procedures for chemical analysis of environmental samples were selected to support the achievement of DQOs. Table 2-9 presents the selected analytical protocol with associated analytes. Chemical analyses performed for the Phase I RI program are:

- Field measurements for temperature, specific conductance, pH, and turbidity during groundwater sampling.
- Field measurements for total VOCs by screening each sample with the FID and/or PID meters.
- Field GC screening for VOCs for soil gas samples was performed using an on-site GC.
- Field GC screening for selected VOCs and pyridines for soil and water samples was performed using on-site GCs.

- Laboratory analysis for Target Compound List (TCL) VOCs, SVOCs and selected pyridines, pesticides and PCBs, TAL inorganics, and 2,4-TDA was performed by RECRA Environmental, located in Amherst, New York.

2.2.2.1 Field Parameters.

2.2.2.1.1 Field Measurements. All samples collected were screened in the field with a PID and/or FID for total VOCs. Additionally, groundwater samples were also measured for pH, specific conductance, temperature, and turbidity prior to collection. A summary of the groundwater field parameter measurements is in Appendix B.

2.2.2.1.2 GC Screening Analysis. Samples collected using the TerraProbe^{SM} System were analyzed in the field using field analytical techniques adapted from USEPA standard laboratory methodology. Two separate methods were used for analysis of selected target compounds of concern. GC volatile purge-and-trap methodology was used to quantify selected VOCs, and a GC micro-extraction technique was used to detect the presence of selected pyridines. Appendix B contains a detailed description of the field analysis program. To confirm the field analytical results, 25 percent of soil and water samples analyzed by field GC methods were duplicated (i.e., split samples) and analyzed by the off-site laboratory. Refer to Subsection 2.2.4.3 for a comparison between field GC screening results and off-site laboratory results.

<u>GC Volatile Purge-and-Trap Methodology</u>. GC volatile purge-and-trap methodology was used to quantify VOCs. Procedures for the purge and trap method for VOCs are described in the QAPP (ABB-ES, 1993) in SOP FGCPT00101.

The purge-and-trap method involves purging samples at ambient air temperature with helium and concentrating the VOCs on a polymer trap. VOCs are then desorbed onto the GC for compound separation and identification. Compounds were quantified using a GC set up at the Olin facility for the analysis of selected VOC halocarbons. The GC was equipped with an electron capture detector (ECD) and a 75-meter megabore column was used for compound separation. Target VOCs selected for the field analytical program include:

- carbon tetrachloride
- chloroform
- methylene chloride
- tetrachloroethene (PCE)
- trichloroethene (TCE)
- 1,1,1-trichloroethane (1,1,1-TCA)
- 1,1-dichloroethene (1,1-DCE)
- cis-1,2-dichloroethylene
- trans-1,2-dichloroethylene

GC Micro-Extraction Technique. The micro-extraction method was used to determine the presence of selected pyridine compounds in site media and was based on a report by the Olin Corporation Research Center on the feasibility of using EPA Method 625 to determine the presence of various isomeric chloropyridines. A summary of this report was provided in Appendix B of the QAPP (ABB-ES, 1993). The field screening analysis used a second GC set up on-site, equipped with an ECD. Based on results of previous investigations at the study area, the following pyridines were analyzed for as part of the field analytical program:

- 4-chloropyridine
- 3-chloropyridine
- 2-chloropyridine
- 2,6-dichloropyridine

Required calibration, matrix spikes, surrogate spikes, method blanks, analytical duplicates, and calibration check samples were analyzed and reviewed against the specified acceptance ranges listed in Tables 2-6 through 2-8. Calibration standards for each analyte of interest were run once every 24 hours. Samples with results exceeding the calibration range were either diluted and rerun or reported as estimated, as determined by the field chemist. Method blanks were run as the first run of the day, after a calibration check standard, and after any high-level sample to ensure that carry-over was not occurring. Matrix spikes were prepared and analyzed in duplicate to assess precision and accuracy.

Routine quality control activities performed during field GC analysis included the following:

- checking method detection limits for on-site instrument(s)
- performing 3-5 multi-point calibration curve compound for quantitation
- analyzing reagent blanks, duplicate samples, spiked samples, and system blanks.

2.2.2.2 Off-Site Laboratory Chemical Analysis. Data generated for the RI/FS at the Olin Study Area will be used for several purposes, depending on the RI phase and objectives, and the media of concern. DQOs for the this RI are identified by measurement in Table 2-5. The following discussion summarizes the off-site laboratory analytical program for the media collected at the study area.

Soils. Soil samples submitted for laboratory analysis were analyzed in accordance with Level IV data quality requirements as specified by NYSDEC ASP, Superfund CLP for TCL VOCs, SVOCs and selected pyridines, and TAL inorganics. 2,4-TDA analysis was also done as a special analytical services (SAS) request through the SVOC analysis. The laboratory was requested to perform library searches on all samples (i.e., TICs).

Groundwater. Laboratory analyses of TerraProbe^{SM} splits and monitoring well samples were conducted in accordance with Level III data quality requirements as specified by USEPA methods under the NYSDEC ASP for TCL VOCs, SVOCs and selected pyridines, pesticides and PCBs, TAL elements, and 2,4-TDA. It is anticipated that a Level IV analysis for selected wells may be completed in Phase II of the RI.

Tentatively Identified Compounds. During the Phase I RI, the off-site laboratory was requested to report information on non-target compounds which were detected during the VOC and SVOC analyses. Chromatographic peaks in both VOC and SVOC analyses that do not correspond to target analytes are reported as TICs by the laboratory. For each sample, the laboratory must conduct a mass spectral search of the National Institute of Standards and Technology (NIST) library for the 10 largest volatile fraction peaks and the 20 largest semivolatile fraction peaks. Identification of these peaks is made by comparison of the mass spectrum from the library with the mass spectrum of the peak. When several compounds coelute or are incompletely resolved, the mass spectra may contain molecular ions and fragments from several different chemicals. One of the criteria for the assignment of identity is that the agreement with the library's and the sample's mass spectra is within 20 percent; the goodness of fit must be greater than 80 percent. Another is that the major ions and molecular ions in the reference spectrum must also be present in the sample spectrum. TICs are reported as a specific chemical if the laboratory chemist determines that the primary ions from the sample match the library (laboratory qualifies value with a "N"). In many cases this involves professional judgment and the identification of the compound remains tentative. In cases where library comparisons do not indicate a match, the laboratory may report the compound as a chemical class (e.g., unknown hydrocarbon), or simply an unknown and qualifies the value with a "J".

When samples are contaminated with mixtures of chemicals such as fuels, the resolution of individual peaks is often difficult, and agreement of TIC mass spectra with library matches is often poor. In these cases, identification of TICs is not always straight forward and more of the TICs are reported as unknowns. Further review of many of the reported TICs reveals several compounds that can be classified as pyridines, oxygenated compounds, polynuclear aromatic hydrocarbon (PAH) or fuel-related compounds, halogenated or nonhalogenated aromatic and aliphatic hydrocarbons, sulfur containing compounds, and unknowns. A more detailed discussion regarding the chemical classes of compounds reported for samples collected during Phase I is provided in Subsection 2.2.4.

TICs that are laboratory or sampling artifacts may also be reported by the laboratory. Laboratories are required to review method blank data and identify chemicals which may be related to laboratory preparation contamination. Blank contaminants are evaluated during validation, however it is possible that low concentrations of false positive TICs may be reported.

In all cases, TICs are reported as estimated concentrations ("J"). TICs are not quantified using calibration standards. The concentration is determined by comparing the TIC response to the nearest internal standard. The method assumes a response ratio of one to one. The actual response of the TIC to the detector is unknown. The actual concentrations reported may be accurate, however, concentrations may be several orders of magnitude greater or smaller, and should only be considered a rough estimate of the concentration of the TIC.

2.2.3 Data Quality Evaluation

The data collected during Phase I of the RI underwent a systematic review for compliance with the DQOs and performance objectives of the RI. In particular, laboratory and field data were reviewed for compliance with the method QC criteria for performance and accuracy as outlined in Subsection 2.2.3.2. Fifty-three percent of the chemical data were subjected to data validation for qualification purposes in accordance with USEPA Region II Validation Standard Operating Procedures, modified with NYSDEC analytical holding time criteria (USEPA, 1992a,b).

The data were then evaluated for useability. In particular, data outside QC criteria, but not rejected, were reviewed for the magnitude of possible positive and negative bias. A data validation memorandum, summarizing the actions taken during data validation, is provided in Appendix B-2. The data validation memorandum includes a discussion of any issue in precision, accuracy, completeness, or representativeness that may affect the usability of the data. The overall usability of the data is summarized in Subsection 2.2.4 and its subheadings.

After data validation, the data were evaluated for consistency with site conditions and conceptual models were developed.

Data evaluation efforts were organized as follows:

- <u>Source Characterization</u> - was based on chemical analysis results for water and soil as well as pathway hydrodynamics, to define the possible location, size, and types of sources of contamination on-site. The analytical results of soil and groundwater sampling tasks are presented on interpretive site plans.
- <u>Geologic and Hydrogeologic Characterization</u> - incorporated the results of exploration and sampling activities, groundwater sampling and monitoring activities, as well as general hydrogeologic and hydrologic features of the study area. This characterization led to an understanding of the groundwater systems throughout the study area. Interpretive figures produced during data evaluation included cross-sections, stratigraphic surface contour maps, and piezometric plots. Hydrologic interpretation included horizontal and vertical gradient analysis and calculation of groundwater seepage velocity.

- Water Quality Characterization - was based upon the chemical analyses performed on groundwater samples, where appropriate, to evaluate measured concentrations of organic and inorganic analytes with respect to drinking water standards and other health and safety guidelines. Isopleth maps were generated that characterize the distribution of chemicals in groundwater.

2.2.3.1 Data Reduction. Data reduction at the laboratory is the process of converting measurement system outputs to an expression of the parameter which is consistent with the comparability objective. Calculations made during data reduction are described in the referenced analytical methods and in the participating laboratory QA Program Documents.

Upon receipt of laboratory data at ABB-ES, each analytical data package was turned over to data entry staff for reduction to standard data tabulations. Reduction may have occurred in one of two ways:

- the data were manually entered into data table templates
- the data were loaded from magnetic media supplied with the data package by the laboratory

Completed data tabulations were then provided to the data validation staff. As described in Subsection 2.2.3.3, two additional data tabulations were prepared.

The original data, tabulations and magnetic media are stored in a secure and retrievable fashion.

2.2.3.2 Data Validation. Analytical data generated during the Phase I RI field investigation were reviewed by the project chemist and the data validation staff. A data review of the Level III and Level IV analytical deliverables was completed.

Data review was performed following USEPA Region II validation SOPs, modified with NYSDEC analytical holding time criteria (USEPA, 1992a,b). Generally, data review involved checking the analytical hold times, the accuracy of the surrogate recoveries, precision and accuracy of MS/MSDs, checking precision of field duplicates, and evaluating the effect of laboratory and field blanks on the sample results. Level III review was equivalent to a partial validation (i.e., reviewing the CLP forms or equivalents, but not reviewing the supporting data). Level IV validation included the review of supporting raw documentation. The table below presents validation efforts completed during the Phase I RI/FS.

Matrix	Validation Review Level	Percentage of Samples Validated
Soil	IV	100 percent
Water	III	40 percent(1)

(1) Remaining water sample analyses were reviewed for completeness, and consolidated if appropriate.

Besides chemical data review, other sampling activity data were reviewed, including checking field sample data records and chains of custody.

2.2.3.3 Data Reporting. Two presentation types of analytical data were prepared and are presented in Appendix B. Data organized in Appendix B by media type (e.g., soil, groundwater). The data tables represent the following:

Table 1 -	Analytical Report of Analysis - The raw data as received from the laboratory, tabulated by media and analytical fraction. Results have been reduced to show a single value where multiple results were reported because of dilutions.
Table 2 -	Validation/Summary Table - The annotated data resulting from the review process, tabulated in a similar format as Table 1.

Each table contains sample information including the 14-digit sample identification code (i.e., identifying the sample location, sample type, horizontal and vertical locators, event number, and modifier), laboratory identification number, dates for sample collection and analysis, analytes tested with corresponding laboratory reporting limits, sample quantitation limits, dilution factors, and associated sample blanks.

2.2.4 Data Quality

A critical data quality evaluation was conducted on analytical data generated for the Phase I investigation for both field screening analyses and off-site chemical analyses.

A review of all validation actions, QC blank results, and the precision, accuracy, representativeness, completeness, and comparability parameters of the two data sets are discussed below. Analytical results for the Phase I RI are discussed in Section 4.0.

2.2.4.1 Field Screening Analyses. Water and soil preparation and analytical methods showed good precision and accuracy. QC analyses (i.e., surrogate standards and MS/MSDs) generally indicated average water and soil recovery ranges were observed within expected recovery ranges. Appendix B contains a detailed discussion of the field analytical program, related QA/QC, and field GC qualifier flag definitions.

<u>Volatile Organics</u>. Only one sample (01TW119006XRF) result out of 149 volatile surrogate standard recoveries exceeded the method performance recovery range.

Average water and soil volatile MS/MSD recoveries were observed within 79 - 112 percent and 60 - 127 percent, respectively (well within method recovery ranges).

<u>Pyridines</u>. All 138 surrogate recovery results were within the method performance limits. There are no method (SW-846) percent recovery range criteria for either pyridine or the chloropyridines. However, recovery ranges for 2-chlorophenol and 2,4-dichlorophenol (compounds similar to the chloropyridines in having distinct acid-base properties), were used as noted in SW-846 (USEPA, 1986b). All average water and soil MS/MSD recoveries (except average soil 4-chloropyridine recovery) were observed within method performance recovery ranges for semivolatile organic analyses (SVOAs). 4-Chloropyridine soil results may be biased high, based on the average recovery observed above the expected recovery range.

2.2.4.2 Off-Site Laboratory Analyses. Water and soil preparation and analytical methods showed good precision and accuracy. QC analyses (e.g., surrogate standards and MS/MSDs) generally indicated average water and soil recovery ranges were observed within expected recovery ranges. Appendix B contains a discussion of the off-site analytical program and related QA/QC information.

<u>Volatile Organics</u>. Due to trip, equipment, field, or laboratory method blank contamination, methylene chloride, 4-methyl-2-pentanone, toluene, xylenes (total), chloroform, and chlorobenzene were qualified as non-detected (U) in associated samples where the results were below the calculated blank action level. Additionally,

the following table illustrates validation actions for volatile organic analysis (VOA) samples.

Sample ID	Compound(s) Affected	Qualifier	Reason
01TW102012X1XX/DX	1,2-dichloropropane	J	Field Duplicate Precision
01TR137002X1XX/DX	Acetone	J	Field Duplicate Precision
01BR105XXDX1XX/DX	Vinyl Chloride	J	Field Duplicate Precision
01TR152004X1XX/DX	Methylene Chloride	J	Field Duplicate Precision
	Acetone	J	Field Duplicate Precision
	Chloroform	J	Field Duplicate Precision
	Tetrachloroethene	J	Field Duplicate Precision
	Toluene	J	Field Duplicate Precision
01TW10201X1XX	Undiluted results	J	Surrogate Accuracy
01TW10201X1DX	Undiluted results	J	Surrogate Accuracy
01BR101XXXX1X	All results	J	Surrogate Accuracy
01BR105XXDX1DX	All results	J	Surrogate Accuracy
01TW157015X1XX	All results	J	Sample Shipment Temperature
01TW159013X1XX	All results	J	Sample Shipment Temperature
01TW159013X1DX	All results	J	Sample Shipment Temperature

Semivolatile Organics. Due to equipment, field, or laboratory method blank contamination, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, 2-chloropyridine, and butylbenzylphthalate were qualified as non-detected (U) in associated samples where the results were below the calculated blank action level. Also, the following table illustrates validation actions for SVOA samples.

Sample ID	Compound(s) Affected	Qualifier	Reason
01BR10XXXX1XX	base/neutral results	J	Surrogate Accuracy
01TW138010XX1XX	All results	J	Holding Time Expired
01TW138010XX1DX	All results	J	Holding Time Expired
01TW159013X1XX	pyrene	J	Field Duplicate Precision
01TR152004X1XX	bis(2-ethylhexyl)phthalate	J	Field Duplicate Precision
01SS102000X1XX	phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, bis(2-ethylhexyl)phthalate,		

	benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene		
01SS111000X1XX	phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, bis(2-ethylhexyl) phthalate, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, anthracene, carbazole, indeno (1,2,3-c,d)pyrene, benzo(g,h,i) perylene	J	Field Duplicate Precision

Inorganics. Due to equipment, field, or laboratory blank contamination, lead, magnesium, and calcium results were rejected (R) for associated samples where the sample results were below the calculated blank action level.

Associated samples were estimated (J) for non-compliant matrix spike results for mercury, silver, thallium, cyanide, selenium, lead, antimony, and arsenic. Positive iron and zinc results and positive and non-detect silver, thallium, lead, and selenium results were rejected (R) in associated samples because of non-compliant matrix spike results.

Results were estimated (J) for poor laboratory duplicate precision for aluminum, arsenic, iron, potassium, chromium, and manganese for all associated samples.

Associated water samples were estimated (J) for arsenic and cyanide, and associated soil samples were estimated for lead, calcium, chromium, copper, manganese, magnesium, and nickel, because field duplicate precision criteria were not met.

Pesticides/PCBs. Due to the limited number of samples submitted for analysis, no validation was requested for these analyses. Results for these analyses, however, were generated using Level III data quality analytical protocols. These protocols provide assurance that the data are adequate for their intended use.

Tentatively Identified Compounds. TICs identified by the laboratory in samples collected as part of the Phase I RI program included the following chemical classes: pyridine-related compounds; oxygenated compounds; alcohols; PAH and fuel-related compounds; sulfur containing compounds; unknown halogenated and nonhalogenated aliphatic and aromatic organic compounds; and unknowns. In general, a pattern was recognized whereby soil sample analyses indicated the presence of SVOC TICs including, pyridine-related compounds, oxygenated compounds, ether compounds, unknown hydrocarbons, and PAH and fuel-related compounds in the majority of soil samples. In contrast, groundwater sample analyses indicated the presence of VOC TICs including, sulfur-containing compounds, pyridine-related compounds, alcohols, and aromatic VOCs. SVOC TICs were also observed, but to a lesser degree.

The highest total TIC concentration for both soils and groundwater was observed to generally be reported with the classification of oxygenated compounds. In some cases, two or more detected TICs were added to report a total estimated concentration. This occurrence was documented on the TIC summary tables by including the total number of detected TICs in that class in parentheses. For example, the SVOC TIC report for sample 01SS103000X1XX indicated the presence of an oxygenated compound totaling 19000 J (2) ug/kg. The (2) indicates two TICs were added to obtain the estimated concentration for this classification. In all cases, TICs are reported as estimated concentrations. TICs are not quantified using calibration standards. Concentration is determined by comparing the TIC response to the nearest interval standard. The method assumes a response ratio of one to one. The actual response of the TIC to the detector is unknown. The actual concentrations reported may be accurate, however, concentrations may be several orders of magnitude greater or smaller, and should only be considered a rough estimate of the concentration of the TIC.

2.2.4.3 Comparison of Field Screening and Off-Site Laboratory Analytical Results. Qualitative and quantitative comparisons were conducted to evaluate agreement between field screening results and off-site laboratory results. Qualitative comparisons included evaluating agreement between the data sets with regard to the presence and/or absence of individual chemical constituents. Quantitative measurements were conducted statistically to evaluate the relationship between the two data sets.

Qualitative comparison of the two data sets revealed that the data sets agree with regard to presence or absence of selected chemicals. When comparing results, the following percentages of agreement were noted:

COMPARISON TYPE	ANALYSIS			
	VOA		PYRIDINES	
	WATER	SOIL	WATER	SOIL
Non-detected off-site and non-detected on-site	76%	84%	60%	63%
Detection off-site and detection on-site	17%	7%	24%	20%
TOTAL PERCENTAGE	93%	91%	84%	83%

Field screening results for 2-chloropyridine, however, did not compare well with laboratory results. Where field analyses indicated no detection of 2-chloropyridine some laboratory results did show a presence of this compound; 58.3 percent waters and 36.4 percent soils samples analyzed for by field screening did not show a detection, but did so in the laboratory analysis for this compound.

Bar charts representing the total configuration of this comparison are included in Appendix B.

Quantitative comparison consisted of plotting data via a linear regression comparison. This regression analysis is used to simply identify how well the data sets, when plotted against each other, fit a linear model. Along with this analysis, the data and a best-fit line were plotted for visual confirmation of the linear fit. A correlation was also calculated as an indicator of how well the data fit a straight line: the closer to 1.0, the better to fit. These plots are included in Appendix B.

The quantitative evaluation demonstrates that the majority of field screening results have a linear relationship with the off-site laboratory results (correlation coefficients greater than 0.910). However, the field screening results were observed to be biased high when plotted against off-site laboratory results (i.e., conservative measurements).

This is not the case for aqueous chloroform and TCE results, however. These results, when plotted against laboratory results, were observed to be biased low.

Regression plots were generated when field and laboratory results were both identified as being "hits", where instances of this was greater than three times, and assuming a normal distribution. The following table summarizes the quantitative evaluation:

Compound	Field Screening Results Bias	Correlation Coefficient
2,6-dichloropyridine - soil	high	0.919
- water	high	0.998
Dichloroethenes - water	high	0.997
Chloroform - water	low	0.619
PCE - water	high	0.968
TCE - water	low	0.980

2.3 PRELIMINARY IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND STATE CRITERIA GUIDELINES

Applicable or Relevant and Appropriate Requirements (ARARs) and State Criteria Guidelines (SCGs) are federal and state public health and environmental requirements used to (1) evaluate the appropriate extent of cleanup, (2) define and formulate remedial action alternatives, and (3) govern implementation and operation of the selected action. To properly consider ARARs and SCGs and to clarify the function of these requirements in the RI/FS and remedial response processes, the National Contingency Plan (NCP) (USEPA, 1990) (40 CFR Part 300) defines two ARAR components: (1) applicable requirements, and (2) relevant and appropriate requirements. These definitions are discussed in the following paragraphs.

Applicable requirements are those federal and state requirements that would be legally applicable, either directly or as incorporated by a federally authorized state program. Requirements that specifically address and have jurisdiction over a given situation are considered "applicable requirements." An example of an applicable requirement is the use of Maximum Contaminant Levels (MCLs) for a site where groundwater contamination enters a public water supply. For the study area, MCLs may not be applicable because the area is served by a public water supply that is drawn from a surface water body.

Relevant and appropriate requirements are those federal and state requirements that, while not legally "applicable," can be applied to a site if it is determined that site circumstances are sufficiently similar to those situations that are covered, and use of the requirement makes good sense. Relevant and appropriate requirements are intended to have the same weight and consideration as applicable requirements.

The term "relevant" was included so that a requirement initially screened as nonapplicable because of jurisdictional restrictions would be reconsidered and, if appropriate, be included as an ARAR for the study area. For example, MCLs would be relevant and appropriate requirements at a site where groundwater contamination could affect a potential, rather than actual, drinking water source.

Other requirements to be considered (TBCs) are federal and state nonpromulgated advisories or guidelines that are not legally binding and do not have the status of potential ARARs and SCGs. However, if there are no specific ARARs and SCGs for a chemical or site condition, or if existing ARARs and SCGs are not deemed sufficiently protective, then guidance or advisory criteria should be identified and used to ensure protection of public health and the environment.

Under the description of ARARs in the NCP, state and federal environmental requirements must be considered. These requirements include ARARs that are:

- chemical-specific (i.e., govern the level or extent of site remediation);
- location-specific (i.e., pertain to existing site features); and
- potential action-specific (i.e., pertain to proposed site remedies and govern implementation of the selected site remedy).

2.3.1 Chemical-Specific ARARs and SCGs

Chemical-specific ARARs and SCGs are usually health- or risk-based standards limiting the concentration of a chemical found in or discharged to the environment. They govern the extent of site remediation by providing either actual clean-up levels, or the basis for calculating such levels. For example, groundwater standards may provide necessary cleanup goals for sites with contaminated groundwater. Chemical-specific ARARs and SCGs for the study area may also be used to indicate acceptable levels of discharge in determining treatment and disposal requirements, and to assess the effectiveness of future remedial alternatives. Table 2-10 lists and summarizes the potential chemical-specific ARARs and SCGs that may apply to the study area.

Groundwater in the vicinity of the study area is not used as a drinking water source and residents are served by public drinking water. Therefore, drinking water standards, promulgated under the Safe Drinking Water Act (SDWA) MCLs (40 CFR 141.11-141.16) and SDWA Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50-141.51), and New York State Department of Health (NYSDOH) Public Water Supplies Drinking Water Standards (10 NYCRR Subpart 5-1) are not directly applicable. These standards however, are used during the RI/FS to compare to the concentration of chemicals detected in the groundwater (Table 2-11). New York State Water Quality Regulations for Groundwater (6 NYCRR Parts 701 - 705) are applicable. Groundwater in the Rochester area is classified as Class GA.

Surface water quality is regulated under the Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC) and New York State Water Quality Regulations for Surface Water (6 NYCRR Parts 701 - 703). The CWA AWQC are nonenforceable guidance values developed under the CWA and are used by the state to establish water quality standards for designated uses of surface water bodies. New York State Water Quality Regulations establish criteria for the classification of surface waters and set numeric standards for each water quality classification. At the study area, the nearby Erie Barge Canal is designated an NYS Class B stream. CWA AWQC and NYS Class B surface water standards and guidance are included in Table 2-11.

2.3.2 Location-Specific ARARs and SCGs

Location-specific ARARs and SCGs pertain to natural site features (e.g., wetlands, floodplains, and sensitive ecosystems) and man-made features (e.g., existing landfills, disposal areas, and places of historical or archeological significance). These ARARs and SCGs generally restrict the concentration of hazardous substances or the conduct of activities based on a site's particular characteristics or location.

The Erie Barge Canal is the only feature associated with the study area that is protected by federal and state regulations. The water quality of the canal is regulated under CWA and NYSDEC Water Quality Regulations; however, these regulations were presented and discussed in the previous subsection, Chemical-specific ARARs and SCGs, because they have numeric standards associated with the regulations. No other study area features were identified that are regulated or protected by location-specific ARARs and SCGs.

2.3.3 Action-Specific ARARs and SCGs

Action-specific ARARs are technology- or activity-based limitations controlling actions at hazardous waste sites. Potential action-specific ARARs will be identified in the FS.

2.4 EXISTING REMEDIAL ACTION

A system of overburden and bedrock groundwater interceptor wells is presently in operation at the Olin Plant to prevent further migration of contaminants off the Olin property. The system includes 10 overburden wells (all W- and S- series wells and E-1), which began pumping in 1983, and five shallow bedrock wells. Two of the bedrock wells (BR-2 and BR-3) began pumping in 1989, and three others (BR-5, BR-6, and BR-7) were added to the system in 1991. The overburden wells extend along the western and southern property boundaries, and the bedrock wells are located in the southwest, central and east parts of the Olin Plant property (see Figure 2-6).

Groundwater pumped by the interceptor system wells is passed through granular activated carbon to remove organic constituents, merged with plant effluent, and discharged to the Monroe County Pure Waters POTW. Olin regularly monitors interceptor system flow rates, carbon system influent and effluent concentrations, and groundwater levels in the vicinity of pumping wells.

3.0 SITE PHYSICAL CHARACTERISTICS

This section discusses the physical characteristics of the study area. Included in this discussion are site geology and hydrogeology, with results of physical testing conducted during the Phase I RI.

3.1 GEOLOGY

This subsection describes the surficial and bedrock geology of the study area. The geologic setting is an important determinant of the hydrogeologic environment. Three interpreted geologic cross sections have been developed; Figure 3-1 illustrates the location of each cross section. Figures 3-2 through 3-4 present the three interpreted geologic cross sections at the study area.

The surficial geology of the study area is characterized by Late Pleistocene glacially deposited stratified sands and silty sands. In general, sediments in the upper part of the overburden are more poorly graded than the lower part. Upper overburden sediments show signs of stratification. The sands and silty sands are covered locally by fill interpreted to be a recompacted glacial sediments. Collectively the undisturbed sediment and fill are referred to as overburden in this report. Overburden thickness in the McKee Road area ranges from approximately 10 to 20 feet.

Bedrock underlying the overburden has been identified as the Lockport Dolomite (Olin, 1990). Regionally, this formation consists of flat or very gently dipping medium-to-thick bedded fine-grained dolomite with interbedded shales (Williams, 1990). Within the study area, the formation is characterized by light gray color, medium bedding, and fine-grained texture with interbedded shale lenses and stringers. The bedrock surface is interpreted to have little to moderate relief, with elevations ranging from approximately 520 to 530 feet above MSL. Figure 3-5 shows interpretive bedrock surface elevation contours in and around the Olin property area. Local bedrock highs exist onsite in the Tank Farm Area and at the southeast corner of the Olin property. Apparent bedrock lows are present off Olin's southern boundary and at the extreme northwest corner of the Olin Plant property.

The seismic surveys performed in the southern part of the Olin property and to the west and southwest indicate that the bedrock surface occurs between 8 and 17 feet bgs. Two seismic anomalies were interpreted to represent areas of potentially higher fracture density (and hence higher hydraulic conductivity) in the shallow rock and were used in selecting locations for wells BR-105 and BR-106. Results of the seismic surveys were also used in constructing the geologic cross sections presented in Figures 3-2 through 3-4.

Based on examination of rock cores from the study area, an upper fractured or less-competent bedrock zone ranges in thickness from 11 to 40 feet (27 to 54 feet bgs). Horizontal to subhorizontal fracturing is common along shale lenses and partings, especially in this less-competent zone. Fractures within the upper zone appear to be primarily near horizontal. Some moderate weathering is present, along with apparent partings along calcite or gypsum stringers.

Below the upper zone, the bedrock becomes less fractured and weathering decreases. The deeper rock also contained less shale than the upper zone.

One boring completed during the Phase I RI (BR-105D) extended a significant depth below the upper less-competent zone and encountered a deeper apparent water-bearing fracture zone. This zone was encountered between 73 and 75 feet bgs, or approximately 40 feet below the bottom of the upper less-competent zone. The deeper zone was not identifiable from rock cores, but was readily apparent from packer testing and borehole geophysics. This zone appears to correspond with a horizontal water-producing feature in the east wall of the Dolomite Products Co., Inc. quarry, located approximately 4,000 feet west of the Olin property.

3.2 HYDROGEOLOGY

This subsection discusses the groundwater flow regime at the study area. It begins by presenting the results of in-situ hydraulic conductivity testing conducted during the Phase I RI and then discusses groundwater flow conditions in the overburden and bedrock based on information from the Phase I RI and previous investigations.

3.2.1 Hydraulic Conductivity Testing Results

Hydraulic conductivity testing during the Phase I RI included slug tests conducted in each newly installed monitoring well and packer testing conducted in the BR-105D borehole. Both testing methods provide a measure of the hydraulic conductivity in a limited zone immediately surrounding the tested well or packered section of borehole. Consequently, the hydraulic conductivity values produced by individual tests may or may not be representative of the properties of the aquifer monitored by the well. Results from these tests are usually viewed as order of magnitude estimates of aquifer hydraulic conductivity and are often most useful for identifying differences in hydraulic properties between different locations or depths. They also define a range of hydraulic conductivity values that is likely representative of aquifer-wide properties.

All slug test data were analyzed using the method of Bouwer and Rice (1976), as applied by the AQTESOLV computer program (Geraghty & Miller Modeling Group, 1989). Tests conducted in overburden wells produced hydraulic conductivity values ranging from 1.9×10^{-5} to 7.7×10^{-3} centimeters per second (cm/sec), with the highest values coming from tests conducted in MW-104. Values from most tests were in the 10^{-4} cm/sec range, agreeing with results from previous overburden tests (Olin, 1982).

The tests conducted in the bedrock wells produced data that fit the analysis method less well than those in the overburden, most likely because the fractured bedrock does not strictly adhere to the test method assumption of a porous media aquifer. Most of the Bouwer and Rice semilog data plots for these tests did not result in the readily identifiable straight line segment required by the analysis method. Despite this limitation, the tests are believed to provide reasonable order of magnitude estimates of the bedrock hydraulic conductivity.

The shallow bedrock well slug tests produced estimated hydraulic conductivity values ranging from 4.0×10^{-5} to 1.7×10^{-2} cm/sec. This relatively wide range of values appears to include one result that is unrealistically low, based on a review of data collected during well development. During development of well BR-105, the well that produced the lowest hydraulic conductivity estimate (average value of 4.3×10^{-5} cm/sec), water was pumped at an average rate of 10 gpm with very little drawdown in the pumped well. This pumping rate would theoretically produce a very large drawdown (i.e, more than 400 feet, based on the Theis (1939) equation) if the aquifer hydraulic conductivity were as low as indicated by the slug test. Also, the maximum water level change recorded during the tests in BR-105 was less than 27 percent of the calculated volume displaced by the slug. This suggests that the water level may have recovered so quickly during the tests that the data logger failed to record most of the recovery. Consequently, BR-105 may actually be located in an area of relatively high hydraulic conductivity. Previous testing in the shallow bedrock produced hydraulic conductivity estimates from about 10^{-4} to 10^{-3} cm/sec (Olin, 1990).

The packer testing of the BR-105D borehole identified a single zone of higher hydraulic conductivity in the bedrock beneath the upper fractured zone. This zone, located from approximately 73 to 75 feet bgs, appears to have a hydraulic conductivity similar to that in the upper fractured zone, despite being separated from it by approximately 40 feet of lower permeability rock.

The packer tests results indicate that bedrock below the shallow fractured zone has a much lower permeability than the shallow zone, except in one relatively thin zone. The tests produced essentially two different estimated hydraulic conductivity values for the deeper bedrock; one for the zone from 72 to 77.5 feet bgs (2.4×10^{-4} cm/sec) and another, much lower value for all the other tested zones above and below this horizon (approximately 10^{-6} cm/sec). Figure 3-6 is a graphical presentation of the packer test results, showing estimated hydraulic conductivity value versus depth bgs.

3.2.2 Groundwater Flow Conditions

Groundwater beneath the study area is present in both overburden and bedrock. Most flow in the bedrock is believed to occur in the upper part of the rock, where fracturing appears more extensive than at depth. Consequently, the focus of bedrock groundwater flow discussion and interpretation is primarily on the shallow bedrock system. No barrier to flow between the overburden and the upper bedrock has been identified.

Flow conditions are characterized in the following subsections using groundwater elevation data from March 1994. At the time of measurement, both overburden and bedrock pumping wells were in operation at the Olin Plant. The effect that the pumping wells have on natural gradients is considered in evaluating the hydrogeology at the study area.

3.2.2.1 Overburden Groundwater Flow Conditions. The groundwater table in the overburden is generally less than 10 feet bgs throughout study area. Overburden groundwater flow appears to be controlled to some degree by the underlying bedrock surface topography, the nature and distribution of water bearing fractures, and flow directions in bedrock. Figure 3-7 presents interpreted piezometric contours for overburden groundwater developed using March 14, 1994 water level measurements. Several areas show a significant water table depression due to active pumping. These include the areas around wells W-1, W-2, S-3, E-1, and the overburden wells adjacent to bedrock well BR-5A.

Several monitoring wells west of McKee Road are screened in both overburden and shallow bedrock. These include EC-1, MW-105, and MW-106, and MW-108. Both EC-1 and MW-108 were not included in the overburden piezometric contouring because groundwater was found only in the bedrock portion of the wells at the time of measurement. MW-105 was dry at the time of measurement, while MW-106 was included as an overburden data point because the water level was above the bedrock surface there. An approximate boundary indicating the limit of saturated overburden is shown on Figure 3-7. This boundary was located based on both water level data from March 1994 and the TerraProbe^{SM} groundwater sampling conducted in the fall of 1993.

The piezometric contours indicate that overburden groundwater flows mainly to the west and south from the Olin property toward the Erie Barge Canal and Buffalo Road. A southeastward flow component is also present at the southeast corner of the Olin Plant property. A groundwater divide running from southeast to northwest is evident beneath the central part of the Olin Plant property, separating groundwater flowing to the west and southwest from that flowing to the east.

The overburden piezometric contours indicate localized areas of successful groundwater capture by the interceptor well system, but are constructed from data that are too widely spaced in most areas to demonstrate the presence or absence of capture. Specifically, capture is evident along the southern boundary of the Olin Plant, where there appears to be a groundwater divide, and at wells W-1, W-2, and W-4 along the western boundary.

A typical overburden groundwater linear flow velocity was estimated using an average hydraulic gradient and a typical overburden hydraulic conductivity.

Horizontal hydraulic gradients in the overburden average about 0.013 feet per foot (ft/ft) in areas away from the pumping interceptor wells located south, west, and north of the Olin Plant main building. Assuming an average hydraulic conductivity of 1×10^{-4} cm/sec (calculated from the results of slug tests of the newly installed wells) and an effective porosity of 30 percent, this gradient results in a linear flow velocity of 4.5 feet per year.

3.2.2.2 Bedrock Groundwater Flow Conditions. Figure 3-8 presents interpreted piezometric contours for shallow bedrock groundwater, developed using March 14, 1994 water level measurements. Beneath most of the study area, the shallow bedrock underlies and is in hydraulic communication with the saturated overburden. However, in an area west and southwest of the Olin Plant, the overburden is unsaturated and the water table resides in the shallow bedrock (see Figure 3-8).

Based on the piezometric contours, bedrock groundwater is interpreted to flow primarily west and southwest from the Olin Plant toward the Erie Barge Canal. The strong southerly flow component present in the overburden groundwater system at the south end of the plant properties is absent in the shallow bedrock. Bedrock groundwater flow directly beneath the Olin Plant appears to be governed by the bedrock pumping wells, especially at BR-5A along the eastern property line and at BR-2 in the south central part of the Olin Plant property.

The shallow bedrock piezometric contours indicate localized areas of successful groundwater capture by the interceptor well system, but are constructed from data that are too widely spaced in most areas to demonstrate the presence or absence of capture. Specifically, capture is evident in the southern part of the Olin Plant, at wells BR-3 and BR-6, and at BR-5 in the eastern boundary.

The topography of the bottom of the shallow fractured zone appears to exert some control over shallow bedrock groundwater flow. The cross sections presented as Figures 3-2 through 3-4 shows the piezometric surface roughly paralleling the interpreted top of competent bedrock.

To the west of the Olin Plant, shallow bedrock groundwater flows toward the Erie Barge Canal, where it has been believed to discharge. Piezometric data from the recently-installed westernmost shallow bedrock wells suggest that groundwater may not discharge to the canal during most of the year.

The water level in the canal is lowered by about 10 feet each winter and then raised again each spring. During the high water period (roughly May through November), the water level in the canal appears to be equal to or higher than the piezometric heads in the four westernmost bedrock wells (BR-105, BR-106, BR-107, and BR-108). Under these conditions, groundwater discharge to the canal appears unlikely, and flow may continue beneath the canal. Discharge to the canal may still occur during winter low water conditions.

Piezometric measurements between paired overburden and shallow bedrock wells show a general downward vertical hydraulic gradient. This is most pronounced for well pairs MW/BR-106, MW/BR-107, and MW/BR-108, located west of McKee Road. At well pairs MW/BR-104 and MW/BR-103 to the south and east of the Olin Plant, respectively, downward vertical gradients are less pronounced. Based on measurements from BR-105 and BR-105D, downward vertical gradients also exist between the upper fractured bedrock, at 15 to 45 feet bgs, and the fractured water bearing zone at 70 to 80 feet bgs (see Figure 3-4). Water levels in two other deep bedrock wells on-site (BR-2D and BR-3D) are markedly lower than adjacent shallow bedrock wells.

Typical linear flow velocities for shallow bedrock groundwater were estimated using site-specific values for the hydraulic gradient and hydraulic conductivity, and an assumed effective porosity. Horizontal hydraulic gradients (i_H) in the bedrock range from 0.01 to 0.05 ft/ft in areas remote from pumping interceptor wells at the Olin Plant. Using an average hydraulic conductivity of 6.5×10^{-3} cm/sec and assuming an effective porosity of 10 percent, the linear flow velocity in the shallow bedrock system is estimated to range from 1.8 to 9.2 feet per day.

3.3 SITE PHYSICAL CHARACTERISTICS SUMMARY

In summary, the Phase I RI identified the following physical characteristics of the Olin Plant and surrounding area:

- study area geology consists of 10 to 20 feet of till overburden, consisting of sands and silty sands, overlying Lockport Dolomite bedrock;

- primary groundwater flow occurs in the saturated parts of the overburden and the uppermost 11 to 40 feet of bedrock, which is generally more fractured and weathered than the deeper rock;
- a deeper water-bearing zone was identified within the more competent deep rock, between 73 and 75 feet bgs;
- groundwater beneath the Olin Plant flows primarily to the south, southwest, and west, with a smaller flow component toward the southeast;
- hydraulic conductivity estimates range from 1.9×10^{-5} to 7.7×10^{-3} cm/sec in the overburden and from 4.0×10^{-5} to 1.7×10^{-2} cm/sec in the shallow bedrock;
- deeper bedrock hydraulic conductivities were estimated be approximately 10^{-6} cm/sec in the competent rock and 2.4×10^{-4} in the water-bearing zone between 73 and 75 feet bgs; and
- groundwater capture is evident in some areas of the Olin Plant but evidence of capture is inconclusive in other areas.

4.0 NATURE AND DISTRIBUTION OF CONTAMINATION

This section presents analytical results for samples collected during the Phase I RI field program and discusses the nature and distribution of contamination based on these and the results of previous investigations. Tabulations of the off-site laboratory and field analytical results for each medium are presented in Appendix B-1 and B-2, respectively. Subsection 2.2.3 describes data validation and evaluation procedures performed on the various types of analytical data collected during the Phase I RI. In the following subsections, results are discussed separately by media.

The GPR surveys of two areas at the Olin Plant property, the Sodamide area and the Decommissioned Equipment Lay-Down Area, detected no anomalies that suggest the presence of buried waste materials that could be continuing sources of contamination. Buried objects that were interpreted to be pipes were detected by the GPR in both areas, and chaotic signals typical of heterogeneous material were detected in the Decommissioned Equipment Lay-Down area in the north part of the Olin Plant property. No signals indicative of buried drums, which were the targets of both surveys, were detected in either area. Appendix A presents the results of the GPR surveys.

4.1 SOIL GAS RESULTS

As discussed in Subsection 2.2.2, soil gas samples were analyzed by field screening for nine selected VOCs. Figure 4-1 presents an interpreted concentration isopleth map showing the distribution of summed VOC concentrations. The individual sample analysis results for each detected VOC are shown in Table 4-1. The primary detected constituents were carbon tetrachloride, in 38 percent of all samples; chloroform, in 31 percent of all samples; and PCE, which was found in 29 percent of all samples. 1,1,1-trichloroethane (1,1,1-TCA) was the only VOC not detected in any of the soil gas samples. The highest concentration of VOCs was detected in soil gas sample SG-120, collected near the eastern part the Well B-17 Area. Concentrations of carbon tetrachloride and chloroform at SG-120 measured approximately 10 times the next highest concentrations for these constituents in other samples.

The concentration isopleths indicate two primary areas of VOCs in soil gas within the Olin Plant property. The first of these is the Well B-17 Area (e.g., SG-120). The second is the Lab Sample Area, located in the central part of the plant property. Contouring of VOCs, off the western side of the Olin property, shows two concentration lobes that appear to mimic the distribution of VOCs in overburden groundwater.

Three off-site soil gas samples (SG-174, SG-175, and SG-176) that were collected to evaluate potential migration of VOCs into basements or floor slabs via soil gas detected several VOCs that may be related to the Olin Plant. However, at SG-175, no VOCs were detected in a second sample (SG-183) collected at the same location. The second sample was collected from 13 feet bgs, or 10 feet deeper than SG-175. This result may indicate the presence of a shallow source of VOCs not related to Olin.

4.2 SURFACE SOIL AND SUBSURFACE SOIL RESULTS

Both surface and subsurface soil samples were collected at the Olin Plant during the Phase I RI. Subsurface soil sampling was focused on five identified and potential contaminant source areas at the plant, whereas surface soil samples were collected from locations throughout the property to provide data to support risk assessment. The following subsections present the results of soil sampling and discuss the nature and distribution of chemical constituents in soil.

4.2.1 Surface Soil Results

All of the fifteen surface soil samples collected were found to contain detectable concentrations of at least one chloropyridine isomer and several PAHs. A summary showing the analytes detected, frequency of detection, and maximum concentrations in surface soil is shown in Table 4-2. Chloroform was the only VOC detected in surface soils (up to 1 micrograms per kilogram [μg/kg]), and was detected in four of the fifteen samples. The highest concentrations of chloropyridines and PAHs were at SS-110, which is adjacent to railroad tracks near the Well B-17 Area. Other samples with relatively high PAH and chloropyridine concentrations include SS-109, located along a graveled access road in the southern portion of the plant property, and at SS-113, just off the south end of the Tank Farm Area.

Inorganics detected in surface soil samples include chromium (up to 180 milligrams per kilogram [mg/kg]), lead (up to 530 mg/kg), and mercury (up to 210 mg/kg). Because background samples (SS-106 and SS-107) also contained detectable concentrations of PAHs and chloropyridines that suggest some site impacts, inorganic concentrations were not compared to the results for these samples. Comparing inorganic concentrations to literature values indicates that chromium, mercury, and lead concentrations are above background ranges for surface soils in the eastern United States (McGovern, n.d.). Many of the higher inorganic concentrations were detected in samples collected from the Tank Farm Area (SS-104). Only samples SS-104 and SS-103 contained inorganics above the respective background concentration ranges from literature.

4.2.2 Subsurface Soil Results

Subsurface soil results are discussed individually by identified or potential contaminant source area (see Figure 1-2). Figures 4-2 through 4-6 present a summary of VOCs and SVOCs detected at each area. These figures identify samples collected from the saturated zone, versus those from the unsaturated zone, and show only those compounds detected in each individual boring.

Well BR-5 Area. Relatively few VOCs and SVOCs were detected in soil samples from the Well BR-5 area, and those detected were generally at low concentrations (see Figure 4-2). VOCs at less than 12 μg/kg and chloropyridines and TCL SVOCs at less than 1,000 μg/kg were detected in borings T-106 and T-119, located 50 and 100 feet, respectively, west of Well BR-5. Field laboratory results indicate no chloropyridines or selected VOCs were present in subsurface soil samples collected north and south of Well BR-5 (T-120 and T-121).

Lab Sample and Off-Specification Material Disposal Area. Relatively few VOCs and SVOCs were detected in this area (see Figure 4-3). Concentrations of 2-chloropyridine were detected by field analysis in two samples (T-122 and T-123), but were not confirmed by the off-site laboratory split sample results for one of the borings (T-122). No off-site split sample from T-123 was analyzed. Several other SVOCs were also detected in one sample (at 2 feet bgs) from T-122, but at concentrations less than 1,000 μg/kg.

One of the concerns at the Lab Sample Area was the reported release of TCBO. The TIC data reported in samples from this area show no evidence of TCBO or related compounds, except for an unknown oxygenated compound detected during the SVOA analysis for samples collected from locations T-122 (2 feet bgs) and T-124 (6 feet bgs) (see Appendix B).

Tank Farm Area. The analytical data indicate no areas of significant soil contamination are present in the Tank Farm area (see Figure 4-4). Concentrations of VOCs below 100 μg/kg and/or SVOCs, including chloropyridines, below 1,000 μg/kg were detected in samples from each boring location.

Sodamide Area. VOCs and pyridines were detected in samples from each of the three borings within the Sodamide area, but were generally at low concentrations (see Figure 4-5). The highest pyridine concentration detected was 2-chloropyridine at up to 2,800 μg/kg at 2 to 4 feet bgs at T-139. The highest VOC concentration was 760 μg/kg of 1,1-DCE at 0 to 2 feet bgs in T-138.

Well B-17 Area. The highest concentrations of TCL VOCs, SVOCs, and pyridines in subsurface soil at the Olin Plant were all detected in samples from the Well B-17 Area (see Figure 4-6). The highest concentrations in the area were found in the paved alcove behind the main plant building and adjacent to Well B-17. CLP analyses results show VOCs and pyridines in both saturated and unsaturated soil samples at concentrations exceeding 1,000 μg/kg. Samples collected from borings north (T-153), south (T-151), and east (T-158) of the alcove indicate that the chloropyridines in the unsaturated zone are not confined to the alcove but are distributed along the outer edge of the chlorinator area.

Much lower concentrations of VOCs and chloropyridines in soils at T-161, T-160, and T-159 indicate that the distribution of these constituents in unsaturated soil has been delineated to the east of the chlorinator buildings. Concentrations above 1,000 μg/kgmg/kg of several SVOCs were detected in T-159, but appear unrelated to the Well B-17 area because these analytes were not detected in samples from the alcove where the highest VOC and SVOC concentrations were detected.

4.3 GROUNDWATER RESULTS

This subsection presents the results of groundwater sample analyses. Groundwater was collected from all available wells, piezometers and TerraProbe^{SM} borings in the study area. TerraProbe^{SM} samples were analyzed by both the field and off-site laboratories. Off-site laboratory results are given preference in developing concentration isopleths. Field analytical results, however, are included in the characterization of selected VOCs in overburden groundwater wherever an off-site split sample result is not available for a sample. Tables 4-3 and 4-4 present summaries of off-site laboratory data for overburden and bedrock groundwater, respectively.

In addition to well, piezometer, and TerraProbe^{SM} samples, nine packer samples were collected from the borehole for BR-105D at depths ranging from 51 to 106 feet bgs. Analytical results for these samples show concentrations of several VOCs and pyridines that have been detected in shallow bedrock wells at the Olin Plant. VOCs detected included 1,2-DCE (up to 250 micrograms per liter [μg/L]), vinyl chloride (up to 46 μg/L), and benzene (up to 140 μg/L). 2-Chloropyridine at up to 8,000 μg/L and lesser concentrations of other pyridines were also detected. Although concentrations of these constituents were generally higher in the shallow depth samples than in deeper samples, no clear pattern showing discrete vertical zones of higher concentrations are interpreted from the analytical results. The laboratory results for packer samples are provided in Appendix B-2.

Discussion of the groundwater results is organized by parameter classes, which include TCL VOCs, TCL SVOCs and pyridines, TAL inorganics, and TCL pesticides and PCBs. Interpreted concentration isopleth maps were prepared for total concentrations of three different groups of VOCs and the pyridines. These groups are as follows:

Selected VOCs	Chlorinated Ethenes
1,1,1-TCA	1,2-DCE
1,1-DCE	PCE
1,2-DCE	TCE
carbon tetrachloride	vinyl chloride
chloroform	
methylene chloride	

PCE
TCE

Pyridines	BTEX compounds
2,6-dichloropyridine	benzene
2-chloropyridine	toluene
3-chloropyridine	ethylbenzene
4-chloropyridine	total xylenes
pyridine	

The group designated as selected VOCs includes all VOCs for which the field laboratory analyzed samples. These analytes were previously identified as the primary site-derived VOCs (Olin, 1990), and their presence generally defines the full areal extent of VOCs in groundwater. The other two VOC groups consist of compounds which typically share a common source. The four chlorinated ethenes often occur together in groundwater as a result of releases to the environment of PCE and/or TCE and subsequent dechlorination through anaerobic biological activity. The BTEX compounds are all common components of fuels.

4.3.1 Semivolatile Organics and Pyridines

Pyridines were the most frequently detected organic chemicals in both overburden and bedrock wells. Several TCL SVOCs, including bis(2-chloroethyl)ether and bis(2-ethylhexyl)phthalate, were also detected in a large percentage of wells but at lower concentrations than the pyridines. Olin is the only known potential source of pyridines in the area, and these compounds appear to be more soluble and, therefore, more mobile than other site-derived organic compounds. The distribution of pyridines in overburden and bedrock groundwater systems is believed to represent the greatest extent of site-derived groundwater contamination.

Overburden. Figure 4-7 presents interpreted concentration isopleths for total pyridines in overburden groundwater. Table 4-5 provides a breakdown of the individual pyridines detected at each location that comprise the sums used to construct the isopleths. The highest pyridine concentrations (greater than 100,000 μg/L) are centered in an area covering the south end of the main plant building and the Well B-17 area. 2-Chloropyridine was the primary chemical detected, constituting over 70 percent of the total pyridine concentrations in most on-site and off-site overburden wells.

The pyridines isopleths for overburden groundwater show two main concentration lobes emanating from the Olin Plant. One lobe extends toward the west and northwest to the limit of saturated overburden (see Figure 4-7). The other is located to the southeast where pyridines have been detected as far south as Buffalo Road.

Bedrock. Figure 4-8 presents interpreted concentration isopleths for total pyridines in bedrock wells and piezometers. Table 4-6 provides a breakdown of the individual pyridines that comprise the sums used to construct the isopleths. The location of the highest pyridine concentrations (greater than 100,000 μg/L) in bedrock is roughly coincident with the highest overburden groundwater concentrations at the south end of the main plant building. Results from wells to the north and northwest of the main plant building show a more widespread occurrence than in overburden. To the south, the concentrations in BR-104 are over 3,000 μg/L. This shows that the southern extension of the pyridines in bedrock groundwater has not been fully delineated.

In deep bedrock wells on-site (BR-2D and BR-3D), total pyridines concentrations are at least 3 orders of magnitude less than their shallow bedrock well counterparts. Off site at BR-105D, however, total pyridine concentrations exceed 2,000 μg/L. This suggests that some vertical migration has occurred. Since only one round of sampling has been done for the BR-105D, no firm conclusions can be drawn to characterize pyridines in the deeper bedrock groundwater system off-site. Recommendations for future work are discussed in Section 7.3.

4.3.2 Volatile Organics

Several VOCs were detected in both overburden and bedrock groundwater, with the highest VOC concentrations detected for carbon tetrachloride, chloroform, and methylene chloride. The distributions of these chemicals are illustrated by the sum of selected VOC concentration isopleth maps shown on Figures 4-9 and 4-10. Other VOCs detected include chlorinated ethenes and BTEX compounds. The distributions of chlorinated ethenes are shown on Figures 4-11 and 4-12 while BTEX distributions are shown on Figures 4-13 and 4-14. Other VOCs detected in a high percentage of overburden and bedrock groundwater samples included 1,2-

dichlorobenzene (in 45% of on-site and 42% of off-site samples), and chlorobenzene (77% on-site and 42% off-site). The distribution of VOCs in overburden and bedrock groundwater systems is discussed in the following paragraphs.

Overburden. Table 4-7 shows the dominant VOCs detected in overburden groundwater to be carbon tetrachloride, chloroform, and methylene chloride. The total selected VOCs concentration isopleths (Figure 4-9) show that the highest concentrations of these constituents extend beneath the Well B-17, Tank Farm, and Well BR-5 areas. Carbon tetrachloride and methylene chloride are confined mainly to areas on-site or immediately adjacent to the Olin Plant. Neither carbon tetrachloride nor methylene chloride were detected in samples from more than 50 feet outside the Olin property boundary.

The distribution of total chlorinated ethenes shown on Figure 4-11, is similar to that of the total selected VOCs. Table 4-8 summarizes the data used to construct the total chlorinated ethenes concentration isopleths. The isopleth lobes extending south to southeast from the Olin Plant are comprised mainly of PCE and TCE. Trace concentrations of TCE (less than 1 μg/L) at MW-104 and T-126, mark the southernmost extent of site-derived chlorinated ethenes in overburden groundwater. Isolated detections of TCE (87 μg/L) and 1,2-DCE (5 μg/L) southeast of Ness Machine Company at T-147 appear unrelated to the Olin Plant because these compounds were not detected above trace levels in samples collected from locations (T-125, T-104, T-145, and MW-104) between T-147 and the Olin property. At Well MW-G8 on Griffith Oil property, vinyl chloride and 1,2-DCE were detected but may not be related to the Olin Plant because the interpreted overburden groundwater flow direction at MW-G8 suggests a source to the north, whereas the Olin Plant is to the southeast.

BTEX compounds detected in overburden groundwater are summarized in Table 4-9. These data were used to construct the interpreted total BTEX concentration isopleths presented on Figure 4-13. The highest BTEX concentrations on-site are centered off the south and eastern sides of the main plant building. Off-site BTEX detections extend from this area to the west at PZ-101 and MW-106 and toward the southeast in the direction of T-142. BTEX concentrations represented by isolated isopleths at Griffith Oil are likely related to activity at that site. This interpretation is supported by the southward trending overburden groundwater flow direction in this area. Toluene is the dominant BTEX constituent detected at the Olin Plant. In off-site samples toluene, total xylenes and benzene are the principal compounds detected, possibly indicating a source other than the Olin Plant.

The distribution of BTEX in overburden groundwater has not been fully delineated southeast of the Olin Plant beyond T-154 and T-155. To the west of MW-106, the overburden becomes unsaturated.

Bedrock. A summary of the selected VOCs detected in bedrock groundwater is shown in Table 4-10. Data shown on this table were used to construct the total selected VOC concentration isopleths shown on Figure 4-10. As in the overburden, the highest VOC concentrations detected in bedrock were those for carbon tetrachloride, chloroform, and methylene chloride. The highest concentrations of these compounds were detected in samples from PZ-106 and BR-3, which are both located south of the Well B-17 Area. Off-site, methylene chloride was detected in wells and piezometers west of McKee Road, and south at BR-104 near Buffalo Road. Carbon tetrachloride and chloroform were detected mainly in on-site bedrock groundwater, although lesser concentrations of at least one of these constituents were detected in three off-site wells. Of the identified breakdown products of carbon tetrachloride (chloroform) and methylene chloride (chloromethane), that are on the TCL for VOCs, only chloroform was detected. Chloromethane was not detected in either on-site or off-site wells or sample points. The highest off-site concentration for chloroform was measured in PZ-104 (35 μg/L). This well is located approximately 100 feet south of the Olin property. All other off-site chloroform concentrations were below 7 μg/L, the New York State Class GA standard.

The area of highest concentrations for chlorinated ethenes, shown on Figure 4-12, closely matches that shown for total selected VOCs (see Figure 4-10). Table 4-11 summarizes the data used to construct the concentration isopleths for chlorinated ethenes. On-site concentrations of chlorinated ethenes are dominated by PCE and TCE. Conversely, 1,2-DCE and vinyl chloride were detected at higher concentrations in off-site wells. Total chlorinated ethenes have been delineated to less than 10 μg/L in areas to the south (e.g., BR-104), north (BR-1), and east (BR-103) of the Olin Plant. The extent of chlorinated ethenes has not been bracketed to the southeast or west of the plant, however. To the southwest of the Olin Plant, higher chlorinated ethene concentrations were detected in deep bedrock well BR-105D than in the adjacent shallow bedrock well (BR-105). Vinyl chloride (17J μg/L) and 1,2-DCE (70 μg/L) were both detected in BR-105D.

BTEX compounds detected in bedrock groundwater are summarized on Table 4-12. These data were used to construct the interpreted total BTEX concentration isopleths presented on Figure 4-14. The highest total BTEX concentrations were detected at BR-3/PZ-105, located south of the main plant building, and at BR-101, between the Lab Sample and Well BR-5 Areas. BTEX concentrations represented by the isolated isopleth at BR-107 are interpreted to be related to activity at Griffith Oil. The overburden and bedrock groundwater systems are believed to be in hydraulic communication between BR-107 and upgradient overburden wells. BTEX distribution in bedrock groundwater has been delineated to 10 μg/L in areas to the north (BR-1), and east (BR-103) of the Olin Plant. However, BTEX has not been fully delineated off-site in areas to the southeast, south, and west. In addition, detections of BTEX in BR-105D suggest that these constituents have migrated downward into deeper water-bearing fractures.

4.3.3 Inorganics

TAL inorganics show higher concentrations for most constituents in overburden wells than in bedrock wells. This may be due to high suspended solids concentrations present in many of the unfiltered samples from overburden wells and piezometers. Approximately 68 percent of all samples collected from overburden wells had turbidity measurements of 100 nephelometric turbidity units (NTUs) or higher. This is compared to only 13 percent of bedrock groundwater samples with turbidities above this level. The following paragraphs describe the distribution of inorganics in overburden and bedrock groundwater.

Overburden. Maximum on-site inorganic concentrations were mainly detected in piezometers located along the western and southern property boundary. Table 4-3 shows a summary of results for on-site and off-site overburden wells. Included in Table 4-3 are the frequency of detections, maximum concentrations, and location of maximum concentrations for all inorganics detected on-site and off-site. The maximum concentrations for on-site samples may be biased high because nearly all were detected in samples from piezometers that had high turbidity measurements.

Most of the highest inorganics concentrations in off-site overburden groundwater were detected in monitoring wells at Griffith Oil and in several piezometers located within 20 feet of the Olin property boundary. The highest lead concentration (640 μg/L) was measured in MW-106.

Bedrock. Some of the highest inorganics concentrations detected in bedrock groundwater were in wells also showing high concentrations of site-related organics. These include BR-5 (aluminum), BR-6 (antimony), BR-101 (barium, calcium, copper, and cyanide), and PZ-106 (lead and nickel). Off-site bedrock wells showing the highest inorganic concentrations include BR-105D and BR-104. Based on the distributions of inorganics on-site and off-site, there does not appear to be a pattern showing a plume of inorganics migrating from known or suspected source areas.

4.3.4 Pesticides and PCBs

Samples from six wells were analyzed for pesticides and PCBs to investigate pesticides detected previously in Wells BR-5A and BR-3. The six wells included both BR-5A and BR-3 and overburden wells C-1, C-5, B-17, and F-3. Analytical results shows twelve TCL pesticides detected in these wells. Results are summarized in Table 4-13. The highest concentrations of pesticides were detected in BR-3, B-17, and C-5. Pesticide concentrations of less than 1 μg/L were detected for wells in the area of BR-5. The presence of pesticides is believed to be the result of the use of commercial products for their intended purposes rather than releases from spills or waste disposal.

4.4 NATURE AND DISTRIBUTION OF CONTAMINATION SUMMARY

Site-related contaminants were detected in soil gas, surface soil, subsurface soil, and groundwater. Past releases of chemicals to the environment on-site have resulted in residual soil concentrations. The distribution of these site-related contaminants in environmental media other than soil is the result of the transfer from contaminated soils on-site, and the fate and transport mechanisms discussed in Section 5. No ongoing releases of chemicals to the environment are evident.

Soil Gas. Selected VOCs were detected in soil gas on-site and, at lower concentrations, off-site. The primary on-site areas of VOCs in soil gas were the Well B-17 Area and the Lab Sample Area.

Surface Soil. Chloroform was the only VOC detected in surface soils samples, which were collected from on-site areas. All surface soil samples contained PAHs and one or more chloropyridine isomers.

Subsurface Soil. Results of analyses of subsurface soil showed no significant areas of soil contamination that could be considered contaminant sources in four of the five potential contaminant source areas investigated on-site. The highest concentrations of VOCs, pyridines, and other SVOCs were detected in samples from one area: the Well B-17 area.

Groundwater. Pyridines, other SVOCs, VOCs, and inorganic analytes were detected in overburden and bedrock groundwater, beneath both the Olin Plant and the off-site study area.

Pyridines were the most frequently-detected organic chemicals in both overburden and bedrock groundwater, and the distribution of pyridines is believed to represent the greatest extent of site-derived groundwater contamination. Two primary lobes of pyridines in overburden groundwater are present, one extending west and northwest of the Olin Plant, and the other extending south of the plant. Total pyridine concentrations were lower in deep bedrock than in adjacent shallow bedrock wells.

In overburden groundwater, total pyridine concentrations were delineated to 10 μg/L in all directions except the southeast, where they were delineated to 4,600 μg/L. In shallow bedrock, the extent of total pyridine concentrations above 10 μg/L was delineated in all directions except south and southwest of the Olin Plant, where concentrations up to 3,000 and 23,000 μg/L, respectively, were detected at the limit of explorations.

Several VOCs were detected in overburden and bedrock groundwater, including carbon tetrachloride, chloroform, methylene chloride, chlorinated ethenes, and BTEX compounds. The highest overburden concentrations of VOCs were detected beneath the Well B-17, Tank Farm, and Well BR-5 areas. Off-site overburden VOCs include PCE, TCE, and BTEX. Overburden groundwater VOC concentrations were delineated to 56 μg/L (total BTEX) to the southeast of the Olin Plant and to 10 μg/L in other directions. Overburden becomes unsaturated to the west of the plant. The highest bedrock concentrations were detected south of the Well B-17 Area. Bedrock VOC concentrations were detected west and south of the plant, where they were delineated to 920 and 9 μg/L (total selected VOCs), respectively.

Inorganic concentrations in groundwater were higher in the overburden than in the bedrock, perhaps due to suspended solids concentrations in unfiltered overburden samples. Maximum inorganic concentrations in overburden were detected primarily along the western and southern site boundaries. Maximum inorganic concentrations in bedrock were detected in wells showing high site-related organic constituent concentrations. Most inorganics detected in groundwater are believed to be naturally occurring elements unrelated to operations at the Olin Plant.

Pyridines and VOCs were detected in the single deep bedrock well installed during the Phase I RI. The extent of site-related contaminants in the deep bedrock was not delineated.

No DNAPL was detected in any well installed during the Phase I RI.

5.0 CONTAMINANT FATE AND TRANSPORT

This section evaluates the migration potential and potential environmental fate of site contaminants. Contaminants found at the Olin Plant include pyridines, VOCs, SVOCs, pesticides, and inorganics. The observed distribution of these contaminants in soil and groundwater at the study area is the result of their physico-chemical properties and site conditions. Site conditions governing fate and transport (i.e., persistence and migration) of chemicals include original chemical distribution, topography, meteorological conditions, and hydrogeology. Applicable physico-chemical properties for organic chemicals at the study area include specific gravity, solubility, and the organic carbon partition coefficient (K_{oc}). Applicable physico-chemical properties for inorganic constituents include oxidation state, pH, and specific solute species.

5.1 CONTAMINANT TRANSPORT

Site conditions and the physico-chemical properties of site-related chemicals determine which contaminant transport mechanisms will predominate. Once the dominant transport mechanisms have been identified, the contaminant distribution can be interpreted in terms of past events, and the future contaminant distribution can be estimated.

Applicable physico-chemical properties of site-related chemicals are listed in Table 5-1. Specific gravity is the ratio of the mass of a given volume of a liquid substance to the mass of an equal volume of water. Liquids with specific gravities greater than 1 are termed "heavier" than water. Solubility values and the K_{oc} represent measures of the tendency of a material to move from one phase to another. Solubility measures the partitioning between the pure liquid or solid form of a chemical and the aqueous phase, or the tendency of a material to dissolve in water. Substances with relatively low solubilities are more likely to remain in a separate phase when in contact with water; substances with high solubilities will dissolve and move with water. K_{oc} measures the extent that an organic chemical partitions between a solid phase and a liquid phase, and is used to predict whether a chemical could be adsorbed to soil organic carbon (Ney, 1990). Chemicals with a K_{oc} of greater than 10,000 will adsorb strongly to soil organic carbon. Chemicals with a K_{oc} in the range of 1,000 to 10,000 can be partially adsorbed or retarded during transport with water. Chemicals with a K_{oc} of less than 1,000 will generally not adsorb to soil organic carbon and are mobile.

Note that specific gravities, solubilities, and K_{oc} values are not provided for inorganics listed in Table 5-1. This is because inorganic analyses measure the total amount of a particular constituent in the sample; not the actual chemical form (such as a metal hydroxide complex or metal-ligand complex) or metal oxidation state. The distribution of specific solute species, pH, and oxidation state are important in determining the total solubility or mobility of a given inorganic.

5.1.1 Atmospheric Migration

Atmospheric migration of contaminants occurs primarily by: (1) volatilization of the chemical into air, and (2) release of fugitive dust with chemicals adsorbed to soil or other particulates. The first mechanism, volatilization, may be a major pathway for VOCs from surface soils and landfilled materials to receptors either on- or off-site. Contaminants that could be volatilized and transported off-site in significant concentrations via atmospheric migration include the VOCs and, to a lesser extent, the pyridines. The second method, fugitive dust release, predominates for organic compounds with high adsorption characteristics (i.e., high K_{oc} values) such as SVOCs and PCBs, and for inorganics. The extent to which the mechanisms operate is governed, in part, by meteorological conditions and the amount of exposed contaminated surface materials.

Atmospheric migration via volatilization from the subsurface into basements or floor slabs through cracks, openings, or sumps represents a possible contaminant migration pathway.

Atmospheric migration of VOCs, SVOCs, and inorganics via wind-blown particulate matter is a possible contaminant exposure pathway. Migration of VOCs, however, is not expected to be a significant exposure pathway as surface soil results show trace VOC concentrations (1 μg/kg or less).

5.1.2 Surface Water Migration

Surface water can transport chemicals either as a dissolved phase or adsorbed onto entrained particulate matter. Dissolved and adsorbed phase contaminants move to surface water via either runoff from contaminated surface soils and refuse or discharge from contaminated groundwater. Runoff from contaminated surface soil is not expected to be a significant migration pathway because on-site runoff is collected in storm sewers and combined with process water for disposal at the POTW. Surface water discharge from the shallow bedrock groundwater system into the Erie Barge Canal downgradient of the Olin Plant is a possible migration pathway.

5.1.3 Groundwater Migration

Contaminants enter groundwater at the study area through the downward seepage of chemicals, either as pure liquids or dissolved in water by the action of rain, surface water, or shallow groundwater percolating (leaching) through the subsurface soil. In all cases, the concentrations in groundwater depend on the solubility of the chemical in water. Contaminants entering groundwater as a dissolved phase move with groundwater flow.

If contaminants enter groundwater as a non-aqueous phase liquid, the contaminants will migrate in a direction dependent on the specific gravity of the chemical phase, groundwater flow, entry pressures, and the surface topography of any confining layers. Groundwater data from this RI and past sampling events show concentrations of organic contaminants for several VOCs exceeding one percent of solubility limits. A separate phase liquid has been observed in the past in at least two bedrock wells (BR-3 and BR-5) (Olin, 1990); however, no separate phase liquid was observed during the Phase I RI investigations.

Vertical Migration of Contaminants. Hydrogeologic data were used to assess potential vertical migration of dissolved contaminants in groundwater at the study area. Hydrogeologic data from monitoring well and piezometer clusters at and immediately downgradient of the Olin Plant show vertical hydraulic gradients that indicate groundwater seeps downward from the overburden groundwater to the shallow bedrock groundwater systems. The vertical seepage rate is interpreted to be significantly less than the horizontal seepage rate.

Horizontal Distribution of Contaminants. The horizontal distribution of contaminants suggests a more widespread pattern in the shallow bedrock groundwater system than in the overburden groundwater system. Several VOCs detected at high concentrations on-site (e.g., carbon tetrachloride, chloroform, and methylene chloride) appear to have migrated only a short distance off-site. Conversely, the chloropyridines which are more miscible with water, and the chlorinated volatile organics that are believed to be degradation products of PCE and/or TCE, have migrated off-site up to 1,100 feet to the southwest.

5.1.4 Migration in Soil

Migration of contaminants in unsaturated soil occurs primarily by: (1) volatilization of the chemical in the surface or near surface soils or (2) leaching of the contaminant (either dissolved phase or entrained on particulate matter) via shallow groundwater percolating through the subsurface. Once in the air space of the unsaturated soil zone, the contaminant will either be emitted to the atmosphere or be resolubilized and carried back down to the groundwater.

Partitioning of the contaminant between the soil and groundwater retards the migration of the contaminant with respect to groundwater velocity. This may allow other attenuative processes, such as degradation, to be more effective.

5.2 CONTAMINANT FATE

Pyridine, chloropyridines, VOCs, SVOCs (non-pyridine-related compounds), and inorganics are the primary constituents in the study area that appear to be migrating from past releases at the Olin Plant to groundwater, and potentially discharging into the Erie Barge Canal.

5.2.1 Pyridines

Processes that control the fate of pyridines at the study area include biodegradation and volatilization. Over time, pyridine and chloropyridines are expected to leach from pyridine-contaminated soils into the groundwater. Once in the water, pyridine is expected to migrate in the groundwater regime and eventually undergo biodegradation, photo-oxidation (after discharging to surface water), and volatilization.

Biological degradation and reductive mechanisms constitute the major dissipation of selected pyridines (Sims and O'Loughlin, 1989). Reduction of pyridine in the environment, however is proposed to be by both aerobic and anaerobic microorganisms. Pyridine is readily degraded by microorganisms but the biodegradation rate of pyridine derivations appears to be affected rather dramatically by the nature and position of ring substitutes present in the chloropyridines.

In general, the chloropyridines are more persistent than pyridine and increasing the number of halogen substituents increases the persistence of the pyridine ring (Sims and O'Loughlin, 1989).

5.2.2 Volatile Organic Compounds

The VOC contaminants are classified as halogenated hydrocarbons (e.g., carbon tetrachloride, chloroform, and methylene chloride) which contain one or more halogens, and aromatic hydrocarbons (i.e., BTEX) which possess one benzene ring as the basic structural unit. Variables that will control the fate of VOCs at the study area include volatilization, degradation, and dissolution.

Dissolution of VOCs from past release sources to groundwater and degradation are believed to be the most significant fate processes for VOCs in the study area. Factors affecting dissolution and degradation of VOCs include: (1) water table elevation in contaminated soil, (2) flow rate (residence time) of the groundwater in the contaminated material, and (3) oxygen content.

Biodegradation reactions can reduce the total mass of VOCs in groundwater. Studies have identified naturally occurring soil and aquatic microorganisms capable of degrading aromatic hydrocarbons (Jamison, et al., 1975; and Bailey, et al., 1973). These microorganisms require oxygen for aerobic biodegradation activity.

Halogenated VOCs are degraded by different mechanisms than aromatic hydrocarbons. The primary halogenated VOCs at the study area are carbon tetrachloride, chloroform, methylene chloride, and to a lesser degree, PCE and TCE. 1,2-Dichlorobenzene and chlorobenzene were also observed in the groundwater systems at the Olin Plant. Under aerobic conditions, halogenated VOCs are quite stable and persistent in the environment. Under anaerobic conditions, however, halogenated VOCs are believed to undergo biologic transformation as the dominant fate process. The anaerobic biologic transformation for PCE is well-documented (Vogel and McCarty, 1985; Vogel and McCarty, 1987) and shown as follows:

(1) PCE → TCE → 1,2-DCE → vinyl chloride
(2) PCE → TCE → 1,2-DCE → 1,2-DCA → chloroethane

The physio-chemical properties of the chlorinated aliphatic methanes, which include carbon tetrachloride, chloroform, methylene chloride, chloromethane, and methane are such that water solubility and vapor pressure increases with decreasing chlorinated substitution. These compounds are expected to leach into groundwater where they may reside for long periods of time, (Howard, 1990). In groundwater, these compounds, given time, would most likely undergo reductive dehalogenation (i.e., the removal of one Cl atom and the addition of one H atom) (Dragun, 1988). The reaction products that may be formed (in order of reductive dehalogenation) are: carbon tetrachloride degrading to chloroform degrading to methylene chloride degrading to chloromethane degrading to methane. Each of these compounds, with the exception of methane, is an analyte in the VOC analysis.

Biodegradation of chlorinated alphatic methanes is also possible, but would occur slowly and only in the presence of soil microorganisms capable of degrading the chemical. This degradation process is not expected to be a significant process.

Because these compounds were detected in at least trace amounts at the study area, anaerobic degradation (reductive dechlorination) of PCE to vinyl chloride and carbon tetrachloride to chloromethane is believed to be the most significant fate for these compounds. The net result of these factors is that the chlorinated ethenes are persistent and mobile. Vinyl chloride, chloroethane, and chloromethane in turn can be further transformed to CO_2, or volatilized to the atmosphere.

5.2.3 Non-Pyridine SVOCs and Pesticides

Processes that control the fate of non-pyridine SVOCs (primarily PAHs and phthalates) and pesticides at the study area include adsorption, biodegradation, and dissolution. The TCL SVOCs and pesticides detected at the study area are expected to be relatively immobile because of adsorption to the organic carbon fraction of the soil predicted through organic carbon-water partition coefficients and low solubilities (Tinsley, 1979; Kenaga and Goring, 1978). However, leaching of some PAHs to groundwater is observed to have occurred at the study area, and concentrations are below solubilities for the compounds. Although pesticides have been detected in groundwater they are believed to have resulted from appropriate use of pesticide products rather than releases from waste handling at the Olin Plant.

In aerobic environments, natural biodegradation processes can decrease the concentrations of PAHs (Kenaga and Goring, 1978; Weil, Dune, and Quentin, 1973). Overall, adsorption to soil and sediment is the expected fate of PAHs and pesticides at the Olin Plant.

5.2.4 Inorganics

Several inorganics were detected in groundwater at the study area. Concentrations were generally consistent across the study area, suggesting the inorganics may be ubiquitous naturally occurring elements that are unrelated to the Olin Plant; however, some areas of higher concentrations of metals were noted on-site. Overburden groundwater concentrations were notably higher than bedrock groundwater concentrations. All groundwater analyses, however, were conducted on unfiltered samples, some of which had observable suspended solids content, suggesting particulate matter may have impacted results. As such, the following is limited to a general discussion regarding fate of inorganic analytes.

The discussion in this subsection remains qualitative because of the complex nature of inorganic chemistry. Mobility of inorganics in soil-groundwater systems is strongly affected by compound solubility, pH, soil cation exchange capacity, soil type, oxidation-reduction potential, adsorption processes, major ion concentrations, and salinity. At the Olin Plant, geologic materials contain natural inorganics that could be available for transport to groundwater.

Several analytes readily form complexes with organic matter, carbonates, sulfates, or hydroxides. High concentrations of metals in groundwater can be observed where a relatively low oxidation potential exists because the metals can be reduced to more mobile species (Hem, 1989). If groundwater comes in contact with air, some analytes become oxidized, and may subsequently precipitate as a hydroxide. Bacteria are also known to cause precipitation (oxidizing bacteria) or dissolution (reducing bacterial processes).

In natural waters, some analytes readily precipitate with carbonates, hydroxides, and sulfides to form relatively insoluble compounds. However, others may be quite stable in aqueous solutions and have the potential to migrate over long distances (IRP, 1990).

5.3 SITE CONCEPTUAL MODEL

Based on the discussion of fate and transport presented in this section and on the site characterizations presented in Sections 3 and 4, a conceptual model of the study area was developed to illustrate the contaminant migration pathways and physico-chemical processes resulting in the known distribution of contamination. A schematic cross section illustrating the conceptual model is presented in Figure 5-1. Figure 5-2 illustrates the conceptual flow diagram for the study area. The figures show the primary contamination migration pathway at the study area as leaching of chemicals from materials at the Olin Plant by infiltrating precipitation through the unsaturated zone. A secondary migration pathway is that of DNAPL. As mentioned previously, DNAPL has been observed in two bedrock wells. DNAPL may infiltrate the unsaturated zone independent of precipitation and have a tendency to pool on top of zones or layers of lower permeability (e.g., top of bedrock, or silty zones). Chemicals may be dissolved into groundwater from DNAPL, if present, as groundwater contacts residual DNAPL. The contaminated groundwater then travels in the overburden and shallow bedrock groundwater systems, where some moves vertically to the deeper bedrock and the remainder travels beneath or discharges to the canal. Along the contaminant migration pathways, oxidation/reduction processes, dissolution, degradation, volatilization, dispersion, and adsorption processes act to reduce the overall concentrations of the chemicals detected.

6.0 BASELINE RISK ASSESSMENT

6.1 BASELINE HUMAN HEALTH RISK ASSESSMENT

A human health risk assessment has been conducted to evaluate potential health risks to individuals under current or foreseeable future site conditions associated with the Olin Study Area.

For the human health risk assessment, the study area was subdivided into location-specific areas for evaluation. The study area is considered to be all of the areas and media investigated as part of this RI. Within this general study area there are the on-site areas and the off-site area. The on-site area is considered to be the area within the property boundaries of the Olin Plant. The on-site area is further subdivided into areas associated with the active chemical plant facility (the facility), and areas that do not involve the plant and are open, usually grassy areas on plant property (non-facility).

Media sampled at on-site locations were soil gas, surface soil (0-2 inches bgs), soil (0-10 ft bgs) and groundwater (overburden and bedrock). Media sampled at off-site locations included only soil gas and overburden and bedrock groundwater. No surface or subsurface soil samples were collected off-site because no source area associated with the Olin Plant was identified off-site, and because surface soil is not expected to migrate off-site. The Olin Plant is expected to remain an active chemical plant under Olin management and exposures to on-site chemicals would involve work place conditions under Occupational Safety and Health Administration regulations.

Although potential health risks associated with on-site chemicals are quantitatively assessed, the purpose of this assessment is to evaluate potential health risks from exposure to off-site media, which may not be under Olin management.

The risk assessment is consistent with relevant guidance and standards developed by USEPA (USEPA, 1989d,f, 1991a,c, 1992d,e,f) and NYSDEC (NYSDEC, 1994a), reflects comments and guidance received from USEPA Region II, and incorporates data from the scientific literature used in conjunction with professional judgment. NYSDEC, in general, follows USEPA guidance for risk assessment and does not have specific promulgated guidances for risk assessment methodology.

The risk assessment for the study area consists of the following components:

- Identification of Chemicals of Potential Concern
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Evaluation
- Summary and Conclusions

6.1.1 Identification of Chemicals of Potential Concern

The first step in the risk assessment was to collect, summarize, and analyze the study area data to identify those chemicals present in environmental media and related to the Olin Plant. Study-area-related chemicals that were selected for quantitative evaluation were termed Chemicals of Potential Concern (CPCs) and defined as those chemicals that are present as a result of past activities at the Olin Plant. For example, chemicals that are associated with sampling or laboratory contamination were not selected as CPCs. The procedures used to summarize available data and to screen data for the selection of CPCs are discussed below.

6.1.1.1 Data Summary Procedures. In selecting CPCs, the analytical data for soil gas, surface soil (0-2 inches bgs) soil (0-10 feet bgs or to groundwater), and groundwater (overburden and bedrock) samples collected during the field investigation were first grouped and summarized. Tables 6-1 through 6-4 present a summary of data used to perform this risk assessment. Sampling procedures are described in Subsection 2.1. Samples were analyzed as discussed in Section 2.2. On-site analytical results are used for the evaluation of soil gas. Off-site laboratory results are used for the evaluation of the other media. The following steps, which are in accordance with USEPA (1989d) guidance, were used to summarize the analytical data for this risk assessment:

- Data were summarized by environmental medium (i.e., soil gas, surface soil, soil, and overburden and bedrock groundwater). All chemicals detected in at least one sample in each medium were listed.

- Frequency of detection was calculated as the number of samples in which the chemical was detected, over the total number of samples collected. Duplicate samples were considered as one data point for determining frequency of detection.

- The maximum detected concentration for each chemical was reported. For this determination, any duplicate samples were considered individually to ensure that any reported maximum concentration was an actual measured number, and not the average of two samples.

- The arithmetic mean of duplicate samples was calculated and this averaged value was used to represent the concentration for that location for the purpose of calculating the arithmetic mean.

- The arithmetic mean was calculated for each chemical using the detected concentration(s), or using one-half the sample quantitation limit (SQL) for the nondetect sample(s). If the reporting limit for a nondetect sample was two or more times higher than the maximum detected concentration in that medium, the sample was not included in the calculation of the mean for that chemical. Duplicate samples for a given sampling point also were treated in this manner if a chemical was detected in only one sample of a duplicate pair.

- TICs, which are chemicals identified during a library search of mass spectra, were not included in the analyte list for a specified analysis but show up as additional peaks in the laboratory analysis. Because of uncertainties regarding the identity and concentration of TICs, these data were not used to make quantitative assessments of risk.

Summary sampling data for the study area are presented by medium in Tables 6-1 through 6-4. Summary data were then used in the data screening procedures to select CPCs.

6.1.1.2 Data Screening Procedures. The selection of CPCs following procedures based on USEPA (1989b) guidance is described below. The results are indicated in Tables 6-1 through 6-4.

- Sampling data were compared to blank (laboratory, field, and trip) concentration data as described in Section 2. For purposes of the risk assessment, if all concentrations of a chemical within a sample grouping were considered to be laboratory or sampling artifacts, then that chemical was eliminated as a CPC for that grouping.

- Because there are no site-specific background concentrations available for naturally-occurring chemicals, the summary data were not screened to eliminate these chemicals. It should be noted that some organic chemicals may be present due to general urban/industrial anthropogenic activities (e.g., pesticides, PAHs) and not specifically related to activities at the Olin Plant. Ambient conditions, both naturally-occurring compounds and anthropogenic compounds are evaluated qualitatively.

- An assessment of essential nutrients was also performed to eliminate from the risk assessments those chemicals unlikely to result in adverse effects. Chemicals considered to be essential human nutrients include calcium, iron, magnesium, potassium, and sodium.

- If the number of organic compounds detected was twenty or more, a concentration/toxicity screening procedure (USEPA, 1989d) was used to limit the number of chemicals in a particular medium to those most likely to contribute the majority of risk. Concentration/toxicity screens were performed for surface soil, soil and overburden groundwater, and are included in Appendix C as Tables C.1-1 and C.1-2, respectively.

The toxicity screening was performed by scoring each chemical in a medium according to its concentration and toxicity to obtain a risk factor (R_{ij}). Separate scores were calculated for each medium being evaluated using the following formula:

$$R_{ij} = (C_{ij})(T_{ij})$$

where:

R_{ij} = risk factor for chemical *i* in medium *j*;

C_{ij} = concentration of chemical *i* in medium *j*; and

T_{ij} = toxicity value for chemical *i* in medium *j* (i.e., either the cancer slope factor or 1/risk reference dose [RfD]).

The concentration used in the above equation was the maximum detected concentration for each compound (USEPA, 1989b). In some cases, both the oral and inhalation toxicity factors were available. Normally, in these cases, the most conservative toxicity value (i.e., one yielding the larger risk factor) is used unless an inhalation exposure scenario is unlikely (e.g., sediment).

Chemical risk factors were summed to obtain the total risk factor for all CPCs in a medium. Separate risk factors were calculated for carcinogenic and noncarcinogenic effects. The ratio of the individual risk factor for each chemical to the total risk factor approximates the relative risk for each chemical in a medium. Chemicals with very low ratios (i.e., less than 0.01) were eliminated as CPCs unless they belonged to a class of compounds in which one or more of the compounds exceed the risk ratio of 0.01 (e.g., PAHs) or were detected in a medium at concentrations greater than a regulatory standard or guideline. Degradation compounds of a compound which exceeds the risk ratio were retained in the risk assessment.

CPCs retained in the selection process are presented in Tables 6-1 through 6-4 for the various media and are briefly discussed below.

Soil Gas. Volatile organic compounds were analyzed in soil gas samples. 1,1-Dichloroethene, carbon tetrachloride, chloroform, methylene chloride and other chlorinated organic compounds were detected (Table 6-1). Carbon tetrachloride was detected at the highest concentration.

Surface Soil (0-2 inches bgs). CPCs selected in surface soil samples include PAHs and inorganic compounds (Table 6-2). PAHs present in surface soil may represent general ambient conditions from anthropogenic sources and may not be site-related.

Soil (0-10 feet bgs, or to groundwater). Chloropyridines, PAHs, and inorganics were identified in subsurface soil samples (see Table 6-2). These were retained as CPCs following the toxicity screening.

Groundwater. Groundwater samples were divided into overburden and bedrock samples, respectively. CPCs selected in on-site, overburden groundwater samples included VOCs (e.g., benzene, dichlorobenzene, chlorobenzene, chloroform, methylene chloride, PCE, carbon tetrachloride) SVOCs (e.g., chloropyridines, PAHs), pesticides (e.g., heptachlor epoxide, BHCs, and inorganic compounds (Table 6-3).

CPCs selected for off-site, overburden groundwater did not include PAHs.

CPCs selected for bedrock groundwater evaluation included VOCs (benzene, dichlorobenzene, carbon tetrachloride, bromoform, chlorobenzene, chloroform, methylene chloride), SVOCs (e.g., chloropyridines), pesticides (heptachlor epoxide, BHCs, DDE, DDT) and inorganics (Table 6-4).

6.1.2 Exposure Assessment

Potential exposures associated with the study area involve both on-site and off-site exposure scenarios. Workers on-site, at the plant, may be exposed to several different media. Because media at the plant (soils and groundwater) may have been affected by past practices, these media were sampled to provide data for the exposure assessment and exposure point concentrations. Exposures to chemicals on-site are considered to be within the Olin property and therefore under Olin management. Because no source areas from the Olin Plant are identified for off-site media, no surface soil samples were taken off-site.

CPCs associated with the Olin Plant may have migrated from Olin property by groundwater transport. The off-site exposures to groundwater were also assessed because of differences in CPC (on-site versus off-site) and off-site exposures are not necessarily under direct Olin management.

For individual media on-site, and groundwater off-site, potential exposure pathways were identified. An exposure pathway (i.e., the sequence of events leading to contact with a chemical) generally consists of four elements:

(1) A source and mechanism of chemical release to the environment;

(2) A retention or transport medium for the released chemical;

(3) A point of potential human contact with the contaminated medium (i.e., the exposure point); and

(4) A route of exposure (e.g., ingestion, dermal contact) for a potential receptor.

When all four of these elements are present, an exposure pathway is considered "complete." In some cases, element (2) is not necessary if exposure to the medium to which the chemical was released occurs. In the risk assessment, only complete exposure pathways are evaluated. The exposure assessment is performed to identify complete pathways at the study area and it draws on information regarding the source, fate and transport of chemicals, and information on human populations potentially exposed to chemicals in environmental media.

In evaluating potential human exposure pathways, exposures under both current and potential future site and surrounding land use conditions were evaluated. Current land use conditions were evaluated to take into account actual or possible exposures. Future site land use conditions were considered to address exposures which may occur as a result of any future activities or land use changes.

The basic future site and surrounding land use conditions at the study area were assumed to be similar to current conditions, a heavy industrial area. Future residential use of the area is not considered plausible, and therefore, future residential exposure was not evaluated.

Possible exposure pathways encompassing both current and future conditions are presented in Table 6-5 and are discussed below.

6.1.2.1 Potential Exposures Under Current Site Use. The Olin Plant is located in a highly industrialized area, and the foreseeable use of the site will remain industrial. Appropriate exposure scenarios for the facility reflect the industrial/commercial use of the property. Residential exposures are not appropriate.

Soil Gas. VOCs in the subsurface soil may migrate to indoor air, particularly into basements of nearby buildings. A qualitative evaluation of soil gas was conducted by assuming direct worker exposure to the soil gas rather than model soil gas migration into buildings. This represents a worst-case exposure situation because no direct exposure to soil vapor is expected. Soil gas migrating to the surface soil outside of buildings is expected to quickly dissipate and would represent negligible exposures.

Surface Soil. Exposure to surface soil is evaluated using a site worker exposure scenario. Exposures may occur through dermal contact and incidental ingestion of the soil, and inhalation of particulates. Visitors to the Olin Plant may also be exposed to surface soil; however, their exposures would be less than that of a site worker and this exposure scenario was therefore not evaluated.

6.1.2.2 Potential Exposures Under Future Site Use. In addition to potential exposures discussed under current conditions, other exposures may occur through future-industrial activities.

Soil. Exposures to surface and subsurface soil (0-10 ft. bgs) were evaluated using a construction or utility worker scenario. Excavation activities may result in dermal contact and incidental ingestion of soil, and inhalation of VOCs and particulates.

Groundwater. Exposures to relatively shallow, overburden groundwater may also occur through excavation activities. Dermal contact and incidental ingestion of the water, and inhalation of volatiles from the water may occur during deep-excavation.

Exposure to bedrock groundwater is not anticipated and not quantitatively evaluated.

6.1.2.3 Surface Water. No surface water bodies were identified at the Olin Plant. Groundwater migrating off-site from the plant may eventually discharge to the Erie Barge Canal. Potential exposures to surface water in the canal has been previously assessed (Olin, 1990). Potential health risks associated with this surface water are assessed qualitatively and based on the previous report.

6.1.2.4 Development of Exposure Point Concentrations. To quantitatively estimate the magnitude of exposures and thus the risks that may be experienced by an individual, the concentration of the CPC in the contact medium must be known or estimated. This concentration is referred to as an exposure point concentration (EPC). To estimate exposures, the EPC is combined with assumptions on the rate and magnitude of chemical contact. EPCs for each pathway were determined using data collected during the RI and are described below.

Quantitative exposure estimates are derived by combining predicted EPCs with information describing the extent, frequency, and duration of exposure for each receptor of concern. An overview of the approaches used to quantify exposures is given below, followed by specific details for potential exposure pathways. The approaches described in the following paragraphs to quantify exposures are consistent with guidance provided by USEPA (1989d, 1991a, 1992e,f).

Based on USEPA risk assessment guidance (USEPA 1989d, 1991a), exposures were quantified by estimating the reasonable maximum exposure (RME) associated with a pathway of concern. The term RME is defined as the maximum exposure that is reasonably expected to occur at a site (USEPA 1989d). The RME is intended to place a conservative upper-bound on the potential risks, meaning that the risk estimate is unlikely to be underestimated but it may very well be overestimated. The likelihood that this RME scenario may actually occur is small, due to the combination of conservative assumptions incorporated into the scenario. The RME estimate for a given pathway is derived by combining the selected exposure point concentration (based on the maximum detected concentration) of each chemical with reasonable maximum values describing the extent, frequency, and duration of exposure (USEPA 1989d). Many of the exposure parameter values used in this assessment have been defined by USEPA (1989b, 1989g, 1991a) for the RME case.

In order to provide a range of risk estimates to be used for risk management decisions, EPCs were also calculated using the average concentration. This provides a more likely EPC than using only the maximum detected concentration and maximum exposure values.

EPCs for the study area are media- and location-specific. As previously discussed, surface soil was defined as either on-site-facility related or on-site-non-facility related. The facility is defined as the plant area of active industrial use at the Olin Plant. The non-facility area is defined as those areas on the Olin property which are not part of the active chemical plant but represent grassy non-active areas. Groundwater was divided into on-site and off-site areas. Groundwater samples taken at the Olin property are considered on-site, while those taken beyond the property line are considered off-site.

The general equation for calculating chemical intake is as follows:

$$Intake = \frac{(C \times CR \times RAF \times EF \times ED)}{BW \times AT \times CF}$$

where:

Intake = daily intake averaged over the exposure period
C = concentration of the chemical in the exposure medium
CR = contact rate for the medium of concern
RAF = relative absorption factor
EF = exposure frequency
ED = exposure duration
BW = body weight of the hypothetically exposed individual
AT = averaging time (for carcinogens, AT = 70 years; for noncarcinogens, AT = ED)
CF = units conversion factor (365 days/yr)

Specific equations for each exposure scenario are provided in Appendix C on Table C-3. Standard parameters from USEPA guidance were used to the extent possible in the intake equations. Table C-3 delineates the parameters used in each scenario and lists a source for each.

The contact rate reflects the amount of contaminated medium contacted per unit of time or event. The relative oral bioavailability factor represents the ratio of a chemical's bioavailability (i.e., ability to be absorbed and potentially exert an affect) when administered in an environmental matrix, relative to its bioavailability when administered in the experimental dose-response study from which the toxicity criterion for that chemical was derived. The relative oral bioavailability factor is applied to account for the potentially reduced bioavailability of chemicals when ingested in a soil matrix, compared to when experimentally administered in a food mash, water or a solvent medium. In keeping with the conservative nature of these assessments, a relative oral bioavailability of 100% (or 1.0) was assumed for all chemicals.

The contact rate for dermal exposure to CPCs in water is estimated by combining information on exposed skin surface area, the dermal permeability of the CPC, and the exposure time. Dermal permeability of CPCs in water was evaluated using an approach identified in "Dermal Exposure Assessment: Principles and Application" (USEPA, 1992e). For inorganics, a steady-state approach was used, wherein the permeability coefficient for the inorganic is multiplied by the exposure time, assuming that the contact rate depends only on the amount of chemical crossing the skin barrier. For organic CPCs, a nonsteady-state approach was used which accounts for the total amount of chemical crossing the exposed (outside) skin surface rather than the amount which has traversed the skin and entered the blood during the exposure period (i.e., under a steady-state condition). Therefore, the nonsteady-state approach more accurately reflects normal exposure conditions (under which steady-state often may not occur) and accounts for the dose that may enter the circulatory system after the exposure event due to the storage of chemicals in skin lipids (USEPA, 1992e). In this approach, the permeability coefficient is modified by various factors to account for partitioning properties of the chemical, thickness of the skin, and diffusivity of the chemical within the skin layer. The equations to adjust the permeability coefficient vary according to whether the actual exposure time is more or less than the time it takes for the chemical to reach steady-state. The equations and factors used for each identified CPC in groundwater and surface water are listed in Table C-2.

6.1.3 Toxicity Assessment

The objective of the dose-response assessment is to define the relationship between the dose of a substance and the likelihood that a toxic effect, either carcinogenic or noncarcinogenic, will result from exposure to that substance. Dose-response values were identified and used to estimate the likelihood of adverse effects as a function of human exposure to an agent. Dose-response summaries are presented in Appendix C on Tables C.2-1 through C.2-5.

There are two types of dose-response values: cancer slope factors (CSFs) and reference doses (RfDs). The derivation of each value for a particular compound depends on the toxicity of that compound and whether it displays carcinogenic or noncarcinogenic effects. USEPA has derived CSFs and RfDs to evaluate carcinogenic risks and noncarcinogenic (systemic) effects, respectively. The definition of CSFs and RfDs, as stated in USEPA guidance are:

- Cancer Slope Factor - a plausible upper bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The CSF is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime exposure to a particular concentration of a potential carcinogen (USEPA Class A or B carcinogens) (USEPA, 1989d).

- Chronic Reference Dose - an estimate of a daily exposure concentration for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. Chronic RfDs are specifically developed to be protective from long-term exposure to a compound (e.g., as a Superfund program guideline, seven years to lifetime) (USEPA, 1989d).

- Subchronic Reference Dose - an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a portion of a lifetime (e.g., as a Superfund program guideline, two weeks to seven years) (USEPA, 1989d).

In addition, because the toxicity and/or carcinogenicity of a compound can depend on the route of exposure (e.g., oral or inhalation), unique dose-response values (e.g., CSFs and RfDs) have been developed for the oral and inhalation exposure routes.

The primary source for identifying dose-response values is the Integrated Risk Information System (IRIS) (USEPA, 1994a). If no information is found in IRIS, the USEPA Health Effects Assessment Summary Tables (HEAST) (USEPA, 1994b) are used. If appropriate dose-response values are not available from either of these two sources, other USEPA sources are consulted (e.g., the USEPA Environmental Criteria and Assessment Office [ECAO]). If no data exist to support the derivation of a toxicity value for a given substance, it is discussed qualitatively in the uncertainty section.

The methodology used to develop dermal toxicity values is obtained from Risk Assessment Guidance for Superfund, Appendix A (USEPA, 1989d). In general, the oral toxicity value is adjusted from administered dose to absorbed dose, if necessary.

The absorption efficiency of a particular compound is used to calculate the RfD based on absorbed dose. For example: if the RfD based on administered dose was 20 mg/kg/day, and the absorption efficiency in the study, which is the basis of the RfD, was 10 percent, then: 20 mg/kg/day x 0.10 = 2 mg/kg/day. Therefore, the adjusted RfD is 2 mg/kg/day. The adjusted RfD is compared to the amount estimated to be absorbed from dermal exposure. This adjusted value is the dermal reference dose (RfDerm). Similarly, the dermal cancer slope factor (SFD) is adjusted from the oral CSF. For example: if the CSF based on administered dose was 1.6 $(mg/kg/day)^{-1}$, and the absorption efficiency in the study, which is the basis of the CSF, is 20 percent, then: 1.6 $(mg/kg/day)^{-1}/0.20$ = 8 $(mg/kg/day)^{-1}$. The adjusted CSF is compared to the amount estimated to be absorbed from dermal exposure. This adjusted value is the SFD.

The oral (or in some cases inhalation) absorption efficiency for individual compounds is obtained from IRIS, HEAST or Agency for Toxic Substances and Disease Registry (ATSDR) toxicity profiles. If the absorption efficiency is not available from these sources, the efficiency is assumed to be similar to structurally similar compounds.

Several carcinogenic PAHs were detected in soil or groundwater. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene are classified as carcinogenic PAHs by USEPA. Among the carcinogenic PAHs, the only one for which a CSF has been developed by USEPA is benzo(a)pyrene. In order to characterize risks associated with exposures to the other carcinogenic PAHs selected as CPCs, a CSF was derived for each of these chemicals by adjusting the toxicity value for benzo(a)pyrene with an estimated order of potential potency (OPP). The OPP used for each carcinogenic PAH is based on that compound's relative potency compared to the potency of benzo(a)pyrene. The OPPs used in this assessment were developed in "Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons," (USEPA, 1993). Specifically, the OPPs used for each carcinogenic PAH are as follows:

Carcinogenic PAH	OPP
Benzo(a)pyrene	1.0
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1

Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenzo(a,h)anthracene	1.0
Indeno(1,2,3-c,d)pyrene	0.1

The CSFs developed for the carcinogenic PAHs using the OPP approach are presented in Appendix C on Table C.2-1.

No dose-response health effects criteria were available for some of the CPCs. Therefore, risks associated with these chemicals could not be quantitatively evaluated although they may be retained as CPCs as indicated in the appropriate tables. Chemicals not quantitatively evaluated include aluminum, lead, nutrients in groundwater, and a number of TICs. Because of the relatively high concentrations of chloropyridines detected, these compounds were quantitatively evaluated using pyridines as a surrogate compound, although this adds to the uncertainty of the risk evaluation.

6.1.4 Risk Characterization

In this final step of the risk assessment process, the exposure and toxicity information are integrated to develop both quantitative and qualitative evaluations of risk. To quantitatively assess risks associated with CPCs in an environmental medium, the average daily intakes calculated in the Exposure Assessment were combined with the health effects criteria presented in the Toxicity Assessment. The methodology used to quantitatively assess risks is described in detail below.

Methodology

USEPA (1989d, 1992f) has developed guidance for assessing the potential risks to individuals from exposure to carcinogenic and noncarcinogenic chemicals. The USEPA uses separate methodologies for estimating the risks from chemicals causing cancer and from chemicals causing adverse noncarcinogenic effects.

For exposures to a chemical exhibiting carcinogenic effects, an individual upper bound excess lifetime cancer risk was calculated by multiplying the estimated daily intake by the relevant CSF. The resulting risk estimate is an estimate of the probability of contracting, not dying from, cancer as a result of exposure to the potential carcinogen over a 70-year lifetime under the specified exposure conditions. A risk level of 1x10^{-6}, for example, represents an upper bound probability of one in one million that an individual will contract cancer. The upper bound cancer risk estimates provide estimates of the upper limits of risk, and the risk estimates produced are likely to be greater than the 99th percentile of risks faced by actual receptors (USEPA 1992f). To assess the upper bound individual excess lifetime cancer risks associated with simultaneous exposure to all carcinogenic chemicals of concern, the risks derived from the individual chemicals were summed within each exposure pathway. This approach is consistent with the USEPA's guidelines for evaluating the toxic effects of chemical mixtures (USEPA 1989d), but is not realistic if maximum concentrations occurring in different locations were used as exposure point concentrations. The relative significance of risk estimates were evaluated by comparison to a target risk level of 10^{-4} to 10^{-6} established by USEPA (USEPA, 1989b).

Unlike carcinogenic effects, noncarcinogenic effects are not expressed as incidence probabilities. Rather, potential noncarcinogenic impacts were calculated by means of a hazard quotient (HQ)/hazard index (HI) technique as recommended by USEPA (1989d). To assess impacts associated with noncarcinogenic exposures, the ratio of the daily intake to the reference dose was calculated for each noncarcinogenic chemical to derive an HQ. In general, HQs that are less than one indicate that the associated exposure is not likely to result in any adverse health effects, while HQs greater than one indicate that adverse health effects may occur. The effects from simultaneous exposures to all CPCs were computed by summing the individual HQs within each exposure pathway. This sum, known as the hazard index (HI), serves the same function for exposures to a mixture as the HQ does for exposures to an individual compound. HIs greater than one indicate the potential for the occurrence of adverse health effects. A conclusion should not be categorically drawn, however, that all HIs greater than one are "unacceptable," because of the multiple conservatisms built into the exposure estimates and toxicity characterization. For these same reasons, the HIs less than one are generally regarded as being "safe." If an HI calculated in this assessment was greater than one, the CPCs were subdivided into categories based on target organ/critical effect affected by exposure (e.g., liver, skin, etc.) in accordance with USEPA guidance (USEPA, 1989d). HIs were then reexamined for these categories to better identify the potential for noncarcinogenic effects to occur.

Results

Potential human health risks associated with the various environmental media investigated at the Olin Study Area were characterized using USEPA guidance. The media evaluated were soil gas, surface soil, and groundwater. Cancer risks were characterized by comparison to the USEPA acceptable risk level of $1x10^{-4}$ to $1x10^{-6}$. Noncancer risks were evaluated by comparison to the USEPA HI of 1.0. An HI of 1.0 or less indicates that no adverse health risks are expected from exposures at the study area. The results of the risk characterization for each of the media are discussed below. NYSDEC has established guidance risk levels for residential exposures, but not industrial exposures (NYSDEC, 1994a).

The risk characterization tables for the individual media and exposure scenarios are presented in Appendix C-5. Quantitative potential health risks are summarized by media in Table 6-6, and by receptor in Table 6-7.

Soil Gas. Potential health risks for worker exposures to CPCs detected in soil gas were evaluated qualitatively by comparison to Threshold Limit Values (TLVs). TLVs are developed to be protective of worker health during work place exposures (ACGIH, 1994). As shown in Table 6-1, only one sample had a CPC detected above the appropriate TLV. Carbon tetrachloride in SS-120 detected at 38 μg/L only slightly exceeded the TLV of 31 μg/L. Because no other CPC exceeded the criteria and because of the conservative nature of the evaluation, no potential adverse health risks were identified based on the soil gas results.

Surface Soil. An industrial/commercial worker exposure scenario is used to characterize potential health risks associated with exposures to on-site surface soil, both in active facility and non-facility areas, using mean and maximum detected concentrations. Potential health risks characterized for exposures to surface soil were within acceptable USEPA risk ranges (Table 6-6).

Soil (0-10 ft. bgs). Potential health risks associated with exposures to subsurface soil (including surface soil) were evaluated using a construction worker involved in excavation activities. Only on-site subsurface soil samples were available for evaluation. Exposure durations were based on a one-month and a long-term (six months) exposure, using mean and maximum detected concentrations. The potential cancer risks characterized for these scenarios are within the USEPA acceptable risk range (Table 6-6). The noncancer risk levels, however, exceed acceptable USEPA levels and indicate potential health risks from exposures to subsurface soil. The predominant contributors to this risk are inhalation of manganese (97% of the risk), and ingestion of mercury (3% of the risk) (Table 6-9). The actual site-related risk attributable to manganese is uncertain due to the natural occurrence of manganese and uncertainties in the toxicity of manganese (see Subsection 6.1.5).

Groundwater. Groundwater associated with the study area was characterized as overburden (relatively shallow) and bedrock groundwater. The overburden groundwater was further characterized as on-site and off-site. Overburden groundwater is quantitatively evaluated in the risk assessment because of the potential for exposures to construction workers during excavation activities. As shown in Table 6-6, potential cancer risks for exposure to on-site groundwater exceed the USEPA acceptable carcinogenic risk range. Noncancer risks also exceed acceptable levels. The predominant contributors to carcinogenic risk are the PAHs through dermal exposures (nearly 90% of the risk). The major contributors to noncancer risk were carbon tetrachloride (34% of the risk), 2-chloropyridine (17% of the risk), and manganese (39% of the risk), primarily from dermal contact (see Table 6-9). These results indicate potential health risks associated with exposure to on-site overburden groundwater.

Off-site overburden groundwater was evaluated in a similar manner. The cancer risk levels for off-site overburden groundwater, however, did not exceed USEPA acceptable carcinogenic risk range (Table 6-6). Noncarcinogenic risks, predominantly from incidental ingestion and dermal contact of 2-chloropyridine (24%) and manganese (68%), exceed USEPA acceptable levels (Table 6-9). Dermal contact contributes the majority the risk.

Off-site overburden groundwater specifically associated with the Kodak property south of the Olin facility was evaluated separately. The maximum concentrations detected were used. The cancer risk levels are within the acceptable range, although the noncancer risks exceed the USEPA acceptable level (Table 6-6).

Potential health risks to construction workers involved in excavation activities and exposed to subsurface soil and groundwater were added and are summarized in Table 6-7. The potential risks are characterized as exceeding acceptable USEPA levels.

Bedrock groundwater was not quantitatively evaluated in this risk assessment. The bedrock groundwater is not currently used for residential purposes and is not expected to be used because of the high concentrations of salts making the water unpotable (see Sections 2 and 4). Bedrock groundwater CPCs were evaluated by comparison to MCLs and New York State groundwater standards. Table 6-5 shows that many of the CPCs detected exceed MCLs and New York State standards. This evaluation is included for informational purposes.

6.1.4 Surface Water

Sirrine Environmental (Olin, 1990) conducted an assessment of potential human health risks associated with surface water in the Erie Barge Canal. The assessment was part of an investigation of the groundwater at the Olin Plant. The risk assessment modelled the transport of site-related CPCs to the Erie Barge Canal. Exposure to the CPCs were assumed to occur through swimming in the canal and consumption of fish caught from the canal. The CPCs identified were benzene, dibromochloromethane, bromoform, carbon tetrachloride, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, trichloroethylene, tetrachloroethylene, chloroform, p-fluoroaniline, methylene chloride, pyridine, monochloropyridines, 2,6-dichloropyridines, and vinyl chloride. The risk characterization identified a noncancer HI of only 7×10^{-4}, well below the USEPA guidance level of 1.0. The cancer risk calculated, 4.5×10^{-8}, is also below the USEPA target risk range of 1×10^{-4} to 1×10^{-6}.

The CPCs identified in samples of off-site bedrock groundwater taken as part of this RI are summarized in Table 6-4. The CPCs include a similar list of compounds as used in the Sirrine evaluation. The maximum detected concentrations for the CPCs in the present RI are lower than the mean concentration used in the Sirrine canal surface-water evaluation. Because the CPCs are similar between the previous and current investigation and the concentrations currently lower, and there were no significant risks previously identified, potential human health risks associated with the Erie Barge Canal are expected to still be within USEPA acceptable risk levels and are not further evaluated.

6.1.5 Evaluation of Uncertainty

The interpretation of risk estimates is subject to a number of uncertainties as a result of conservative assumptions inherent in risk assessment. All quantitative estimates of risk are based on numerous assumptions, most intended to be protective of human health (i.e., conservative). As such, risk estimates are not truly probabilistic estimates of risk, but rather conditional estimates given a series of conservative assumptions about exposure and toxicity.

In general, sources of uncertainty are categorized into site-specific factors (e.g., variability in analytical data, modeling results, and exposure parameter assumptions) and toxicity factors. Toxicity information for many chemicals is very limited, leading to varying degrees of uncertainty associated with calculated toxicity values. Sources of uncertainty for calculating toxicity factors include extrapolation from short-term to long-term exposures, amount of data (e.g., number of studies) supporting the toxicity factors, consistency of different studies for the same chemical, and responses of various species to equivalent doses. Major sources of uncertainty and their potential effects (e.g., to over- or underestimate risks) are presented in Table 6-8.

In addition to the sources of uncertainty presented, site-specific uncertainties were identified. PAHs detected at soil locations may reflect normally-occurring levels and may not be related to site-specific releases or contamination. PAH concentrations in soils in urban, industrial, and rural areas have been studied by several investigators. Butler (Butler, et. al., 1984) reported the PAH content of surface soils in the vicinity of heavy vehicular traffic. A sample of surface soil taken approximately 1 meter from the road contained 20 mg/kg PAHs comprising pyrene, fluoranthene, chrysene, benzo(a)anthracene, benzo(a)pyrene, and benzo(e)pyrene. PAHs detected in samples taken 600 meters from the road ranged in concentrations of 4-8 mg/kg. In another study (Munch, 1992), up to 10 mg/kg PAHs, including 0.5 mg/kg benzo(a)pyrene, were detected along asphalt roads. Blumer (1977) reported the PAH content of dry soil near the highway. Concentrations ranged from 300 mg/kg near the highway to 8 mg/kg in the surrounding mountains. The PAH mixtures resembled that of automobile exhaust. Menzie, et al., (1992) reviewed the occurrence of PAHs in the environment. The majority of urban soil concentrations fall in the 0.6-3 mg/kg range. PAHs in road dust have been reported in the 8-336 mg/kg range. Because of the normal occurrence of PAHs in urban/industrial soil, the levels detected at the Olin facility may be a result of past activities, such as vehicle traffic and surrounding industrial activity, rather than site-related releases.

Manganese was evaluated in several media at the Olin Plant. The manganese present may be naturally occurring and not a result of part activities at the Olin Plant. No specific, historical use of manganese in the chemical plant has been identified (Young, J., 1994). The maximum detected concentration of manganese in soil sample at the Olin Plant is 1,200 mg/kg (Table 6-2). (McGovern) has presented a background concentration range of 50-5,000 ppm for manganese in Eastern United States soils. Shacklette and Boerngen (1984) have published a similar range of 2-7,000 ppm. The manganese concentration at the Olin Plant is within these background ranges, and is probably naturally occurring. Manganese is not expected to pose a site-related potential health risk.

Inhalation of manganese, assumed to occur by inhalation of soil particles, contributes the majority of noncarcinogenic risk to worker exposures. The inhalation toxicity value (RfC) at 5E-5 milligrams per cubic meter (mg/m^3) is based on an occupational study. The study evaluated neurobehavioral functions of workers and is based on 8-hour occupational exposure to manganese dioxide (MnO_2). The Lowest Observed Adverse Effect Level (LOAEL) for this study was reported as 0.15 mg/m^3. The occupational exposure to MnO_2 had a LOAEL (ADJ) of 0.05 mg/m^3. An uncertainty factor of 1,000 (10 to protect sensitive individuals, 10 for use of a LOAEL, and 10 to reflect less-than-chronic periods of exposure) was used to develop the RfC. The use of this value to evaluate noncarcinogenic risks also adds to the uncertainty of the risk evaluation. The RfC was modified for chronic exposures, which do not reflect anticipated exposures at the Olin Plant. The study evaluated MnO_2, which may not be the predominate form of manganese. Absorption of manganese from inhalation of soil particles may not be similar to absorption of MnO_2 through occupational exposures. Because of these uncertainties and the use of the RfC for MnO_2, the noncarcinogenic risk calculated for inhalation exposure to manganese may greatly overestimate potential risks to workers at the Olin Plant and adds to the uncertainties of the risk evaluation.

Analytical results for manganese evaluated in the groundwater are based on unfiltered samples (see Sections 2 and 4). The relatively high levels of solids in these samples cause an over-estimation of manganese EPCs and risk. The actual risks associated with exposure to the overburden groundwater are likely much less than those calculated.

6.1.6 Human Health Risk Assessment Summary and Conclusions

Potential health risks associated with exposures at the Olin Plant were evaluated for soil gas, surface soil, subsurface soil, overburden groundwater, and bedrock groundwater. CPCs were selected on a media- and location-specific basis. Generally, the CPCs identified were VOCs (particularly chlorinated compounds), SVOCs (primarily chloropyridines and PAHs), and inorganics. The exposure scenarios quantitatively evaluated include industrial/commercial worker and construction/excavation worker exposures. Potential health risks are characterized using USEPA-acceptable risk levels. Table 6-9 presents exposure scenarios which are characterized as exceeding USEPA acceptable levels.

- Soil gas samples are evaluated qualitatively by comparison to TLVs. Although one sample did slightly exceed a TLV, because of the conservative nature of the evaluation, no health risks were identified.

- Evaluation of worker exposure to surface soil identified no unacceptable risk levels.

- Soil (0-10 ft. bgs) was evaluated using an excavation scenario. Potential cancer risks to workers were characterized as within acceptable USEPA cancer risk range. Noncancer risk, however, did exceed the acceptable levels.

- On-site overburden groundwater was characterized as exceeding USEPA acceptable risk levels for carcinogenic and noncarcinogenic risks using an excavation scenario.

- Off-site overburden groundwater was also evaluated using an excavation scenario. Potential carcinogenic risks are within the acceptable USEPA carcinogenic risk range. Noncarcinogenic risks exceed USEPA acceptable levels.

- Bedrock groundwater exceeded MCLs and New York Standards for several CPCs. No direct exposures to the bedrock groundwater are anticipated.

- No significant human health risks were identified for potential exposures to surface water in the Erie Barge Canal.

The human health risk characterized for exposure to soil (0-10 ft bgs) exceeds acceptable levels. The predominant contributor to the risk is inhalation of manganese (97% of the risk). The actual site-related risk may be much less due to the natural occurrence of manganese and concentrations in the toxicity of manganese (see Section 6.1.5). Inorganic compounds also contributed to potential health risks of groundwater. The concentrations of inorganic chemicals, particularly manganese, may reflect naturally occurring concentrations and not site-related CPCs.

The human health risk assessment characterized potential risks from exposures to the overburden groundwater, predominantly the on-site overburden groundwater, as exceeding USEPA acceptable risk levels. The exposure parameters used in the evaluation are conservative and overestimate anticipated actual exposures. Reducing or eliminating exposure to groundwater during excavation activities would reduce the level of risk. The primary exposure pathway is dermal contact with contaminated groundwater. Use of personal protective equipment, such as gloves, masks and coveralls, would greatly reduce the level of incidental ingestion and dermal exposure and is expected to reduce the risk to acceptable levels.

6.2 HABITAT-BASED ECOLOGICAL ASSESSMENT

This subsection presents the results of an ecological habitat-based assessment (HBA) of the Olin Study Area performed in accordance with NYSDEC (1989, 1991a) guidance, which provides an approach for "the characterization of the fish and wildlife values and threats at hazardous waste sites being considered for remediation". The objectives of the HBA are:

- to provide a characterization of the existing ecological habitats at the study area

- to identify those ecological habitats which may be located within pathways of contamination
- to identify the types of fish and wildlife receptors that may utilize those habitats located within potential contaminant pathways
- to evaluate the potential acute, chronic, and bioaccumulation effects expected from site-related contamination
- to identify areas where further sampling may be needed

In accordance with NYSDEC guidance (1989, 1991a), this HBA includes Step I ("A Description of the Existing Environment") and Step III ("Impact Analysis") evaluations. The Step I description of the existing environment includes a site description, resource characterization, and hazard threshold identification. The Step III impact analysis includes a baseline ecological risk assessment (ERA), identification of mitigative measures, and an assessment of future risk with and without remediation. The baseline ERA was conducted as part of the RI; mitigative measures and assessment of future risk will be conducted as part of the FS. All components of the Step I and Step III HBA have been incorporated into the following baseline ERA.

6.2.1 Introduction to Baseline Ecological Risk Assessment

The purpose of the ERA is to provide a screening-level evaluation of actual and potential risks that environmental contaminants may pose to the resident and migratory fish and wildlife receptors using the study area. This information, in conjunction with the human health risk assessment and other information presented in the RI report, will be used to determine appropriate future action at the study area.

The ERA for the study area includes the following elements:

- Selection of Chemicals of Potential Concern (Subsection 6.2.2)
- Identification of Potential Ecological Receptors (Subsection 6.2.3)
- Ecological Exposure Pathways (Subsection 6.2.4)
- Ecological Effects Assessment (Subsection 6.2.5)

- Ecological Risk Assessment (Subsection 6.2.6)
- Ecological Risk Assessment Uncertainties (Subsection 6.2.7)

Because the ERA must meet the statutory requirements of both New York State and federal regulations, the ERA was conducted in accordance with the following state and federal guidance documents:

- "Framework for Ecological Risk Assessment" (USEPA, 1992c);
- "Risk Assessment Guidance for Superfund: Volume 2 - Environmental Evaluation Manual" (USEPA, 1989e);
- "Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference" (USEPA, 1989a);
- "Habitat Based Assessment Guidance Document for Conducting Environmental Risk Assessments at Hazardous Waste Sites" (NYSDEC, 1989); and,
- "Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites" (NYSDEC, 1991a).

Additional supplemental risk assessment guidance such as USEPA "ECO Update Bulletins" (USEPA, 1991a; 1992g,h,i) have been incorporated into the ERA, where appropriate.

6.2.2 Selection of Chemicals of Potential Concern

The selection of CPCs is a screening process used to define the site-related contaminants requiring evaluation in the ERA. Factors considered when selecting CPCs include: the validity of the data for ecological risk assessment; the classification of chemicals (i.e., inorganic, organic, pesticides, etc.); the physical and chemical properties of chemicals; the frequency of release and detection; and the inherent toxicity of exogenous chemicals (USEPA, 1989d).

Sampling conducted as part of the Phase I RI has revealed the presence of contaminants in surface soil, subsurface soil and groundwater media. The results of the Phase I RI sampling program are discussed in Section 4.

Surface Soils. Surface soil samples represent those soils obtained from the interval between ground surface and 24 inches bgs. Subsection 2.1.3 presents a discussion of the surface soil sampling program conducted during the Phase I RI. Six surface soil sampling locations (i.e., SS-102, SS-105, SS-109, SS-112, SS-113, and SS-115) were selected to represent ecological exposures at the Olin Plant. These surface soil sampling locations are shown in Figure 2-3. Ecological exposures at other on-site surface soil sampling locations are considered unlikely because of habitat limitations (e.g., unvegetated and compacted soil or overlain by a gravel cover) or because of the frequency of human activity in the immediate vicinity of the facility itself. No background surface soil samples are available; however, Subsection 4.2 presents a discussion on the range of background concentrations for inorganic compounds in surface soil. All detected analytes were selected as CPCs except for several inorganic analytes (i.e., calcium, iron, magnesium, potassium, and sodium) that are essential nutrients and which were not detected at concentrations considered to be hazardous to terrestrial receptors. A summary of analytical results for the selected surface soil samples is presented in Table 6-10.

Subsurface Soils. Subsection 4.2.2 presents the analytical results collected for subsurface soils at the Olin Plant. However, no terrestrial receptors at the plant are likely to have significant exposure to the subsurface soil medium and, consequently, this medium was not evaluated in the ERA.

Groundwater. Subsection 4.3 presents the analytical results collected for groundwater at the Olin facility. The groundwater sampling locations are shown in Figure 2-6, and a summary of analytical results are presented in Tables 4-3 and 4-4. Although it is unlikely that ecological receptors would come in direct contact with either overburden or bedrock groundwater, aquatic organisms that reside in the Erie Barge Canal could be exposed to constituents following the discharge of groundwater into the canal. To evaluate this potential exposure route, groundwater data collected from the four bedrock wells (BR-105, BR-106, BR-107, and BR-108) located closest to the Erie Barge Canal were summarized. No background bedrock monitoring well data are available and, consequently, no background inorganic screening was conducted. Several inorganic analytes (i.e., calcium, magnesium, potassium, and sodium) detected in these four wells are essential nutrients and were not detected at concentrations associated with adverse impacts to freshwater aquatic organisms. With these exceptions, all detected analytes were selected as CPCs for estimating future exposures for aquatic receptors.

6.2.3 Identification of Potential Ecological Receptors

The purpose of the ecological characterization is to identify ecological receptors potentially exposed to contamination at the study area. This subsection includes general descriptions and mapping of vegetative cover-types at the study area and is based upon a review of scientific literature and other published accounts, site-specific reports and records, contact with regional authorities, and observations made during an October 1993 site inspection. The presence or absence of rare and endangered flora and fauna at the study area, as well as information regarding any other critical ecological receptors, is reviewed in this subsection.

In accordance with the NYSDEC Step I requirements, a map of vegetative cover types at the study area and immediate vicinity was prepared (Figure 6-1). The major vegetative cover types within one half mile of the Olin Plant were also mapped (Figure 6-2). Preparation of the vegetative cover-type maps included review of the site topographic map, National Wetland Inventory Map, and a field walkover by ABB-ES ecologists conducted on October 18-19, 1993.

6.2.3.1 Aquatic Habitat. The Erie Barge Canal, a NYS Class B water body (NYSDEC, 1994f), is located approximately 1,500 feet to the west of the Olin Plant (Figure 1-1). The canal flows in a southerly direction and drains into the Genessee River approximately 2.1 miles south of the plant. The Genessee River is classified as an NYS Class B stream, indicating that it provides trout habitat, but no trout spawning grounds (NYSDEC, 1994e). The Genessee River flows north and discharges to Lake Ontario, north of Rochester.

According the National Wetland Inventory Map for the Rochester, New York quadrangle, the Erie Barge Canal and the Genessee River are both categorized as lower perennial riverine systems (Cowardin, et al., 1992). NYSDEC (1990) categorizes this cover type as riverine cultural community No. 2 ("canal"). Low velocity water flow, sand and/or muck bottom substrate, and periodic oxygen deficits are characteristic of lower perennial rivers (Cowardin et al., 1992). Extensive floodplain habitat is typically found along the banks of lower perennial rivers, and this is the case with the Genessee River. However, floodplains are absent along the barge canal in the vicinity of the study area because the canal was excavated in a bedrock outcropping. In the vicinity of the study area, the Erie Barge Canal is approximately 50 feet wide with the water surface approximately 15-20 feet below the top of the steep bank.

Several surveys of the fish community within the Genessee River and the Erie Barge Canal have been conducted by New York State (NYSDEC, 1994d,e). These surveys indicate that these water bodies contain a warm-water fishery including walleye (*Stizostedion vitreum*), chain pickerel (*Esox niger*), small-mouth bass (*Micropterus dolomieui*), sunfish (*Lepomis* sp.), common shiner (*Notropis cornutus*), and johnny darter (*Etheostoma nigrum*). Although Atlantic salmon (*Salmo salar*) and trout (both rainbow [*Salmo gairdneri*] and brown trout [*Salmo trutta*]) do not occur in the Erie Barge Canal, these important gamefish are found in the Genessee River.

A drainage swale exists north of the fifth Rixson Site measuring approximately 16 feet (5 meters) wide and 10 feet (3 meter) deep. As shown on Figure 6-2, the ditch is classified as ditch/artificial intermittent stream, and is believed to receive most of its waters from roof runoff north of the Olin property. The ditch was observed to contain standing water during the ecological site visit in November 1993; however, no flow was observable. This ditch may be dry during certain times of the year.

The vegetation along the ditch is characteristic of disturbed habitats. Although this ephemeral aquatic habitat probably supports amphibian and invertebrate species, it is unlikely that fish would occur in this limited habitat which is characterized by low oxygen levels and peroidic elevated temperatures.

Wildlife such as raccoons, shrews, and crows are expected to forage occasionally in this ditch.

6.2.3.2 Terrestrial Habitat. Rochester, New York is located within the Northern Hardwoods Forest Ecoregion (Bailey, 1978); the predominant vegetation in the area is termed a "black ash (*Fraxinus nigra*)/American elm (*Ulmus americana*)/red maple (*Acer rubrum*)" forest cover type (SAF, 1980). In New York, white ash (*F. americana*), slippery elm (*Ulmus rubra*), rock elm (*U. thomasii*), yellow birch (*Betula* *allegheniensis*), black tupelo (*Nyssa sylvatica*), sycamore (*Platanus occidentalis*), eastern hemlock (*Tsuga canadensis*), bur oak (*Quercus macrocarpa*), swamp white oak (*Q. bicolor*), and silver maple (*A. saccharinum*) are associated with these cover type species (SAF, 1980).

The study area is located in a heavily industrialized portion of Rochester, New York, and the majority of the terrestrial habitat found on the Olin Plant is categorized as a terrestrial cultural communities No. 31 ("urban vacant lot"), No. 15 ("unpaved road/path), and No. 12 ("mowed lawn") (NYSDEC, 1990) (Figure 6-1). The urban vacant lot cover type is unvegetated or only sparsely vegetated due to the compactness of the surface soil or the presence of a gravel cover. Much of the mowed lawn habitat at the Olin Plant is found in the immediate vicinity of the plant buildings; these areas are well maintained with clipped lawn grass predominating. This habitat type is also found along the southern border of the plant property, where the following herbaceous species were noted during the field walkover: Queen Anne's lace (*Daucus carota*), English plantain (*Plantago lanceolata*), thistle (*Cirsium vulgare*), ragweed (*Ambrosia artemisiifolia*), clover (*Trifolium spp., Melilotus spp.*), daisy fleabane (*Erigeron annuus*), goldenrod (*Solidago* sp.), and various grass species (Gramineae). Many of these same species are found in the northern portion of the plant, which is categorized as a "junkyard" cover type (NYSDEC terrestrial cultural community No. 30). A shallow grass-lined drainage swale that conveys surface water following periods of heavy rainfall and snowmelt is located in this regularly mowed area.

A narrow strip of wetland vegetation, located in a depression between the eastern boundary of the Olin Plant and an off-site railroad spur, is characterized by a number of hydrophytic herbaceous plant species. Although the area was probably created by railroad bed construction activities, it presently meets the NYSDEC (1990) palustrine cultural classification Number 4: "reedgrass/purple loosestrife marsh". Vegetation in this area includes broad-leafed cattail (*Typha latifolia*), common reed (*Phragmites australis*), purple loosestrife (*Lythrium salicaria*), rushes (*Juncus* spp.), and sedges (*Carex* spp.). Several shrub and tree species include black willow (*Salix nigra*), gray-stemmed dogwood (*Cornus racemosa*), red-osier dogwood (*C. stolonifera*). In slightly drier portions of the narrow strip of habitat located between the eastern perimeter and the railroad spur, extensive clumps of staghorn sumac (*Rhus typhina*), common cottonwood (*Populus deltoides*) saplings, and red-osier dogwood are found.

Industrial- and service-related facilities are located to the west of McKee Road. NYSDEC cover types associated with these businesses include "mowed lawn", "mowed lawn with trees", "unpaved road/path", "paved road/path", "urban vacant lot", "urban structure exterior", and "interior of non-agricultural building" categories. These categories are only shown qualitatively in Figure 6-2; as discussed in Subsection 6.2.4, there are no relevant migration pathways from potential source areas at the Olin Plant to ecological receptors that may occur in these habitats.

The forested upland habitat located between McKee Road and the Erie Barge Canal is categorized as cover type No. 20 ("successional northern hardwoods"). Cottonwood is the dominant hardwood in this habitat, with white ash, slippery elm, and tree-of-heaven (*Ailanthus altissima*) found occasionally throughout. The canopy is fairly open with mature cottonwood trees growing to 60-75 feet high. Slippery elm, box elder (*Acer negundo*), and buchthorns (*Rhamnus* sp.) are the predominant shrub species found in this habitat. In portions of this general area, obvious signs of earthmoving activities were noted; these areas would be categorized as open uplands cover type No. 22 ("successional old field"). Herbaceous species include various grasses, ragweed, goldenrods, Queen Anne's lace, common teasel (*Dipsacus sylvestris*), and daisy fleabane.

A paved bike path (terrestrial cultural community No. 16 "paved road/path") is located along the western bank of the canal and an unpaved access road (No. 15, "unpaved road/path") runs along the eastern bank. Along the western side of the canal, successional shrub growth occurs along both sides of the bike path. Characteristic vegetation includes: cottonwood saplings, gray dogwood, European buckthorn, red-osier dogwood, silky dogwood (*Cornus amomum*), goldenrods, and various grasses. Shale tailings, deposited during the construction of the Erie Barge Canal, are located approximately 30 feet beyond both edges of the canal and are approximately 15-20 feet high. These tailing piles, which fit the terrestrial cultural community type "mine spoils" most closely, have become revegetated with cottonwood, multiflora rose, cherry (*Prunus virginiana*), dogwoods, and various ruderal plants. Community types found to the west of the Erie Barge Canal include "successional shrubland", "successional old field" and "successional northern hardwood" habitats. Cottonwood dominates the forested areas along with silver maple (*Acer saccharinum*); shrubland areas consist of extensive clumps of staghorn sumac, cherry, and European buckthorn. Ragweed, goldenrods, and grass species typify the old field habitat located in this area. A large residential complex is located approximately 0.5 miles west of the Olin Plant; community types include "rural structure exterior", "paved road/path", "mowed grass", and "mowed grass with trees". Gray squirrels (*Sciurus carolinensis*) were frequently seen in the successional northern hardwood community type to the west of the barge canal.

A former rock quarry (terrestrial cultural community No. 19 "rock quarry") is located immediately southwest of the Conrail railroad bridge on the western side of the Erie Barge Canal. The quarry is only sparsely vegetated; characteristic ruderal plants observed during the field walkover include daisy fleabane, evening primrose (*Oenothera biennis*), purple aster (*Aster patens*), and thistle. Successional shrubland (NYSDEC terrestrial open uplands No. 22), dominated by gray and red-osier dogwoods, common and European buckthorn, cottonwood saplings, staghorn sumac, and multiflora rose (*Rosa multiflora*), is found immediately east of the quarry. Several mixed flocks of birds, including juncos (*Junco hyemalis*), robins, starlings (*Sturnus vulgaris*), and crows (*Corvus brachyrhynchos*) were observed at the quarry. This ruderal habitat probably provides suitable forage for small mammals as well.

Much of the remaining upland within the one-half mile vicinity of the Olin Plant can be classified according to NYSDEC (1990) as "paved road/path" (terrestrial cultural habitat No. 16), "mowed lawn" (terrestrial cultural habitat No. 12), and "mowed lawn with trees" (terrestrial cultural habitat No. 11).

6.2.3.3 Species and Habitats of Special Concern. The NYS Significant Habitat Unit and New York Natural Heritage Program (NYNHP) maintain the New York Natural Heritage Database, a computerized database which stores site-specific information on rare plant and animal species and natural communities in New York State. Although the files of the NYNHP are continually updated as rare species and communities are discovered, NYSDEC is unable to provide definitive information regarding the presence or absence of species, habitats, or natural communities (NYSDEC, 1994d). The Significant Habitat Program was contacted regarding the presence of rare and endangered plant and animal species at or in the vicinity of the Olin Plant. According to NYSDEC (1994c), no rare and endangered plant or animal species are known to occur in the vicinity of the Olin Plant.

The United States Fish and Wildlife Service (USFWS) maintains records regarding rare and endangered species under the federal jurisdiction of the Endangered Species Act. Except for occasional transient individuals, no federally listed or proposed endangered or threatened species are known to exist in the vicinity of the Olin Plant (USFWS, 1994).

6.2.4 Ecological Exposure Assessment

The purpose of the ecological exposure assessment is to evaluate the potential for ecological receptor exposure to chemical constituents in the study area. This evaluation involves the identification of actual or potential exposure routes to receptors and evaluation of the magnitude of exposure to identified ecological receptors. In this subsection, exposure concentrations are estimated for each receptor and for each exposure pathway. This exposure information is used in conjunction with the toxicological information presented in Subsection 6.2.5 to evaluate ecological risk.

Exposure pathways describe the mechanism(s) by which ecological receptors are exposed to contaminated media, and consist of: (1) a contaminant source; (2) an environmental transport medium; (3) a point of receptor contact; and (4) the exposure route (e.g., ingestion of prey items that have bioaccumulated contaminants in their tissues, drinking of contaminated surface water, incidental soil ingestion, dermal absorption, inhalation, etc.). Potential receptors for which exposure and risks were quantified include:

- Terrestrial biota at the Olin Plant
- Aquatic biota in the canal

Exposure pathways and receptors evaluated in the ERA were chosen based on the characteristics of ecological receptors and communities at the study area, the physical and chemical properties of the CPCs, and the affected environmental media at the study area. Exposure of aquatic receptors (including plants) was evaluated based on modeled surface water concentrations estimated for high- and low-water level conditions. Exposure of terrestrial ecological receptors was evaluated using measured soil concentrations and food web models.

6.2.4.1 Aquatic Biota. Aquatic fauna (including invertebrates, fish, and amphibians) may potentially be exposed to contaminants through dermal contact with and/or ingestion of contaminated surface water, sediment, and food items. Aquatic plants may be exposed to contamination via direct contact and root uptake from sediments and water. To evaluate ecological risks to aquatic receptors, the exposure concentrations employed in the ERA are the modeled surface water concentrations under high- and low-water conditions (see Subsection 6.2.6.1).

6.2.4.2 Terrestrial Biota. Indicator species for terrestrial biota were selected which were assumed to be representative of the potential receptors in the vicinity of the Olin Plant. The following indicator species or species groups were selected to represent terrestrial organisms potentially exposed via soil and food web exposure pathways at Olin:

- Terrestrial plants;
- Terrestrial invertebrates;
- Meadow vole (*Microtus pennsylvanicus*, a small herbivorous mammal); and
- American robin (*Turdus migratorius*, a small omnivorous bird).

These receptors are representative of the species considered most likely to utilize the study area.

Exposure Quantification for Terrestrial Plants and Invertebrates. Terrestrial plants may be exposed via direct contact with contaminants in surface soil. Terrestrial invertebrates such as earthworms may be exposed both via direct contact with and ingestion of contaminants in surface soil. Direct contact exposures of terrestrial plants and terrestrial invertebrates will be evaluated by comparing maximum and average surface soil concentrations with screening level toxicological benchmark values discussed in Subsection 6.2.5.

Exposure Quantification for Terrestrial Birds and Mammals. Terrestrial birds and mammals may be exposed via inhalation of airborne contaminants and via direct contact with and/or incidental ingestion of surface soil while foraging or preening. Terrestrial wildlife also may be exposed via ingestion of prey items which have accumulated surface soil contaminants in their tissue.

Exposures of terrestrial birds and mammals via dermal uptake and inhalation were not assessed in the ERA because little data regarding these exposure routes are available. Although dermal exposure may be an ecologically significant exposure pathway for amphibians and for young, hairless mammals in subterranean dens (i.e., juvenile muskrats), in general, fur, feathers, and chitinous integument will minimize dermal absorption for the majority of ecological receptors. Inhalation exposures by ecological receptors are usually insignificant, except in emergency situations (e.g., following a chemical spill), and were not evaluated in the ERA.

Exposures of terrestrial birds and mammals via ingestion of soil and contaminated food items were evaluated using the food web model discussed below. Because of the limited size of the Olin Plant, a receptor with a relatively small foraging area (i.e., the meadow vole and robin) was selected for the food web analysis because it is likely to obtain a higher percentage of their dietary intake from food items on-site, and, therefore, could receive higher exposures than other species with larger foraging ranges.

An ecological food web model was employed to evaluate potential ecological risks associated with surface soil contamination at the Olin Plant. The robin and vole were selected because they are representative of the types of mammals and birds that may occur in the disturbed habitats characteristic of the study area. Exposure parameters for these species, which were used to estimate total body doses (TBDs), are presented in Appendix D (Table D-1).

The food web model was used to estimate the potential exposure levels of surface soil contaminants for the two selected indicator species. Two scenarios, one based on the average soil concentration and one based on the maximum detected soil concentration, were evaluated. The food-web model was used to estimate contaminant levels in various primary prey items (e.g., invertebrates and plants) consumed by each receptor species. Estimated contaminant tissue residues in each prey species were estimated using specific bioaccumulation factors (BAFs) obtained directly or extrapolated from values in the scientific literature (see Appendix D, Table D-2), as shown in the following equation:

$$T_n = S \times BAF_n$$

where:

T_n = Tissue concentration of prey item n (mg/kg);

S = Soil concentration (mg/kg);
BAF_n = Soil-to-tissue bioaccumulation factor for prey item n.

The TBD associated with ingestion of contaminated prey items for each receptor species was calculated by multiplying the predicted tissue concentration for each specific prey item by the proportion of that prey type in the receptor's diet, multiplying by the receptor's food ingestion rate, and dividing by the receptor's body weight as shown in the following equation:

$$TBD = \frac{[(P_1 \times T_1) + (P_2 \times T_2) + \ldots + (P_n \times T_n)] \times IR \times ED \times SFF}{BW}$$

where:

TBD = Total Body Dose (mg/kgBW/day)
P_n = Percent of diet represented by prey item n
T_n = Tissue concentration in prey item n (mg/kg)
IR = Ingestion Rate (kg/day)
SFF = Site Foraging Frequency; site area (acres)/home range (acres)
ED = Exposure Duration; fraction of year spent at site
BW = Body Weight (kg)

Exposures via the incidental soil ingestion pathway (i.e., associated with foraging, preening, and cleaning activities) were included in this calculation by multiplying the soil concentrations by the estimated percentage of soil in the diet of each modeled receptor species (i.e., by including soil as one of the constituents of the diet). Incidental soil ingestion was conservatively assumed to be five percent of the receptor's dietary intake for both the robin and meadow vole.

TBD estimates, based on exposure to maximum and average surface soil concentrations, are summarized in Tables E-1 and E-2, respectively. TBDs are expressed in mg/kg BW-day (milligrams per kilogram body-weight per day), are directly comparable to the available toxicological dose-response data (discussed in the following subsection), and were used in conjunction with toxicological data to evaluate ecological risks to terrestrial receptors at the study area.

6.2.5 Ecological Effects Assessment

The purpose of the Ecological Effects Assessment is to describe the toxic or adverse ecological effects associated with the identified CPCs in each medium of concern and to evaluate the relationship between the concentration to which an organism is exposed and the potential for adverse effects due to such exposure.

An important aspect of the effects assessment is identification of reference or threshold toxicity values for each identified contaminant in all media evaluated. Information contained in the effects assessment, in conjunction with exposure information presented in Subsection 6.2.4, is used to evaluate ecological risks to terrestrial and aquatic organisms in the ecological risk characterization (see Subsection 6.2.6).

From the toxicological data set evaluated, the lowest chronic values for each representative species were selected as the Reference Toxicity Values (RTVs) for each CPC. These RTVs, which represent a threshold concentration or dose for effects to terrestrial and aquatic organisms, are expressed in μg/L in surface water, mg/kg in soil for terrestrial plants and invertebrates, and mg/kg body weight (BW) per day (mg/kg BW-day) for terrestrial organisms.

6.2.5.1 Toxicity to Aquatic Receptors. Surface water benchmark values were identified by examining available water quality standards and criteria as well as published toxicological data.

AWQC have been developed and published by USEPA (summarized most recently in USEPA 1986a) for the protection of aquatic life. The aquatic life AWQC are intended to be protective of a wide range of life stages of aquatic animals and plants. These criteria specify the contaminant concentration in ambient surface water that, if not exceeded, should protect most species of aquatic life and their uses. The chronic criterion represents the contaminant concentration that should not be exceeded by the four-day average chemical concentration more than once every three years (USEPA, 1986a). In developing a chronic AWQC, USEPA estimates protective contaminant levels based on chronic toxicological data for non-aquatic animals and plants, and based on residue levels in aquatic organisms. The acute criterion represents the level that should not be exceeded by the one-hour average concentration more than once every three years.

For most CPCs at the study area, AWQC were not available from USEPA due to insufficient data, and USEPA presents LOELs (Lowest Observed Effect Levels) instead. The LOELs are based on biological effects studies such as LC_{50}s (the concentration which is lethal to 50 percent of the study population) and reproduction and growth studies on organisms such as algae, cladocerans, and fish. USEPA chronic LOELs were used when available, but the majority of chronic values were extrapolated from acute LOELs and LC_{50}s obtained from USEPA documents and other available literature sources.

If no chronic LOELs were available but an acute LOEL was available then an acute:chronic ratio of 0.1 was applied to the acute LOEL to derive a chronic LOEL. If only an acute LC_{50} was available, a chronic NOEL (No Observed Effect Level) was extrapolated from the acute LC_{50} using the following equation presented in Sloof et al. (1986):

$$logNOEL = -1.28 + 0.95\ logLC_{50}$$

Surface water benchmark values for the ERA were also obtained from the Aquatic Information Retrieval (AQUIRE) system when USEPA values were unavailable. The majority of the effects concentrations selected from AQUIRE for benchmark development were derived from 24, 48, and 96 hour LC_{50} studies. Chronic exposure studies (generally ranging from 72 hours to 100 days in length) data were used preferentially when available. Studies on marine test species were not considered.

Surrogate benchmark values from a related compound were used when no data were otherwise available for a CPC (e.g., 1,2-dichloroethane for 1,1-dichloroethane).

Ambient water quality standards and guidance values have also been developed and published by NYSDEC (1991b) (see Table D-4). A standard is an ambient water quality value that has been promulgated and placed into regulation, whereas a guidance value is intended to be used when a standard for a substance (or a group of substances) has not been established (NYSDEC, 1991b). NYSDEC has developed standards and guidance values for specific classes of freshwater bodies, depending upon usage. The surface water standards are further designated by "Type". This designation addresses whether the standard is protective of either human health (i.e., if contaminants exist in a drinking water source or if human consumers of fish are likely to ingest bioaccumulated contamination), or aquatic health (i.e., fish survival or wildlife consumption of fish). The Erie Barge Canal is classified as an NYS Class B river and the Genessee River is a NYS Class B water body. The Class B water quality standards and guidance values were used for screening purposes in this assessment. The lowest of the chronic AWQC and NYSDEC Class B standard/ guidance values was selected as the chronic surface water benchmark for each groundwater analyte. The chronic surface water benchmark is identified in Table D-4. These values represent the concentration below which no adverse effects are expected.

Bioconcentration factors (BCFs) and data on environmental persistence of groundwater constituents were also evaluated to determine the potential bioaccumulation hazards posed to ecological receptors. These data for the groundwater analytes detected in the four western perimeter wells are presented in Table D-3 (Appendix D).

6.2.5.2 Toxicity to Terrestrial Receptors. Potential impacts to terrestrial receptors were evaluated using published laboratory-derived toxicological data, as well as threshold toxicity values developed using extrapolation techniques. Toxicological endpoints evaluated include mortality, growth impairment, behavioral effects, reproductive impairment, immobilization, physiological changes, fetotoxicity, and changes in organ weight, size, or functionality. Lethal concentration and dose studies (e.g., LC_{50} and LD_{50} studies) and effects concentration studies (e.g., EC_{50} studies) were also considered. The methodologies used to identify RTVs for each of the terrestrial receptors or receptor groups are discussed below.

Toxicity to Plants. Suter et al. (1993) developed phytotoxicity benchmarks for use as a screening tool for selection of surface soil CPCs. The database from which benchmark values were derived was developed through a comprehensive literature search that employed a protocol to exclude unreliable study data. For chemicals for which more than ten data points were available, the tenth percentile Lowest Effect Concentration (LOEC) data were used as the benchmark. For chemicals for which less than ten data points were available, the lowest LOEC concentration in the database was used as the benchmark value. Table D-5 presents available phytotoxicity benchmarks for analytes detected in Olin surface soil. With the exception of iron, for which no soil test data were available, soil benchmark values were available for all inorganics detected. As indicated in Table D-5, a large sample population was available for several inorganics for which benchmarks were developed. This suggests that the benchmark values for these inorganics reflect a wide range of testing conditions, including variability in the plant species tested, soil type, soil pH, and chemical form. The inclusion of these data in benchmark derivations may lessen uncertainty associated with applying these benchmark values to site-specific conditions. The database for organic chemicals is extremely limited. Di-n-butylphthalate was the only organic detected in surface soil for which a phytotoxicity benchmark was available. Based on structural and toxicological similarities, this benchmark was used as a surrogate benchmark value for other phthalate esters detected in surface soil.

Toxicity to Terrestrial Invertebrates. Chemical effects data for earthworms have been assessed for a variety of organic and inorganic compounds. The available toxicological data for earthworms and derived RTVs are provided in Table D-6.

Data on earthworm toxicity from organic chemicals are limited. Neuhauser et al. (1985) conducted 14-day soil tests on one to two chemicals from each of several organic chemical classes (i.e., phenols, amines, aromatic VOCs, halogenated aliphatic VOCs, PAHs, and phthalates). A single representative RTV was generated for each of the class of compounds. All compounds within a chemical class used the same representative RTV as a benchmark value. For instance, the lowest PAH soil test LC_{50} result in the Neuhauser et al. (1985) study was used as a surrogate to represent the toxicity of all PAHs. As described above, one-fifth of the LC_{50} value was used for the RTV.

Available earthworm data for pesticides and inorganics consist of acute LC_{50} data, subchronic mortality data, and subchronic reproductive toxicity data. Reproductive effects are generally more sensitive toxicity endpoints than are lethality effects. Therefore, reproductive effects were generally chosen as RTVs when available. When reproductive data were unavailable, appropriate mortality endpoints were chosen as RTVs. Because LC_{50} data do not represent protective soil chemical concentrations (e.g., they represent chemical concentrations lethal to 50% of the tested population), one-fifth of the LC_{50} value was used. The resultant chemical concentration (selected as the RTV) is expected to be protective of 99.9% of the exposed population from lethal effects (USEPA, 1986b). When appropriate, RTVs for a particular compound were used as a surrogate for similarly structured compounds that lack toxicity data.

Toxicity to Birds and Mammals. RTVs for birds and mammals are expressed as body weight-normalized doses (mg/kgBW-day). In general, LOAELs were used as the chronic RTV for semi-terrestrial receptors. In cases where no chronic RTV data were available, two factors were applied to the acute LD_{50} (the single dose lethal to 50 percent of the test organisms). These factors are: (1) a factor of 0.2 for extrapolating from the oral LD_{50} to a value expected to protect 99.9 percent of the population from acute effects (USEPA, 1986b); and, (2) a factor of 0.1 for extrapolating from acute to chronic values (the acute-chronic ratio for many chemicals is approximately 10) (Newell et al., 1987).

A number of the concentration/response and dose/response studies reviewed for the ERA evaluate the toxic effects of contaminants on either laboratory rats or mice; however, many toxicological studies with minks, dogs, birds, and other receptor taxa were also reviewed. Whenever possible, RTVs were selected to represent the closest phylogenetically related ecological receptor species. For instance, RTVs for the meadow vole were based on laboratory mice or rat studies; whereas, whenever possible, RTVs for the robin were based on avian concentration/response studies. RTVs for terrestrial receptors evaluated in the food chain model are presented in Appendix D, Table D-7.

6.2.6 Ecological Risk Characterization

This subsection characterizes the risks to terrestrial and aquatic receptors potentially exposed to surface soil and surface water contaminants at the study area. The ecological risk is dependent on the magnitude, duration, and frequency of exposure to site-related contaminants, and on the characteristics of the exposed populations. The exposure information (see Subsection 6.2.4), combined with the ecotoxicity information (see Subsection 6.2.5) provides the basis for the risk characterization.

Division of the estimated exposure concentration or dose by an RTV yields a ratio referred to as an HQ. The HQs for all of the CPCs are then summed for a given receptor to yield an HI. Any estimated adverse effects are assumed to be similar to the types of effects reported in the study upon which the RTV is based. The probability of adverse effects is assumed to increase as the HI increases in magnitude.

6.2.6.1 Risks to Aquatic Receptors. In this subsection, the potential risks associated with exposure to surface water in the Erie Barge Canal are evaluated.

Comparison of the estimated surface water concentrations for contaminants detected in groundwater with RTVs for aquatic organisms provides a means to evaluate the potential for adverse effects on aquatic environmental receptors. Table 6-11 presents comparisons of surface water concentrations under high- and low-water conditions with the corresponding aquatic RTVs.

As shown in this table, the estimated surface water concentrations under both high- and low-water conditions are in all cases several orders of magnitude below the corresponding RTVs. This comparison indicates that aquatic life in the canal is unlikely to be adversely affected by groundwater-related contaminants associated with the Olin Plant.

Table D-3 (Appendix D) presents data on bioconcentration potential and environmental persistence (i.e., half-life) of the groundwater analytes detected in the four western perimeter wells. In general, both the fish BCFs and environmental persistence of the detected organic groundwater constituents are low; it is unlikely that these analytes would pose a bioaccumulation risk to aquatic receptors. BCFs for inorganic groundwater analytes are generally higher than those for organic compounds (Table D-3), ranging to 86,000 for mercury. However, the extremely low site-related surface water concentrations estimated for these groundwater constituents suggest that bioaccumulation hazards are not likely for inorganics as well. Although, mercury is known to bioaccumulate in aquatic systems, the surface water toxicological benchmark (Table D-4) employed in this ERA is specifically based on this endpoint and the estimated surface water concentrations, under both high- and low-flow assumptions, were not exceeded.

6.2.6.2 Risks to Terrestrial Plants and Invertebrates. Risks to terrestrial plants and invertebrates were evaluated by comparing average and maximum surface soil concentrations with available RTVs. This comparison is presented in Table 6-12 for plants and Table 6-13 for invertebrates. Phytotoxicity data are limited for the organic CPCs in surface soil. Screening-level plant RTVs for the inorganic CPCs are exceeded by both the average and maximum detected concentrations of aluminum, chromium, lead, vanadium, and zinc. The HQ for aluminum contributes to the majority of the overall HI. Maximum concentrations of arsenic, copper, manganese, mercury, and nickel exceed the respective screening-level RTVs for these chemicals, but the average concentrations are below the RTVs, indicating that any effects associated with these chemicals are likely to be limited.

Toxicity data are more plentiful for terrestrial invertebrates for the CPCs in surface soil. Maximum concentrations of chromium, copper, and zinc exceed the screening-level invertebrate RTVs for these chemicals. Average concentrations of chromium and copper are below the RTVs, however, and the average concentration for zinc (150 mg/kg) is only slightly above the screening-level RTV for this chemical (130 mg/kg). These results indicate that risks to terrestrial invertebrates inhabiting the study area are likely to be minimal.

It is important to reiterate that the ecological habitat available at the study area is of poor quality, the majority of which is limited to partially vegetated areas that have been colonized with ruderal plants characteristic of urban areas. The screening toxicological benchmarks were developed from toxicological data reported from various literature studies representing a wide range of environmental conditions as well. Because environmental factors (e.g., soil type, cation exchange capacity, soil pH, fraction organic carbon) are known to affect the bioavailability of contaminants and worst-case exposure assumptions were selected in this ERA, the plant and invertebrate toxicological benchmarks very likely overestimate potential impacts to these receptors. Selection of the lowest reported toxicological values for each surface soil CPC presupposes that the most sensitive receptors would occur at the Olin Plant. Although this assumption is appropriate for a baseline assessment, actual risks to the plants and invertebrates that occur at the study area were most likely overestimated in this ERA.

6.2.6.3 Risks to Terrestrial Wildlife. Risks to additional terrestrial wildlife receptors at the study area were evaluated through the use of a food web exposure model. Analyte-specific TBDs for each model receptor species were calculated as described in Subsection 6.2.4.2, and provide an estimate of the combined effects of exposure to both surface soil and the consumption of contaminated prey items. The average and maximum TBD for each constituent was divided by the chronic RTV to develop average and maximum exposure HQs. For each species evaluated, HIs were determined by summing the HQs for all CPCs. Estimates of food chain exposure and risk to terrestrial receptors at Olin are presented in Appendix E, and Tables E-3 and E-4, for maximum and average surface soil exposures respectively.

This approach evaluates potential ecological effects to individual organisms and does not evaluate potential population-wide risks. Contaminants may cause population reductions by affecting birth and mortality rates, immigration, and emigration (USEPA, 1989d). In many circumstances, acute (or chronic) exposure effects may occur to individual organisms with little potential population or community level effects; however, as the number of individual organisms experiencing toxic effects increases, the probability that population-level effects will occur also increases. The number of affected individuals in a population presumably increases with increasing HI values; therefore, the likelihood of population level effects occurring is generally expected to increase with higher HI values.

For both the average and maximum exposure scenarios, HIs are less than one, indicating that the risk to terrestrial ecological receptors from food web exposures to surface soil contaminants is likely to be negligible.

6.2.7 Ecological Risk Assessment Uncertainties

Evaluating ecological risks at Olin involves numerous uncertainties and assumptions. Although many assumptions and uncertainties are inherent in the ecological risk assessment process (e.g., in development and formulation of the conceptual model), others are related to lack of data and information and to natural environmental stochasticity (USEPA, 1992a). The uncertainty evaluation identifies and, whenever possible, qualifies the uncertainty associated with all aspects of the ERA, from selection of CPCs to risk characterization. To the extent possible, the uncertainty analysis provides an evaluation of the effects of uncertainties on the risk assessment conclusions. This evaluation can: (1) provide insight regarding strengths and weaknesses of the ERA; (2) contribute towards development of future actions and remedial alternatives; and, (3) provide a basis for obtaining additional information to reduce risk estimation uncertainty (USEPA, 1992a).

6.2.7.1 Uncertainties and Assumptions. Assumptions and uncertainties include the following:

- The models used to estimate exposures involve numerous exposure parameters, some of which are values from the literature, and some of which are assumed or estimated. Efforts were made to select exposure parameters representative of a variety of species or feeding guilds, so that exposure estimates would be representative of more than a single species. However, numerous extrapolations relating measurement and assessment endpoints have been included in the ERA. These include extrapolations between taxa, between responses, and from laboratory to field studies.

- The exposure models assume that organisms will spend equal amounts of time in all habitats within their home ranges. In actuality, organisms will spend varying amounts of time in different habitats which would affect their exposures. Given the poor ecological habitat available at the study area, it is likely that this assumption resulted in an over-estimate of ecological exposure.

- In selecting RTVs, the lowest chronic toxicity value reported in available literature was selected for each surface soil CPC. Therefore, the RTVs employed in the ERA may conservatively overestimate ecological risk.

- Neither dermal contact nor inhalation were evaluated because of a lack of information concerning uptake rates for wildlife. Therefore, total ecological exposure may be greater than predicted based solely on modeled ingestion scenarios. However, the relative contribution of dermal contact to total ecological risk is expected to be much lower than that of food and soil ingestion, because of the protective fur, feathers, or hardened skin covering most wildlife species.

- The hazard ranking scheme employed evaluates potential ecological effects to individual organisms and does not evaluate potential population-level risks. In many circumstances, acute or chronic effects may occur to individual organisms with little potential population or community level effects; however, as the number of individual organisms experiencing toxic effects increases, the probability that population-level effects will occur also increases. As a result of this assumption, the calculated risk may overestimate the true community or population level effects.

- The exposure modeling does not consider the possibility that many ecological receptors may discriminate and avoid consuming contaminated prey items (especially those that are most contaminated and would pose the most significant toxicological impact). This simplification could result in overly conservative estimates of potential exposure. Conversely, contaminated prey items may be selectively consumed if physiological, morphological, or behavioral effects make them more apparent or vulnerable. If this is the case, the calculated risk could be underestimated in the model.

- A number of conservative toxicological and ecological assumptions have been made in the ERA. As a result of the cumulative impact of multiple conservative assumptions, risk to ecological receptors may occasionally be predicted at soil and sediment chemical concentrations near background levels.

- Some BAFs were not available in the literature and regression equations were employed to develop BAFs. Although these equations generally have high coefficients of confidence, the values derived from this method are not precise. This may result in an over- or under-estimation of risk at the study area.

6.2.8 Ecological Risk Assessment Summary and Conclusions

The objectives of the ERA include characterizing the ecological habitats in the general vicinity of the Olin Plant; identifying the types of ecological receptors that may utilize habitats located within potential contaminant pathways; and evaluating the likelihood that toxicological effects may occur. Most cover types found in the vicinity of the Olin Plant are classified by NYSDEC as "terrestrial cultural" reflecting the heavily industrialized nature of this area. Most terrestrial cover types are not anticipated to provide habitat necessary to support a diverse and well-balanced ecological community. However, wildlife, such as small ground-foraging birds and small mammals that are tolerant of human activity, may occur in the immediate vicinity of the Olin Plant. The Erie Barge Canal supports fish and other aquatic organisms that are characteristic of warm-water habitat in the area.

- Based on the findings of the ERA, terrestrial wildlife and aquatic receptors in the canal are not anticipated to be adversely impacted as a result of exposure to site-related contaminants.

- HIs for the modeled terrestrial wildlife receptors (i.e., American robin and meadow vole) were less than 1 under both maximum and average surface soil exposure assumptions.

- HIs, based on the future discharge of groundwater into the barge canal, were several orders of magnitude below 1, under both high- and low-flow assumptions. Based on the magnitude of the estimated surface water concentrations, there is no indication of a bioaccumulation hazard.

- Maximum detected surface soil concentrations of several inorganic CPCs exceeded the screening toxicological benchmarks for plants and invertebrates. However, the poor ecological habitat quality of the study area, combined with the conservative nature of the screening benchmark values employed, suggests that potential risks to these two groups of receptors were overestimated in this baseline assessment.

No toxicological impacts or bioaccumulation hazards associated with the discharge of groundwater into the Erie Barge Canal are anticipated. Ecological wildlife receptors that may occur at the study area are unlikely to be adversely impacted as a result of exposures associated with foraging activities as well.

7.0 REMEDIAL INVESTIGATION SUMMARY AND CONCLUSIONS

Subsection 7.1 presents summaries of the nature and distribution of contamination (Section 4), contaminant fate and transport (Section 5), and the risk assessment (Section 6). Conclusions of the RI are presented in Subsection 7.2. Data gaps and recommendations for further work at the study area are discussed in Subsection 7.3.

7.1 SUMMARY

The following subsections summarize the major findings concerning the nature and distribution of site contaminants, contaminant fate and transport, and the risk assessment.

7.1.1 Nature and Distribution of Contamination

Site-related contaminants were detected in soil gas, surface soil, subsurface soil, and groundwater. The distribution of these contaminants is the result of the leaching of contaminated soils on-site, and the fate and transport mechanisms discussed in Section 5.

Soil Gas. Selected VOCs were detected in soil gas on-site and, at lower concentrations, off-site. The primary on-site areas of VOCs in soil gas were the Well B-17 Area and the Lab Sample Area.

Surface Soil. Chloroform was the only VOC detected in surface soils samples, which were collected from on-site areas. All surface soil samples contained PAHs and one or more chloropyridine isomers.

Subsurface Soil. Results of analyses of subsurface soil showed no significant areas of soil contamination that could be considered contaminant sources in four of the five potential contaminant source areas investigated on-site. The highest concentrations of VOCs, pyridines, and other SVOCs were detected in samples from one area: the Well B-17 area.

Groundwater. Pyridines, other SVOCs, VOCs, and inorganic analytes were detected in overburden and bedrock groundwater, beneath both the Olin Plant and the off-site study area.

Pyridines were the most frequently-detected organic chemicals in both overburden and bedrock groundwater, and the distribution of pyridines is believed to represent the greatest extent of site-derived groundwater contamination. Two primary lobes of pyridine in overburden groundwater are present, one extending west and northwest of the Olin Plant, and the other extending south of the plant. Total pyridine concentrations were lower in deep bedrock than in adjacent shallow bedrock wells.

In overburden groundwater, total pyridine concentrations were delineated to the 10 μg/L in all directions except the southeast, where they were delineated to 4,600 μg/L. In shallow bedrock, the extent of total pyridine concentrations above 10 μg/L was delineated in all directions except south and southwest of the Olin Plant, where concentrations up to 3,000 and 23,000 μg/L, respectively, were detected at the limit of explorations.

Several VOCs were detected in overburden and bedrock groundwater, including carbon tetrachloride, chloroform, methylene chloride, chlorinated ethenes, and BTEX compounds. The highest overburden concentrations of VOCs were detected beneath the Well B-17, Tank Farm, and Well BR-5 areas. Off-site overburden VOCs include PCE, TCE, and BTEX. Overburden groundwater VOC concentrations were delineated to 56 μg/L (total BTEX) to the southeast of the Olin Plant and to 10 μg/L in other directions. Overburden becomes unsaturated to the west of the plant. The highest bedrock concentrations were detected south of the Well B-17 Area. Bedrock VOC concentrations were detected west and south of the plant, where they were delineated to 920 and 9 μg/L (total selected VOCs), respectively.

Inorganic concentrations in groundwater were higher in the overburden than in the bedrock, perhaps due to suspended solids concentrations in unfiltered overburden samples. Maximum inorganic concentrations in overburden were detected primarily along the western and southern plant boundaries. Maximum inorganic concentrations in bedrock were detected in wells showing high site-related organic constituent concentrations. Most inorganics detected in groundwater are believed to be naturally occurring elements to operators at the Olin Plant.

Pyridines and VOCs were detected in the single deep bedrock well installed during the Phase I RI. The extent of site-related contaminants in the deep bedrock was not delineated.

No DNAPL was detected in any well installed during the Phase I RI.

7.1.2 Fate and Transport

The fate and transport analysis concentrated on site-related VOCs, pyridines and other SVOCs, and inorganics migrating from on-site sources to overburden and bedrock groundwater. Dissolved-phase transport in groundwater is considered the most important contaminant migration pathway. Other less significant pathways that were investigated include atmospheric migration of VOCs from the subsurface into neighboring buildings and surface water transport of constituents potentially discharged via groundwater to the Erie Barge Canal.

The physico-chemical properties of VOCs, pyridines, and other SVOCs (primarily PAHs and phthalates) were evaluated to assess the importance of biodegradation, adsorption, volatilization, and dissolution as fate processes. Dissolution and degradation of VOCs from past releases to groundwater are believed to be the most significant fate process for VOCs at the study area. Dissolution occurs for all VOCs, and depends upon residence time of groundwater in contaminated soil. Anaerobic degradation is believed to be the most important fate process for PCE and TCE; however, other halogenated VOCs may also biodegrade over time. Adsorption to soil was identified as the most important fate process controlling the distribution of PAHs and pesticides. Biodegradation was identified as the most important fate process for pyridines, however photo-oxidation and volatilization also control the fate.

Assessment of fate processes for inorganics was qualitative. Mobility of inorganics in soil-groundwater systems is affected by soil-, water- and chemical-specific properties including compound solubility, pH, soil cation exchange capacity, and oxidation-reduction potential. Groundwater in the vicinity of the Olin Plant is naturally high in sulfur, and would be expected to be high in calcium and magnesium because of the carbonate bedrock.

A conceptual model was developed for the study area which illustrates that chemicals leach from soil at the Olin Plant by infiltrating precipitation, or formerly percolated through the unsaturated overburden to the groundwater. Once in the groundwater, contamination migrates in the dissolved phase in the saturated overburden and bedrock. Groundwater may discharge from bedrock to the Erie Barge Canal, or it may flow beneath the canal in fractures. Oxidation/reduction processes, dissolution, degradation, volatilization, and adsorption processes act to reduce concentrations of chemicals in groundwater during migration.

7.1.3 Baseline Risk Assessment

The baseline risk assessment is summarized in the flowing subsections:

7.1.3.1 Baseline Human Health Risk Assessment. Potential health risks associated with exposures at the Olin facility were evaluated using current USEPA and NYSDEC guidance. The media assessed were soil gas, surface soil (0-2 inches bgs), soil (0-10 ft. bgs), overburden groundwater, and bedrock groundwater. The predominant CPCs identified were chlorinated VOCs, chloropyridines, PAHs, and inorganics.

The Olin facility is in a highly industrialized area with no residential housing nearby. The exposure scenarios selected for quantitative evaluation are:

- industrial/commercial worker exposures to surface soil;
- construction/excavation worker exposures to subsurface soil; and
- construction/excavation worker exposures to overburden groundwater.

Exposure to soil gas and bedrock groundwater are evaluated qualitatively.

The USEPA acceptable risk level for noncarcinogenic risk of an HI of 1 was used to characterize potential noncancer risks. The USEPA risk range of $1x10^{-4}$ to $1x10^{-6}$ for carcinogenic risk was used to characterize potential cancer risks.

Potential human health risks characterized as exceeding the USEPA acceptable cancer risk range and noncancer risk level are considered significant.

The results of the human health risk characterization are:

- No health risks identified for worker exposures to soil gas, either on-site or in buildings on adjacent properties.
- No significant health risks identified for worker exposures to surface soil.
- Potential health risks characterized for construction workers exposed to subsurface soil exceed USEPA acceptable values.
- Potential health risks characterized for construction workers exposed to overburden groundwater exceed USEPA acceptable values.
- Bedrock groundwater samples exceed federal MCLs and state guidance concentrations for several compounds.

7.1.3.2 Ecological Risk Assessment. An habitat-based ERA of the study area was conducted in accordance with NYSDEC (1989 and 1991a) guidance. The objectives of the ERA include characterizing the ecological habitats in the general vicinity of the Olin Plant; identifying the types of ecological receptors that may utilize habitats located within potential contaminant pathways; and evaluating the likelihood that toxicological effects may occur.

- Cover types found in the vicinity of the study area are classified by NYSDEC as "terrestrial cultural" reflecting the heavily industrialized nature of this area and are not anticipated to provide habitat necessary to support a diverse and well-balanced ecological community.
- Based on the findings of the ERA, terrestrial wildlife and aquatic receptors in the canal are not anticipated to be adversely impacted as a result of exposure to site-related contaminants. Fish BCFs for the organic groundwater constituents were generally low, and most of the CPCs are known to degrade rapidly.
- Maximum detected surface soil concentrations of several inorganic CPCs exceeded the screening toxicological benchmarks for plants and

invertebrates. The poor ecological habitat quality of Olin Study Area, combined with the conservative nature of the screening benchmark values employed however, suggests that potential risks to these two groups of receptors were over-estimated in this baseline assessment.

7.2 PHASE I REMEDIAL INVESTIGATION CONCLUSIONS

Results of investigations undertaken during the Phase I RI at the Olin Study Area have corroborated previous conclusions regarding the geology and hydrogeology, direction of groundwater flow, and on-site groundwater quality. No new source areas were identified during the investigation, and the limits of on-site soil contamination were identified.

The highest concentrations of site-related contaminants in overburden and bedrock groundwater were detected on-site, generally in the vicinity of the Well B-17 area. Groundwater contamination was found to the limits of exploration. Overburden groundwater contamination was limited west of the Olin Plant where the water table intercepts the bedrock surface. Contamination was limited east of the plant as indicated by water quality in the wells MW-103 and BR-103, and the capture shown by the groundwater piezometric contour maps. Contamination in overburden groundwater has not been delineated to the south, southeast and northwest of the plant. Contamination in bedrock groundwater has not been delineated to the south or west of the plant.

Site-related chemicals were detected in the deep bedrock well drilled southwest of the Olin Plant (BR-105D). Higher concentrations of chlorinated ethenes were detected in the deeper bedrock well than in the adjacent shallow well. The potential exists that groundwater transport is occurring in relatively deep fractures beneath the upper fractured bedrock which was the focus of most of the Phase I RI.

The human health risk assessment identified no significant risks associated with exposures to soil gas or surface soil. Although potential noncancer risks from subsurface soil CPCs exceed USEPA acceptable values, these risks may be a result of naturally occurring elements at ambient concentrations and may not be related to the Olin Plant.

Potential risks characterized for exposures to the overburden groundwater, predominantly the on-site overburden groundwater, exceed USEPA acceptable risk levels. The exposure parameters used in the evaluation are conservative and most likely over-estimate anticipated actual exposures. Reducing or eliminating exposure to groundwater during potential future excavation activities would mitigate the level of risk. Use of personal protective equipment would greatly reduce the level of exposure and is expected to reduce the risk to acceptable levels.

No toxicological impacts or bioaccumulation hazards associated with the discharge of groundwater into the Erie Barge Canal are anticipated. Ecological wildlife receptors that may occur at the study area are unlikely to be adversely impacted as a result of exposures associated with foraging activities, as well.

Screening toxicological benchmarks for terrestrial plants and invertebrates were exceeded by surface soil concentrations of several inorganic CPCs. There is considerable uncertainty involved in the interpretation of the benchmark exceedances which were derived from a number of studies where environmental conditions varied considerably. Moreover, the selection of the lowest reported toxicological values for each surface soil CPC assumes that the most sensitive receptors would occur at the Olin Plant. Although this assumption is appropriate for a baseline assessment, actual risks to the plants and invertebrates that occur at the study area were most likely over-estimated in this ERA.

7.3 RECOMMENDATIONS FOR FUTURE WORK

Based on the information collected during the Phase I RI and previous investigations, general recommendations for additional work are as follows:

- Further delineate the overburden groundwater plume, particularly to the southeast of the Phase I investigation locations.
- Further delineate the shallow bedrock groundwater plume west and south of the Phase I investigation locations.
- Further characterize groundwater flow and quality in deeper bedrock fractures.

- More completely characterize background soil concentrations.
- Develop more realistic assumptions for potential exposures to groundwater for risk assessment purposes.
- Assess potential impacts of site-related contaminants on the Erie Barge Canal.

ABB-ES	ABB Environmental Services, Inc.
ARAR	Applicable or Relevant and Appropriate Requirement
ASP	Analytical Services Protocol
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criteria
BAF	bioaccumulation factor
BCF	bioconcentration factor
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, xylenes
CLP	Contract Laboratory Program
cm/sec	centimeters per second
CPC	chemical of potential concern
CSF	cancer slope factor
CWA	Clean Water Act
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
DDT	dichlorodiphenyltrichloroethene
DNAPL	dense nonaqueous phase liquid
DQO	Data Quality Objective
ECAO	Environmental Criteria Assessment Office
ECD	electron capture detector
EPC	exposure point concentration
ERA	ecological risk assessment
FID	flame ionization detector
FS	Feasibility Study
ft/ft	feet per foot
GC	gas chromatograph
GPR	ground-penetrating radar
HBA	habitat-based assessment
HEAST	Health Effects Assessment Summary Tables

HI	hazard index
HQ	hazard quotient
ID	inside diameter
IRIS	Integrated Risk Information System
K_{oc}	organic carbon partition coefficient
LC_{50}	lethal concentration for 50 percent of study population
LD_{50}	lethal dose for 50 percent of study population
LNAPL	light nonaqueous phase liquid
LOAEL	lowest observed adverse effects level
LOEC	lowest observed effects concentration
LOEL	lowest observed effects level
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/kg	milligrams per kilogram
mg/m^3	milligrams per cubic meter
MS	mass spectrograph
MS/MSD	matrix spike/matrix spike duplicate
MSL	mean sea level
NCP	National Contingency Plan
NIST	National Institute of Standards and Technology
NOEL	no observed effects level
NTU	nephelometric turbidity units
NYCRR	New York Code or Rules and Regulations
NYNHP	New York Natural Heritage Program
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OD	outside diameter
OPP	order of potential potency
OVA	organic vapor analysis

PA	preliminary assessment
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PID	photoionization detector
POTW	publicly-owned treatment works
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RfC	reference concentration
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
RPD	relative percent difference
RTV	reference toxicity value
SAS	Special Analytical Services
SCG	state criteria guidelines
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SP	spontaneous potential
SPR	single point resistance
SQL	Sample Quantitation Limit
SVOA	semivolatile organic analysis
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TAL	Target Analyte List
TBC	to be considered
1,1,1-TCA	1,1,1-trichloroethane
TCBO	trichlorobutylene oxide
TCE	trichloroethene
TCL	Target Compound List
TDA	toluene diamine

TIC	tentatively identified compounds
TLV	threshold limit value
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
VOA	volatile organic analysis
VOC	volatile organic compound

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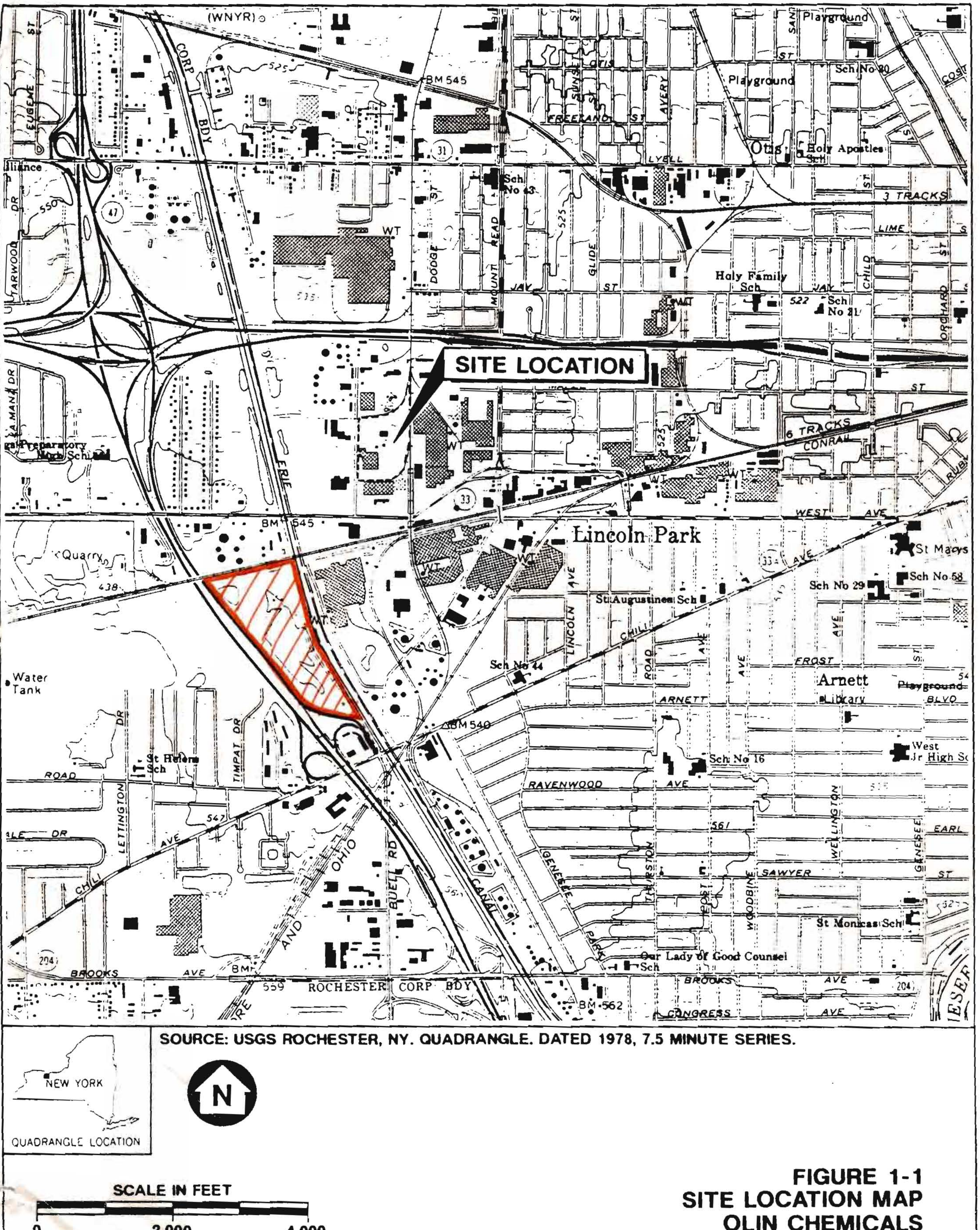
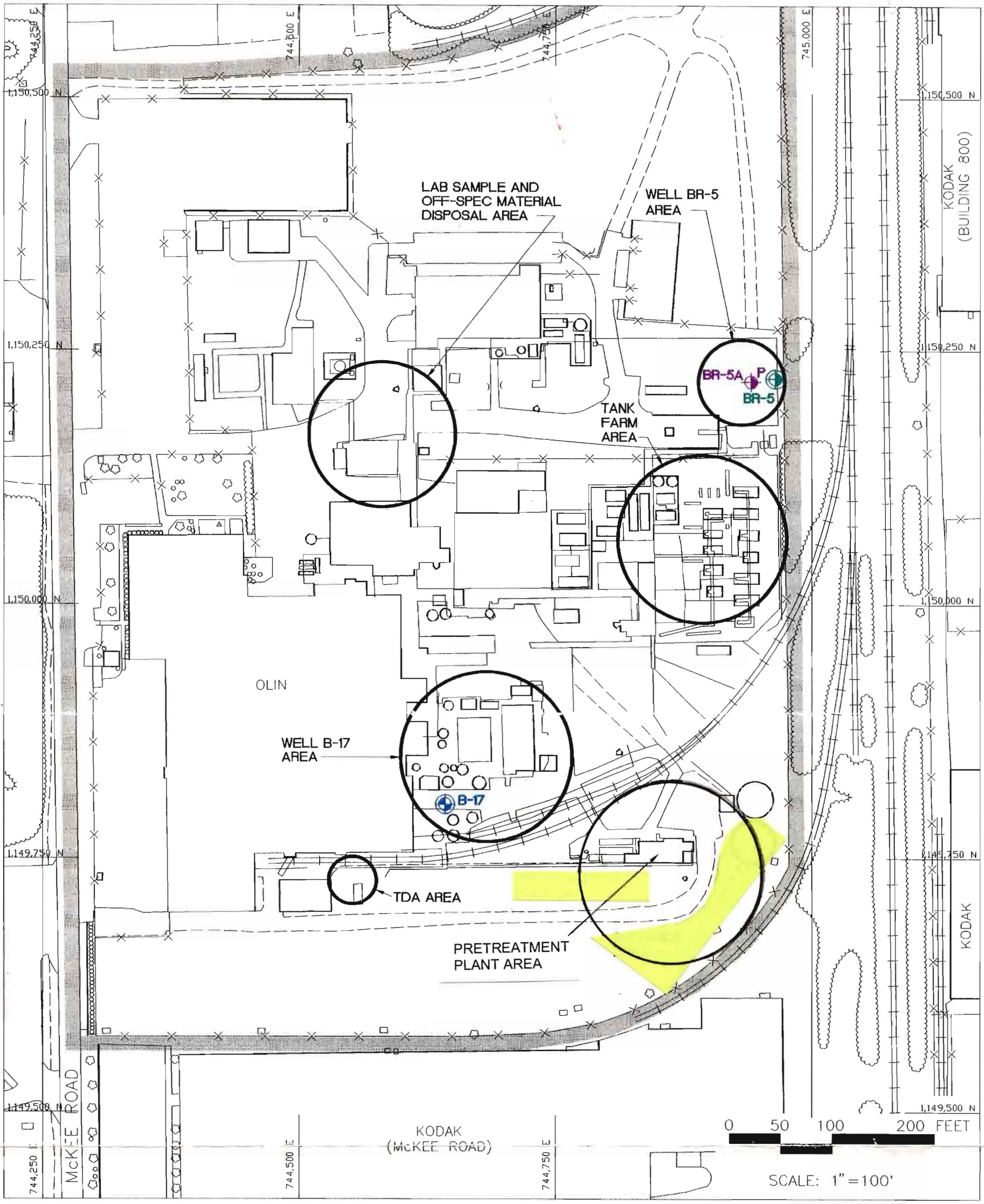


SOURCE: USGS ROCHESTER, NY. QUADRANGLE. DATED 1978, 7.5 MINUTE SERIES.

FIGURE 1-1
SITE LOCATION MAP
OLIN CHEMICALS
ROCHESTER, NEW YORK

ABB Environmental Services, Inc.

6484-00



LEGEND

▨ OUTLINE OF OLIN PROPERTY BOUNDARY

● OVERBURDEN MONITORING WELL

● BEDROCK MONITORING WELL

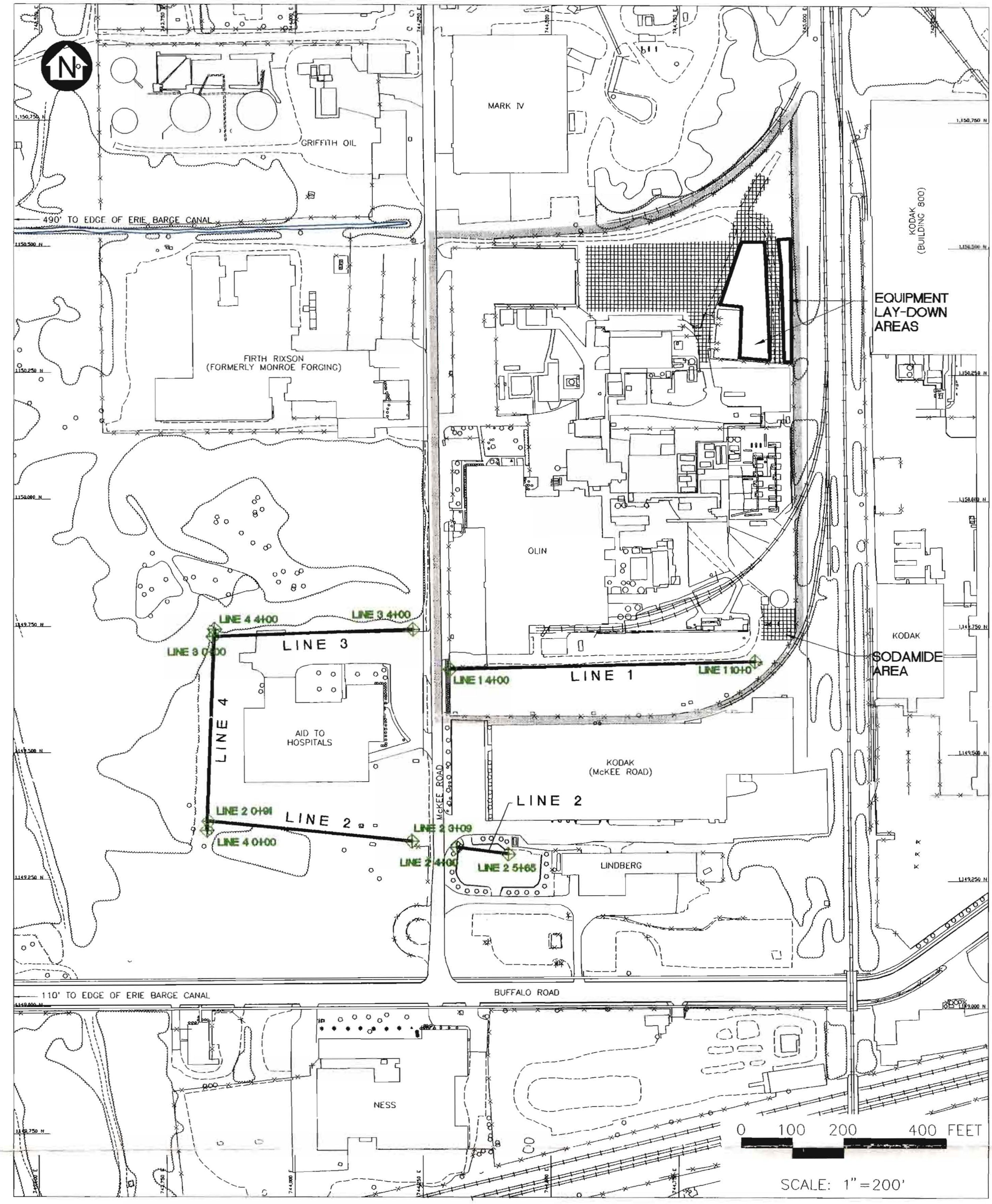
● BEDROCK PUMPING WELL

FIGURE 1-2

LOCATION OF IDENTIFIED AND POTENTIAL CONTAMINANT SOURCE AREAS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG2F 8-17-94 6:35 PM



LEGEND

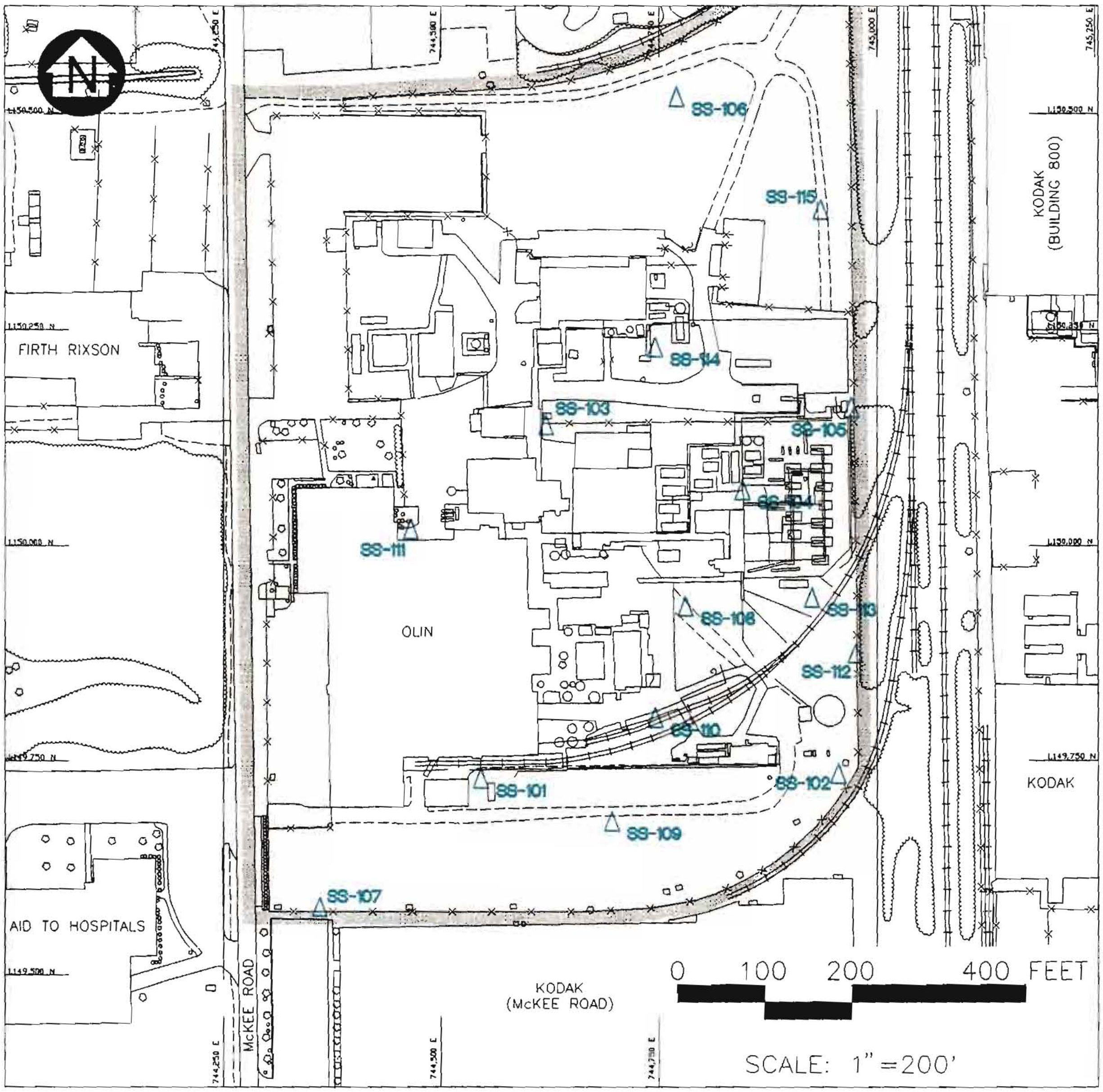
⊕	SEISMIC SURVEY TRAVERSE ENDPOINT EXPLORATION LOCATION
▦	GPR SURVEY AREA
LINE 2	SEISMIC TRAVERSE LINE POSITION
▨	OUTLINE OF OLIN PROPERTY BOUNDARY

FIGURE 2-1

GEOPHYSICAL SURVEY LOCATIONS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG7 8-29-94 09:35



LEGEND

△ SURFACE SOIL SAMPLE LOCATION

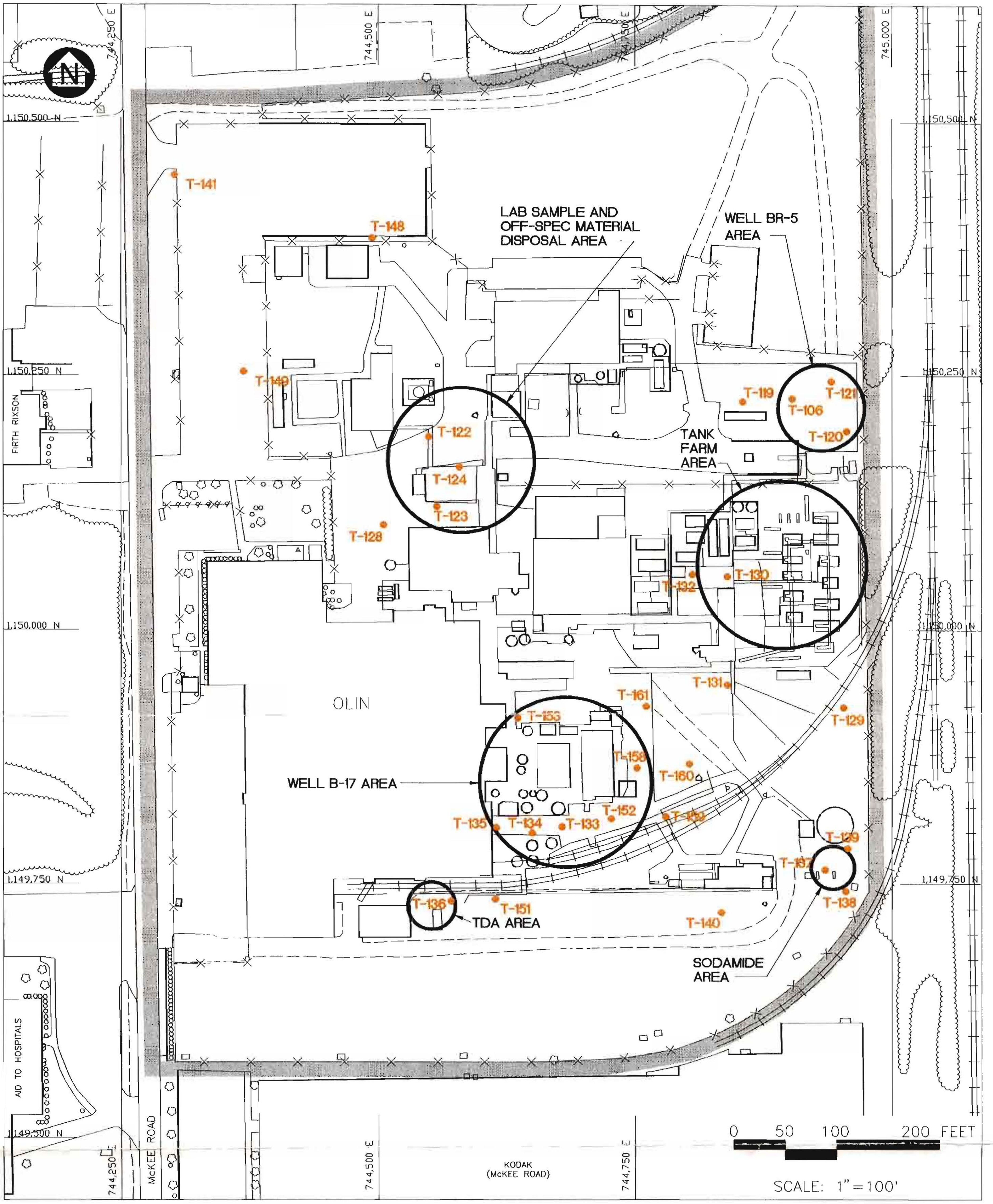
—×—×— OUTLINE OF OLIN PROPERTY BOUNDARY

FIGURE 2-3

SURFACE SOIL SAMPLE LOCATIONS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG9 8-29-94 08:25



LEGEND

● TERRAPROBE BORING

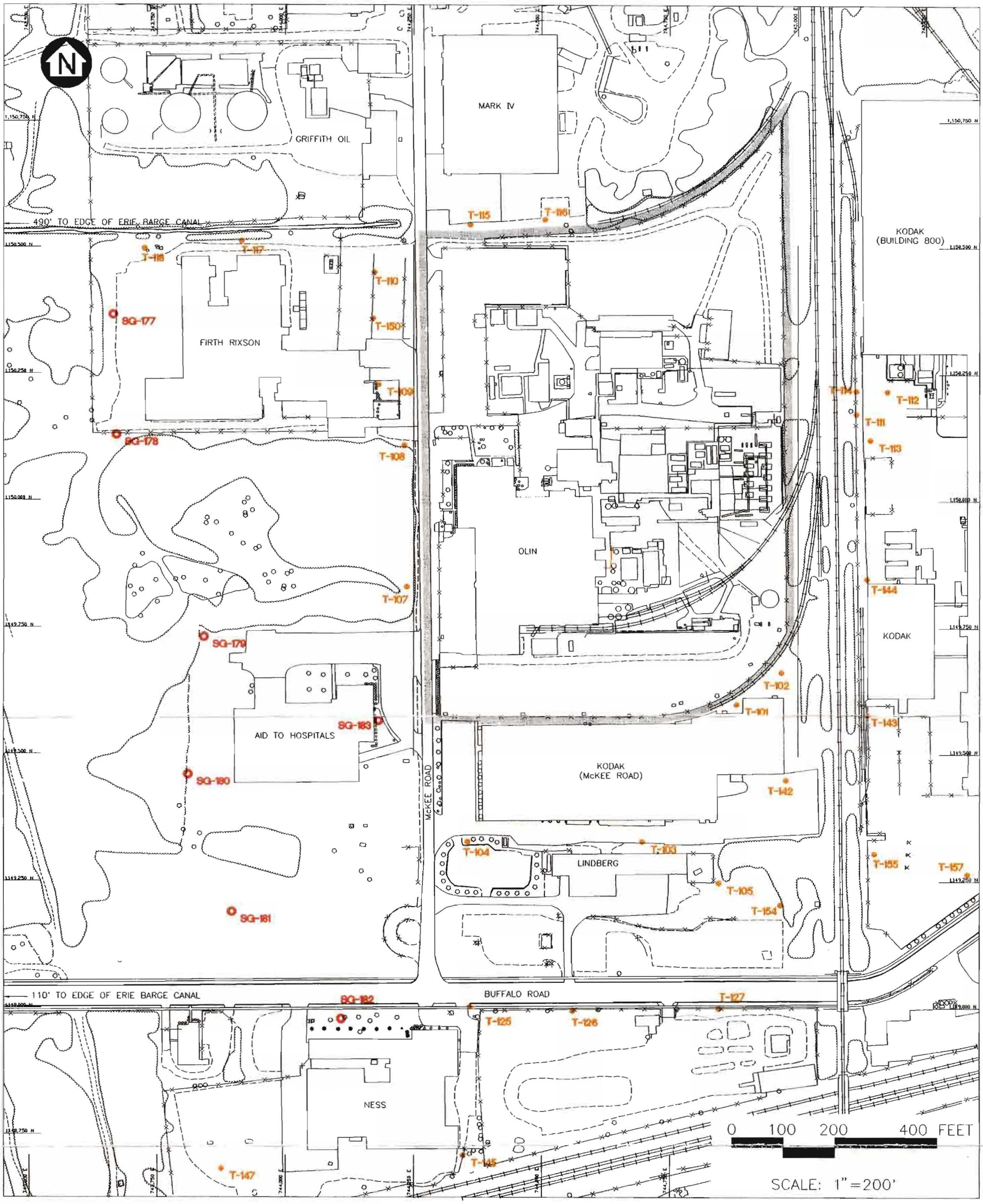
▨ OUTLINE OF OLIN PROPERTY BOUNDARY

FIGURE 2-4

ON-SITE TERRAPROBE SOIL AND GROUNDWATER SAMPLE LOCATIONS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG11 8-29-94 08:45



LEGEND

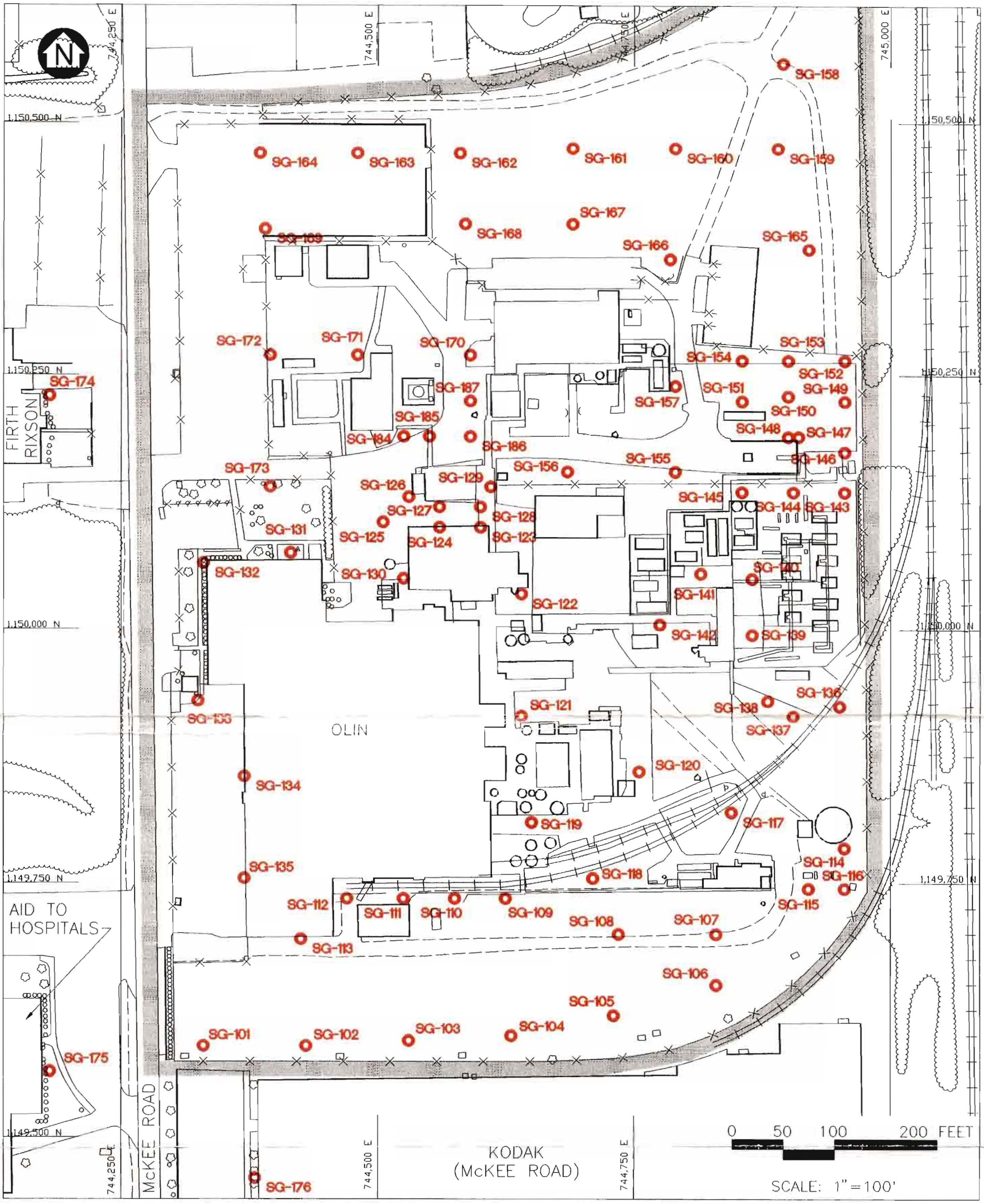
- ● TERRAPROBE BORING
- ○ SOIL GAS SAMPLE LOCATION
- ▨ OUTLINE OF OLIN PROPERTY BOUNDARY

FIGURE 2-5

OFF-SITE TERRAPROBE GROUNDWATER AND SOIL GAS SAMPLE LOCATIONS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG12 8-29-94 09:45



LEGEND

● SOIL GAS SAMPLE LOCATION

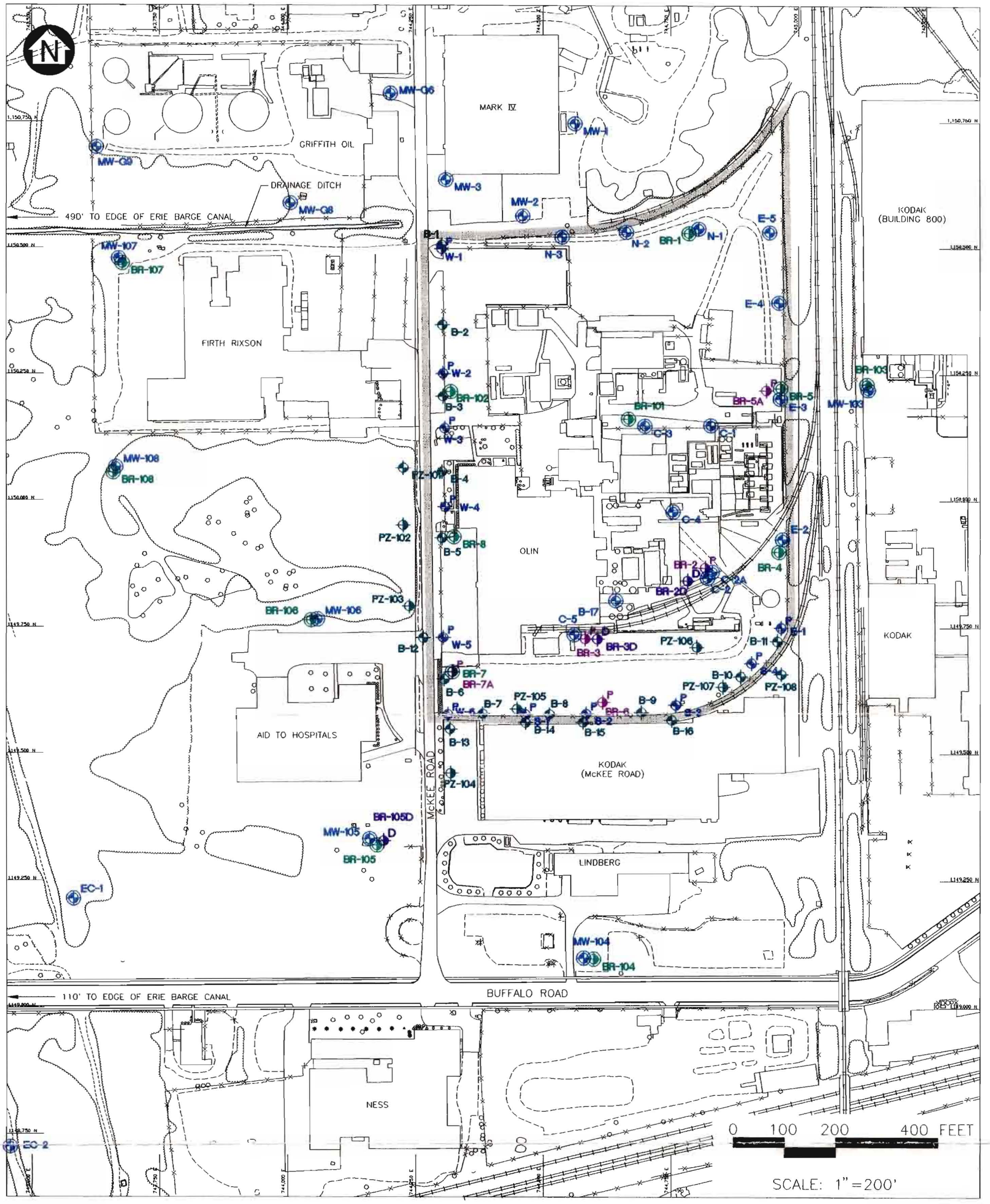
▨ OUTLINE OF OLIN PROPERTY BOUNDARY

FIGURE 2-2

ON-SITE SOIL GAS SAMPLE LOCATIONS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG8 8-30-94 08:00



LEGEND

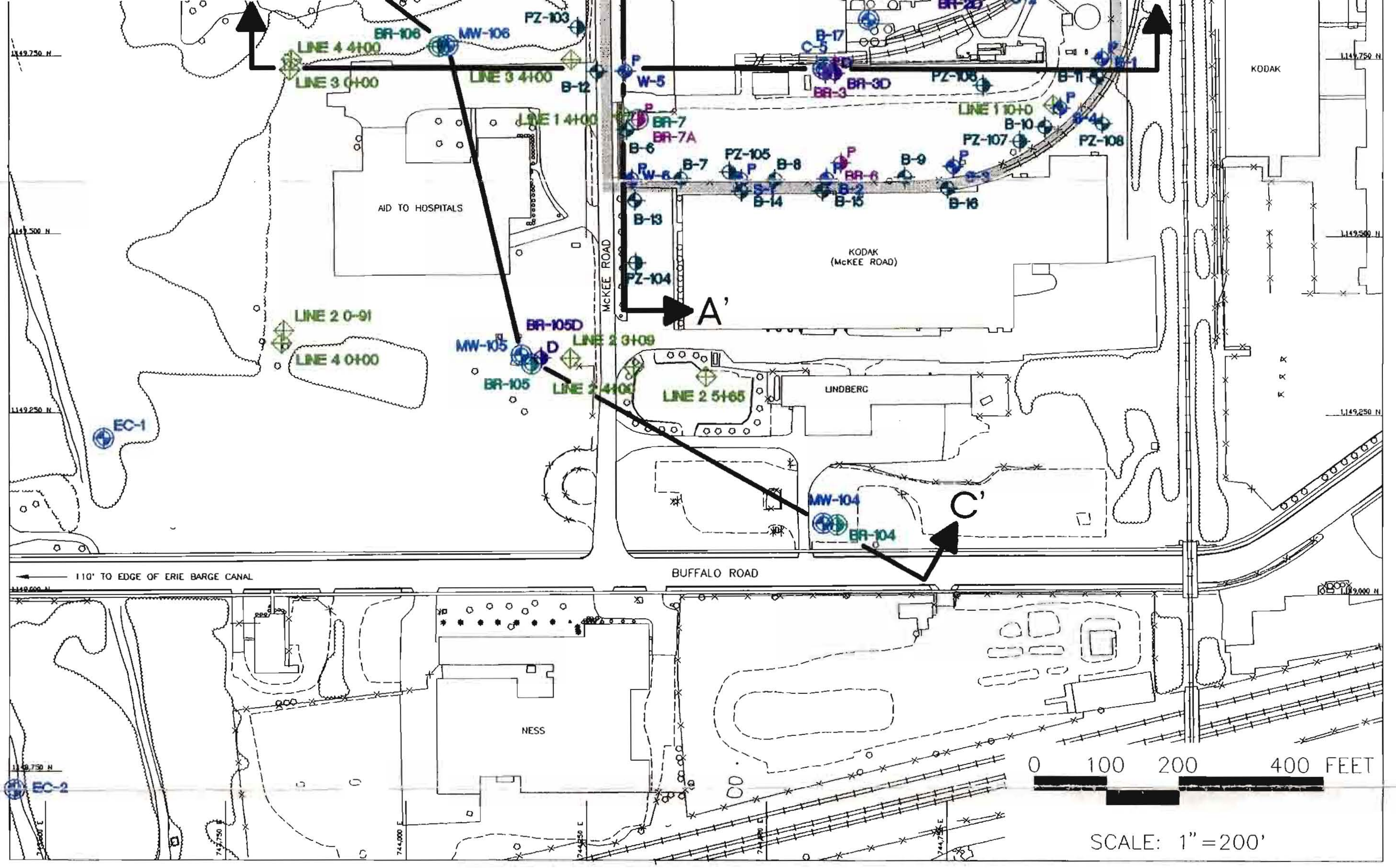
- ✦ OVERBURDEN PIEZOMETER
- ✦ BEDROCK PIEZOMETER
- ⊕ OVERBURDEN MONITORING WELL
- ⊕ BEDROCK MONITORING WELL
- ⊕D DEEP BEDROCK MONITORING WELL
- ⊕P OVERBURDEN PUMPING WELL
- ⊕P BEDROCK PUMPING WELL
- ▨ OUTLINE OF OLIN PROPERTY BOUNDARY

FIGURE 2-6

LOCATION OF ALL WELLS AND PIEZOMETERS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG10 8-29-94 9:15



LEGEND

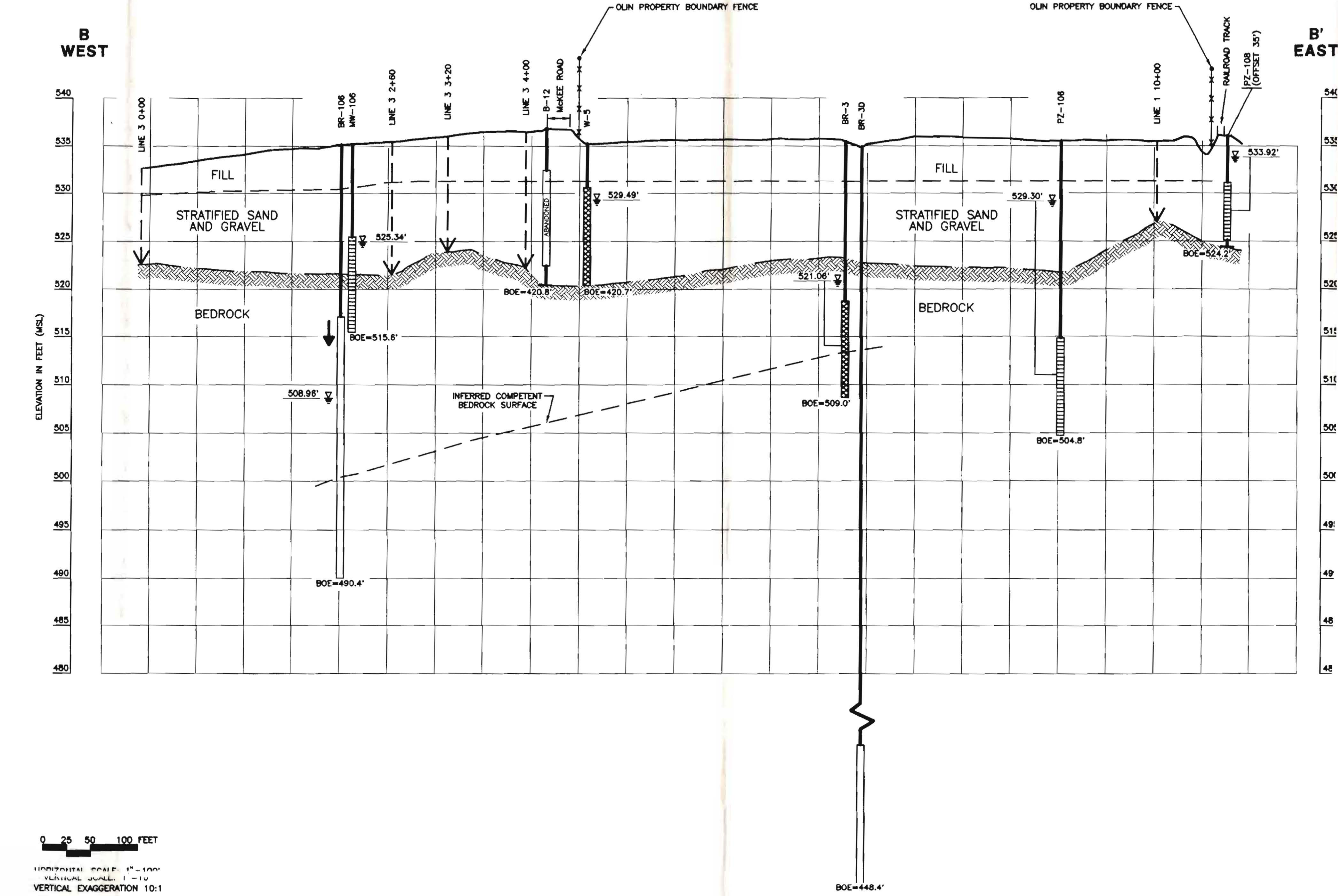
- OVERBURDEN PIEZOMETER
- BEDROCK PIEZOMETER
- OVERBURDEN MONITORING WELL
- BEDROCK MONITORING WELL
- DEEP BEDROCK MONITORING WELL
- OVERBURDEN PUMPING WELL
- BEDROCK PUMPING WELL
- SEISMIC SURVEY TRAVERSE ENDPOINT EXPLORATION LOCATION
- OUTLINE OF OLIN PROPERTY BOUNDARY
- A A' CROSS SECTION LINE

FIGURE 3-1

LOCATION OF GEOLOGIC CROSS SECTIONS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG6 8-19-94 2:00 PM



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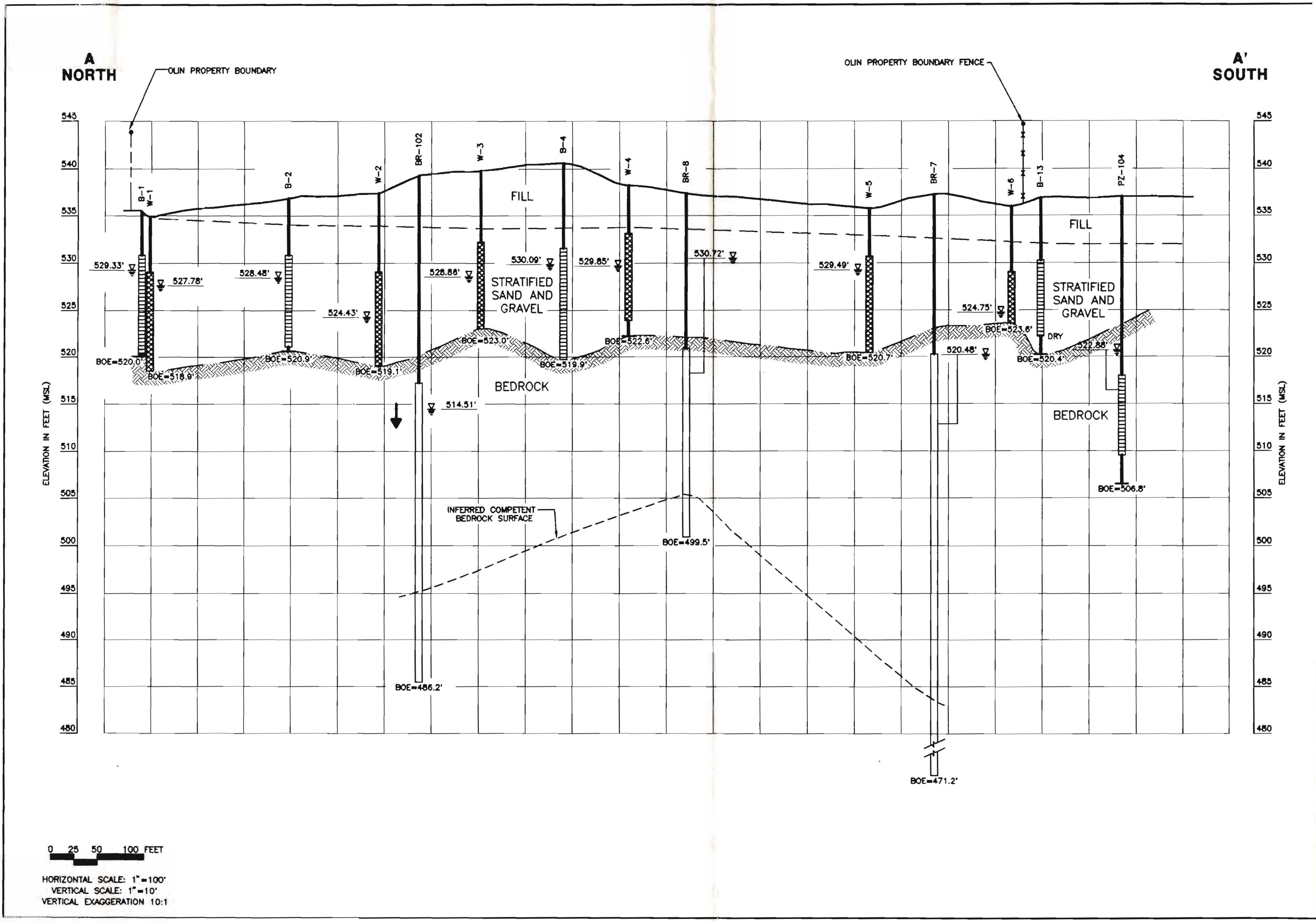

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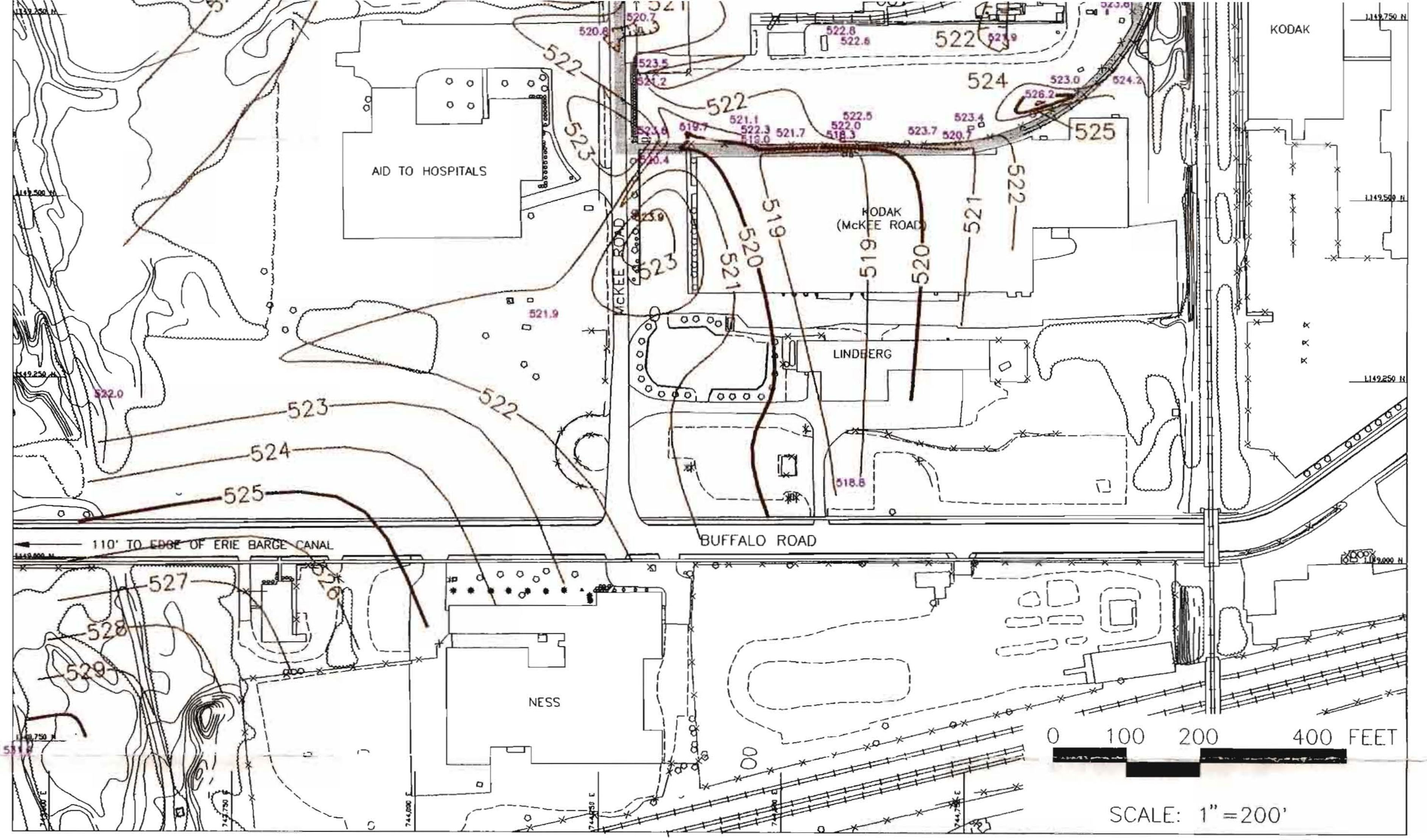


LEGEND

▨ OUTLINE OF OLIN PROPERTY BOUNDARY

—525— BEDROCK GROUNDWATER ELEVATION CONTOUR (MSL) 5' INTERVAL

—525— BEDROCK GROUNDWATER ELEVATION CONTOUR (MSL) 1' INTERVAL

521.9 BEDROCK SURFACE ELEVATION AT WELL OR PIEZOMETER (MSL)

FIGURE 3-5

BEDROCK SURFACE INTERPRETED ELEVATION CONTOURS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG10A 8-19-94 1:55 PM

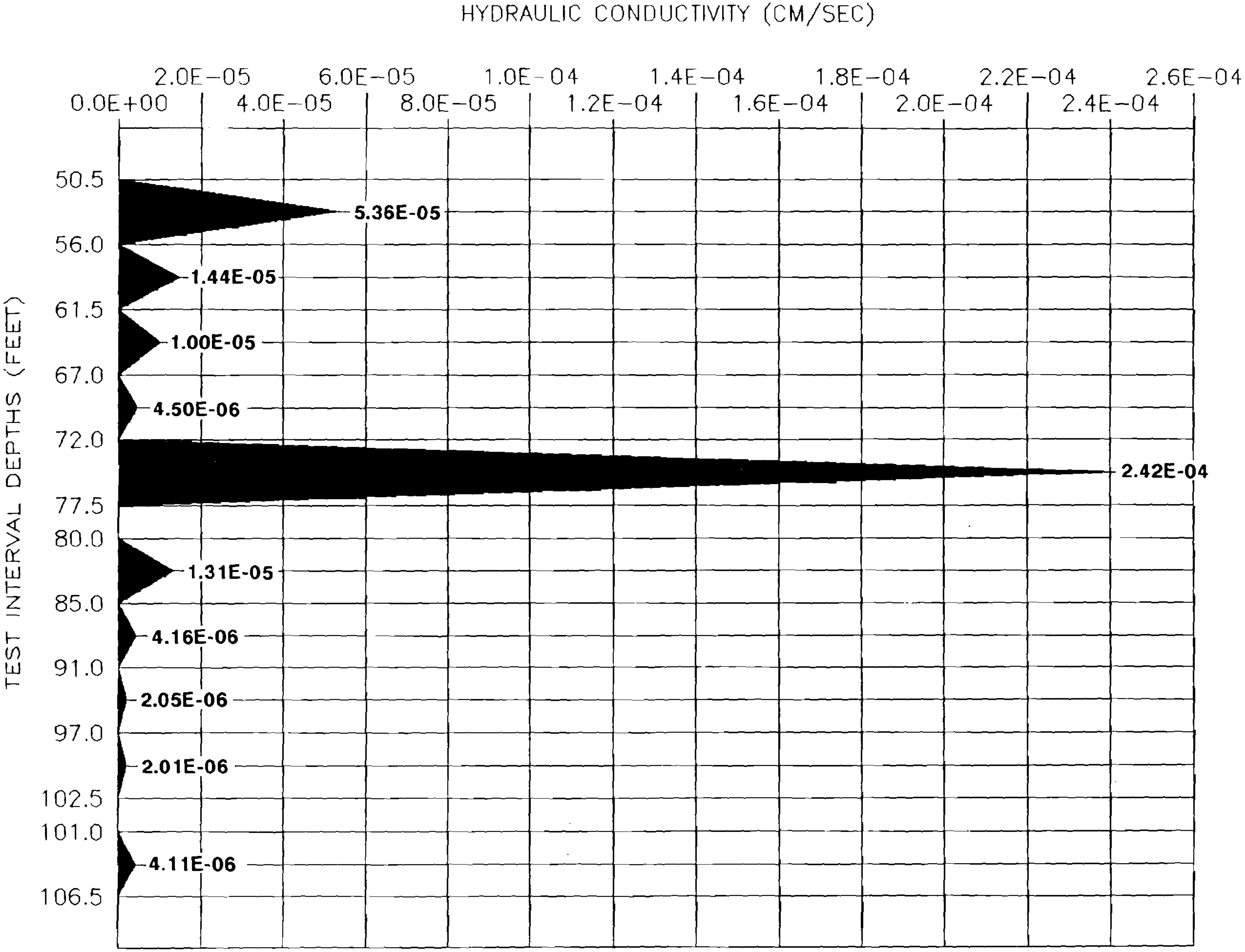
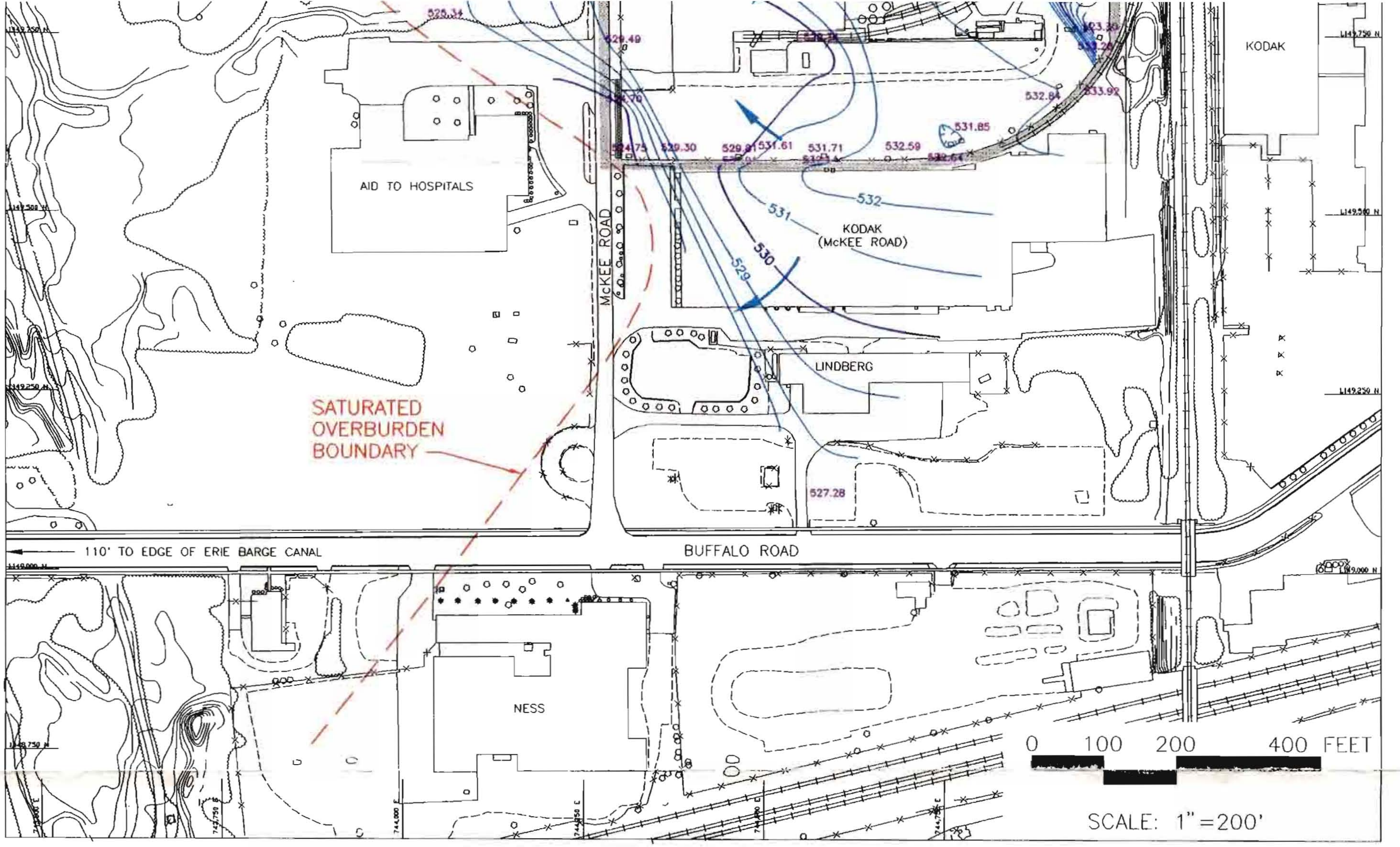


FIGURE 3-6
BR-105D PACKER TEST RESULTS
OLIN CHEMICALS PHASE I RI REPORT, ROCHESTER, NY



LEGEND

▨ OUTLINE OF OLIN PROPERTY BOUNDARY

—530— OVERBURDEN GROUNDWATER ELEVATION CONTOUR (MSL) 5' INTERVAL

—529— OVERBURDEN GROUNDWATER ELEVATION CONTOUR (MSL) 1' INTERVAL

527.28 PIEZOMETER ELEVATION AT WELL OR PIEZOMETER (MSL)

→ INTERPRETED GROUNDWATER FLOW DIRECTION

NOTE:

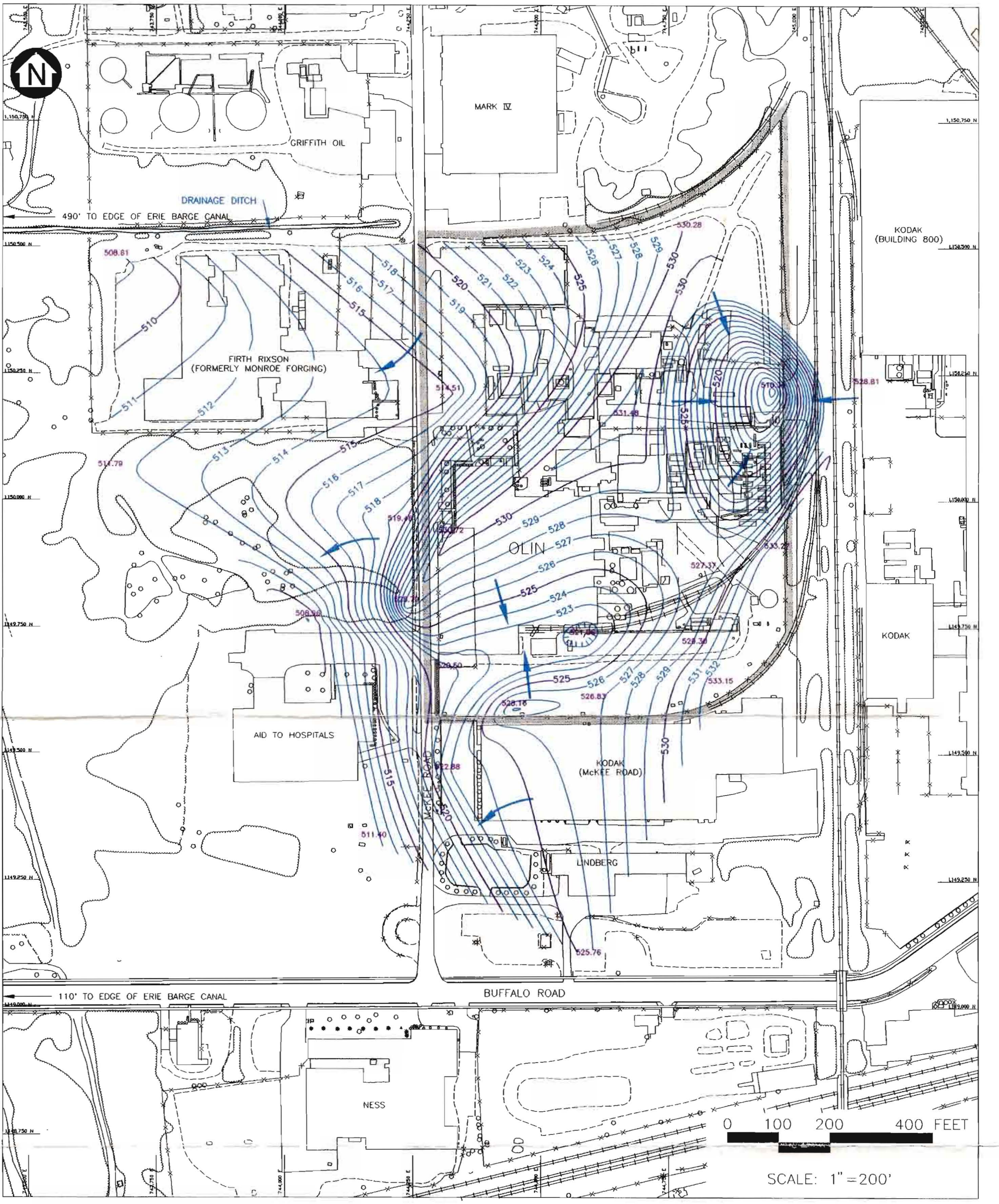
WATER LEVELS MEASURED ON MARCH 14,1994.

FIGURE 3-7

OVERBURDEN GROUNDWATER INTERPRETED PIEZOMETRIC CONTOURS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG1F 9-1-94 5:00 PM



LEGEND

▨ OUTLINE OF OLIN PROPERTY BOUNDARY

—530— BEDROCK GROUNDWATER ELEVATION CONTOUR (MSL) 5' INTERVAL

—531— BEDROCK GROUNDWATER ELEVATION CONTOUR (MSL) 1' INTERVAL

525.76 PIEZOMETER ELEVATION AT WELL OR PIEZOMETER (MSL)

→ INTERPRETED GROUNDWATER FLOW DIRECTION

NOTE:

WATER LEVELS MEASURED ON MARCH 14,1994.

FIGURE 3-8

BEDROCK GROUNDWATER INTERPRETED PIEZOMETRIC CONTOURS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG2G 9-1-94 4:30 PM

LEGEND

○ SOIL GAS EXPLORATION LOCATION

▨ OUTLINE OF OLIN PROPERTY BOUNDARY

NOTE: RESULTS REPORTED AS SUM OF FIELD LABORATORY CONCENTRATIONS IN MICROGRAMS PER LITER IN AIR FOR THE FOLLOWING CHEMICALS:

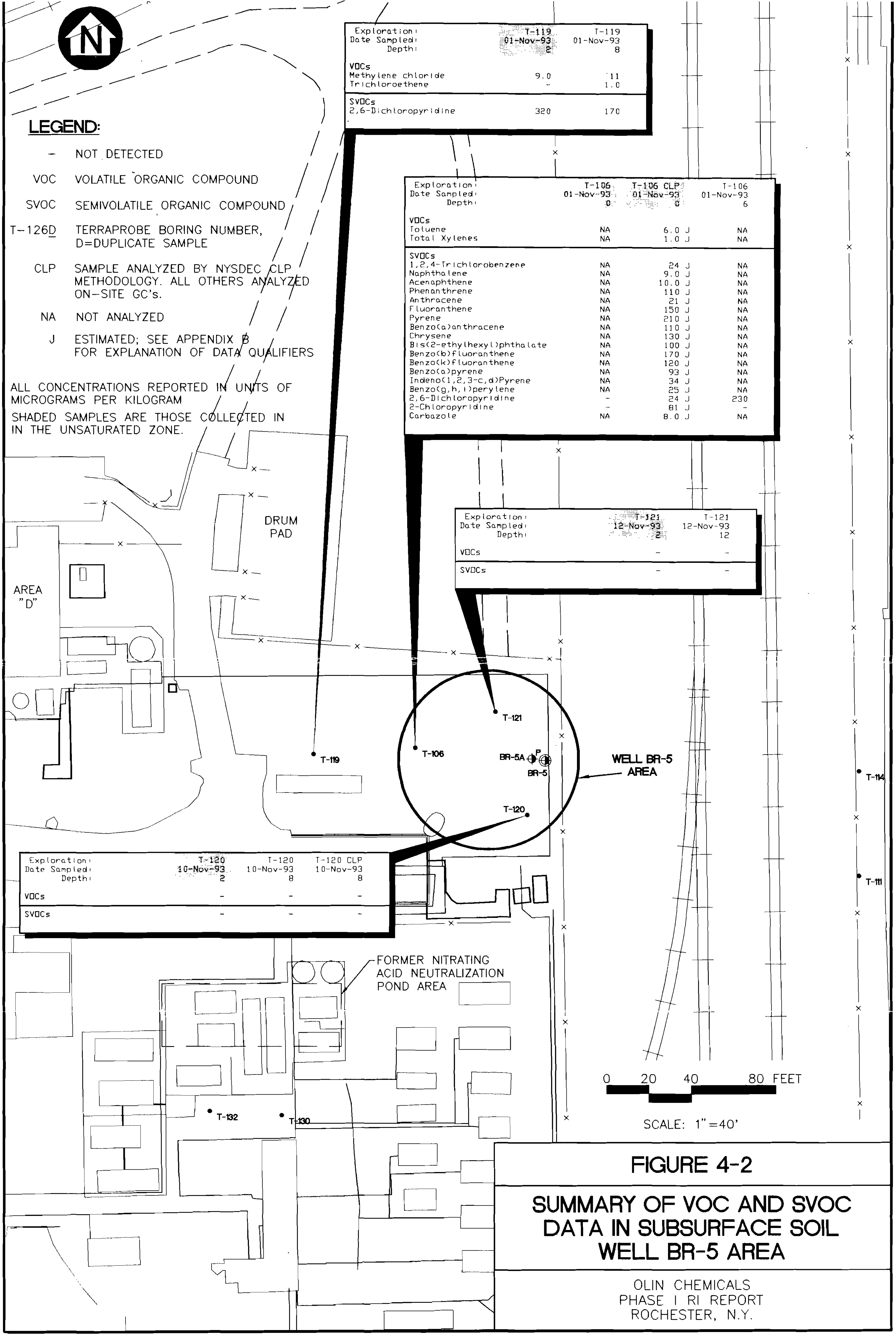
- 1,1,1-TRICHLOROETHANE
- 1,1-DICHLOROETHENE
- CARBON TETRACHLORIDE
- CHLOROFORM
- CIS-1,2-DICHLOROETHENE
- METHYLENE CHLORIDE
- TETRACHLOROETHENE
- TRANS-1,2-DICHLOROETHENE
- TRICHLOROETHENE

FIGURE 4-1

TOTAL SELECTED VOCS INTERPRETED CONCENTRATION ISOPLETHS FOR SOIL GAS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG3A 8-29-94 10:20



LEGEND:

–	NOT DETECTED
VOC	VOLATILE ORGANIC COMPOUND
SVOC	SEMIVOLATILE ORGANIC COMPOUND
T-126D	TERRAPROBE BORING NUMBER, D=DUPLICATE SAMPLE
CLP	SAMPLE ANALYZED BY NYSDEC CLP METHODOLOGY. ALL OTHERS ANALYZED ON-SITE GC's.
NA	NOT ANALYZED
J	ESTIMATED; SEE APPENDIX B FOR EXPLANATION OF DATA QUALIFIERS

ALL CONCENTRATIONS REPORTED IN UNITS OF MICROGRAMS PER KILOGRAM

SHADED SAMPLES ARE THOSE COLLECTED IN IN THE UNSATURATED ZONE.

Exploration:	T-119	T-119
Date Sampled:	01-Nov-93	01-Nov-93
Depth:	2	8
VOCs		
Methylene chloride	9.0	11
Trichloroethene	–	1.0
SVOCs		
2,6-Dichloropyridine	320	170

Exploration:	T-106	T-106 CLP	T-106
Date Sampled:	01-Nov-93	01-Nov-93	01-Nov-93
Depth:	0	0	6
VOCs			
Toluene	NA	6.0 J	NA
Total Xylenes	NA	1.0 J	NA
SVOCs			
1,2,4-Trichlorobenzene	NA	24 J	NA
Naphthalene	NA	9.0 J	NA
Acenaphthene	NA	10.0 J	NA
Phenanthrene	NA	110 J	NA
Anthracene	NA	21 J	NA
Fluoranthene	NA	150 J	NA
Pyrene	NA	210 J	NA
Benzo(a)anthracene	NA	110 J	NA
Chrysene	NA	130 J	NA
Bis(2-ethylhexyl)phthalate	NA	100 J	NA
Benzo(b)fluoranthene	NA	170 J	NA
Benzo(k)fluoranthene	NA	120 J	NA
Benzo(a)pyrene	NA	93 J	NA
Indeno(1,2,3-c,d)Pyrene	NA	34 J	NA
Benzo(g,h,i)perylene	NA	25 J	NA
2,6-Dichloropyridine	–	24 J	230
2-Chloropyridine	–	81 J	–
Carbazole	NA	8.0 J	NA

Exploration:	T-121	T-121
Date Sampled:	12-Nov-93	12-Nov-93
Depth:	2	12
VOCs	–	–
SVOCs	–	–

Exploration:	T-120	T-120	T-120 CLP
Date Sampled:	10-Nov-93	10-Nov-93	10-Nov-93
Depth:	2	8	8
VOCs	–	–	–
SVOCs	–	–	–

FIGURE 4-2

SUMMARY OF VOC AND SVOC DATA IN SUBSURFACE SOIL WELL BR-5 AREA

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

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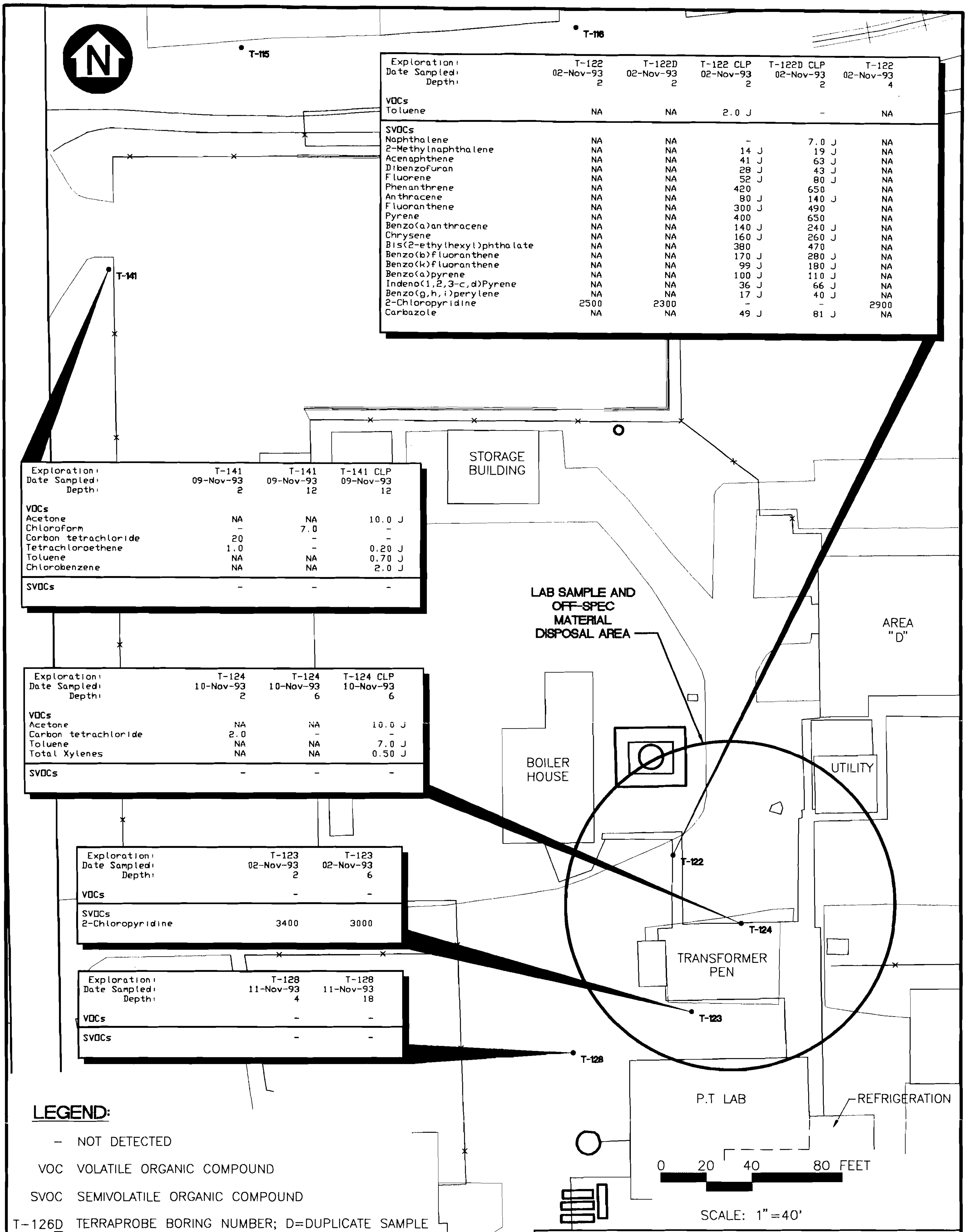

SCALE: 1"=40'

Exploration:	T-122	T-122D	T-122 CLP	T-122D CLP	T-122
Date Sampled:	02-Nov-93	02-Nov-93	02-Nov-93	02-Nov-93	02-Nov-93
Depth:	2	2	2	2	4
VOCs					
Toluene	NA	NA	2.0 J	-	NA
SVOCs					
Naphthalene	NA	NA	-	7.0 J	NA
2-Methylnaphthalene	NA	NA	14 J	19 J	NA
Acenaphthene	NA	NA	41 J	63 J	NA
Dibenzofuran	NA	NA	28 J	43 J	NA
Fluorene	NA	NA	52 J	80 J	NA
Phenanthrene	NA	NA	420	650	NA
Anthracene	NA	NA	80 J	140 J	NA
Fluoranthene	NA	NA	300 J	490	NA
Pyrene	NA	NA	400	650	NA
Benzo(a)anthracene	NA	NA	140 J	240 J	NA
Chrysene	NA	NA	160 J	260 J	NA
Bis(2-ethylhexyl)phthalate	NA	NA	380	470	NA
Benzo(b)fluoranthene	NA	NA	170 J	280 J	NA
Benzo(k)fluoranthene	NA	NA	99 J	180 J	NA
Benzo(a)pyrene	NA	NA	100 J	110 J	NA
Indeno(1,2,3-c,d)Pyrene	NA	NA	36 J	66 J	NA
Benzo(g,h,i)perylene	NA	NA	17 J	40 J	NA
2-Chloropyridine	2500	2300	-	-	2900
Carbazole	NA	NA	49 J	81 J	NA

Exploration:	T-141	T-141	T-141 CLP
Date Sampled:	09-Nov-93	09-Nov-93	09-Nov-93
Depth:	2	12	12
VOCs			
Acetone	NA	NA	10.0 J
Chloroform	-	7.0	-
Carbon tetrachloride	20	-	-
Tetrachloroethene	1.0	-	0.20 J
Toluene	NA	NA	0.70 J
Chlorobenzene	NA	NA	2.0 J
SVOCs	-	-	-

Exploration:	T-124	T-124	T-124 CLP
Date Sampled:	10-Nov-93	10-Nov-93	10-Nov-93
Depth:	2	6	6
VOCs			
Acetone	NA	NA	10.0 J
Carbon tetrachloride	2.0	-	-
Toluene	NA	NA	7.0 J
Total Xylenes	NA	NA	0.50 J
SVOCs	-	-	-

Exploration:	T-123	T-123
Date Sampled:	02-Nov-93	02-Nov-93
Depth:	2	6
VOCs	-	-
SVOCs		
2-Chloropyridine	3400	3000

Exploration:	T-128	T-128
Date Sampled:	11-Nov-93	11-Nov-93
Depth:	4	18
VOCs	-	-
SVOCs	-	-

LEGEND:

-	NOT DETECTED
VOC	VOLATILE ORGANIC COMPOUND
SVOC	SEMIVOLATILE ORGANIC COMPOUND
T-126D	TERRAPROBE BORING NUMBER; D=DUPLICATE SAMPLE
CLP	SAMPLE ANALYZED BY NYSDEC CLP METHODOLOGY. ALL OTHERS ANALYZED BY ON-SITE GC's.
NA	NOT ANALYZED
J	ESTIMATED; SEE APPENDIX B FOR EXPLANATION OF DATA QUALIFIERS

ALL CONCENTRATIONS REPORTED IN UNITS OF MICROGRAMS PER KILOGRAM
SHADED SAMPLES ARE THOSE COLLECTED IN THE UNSATURATED ZONE.

FIGURE 4-3

SUMMARY OF VOC AND SVOC DATA IN SUBSURFACE SOIL LAB SAMPLE DISPOSAL AND NORTHWEST CORNER AREAS

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

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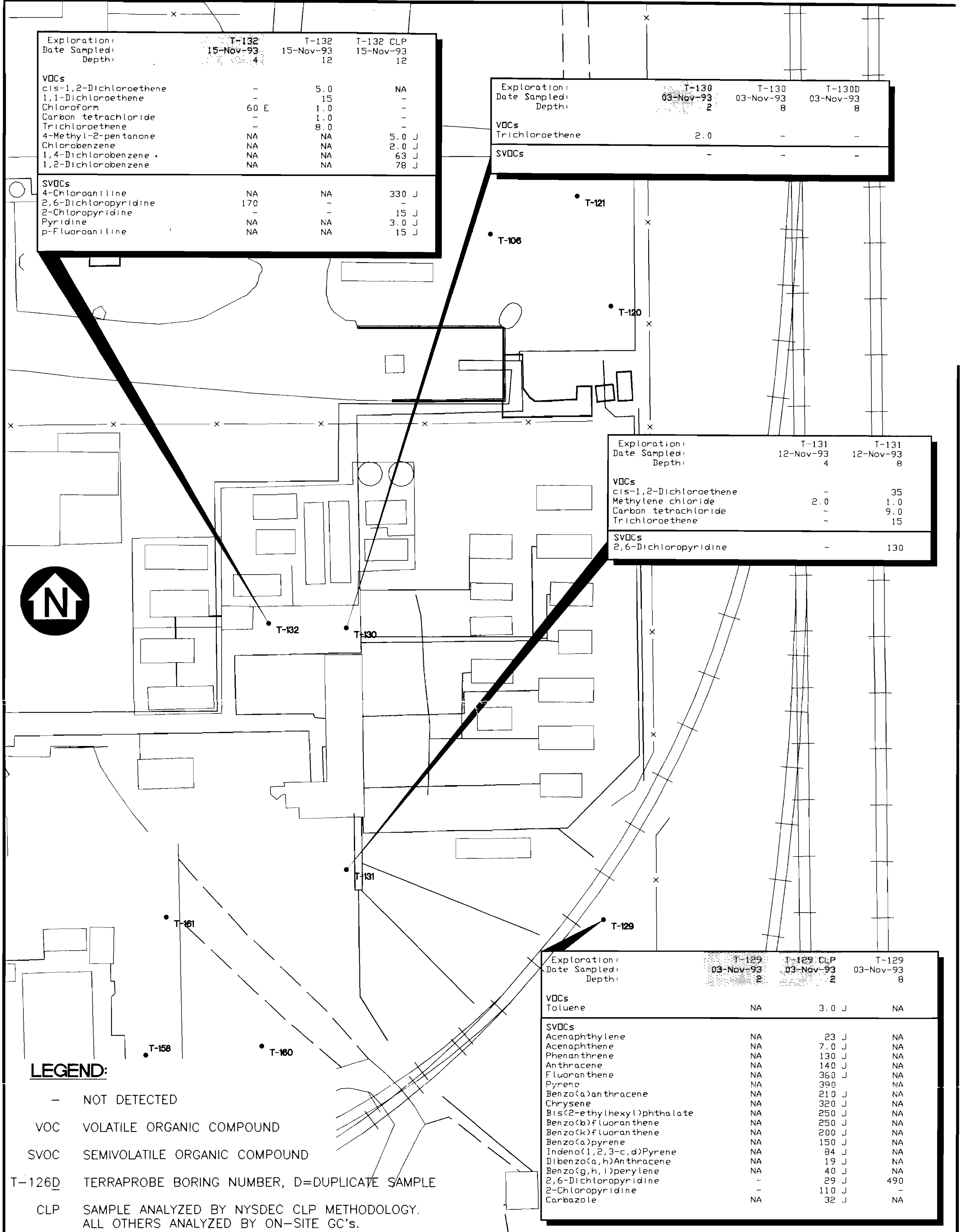

Exploration:	T-132	T-132	T-132 CLP
Date Sampled:	15-Nov-93	15-Nov-93	15-Nov-93
Depth:	4	12	12
VOCs			
cis-1,2-Dichloroethene	-	5.0	NA
1,1-Dichloroethene	-	15	-
Chloroform	60 E	1.0	-
Carbon tetrachloride	-	1.0	-
Trichloroethene	-	8.0	-
4-Methyl-2-pentanone	NA	NA	5.0 J
Chlorobenzene	NA	NA	2.0 J
1,4-Dichlorobenzene	NA	NA	63 J
1,2-Dichlorobenzene	NA	NA	78 J
SVOCs			
4-Chloroaniline	NA	NA	330 J
2,6-Dichloropyridine	170	-	-
2-Chloropyridine	-	-	15 J
Pyridine	NA	NA	3.0 J
p-Fluoroaniline	NA	NA	15 J

Exploration:	T-130	T-130	T-130D
Date Sampled:	03-Nov-93	03-Nov-93	03-Nov-93
Depth:	2	8	8
VOCs			
Trichloroethene	2.0	-	-
SVOCs	-	-	-

Exploration:	T-131	T-131
Date Sampled:	12-Nov-93	12-Nov-93
Depth:	4	8
VOCs		
cis-1,2-Dichloroethene	-	35
Methylene chloride	2.0	1.0
Carbon tetrachloride	-	9.0
Trichloroethene	-	15
SVOCs		
2,6-Dichloropyridine	-	130

Exploration:	T-129	T-129 CLP	T-129
Date Sampled:	03-Nov-93	03-Nov-93	03-Nov-93
Depth:	2	2	8
VOCs			
Toluene	NA	3.0 J	NA
SVOCs			
Acenaphthylene	NA	23 J	NA
Acenaphthene	NA	7.0 J	NA
Phenanthrene	NA	130 J	NA
Anthracene	NA	140 J	NA
Fluoranthene	NA	360 J	NA
Pyrene	NA	390	NA
Benzo(a)anthracene	NA	210 J	NA
Chrysene	NA	320 J	NA
Bis(2-ethylhexyl)phthalate	NA	250 J	NA
Benzo(b)fluoranthene	NA	250 J	NA
Benzo(k)fluoranthene	NA	200 J	NA
Benzo(a)pyrene	NA	150 J	NA
Indeno(1,2,3-c,d)Pyrene	NA	84 J	NA
Dibenzo(a,h)Anthracene	NA	19 J	NA
Benzo(g,h,i)perylene	NA	40 J	NA
2,6-Dichloropyridine	-	29 J	490
2-Chloropyridine	-	110 J	-
Carbazole	NA	32 J	NA

LEGEND:

-	NOT DETECTED
VOC	VOLATILE ORGANIC COMPOUND
SVOC	SEMIVOLATILE ORGANIC COMPOUND
T-126D	TERRAPROBE BORING NUMBER, D=DUPLICATE SAMPLE
CLP	SAMPLE ANALYZED BY NYSDEC CLP METHODOLOGY. ALL OTHERS ANALYZED BY ON-SITE GC's.
NA	NOT ANALYZED
J,E	ESTIMATED; SEE APPENDIX B FOR EXPLANATION OF DATA QUALIFIERS

ALL CONCENTRATIONS REPORTED IN UNITS OF MICROGRAMS PER KILOGRAM
SHADED SAMPLES ARE THOSE COLLECTED IN THE UNSATURATED ZONE.

0 20 40 80 FEET

SCALE: 1"=40'

FIGURE 4-4

SUMMARY OF VOC AND SVOC DATA IN SUBSURFACE SOIL TANK FARM AREA

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

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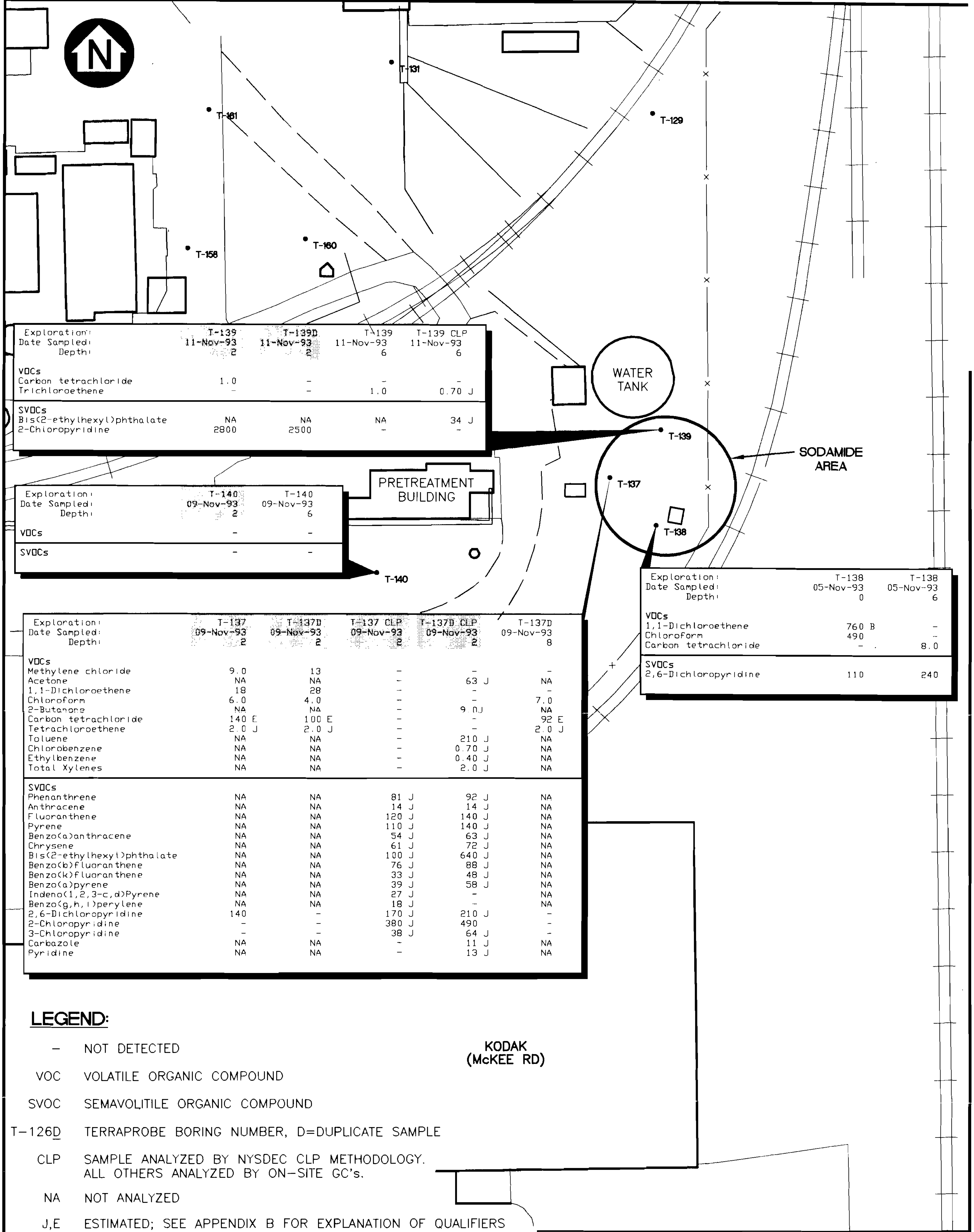

Exploration:	T-139	T-139D	T-139	T-139 CLP
Date Sampled:	11-Nov-93	11-Nov-93	11-Nov-93	11-Nov-93
Depth:	2	2	6	6
VOCs				
Carbon tetrachloride	1.0	-	-	-
Trichloroethene	-	-	1.0	0.70 J
SVOCs				
Bis(2-ethylhexyl)phthalate	NA	NA	NA	34 J
2-Chloropyridine	2800	2500	-	-

Exploration:	T-140	T-140
Date Sampled:	09-Nov-93	09-Nov-93
Depth:	2	6
VOCs	-	-
SVOCs	-	-

Exploration:	T-138	T-138
Date Sampled:	05-Nov-93	05-Nov-93
Depth:	0	6
VOCs		
1,1-Dichloroethene	760 B	-
Chloroform	490	-
Carbon tetrachloride	-	8.0
SVOCs		
2,6-Dichloropyridine	110	240

Exploration:	T-137	T-137D	T-137 CLP	T-137D CLP	T-137D
Date Sampled:	09-Nov-93	09-Nov-93	09-Nov-93	09-Nov-93	09-Nov-93
Depth:	2	2	2	2	8
VOCs					
Methylene chloride	9.0	13	-	-	-
Acetone	NA	NA	-	63 J	NA
1,1-Dichloroethene	18	28	-	-	-
Chloroform	6.0	4.0	-	-	7.0
2-Butanone	NA	NA	-	9.0 J	NA
Carbon tetrachloride	140 E	100 E	-	-	92 E
Tetrachloroethene	2.0 J	2.0 J	-	-	2.0 J
Toluene	NA	NA	-	210 J	NA
Chlorobenzene	NA	NA	-	0.70 J	NA
Ethylbenzene	NA	NA	-	0.40 J	NA
Total Xylenes	NA	NA	-	2.0 J	NA
SVOCs					
Phenanthrene	NA	NA	81 J	92 J	NA
Anthracene	NA	NA	14 J	14 J	NA
Fluoranthene	NA	NA	120 J	140 J	NA
Pyrene	NA	NA	110 J	140 J	NA
Benzo(a)anthracene	NA	NA	54 J	63 J	NA
Chrysene	NA	NA	61 J	72 J	NA
Bis(2-ethylhexyl)phthalate	NA	NA	100 J	640 J	NA
Benzo(b)fluoranthene	NA	NA	76 J	88 J	NA
Benzo(k)fluoranthene	NA	NA	33 J	48 J	NA
Benzo(a)pyrene	NA	NA	39 J	58 J	NA
Indeno(1,2,3-c,d)Pyrene	NA	NA	27 J	-	NA
Benzo(g,h,i)perylene	NA	NA	18 J	-	NA
2,6-Dichloropyridine	140	-	170 J	210 J	-
2-Chloropyridine	-	-	380 J	490	-
3-Chloropyridine	-	-	38 J	64 J	-
Carbazole	NA	NA	-	11 J	NA
Pyridine	NA	NA	-	13 J	NA

LEGEND:

-	NOT DETECTED
VOC	VOLATILE ORGANIC COMPOUND
SVOC	SEMAVOLITILE ORGANIC COMPOUND
T-126D	TERRAPROBE BORING NUMBER, D=DUPLICATE SAMPLE
CLP	SAMPLE ANALYZED BY NYSDEC CLP METHODOLOGY. ALL OTHERS ANALYZED BY ON-SITE GC's.
NA	NOT ANALYZED
J,E	ESTIMATED; SEE APPENDIX B FOR EXPLANATION OF QUALIFIERS
B	ANALYTE DETECTED IN METHOD BLANK

ALL CONCENTRATIONS REPORTED IN UNITS OF MICROGRAMS PER KILOGRAM
SHADED SAMPLES ARE THOSE COLLECTED IN THE UNSATURATED ZONE.

0 20 40 80 FEET

SCALE: 1"=40'

FIGURE 4-5

SUMMARY OF VOC AND SVOC DATA IN SUBSURFACE SOIL SODAMIDE AREA AND PRETREATMENT BUILDING

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

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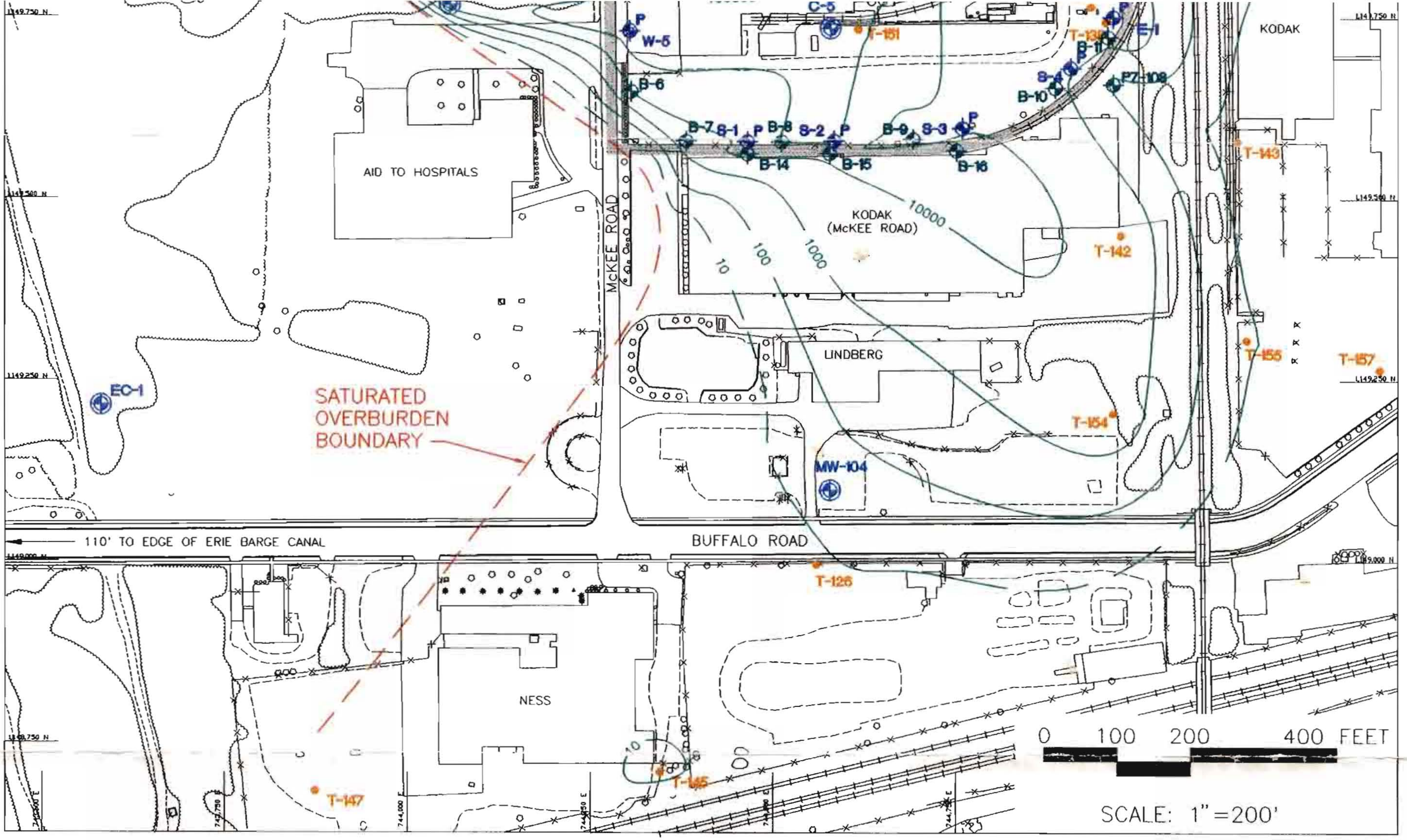


LEGEND

⊕ OVERBURDEN PIEZOMETER

◉ OVERBURDEN MONITORING WELL

⊕P OVERBURDEN PUMPING WELL

● TERRAPROBE BORING

▨ OUTLINE OF OLIN PROPERTY BOUNDARY

NOTES: RESULTS REPORTED AS SUM OF OFF-SITE LABORATORY CONCENTRATIONS IN MICROGRAMS PER LITER FOR THE FOLLOWING CHEMICALS:

2,6-DICHLOROPYRIDINE
2-CHLOROPYRIDINE
3-CHLOROPYRIDINE
4-CHLOROPYRIDINE
PYRIDINE

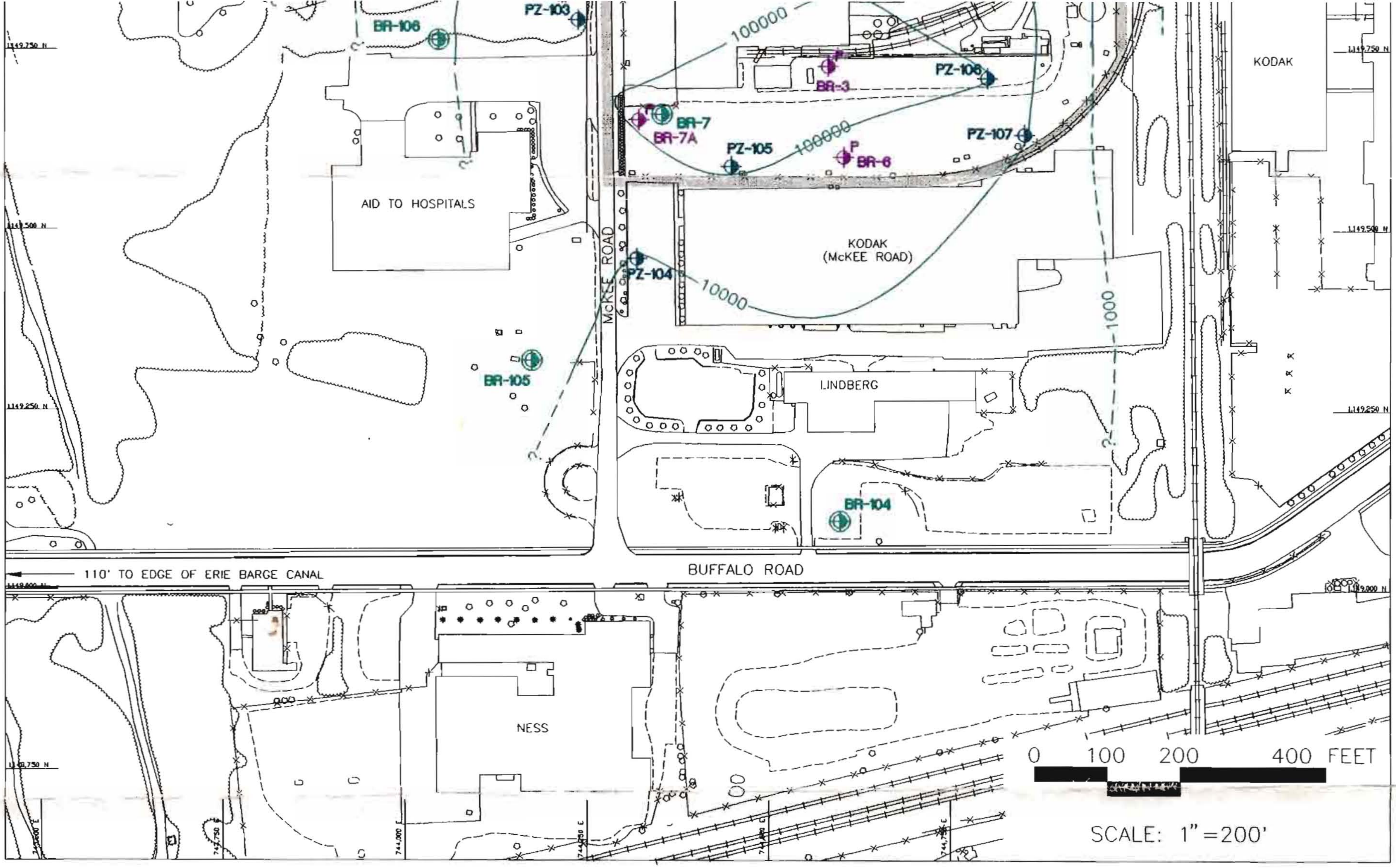
NOTE: DATA FROM SAMPLES COLLECTED BETWEEN 11/93 AND 2/94 USED FOR THIS INTERPRETATION.

FIGURE 4-7

TOTAL PYRIDINES INTERPRETED CONCENTRATION ISOPLETHS FOR OVERBURDEN GROUNDWATER

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG1C 8-29-94 11:25



LEGEND

⊕ BEDROCK PIEZOMETER

⊕ BEDROCK MONITORING WELL

⊕D DEEP BEDROCK MONITORING WELL

⊕P BEDROCK PUMPING WELL

▨ OUTLINE OF OLIN PROPERTY BOUNDARY

NOTES: RESULTS REPORTED AS SUM OF OFF-SITE LABORATORY CONCENTRATIONS IN MICROGRAMS PER LITER FOR THE FOLLOWING CHEMICALS:

2,6-DICHLOROPYRIDINE
2-CHLOROPYRIDINE
3-CHLOROPYRIDINE
4-CHLOROPYRIDINE
PYRIDINE

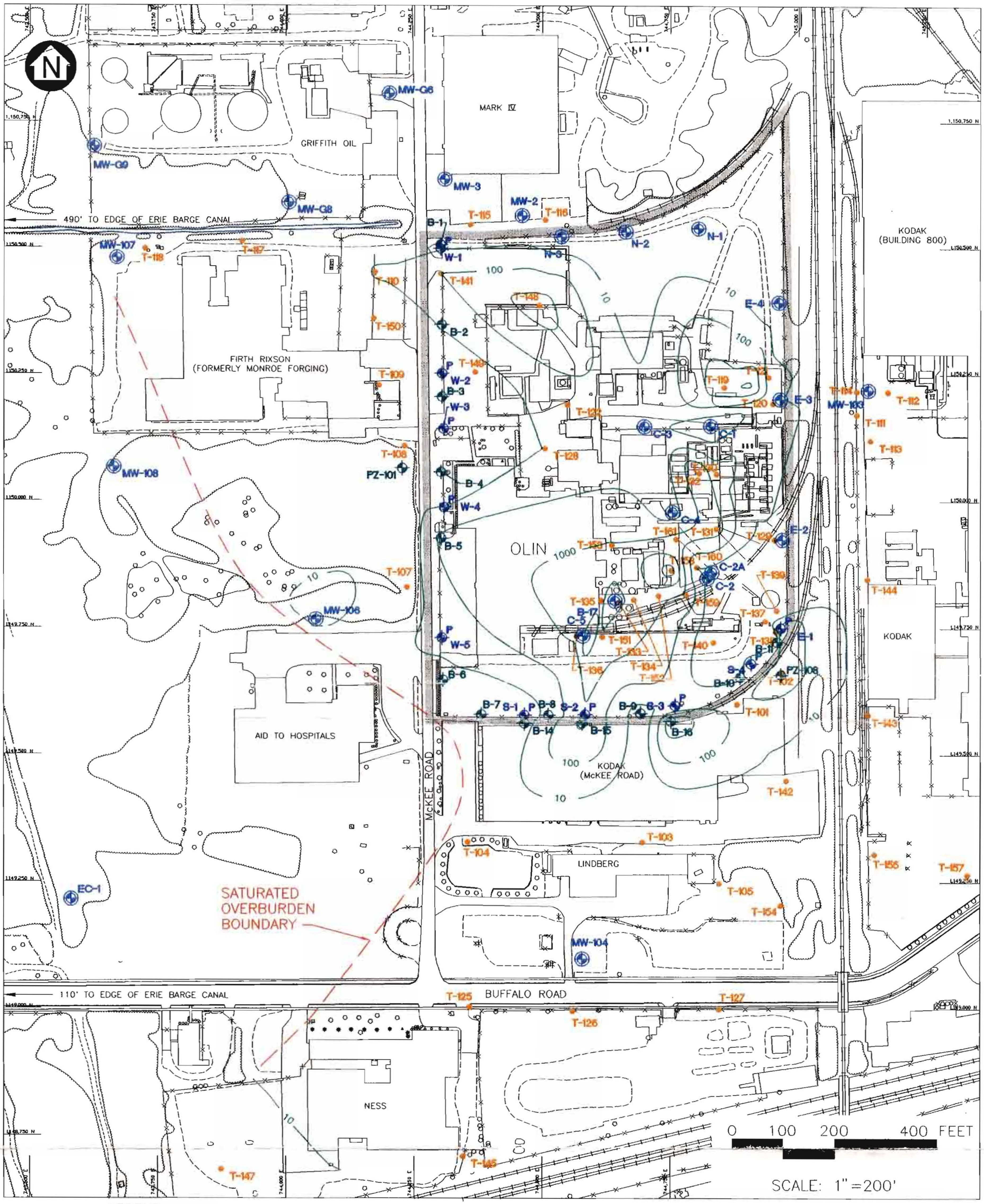
NOTE: DATA FOR SHALLOW BEDROCK WELLS AND PIEZOMETERS SAMPLED BETWEEN 1/94 AND 2/94 USED FOR THIS INTERPRETATION.

FIGURE 4-8

TOTAL PYRIDINES INTERPRETED CONCENTRATION ISOPLETHS FOR BEDROCK GROUNDWATER

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG2C 8-19-94 1:40 PM



LEGEND

⊕	OVERBURDEN PIEZOMETER
◉	OVERBURDEN MONITORING WELL
⊕P	OVERBURDEN PUMPING WELL
●	TERRAPROBE BORING
▨	OUTLINE OF OLIN PROPERTY BOUNDARY

NOTES: RESULTS REPORTED AS SUM OF FIELD OR OFF-SITE LABORATORY CONCENTRATIONS IN MICROGRAMS PER LITER FOR THE FOLLOWING CHEMICALS:

1,2-DICHLOROETHENE (TOTAL)	CHLOROFORM
1,1,1-TRICHLOROETHANE	METHYLENE CHLORIDE
1,1-DICHLOROETHENE	TETRACHLOROETHENE
CARBON TETRACHLORIDE	TRICHLOROETHENE

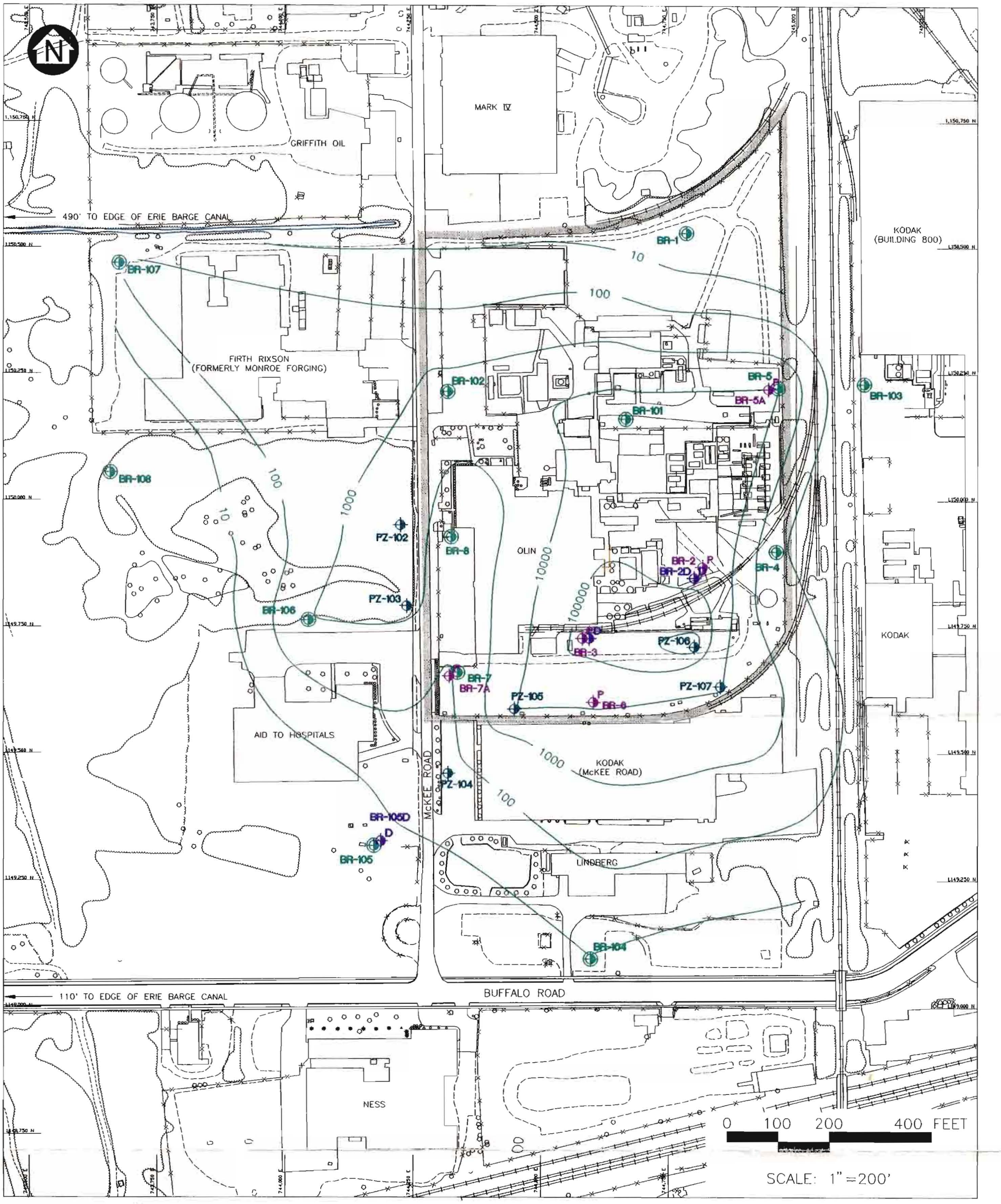
NOTE: DATA FROM SAMPLES COLLECTED BETWEEN 11/93 AND 2/94 USED FOR THIS INTERPRETATION.

FIGURE 4-9

TOTAL SELECTED VOCS INTERPRETED CONCENTRATION ISOPLETHS FOR OVERBURDEN GROUNDWATER

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG1B 8-29-94 10:35



LEGEND

- BEDROCK PIEZOMETER
- BEDROCK MONITORING WELL
- D DEEP BEDROCK MONITORING WELL
- P BEDROCK PUMPING WELL
- ▨ OUTLINE OF OLIN PROPERTY BOUNDARY

NOTES: RESULTS REPORTED AS SUM OF OFF-SITE LABORATORY CONCENTRATIONS IN MICROGRAMS PER LITER FOR THE FOLLOWING CHEMICALS:

1,2-DICHLOROETHENE (TOTAL)	CHLOROFORM
1,1,1-TRICHLOROETHANE	METHYLENE CHLORIDE
1,1-DICHLOROETHENE	TETRACHLOROETHENE
CARBON TETRACHLORIDE	TRICHLOROETHENE

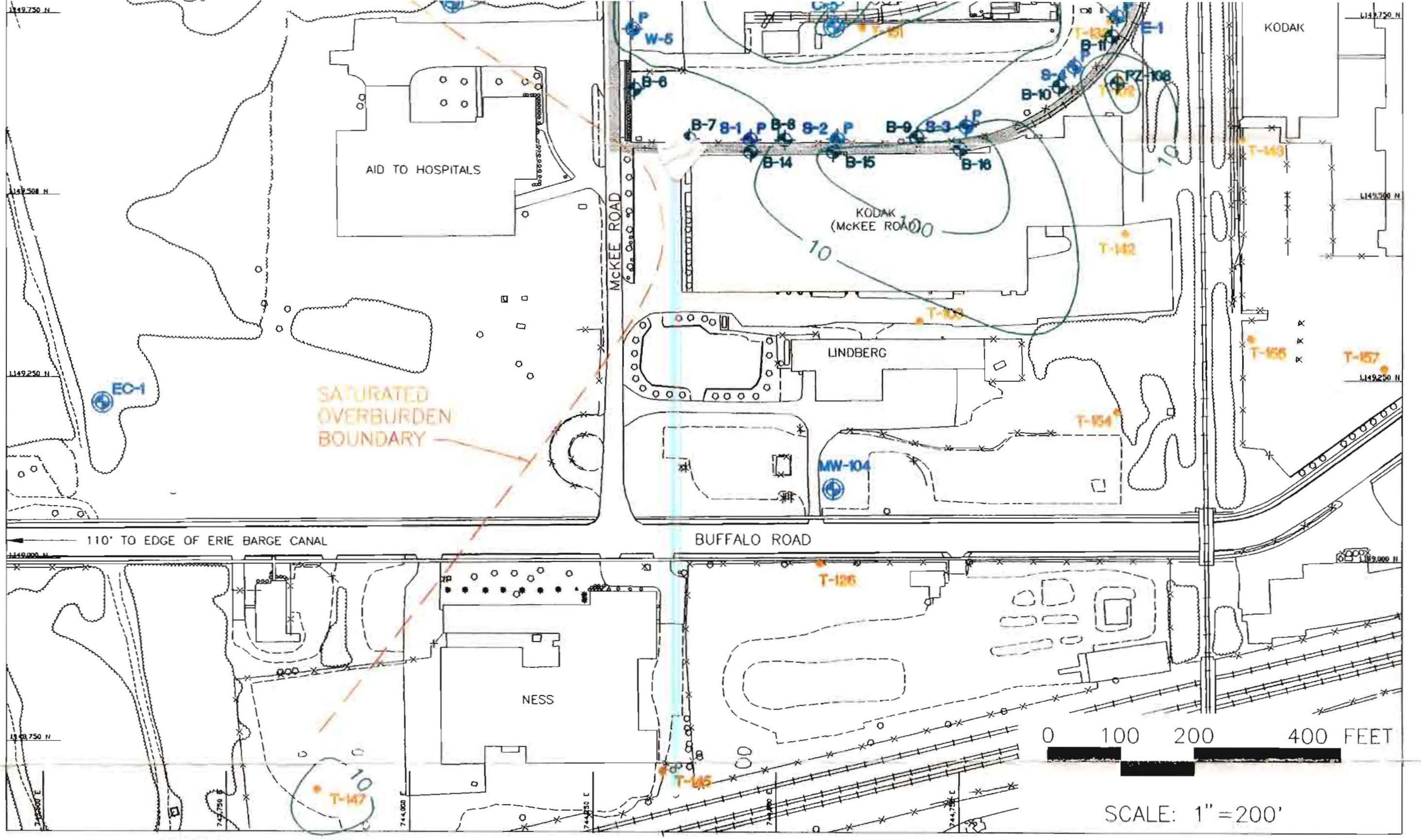
NOTE: DATA FOR SHALLOW BEDROCK WELLS AND PIEZOMETERS SAMPLED BETWEEN 1/94 AND 2/94 USED FOR THIS INTERPRETATION.

FIGURE 4-10

TOTAL SELECTED VOCS INTERPRETED CONCENTRATION ISOPLETHS FOR BEDROCK GROUNDWATER

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG2B 8-29-94 11:45



LEGEND

⊕ OVERBURDEN PIEZOMETER

◉ OVERBURDEN MONITORING WELL

⊕P OVERBURDEN PUMPING WELL

● TERRAPROBE BORING

▨ OUTLINE OF OLIN
PROPERTY BOUNDARY

NOTES: RESULTS REPORTED AS SUM OF OFF-SITE LABORATORY CONCENTRATIONS IN MICROGRAMS PER LITER FOR THE FOLLOWING CHEMICALS:

1,2-DICHLOROETHENE (TOTAL)
TETRACHLOROETHENE
TRICHLOROETHENE
VINYL CHLORIDE

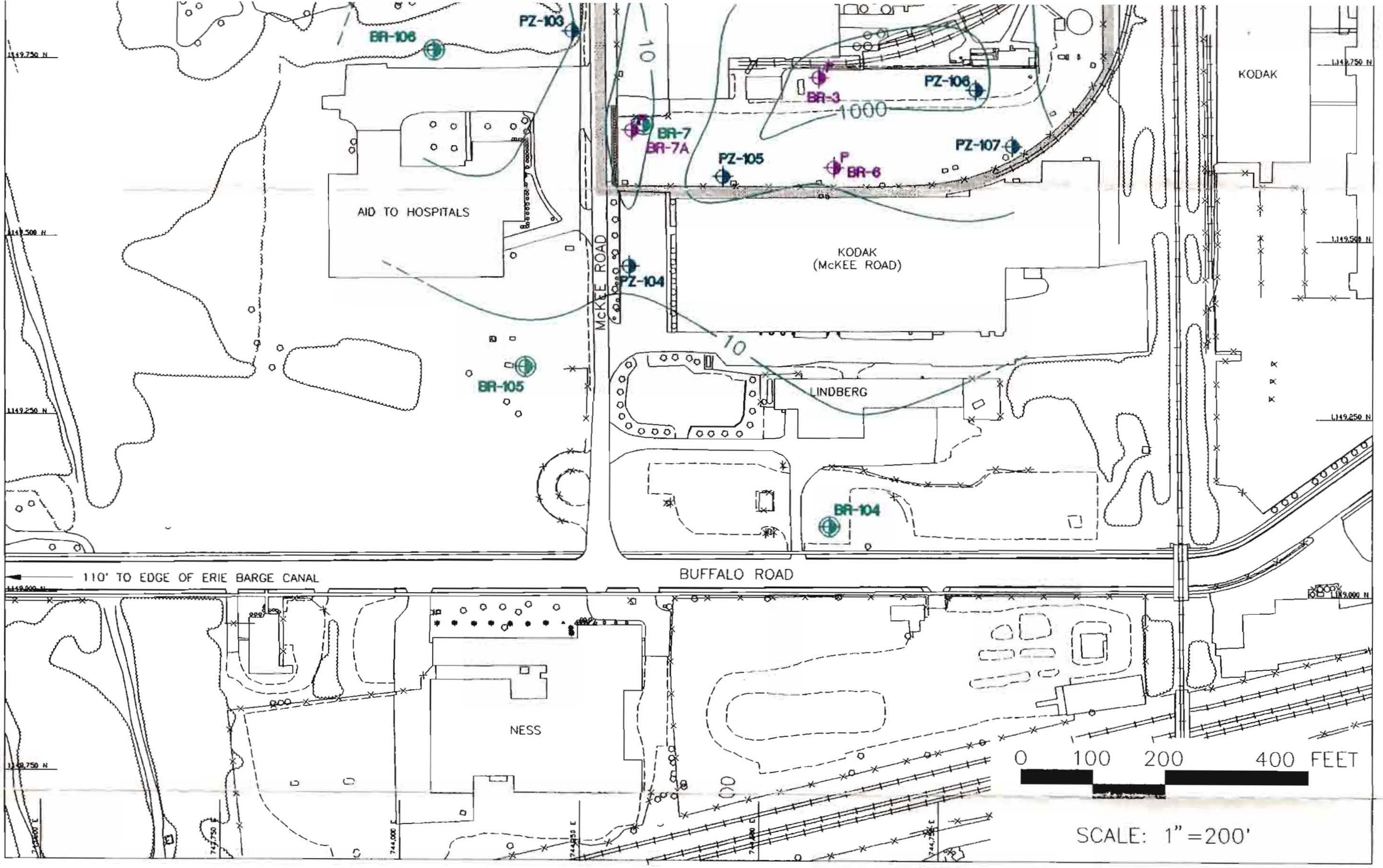
NOTE: DATA FROM SAMPLES COLLECTED BETWEEN 11/93 AND 2/94 USED FOR THIS INTERPRETATION.

FIGURE 4-11

TOTAL CHLORINATED ETHENES INTERPRETED CONCENTRATION ISOPLETHS FOR OVERBURDEN GROUNDWATER

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG1D 8-29-94 11:00



LEGEND

⊕	BEDROCK PIEZOMETER
⊕	BEDROCK MONITORING WELL
⊕D	DEEP BEDROCK MONITORING WELL
⊕P	BEDROCK PUMPING WELL
▨	OUTLINE OF OLIN PROPERTY BOUNDARY

NOTES: RESULTS REPORTED AS SUM OF OFF-SITE LABORATORY CONCENTRATIONS IN MICROGRAMS PER LITER FOR THE FOLLOWING CHEMICALS:

1,2-DICHLOROETHENE (TOTAL)
TETRACHLOROETHENE
TRICHLOROETHENE
VINYL CHLORIDE

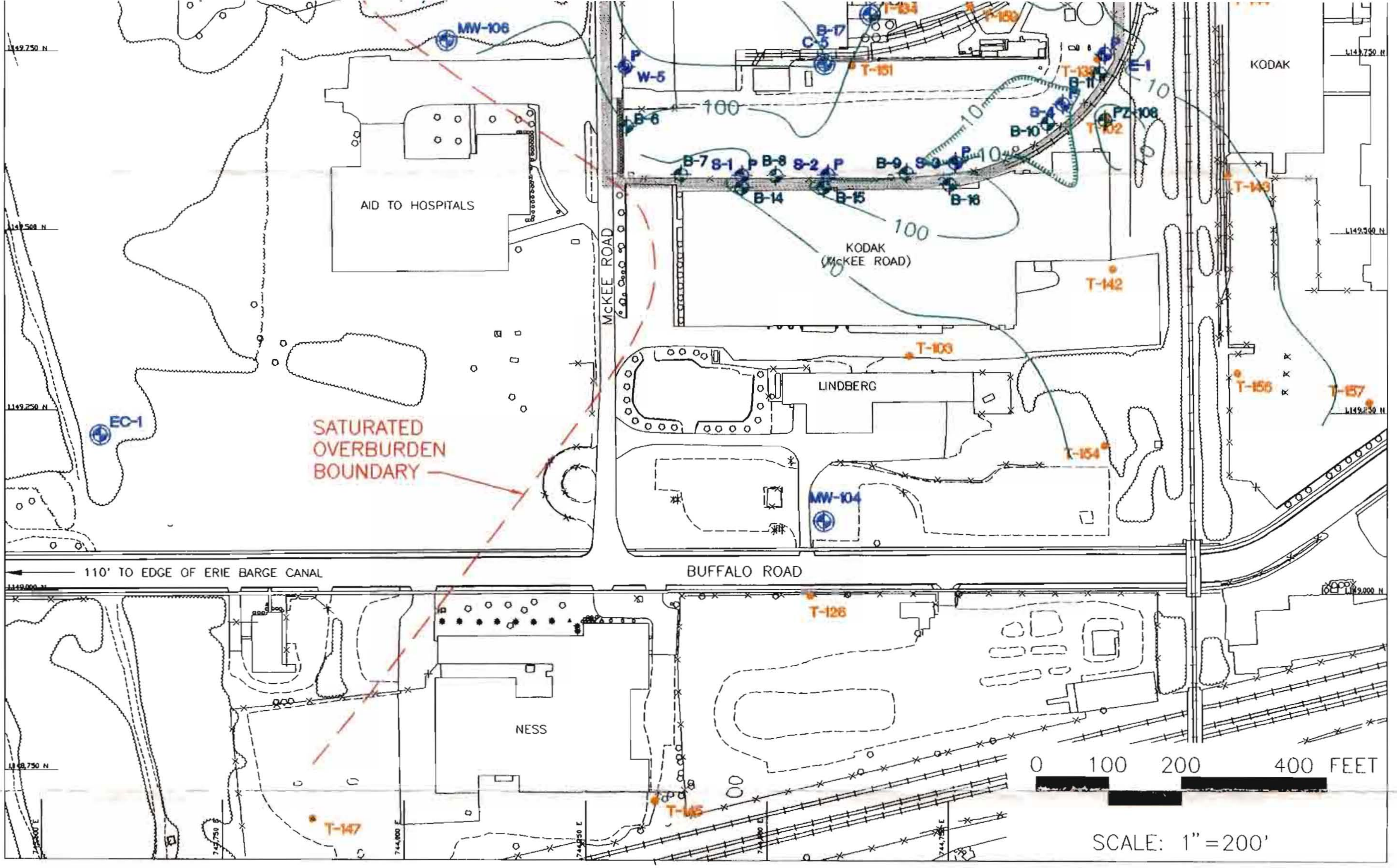
NOTE: DATA FOR SHALLOW BEDROCK WELLS AND PIEZOMETERS SAMPLED BETWEEN 1/94 AND 2/94 USED FOR THIS INTERPRETATION.

FIGURE 4-12

TOTAL CHLORINATED ETHENES INTERPRETED CONCENTRATION ISOPLETHS FOR BEDROCK GROUNDWATER

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG2D 8-17-94 10:45 AM



LEGEND

◆ OVERBURDEN PIEZOMETER

⊕ OVERBURDEN MONITORING WELL

◆P OVERBURDEN PUMPING WELL

● TERRAPROBE BORING

▨ OUTLINE OF OLIN PROPERTY BOUNDARY

NOTES: RESULTS REPORTED AS SUM OF OFF-SITE LABORATORY CONCENTRATIONS IN MICROGRAMS PER LITER FOR THE FOLLOWING CHEMICALS:

BENZENE
TOLUENE
ETHYLBENZENE
TOTAL XYLENES

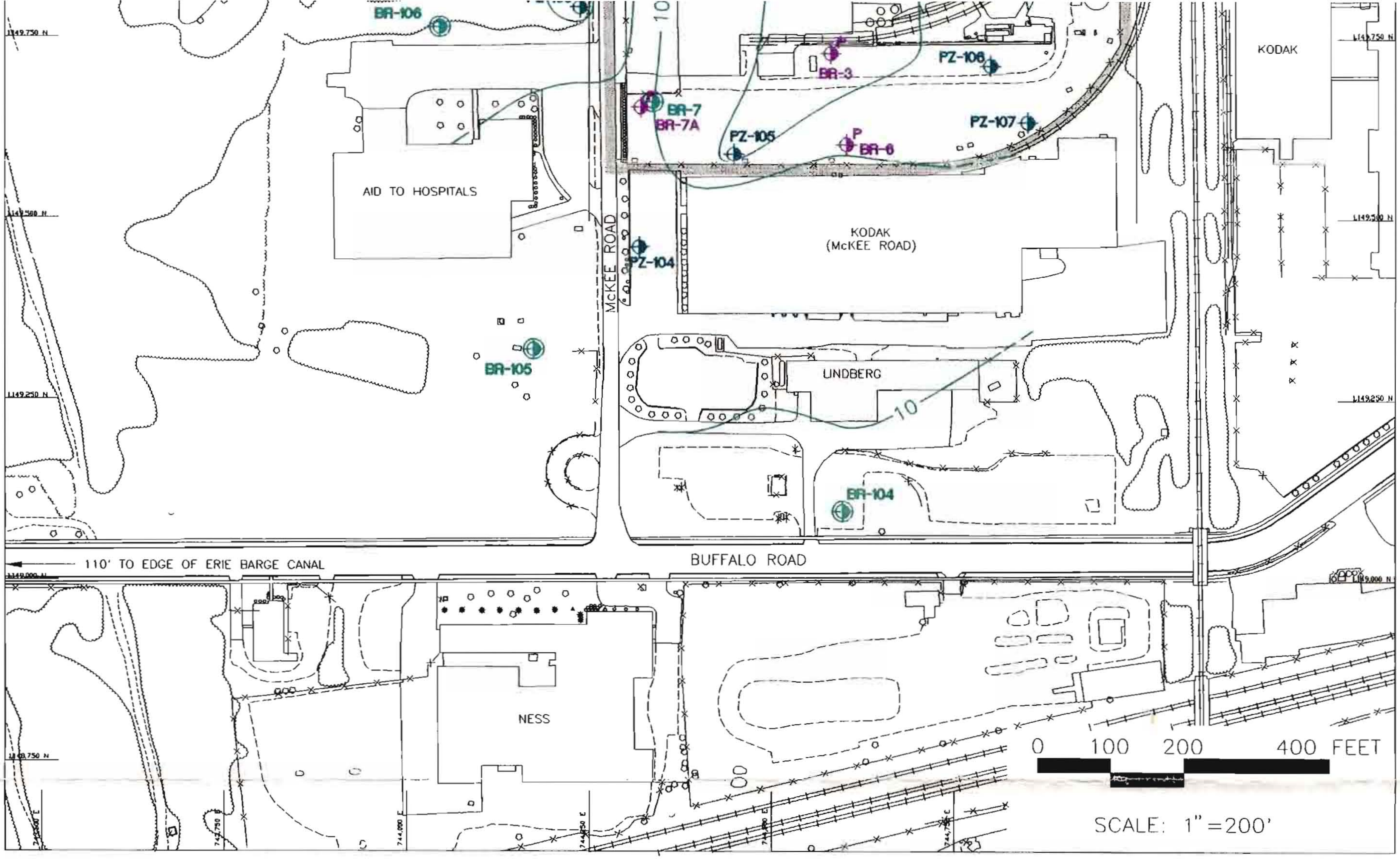
NOTE: DATA FROM SAMPLES COLLECTED BETWEEN 11/93 AND 2/94 USED FOR THIS INTERPRETATION.

FIGURE 4-13

TOTAL BTEX INTERPRETED CONCENTRATION ISOPLETHS FOR OVERBURDEN GROUNDWATER

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG1E 8-29-94 12:00



LEGEND

⊕ BEDROCK PIEZOMETER

◉ BEDROCK MONITORING WELL

⊕D DEEP BEDROCK MONITORING WELL

⊕P BEDROCK PUMPING WELL

▨ OUTLINE OF OLIN PROPERTY BOUNDARY

NOTES: RESULTS REPORTED AS SUM OF OFF-SITE LABORATORY CONCENTRATIONS IN MICROGRAMS PER LITER FOR THE FOLLOWING CHEMICALS:

BENZENE
TOLUENE
ETHYLBENZENE
TOTAL XYLENES

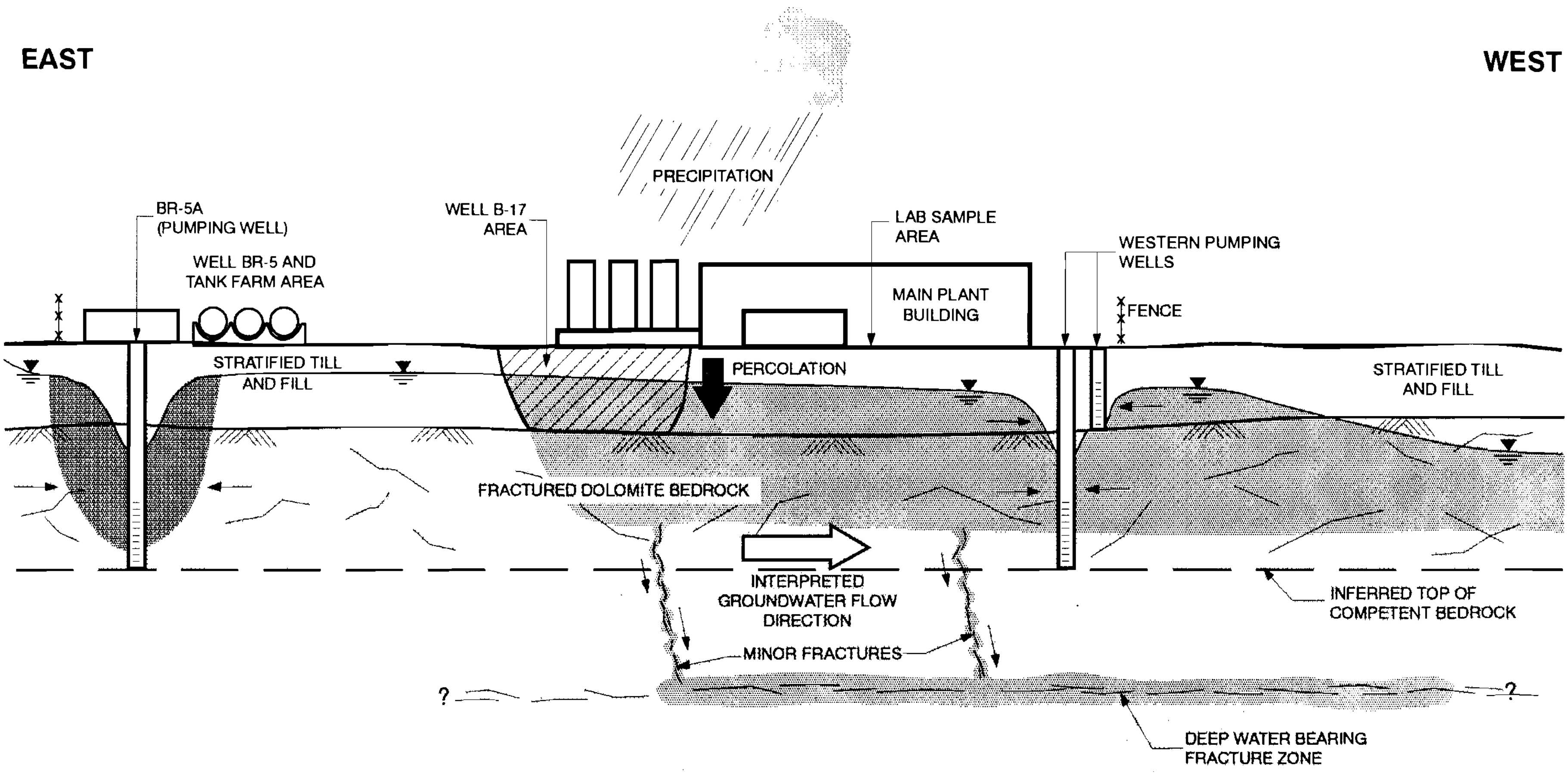
NOTE: DATA FOR SHALLOW BEDROCK WELLS AND PIEZOMETERS SAMPLED BETWEEN 1/94 AND 2/94 USED FOR THIS INTERPRETATION.

FIGURE 4-14

TOTAL BTEX INTERPRETED CONCENTRATION ISOPLETHS FOR BEDROCK GROUNDWATER

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

J:\7311-04\FIG2E 8-29-94 12:30



NOT TO SCALE

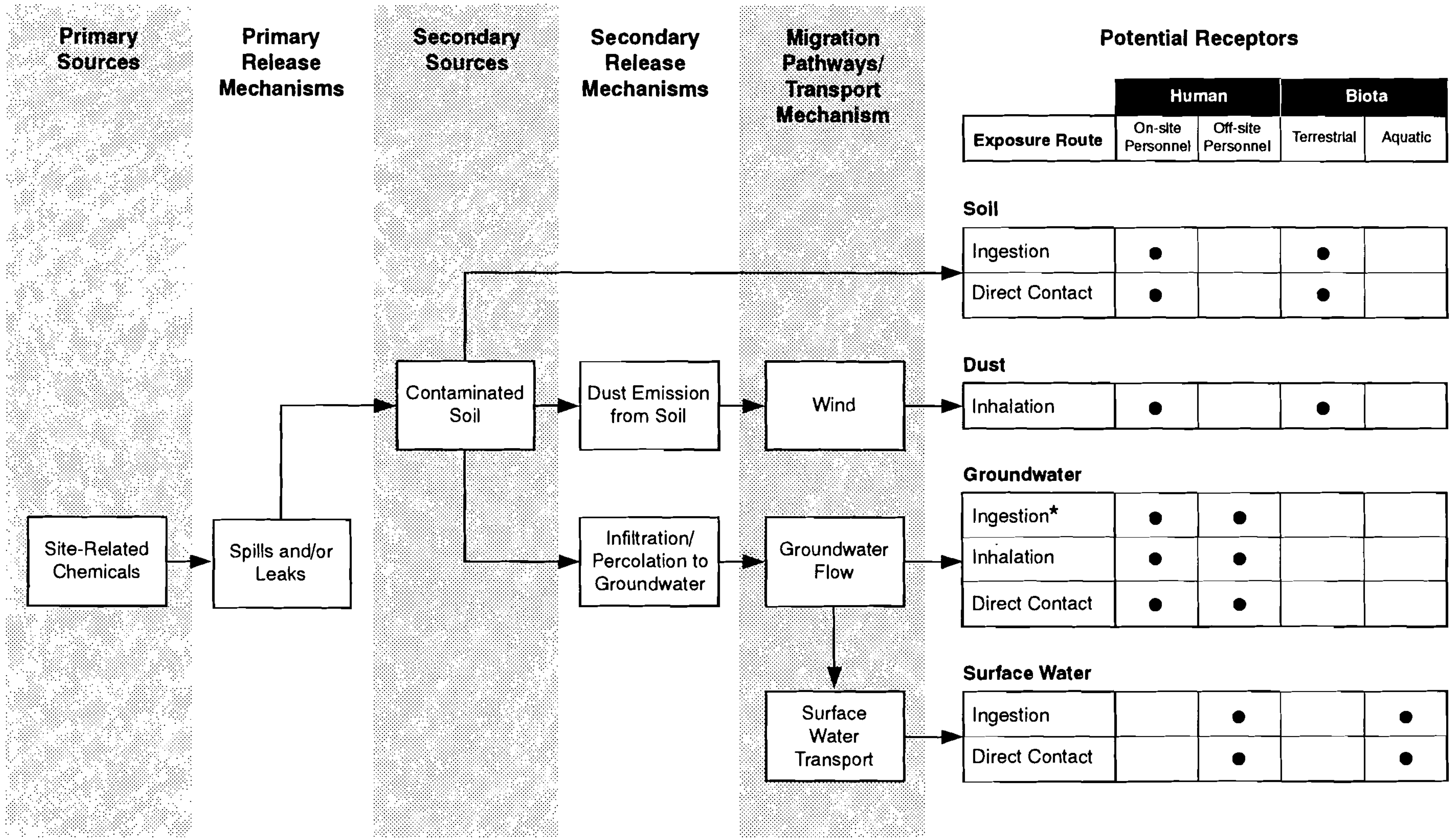
POTENTIAL TRANSPORT MECHANISMS

- LEACHING AND TRANSPORT OF RESIDUAL SOIL CONTAMINANTS AND NAPL TO WATER TABLE.
- GROUNDWATER TRANSPORT OF SUSPENDED AND DISSOLVED CONTAMINANTS IN BEDROCK.
- GROUNDWATER TRANSPORT OF DISSOLVED AND SUSPENDED CONTAMINANTS IN OVERBURDEN.
- GROUNDWATER TRANSPORT OF DISSOLVED CONTAMINANTS FROM BEDROCK GROUNDWATER TO SURFACE WATER.

FIGURE 5-1

SITE CONCEPTUAL MODEL

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, NEW YORK



	Human		Biota	
Exposure Route	On-site Personnel	Off-site Personnel	Terrestrial	Aquatic
Soil				
Ingestion	●		●	
Direct Contact	●		●	
Dust				
Inhalation	●		●	
Groundwater				
Ingestion*	●	●		
Inhalation	●	●		
Direct Contact	●	●		
Surface Water				
Ingestion		●		●
Direct Contact		●		●

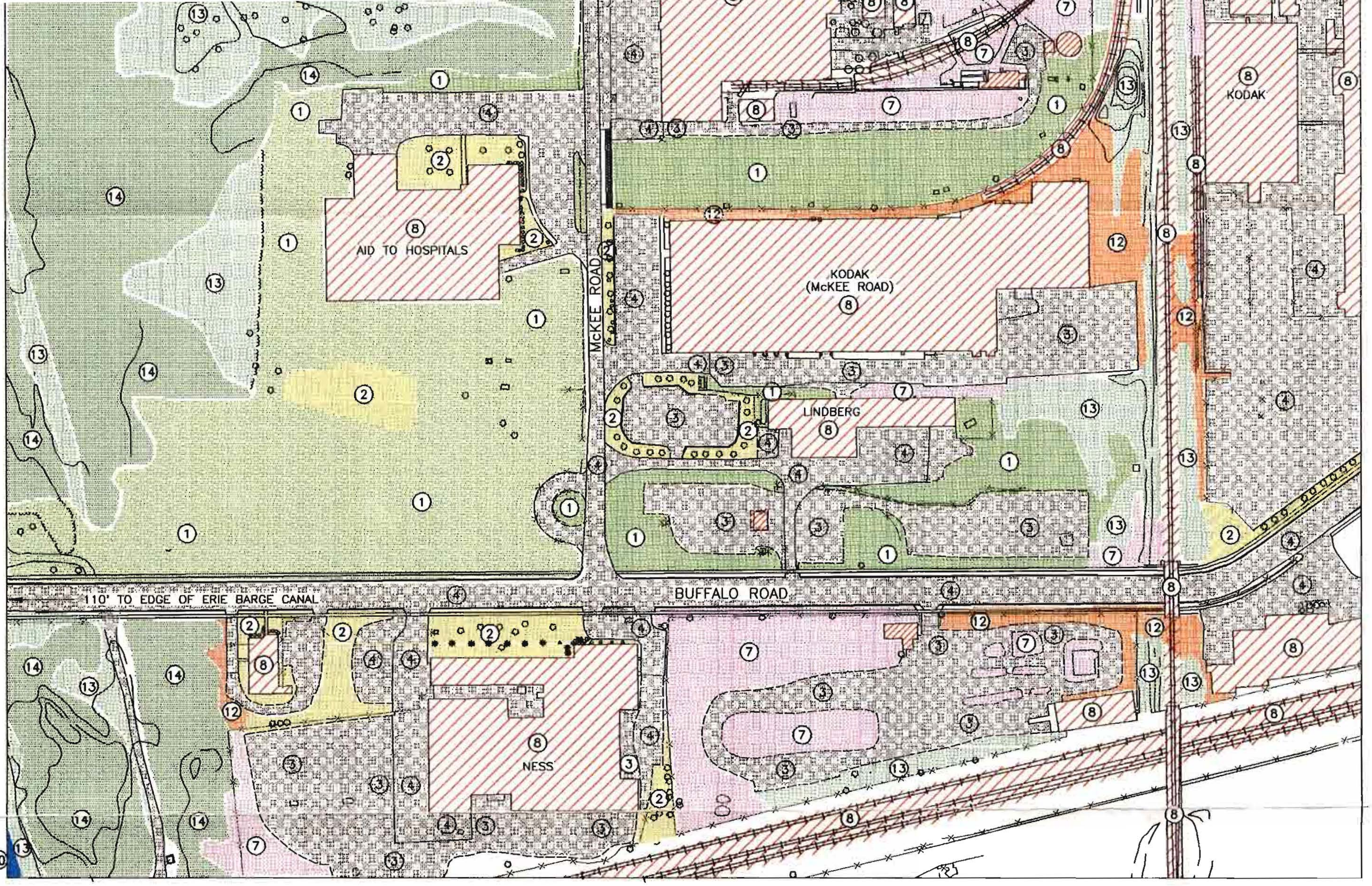
*Incidental Ingestion during Excavations

FIGURE 5-2

CONCEPTUAL MODEL FLOW DIAGRAM

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, NEW YORK

W9408044D(b)



0 100 200 400 FEET

SCALE: 1"=200'

INDIVIDUAL COMMUNITY TYPES

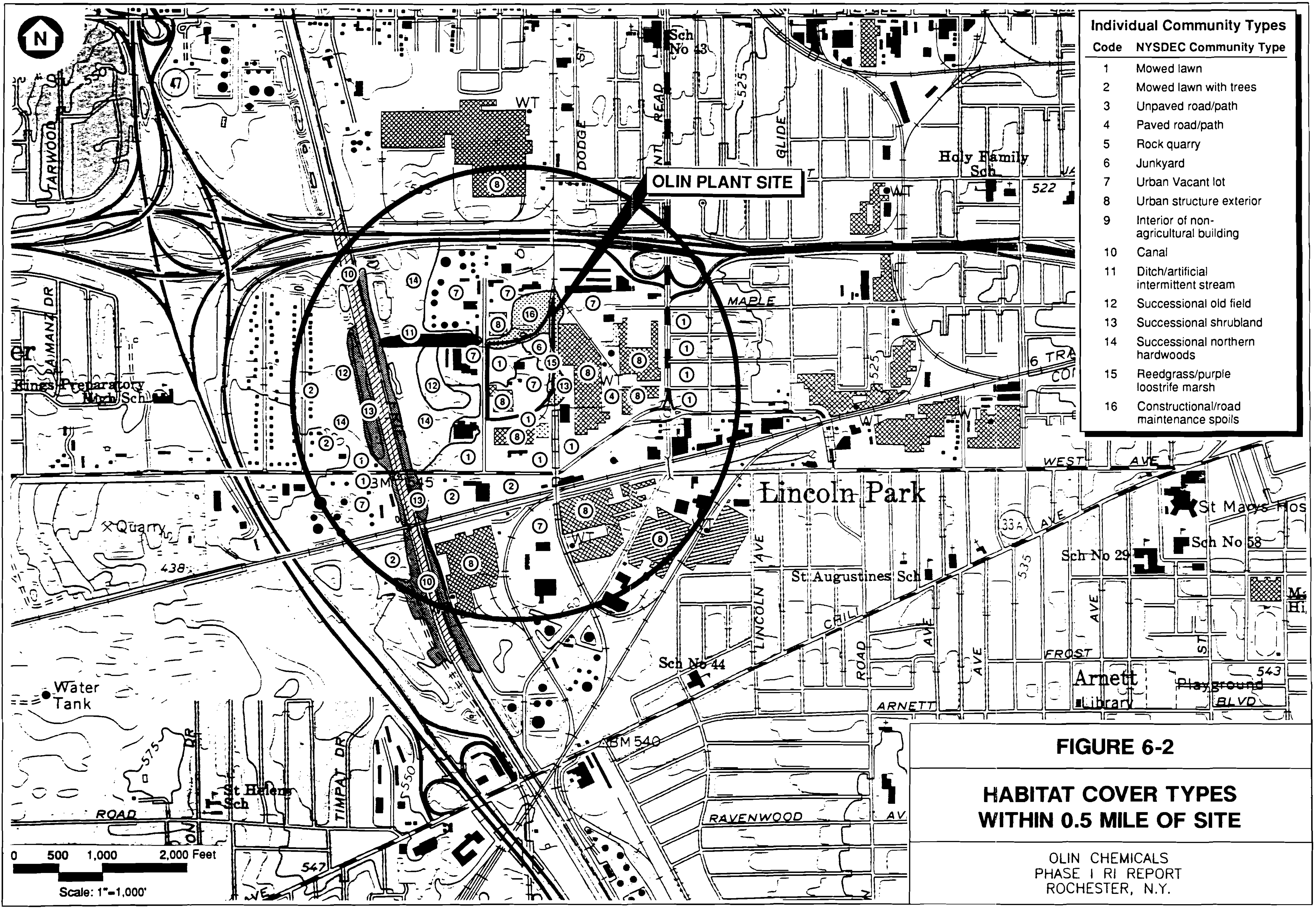
CODE	NYSDEC COMMUNITY TYPE	CODE	NYSDEC COMMUNITY TYPE
①	MOWED LAWN	⑩	CANAL
②	MOWED LAWN WITH TREES	⑪	DITCH/ARTIFICIAL INTERMITTENT STREAM
③	UNPAVED ROAD/PATH	⑫	SUCCESSIONAL OLD FIELD
④	PAVED ROAD/PATH	⑬	SUCCESSIONAL SHRUBLAND
⑤	ROCK QUARRY	⑭	SUCCESSIONAL NORTHERN HARDWOODS
⑥	JUNKYARD	⑮	REEDGRASS/PURPLE LOOSTRIFE MARCH
⑦	URBAN VACANT LOT	⑯	CONSTRUCTIONAL/ROAD MAINTENANCE SPOILS
⑧	URBAN STRUCTURE EXTERIOR		
⑨	INTERIOR OF NON-AGRICULTURAL BUILDING		

FIGURE 6-1

HABITAT COVER TYPES IN IMMEDIATE SITE AREA

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

C:\ROY\FIG6-2



Individual Community Types

Code	NYSDEC Community Type
1	Mowed lawn
2	Mowed lawn with trees
3	Unpaved road/path
4	Paved road/path
5	Rock quarry
6	Junkyard
7	Urban Vacant lot
8	Urban structure exterior
9	Interior of non-agricultural building
10	Canal
11	Ditch/artificial intermittent stream
12	Successional old field
13	Successional shrubland
14	Successional northern hardwoods
15	Reedgrass/purple loostrife marsh
16	Constructional/road maintenance spoils

FIGURE 6-2

HABITAT COVER TYPES WITHIN 0.5 MILE OF SITE

OLIN CHEMICALS
PHASE I RI REPORT
ROCHESTER, N.Y.

TABLE 2–1
SOIL GAS SAMPLING SUMMARY

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

SOURCE OR AREA	LOCATION IDs	TOTAL COMPLETED	TOTAL PLANNED
SITE–WIDE	SG–101 to SG–109, SG–117, SG–118, and SG–155 to SG–173	30	29
MAIN PLANT BUILDING PERIMETER	SG–119 to SG–122, and SG–130 to SG–135	10	11
TDA AREA	SG–110 to SG–113,	4	4
SODAMIDE AREA	SG–114, SG–115, and SG–116	3	3
LAB SAMPLE DISPOSAL AREA	SG–123 to SG–129 and SG–184 to SG–187	11	7
TANK FARM AREA	SG–136 to SG–142	7	7
BR–5 AREA	SG–143 to SG–154	12	12
ADJACENT TO OFF–SITE BUILDINGS	SG–174, SG–175 and SG–176	3	3
SUBTOTAL		**80**	**76**
ADDITIONAL OFF–SITE SUBSTITUTE SAMPLES (1)	SG–177 to SG–183	7	0
TOTAL		**87**	**76**

Notes:

(1) Samples collected at base of overburden where no overburden groundwater was present.

TABLE 2-2
TERRAPROBE SOIL SAMPLING SUMMARY

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

SOURCE OR AREA	LOCATION IDs	BORINGS COMPLETED	SAMPLES COLLECTED (1)	BORINGS PLANNED	SAMPLES PLANNED (1)
WELL BR-5 AREA	T-106, T-119, T-120, and T-121	4	8	4	8
LAB SAMPLE DISPOSAL AREA	T-122, T-123, T-124, and T-128	4	8	4	8
TANK FARM AREA (perimeter)	T-129, T-130, T-131, and T-132	4	8	4	8
WELL B-17 AREA (2)	T-133, T-134, T-135, T-151, T-152 T-153, T-158, T-159 T-160, and T-161	10	17	3	6
SODAMIDE AREA	T-137, T-138, and T-139	3	6	3	6
TDA AREA	T-136	1	2	1	2
PRETREATMENT AREA	T-140	1	2	1	2
NORTHWEST CORNER AREA	T-141	1	2	1	2
TOTAL		28	53	21	42

Notes:

(1) Number of samples does not include off-site laboratory splits or QA/QC.
(2) Two samples collected for analysis from all borings listed except T-158, T-159, T-160, and T-161.

TABLE 2-3
TERRAPROBE GROUNDWATER SAMPLING SUMMARY

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

SOURCE OR AREA	LOCATION IDs	SAMPLES COLLECTED (1)	SAMPLES PLANNED (1)
OFF-SITE (2)	T-101 to T-105 T-107 to T-118 T-125, T-126, and T-127 T-142 to T-145 T-147, T-150 T-154, T-155, T-157	29	27
BR-5 AREA	T-106, T-119, T-120, and T-121	4	4
LAB SAMPLE DISPOSAL AREA	T-122 and T-128	2	4
TANK FARM AREA (perimeter)	T-129, T-130, T-131, and T-132	4	4
SODAMIDE AREA	T-137, T-138, and T-139	3	3
WELL B-17 AREA	T-133, T-134, T-135, T-151, T-152, T-153, T-158, T-159, T-160, T-161	10	3
TDA AREA	T-136	1	1
PRETREATMENT AREA	T-140	1	1
NORTHWEST CORNER AREA	T-141, T-148 and T-149	3	1
TOTAL		57	48

Notes:

(1) One sample collected for analysis from all borings, not including off-site splits and QA/QC.

(2) Attempts were made to collect seven additional samples. At these locations, soil gas samples were collected because no overburden groundwater was present. See Table 2-1 for details.

TABLE 2-4
SURFACE SOIL SAMPLE LOCATION DESCRIPTIONS

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

LOCATION ID	DESCRIPTION
SS-101	TDA Area: Outside concrete footwall and beneath 6" of crushed stone cover.
SS-102	Sodamide Area: At exposed soil area in low lying area near Pumping Well E-1.
SS-103	Lab Sample Area: At only exposed surface soil which is adjacent to a small storage building.
SS-104	Tank Farm Area: Between rows of tanks adjacent to berm liner.
SS-105	BR-5 Area: Sited at only exposed surface soil where periodic runoff discharges into a wet area behind the olin fence.
SS-106	Background Sample: 30' West of BR-1 and off gravel access road. Exposed soil in this area is surrounded by grass.
SS-107	Background Sample: Approximately 20' west of B-7, off access road and 3' inside the Olin boundary fence.
SS-108	Off pavement where surface soil is exposed behind the production area.
SS-109	On a gravel road where maintenance vehicles travel.
SS-110	Along the edge of a railroad bed where soil is exposed adjacent to areas with a crushed stone cover.
SS-111	In exposed soil area at the edge of pavement and near entrance to the main plant building
SS-112	Along fence on eastem side of Olin property where there is exposed soil.
SS-113	Adjacent to southeast corner of tank berm nearest the eastern property line.
SS-114	Near boiler house in Area "D" near above ground tanks; sample collected below crushed stone cover.
SS-115	In gravel road the "Bone Yard Area" where there is little vehicular traffic.

TABLE 2-5
DATA QUALITY OBJECTIVES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

MEASUREMENTS/ANALYSIS	METHOD - REFERENCE	DQO LEVEL	RATIONALE/DATA USE
pH	Field Probe	I	groundwater quality, fate and transport
Temperature	Field Probe	I	groundwater quality, fate and transport
Conductivity	Field Probe	I	groundwater quality, fate and transport
Turbidity	Turbidimeter	I	well development, sampling criteria
Water Level Measurements	Water Level Meter	I	engineering studies, fate and transport
Total Volatiles	FID/PID Screening	I	sample collection, health and safety, source characterization
Target Volatiles	GC Field Screening - SOP	II	source characterization, monitoring well siting
Target Pyridines (Field Analysis)	GC Field Screening - Olin Research	II	source characterization, monitoring well siting
Selected Pyridines (Laboratory Analysis)	GC/MS-Modified USEPA 8270/NYSDEP ASP CLP	III (water)/ IV (soil)	site characterization, fate and transport, risk assessment
TCL VOCs	GC/MS-USEPA 8240/NYSDEC ASP CLP	III (water)/ IV (soil)	site characterization, fate and transport, risk assessment
TCL SVOCs + 2,4-TDA			site characterization, fate and transport, risk assessment
TCL Pesticides/PCBs	GC/MS-USEPA 8270/NYSDEC ASP CLP	III (water)/ IV (soils)	site characterization, fate and transport, risk assessment
TAL Elements			site characterization, fate and transport, risk assessment
	GC/ECD-USEPA 8080/NYSDEC ASP CLP	III (water)/ IV (soils)	
	AAS-PES/USEPA 6000/7000/NYSDEC ASP CLP	III (water)/ IV (soils)	

Notes:

AAS	atomic absorption spectrophotometry
ASP	analytical services protocol
DQO	data quality objective
ECD	electron capture detector
FID	flame ionization detector
GC	gas chromatography
MS	mass spectrometry
PES	plasma emission spectroscopy
PID	photoionization detector
SVOCs	semivolatile organic compounds
TAL	target analyte list
TCL	target compound list
VOCs	volatile organic compounds
NYSDEC	New York State Department of Environmental Conservation
SOP	Standard Operating Procedure (in QAPP)
USEPA	U.S. Environmental Protection Agency
2,4-TDA	2,4-Toluenediamine

DQO Level Definitions:
I Qualitative field measurements using portable instruments: real-time results.
II Qualitative/quantitative field analyses using more sophisticated analytical instruments: real-time results.
III Quantitative analyses performed in an off-site analytical laboratory following standard, documented methodology.
IV Quantitative analyses performed in an off-site analytical laboratory following Contract Laboratory Program protocols.
III (water)/IV (soil) DQO Level III methodology followed for all water samples/DQO Level IV methodology followed for all soil samples.

TABLE 2-6
PRECISION OBJECTIVES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

	PRECISION as RPD (%)	
PARAMETER	WATER	SOIL/SEDIMENTS
Matrix Spike (Duplicates)		
TCL VOCs	11-14	21-24
TCL SVOCs	28-50	19-50
TCL Pesticides/PCBs	15-27	31-50
Duplicate Samples		
TCL VOCs, SVOCs, Pesticides, PCBs, and Inorganics	35	50

Notes:

VOCs	volatile organic compounds
TCL	target compound list
PCBs	polychlorinated biphenyls
SVOCs	semivolatile organic compounds
RPD	relative percent difference

TABLE 2-7
ACCURACY OBJECTIVES FOR MATRIX SPIKES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

		ACCURACY AS PERCENT RECOVERY	
FRACTION	MATRIX SPIKE	WATER	SOIL/SEDIMENT
	VOCs		
VOA	1,1-Dichloroethene	61-145	59-172
VOA	Trichloroethane	71-120	62-137
VOA	Chlorobenzene	75-130	60-133
VOA	Toluene	76-125	59-139
VOA	Benzene	76-127	66-142
	SVOCs		
BN	1,2,4-Trichlorobenzene	39-98	38-107
BN	Acenaphthene	46-118	31-137
BN	2,4-Dinitrotoluene	24-96	28-89
BN	Pyrene	26-127	35-142
BN	N-Nitroso-di-n-propylamine	41-116	41-126
BN	1,4-Dichlorobenzene	36-97	28-104
A	Phenol	12-110	26-90
A	2-Chlorophenol	27-123	25-102
A	4-Nitrophenol	10-80	11-114
A	Pentachlorophenol	9-103	17-109
A	4-Chloro-3-methylphenol	23-97	26-103
	Pesticide/PCBs		
Pesticide	Lindane	56-123	46-127
Pesticide	Heptachlor	40-131	35-130
Pesticide	Aldrin	40-120	34-132
Pesticide	Dieldrin	52-126	31-134
Pesticide	Endrin	56-121	42-139
Pesticide	4,4'-DDT	38-127	23-134
	Inorganics		
Inorganic	Elements	75-125	75-125

Notes:

VOA	volatile organic analysis
BN	base neutral
PCBs	polychlorinated biphenyls
DDT	dichloro-diphenyl trichloroethane
A	acid
SVOCs	semivolatile organic compounds
VOCs	volatile organic compounds

TABLE 2-8
ACCURACY OBJECTIVES FOR SURROGATE SPIKES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

		ACCURACY AS PERCENT RECOVERY	
FRACTION	SURROGATE COMPOUND	WATER	SOIL/SEDIMENT
	VOCs		
VOA	4-Bromofluorobenzene	86-115	59-113
VOA	1,2-Dichloroethane-d4	76-114	70-121
VOA	Toluene-d8	88-110	84-138
	SVOCs		
BN	Nitrobenzene-d5	35-114	23-120
BN	2-fluorobiphenyl	43-116	30-115
BN	terphenyl-d14	33-141	18-137
A	Phenol-d5	10-110	24-113
A	2-fluorophenol	21-110	25-121
A	2,4,6-tribromophenol	10-123	19-122
A	2-chlorophenol-d4	33-110	20-130 (advisory)
BN	1,2-dichlorobenzene-d4	16-110	20-130 (advisory)
	Pesticide/PCBs		
Pesticide	tetra chloro-m-xylene	60-150	60-150 (advisory)
Pesticide	decachlorobiphenyl	60-150	60-150 (advisory)

Notes:

BN	base neutral
PCBs	polychlorinated biphenyls
A	acid
SVOCs	semivolatile organic compounds
VOCs	volatile organic compounds

TABLE 2-9
ANALYTICAL PROCEDURES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

MEDIUM	ANALYTE CATEGORY	METHOD
	Laboratory Analysis	
Soil	TCL VOCs	NYSDEC ASP CLP
	Pyridine/Chloropyridine	NYSDEC ASP CLP
	TCL SVOCs	NYSDEC ASP CLP
	TAL Inorganics	NYSDEC ASP CLP
Aqueous	TCL VOCs	USEPA 8240
	Pyridine/Chloropyridine	USEPA 8270
	TCL SVOCs	USEPA 8270
	TCL PCB/Pesticides	USEPA 8080
	TAL Inorganics	USEPA 6010/7000s/9010
Soil	VOCs/Pyridines	Mod. 8010/8020 and Mod. 8270
Aqueous	VOCs/Pyridines	Mod. 8010/8020 and Mod. 8270
Soil Gas	VOCs	SOP - FAGCHS-001-01[1]

Notes:

NYSDEC	New York State Department of Environmental Conservation
ASP	Analytical Services Protocol
CLP	Contract Laboratory Program
PCB	polychlorinated biphenyls
TCL	target compound list
TAL	target analyte list
SVOCs	semivolatile organic compounds
VOCs	volatile organic compounds
Mod.	modified

[1] Refer to Quality Assurance Project Plan (ABB-ES, 1993).

TABLE 2-10
CHEMICAL-SPECIFIC ARARs AND SCGs

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN RI/FS
GROUNDWATER/ SURFACE WATER				
Federal	SDWA - MCLs [40 CFR 141.11 - 141.16]	Relevant and Appropriate	MCLs have been promulgated for several common organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water.	Because groundwater is not used for drinking water in the vicinity of the Olin Plant, the SDWA is not applicable.
	SDWA - MCLGs [40 CFR 141.50 - 141.50]	Relevant and Appropriate	MCLGs are standards at which there are no known or anticipated public health effects. These are guidance values.	The 1990 National Contingency Plan states that non-zero MCLGs are to be used as goals. Because groundwater is not used as a drinking water source, the concentrations of contaminant detected in groundwater at the study area will be compared to their MCLGs.
	Federal AWQC	Relevant and Appropriate	Federal AWQC include (1) health-based criteria developed for 95 carcinogenic and noncarcinogenic compounds and (2) water quality parameters. AWQC, for the protection of human health, provide levels for exposure from drinking water and consuming aquatic organisms and from consuming just fish. Remedial actions involving contaminated surface water or groundwater must consider the uses of the water and the circumstances of the release or threatened release; this determines whether AWQC are relevant and appropriate.	AWQC will be used, where appropriate, in the development of clean-up levels for surface water.

TABLE 2-10
CHEMICAL-SPECIFIC ARARs AND SCGs

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN RI/FS
State	New York Water Classifications and Quality Standards [6 NYCRR Parts 701 - 705]	Applicable	New York State has classified surface water bodies and groundwater based on use. Water Quality Standards have been set to protect the designated uses of water.	Because groundwater in the vicinity of the Olin Plant is not used as a drinking water supply, this regulation is applicable. Groundwater at the Site is designated as Class GA. The Erie Barge Canal is classified as Class B and therefore applicable surface water quality standards apply.
	New York Department of Public Health Public Water Systems [Subpart 5-1]	Relevant and Appropriate	This requirement outlines MCLs that are not to be exceeded in public water supplies. Where MCLs have been exceeded, action is required to comply with regulatory standards.	Because groundwater is not used for drinking water in the vicinity of the Olin Plant, these standards will be reviewed and evaluated in developing target cleanup levels.
Federal Guidance and Criteria To Be Considered	USEPA Reference Doses (RfDs) and Risk Reference Concentrations (RfCs)	To Be Considered	RfDs/RfCs are estimates of a daily exposure level for the human population without an appreciable risk of deleterious effects during a lifetime.	USEPA RfDs/RfCs are used to characterize risks due to noncarcinogens in various media.
	USEPA Health Advisories (HAs)	To Be Considered	HAs are issued as nonregulatory guidance. HA values represent the concentration of contaminants in drinking water at which adverse health effects would not be expected to occur. HAs are established for one-day and ten-day exposure durations.	USEPA HAs are used to evaluate noncarcinogenic effects for oral exposures of shorter durations.
State Guidance and Criteria to be Considered	New York State Cleanup Criteria for Sediments	To Be Considered	This guidance document sets for th the numeric criteria for the cleanup of organic and inorganic contaminants in sediments. The criteria reflect contaminant concentrations that would be protective of aquatic life and/or prevent bioaccumulation.	Sediment criteria for inorganics will be evaluated in establishing preliminary remediation goals for contaminated sediments.

TABLE 2-10
CHEMICAL-SPECIFIC ARARs AND SCGs

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN RI/FS
	USEPA Human Health Carcinogen Assessment Group Cancer Slope Factors (CSFs)	To Be Considered	Carcinogenic effects present the most up-to-date information on cancer risk potency derived from USEPA's Human Health Carcinogen Assessment Group.	USEPA CSFs are used to compute the individual incremental cancer risk resulting from exposure to certain compounds.

Notes:

ARARs = Applicable or Relevant and Appropriate Requirements
AWQC = Ambient Water Quality Criteria
CFR = Code of Federal Regulations
CSF = Cancer Slope Factor
MCL = Maximum Contaminant Level
MCLG = Maximum Contaminant Level Goal
mg/L = milligrams per liter
NYCRR = New York Code of Rules and Regulations
ppm = parts per million
RfC = Risk Reference Concentration
RfD = Risk Reference Dose
RI/FS = Remedial Investigation/Feasibility Study
SCG = Standards, Criteria, and Guidelines
SDWA = Safe Drinking Water Act
μg/L = micrograms per liter
$\mu g/m^3$ = micrograms per cubic meter
USEPA = U.S. Environmental Protection Agency

TABLE 2–11
SUMMARY OF GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDANCE

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compounds	NY STATE Groundwater Quality Class GA (µg/L)	FEDERAL MCL (µg/L)	FEDERAL MCLG (µg/L)	FEDERAL WQC Water & Organisms (µg/L)	NY STATE Surface Water Quality Class B (µg/L)
VOLATILE ORGANIC COMPOUNDS					
Chloromethane	5			0(0.19)	
Bromoethane				0(0.19)	
Vinyl Chloride	2	2	0	0(2.0)	
Chloroethane				IND	
Methylene chloride	5	(5)	(0)		
Acetone					
Carbon disulfide					
1,1–Dichloroethene	5	7	7	0(33ng/L)	
1,1–Dichloroethane	5				
1,1,1–Trichloroethane	5	200	200	18400	
1,2–Dichloroethene (total)	5	70/100	70/100	IND	
Chloroform	7	(100)		0(0.19)	
1,2–Dichloroethane	5	5	0	0(0.94)	
2–Butanone					
1,1,1–Trichloroethane	5	200	200		
Carbon tetrachloride	5	5	0	0(0.42ng/L)	
Vinyl Acetate					
Bromodichloromethane	50 G	100			
1,2–Dichloropropane	5	5	0	IND	
cis–1,3–Dichloropropene	5			87	
Trichloroethene	5	5	0	0(2.8)	11 G
Dibromochloromethane	50 G	100		0(0.19)	
1,1,2–Trichloroethane	5	(5)	(3)	0(0.6)	
Benzene	0.7	5	0	0(0.66)	6 G
trans–1,3–Dichloropropene	5			87	
Bromoform	50 G	100			
4–Methyl–2–Pentanone					

TABLE 2-11
SUMMARY OF GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDANCE

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compounds	NY STATE Groundwater Quality Class GA (µg/L)	FEDERAL MCL (µg/L)	FEDERAL MCLG (µg/L)	FEDERAL WQC Water & Organisms (µg/L)	NY STATE Surface Water Quality Class B (µg/L)
VOLATILE ORGANIC COMPOUNDS (continued)					
2-Hexanone	50 G				
Tetrachloroethene	5	5	0	0(0.88)	1 G
1,1,2,2-Tetrachloroethane	5			0(0.17)	
Toluene	5	1000	1000	14300	
Chlorobenzene	5	100	100	488	5
Ethylbenzene	5	700	700	2400	
Styrene	5	100	100		
Xylenes (Total)	5	10000	10000		
SEMIVOLATILE ORGANIC COMPOUNDS					
Phenol (Total)	1			3500	
bis(2-Chloroethyl)ether	1.0			0(30ng/L)	
2-Chlorophenol	+			0.1 (01)	
1,3-Dichlorobenzene	5	(600)	(600)	470	5 ++
1,4-Dichlorobenzene	4.7	75	75	470	5 ++
Benzyl alcohol					
1,2-Dichlorobenzene	4.7	(600)	(600)	470	5 ++
2-Methylphenol	+				
bis(2-Chloroisopropyl)ether				34.7	
4-Methylphenol	+				
N-Nitroso-di-n-propylamine					
Hexachloroethane				0 (2.4)	
Nitrobenzene	5			19800	
Isophorone	50 G			5200	
2-Nitrophenol	+				
2,4-Dimethylphenol	+			400 (01)	

TABLE 2-11
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OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compounds	NY STATE Groundwater Quality Class GA (µg/L)	FEDERAL MCL (µg/L)	FEDERAL MCLG (µg/L)	FEDERAL WQC Water & Organisms (µg/L)	NY STATE Surface Water Quality Class B (µg/L)
SEMIVOLATILE ORGANIC COMPOUNDS (continued)					
Benzoic Acid					
bis(2-Chloroethoxy)methane					
2,4-Dichlorophenol	+			3090	
1,2,4-Trichlorobenzene	5	(9)	(9)	IND	5
Naphthalene	10 G			IND	
4-Chloroanaline					
Hexachlorobutadiene	5			0 (0.45)	1
4-Chloro-3-methylphenol	+			3000	
2-Methylnaphthalene				0 (3.1 ng/L)	
Hexachlorocyclopentadiene	5	(50)	(50)	206	0.45
2,4,6-Trichlorophenol	+			0 (1.8)	
2,4,5-Trichlorophenol	+			2600	
2-Chloronaphthalene	10			IND	
2-Nitroanaline					
Dimethylphthalate	50 G			350000	
2,6-Dinitrotoluene	5				
3-Nitroanaline					
Acenaphthene	20 G			0 (3.1 ng/L)	
2,4-Dinitrophenol	+			70	
4-Nitrophenol	+				
Dibenzofuran					
2,4-Dinitrotoluene				0 (0.11)	
Diethylphthalate	50 G			434000	
4-Chlorophenyl-phenylether					
Fluorene	50 G			0 (2.8 ng/L)	
4-Nitroanaline					

TABLE 2-11
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OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compounds	NY STATE Groundwater Quality Class GA (µg/L)	FEDERAL MCL (µg/L)	FEDERAL MCLG (µg/L)	FEDERAL WQC Water & Organisms (µg/L)	NY STATE Surface Water Quality Class B (µg/L)
SEMIVOLATILE ORGANIC COMPOUNDS (continued)					
4,6-Dinitro-2-methylphenol	+				
N-Nitrosodiphenylamine	50 G			0 (7.0)	
4-Bromophenyl-phenylether					
Hexachlorobenzene	0	(1)	(0)	0 (21 ng/L)	
Pentachlorophenol	+	1	0	200	0.4
Phenanthrene	50 G			0 (3.1 ng/L)	
Anthracene	50 G			0 (3.1 ng/L)	
Di-n-butylphthalate	50			******	
Fluoranthene	50 G			188	
Pyrene	50 G			0 (3.1 ng/L)	
Butylbenzylphthalate	50 G				
3,3-Dichlorobenzidene				470	
Benzo(a)anthracene	0.002 G	(0.1)	(0)	0 (3.1 ng/L)	
Chrysene	0.002 G	(0.2)	(0)	0 (3.1 ng/L)	
bis(2-Ethylhexyl)phthalate	50				0.6
Di-n-octylphthalate	50 G				
Benzo(b)fluoranthene	0.002 G	(0.2)	(0)	0 (3.1 ng/L)	
Benzo(k)fluoranthene	0.002 G	(0.2)	(0)	0 (3.1 ng/L)	
Benzo(a)pyrene	ND	(0.2)	(0)	0 (3.1 ng/L)	0.0012 G
Indeno(1,2,3-cd)Pyrene	0.002 G	(0.4)	(0)	0 (3.1 ng/L)	
Dibenz(a,h)Anthracene		(0.3)	(0)	0 (3.1 ng/L)	
Benzo(g,h,i)perylene				0 (3.1 ng/L)	

TABLE 2–11
SUMMARY OF GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDANCE

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compounds	NY STATE Groundwater Quality Class GA (µg/L)	FEDERAL MCL (µg/L)	FEDERAL MCLG (µg/L)	FEDERAL WQC Water & Organisms (µg/L)	NY STATE Surface Water Quality Class B (µg/L)
PESTICIDE/PCBs					
alpha–BHC	ND	0.2	0.2	0 (73 ng/L)	0.01
beta–BHC	ND	0.2	0.2	0 (23.3 ng/L)	0.01
delta–BHC	ND	0.2	0.2	IND	0.01
gamma–BHC (Lindane)	ND	4	0.2	0 (17.4 ng/L)	0.01
Heptachlor	ND	0.4	0	0 (11 ng/L)	0.001
Aldrin	ND				0.001
Heptachlor epoxide	ND	0.2	0		0.001
Endosulfan I				138	0.009
Dieldrin***	ND			0.000071	0.001
4,4'–DDE	ND				0.001 +++
Endrin	ND	(2)	(2)	1	0.002
Endosulfan II					0.009
4,4'–DDD	ND				0.001 +++
Endosulfan sulfate					
4,4'–DDT	ND			0.000024	0.001 +++
Methoxychlor	***	40	40		0.03
Endrin ketone					
alpha–Chlordane	0	2	0		
gamma–Chlordane	0	2	0		
Toxaphene	ND	3	*	0 (26 ng/L)	0.005
Aroclor–1016	0.1	0	*		0.001 ++++
Aroclor–1221	0.1	0	*		0.001 ++++
Aroclor–1232	0.1	0	*		0.001 ++++
Aroclor–1242	0.1	0	*		0.001 ++++
Aroclor–1248	0.1	0	*		0.001 ++++
Aroclor–1254	0.1	0	*		0.001 ++++
Aroclor–1260	0.1	0	*		0.001 ++++

TABLE 2-11
SUMMARY OF GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDANCE

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compounds	NY STATE Groundwater Quality Class GA (µg/L)	FEDERAL MCL (µg/L)	FEDERAL MCLG (µg/L)	FEDERAL WQC Water & Organisms (µg/L)	NY STATE Surface Water Quality Class B (µg/L)
INORGANICS					
Aluminum					100
Antimony	3 G	(10)	(3)	146	
Arsenic	25	50		0.0022	190 *
Barium	1000	1000	(5000)	1	
Beryllium	3 G	(1)	(0)	0.0037	11/1,100 **
Cadmium	10	5	5	10	***
Calcium					
Chromium	50	100	100		****
Cobalt					5
Copper	200		TT (1300)	1000 (01)	*****
Cyanide	100	200	200	200	5.2 +++++
Iron	300			300	300
Lead	25	TT 15	0	50	******
Magnesium	35000 G				
Manganese	300			50	
Mercury	2	2	(2)	0.144	0.2 G
Nickel		(100)	(100)	13.4	*******
Potassium					
Selenium	***	50	10	10	1 ++++++
Silver	***	50		50	0.1 +++++++
Sodium	20000				
Thallium	4 G	(2)	(0.05)	17.8	8 ++++++
Vanadium					14 ++++++
Zinc	300			5000 (01)	30 ++++++

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TABLE 2-11
SUMMARY OF GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDANCE

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compounds	NY STATE Groundwater Quality Class GA (µg/L)	FEDERAL MCL (µg/L)	FEDERAL MCLG (µg/L)	FEDERAL WQC Water & Organisms (µg/L)	NY STATE Surface Water Quality Class B (µg/L)
WATER QUALITY PARAMETERS					
pH					6.5< X <8.5
Dissolved solids	500 mg/L				500 mg/L
DO					> 4.0 - 7.0 mg/L

Sources:
Federal MCLs and MCLGs from 40 CFR 141.
Federal MCLs and MCLGs in parentheses are proposed (from 54FR22062, 55FR30370, and 56FR3521).
Federal Ambient Water Quality Criteria, May 1, 1991

New York State Groundwater Quality standards taken from 6NYCRR 703 (September 1, 1991) and Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values (November 15, 1991). New York State Public Water Supply MCLs taken from 10 NYCRR 5-1 (March 11, 1992).

Notes:

G = Guidance values taken from New York State Division of Water Technical and Operational Guidance Series (Ambient Water Quality Standards and Guidance Values, November 15, 1991).
IND = Insufficient data
TT = Treatment Technique Action Level
MCL = Maximum Contaminant Level
MCLG = Maximum Contaminant Level Goal
WQC = Water Quality Criteria (for the protection of human health).
ND = Not detectable
* = NYS Surface Water Standards are for dissolved arsenic
** = NYS Surface Water Standards for berylium is 11 µg/L when hardness is less than or equal to 75 ppm; 1,100 µg/L when hardness is greater than 75 ppm.
*** = exp (0.7852[ln (ppm hardness) - 3.490) - apply to acid - soluble form
**** = exp (0.819[ln (ppm hardness) - 1.561) - apply to acid - soluble form

TABLE 2-11
SUMMARY OF GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDANCE

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compounds	NY STATE Groundwater Quality Class GA (µg/L)	FEDERAL MCL (µg/L)	FEDERAL MCLG (µg/L)	FEDERAL WQC Water & Organisms (µg/L)	NY STATE Surface Water Quality Class B (µg/L)

Notes (continued)

*****	= exp (0.8545[ln (ppm hardness) – 1.465) – apply to acid – soluble form
******	= exp (1.266[ln (ppm hardness) + 4.661) – apply to acid – soluble form
*******	= exp (0.76[ln (ppm hardness) + 1.06) – apply to acid – soluble form
+	= total phenols limit of 1.0 ug/L
++	= total Dichlorobenzenes limit of 5 µg/L.
+++	= total DDD, DDE, and DDT limit of 0.001 µg/L.
++++	= total PCBs limit of 0.001 µg/L.
+++++	= NYS Surface Water Standards for cyanide (CN) apply to free cyanide – the sum of HCN and CN expressed as CN.
++++++	= NYS Surface Water Standards for selenium, thallium, vanadium, and zinc apply to acid–soluble form.
+++++++	= NYS Surface Water Standards for silver apply to acid–soluble form.
$	= Not included in 100 ug/L organic total
T	= May also depend on presence of trout habitat. See regulations for limits.
ol	= organoleptic, criteria based on odor and taste, not health. No health–based criteria available
( )	= MCLs and MCLGs in parenthesis are proposed
µg/L	= micrograms per liter
mg/L	= milligrams per liter
ng/L	= nanograms per liter

TABLE 4-1
CHEMICALS DETECTED IN SOIL GAS
OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	SG-108	SG-109	SG-111	SG-112	SG-113	SG-114	SG-115	SG-116
Depth	3	3	3	3	3	3	3	3
Sample Date	12 Oct 93	12 Oct 93	12 Oct 93	12 Oct 93	12 Oct 93	19 Oct 93	19 Oct 93	19 Oct 93
VOCs (μg/L)								
1,1-Dichloroethene	–	0.8	0.2	0.2	–	–	–	0.1
Carbon tetrachloride	–	–	–	–	–	0.3	0.5	2.2
Chloroform	–	–	–	–	–	–	–	2.2
Methylene chloride	–	2.4	0.2	–	–	–	–	–
Tetrachloroethene	0.1	0.4	–	1.3	0.3	–	0.2	0.5
Trichloroethene	–	0.4	–	0.2	–	–	–	–
cis-1,2-Dichloroethene	–	0.2	–	1.6	–	–	–	–
trans-1,2-Dichloroethene	–	–	–	0.2	–	–	–	–
SUM	0.1	4.2	0.4	3.5	0.3	0.3	0.7	5

Location	SG-117	SG-118	SG-119	SG-120	SG-122	SG-124	SG-125	SG-126
Depth	3	3	3	3	3	3	3	3
Sample Date	12 Oct 93	14 Oct 93	14 Oct 93	18 Oct 93	18 Oct 93	15 Oct 93	15 Oct 93	15 Oct 93
VOCs (μg/L)								
1,1-Dichloroethene	–	0.1	–	–	–	–	1.7	–
Carbon tetrachloride	1	–	1	38	2.7	1.1	0.9	0.6
Chloroform	0.1	–	0.1	23	2.4	–	1.6	–
Methylene chloride	–	–	0.3	2.4	–	0.3	–	–
Tetrachloroethene	1.4	–	–	8.5	0.4	1.3	3.9	0.3
Trichloroethene	–	–	–	2.3	–	–	1.7	–
cis-1,2-Dichloroethene	0.1	–	–	–	–	–	1.8	–
trans-1,2-Dichloroethene	–	–	–	–	–	–	1.3	–
SUM	2.6	0.1	1.4	74	5.5	2.7	13	0.9

Location	SG-127	SG-129	SG-130	SG-132	SG-133	SG-134	SG-136	SG-137
Depth	3	3	3	3	3	3	3	3
Sample Date	15 Oct 93	15 Oct 93	15 Oct 93	18 Oct 93	18 Oct 93	14 Oct 93	14 Oct 93	14 Oct 93
VOCs (μg/L)								
1,1-Dichloroethene	0.1	0.1	0.1	0.1	–	–	0.1	0.2
Carbon tetrachloride	2.7	1.3	–	3.1	0.3	1.8	–	–
Chloroform	0.7	0.3	0.1	2.9	0.1	0.2	–	–
Methylene chloride	0.2	0.1	–	–	–	–	–	–
Tetrachloroethene	1.9	0.5	1.8	1.2	–	0.8	–	–
Trichloroethene	0.1	–	0.2	–	0.1	–	–	–
cis-1,2-Dichloroethene	–	–	0.1	–	–	–	–	–
trans-1,2-Dichloroethene	–	–	–	–	–	–	–	–
SUM	5.7	2.3	2.3	7.3	0.5	2.8	0.1	0.2

Location	SG-140	SG-141	SG-143	SG-146	SG-148	SG-151	SG-155	SG-156
Depth	3	3	3	3	3	3	3	3
Sample Date	14 Oct 93	15 Oct 93	13 Oct 93	13 Oct 93	13 Oct 93	13 Oct 93	14 Oct 93	14 Oct 93
VOCs (μg/L)								
1,1-Dichloroethene	–	–	–	0.1	–	–	–	–
Carbon tetrachloride	0.1	0.2	–	–	–	–	0.2	–
Chloroform	–	–	–	–	–	–	2	0.3
Methylene chloride	0.1	–	–	–	0.1	0.1	0.1	–
Tetrachloroethene	–	–	–	–	–	–	–	–
Trichloroethene	–	–	0.2	–	–	–	–	–
cis-1,2-Dichloroethene	–	–	–	–	–	–	–	–
trans-1,2-Dichloroethene	–	–	–	0.2	–	1.3	–	–
SUM	0.2	0.2	0.2	0.3	0.1	1.4	2.3	0.3

TABLE 4-1
CHEMICALS DETECTED IN SOIL GAS
OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	**SG-157**	**SG-162**	**SG-165**	**SG-171**	**SG-172**	**SG-173**	**SG-174**	**SG-175**
Depth	3	3	3	3	3	3	3	3
Sample Date	14 Oct 93	13 Oct 93	13 Oct 93	18 Oct 93	18 Oct 93	18 Oct 93	19 Oct 93	18 Oct 93
VOCs (µg/L)								
1,1-Dichloroethene	-	-	-	-	-	-	0.3	-
Carbon tetrachloride	0.1	-	0.2	0.3	2.8	2.5	2.4	2.4
Chloroform	-	-	0.2	0.2	0.9	0.8	2.7	1.6
Methylene chloride	0.2	0.1	-	-	-	-	-	-
Tetrachloroethene	-	-	-	-	0.4	0.4	0.8	0.6
Trichloroethene	-	-	-	-	-	-	-	1.8
cis-1,2-Dichloroethene	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	-	-	-
SUM	**0.3**	**0.1**	**0.4**	**0.5**	**4.1**	**3.7**	**6.2**	**6.4**

Location	**SG-176**	**SG-177**	**SG-179**	**SG-180**	**SG-181**	**SG-182**	**SG-183**	**SG-184**
Depth	3	3	10	15	12	15	13	3
Sample Date	18 Oct 93	28 Oct 93	28 Oct 93	28 Oct 93	28 Oct 93	28 Oct 93	29 Oct 93	29 Oct 93
VOCs (µg/L)								
1,1-Dichloroethene	-	-	-	-	-	-	-	-
Carbon tetrachloride	0.7 J	0.2	-	0.3	-	0.1	-	0.6
Chloroform	-	0.2	-	0.3	-	0.1	-	0.1
Methylene chloride	-	-	-	-	-	-	-	-
Tetrachloroethene	-	-	-	-	-	-	-	0.3
Trichloroethene	-	-	-	-	-	1.6	-	-
cis-1,2-Dichloroethene	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	-	-	-
SUM	**0.7**	**0.4**	**-**	**0.6**	**-**	**1.8**	**-**	**1**

Location	**SG-185**	**SG-186**	**SG-187**
Depth	3	3	3
Sample Date	29 Oct 93	29 Oct 93	01 Nov 93
VOCs (µg/L)			
1,1-Dichloroethene	0.5	0.3	0.1
Carbon tetrachloride	4.5	2.8	0.5
Chloroform	1.3	1.7	0.3
Methylene chloride	-	-	-
Tetrachloroethene	1.5	2.3	2.1
Trichloroethene	0.3	-	0.6
cis-1,2-Dichloroethene	-	-	-
trans-1,2-Dichloroethene	-	-	-
SUM	**8.1**	**7.1**	**3.6**

Notes:

1) Sample results include only those with compounds detected. All other samples are non-detect.
2) All concentrations reported in micrograms per liter in air.
- Not detected
J Estimated concentration where compound or element does not meet QC criteria.
E Estimated concentration that is above the highest calibration standard.

TABLE 4-2
CHEMICALS DETECTED IN SURFACE SOIL

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound / Analyte	Frequency of Detection	Maximum Detected Concentration	Location of Maximum Concentration
VOLATILE ORGANIC COMPOUNDS (mg/kg)			
Chloroform	4 / 15	0.001	SS-110
SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)			
1,2,4-Trichlorobenzene	1 / 15	0.022	SS-102
2,6-Dichloropyridine	14 / 15	0.56	SS-110
2-Chloropyridine	14 / 15	0.62	SS-110
2-Methylnaphthalene	9 / 15	0.54	SS-110
3-Chloropyridine	4 / 15	0.069	SS-108
4-Methylphenol	1 / 15	0.02	SS-104
Acenaphthene	11 / 15	3.9	SS-110
Acenaphthylene	8 / 15	0.17	SS-113
Anthracene	14 / 15	10	SS-110
Benzo(a)anthracene	15 / 15	34	SS-110
Benzo(a)pyrene	15 / 15	27	SS-110
Benzo(b)fluoranthene	15 / 15	35	SS-110
Benzo(g,h,i)perylene	14 / 15	11	SS-110
Benzo(k)fluoranthene	15 / 15	22	SS-110
Bis(2-ethylhexyl)phthalate	15 / 15	60	SS-107
Carbazole	15 / 15	6.7	SS-110
Chrysene	15 / 15	37	SS-110
Di-n-butylphthalate	2 / 15	0.36	SS-104
Di-n-octylphthalate	1 / 15	0.43	SS-105
Dibenzo(a,h)Anthracene	7 / 15	2.9	SS-110
Dibenzofuran	8 / 15	2.3	SS-110
Dimethylphthalate	2 / 15	4.6	SS-104
Fluoranthene	15 / 15	74	SS-110
Fluorene	7 / 15	4.8	SS-110
Hexachlorobenzene	1 / 15	0.039	SS-102
Hexachlorobutadiene	1 / 15	0.059	SS-110
Hexachloroethane	1 / 15	0.029	SS-110
Indeno(1,2,3-c,d)Pyrene	14 / 15	15	SS-110
Naphthalene	7 / 15	0.37	SS-110
Phenanthrene	15 / 15	48	SS-110
Pyrene	15 / 15	62	SS-110
Pyridine	4 / 15	0.11	SS-113
INORGANICS (mg/kg)			
Aluminum	15 / 15	12000	SS-106, SS-111
Arsenic	15 / 15	12	SS-113
Barium	15 / 15	210	SS-104
Cadmium	15 / 15	1.8	SS-103
Calcium	15 / 15	95000	SS-105
Chromium	15 / 15	180	SS-104
Cobalt	11 / 15	15	SS-111
Copper	15 / 15	300	SS-106
Iron	15 / 15	23000	SS-111
Lead	15 / 15	530	SS-104
Magnesium	15 / 15	50000	SS-105
Manganese	15 / 15	1200	SS-111
Mercury	9 / 15	210	SS-103
Nickel	15 / 15	62	SS-102
Potassium	15 / 15	1900	SS-104
Selenium	1 / 15	0.8	SS-109
Silver	14 / 15	0.7	SS-113
Sodium	15 / 15	2500	SS-111
Vanadium	15 / 15	43	SS-111
Zinc	15 / 15	640	SS-104

Note:
Only detected analytes are listed. See Appendix B for complete analyte list.
mg/kg milligrams per kilogram

TABLE 4-3
SUMMARY OF
OVERBURDEN GROUNDWATER ANALYSES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound / Analyte	Frequency of Detection	Maximum Detected Concentration	Location of Maximum Concentration
OVERBURDEN GROUNDWATER ON-SITE (µg/L)			
VOLATILE ORGANIC COMPOUNDS (mg/kg)			
1,1,1-Trichloroethane	2 / 41	5	B-5
1,1-Dichloroethane	1 / 41	6	C-4
1,1-Dichloroethene	3 / 41	2	T-159
1,2-Dichlorobenzene	25 / 41	2400	W-5
1,2-Dichloroethane	2 / 41	93	B-5
1,2-Dichloroethene (total)	23 / 41	28	B-17
1,2-Dichloropropane	1 / 41	1	W-5
2-Butanone	3 / 41	42	B-11
2-Hexanone	2 / 41	31	R-17
4-Methyl-2-pentanone	5 / 41	70	T-151
Acetone	11 / 41	330	T-151
Benzene	28 / 41	62	B-5
Bromodichloromethane	1 / 41	8	B-17
Bromoform	5 / 41	540	B-17
Carbon disulfide	4 / 41	1900	B-17
Carbon tetrachloride	8 / 41	17000	T-134
Chlorobenzene	29 / 41	2500	W-5
Chloroform	18 / 41	50000	B-17
Chloromethane	1 / 41	6	B-5
Dibromochloromethane	1 / 41	62	B-17
Ethylbenzene	9 / 41	51	C-4
Methylene chloride	15 / 41	35000	C-5
Tetrachloroethene	18 / 41	2000	C-5
Toluene	28 / 41	4600	B-5
Total Xylenes	19 / 41	120	C-5
Trichloroethene	23 / 41	390	C-5
Vinyl chloride	3 / 41	12	W-5
SEMIVOLATILE ORGANIC COMPOUNDS			
1,2,4-Trichlorobenzene	5 / 38	1400	B-17
1,3-Dichlorobenzene	5 / 38	40	B-17
1,4-Dichlorobenzene	7 / 38	77	W-5
2,4,6-Trichlorophenol	1 / 38	0.8	B-5
2-4,Dimethylphenol	1 / 38	0.8	W-4
2,4-Dinitrotoluene	1 / 38	4	T-159
2,6-Dichloropyridine	35 / 38	44000	W-5
2-Chloroethyl Vinyl ether	1 / 41	1	B-2
2-Chlorophenol	1 / 38	2	B-6
2-Chloropyridine	38 / 38	400000	W-5
2-Methylnaphthalene	2 / 38	46	W-1
2-Methylphenol	1 / 38	1	B-6
3-Chloropyridine	24 / 38	1800	B-17
4-Chloroaniline	19 / 38	1200	C-4
4-Chloropyridine	10 / 38		T-151
4-Methylphenol	6 / 38	120	T-151
Acenaphthene	3 / 38	42	B-1
Anthracene	1 / 38	160	B-1
Benzo(a)anthracene	1 / 38	410	B-1
Benzo(a)pyrene	1 / 38	340	B-1
Benzo(b)fluoranthene	2 / 38	470	B-1
Benzo(g,h,i)perylene	1 / 38	45	B-1
Benzo(k)fluoranthene	1 / 38	190	B-1
Benzoic acid	9 / 38	68	T-138
Bis(2-Chloroethyl)ether	25 / 38	690	B-17
Bis(2-ethylhexyl)phthalate	22 / 38	340	W-5
Chrysene	2 / 38	330	B-1
Di-n-butylphthalate	1 / 38	22	E-1
Di-n-octylphthalate	1 / 38	9	B-11
Dibenzo(a,h)Anthracene	1 / 38	19	B-1
Dibenzofuran	1 / 38	25	B-1
Fluoranthene	3 / 38	990	B-1
Fluorene	1 / 38	61	B-1

TABLE 4-3
SUMMARY OF
OVERBURDEN GROUNDWATER ANALYSES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound / Analyte	Frequency of Detection	Maximum Detected Concentration	Location of Maximum Concentration
SEMIVOLATILE ORGANIC COMPOUNDS (CONTINUED)			
Indeno(1,2,3-c,d)Pyrene	1 / 38	69	B-1
Naphthalene	3 / 38	6	W-1
Phenanthrene	2 / 38	300	B-1
Phenol	4 / 38	250	T-151
Pyrene	2 / 38	660	B-1
Pyridine	23 / 38	98000	B-17
p-Fluoroaniline	27 / 38	920	W-5
PESTICIDES/PCBs			
4,4'-DDT	1 / 4	0.1	C-1
Aldrin	2 / 4	0.1	C-1, E-3
Dieldrin	2 / 4	7	C-5
Endosulfan 1	3 / 4	260	B-17
Heptachlor Epoxide	1 / 4	15	B-17
beta-BHC	2 / 4	300	C-5
gamma-BHC (Lindane)	3 / 4	42	C-5
INORGANICS			
Aluminum	30 / 32	630000	B-1
Antimony	8 / 32	9	B-6
Arsenic	29 / 32	920	B-11
Barium	32 / 32	8600	B-11
Beryllium	4 / 32	29	B-11
Cadmium	31 / 32	110	B-11
Calcium	32 / 32	2E+06	B-11
Chromium	24 / 32	2300	B-11
Cobalt	13 / 32	450	B-1
Copper	30 / 32	3600	B-11
Cyanide	12 / 32	84	B-6
Iron	32 / 32	3E+06	B-6
Lead	31 / 31	2700	B-1
Magnesium	31 / 31	720000	B-1
Manganese	32 / 32	56000	B-1
Mercury	15 / 32	630	B-1
Nickel	21 / 32	1800	B-1
Potassium	31 / 32	44000	B-11
Selenium	2 / 32	4	C-5
Silver	5 / 29	56	B-1
Sodium	32 / 32	2E+06	B-17
Vanadium	22 / 32	3400	B-11
Zinc	31 / 32	22000	B-11
OVERBURDEN GROUNDWATER OFF-SITE (µg/L)			
VOLATILE ORGANIC COMPOUNDS			
1,1-Dichloroethane	5 / 31	2	MW-103, T-102, MW-107
1,1-Dichloroethene	2 / 31	5	B-16
1,2-Dichlorobenzene	10 / 31	210	MW-106
1,2-Dichloroethane	2 / 31	170	T-107
1,2-Dichloroethene (total)	10 / 31	39	T-102
1,2-Dichloropropane	2 / 31	2	T-102
2-Butanone	1 / 31	41	T-102
4-Methyl-2-pentanone	1 / 31	19	T-102
Acetone	4 / 31	570	T-102
Benzene	14 / 31	210	MW-106
Carbon disulfide	2 / 31	8	B-16
Carbon tetrachloride	1 / 31	0.6	PZ-108
Chlorobenzene	11 / 31	620	PZ-101
Chloroform	4 / 31	1500	B-16
Ethylbenzene	9 / 31	8	MW-69
Methylene chloride	2 / 31	2500	B-16
Tetrachloroethene	4 / 31	340	B-16
Toluene	18 / 31	610	B-16
Total Xylenes	13 / 31	63	T-107
Trichloroethene	11 / 31	300	T-102
Vinyl chloride	4 / 31	18	MW-68

TABLE 4-3
SUMMARY OF
OVERBURDEN GROUNDWATER ANALYSES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound / Analyte	Frequency of Detection	Maximum Detected Concentration	Location of Maximum Concentration
SEMIVOLATILE ORGANIC COMPOUNDS			
1,2,4-Trichlorobenzene	2 / 26	6	B-15
2-6,Dichloropyridine	15 / 26	6000	B-16
2-Chlorophenol	1 / 26	4	PZ-101
2-Chloropyridine	18 / 26	60000	MW-106
2-Methylnaphthalene	3 / 26	1	MW-G6
3-Chloropyridine	8 / 26	4500	B-16
4-Chloroaniline	5 / 26	110	MW-106
4-Methylphenol	1 / 26	30	B-16
Acenaphthene	4 / 26	7	B-15
Anthracene	1 / 26	2	B-15
Benzo(b)fluoranthene	2 / 26	3	T-147
Benzo(g,h,i)perylene	2 / 26	1	T-147
Benzo(k)fluoranthene	2 / 26	1	T-147
Benzoic acid	1 / 26	59	MW-106
Bis(2-Chloroethyl)ether	8 / 26	130	B-15
Bis(2-ethylhexyl)phthalate	11 / 26	26	B-16
Di-n-octylphthalate	2 / 26	0.9	MW-107
Dibenzofuran	2 / 26	3	MW-G9
Diethylphthalate	1 / 26	1	MW-G6
Fluoranthene	3 / 26	4	T-145
Fluorene	2 / 26	6	B-15
Naphthalene	1 / 26	1	B-15
Phenanthrene	2 / 26	11	B-15
Pyrene	2 / 26	3	T-145
Pyridine	12 / 26	6500	B-16
p-Fluoroaniline	7 / 26	2100	MW-106
INORGANICS			
Aluminum	15 / 15	260000	MW-G6
Antimony	3 / 15	3	MW-104. MW-G8, B-14
Arsenic	13 / 15	150	MW-107
Barium	15 / 15	3100	MW-G6
Beryllium	2 / 15	11	MW-G6
Cadmium	14 / 15	30	MW-G8
Calcium	15 / 15	4E+06	MW-G6
Chromium	11 / 15	520	MW-G6
Cobalt	7 / 15	230	MW-G6
Copper	11 / 15	670	MW-G6
Cyanide	7 / 15	180	B-16
Iron	14 / 14	780000	MW-G6
Lead	13 / 14	640	MW-106
Magnesium	15 / 15	740000	MW-G6
Manganese	15 / 15	37000	B-14
Mercury	3 / 15	13	B-14
Nickel	10 / 15	610	B-14
Potassium	15 / 15	42000	B-14
Selenium	1 / 14	7	MW-106
Silver	2 / 13	15	MW-G8
Sodium	15 / 15	2E+06	B-16
Vanadium	10 / 15	690	B-14
Zinc	13 / 14	2000	MW-G8

Notes:

Frequency[1] – Chemical was detected in fewer than 5 percent of the samples.
μg/L – milligrams per liter
Only detected analytes are listed. See Appendix B for complete analyte list.

TABLE 4-4
SUMMARY OF
BEDROCK GROUNDWATER ANALYSES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound / Analyte	Frequency of Detection	Maximum Detected Concentration	Location of Maximum Concentration
BEDROCK GROUNDWATER ON-SITE (µg/L)			
VOLATILE ORGANIC COMPOUNDS			
1,2-Dichlorobenzene	10 / 15	350	BR-8
1,2-Dichloroethane	1 / 15	580	BR-101
1,2-Dichloroethene (total)	8 / 15	97	BR-2
2-Butanone	1 / 15	7	BR-2D
4-Methyl-2-pentanone	2 / 15	69	BR-101
Acetone	7 / 15	4100	BR-3
Benzene	11 / 15	210	BR-101
Bromodichloromethane	2 / 15	380	PZ-106
Bromoform	5 / 15	65000	PZ-106
Carbon disulfide	5 / 15	37000	PZ-106
Carbon tetrachloride	6 / 15	620000	PZ-106
Chlorobenzene	14 / 15	3600	BR-101
Chloroform	12 / 15	320000	PZ-106
Dibromochloromethane	4 / 15	7200	PZ-106
Ethylbenzene	2 / 15	160	BR-101
Methylene chloride	13 / 15	78000	BR-3
Tetrachloroethene	9 / 15	2100	PZ-106
Toluene	13 / 15	7200	BR-101
Total Xylenes	5 / 15	960	BR-101
Trichloroethene	7 / 15	750	BR-3
Vinyl chloride	4 / 15	85	PZ-105
SEMIVOLATILE ORGANIC COMPOUNDS			
1,2,4-Trichlorobenzene	3 / 15	420	BR-101
1,3-Dichlorobenzene	1 / 15	62	BR-8
1,4-Dichlorobenzene	2 / 15	35	BR-8
2,4-Dichlorophenol	1 / 15	4	BR-8
2,6-Dichloropyridine	14 / 15	22000	BR-3
2-Chlorophenol	1 / 15	3	BR-101
2-Chloropyridine	14 / 15	280000	BR-3
2-Methylphenol	1 / 15	0.8	BR-2D
3-Chloropyridine	13 / 15	19000	BR-3
4-Chloroaniline	9 / 15	70	BR-5
4-Chloropyridine	2 / 15	40	PZ-106
4-Methylphenol	1 / 15	1	BR-2D
4-Nitroaniline	1 / 15	0.8	BR-101
Benzoic acid	5 / 15	1100	BR-3
Bis(2-Chloroethyl)ether	12 / 15	680	PZ-106
Bis(2-ethylhexyl)phthalate	11 / 15	30	BR-6
Di-n-butylphthalate	1 / 15	6	BR-6
Hexachlorobutadiene	2 / 15	4	BR-2
Hexachloroethane	3 / 15	260	PZ-106
Isophorone	1 / 15	0.6	BR-6
Pyridine	13 / 15	45000	BR-3
p-Fluoroaniline	11 / 15	880	PZ-105
PESTICIDES/PCBs			
4,4'-DDE	1 / 2	0.1	BR-5
4,4'-DDT	1 / 2	0.2	BR-5
Endosulfan II	1 / 2	0.1	BR-5
Endosulfan Sulfate	1 / 2	0.1	BR-5
Endrin	1 / 2	0.1	BR-5
Heptachlor Epoxide	1 / 2	17	BR-5
Methoxychlor	1 / 2	0.1	BR-5
gamma-BHC (Lindane)	2 / 2	31	BR-3
INORGANICS			
Aluminum	13 / 15	6900	BR-5
Antimony	2 / 15	7	BR-2D
Arsenic	13 / 15	130	BR-6
Barium	14 / 15	1100	BR-101
Cadmium	10 / 15	2.6	PZ-107

TABLE 4-4
SUMMARY OF
BEDROCK GROUNDWATER ANALYSES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound / Analyte	Frequency of Detection	Maximum Detected Concentration	Location of Maximum Concentration
INORGANICS (Continued)			
Calcium	14 / 14	820000	BR-101
Chromium	6 / 15	99	BR-3D
Copper	11 / 15	150	BR-101
Cyanide	7 / 15	70	BR-101
Iron	15 / 15	300000	BR-3D
Lead	10 / 13	24	PZ-106
Magnesium	14 / 14	150000	BR-3D
Manganese	15 / 15	2200	BR-3D
Mercury	6 / 15	1.6	BR-102
Nickel	3 / 15	110	PZ-106
Potassium	15 / 15	110000	BR-2D
Silver	2 / 13	1	BR-3D
Sodium	15 / 15	3700000	BR-3
Vanadium	6 / 15	6600	BR-6
Zinc	13 / 15	1600	BR-3D
BEDROCK GROUNDWATER OFF-SITE (µg/L)			
VOLATILE ORGANIC COMPOUNDS			
1,1-Dichloroethane	6 / 10	25	BR-106
1,2-Dichlorobenzene	7 / 10	5800	PZ-103
1,2-Dichloroethane	1 / 10	80	PZ-103
1,2-Dichloroethene (total)	7 / 10	580	BR-106
Acetone	1 / 10	760	PZ-103
Benzene	10 / 10	180	PZ-103
Carbon disulfide	1 / 10	4	BR-105
Carbon tetrachloride	1 / 10	1	BR-105D
Chlorobenzene	7 / 10	1700	PZ-103
Chloroform	3 / 10	92	PZ-103
Ethylbenzene	3 / 10	4	BR-106
Methylene chloride	6 / 10	10000	PZ-102
Tetrachloroethene	3 / 10	16	PZ-103
Toluene	8 / 10	2200	PZ-103
Total Xylenes	5 / 10	38	PZ-103
Trichloroethene	6 / 10	69	PZ-103
Vinyl chloride	7 / 10	230	BR-106
SEMIVOLATILE ORGANIC COMPOUNDS			
1,4-Dichlorobenzene	1 / 10	34	PZ-102
2-6,Dichloropyridine	8 / 10	8400	PZ-103
2-Chlorophenol	1 / 10	0.4	PZ-104
2-Chloropyridine	10 / 10	50000	PZ-102
2-Methylnaphthalene	2 / 10	15	BR-105
2-Methylphenol	1 / 10	9	PZ-102
3-Chloropyridine	7 / 10	2100	PZ-103
4-Chloroaniline	5 / 10	310	PZ-103
4-Chloropyridine	2 / 10	10	PZ-102
4-Methylphenol	2 / 10	17	PZ-102
Acenaphthene	1 / 10	1	BR-105
Benzoic acid	3 / 10	73	PZ-103
Bis(2-Chloroethyl)ether	6 / 10	150	PZ-103
Bis(2-ethylhexyl)phthalate	6 / 10	50	BR-105D
Butylbenzylphthalate	1 / 10	1	BR-105D
Di-n-butylphthalate	1 / 10	27	BR-105D
N-Nitrosodiphenylamine	1 / 10	1	BR-105D
Naphthalene	1 / 10	3	BR-107
Phenanthrene	1 / 10	2	BR-105
Pyridine	7 / 10	1800	PZ-102
p-Fluoroaniline	8 / 10	1200	PZ-103
INORGANICS			
Aluminum	10 / 10	1400	BR-104
Antimony	2 / 10	4	BR-105D
Arsenic	3 / 10	42	BR-105D
Barium	10 / 10	600	PZ-103
Cadmium	4 / 10	0.5	BR-105D

TABLE 4-4
SUMMARY OF
BEDROCK GROUNDWATER ANALYSES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound / Analyte	Frequency of Detection	Maximum Detected Concentration	Location of Maximum Concentration
INORGANICS (Continued)			
Calcium	9 / 9	2200000	BR-105D
Chromium	2 / 10	11	PZ-103
Copper	2 / 10	310	BR-105D
Cyanide	6 / 10	73	BR-104
Iron	9 / 9	6400	BR-107
Lead	5 / 6	3	BR-104
Magnesium	9 / 9	400000	BR-105D
Manganese	10 / 10	620	BR-104
Potassium	10 / 10	210000	BR-105D
Sodium	10 / 10	2E+07	BR-105D
Zinc	5 / 10	43	BR-105D

NOTES:

µg/L – milligrams per liter
Only detected analytes are listed. See Appendix B for complete analyte list.

TABLE 4-5
SUMMARY OF PYRIDINES CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	B-1	B-11	B-14	B-15	B-16	B-17
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	21 Jan 94	26 Jan 94	26 Jan 94	26 Jan 94	26 Jan 94	26 Jan 94
2,6-Dichloropyridine	13	150 D	1000 D	1000 D	6000 D	26000 D
2-Chloropyridine	3 J	1400 D	22000 D	11000 D	16000 D	280000D
3-Chloropyridine	5 U	50	190 D	610 D	4500 D	18000 D
4-Chloropyridine	5 U	6 U	5 U	6 U	6 U	250
Pyridine	5 U	70	0.6 J	570 D	6500 D	98000 D
SUM	16	1700	23000	13000	33000	400000

Location	B-2	B-4	B-5	B-6	B-8	B-8
Type					Duplicate	
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	24 Jan 94	24 Jan 94	24 Jan 94	26 Jan 94	26 Jan 94	26 Jan 94
2,6-Dichloropyridine	91	85	140	1000	5300 D	7600 D
2-Chloropyridine	390	600	1100	9700	120000D	99000 D
3-Chloropyridine	6 U	8	44	5 U	1000 D	1900 D
4-Chloropyridine	6 U	6 U	6 U	5 U	6 U	6 U
Pyridine	6 U	6 U	24	5 U	2 J	1 J
SUM	480	690	1300	11000	Maximum =	130000

Location	B-7	B-9	C-1	C-2A	C-3	C-4
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	26 Jan 94	26 Jan 94	25 Jan 94	25 Jan 94	25 Jan 94	25 Jan 94
2,6-Dichloropyridine	660	450 D	33	680 D	57	120 D
2-Chloropyridine	3100	1800 D	110 D	510 D	130 D	440 D
3-Chloropyridine	37	110 D	2 J	17	6 U	37
4-Chloropyridine	6 U	0.5 J	1 J	6 U	6 U	6 U
Pyridine	15	340 D	0.9 J	40	0.7 J	0.1 J
SUM	130000	2700	150	1200	190	600

Location	C-5	C-5	E-1	E-2	E-3	E-4
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	25 Jan 94	25 Jan 94	27 Jan 49	24 Jan 94	25 Jan 94	24 Jan 94
2,6-Dichloropyridine	1700 D	15000 D	1200	17	24	2 J
2-Chloropyridine	170000D	170000D	8300	45	62	13
3-Chloropyridine	13000 D	9000 DJ	480	6	5 U	8 U
4-Chloropyridine	230 D	230 D	0.7 J	6 U	5 U	8 U
Pyridine	24000 D	34000 D	820	6 U	5 U	8 U
SUM	Maximum =	230000	11000	68	86	15

Location	EC-1	MW-103	MW-104	MW-106	MW-107	MW-2
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	24 Jan 94	20 Jan 94	26 Jan 94	02 Feb 94	21 Jan 94	19 Jan 94
2,6-Dichloropyridine	6 U	6 U	28	4200	0.6 J	5 U
2-Chloropyridine	6 U	6 U	7	60000	2 J	0.9 J
3-Chloropyridine	6 U	6 U	6 U	1500	5 U	5 U
4-Chloropyridine	6 U	6 U	6 U	6 U	5 U	5 U
Pyridine	6 U	6 U	6 U	640	5 U	5 U
SUM	ND	ND	35	66000	2.6	0.9

TABLE 4-5
SUMMARY OF PYRIDINES CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	MW-3	MW-G6	MW-G8	MW-G9	N-1	N-1
Type					Duplicate	
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	19 Jan 94	19 Jan 94	19 Jan 94	18 Jan 94	24 Jan 94	24 Jan 94
2,6-Dichloropyridine	5 U	5 U	6 U	6 U	9	10
2-Chloropyridine	4 J	5 U	6 U	6 U	4 J	5 J
3-Chloropyridine	5 U	5 U	6 U	6 U	6 U	6 U
4-Chloropyridine	5 U	5 U	6 U	6 U	6 U	6 U
Pyridine	5 U	5 U	6 U	6 U	6 U	6 U
SUM	4	ND	ND	ND	13	15

Location	N-2	N-3	PZ-101	PZ-108	S-1	S-2
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	21 Jan 94	25 Jan 94	24 Jan 94	24 Jan 94	20 Jan 94	20 Jan 94
2,6-Dichloropyridine	8 U	6 U	820 D	18	410 DJ	7300 D
2-Chloropyridine	2 J	0.9 J	26000 D	47	10000 D	130000D
3-Chloropyridine	8 U	6 U	110 D	2 J	22	7700 D
4-Chloropyridine	8 U	6 U	6 U	6 U	8 U	200 D
Pyridine	8 U	6 U	6	0.4 J	8 U	4200 DJ
SUM	2	0.9	27000	67	10000	150000

Location	S-3	S-4	T-115	T-115	T-121	T-121
Type			Duplicate		Duplicate	
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	19 Jan 94	21 Jan 94	26 Oct 93	26 Oct 93	12 Nov 93	12 Nov 93
2,6-Dichloropyridine	780 D	160 D	23 J	27	10 U	17 U
2-Chloropyridine	5400 D	1100 D	25 U	25 U	63	80
3-Chloropyridine	330 D	60	25 U	25 U	10 U	17 U
4-Chloropyridine	4 J	7 U	25 U	25 U	10 U	17 U
Pyridine	210 D	3 J	25 U	25 U	10 U	17 U
SUM	6400	1300	Maximum =	27	Maximum =	80

Location	T-126	T-129	T-129	T-138	T-138	T-143
Type		Duplicate		Duplicate		
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	27 Oct 93	03 Nov 93	03 Nov 93	08 Nov 93	08 Nov 93	17 Nov 93
2,6-Dichloropyridine	31 U	34	30	110 J	100 J	6 U
2-Chloropyridine	31 U	530	480	3000 J	3500 J	4 J
3-Chloropyridine	31 U	17 J	14 J	130 J	120 J	6 U
4-Chloropyridine	31 U	22 U	20 U	12 UJ	12 UJ	6 U
Pyridine	31 U	200	190	260 J	260 J	6 U
SUM	ND	Maximum =	880	Maximum =	4000	4

Location	T-142	T-142	T-144	T-145	T-147	T-148
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	16 Nov 93	16 Nov 93	16 Nov 93	30 Nov 93	30 Nov 93	16 Nov 93
2,6-Dichloropyridine	170 DJ	160	4 J	1 J	0.5 J	27
2-Chloropyridine	6300 D	6200 D	14	16	5 J	300 D
3-Chloropyridine	19	17	5 U	7 U	7 U	14 U
4-Chloropyridine	9 U	10 U	5 U	7 U	7 U	14 U
Pyridine	11	6 J	0.7 J	7 U	4 J	14 U
SUM	Maximum =	6500	19	17	9.5	330

TABLE 4-5
SUMMARY OF PYRIDINES CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	T-150	T-151	T-154	T-155	T-157	
Type						
Media	Water	Water	Water	Water	Water	
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	
Sample Date	29 Nov 93	18 Nov 93	19 Nov 93	18 Nov 93	02 Dec 93	
2,6-Dichloropyridine	3 J	2100 DJ	88 DJ	9 U	14 U	
2-Chloropyridine	31	120000 D	4500 D	12	14 U	
3-Chloropyridine	8 U	2600 DJ	7	9 U	14 U	
4-Chloropyridine	8 U	1300 E	6 U	9 U	14 U	
Pyridine	2 J	21000 D	5 J	0.7 J	14 U	
SUM	36	150000	4600	13	ND	

Location	T-159	T-159	W-1	W-1	W-2	W-3
Type	Duplicate		Duplicate			
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	01 Dec 93	01 Dec 93	18 Jan 94	18 Jan 94	20 Jan 94	18 Jan 94
2,6-Dichloropyridine	320	440	240	230	240 D	82 D
2-Chloropyridine	1700	1900	230	220	450 D	580 D
3-Chloropyridine	100	120	28 U	28 U	6 U	15
4-Chloropyridine	12 U	2 J	28 U	28 U	6 U	5 U
Pyridine	12 U	0.6 J	28 U	28 U	0.2 J	5 U
SUM	Maximum =	2500	Maximum =	470	690	680

Location	W-4	W-5	
Type			
Media	Water	Water	
Lab	RECRA	RECRA	
Sample Date	20 Jan 94	20 Jan 94	
2,6-Dichloropyridine	400 D	44000 D	
2-Chloropyridine	850 D	400000 D	
3-Chloropyridine	3 J	1500	
4-Chloropyridine	6 U	10 J	
Pyridine	0.1 J	52 J	
SUM	1300	450000	

Notes:

All concentrations reported in units of micrograms per liter.
D Dilution
J Estimated concentration where compound or element does not meet QC criteria.
U Not detected, value equals sample quantitation limit.

TABLE 4-6
SUMMARY OF PYRIDINES CONCENTRATIONS IN BEDROCK GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	**BR-1**	**BR-101**	**BR-102**	**BR-103**	**BR-104**	**BR-105**
Type						
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**20 Jan 94**	**01 Feb 94**	**27 Jan 94**	**20 Jan 94**	**26 Jan 94**	**27 Jan 94**
2,6-Dichloropyridine	6 U	370	160	6 U	230	1800 J
2-Chloropyridine	10	1800	1700	6	2800	21000 J
3-Chloropyridine	6 U	140	36	6 U	13	540 J
4-Chloropyridine	6 U	5 UJ	6 U	6 U	6 U	6 UJ
Pyridine	6 U	970	87	6 U	6	35 J
SUM	10	3300	2000	6	3000	23000

Location	**BR-105D**	**BR-105D**	**BR-106**	**BR-107**	**BR-107**	**BR-108**
Type	**Duplicate**			**Duplicate**		
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**04 Feb 94**	**04 Feb 94**	**02 Feb 94**	**21 Jan 94**	**21 Jan 94**	**02 Feb 94**
2,6-Dichloropyridine	54	62	710	6 U	6 U	0.7 J
2-Chloropyridine	2100	2100	7500	5 J	4 J	13
3-Chloropyridine	32	32	180	6 U	6 U	6 U
4-Chloropyridine	5 U	6 U	5 U	6 U	6 U	6 U
Pyridine	6	8	95	6 U	6 U	6 U
SUM	Maximum =	2200	8500	Maximum =	5	14

Location	**BR-2**	**BR-2D**	**BR-3**	**BR-3D**	**BR-3D**	**BR-4**
Type				**Duplicate**		
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**19 Jan 94**	**26 Jan 94**	**27 Jan 94**	**26 Jan 94**	**26 Jan 94**	**02 Feb 94**
2,6-Dichloropyridine	1600 D	3 J	22000 D	0.8 J	0.6 J	97 D
2-Chloropyridine	15000 D	49 U	280000 D	7	6	520 D
3-Chloropyridine	730 D	3 J	19000 D	6 U	6 U	6
4-Chloropyridine	5 U	6 U	6 U	6 U	6 U	6 U
Pyridine	1800 D	13	45000 D	6 U	6 U	3 J
SUM	19000	19	370000	Maximum =	8	630

Location	**BR-5**	**BR-5**	**BR-6**	**BR-7**	**BR-8**	**PZ-102**
Type	**Duplicate**					
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**19 Jan 94**	**19 Jan 94**	**25 Jan 94**	**19 Jan 94**	**24 Jan 94**	**03 Feb 94**
2,6-Dichloropyridine	58	65	5100 D	17000 D	710	4300 D
2-Chloropyridine	330 D	330 D	33000 D	140000 D	4500	50000 D
3-Chloropyridine	21	21	3800 D	940 D	120	1300 D
4-Chloropyridine	6 U	6 U	6 U	6 U	1 J	10
Pyridine	28	64	8000 D	400 D	77	1800 D
SUM	Maximum =	480	50000	160000	5400	57000

Location	**PZ-103**	**PZ-104**	**PZ-105**	**PZ-106**	**PZ-107**
Type					
Media	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**01 Feb 94**	**01 Feb 94**	**24 Jan 94**	**24 Jan 94**	**27 Jan 94**
2,6-Dichloropyridine	8400 D	1000 DJ	8600 D	14000 D	1600 D
2-Chloropyridine	15000 D	7800 D	150000 D	86000 D	7300 D
3-Chloropyridine	2100 D	220 D	7900 D	6400 D	890 D
4-Chloropyridine	5 U	0.3 J	6 U	40 D	6 U
Pyridine	800 D	38	20000 D	8100 D	1500 D
SUM	26000	9100	190000	110000	11000

Notes:

All concentrations reported in units of micrograms per liter.

D Dilution

J Estimated concentration where compound or element does not meet QC criteria.

U Not detected, value equals sample quantitation limit.

TABLE 4–7
SUMMARY OF SELECTED VOC CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	**B–1**	**B–11**	**B–14**	**B–15**	**B–16**	**B–17**
Type						
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**21 Jan 94**	**26 Jan 94**	**26 Jan 94**	**26 Jan 94**	**26 Jan 94**	**26 Jan 94**
1,1,1–Trichloroethane	2 U	8 U	2 U	20 U	8 U	20 U
1,1–Dichloroethene	2 U	10 U	2 U	25 U	5 J	25 U
1,2–Dichloroethene (total)	2 U	8 U	5	18 J	16	28
Carbon tetrachloride	2 U	8 U	2 U	20 U	8 U	14000 D
Chloroform	1 U	5 U	1 U	1100	1500 D	50000 D
Methylene chloride	1 U	5 U	1 U	200	2500 D	6300 D
Tetrachloroethene	0.6 J	8 U	2 U	120	340	1800
Trichloroethene	2 U	5 J	2 U	43	160	29
cis–1,2–Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
trans–1,2–Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
SUM	0.6	5	5	1500	4500	72000

Location	**B–2**	**B–3**	**B–4**	**B–5**	**B–6**	**B–7**
Type						
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**24 Jan 94**	**26 Jan 94**	**24 Jan 94**	**24 Jan 94**	**26 Jan 94**	**26 Jan 94**
1,1,1–Trichloroethane	2 U	2 U	2 U	5	2 U	2 U
1,1–Dichloroethene	2 U	2 U	2 U	2 U	2 U	2 U
1,2–Dichloroethene (total)	6	2 U	0.8 J	7	0.8 J	2
Carbon tetrachloride	2 U	2 U	2 U	2 U	2 U	2 U
Chloroform	1 U	1 U	1 U	4	1 U	1 U
Methylene chloride	1 U	1 U	1 U	140	1 U	1 U
Tetrachloroethene	2	2 U	2 U	3	2 U	2 U
Trichloroethene	4	2 U	2 U	2	1 J	2 U
cis–1,2–Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
trans–1,2–Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
SUM	12	ND	0.8	160	1.8	2

Location	**B–8**	**B–8**	**B–9**	**C–1**	**C–2A**	**C–3**
Type	**Duplicate**					
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**26 Jan 94**	**26 Jan 94**	**26 Jan 94**	**25 Jan 94**	**25 Jan 94**	**25 Jan 94**
1,1,1–Trichloroethane	4 U	4 U	2 U	2 U	2 U	2 U
1,1–Dichloroethene	5 U	5 U	2 U	2 U	2 U	2 U
1,2–Dichloroethene (total)	9	15	2 U	2 U	3	2 U
Carbon tetrachloride	1 J	4 U	2 U	2 U	2 U	2
Chloroform	3	3 U	1 U	1 U	1 U	2
Methylene chloride	2 U	2 U	3	1 U	1 U	1 U
Tetrachloroethene	4 U	4 U	2 U	2 U	2 U	6
Trichloroethene	4 U	4 U	2 U	2 U	3	2
cis–1,2–Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
trans–1,2–Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
SUM	Maximum=	19	3	ND	6	12

Location	**C–4**	**C–5**	**C–5**	**E–1**	**E–2**	**E–3**
Type		**Duplicate**				
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**25 Jan 94**	**25 Jan 94**	**25 Jan 94**	**27 Jan 49**	**24 Jan 94**	**25 Jan 94**
1,1,1–Trichloroethane	2 U	400 U	400 U	2 U	2 U	2 U
1,1–Dichloroethene	2 U	500 U	500 U	2 U	2 U	2 U
1,2–Dichloroethene (total)	19	400 U	400 U	3	2 U	6
Carbon tetrachloride	2 U	400 U	400 U	16	2 U	2 U
Chloroform	1 U	14000	16000	290	1 U	2
Methylene chloride	1 U	29000	35000	87	1 U	1 U
Tetrachloroethene	1 J	1600	2000	6	3	2 U
Trichloroethene	15	320 J	390 J	4	2	4
cis–1,2–Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
trans–1,2–Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
SUM	35	Maximum =	53000	410	5	12

TABLE 4-7
SUMMARY OF SELECTED VOC CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	E-4	EC-1	MW-103	MW-104	MW-106	MW-107
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	24 Jan 94	24 Jan 94	20 Jan 94	26 Jan 94	02 Feb 94	21 Jan 94
1,1,1-Trichloroethane	2 U	2 U	2 U	2 U	8 U	2 U
1,1-Dichloroethene	2 U	2 U	2 U	2 U	10 U	2 U
1,2-Dichloroethene (total)	2 U	2 U	2 U	2 U	31	2 U
Carbon tetrachloride	2 U	2 U	2 U	2 U	8 U	2 U
Chloroform	1 U	1 U	1 U	1 U	5 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	5 U	1 U
Tetrachloroethene	2 U	2 U	2 U	2 U	8 U	2 U
Trichloroethene	2 U	2 U	2 U	0.8 J	21	2 U
cis-1,2-Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
trans-1,2-Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
SUM	ND	ND	ND	0.8	52	ND

Location	MW-108	MW-2	MW-3	MW-G6	MW-G8	MW-G9
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	02 Feb 94	19 Jan 94	19 Jan 94	19 Jan 94	19 Jan 94	18 Jan 94
1,1,1-Trichloroethane	2 U	2 U	2 U	2 U	2 U	2 U
1,1-Dichloroethene	2 U	2 U	2 U	2 U	2 U	2 U
1,2-Dichloroethene (total)	2 U	2 U	2 U	2 U	16	2 U
Carbon tetrachloride	2 U	2 U	2 U	2 U	2 U	2 U
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	2 U	2 U	2 U	2 U	2 U	2 U
cis-1,2-Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
trans-1,2-Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
SUM	ND	ND	ND	ND	16	ND

Location	N-1	N-1	N-2	N-3	PZ-101	PZ-108
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	24 Jan 94	24 Jan 94	21 Jan 94	25 Jan 94	24 Jan 94	24 Jan 94
1,1,1-Trichloroethane	2 U	2 U	2 U	2 U	2 U	2 U
1,1-Dichloroethene	2 U	2 U	2 U	2 U	2 U	2 U
1,2-Dichloroethene (total)	2 U	2 U	2 U	2 U	2 U	2 U
Carbon tetrachloride	2 U	2 U	2 U	2 U	2 U	0.6 J
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	2 U	2 U	2 U	2 U	2 U	1 J
cis-1,2-Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
trans-1,2-Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
SUM	ND	ND	ND	ND	ND	1.6

Location	S-1	S-2	S-3	S-4	T-102	T-102
Type					Duplicate	
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	20 Jan 94	20 Jan 94	19 Jan 94	21 Jan 94	20 Oct 93	20 Oct 93
1,1,1-Trichloroethane	2 U	1 J	2 U	2 U	2 UJ	2 UJ
1,1-Dichloroethene	2 U	2 U	2 U	2 U	2 J	3 J
1,2-Dichloroethene (total)	0.8 J	3	0.6 J	2	39 J	39 J
Carbon tetrachloride	2 U	2 U	2 U	2 U	2 UJ	2 UJ
Chloroform	1	430 D	12	1 U	1 UJ	1 UJ
Methylene chloride	1 U	170	6	14	8 UJ	7 UJ
Tetrachloroethene	2 U	10	3	2 U	9 J	8 J
Trichloroethene	2 U	4	2	4	300	280
cis-1,2-Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
trans-1,2-Dichloroethene	N/A	N/A	N/A	N/A	N/A	N/A
SUM	1.8	620	24	20	Maximum =	350

TABLE 4-7
SUMMARY OF SELECTED VOC CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	T-101	T-103	T-104	T-105	T-105	T-106
Type				Duplicate		
Media	Water	Water	Water	Water	Water	Water
Lab	ONSITE	RECRA	ONSITE	ONSITE	ONSITE	ONSITE
Sample Date	20 Oct 93	21 Oct 93	22 Oct 93	26 Oct 93	26 Oct 93	01 Nov 93
1,1,1-Trichloroethane	1 U	2 U	1 U	2.7	2.6	10 U
1,1-Dichloroethene	1 UU	2 U	1 U	1 U	1 U	10 U
1,2-Dichloroethene (total)	N/A	2 U	N/A	N/A	N/A	N/A
Carbon tetrachloride	1 U	2 U	1 U	1 U	1 U	10 U
Chloroform	1 U	1 U	1 U	1 U	1 U	59
Methylene chloride	8.1	1 U	1 U	1 U	1 U	18000 E
Tetrachloroethene	45 E	2 U	1 U	1 U	1 U	10 U
Trichloroethene	36 E	2 U	1 U	1 U	1 U	120
cis-1,2-Dichloroethene	1 U	N/A	1 U	1 U	1 U	50
trans-1,2-Dichloroethene	1 U	N/A	1 U	1 U	1 U	10 U
SUM	89	ND	ND	Maximum =	2.7	18000

Location	T-107	T-108	T-109	T-110	T-111	T-112
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	ONSITE	ONSITE	ONSITE	ONSITE	RECRA
Sample Date	26 Oct 93	20 Oct 93	21 Oct 93	21 Oct 93	25 Oct 93	22 Oct 93
1,1,1-Trichloroethane	2 U	1 U	1.3	1 U	1 U	2 U
1,1-Dichloroethene	2 U	1 U	1 U	1.1	1 U	2 U
1,2-Dichloroethene (total)	2	N/A	N/A	N/A	N/A	2 U
Carbon tetrachloride	2 U	1 U	1 U	1 U	1 U	2 U
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	2 U	1 U	1 U	7.8	1 U	2 U
Trichloroethene	2 U	1 U	1 U	1.4	1 U	2 U
cis-1,2-Dichloroethene	N/A	1 U	1 U	1 U	1 U	N/A
trans-1,2-Dichloroethene	N/A	1 U	1 U	1 U	1 U	N/A
SUM	2	ND	1.3	10	ND	ND

Location	T-113	T-114	T-115	T-115	T-116	T-117
Type			Duplicate			
Media	Water	Water	Water	Water	Water	Water
Lab	ONSITE	ONSITE	RECRA	RECRA	ONSITE	ONSITE
Sample Date	25 Oct 93	22 Oct 93	26 Oct 93	26 Oct 93	26 Oct 93	27 Oct 93
1,1,1-Trichloroethane	1 U	1 U	2 U	2 U	1 U	1 U
1,1-Dichloroethene	1 U	1 U	2 U	2 U	1 U	1 U
1,2-Dichloroethene (total)	N/A	N/A	2 U	2 U	N/A	N/A
Carbon tetrachloride	1 U	1 U	2 U	2 U	1 U	1 U
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	2 U	2 U	1 U	1 U
Trichloroethene	1 U	1 U	2 U	2 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	N/A	N/A	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U	N/A	N/A	1 U	1 U
SUM	ND	ND		ND	ND	ND

Location	T-118	T-119	T-120	T-121	T-121	T-122
Type				Duplicate		
Media	Water	Water	Water	Water	Water	Water
Lab	ONSITE	ONSITE	ONSITE	RECRA	RECRA	RECRA
Sample Date	27 Oct 93	01 Nov 93	10 Nov 93	12 Nov 93	12 Nov 93	03 Nov 93
1,1,1-Trichloroethane	1 U	1 U	1 U	2 U	2 U	2 U
1,1-Dichloroethene	1 U	1 U	1 U	2 U	2 U	1 J
1,2-Dichloroethene (total)	N/A	N/A	N/A	2 U	2 U	2 U
Carbon tetrachloride	1 U	1 U	1 U	2 U	2 U	2 U
Chloroform	1 U	1 U	1 U	1 U	1 U	20
Methylene chloride	1 U	5000 S	1 U	27	26	5 U
Tetrachloroethene	1 U	3.8	1 U	2 U	2 U	0.9 J
Trichloroethene	1 U	15	12	2 U	2 U	4
cis-1,2-Dichloroethene	1 U	6.7	13	N/A	N/A	N/A
trans-1,2-Dichloroethene	1 U	11	1 U	N/A	N/A	N/A
SUM	ND	5000	25	Maximum =	27	25

TABLE 4-7
SUMMARY OF SELECTED VOC CONCENTRATIONS
IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location **Type** **Media** **Lab** **Sample Date**	**T-125** **Water** **ONSITE** **27 Oct 93**	**T-126** **Water** **RECRA** **27 Oct 93**	**T-127** **Water** **ONSITE** **27 Oct 93**	**T-129** **Duplicate** **Water** **RECRA** **03 Nov 93**	**T-129** **Water** **RECRA** **03 Nov 93**	**T-130** **Water** **ONSITE** **08 Nov 93**
1,1,1-Trichloroethane	1 U	2 U	1 U	2 U	2 U	5 U
1,1-Dichloroethene	1 U	2 U	1 U	2 U	2 U	140
1,2-Dichloroethene (total)	N/A	2 U	N/A	1 J	1 J	N/A
Carbon tetrachloride	1 U	2 U	1 U	2 U	2 U	5 U
Chloroform	1.9	1 U	1 U	1 U	1 U	35
Methylene chloride	1 U	1 U	1 U	1 U	1 U	66
Tetrachloroethene	1 U	2 U	1 U	2 U	2 U	5 U
Trichloroethene	1 U	0.7 J	1 U	0.5 J	2 U	6.2
cis-1,2-Dichloroethene	1 U	N/A	1 U	N/A	N/A	5 U
trans-1,2-Dichloroethene	1 U	N/A	1 U	N/A	N/A	5 U
SUM	1.9	0.7	ND	Maximum = 1.5		250

Location **Type** **Media** **Lab** **Sample Date**	**T-131** **Water** **ONSITE** **12 Nov 93**	**T-132** **Duplicate** **Water** **ONSITE** **15 Nov 93**	**T-132** **Water** **ONSITE** **15 Nov 93**	**T-133** **Water** **ONSITE** **15 Nov 93**	**T-134** **Water** **RECRA** **05 Nov 93**	**T-136** **Water** **ONSITE** **04 Nov 93**
1,1,1-Trichloroethane	10 U	200 U	1 U	10 U	230 U	250 US
1,1-Dichloroethene	180	200 U	2.1	10 U	250 U	250 US
1,2-Dichloroethene (total)	N/A	N/A	N/A	N/A	200 U	N/A
Carbon tetrachloride	10 U	200 U	1 U	570	17000	250 US
Chloroform	11	9100	8600	1200	14000	3800 S
Methylene chloride	3200 E	200 U	55	44	2100	4800 S
Tetrachloroethene	10 U	200 U	1 U	160	300	250 US
Trichloroethene	10 U	200 U	6	18	120 U	250 US
cis-1,2-Dichloroethene	10 U	200 U	1 U	17	N/A	250 US
trans-1,2-Dichloroethene	10 U	200 U	1 U	10 U	N/A	250 US
SUM	3400	Maximum = 9200		2000	33000	8600

Location **Type** **Media** **Lab** **Sample Date**	**T-136** **Water** **ONSITE** **08 Nov 93**	**T-137** **Water** **ONSITE** **09 Nov 93**	**T-138** **Duplicate** **Water** **RECRA** **08 Nov 93**	**T-138** **Water** **RECRA** **08 Nov 93**	**T-139** **Water** **ONSITE** **11 Nov 93**	**T-140** **Water** **ONSITE** **09 Nov 93**
1,1,1-Trichloroethane	500 U	1 U	4 U	4 U	1 U	1 U
1,1-Dichloroethene	500 U	1 U	5 U	5 U	1 U	1 U
1,2-Dichloroethene (total)	N/A	N/A	4 U	4 U	N/A	N/A
Carbon tetrachloride	730	1 U	4 U	4 U	1 U	1 U
Chloroform	500 U	1 U	3 U	3 U	1 U	1 U
Methylene chloride	890	1 U	12	14	1 U	1 U
Tetrachloroethene	500 U	1 UJ	4 U	4 U	1 U	1 U
Trichloroethene	500 U	1 U	2 J	2 J	1	1 U
cis-1,2-Dichloroethene	500 U	1 U	N/A	N/A	1 U	1 U
trans-1,2-Dichloroethene	500 U	1 U	N/A	N/A	1 U	1 U
SUM	730	ND	Maximum = 16		1	ND

Location **Type** **Media** **Lab** **Sample Date**	**T-141** **Water** **ONSITE** **09 Nov 93**	**T-142** **Duplicate** **Water** **RECRA** **16 Nov 93**	**T-142** **Water** **RECRA** **16 Nov 93**	**T-143** **Water** **RECRA** **17 Nov 93**	**T-144** **Water** **RECRA** **16 Nov 93**	**T-145** **Duplicate** **Water** **RECRA** **30 Nov 93**
1,1,1-Trichloroethane	1 U	2 U	2 U	2 U	2 U	2 U
1,1-Dichloroethene	1 U	2 U	2 U	2 U	2 U	2 U
1,2-Dichloroethene (total)	N/A	2 U	0.6 J	2 U	2 U	2 U
Carbon tetrachloride	1 U	2 U	2 U	2 U	2 U	2 U
Chloroform	74 E	1 U	1 U	1 U	1 U	1 U
Methylene chloride	26	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	2.6	2 U	0.7 J	2 U	2 U	2 U
Trichloroethene	1 U	0.6 J	1 J	2 U	1 U	2 U
cis-1,2-Dichloroethene	1 U	N/A	N/A	N/A	N/A	N/A
trans-1,2-Dichloroethene	1 U	N/A	N/A	N/A	N/A	N/A
SUM	100	Maximum = 2.3		ND	ND	ND

TABLE 4-7
SUMMARY OF SELECTED VOC CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	**T-145**	**T-147**	**T-148**	**T-149**	**T-150**	**T-151**
Type						
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**ONSITE**	**RECRA**	**RECRA**
Sample Date	**30 Nov 93**	**30 Nov 93**	**16 Nov 93**	**16 Nov 93**	**29 Nov 93**	**18 Nov 93**
1,1,1-Trichloroethane	2 U	2 U	2 U	1 U	2 U	22 U
1,1-Dichloroethene	2 U	2 U	1 J	1 U	2 U	25 U
1,2-Dichloroethene (total)	2 U	5	1 J	N/A	2 U	12 J
Carbon tetrachloride	2 U	2 U	490 D	1.8	2 U	18 U
Chloroform	1 U	1 U	2700 D	2	1 U	7100 D
Methylene chloride	1 U	1 U	150	1 U	1 U	550
Tetrachloroethene	2 U	2 U	9	1 U	2 U	120
Trichloroethene	0.6 J	82	2 U	1 U	2 U	11 J
cis-1,2-Dichloroethene	N/A	N/A	N/A	1 U	N/A	N/A
trans-1,2-Dichloroethene	N/A	N/A	N/A	1 U	N/A	N/A
SUM	0.6	87	3400	3.8	ND	13000

Location	**T-152**	**T-153**	**T-154**	**T-155**	**T-157**	**T-158**
Type						
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**ONSITE**	**ONSITE**	**RECRA**	**RECRA**	**RECRA**	**ONSITE**
Sample Date	**19 Nov 93**	**18 Nov 93**	**19 Nov 93**	**18 Nov 93**	**02 Dec 93**	**30 Nov 93**
1,1,1-Trichloroethane	100 U	10 U	2 U	2 U	2 UJ	1000 U
1,1-Dichloroethene	100 U	240	2 U	2 U	2 UJ	1000 U
1,2-Dichloroethene (total)	N/A	N/A	3	2 U	2 UJ	N/A
Carbon tetrachloride	100 U	10 U	2 U	2 U	2 UJ	230000EJ
Chloroform	990	320	1 J	2	1 UJ	52000ES
Methylene chloride	200	480 E	1 U	1 U	1 UJ	1000 U
Tetrachloroethene	470	92	2 U	2 U	2 UJ	1400 S
Trichloroethene	100 U	12	0.6 J	2 U	2 UJ	1900 S
cis-1,2-Dichloroethene	420	10 U	N/A	N/A	N/A	1000 U
trans-1,2-Dichloroethene	100 U	10 U	N/A	N/A	N/A	1000 U
SUM	2100	1100	4.6		ND	290000

Location	**T-159**	**T-159**	**T-160**	**T-161**	**W-1**	**W-1**
Type	**Duplicate**				**Duplicate**	
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**ONSITE**	**ONSITE**	**RECRA**	**RECRA**
Sample Date	**01 Dec 93**	**01 Dec 93**	**01 Dec 93**	**02 Dec 93**	**18 Jan 94**	**18 Jan 94**
1,1,1-Trichloroethane	2 UJ	2 UJ	1 U	1 U	2 U	2 U
1,1-Dichloroethene	2 UJ	2 J	1 U	1 U	2 U	2 U
1,2-Dichloroethene (total)	7 J	19 J	N/A	N/A	2 U	2 U
Carbon tetrachloride	16 J	2 UJ	1 U	1 U	0.6 J	2 U
Chloroform	240 J	680 J	1 U	11	7	4
Methylene chloride	2 J	17 J	1 U	1500 E	1 U	1 U
Tetrachloroethene	35 J	120 J	3.7	4.5	1 J	2 U
Trichloroethene	11 J	30 J	5.7	19	0.8 J	2 U
cis-1,2-Dichloroethene	N/A	N/A	1 U	16	N/A	N/A
trans-1,2-Dichloroethene	N/A	N/A	1 U	5.5	N/A	N/A
SUM	Maximum=	870	9.4	1600	Maximum =	9.4

Location	**W-2**	**W-3**	**W-4**	**W-5**	
Type					
Media	**Water**	**Water**	**Water**	**Water**	
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	
Sample Date	**20 Jan 94**	**18 Jan 94**	**20 Jan 94**	**20 Jan 94**	
1,1,1-Trichloroethane	2 U	2 U	2 U	2 U	
1,1-Dichloroethene	2 U	2 U	2 U	2 U	
1,2-Dichloroethene (total)	2 U	0.5 J	4	7	
Carbon tetrachloride	2 U	2 U	2 U	2 U	
Chloroform	3	1 U	1 U	16	
Methylene chloride	1 U	1 U	1 U	1 U	
Tetrachloroethene	2 U	2 U	2 U	0.8 J	
Trichloroethene	2 U	2 U	2 U	8	
cis-1,2-Dichloroethene	N/A	N/A	N/A	N/A	
trans-1,2-Dichloroethene	N/A	N/A	N/A	N/A	
SUM	3	0.5	4	32	

Notes:

D Dilution
E Estimated concentration that is above the highest calibration standard.
J Estimated concentration where compound or element does not meet QC criteria.
S Associated surrogate recovery does not meet QC criteria.
U Not detected, value equals sample quantitation limit.
N/A Not Analyzed
All concentrations reported in units of micrograms per liter.

TABLE 4-8
SUMMARY OF "CHLORINATED ETHENES" CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	B-1	B-11	B-14	B-15	B-16	B-17
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	21 Jan 94	26 Jan 94	26 Jan 94	26 Jan 94	26 Jan 94	26 Jan 94
1,2-Dichloroethene (total)	2 U	8 U	5	18 J	16	28
Tetrachloroethene	0.6 J	8 U	2 U	120	340	1800
Trichloroethene	2 U	5 J	2 U	43	160	29
Vinyl chloride	1 U	5 U	1 U	12 U	9	12 U
SUM	0.6	5	5	180	530	1900

Location	B-2	B-3	B-4	B-5	B-6	B-7
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	24 Jan 94	26 Jan 94	24 Jan 94	24 Jan 94	26 Jan 94	26 Jan 94
1,2-Dichloroethene (total)	6	2 U	0.8 J	7	0.8 J	2
Tetrachloroethene	2	2 U	2 U	3	2 U	2 U
Trichloroethene	4	2 U	2 U	2	1 J	2 U
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U
SUM	12	ND	0.8	12	1.8	2

Location	B-8	B-8	B-9	C-1	C-2A	C-3
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	26 Jan 94	26 Jan 94	26 Jan 94	25 Jan 94	25 Jan 94	25 Jan 94
1,2-Dichloroethene (total)	9	15	2 U	2 U	3	2 U
Tetrachloroethene	4 U	4 U	2 U	2 U	2 U	6
Trichloroethene	4 U	4 U	2 U	2 U	3	2
Vinyl chloride	2 U	2 U	1 U	1 U	1 U	1 U
SUM	Maximum = 15		ND	ND	6	8

Location	C-4	C-5	C-5	E-1	E-2	E-3
Type		Duplicate				
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	25 Jan 94	25 Jan 94	25 Jan 94	27 Jan 49	24 Jan 94	25 Jan 94
1,2-Dichloroethene (total)	19	400 U	400 U	3	2 U	6
Tetrachloroethene	1 J	1600	2000	6	3	2 U
Trichloroethene	15	320 J	390 J	4	2	4
Vinyl chloride	7	240 U	240 U	1 U	1 U	1 U
SUM	42	Maximum = 2400		13	5	10

Location	E-4	EC-1	MW-103	MW-104	MW-106	MW-107
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	24 Jan 94	24 Jan 94	20 Jan 94	26 Jan 94	02 Feb 94	21 Jan 94
1,2-Dichloroethene (total)	2 U	2 U	2 U	2 U	31	2 U
Tetrachloroethene	2 U	2 U	2 U	2 U	8 U	2 U
Trichloroethene	2 U	2 U	2 U	0.8 J	21	2 U
Vinyl chloride	1 U	1 U	1 U	1 U	10	1 U
SUM	ND	ND	ND	0.8	72	ND

TABLE 4-8
SUMMARY OF "CHLORINATED ETHENES" CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	MW-108	MW-2	MW-3	MW-G6	MW-G8	MW-G9
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	02 Feb 94	19 Jan 94	19 Jan 94	19 Jan 94	19 Jan 94	18 Jan 94
1,2-Dichloroethene (total)	2 U	2 U	2 U	2 U	16	2 U
Tetrachloroethene	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	2 U	2 U	2 U	2 U	2 U	2 U
Vinyl chloride	1 U	1 U	1 U	1 U	18	1 U
	ND	ND	ND	ND	34	ND

Location	N-1	N-1	N-2	N-3	PZ-101	PZ-108
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	24 Jan 94	24 Jan 94	21 Jan 94	25 Jan 94	24 Jan 94	24 Jan 94
1,2-Dichloroethene (total)	2 U	2 U	2 U	2 U	2 U	2 U
Tetrachloroethene	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	2 U	2 U	2 U	2 U	2 U	1 J
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U
SUM	ND	ND	ND	ND	ND	1

Location	S-1	S-2	S-3	S-4	T-102	T-102
Type					Duplicate	
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	20 Jan 94	20 Jan 94	19 Jan 94	21 Jan 94	20 Oct 93	20 Oct 93
1,2-Dichloroethene (total)	0.8 J	3	0.6 J	2	39 J	39 J
Tetrachloroethene	2 U	10	3	2 U	9 J	8 J
Trichloroethene	2 U	4	2	4	300	280
Vinyl chloride	1 U	1 U	1 U	1 U	12 J	13 J
SUM	0.8	17	5.6	6	Maximum =	360

Location	T-103	T-107	T-112	T-115	T-115	T-122
Type				Duplicate		
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	21 Oct 93	26 Oct 93	22 Oct 93	26 Oct 93	26 Oct 93	03 Nov 93
1,2-Dichloroethene (total)	2 U	2	2 U	2 U	2 U	2 U
Tetrachloroethene	2 U	2 U	2 U	2 U	2 U	0.9 J
Trichloroethene	2 U	2 U	2 U	2 U	2 U	4
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U
SUM	ND	2	ND		ND	4.9

Location	T-121	T-121	T-126	T-129	T-129	T-134
Type	Duplicate			Duplicate		
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	12 Nov 93	12 Nov 93	27 Oct 93	03 Nov 93	03 Nov 93	05 Nov 93
1,2-Dichloroethene (total)	2 U	2 U	2 U	1 J	1 J	200 U
Tetrachloroethene	2 U	2 U	2 U	2 U	2 U	300
Trichloroethene	2 U	2 U	0.7 J	0.5 J	2 U	120 U
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	120 U
SUM	ND	ND	0.7	Maximum	= 1.5	300

TABLE 4-8
SUMMARY OF "CHLORINATED ETHENES" CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	T-138	T-138	T-142	T-142	T-143	T-144
Type	Duplicate		Duplicate			
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	08 Nov 93	08 Nov 93	16 Nov 93	16 Nov 93	17 Nov 93	16 Nov 93
1,2-Dichloroethene (total)	4 U	4 U	2 U	0.6 J	2 U	2 U
Tetrachloroethene	4 U	4 U	2 U	0.7 J	2 U	2 U
Trichloroethene	2 J	2 J	0.6 J	1 J	2 U	1 U
Vinyl chloride	2 U	2 U	1 U	1 U	1 U	1 U
SUM	Maximum = 2		Maximum = 2.3		ND	ND

Location	T-145	T-145	T-147	T-148	T-150	T-151
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	30 Nov 93	30 Nov 93	30 Nov 93	16 Nov 93	29 Nov 93	18 Nov 93
1,2-Dichloroethene (total)	2 U	2 U	5	1 J	2 U	12 J
Tetrachloroethene	2 U	2 U	2 U	9	2 U	120
Trichloroethene	2 U	0.6 J	82	2 U	2 U	11 J
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	12 U
SUM	Maximum = 0.6		87	10	ND	140

Location	T-154	T-155	T-157	T-159	T-159
Type				Duplicate	
Media	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	19 Nov 93	18 Nov 93	02 Dec 93	01 Dec 93	01 Dec 93
1,2-Dichloroethene (total)	3	2 U	2 UJ	7 J	19 J
Tetrachloroethene	2 U	2 U	2 UJ	35 J	120 J
Trichloroethene	0.6 J	2 U	2 UJ	11 J	30 J
Vinyl chloride	1 U	1 U	1 UJ	2 J	7 J
SUM	3.6	ND	ND	Maximum = 180	

Location	W-1	W-1	W-2	W-3	W-4	W-5
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	18 Jan 94	18 Jan 94	20 Jan 94	18 Jan 94	20 Jan 94	20 Jan 94
1,2-Dichloroethene (total)	2 U	2 U	2 U	0.5 J	4	7
Tetrachloroethene	1 J	2 U	2 U	2 U	2 U	0.8 J
Trichloroethene	0.8 J	2 U	2 U	2 U	2 U	8
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	12
SUM	Maximum = 1.8		ND	0.5	4	28

Notes:

All concentrations reported in units of micrograms per liter.
J Estimated concentration where compound or element does not meet QC criteria.
U Not detected, value equals sample quantitation limit.

TABLE 4-9
SUMMARY OF BTEX CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	B-1	B-11	B-14	B-15	B-16	B-17
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	21 Jan 94	26 Jan 94	26 Jan 94	26 Jan 94	26 Jan 94	26 Jan 94
Benzene	0.8 U	4	11	11	20	33
Ethylbenzene	0.9 U	6 U	0.9 U	9 U	3 U	9 U
Toluene	0.8 J	8	0.7 J	100	610	340
Total Xylenes	2 U	9 U	2 U	7 J	7 J	25
SUM	0.8	12	12	120	640	400

Location	B-2	B-3	B-4	B-5	B-6	B-7
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	24 Jan 94	26 Jan 94	24 Jan 94	24 Jan 94	26 Jan 94	26 Jan 94
Parameter						
Benzene	11	0.8 U	3	62	55	5
Ethylbenzene	0.9 U	0.9 U	0.9 U	3	4	0.9 U
Toluene	1 U	1 U	1 U	4600	42	0.5 J
Total Xylenes	2 U	2 U	2 U	3	1 J	2 U
SUM	11	ND	3	4700	100	5.5

Location	B-8	B-8	B-9	C-1	C-2A	C-3
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	26 Jan 94	26 Jan 94	26 Jan 94	25 Jan 94	25 Jan 94	25 Jan 94
Benzene	22	30	0.8 U	0.8 U	0.7 J	1
Ethylbenzene	2 U	2 U	0.9 U	0.9 U	0.9 U	1
Toluene	3	3	1 U	1 U	3	100
Total Xylenes	2 J	2 J	2 U	2 U	2 U	2
SUM	Maximum =	35	ND	ND	3.7	100

Location	C-4	C-5	C-5	E-1	E-2	E-3
Type		Duplicate				
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	25 Jan 94	25 Jan 94	25 Jan 94	27 Jan 49	24 Jan 94	25 Jan 94
Benzene	13	160 U	160 U	2	0.8 U	34
Ethylbenzene	51	170 U	170 U	2	0.9 U	0.9 U
Toluene	160	850	1000	13	0.6 BJ	1
Total Xylenes	15	100 J	120 J	8	2 U	2 U
SUM	240	Maximum =	1100	25	0.6	35

Location	E-4	EC-1	MW-103	MW-104	MW-106	MW-107
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	24 Jan 94	24 Jan 94	20 Jan 94	26 Jan 94	02 Feb 94	21 Jan 94
Benzene	0.8 U	0.8 U	0.8 U	0.8 U	210	0.8 U
Ethylbenzene	0.9 U	0.9 U	0.9 J	0.9 U	3 U	0.9 U
Toluene	1 U	1 U	1 U	1 U	500	1 U
Total Xylenes	2 U	2 U	2 U	2 U	6 J	2 U
SUM	ND	ND	0.9	ND	720	ND

TABLE 4-9
SUMMARY OF BTEX CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	MW-108	MW-2	MW-3	MW-G6	MW-G8	MW-G9
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	02 Feb 94	19 Jan 94	19 Jan 94	19 Jan 94	19 Jan 94	18 Jan 94
Benzene	0.8 U	0.8 U	0.8 U	150	0.8 U	4
Ethylbenzene	0.9 U	0.9 U	0.9 U	5	0.9 U	8
Toluene	1 U	1 U	1 U	2	1 U	4
Total Xylenes	2 U	2 U	2 U	10	2 U	54
SUM	ND	ND	ND	170	ND	70

Location	N-1	N-1	N-2	N-3	PZ-101	PZ-108
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	24 Jan 94	24 Jan 94	21 Jan 94	25 Jan 94	24 Jan 94	24 Jan 94
Benzene	0.8 U	0.8 U	0.8 U	0.8 U	120	0.8 U
Ethylbenzene	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U
Toluene	1 U	1 U	1 U	1 U	7	3
Total Xylenes	2 U	2 U	2 U	2 U	2 U	2 U
SUM		ND	ND	ND	130	3

Location	S-1	S-2	S-3	S-4	T-102	T-102
Type					Duplicate	
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	20 Jan 94	20 Jan 94	19 Jan 94	21 Jan 94	20 Oct 93	20 Oct 93
Benzene	2	1	0.8 U	1	51 J	51 J
Ethylbenzene	0.9 U	0.9 U	0.9 U	0.9 U	0.9 UJ	0.9 UJ
Toluene	1 U	22	6	4	260	250
Total Xylenes	2 U	1 J	0.4 J	2 U	2 UJ	2 UJ
SUM	2	24	6.4	5.9	Maximum =	310

Location	T-103	T-107	T-112	T-115	T-115	T-122
Type				Duplicate		
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	21 Oct 93	26 Oct 93	22 Oct 93	26 Oct 93	26 Oct 93	03 Nov 93
Benzene	3	35	0.8 U	0.8 U	0.8 U	3
Ethylbenzene	0.9 U	4	0.9 U	0.9 U	0.9 U	0.9 U
Toluene	0.4 J	5	0.3 J	0.4 J	1 U	4
Total Xylenes	2 U	63	2 U	2 U	2 U	62
SUM	5.4	110	0.3	Maximum =	0.4	69

Location	T-121	T-121	T-126	T-129	T-129	T-134
Type	Duplicate			Duplicate		
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	12 Nov 93	12 Nov 93	27 Oct 93	03 Nov 93	03 Nov 93	05 Nov 93
Benzene	1	1	0.8 U	0.8 U	0.8 U	84 U
Ethylbenzene	0.9 J	0.7 J	0.9 U	0.9 U	0.9 U	87 U
Toluene	0.8 J	0.8 J	1 U	0.5 J	0.5 J	43 J
Total Xylenes	5	7	2 J	5	5	230 U
SUM	Maximum =	9.5	2	Maximum =	5.5	43

TABLE 4-9
SUMMARY OF BTEX CONCENTRATIONS IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	T-138	T-138	T-142	T-142	T-143	T-144
Type	Duplicate		Duplicate			
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	08 Nov 93	08 Nov 93	16 Nov 93	16 Nov 93	17 Nov 93	16 Nov 93
Benzene	20	19	9	13	0.8 U	0.8 U
Ethylbenzene	2	2	0.4 J	0.9	1	0.9 U
Toluene	15	14	2	2	0.5 J	1 U
Total Xylenes	16	19	8	13	21	2 U
SUM	Maximum = 56		Maximum = 29		23	ND

Location	T-145	T-145	T-147	T-148	T-150	T-151
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	30 Nov 93	30 Nov 93	30 Nov 93	16 Nov 93	29 Nov 93	18 Nov 93
Benzene	0.8 U	0.8 U	0.8 U	5	0.8 U	8 J
Ethylbenzene	0.9 U	0.9 U	1	0.9 U	0.9 U	5 J
Toluene	1 U	1 U	0.3 J	1	1 U	67
Total Xylenes	2 U	2 U	9	3	2 U	14 J
SUM	Maximum = ND		10	9	ND	94

Location	T-154	T-155	T-157	T-159	T-159
Type				Duplicate	
Media	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	19 Nov 93	18 Nov 93	02 Dec 93	01 Dec 93	01 Dec 93
Benzene	2	0.7 J	5 J	0.9 J	2 J
Ethylbenzene	0.5 J	3	0.9 UJ	1 J	4 J
Toluene	0.3 J	0.8 J	1 UJ	2 J	4 J
Total Xylenes	10	51	4 J	22 J	68 J
SUM	13	56	9	Maximum = 78	

Location	W-1	W-1	W-2	W-3	W-4	W-5
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	18 Jan 94	18 Jan 94	20 Jan 94	18 Jan 94	20 Jan 94	20 Jan 94
Benzene	4	2	2	3	8	44
Ethylbenzene	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U
Toluene	1 U	1 U	1 U	0.4 J	1 U	860 D
Total Xylenes	2 U	2 U	2 U	0.4 J	2 U	34
SUM	Maximum = 4		2	3.8	8	940

Notes:

All concentrations reported in units of micrograms per liter.
B Target compound or element is detected in an associated method blank.
D Dilution
J Estimated concentration where compound or element does not meet QC criteria.
U Not detected, value equals sample quantitation limit.

TABLE 4-10
SUMMARY OF "SELECTED VOC" CONCENTRATIONS IN BEDROCK GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	BR-1	BR-101	BR-102	BR-103	BR-104	BR-105
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	20 Jan 94	01 Feb 94	27 Jan 94	20 Jan 94	26 Jan 94	27 Jan 94
1,1,1-Trichloroethane	2 U	40 U	20 U	2 U	2 U	2 U
1,1-Dichloroethene	2 U	50 U	25 U	2 U	2 U	2 U
1,2-Dichloroethene (total)	2 U	40 U	20 U	20	2 U	2
Carbon tetrachloride	2 U	40 U	180	2 U	2 U	2 U
Chloroform	1 U	13000	720	1 U	8 U	1 U
Methylene chloride	1 U	30000	1800	1 U	6	2
Tetrachloroethene	2 U	40 U	24	2 U	1 J	2 U
Trichloroethene	2 U	40 U	20 U	1 J	2	3
SUM	ND	43000	2700	21	9	7

Location	BR-105D	BR-105D	BR-106	BR-107	BR-107	BR-108
Type	Duplicate			Duplicate		
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	04 Feb 94	04 Feb 94	02 Feb 94	21 Jan 94	21 Jan 94	02 Feb 94
1,1,1-Trichloroethane	2 U	2 U	8 U	2 U	2 U	2 U
1,1-Dichloroethene	2 U	2 U	10 U	2 U	2 U	2 U
1,2-Dichloroethene (total)	58 J	70	580	110	110	2 U
Carbon tetrachloride	1 J	1 J	8 U	2 U	2 U	2 U
Chloroform	3 J	3 U	8 U	1 U	1 U	1 U
Methylene chloride	3 J	3	330	1 U	1 U	1 U
Tetrachloroethene	2 U	2 U	8 U	2 U	2 U	2 U
Trichloroethene	2 U	2 U	14	2 U	2 U	2 U
SUM	Maximum	= 74	920	Maximum	= 110	ND

Location	BR-2	BR-2D	BR-3	BR-3D	BR-3D	BR-4
Type				Duplicate		
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	19 Jan 94	26 Jan 94	27 Jan 94	26 Jan 94	26 Jan 94	02 Feb 94
1,1,1-Trichloroethane	20 U	2 U	800 U	2 U	2 U	2 U
1,1-Dichloroethene	25 U	2 U	1000 U	2 U	2 U	2 U
1,2-Dichloroethene (total)	97	2 U	800 U	1 J	1 J	1 J
Carbon tetrachloride	25000 D	2 U	72000	2 U	2 U	2 U
Chloroform	26000 D	1 U	53000	4	5	4
Methylene chloride	17000 D	380 D	78000	1 U	1 U	140
Tetrachloroethene	410	0.7 J	1800	2 U	2 U	2 U
Trichloroethene	27	2 U	750 J	2 U	2 U	2 U
SUM	69000	380	210000	Maximum	= 6	140

Location	BR-5	BR-5	BR-6	BR-7	BR-8	PZ-102
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	19 Jan 94	19 Jan 94	25 Jan 94	19 Jan 94	24 Jan 94	03 Feb 94
1,1,1-Trichloroethane	20 U	20 U	20 U	5 U	2 U	200 U
1,1-Dichloroethene	25 U	25 U	25 U	6 U	2 U	250 U
1,2-Dichloroethene (total)	85	87	20 U	4 J	6	200 U
Carbon tetrachloride	20 U	20 U	1800	5 U	2 U	200 U
Chloroform	10000 D	10000 D	7100 D	22	1 U	130 U
Methylene chloride	1400	1400	4600 D	58	94	10000
Tetrachloroethene	20 U	20 U	100	5 U	2	200 U
Trichloroethene	110	120	26	5 U	2	200 U
SUM	Maximum	= 12000	13000	84	100	10000

Location	PZ-103	PZ-104	PZ-105	PZ-106	PZ-107
Type					
Media	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	01 Feb 94	01 Feb 94	24 Jan 94	24 Jan 94	27 Jan 94
Parameter					
1,1,1-Trichloroethane	40 U	2 U	80 U	200 U	20 U
1,1-Dichloroethene	50 U	2 U	100 U	250 U	25 U
1,2-Dichloroethene (total)	10 J	4	62 J	200 U	20
Carbon tetrachloride	40 U	2 U	80 U	620000 D	7200 D
Chloroform	92	35	3400	320000 D	3500 D
Methylene chloride	4700 D	1 U	5600	22000 D	700
Tetrachloroethene	16 J	1 J	320	2100	200
Trichloroethene	69	4	370	200 U	70
SUM	4900	44	9800	960000	12000

Notes:

All concentrations reported in units of micrograms per liter.
D Dilution
J Estimated concentration where compound or element does not meet QC criteria.
U Not detected, value equals sample quantitation limit.

TABLE 4-11
SUMMARY OF "CHLORINATED ETHENES" CONCENTRATIONS IN BEDROCK GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	BR-1	BR-101	BR-102	BR-103	BR-104	BR-105
Type						
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	20 Jan 94	01 Feb 94	27 Jan 94	20 Jan 94	26 Jan 94	27 Jan 94
1,2-Dichloroethene (total)	2 U	40 U	20 U	20	2 U	2
Tetrachloroethene	2 U	40 U	24	2 U	1 J	2 U
Trichloroethene	2 U	40 U	20 U	1 J	2	3
Vinyl chloride	1 U	24 U	26	5	1 U	3
SUM	ND	ND	50	26	3	8
Location	BR-105D	BR-105D	BR-106	BR-107	BR-107	BR-108
Type	Duplicate			Duplicate		
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	04 Feb 94	04 Feb 94	02 Feb 94	21 Jan 94	21 Jan 94	02 Feb 94
1,2-Dichloroethene (total)	58 J	70	580	110	110	2 U
Tetrachloroethene	2 U	2 U	8 U	2 U	2 U	2 U
Trichloroethene	2 U	2 U	14	2 U	2 U	2 U
Vinyl chloride	17 J	6 J	230	100	96	1 U
SUM	Maximum = 76		820	Maximum = 200		ND
Location	BR-2	BR-2D	BR-3	BR-3D	BR-3D	BR-4
Type				Duplicate		
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	19 Jan 94	26 Jan 94	27 Jan 94	26 Jan 94	26 Jan 94	02 Feb 94
1,2-Dichloroethene (total)	97	2 U	800 U	1 J	1 J	1 J
Tetrachloroethene	410	0.7 J	1800	2 U	2 U	2 U
Trichloroethene	27	2 U	750 J	2 U	2 U	2 U
Vinyl chloride	28	1 U	480 U	1 U	1 U	5
SUM	560	0.7	2600	Maximum = 1		6
Location	BR-5	BR-5	BR-6	BR-7	BR-8	PZ-102
Type	Duplicate					
Media	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	19 Jan 94	19 Jan 94	25 Jan 94	19 Jan 94	24 Jan 94	03 Feb 94
1,2-Dichloroethene (total)	85	87	20 U	4 J	6	200 U
Tetrachloroethene	20 U	20 U	100	5 U	2	200 U
Trichloroethene	110	120	26	5 U	2	200 U
Vinyl chloride	12 U	12 U	12 U	3 U	1 U	120 U
SUM	Maximum = 210		130	4	10	ND
Location	PZ-103	PZ-104	PZ-105	PZ-106	PZ-107	
Type						
Media	Water	Water	Water	Water	Water	
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	
Sample Date	01 Feb 94	01 Feb 94	24 Jan 94	24 Jan 94	27 Jan 94	
1,2-Dichloroethene (total)	10 J	4	62 J	200 U	20	
Tetrachloroethene	16 J	1 J	320	2100	200	
Trichloroethene	69	4	370	200 U	70	
Vinyl chloride	37	2	85	120 U	12 U	
SUM	130	11	840	2100	290	

Notes:

All concentrations reported in units of micrograms per liter.
J Estimated concentration where compound or element does not meet QC criteria.
U Not detected, value equals sample quantitation limit.

TABLE 4-12
SUMMARY OR "BTEX" CONCENTRATIONS IN BEDROCK GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location	**BR-1**	**BR-101**	**BR-102**	**BR-103**	**BR-104**	**BR-105**
Type						
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**20 Jan 94**	**01 Feb 94**	**27 Jan 94**	**20 Jan 94**	**26 Jan 94**	**27 Jan 94**
Benzene	0.8 U	210 J	37	1	3	16
Ethylbenzene	0.9 U	160 J	9 U	0.9 U	0.9 U	0.9 U
Toluene	1 U	7200	64	1 U	2	11
Total Xylenes	2 U	960 J	23 U	2 U	2 U	0.8 J
SUM	ND	7200	100	1	5	28

Location	**BR-105D**	**BR-105D**	**BR-106**	**BR-107**	**BR-107**	**BR-108**
Type	**Duplicate**			**Duplicate**		
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**04 Feb 94**	**04 Feb 94**	**02 Feb 94**	**21 Jan 94**	**21 Jan 94**	**02 Feb 94**
Benzene	41 J	33	77	97	110	31
Ethylbenzene	2 J	2 U	4	3	4	0.9 U
Toluene	42 J	41	120	6	6	1 U
Total Xylenes	15 J	16	4 J	24	25	2 U
SUM	Maximum = 100		210	Maximum = 145		31

Location	**BR-2**	**BR-2D**	**BR-3**	**BR-3D**	**BR-3D**	**BR-4**
Type				**Duplicate**		
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**19 Jan 94**	**26 Jan 94**	**27 Jan 94**	**26 Jan 94**	**26 Jan 94**	**02 Feb 94**
Benzene	35	16	320 U	2	2	0.8 U
Ethylbenzene	9 U	4	350 U	0.7 U	0.7 U	0.9 U
Toluene	96	28	5000	4	4	1 U
Total Xylenes	23 U	33	920 U	3	3	2 U
SUM	130	80	5000	Maximum = 9		ND

Location	**BR-5**	**BR-5**	**BR-6**	**BR-7**	**BR-8**	**PZ-102**
Type	**Duplicate**					
Media	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**19 Jan 94**	**19 Jan 94**	**25 Jan 94**	**19 Jan 94**	**24 Jan 94**	**03 Feb 94**
Benzene	18	20	8 U	10	18	170
Ethylbenzene	87 U	9 U	9 U	2 U	0.9 U	87 U
Toluene	26	27	110	59	37	940 B
Total Xylenes	23 U	23 U	23 U	2 J	1 J	230 U
SUM	Maximum = 47		110	71	56	1100

Location	**PZ-103**	**PZ-104**	**PZ-105**	**PZ-106**	**PZ-107**
Type					
Media	**Water**	**Water**	**Water**	**Water**	**Water**
Lab	**RECRA**	**RECRA**	**RECRA**	**RECRA**	**RECRA**
Sample Date	**01 Feb 94**	**01 Feb 94**	**24 Jan 94**	**24 Jan 94**	**27 Jan 94**
Benzene	180	8	140	120	11
Ethylbenzene	17 U	0.9 U	35 U	87 U	9 U
Toluene	2200	16	1800 B	320	150
Total Xylenes	38 J	2 U	92 U	230 U	23 U
SUM	2400	26	1900	440	160

Notes:

All concentrations reported in units of micrograms per liter.
B Target compound or element is detected in an associated method blank.
J Estimated concentration where compound or element does not meet QC criteria.
U Not detected, value equals sample quantitation limit.

TABLE 4-13
SUMMARY OF PESTICIDES CONCENTRATIONS IN ON-SITE GROUNDWATER

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Location[a]	B-17	BR-3	BR-5A	BR-5A	C-1	C-5	C-5	E-3
Type			Duplicate			Duplicate		
Media	Water	Water	Water	Water	Water	Water	Water	Water
Lab	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA	RECRA
Sample Date	26 Jan 94	27 Jan 94	19 Jan 94	19 Jan 94	25 Jan 94	25 Jan 94	25 Jan 94	25 Jan 94
4,4'-DDE	–	–	0.1	0.1	–	–	–	–
4,4'-DDT	–	–	0.1 J	0.2 J	0.1 J	–	–	–
Aldrin	–	–	–	–	0.1	–	–	0.1 J
Dieldrin	–	–	–	–	0.1	–	7.4	–
Endosulfan I	260	–	–	–	0.1	150	100	–
Endosulfan II	–	–	0.1	0.1	–	–	–	–
Endosulfan Sulfate	–	–	0.1 J	0.1 J	–	–	–	–
Endrin	–	–	–	0.1 J	–	–	–	–
Heptachlor Epoxide	15 J	17	–	–	–	–	–	–
Methoxychlor	–	–	0.1	0.1	–	–	–	–
beta-BHC	–	–	–	–	0.4	300	230	–
delta-BHC	–	–	0.04	–	–	–	–	–
gamma-BHC (Lindane)	20	31	0.3	0.3	0.1	39	42	–

Notes:

All concentrations reported in units of micrograms per liter.

[a] – Only wells B-17, BR-3, BR-5, C-1, C-5, and E-3 were sampled, as planned.

– Not detected

J Estimated concentration where compound or element does not meet QC criteria.

TABLE 5-1
PHYSIO-CHEMICAL PROPERTIES OF SELECTED CHEMICALS

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Chemical Name	CAS Number	Specific Gravity	Water Solubility (mg/L)	Vapor Pressure (mmHg)	Henry's Law (1) (atm-m3/mol)	Koc (ml/g) (2)
VOCs						
1,1,1-Trichloroethane	71-55-6	1.3492	1330	1.20E+02	2.80E-02	152
1,1-Dichloroethane	75-34-3	1.175	5500	2.30E+02	5.70E-03	30
1,1-Dichloroethene	75-35-4	1.218	2250	6.00E+02	1.54E-01	65
1,2-Dichlorobenzene	95-50-1	1.35	118	1.47E+00	1.90E-03	1700
1,2-Dichloroethane	107-06-2	1.25	7990	8.56E+01	1.10E-03	14
1,2-Dichloropropane	78-87-5	1.16	2700	4.20E+01	1.54E-01	51
2-Hexanone	591-78-6	0.83	35000	1.00E+01	3.78E-05	14.8
4-Methyl-2-pentanone	108-10-1	0.8006	19000	6.00E+00	6.77E-05	19
Acetone	67-64-1	0.791	miscible	2.70E+02	3.67E-05	2.2
Benzene	71-43-2	0.871	1750	9.52E+01	5.46E-03	65
Bromoform	75-25-2	2.89	3010	5.00E+00	5.32E-04	116
Carbon Disulfide	75-15-0	1.263	2940	3.60E+02	1.23E-02	54
Carbon Tetrachloride	56-23-5	1.59	758	1.10E+02	2.30E-02	439
Chlorobenzene	108-90-7	1.1	491	1.17E+01	3.40E-03	330
Chloroform	67-66-3	1.489	7220	1.51E+02	3.80E-03	44
Chloromethane	74-87-3	0.991	6500	7.60E+02	9.90E-03	5.5
Dibromochloromethane	124-48-1	2.38	4540	7.60E+01	4.59E-03	107
Ethyl Benzene	100-41-4	0.867	153	7.00E+00	8.43E-03	220
Methyl ethyl ketone	78-93-3	0.805	268000	7.75E+01	5.14E-05	4.51
Methylene chloride	75-09-2	1.325	18000	4.11E+02	2.60E-03	8.8
Tetrachloroethene	127-18-4	1.626	484	1.85E+01	2.30E-02	364
Toluene	108-88-3	0.867	1550	2.84E+01	6.60E-03	120
Trichloroethene	79-01-6	1.4679	1470	7.43E+01	8.90E-03	126
Vinyl Chloride	75-01-4	0.912	2670	7.60E+02	6.90E-01	8.2
p-Xylene	106-42-3	0.86	198	8.82E+00	7.04E-03	238
trans-1,2-Dichloroethene	156-60-5	1.26	6300	3.24E+02	6.60E-03	59
SVOCs						
1,2,4-Trichlorobenzene	120-82-1	1.574	48.8	2.90E-01	1.42E-03	9200
1,3-Dichlorobenzene	541-73-1	1.288	133	2.28E+00	3.60E-03	1700
1,4-Dichlorobenzene	106-46-7	1.458	73.8	1.18E+00	1.60E-03	1700
2,4,6-Trichlorophenol	88-06-2	1.49	434	1.20E-02	4.82E-06	2000
2,4-Dimethylphenol	105-67-9	1.036	7870	2.60E-02	5.31E-07	96
2,4-Dinitrotoluene	121-14-2	1.521	280	2.17E-04	1.86E-07	251
2,6-Dichloropyridine	2402-78-0	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	110-75-8	1.048	18900	2.68E+01	1.99E-04	11.7

TABLE 5–1
PHYSIO–CHEMICAL PROPERTIES OF SELECTED CHEMICALS

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Chemical Name	CAS Number	Specific Gravity	Water Solubility (mg/L)	Vapor Pressure (mmHg)	Henry's Law (1) (atm–m3/mol)	Koc (ml/g) (2)
2–Chlorophenol	95–57–8	ND	11400	2.35E+00	3.49E–05	73
2–Chloropyridine	109–09–1	1.205	ND	ND	ND	ND
2–Methylnaphthalene	91–57–6	0.994	25.4	4.50E–02	3.31E–04	7940
3–Chloropyridine	626–60–8	1.194	ND	ND	ND	ND
4–Chloropyridine	7379–35–3	ND	ND	ND	ND	ND
Acenaphthene	83–32–9	1.069	3.93	2.15E–03	2.40E–04	4600
Anthracene	120–12–7	1.25	0.073	6.00E–06	5.90E–05	14000
Benzo(a)anthracene	56–55–3	ND	0.014	2.10E–07	4.50E–06	1380000
Benzo(a)pyrene	50–32–8	ND	0.00005	5.60E–09	3.72E–05	5500000
Benzo(b)fluoranthene	205–99–2	ND	0.014	5.00E–07	1.18E–05	550000
Benzo(g,h,i)perylene	191–24–2	ND	0.0003	1.03E–10	1.25E–07	1600000
Benzo(k)fluoranthene	207–08–9	ND	0.0043	5.10E–07	3.94E–05	550000
Benzoic acid	65–85–0	1.265	2900	7.05E–03	3.92E–07	54.4
Butylbenzylphthalate	85–68–7	1.1	2	2.12E–05	4.35E–06	17000
Chrysene	218–01–9	1.274	0.002	6.40E–09	9.60E–07	200000
Di–n–butylphthalate	84–74–2	1.046	9.2	1.00E–05	1.30E–06	1390
Di–n–octylphthalate	117–84–0	0.986	0.34	1.40E–04	5.50E–06	19000
Dibenzo(a,h)anthracene	53–70–3	ND	0.014	1.00E–10	2.61E–09	3300000
Dibenzofuran	132–64–9	1.089	10	3.37E–05	7.45E–07	9120
Diethylphthalate	84–66–2	1.12	680	3.50E–03	1.50E–06	69
Dimethylphthalate	131–11–3	1.189	2120	4.19E–03	5.05E–07	17.4
Fluoranthene	206–44–0	1.252	0.26	9.20E–06	9.41E–06	38000
Fluorene	86–73–7	1.203	1.98	6.00E–04	8.40E–05	7300
Hexachlorobenzene	118–74–1	2.044	0.006	2.58E–03	1.70E–03	3900
Hexachlorobutadiene	87–68–3	1.675	3.23	2.00E+00	1.03E–02	29000
Hexachloroethane	67–72–1	2.09	50	4.00E–01	3.89E–03	20000
Indeno(1,2,3–c,d)pyrene	193–39–5	ND	0.00053	1.00E–10	6.85E–08	1600000
N–Nitrosodiphenylamine	86–30–6	1.23	35	6.69E–04	5.00E–06	648
Naphthalene	91–20–3	1.152	31.7	7.80E–02	4.20E–04	940
Phenanthrene	85–01–8	1.025	1.29	1.20E–04	3.90E–05	14000
Phenol	108–95–2	1.07	93000	3.41E–01	3.95E–07	14.2
Pyrene	129–00–0	1.271	0.135	4.50E–06	8.86E–06	38000
Pyridine	110–86–1	0.982	miscible	2.00E+01	8.85E–06	3.02
bis(2–Chloroethyl)ether	111–44–4	1.22	10200	7.10E–01	1.31E–05	13.9
bis(2–Ethylhexyl)phthalate	117–81–7	0.99	0.4	2.00E–07	4.40E–07	87400
p–Fluoroaniline		1.1725	ND	ND	ND	ND
p–Nitroaniline	100–01–6	1.424	800	1.50E–03	3.41E–07	15.1

TABLE 5-1
PHYSIO-CHEMICAL PROPERTIES OF SELECTED CHEMICALS

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Chemical Name	CAS Number	Specific Gravity	Water Solubility (mg/L)	Vapor Pressure (mmHg)	Henry's Law (1) (atm-m3/mol)	Koc (ml/g) (2)
PESTICIDES						
4,4'-DDE	72-55-9	ND	0.04	6.50E-06	6.80E-05	29700
4,4'-DDT	50-29-3	0.98	0.005	5.50E-06	8.30E-06	243000
Aldrin	309-00-2	ND	0.18	1.24E-04	4.96E-04	96000
Dieldrin	60-57-1	1.75	0.195	1.78E-07	1.10E-05	1700
Endosulfan I	959-98-8	ND	0.53	1.00E-05	1.01E-05	2030
Endosulfan II	33213-65-9	ND	0.28	1.00E-05	1.91E-05	2220
Endosulfan Sulfate	1031-07-8	ND	0.117	1.00E-05	2.60E-05	4790
Endrin	72-20-8	ND	0.2	3.00E-06	4.20E-06	10600
Heptachlor Epoxide	1024-57-3	ND	0.35	3.00E-04	3.20E-05	220
Methoxychlor	72-43-5	1.41	0.1	4.96E-09	2.26E-08	80000
beta-BHC	319-85-7	ND	0.24	2.80E-07	4.47E-07	3800
gamma-BHC (Lindane)	58-89-9	1.87	7.8	1.60E-04	7.85E-06	1080

NOTES:

VOC = Volatile Organic Compounds
SVOC = Semivolatile Organic Compounds
Koc = Organic carbon partion coefficient
mg/L = milligrams per liter
mmHg = millimeters of mercury
atm-m3/mol = Atmosphere-cubic meters per mole
ml/g = milliliters per gram
ND = No Data

1) Range of H (atm-m3/mol)	Degree of Volatility
H < 3.0E-07	non-volatile
3.0E-07 < H < 1.0E-05	low volatility
1.0E-05 < H < 1.0E-03	moderate volatility
H > 1.0E-03	high volatility

2) Degree of Adsorptio	Koc	Degree of Mobility
very weak	< 10	very high
weak	10 - 100	high
moderate	100 - 1000	moderate
moderate to strong	1000-10000	low
strong	10000-1000000	very low
very strong	>100000	extremely low

TABLE 6-1
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT SOIL GAS [1]

OLIN CHEMICAL PHASE I RI REPORT
ROCHESTER, N.Y.

Compound	Frequency of Detection	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	TLV[2] (µg/L)	Maximum Concentration Exceeds Standard?
1,1-Dichloroethene	17 / 87	0.1	1.7	20	No
Carbon Tetrachloride	33 / 87	0.1	38	31	Yes
Chloroform	27 / 87	0.1	23	49	No
Methylene Chloride	13 / 87	0.1	2.4	174	No
Tetrachloroethene	25 / 87	0.1	8.5	170	No
Trichloroethene	12 / 87	0.1	2.3	269	No
cis-1,2-Dichloroethene	5 / 87	0.1	1.8	793 [3]	No
trans-1,2-Dichloroether	4 / 87	0.2	1.3	793 [3]	No

NOTES:

[1] Soil gas samples used for evaluation included all soil gas sample locations, as described in Section 2.

[2] from: ACGIH, 1993. 1993-1994 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. American Conference of Governmental Industrial Hygienists, 1993.

[3] Value is for total 1,2-dichloroethene

Acronyms:

µg = microgram
L = liter
TLV = Threshold Limit Value

TABLE 6-2
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
SOIL

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen-tration	Maximum Detected Concen-tration	Mean of all Samples	CPC?	Notes
Onsite Facility Surface (0-2 inches) Soil* (mg/kg)							
VOLATILE ORGANIC COMPOUNDS							
Chloroform	0.011 – 0.014	2 / 5	0.0004	0.001	0.0046	N	Toxicity Screening^1
SEMIVOLATILE ORGANIC COMPOUNDS							
2,6-Dichloropyridine		5 / 5	0.007	0.56	0.143	N	Toxicity Screening^1
2-Chloropyridine		5 / 5	0.021	0.62	0.196	N	Toxicity Screening^1
2-Methylnaphthalene	0.36 – 0.4	3 / 5	0.038	0.54	0.219	Y	Class^2
3-Chloropyridine	0.36 – 0.4	2 / 5	0.044	0.069	0.139	N	Toxicity Screening^1
4-Methylphenol	0.36 – 0.4	1 / 5	0.02	0.02	0.156	N	Toxicity Screening^1
Acenaphthene	0.36 – 0.36	4 / 5	0.013	3.9	0.881	Y	Class^2
Acenaphthylene	0.36 – 0.4	2 / 5	0.028	0.087	0.156	Y	Class^2
Anthracene		5 / 5	0.013	10	2.169	Y	Class^2
Benzo(a)anthracene		5 / 5	0.15	34	7.578	Y	
Benzo(a)pyrene		5 / 5	0.19	27	6.177	Y	
Benzo(b)fluoranthene		5 / 5	0.27	35	8.322	Y	
Benzo(g,h,i)perylene		5 / 5	0.11	11	2.508	Y	Class^2
Benzo(k)fluoranthene		5 / 5	0.19	22	5.050	Y	
Bis(2-ethylhexyl)phthalate		5 / 5	1.1	4.4	2.780	N	Toxicity Screening^1
Carbazole		5 / 5	0.015	6.7	1.437	N	Toxicity Screening^1
Chrysene		5 / 5	0.21	37	8.290	Y	Class^2
Di-n-butylphthalate	0.36 – 0.64	1 / 5	0.36	0.36	0.252	N	Toxicity Screening^1
Dibenzo(a,h)Anthracene	0.36 – 0.4	3 / 5	0.055	2.9	0.710	Y	
Dibenzofuran	0.36 – 0.4	3 / 5	0.035	2.3	0.566	Y	Toxicity Value^3
Dimethylphthalate	0.36 – 0.4	2 / 5	0.11	4.6	1.063	N	Toxicity Screening^1
Fluoranthene		5 / 5	0.34	74	16.274	Y	Class^2
Fluorene	0.36 – 0.4	3 / 5	0.079	4.8	1.100	Y	Class^2
Hexachlorobutadiene	0.36 – 0.4	1 / 5	0.059	0.059	0.168	N	Toxicity Screening^1
Hexachloroethane	0.36 – 0.4	1 / 5	0.029	0.029	0.162	N	Toxicity Screening^1
Indeno(1,2,3-c,d)Pyrene		5 / 5	0.086	15	3.347	Y	
Naphthalene	0.36 – 0.4	3 / 5	0.022	0.37	0.169	Y	Class^2
Phenanthrene		5 / 5	0.12	48	10.400	Y	Class^2
Pyrene		5 / 5	0.24	62	14.000	Y	Class^2
Pyridine	0.36 – 0.4	3 / 5	0.016	0.11	0.126	N	Toxicity Screening^1

TABLE 6–2
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
SOIL

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen–tration	Maximum Detected Concen–tration	Mean of all Samples	CPC?	Notes
INORGANICS							
Aluminum		5 / 5	2700	12000	6710.0	Y	Toxicity Value[3]
Arsenic		5 / 5	1.8	4.8	3.3	Y	
Barium		5 / 5	21	210	75.7	N	Toxicity Screening[1]
Cadmium		5 / 5	0.1	1.8	0.9	N	Toxicity Screening[1]
Calcium		5 / 5	6900	55000	29520.0	N	Nutrient[4]
Chromium		5 / 5	5.4	180	52.8	Y	
Cobalt	4.8 – 4.8	4 / 5	5.3	15	7.2	Y	Toxicity Value[3]
Copper		5 / 5	3.3	56	17.9	N	Toxicity Screening[1]
Iron		5 / 5	6900	23000	15780.0	N	Nutrient[4]
Lead		5 / 5	12	530	137.7	Y	Toxicity Value[3]
Magnesium		5 / 5	3100	20000	10330.0	N	Nutrient[4]
Manganese		5 / 5	270	1200	455.0	Y	
Mercury	0.1 – 0.1	3 / 5	0.2	210	42.49	Y	
Nickel	7.2 – 7.2	4 / 5	17	50	30.7	N	Toxicity Screening[1]
Potassium		5 / 5	590	1900	994.0	N	Nutrient[4]
Silver	0.1 – 0.1	4 / 5	0.1	0.6	0.2	N	Toxicity Screening[1]
Sodium		5 / 5	280	2500	838.0	N	Nutrient[4]
Vanadium		5 / 5	7.6	43	22.4	N	Toxicity Screening[1]
Zinc		5 / 5	30	640	228.0	N	Toxicity Screening[1]
Onsite Subsurface (0–10 feet) Soil[b] (mg/kg)							
VOLATILE ORGANIC COMPOUNDS							
1,2–Dichloroethene (total)	0.011 – 0.014	2 / 24	0.003	0.009	0.0058	N	Toxicity Screening[1]
1,2–Dichloropropane	0.011 – 0.014	1 / 24	0.007	0.007	0.0058	N	Toxicity Screening[1]
2–Butanone	0.011 – 0.014	2 / 24	0.009	0.036	0.0065	N	Toxicity Screening[1]
Acetone	0.011 – 0.014	4 / 24	0.01	0.13	0.0112	N	Toxicity Screening[1]
Benzene	0.011 – 0.014	1 / 24	0.009	0.009	0.0059	N	Toxicity Screening[1]
Carbon disulfide	0.011 – 0.014	1 / 24	0.003	0.003	0.0057	N	Toxicity Screening[1]
Chlorobenzene	0.011 – 0.014	3 / 24	0.0007	0.038	0.0066	N	Toxicity Screening[1]
Chloroform	0.011 – 0.014	5 / 24	0.0004	0.57	0.0213	N	Toxicity Screening[1]
Ethylbenzene	0.011 – 0.014	3 / 24	0.0002	0.0004	0.0053	N	Toxicity Screening[1]
Methylene chloride	0.011 – 0.014	1 / 24	0.017	0.11	0.0082	N	Toxicity Screening[1]
Tetrachloroethene	0.011 – 0.014	1 / 24	0.14	0.24	0.0135	N	Toxicity Screening[1]

TABLE 6–2
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
SOIL

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen–tration	Maximum Detected Concen–tration	Mean of all Samples	CPC?	Notes
Toluene	0.011 – 0.025	7 / 24	0.0009	0.007	0.0056	N	Toxicity Screening[1]
Total Xylenes	0.011 – 0.014	5 / 24	0.0005	0.002	0.0050	N	Toxicity Screening[1]
Trichloroethene	0.011 – 0.014	3 / 24	0.0007	0.009	0.0056	N	Toxicity Screening[1]
SEMIVOLATILE ORGANIC COMPOUNDS							
1,2,4–Trichlorobenzene	0.34 – 0.52	2 / 24	0.022	0.024	0.186	N	Toxicity Screening[1]
2,6–Dichloropyridine	0.36 – 0.38	20 / 24	0.007	3.1	0.227	Y	Class[2]
2–Chloropyridine	0.36 – 0.38	21 / 24	0.011	12	0.787	Y	
2–Methylnaphthalene	0.34 – 0.48	10 / 24	0.014	0.54	0.159	Y	Class[2]
3–Chloropyridine	0.34 – 0.52	8 / 24	0.017	2.9	0.265	Y	Class[2]
4–Methylphenol	0.34 – 0.52	2 / 24	0.02	0.31	0.190	N	Toxicity Screening[1]
Acenaphthene	0.34 – 0.48	15 / 24	0.007	3.9	0.307	Y	Class[2]
Acenaphthylene	0.34 – 0.48	8 / 24	0.012	0.17	0.151	Y	Class[2]
Anthracene	0.34 – 0.48	17 / 24	0.013	10	0.612	Y	Class[2]
Benzo(a)anthracene	0.34 – 0.48	18 / 24	0.041	34	1.909	Y	
Benzo(a)pyrene	0.34 – 0.48	18 / 24	0.039	27	1.573	Y	
Benzo(b)fluoranthene	0.34 – 0.48	18 / 24	0.075	35	2.184	Y	
Benzo(g,h,i)perylene	0.34 – 0.48	18 / 24	0.017	11	0.635	Y	Class[2]
Benzo(k)fluoranthene	0.34 – 0.48	18 / 24	0.033	22	1.364	Y	
Bis(2–ethylhexyl)phthalate	0.38 – 0.48	22 / 24	0.034	9.5	1.677	N	Toxicity Screening[1]
Carbazole	0.34 – 0.48	18 / 24	0.005	6.7	0.408	N	Toxicity Screening[1]
Chrysene	0.34 – 0.48	18 / 24	0.061	37	2.085	Y	Class[2]
Di–n–butylphthalate	0.34 – 0.64	2 / 24	0.33	0.36	0.211	N	Toxicity Screening[1]
Di–n–octylphthalate	0.34 – 0.52	1 / 24	0.43	0.43	0.206	N	Toxicity Screening[1]
Dibenzo(a,h)Anthracene	0.34 – 0.48	9 / 24	0.014	2.9	0.264	Y	
Dibenzofuran	0.34 – 0.48	10 / 24	0.024	2.3	0.247	Y	Toxicity Value[3]
Dimethylphthalate	0.34 – 0.52	2 / 24	0.11	4.6	0.377	N	Toxicity Screening[1]
Fluoranthene	0.34 – 0.48	18 / 24	0.12	74	4.014	Y	Class[2]
Fluorene	0.34 – 0.48	9 / 24	0.047	4.8	0.389	Y	Class[2]
Hexachlorobenzene	0.34 – 0.52	1 / 24	0.024	0.039	0.189	N	Toxicity Screening[1]
Hexachlorobutadiene	0.34 – 0.52	2 / 24	0.059	1.8	0.253	N	Toxicity Screening[1]
Hexachloroethane	0.34 – 0.52	1 / 24	0.029	0.029	0.189	N	Toxicity Screening[1]
Indeno(1,2,3–c,d)Pyrene	0.34 – 0.48	18 / 24	0.027	15	0.837	Y	
Naphthalene	0.34 – 0.52	10 / 24	0.007	0.37	0.155	Y	Class[2]
Phenanthrene	0.34 – 0.48	19 / 24	0.032	48	2.609	Y	Class[2]

TABLE 6-2
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
SOIL

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	Mean of all Samples	CPC?	Notes
Pyrene	0.34 – 0.48	18 / 24	0.11	62	3.502	Y	Class[2]
Pyridine	0.34 – 0.52	7 / 24	0.013	8.4	0.484	Y	Class[2]
INORGANICS							
Aluminum		13 / 13	2700	12000	6750.0	Y	Toxicity Value[3]
Arsenic		13 / 13	1.8	12	4.9	Y	
Barium		13 / 13	21	210	64.0	N	Toxicity Screening[1]
Cadmium		13 / 13	0.1	1.8	0.6	N	Toxicity Screening[1]
Calcium		13 / 13	4900	95000	32861.5	N	Nutrient[4]
Chromium		13 / 13	5.4	180	36.1	Y	
Cobalt	4.4 – 5	9 / 13	5	15	5.5	Y	Toxicity Value[3]
Copper		13 / 13	3.3	56	17.9	N	Toxicity Screening[1]
Iron		13 / 13	6900	23000	14530.8	N	Nutrient[4]
Lead		13 / 13	12	530	94.2	Y	Toxicity Value[3]
Magnesium		13 / 13	2700	50000	12884.6	N	Nutrient[4]
Manganese		13 / 13	240	1200	440.4	Y	
Mercury	0.1 – 0.1	8 / 13	0.2	210	16.46	Y	
Nickel	7.2 – 7.2	12 / 13	13	62	27.2	N	Toxicity Screening[1]
Potassium		13 / 13	590	1900	938.1	N	Nutrient[4]
Selenium	0.7 – 0.9	1 / 13	0.8	0.8	0.4	N	Toxicity Screening[1]
Silver	0.1 – 0.1	12 / 13	0.1	0.7	0.3	N	Toxicity Screening[1]
Sodium		13 / 13	260	2500	676.5	N	Nutrient[4]
Vanadium		13 / 13	7.6	43	18.9	N	Toxicity Screening[1]
Zinc		13 / 13	30	640	172.4	N	Toxicity Screening[1]
Onsite Non-Facility Surface (0-2 inches) Soil[c] (mg/kg)							
VOLATILE ORGANIC COMPOUNDS							
Chloroform	0.011 – 0.013	1 / 6	0.0004	0.0005	0.0050	N	Toxicity Screening[1]
SEMIVOLATILE ORGANIC COMPOUNDS							
1,2,4-Trichlorobenzene	0.36 – 0.52	1 / 6	0.022	0.022	0.192	N	Toxicity Screening[1]
2,6-Dichloropyridine		6 / 6	0.017	0.17	0.065	N	Toxicity Screening[1]
2-Chloropyridine		6 / 6	0.011	0.57	0.224	N	Toxicity Screening[1]
2-Methylnaphthalene	0.36 – 0.36	4 / 6	0.016	0.087	0.107	Y	Class[2]
3-Chloropyridine	0.36 – 0.52	2 / 6	0.017	0.063	0.164	N	Toxicity Screening[1]

TABLE 6–2
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
SOIL

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen–tration	Maximum Detected Concen–tration	Mean of all Samples	CPC?	Notes
Acenaphthene	0.36 – 0.36	5 / 6	0.016	0.27	0.103	Y	Class[2]
Acenaphthylene	0.36 – 0.36	4 / 6	0.012	0.17	0.110	Y	Class[2]
Anthracene	0.36 – 0.36	5 / 6	0.03	0.48	0.179	Y	Class[2]
Benzo(a)anthracene		6 / 6	0.041	1.6	0.643	Y	
Benzo(a)pyrene		6 / 6	0.04	1.2	0.563	Y	
Benzo(b)fluoranthene		6 / 6	0.075	2	1.003	Y	
Benzo(g,h,i)perylene		6 / 6	0.063	0.22	0.147	Y	Class[2]
Benzo(k)fluoranthene		6 / 6	0.043	1.3	0.703	Y	
Bis(2–ethylhexyl)phthalate		6 / 6	0.14	9.5	3.475	N	Toxicity Screening[1]
Carbazole		6 / 6	0.005	0.33	0.102	N	Toxicity Screening[1]
Chrysene		6 / 6	0.07	1.5	0.761	Y	Class[2]
Di–n–butylphthalate	0.36 – 0.46	1 / 6	0.33	0.33	0.217	N	Toxicity Screening[1]
Di–n–octylphthalate	0.36 – 0.52	1 / 6	0.43	0.43	0.247	N	Toxicity Screening[1]
Dibenzo(a,h)Anthracene	0.36 – 0.4	2 / 6	0.014	0.11	0.144	Y	
Dibenzofuran	0.36 – 0.36	4 / 6	0.024	0.15	0.116	Y	Toxicity Value[3]
Fluoranthene		6 / 6	0.12	2.8	1.226	Y	Class[2]
Fluorene	0.36 – 0.46	3 / 6	0.049	0.27	0.175	Y	Class[2]
Hexachlorobenzene	0.36 – 0.52	1 / 6	0.024	0.039	0.180	N	Toxicity Screening[1]
Indeno(1,2,3–c,d)Pyrene		6 / 6	0.033	0.4	0.198	Y	Class[2]
Naphthalene	0.36 – 0.52	3 / 6	0.019	0.061	0.134	Y	Class[2]
Phenanthrene		6 / 6	0.054	1.9	0.672	Y	Class[2]
Pyrene		6 / 6	0.11	3	1.178	Y	Class[2]
Pyridine	0.36 – 0.52	1 / 6	0.074	0.074	0.179	N	Toxicity Screening[1]
INORGANICS							
Aluminum		6 / 6	3900	8700	6533.3	Y	Toxicity Value[3]
Arsenic		6 / 6	2.7	12	5.4	Y	
Barium		6 / 6	37	110	60.0	Y	
Cadmium		6 / 6	0.1	0.8	0.5	Y	
Calcium		6 / 6	4900	95000	42983.3	N	Nutrient[4]
Chromium		6 / 6	8.2	150	28.0	Y	
Cobalt	4.4 – 5	3 / 6	5	7.1	3.9	Y	Toxicity Value[3]
Copper		6 / 6	8.6	48	20.6	Y	
Iron		6 / 6	12000	17000	13833.3	N	Nutrient[4]
Lead		6 / 6	12	140	73.7	Y	Toxicity Value[3]

TABLE 6–2
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
SOIL

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen–tration	Maximum Detected Concen–tration	Mean of all Samples	CPC?	Notes
Magnesium		6 / 6	2700	50000	17508.3	N	Nutrient[4]
Manganese		6 / 6	240	760	428.3	Y	
Mercury	0.1 – 0.1	4 / 6	0.2	0.4	0.20	Y	
Nickel		6 / 6	13	62	23.6	Y	
Potassium		6 / 6	630	1200	892.5	N	Nutrient[4]
Selenium	0.7 – 0.7	1 / 6	0.8	0.8	0.4	N	Toxicity Screening[1]
Silver		6 / 6	0.1	0.7	0.4	N	Toxicity Screening[1]
Sodium		6 / 6	260	1400	647.5	N	Nutrient[4]
Vanadium		6 / 6	12	20	16.9	Y	
Zinc		6 / 6	65	240	150.0	N	Toxicity Screening[1]

NOTES:

Toxicity Screening[1] – Chemicals with low ratios (i.e., less than 0.01) are not considered chemicals of potential concern (CPCs)
Class[2] – Although the toxicity screening ratio was less than 0.01, this compound belongs to a class of compounds where at least one compound within this class has a risk ratio greater than 0.01.
Toxicity Value[3] – Compound cannot be evaluated quantitatively because toxicity values are not available.
Nutrient[4] – Analyte is an essential human nutrient (iron, magnesium, calcium, potassium, sodium) and is not considered a CPC.

Sample Locations:
[a] – Based on samples SS–103, –104, –108, –110, –111.
[b] – Based on samples SS–101 through –105, SS–108 through –115, T–106, –120, –122, –124, –129, –133, –136, –137, –139, –152, –159.
[c] – Based on samples SS–102, –105, –109, –112, –113, –115.

Acronyms:
SQL – Sample Quantitation Limit
CPC – Chemical of Potential Concern
mg – milligram
kg – kilogram

TABLE 6–3
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
OVERBURDEN GROUNDWATER

OLIN ROCHESTER PHASE I RI/FS
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen–tration	Maximum Detected Concen–tration	Mean of all Samples	MCL	CPC?	Notes
OVERBURDEN GROUNDWATER: ON–SITE[a] (mg/L)								
VOLATILE ORGANIC COMPOUNDS								
1,1,1–Trichloroethane	0.002 – 0.4	2 / 40	0.001	0.005	0.0094	0.2	N	Frequency[1]
1,1–Dichloroethane	0.002 – 0.34	1 / 40	0.006	0.006	0.0078	–	N	Frequency[1]
1,1–Dichloroethene	0.002 – 0.5	3 / 40	0.001	0.002	0.0106	0.007	N	Toxicity Screening[2]
1,2–Dichlorobenzene	0.0008 – 0.1	24 / 40	0.0005	2.4	0.0888	0.6	Y	Standard[3]
1,2–Dichloroethane	0.001 – 0.28	2 / 40	0.013	0.093	0.0087	0.005	Y	Standard[3]
1,2–Dichloroethene (total)	0.002 – 0.4	22 / 40	0.0005	0.028	0.0110	–	N	Toxicity Screening[2]
1,2–Dichloropropane	0.001 – 0.26	1 / 40	0.001	0.001	0.0056	0.07	N	Frequency[1]
2–Butanone	0.004 – 0.8	3 / 40	0.009	0.042	0.0184	–	N	Toxicity Screening[2]
2–Hexanone	0.002 – 0.48	2 / 40	0.014	0.031	0.0112	–	N	Frequency[1]
4–Methyl–2–pentanone	0.002 – 0.4	4 / 40	0.004	0.014	0.0094	–	N	Toxicity Screening[2]
Acetone	0.008 – 1.4	10 / 40	0.018	0.29	0.0550	–	N	Toxicity Screening[2]
Benzene	0.0008 – 0.16	27 / 40	0.0007	0.062	0.0118	0.005	Y	Standard[3]
Bromodichloromethane	0.001 – 0.28	1 / 40	0.008	0.008	0.0061	0.1	N	Frequency[1]
Bromoform	0.001 – 0.2	5 / 40	0.003	0.54	0.0272	0.1	Y	Standard[3]
Carbon disulfide	0.004 – 0.8	4 / 40	0.012	1.9	0.0634	–	N	Toxicity Screening[2]
Carbon tetrachloride	0.002 – 0.4	8 / 40	0.0006	17	0.7938	0.005	Y	
Chlorobenzene	0.001 – 0.004	28 / 40	0.0004	2.5	0.1444	0.1	Y	Standard[3]
Chloroform	0.001 – 0.004	17 / 40	0.001	50	2.0741	0.1	Y	
Chloromethane	0.001 – 0.2	1 / 40	0.008	0.008	0.0046	–	N	Frequency[1]
Dibromochloromethane	0.001 – 0.24	1 / 40	0.062	0.062	0.0066	0.1	N	Frequency[1]
Ethylbenzene	0.0008 – 0.17	8 / 40	0.0007	0.051	0.0053	0.7	N	Toxicity Screening[2]
Methylene chloride	0.001 – 0.004	14 / 40	0.002	35	1.0260	0.005	Y	
Tetrachloroethene	0.002 – 0.008	17 / 40	0.0006	2	0.1013	0.005	Y	Standard[3]
Toluene	0.001 – 0.001	27 / 40	0.0004	4.6	0.1791	1	Y	Standard[3]
Total Xylenes	0.002 – 0.24	18 / 40	0.0004	0.12	0.0121	10	N	Toxicity Screening[2]
Trichloroethene	0.002 – 0.12	22 / 40	0.0005	0.39	0.0138	0.005	Y	Standard[3]
Vinyl chloride	0.001 – 0.24	3 / 40	0.002	0.012	0.0057	0.002	Y	
SEMIVOLATILE ORGANIC COMPOUNDS								
1,2,4–Trichlorobenzene	0.002 – 0.052	4 / 37	0.01	1.4	0.0681	0.07	Y	Standard[3]
1,3–Dichlorobenzene	0.002 – 0.052	5 / 38	0.0008	0.04	0.0040	0.6	Y	Toxicity Value[4]

TABLE 6-3
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
OVERBURDEN GROUNDWATER

OLIN ROCHESTER PHASE I RI/FS
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen-tration	Maximum Detected Concen-tration	Mean of all Samples	MCL	CPC?	Notes
1,4-Dichlorobenzene	0.002 – 0.043	7 / 38	0.001	0.077	0.0070	0.075	Y	Standard[3]
2,4,6-Trichlorophenol	0.006 – 0.15	1 / 37	0.0008	0.0008	0.0121	–	N	Frequency[1]
2,4-Dimethylphenol	0.004 – 0.082	1 / 37	0.0008	0.0008	0.0065	–	N	Frequency[1]
2,4-Dinitrotoluene	0.001 – 0.028	1 / 37	0.004	0.004	0.0015	–	N	Frequency[1]
2,6-Dichloropyridine	0.006 – 0.0135	34 / 37	0.002	44	2.6970	–	Y	
2-Chloroethyl Vinyl ether	0.002 – 0.32	1 / 40	0.001	0.001	0.0073	–	N	Frequency[1]
2-Chlorophenol	0.004 – 0.11	1 / 37	0.002	0.002	0.0072	–	N	Frequency[1]
2-Chloropyridine		37 / 37	0.0009	400	30.8876	–	Y	
2-Methylnaphthalene	0.002 – 0.04	2 / 37	0.001	0.046	0.0033	–	Y	Class
2-Methylphenol	0.004 – 0.11	1 / 37	0.001	0.001	0.0072	–	N	Frequency[1]
3-Chloropyridine	0.001 – 0.028	23 / 37	0.002	18	1.1129	–	Y	
4-Chloroaniline	0.002 – 0.01	19 / 37	0.001	1.2	0.0494	–	N	Toxicity Screening[2]
4-Chloropyridine	0.004 – 0.028	9 / 37	0.0005	0.25	0.0220	–	Y	Class
4-Methylphenol	0.004 – 0.088	5 / 37	0.028	0.084	0.0123	–	N	Toxicity Screening[2]
Acenaphthene	0.001 – 0.036	3 / 37	0.001	0.042	0.0032	–	Y	Class
Anthracene	0.001 – 0.032	1 / 37	0.16	0.16	0.0060	–	Y	Class
Benzo(a)anthracene	0.002 – 0.04	1 / 37	0.41	0.41	0.0134	0.0001	Y	
Benzo(a)pyrene	0.001 – 0.024	1 / 37	0.34	0.34	0.0105	0.0002	Y	
Benzo(b)fluoranthene	0.002 – 0.048	2 / 37	0.001	0.47	0.0153	0.0002	Y	
Benzo(g,h,i)perylene	0.001 – 0.032	1 / 37	0.045	0.045	0.0029	–	Y	Class
Benzo(k)fluoranthene	0.002 – 0.052	1 / 37	0.19	0.19	0.008	0.0002	Y	Class
Benzoic acid	0.008 – 0.22	9 / 37	0.0007	0.068	0.0140	–	N	Toxicity Screening[2]
Bis(2-Chloroethyl)ether	0.001 – 0.004	24 / 37	0.002	0.69	0.0603	–	Y	
Bis(2-ethylhexyl)phthalate	0.002 – 0.032	22 / 37	0.0003	0.34	0.0157	0.006	Y	Standard[3]
Chrysene	0.001 – 0.024	2 / 37	0.0004	0.33	0.0102	0.0002	Y	Class
Di-n-butylphthalate	0.001 – 0.03	1 / 37	0.022	0.022	0.0021	–	N	Frequency[1]
Di-n-octylphthalate	0.001 – 0.036	1 / 37	0.009	0.009	0.0023	–	N	Frequency[1]
Dibenzo(a,h)Anthracene	0.001 – 0.028	1 / 37	0.019	0.019	0.0020	0.0003	Y	Class
Dibenzofuran	0.001 – 0.024	1 / 37	0.025	0.025	0.002	–	N	Frequency[1]
Fluoranthene	0.001 – 0.032	3 / 37	0.0005	0.99	0.0285	–	Y	Class
Fluorene	0.001 – 0.034	1 / 37	0.061	0.061	0.0036	–	Y	Class
Indeno(1,2,3-c,d)Pyrene	0.001 – 0.024	1 / 37	0.069	0.069	0.0031	0.0004	Y	Class
Naphthalene	0.001 – 0.034	2 / 37	0.003	0.006	0.0021	–	Y	Class
Phenanthrene	0.001 – 0.036	2 / 37	0.0005	0.3	0.0101	–	Y	Class
Phenol	0.003 – 0.075	3 / 38	0.063	0.25	0.0150	–	N	Toxicity Screening[2]

TABLE 6–3
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
OVERBURDEN GROUNDWATER

OLIN ROCHESTER PHASE I RI/FS
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen–tration	Maximum Detected Concen–tration	Mean of all Samples	MCL	CPC?	Notes
Pyrene	0.002 – 0.038	2 / 37	0.007	0.66	0.0200	–	Y	Class
Pyridine	0.004 – 0.028	22 / 37	0.0001	98	3.6033	–	Y	Class
p–Fluoroaniline	0.004 – 0.028	26 / 37	0.001	0.92	0.0859	–	Y	Toxicity Value
PESTICIDES/PCBs								
4,4'–DDT	0.0002 – 0.044	1 / 4	0.0001	0.0001	0.0084	–	N	Toxicity Screening[2]
Aldrin	0.01 – 0.02	2 / 4	0.0001	0.0001	0.0038	–	N	Toxicity Screening[2]
Dieldrin	0.006 – 0.006	2 / 4	0.0001	0.007	0.0019	–	N	Toxicity Screening[2]
Endosulfan I		3 / 4	0.0001	0.26	0.0963	–	N	Toxicity Screening[2]
Heptachlor Epoxide	0.0001 – 0.01	1 / 4	0.015	0.015	0.0050	0.0002	Y	Standard[3]
beta–BHC	0.006 – 0.006	2 / 4	0.0004	0.3	0.0671	–	Y	
gamma–BHC (Lindane)	0.0001 – 0.0001	3 / 4	0.0001	0.042	0.0152	0.0002	Y	Standard[3]
INORGANICS								
Aluminum	0.09 – 0.09	30 / 32	0.14	630	51.2063	0.2#	Y	Toxicity Value[4]
Antimony	0.003 – 0.004	8 / 32	0.004	0.009	0.0026	0.006	Y	Standard[3]
Arsenic	0.004 – 0.004	29 / 32	0.003	0.92	0.1167	0.05	Y	
Barium		32 / 32	0.031	8.6	1.072	2	Y	Standard[3]
Beryllium	0.003 – 0.003	4 / 32	0.0038	0.029	0.0033	0.004	Y	Standard[3]
Cadmium	0.0002 – 0.0002	31 / 32	0.0002	0.11	0.0127	0.005	Y	Standard[3]
Calcium		32 / 32	5.3	2300	447.4313	–	Y	Toxicity Value[4]
Chromium	0.01 – 0.01	24 / 32	0.01	2.3	0.1407	0.1	Y	Standard[3]
Cobalt	0.02 – 0.02	13 / 32	0.021	0.45	0.0529	–	Y	Toxicity Value[4]
Copper	0.01 – 0.01	30 / 32	0.01	3.6	0.3015	1.3	Y	Standard[3]
Cyanide	0.01 – 0.01	12 / 32	0.012	0.084	0.0115	0.2	N	Toxicity Screening[2]
Iron		32 / 32	0.4	2500	251.0969	0.3#	Y	Toxicity Value[4]
Lead		31 / 31	0.002	2.7	0.2610	0.015*	Y	Toxicity Value[4]
Magnesium		31 / 31	3.2	720	109.2919	–	Y	Toxicity Value[4]
Manganese		32 / 32	0.065	56	8.0019	0.05#	Y	Standard[3]
Mercury	0.0004 – 0.0004	15 / 32	0.0004	0.63	0.0208	0.002	Y	Standard[3]
Nickel	0.03 – 0.03	21 / 32	0.033	1.8	0.1763	0.1	Y	Standard[3]
Potassium	0.5 – 0.5	31 / 32	1.2	44	12.4219	–	Y	Toxicity Value[4]
Selenium	0.003 – 0.003	2 / 32	0.003	0.004	0.0016	0.05	N	Toxicity Screening[2]
Silver	0.01 – 0.01	5 / 29	0.0024	0.056	0.0074	0.1#	N	Toxicity Screening[2]
Sodium		32 / 32	11	2300	533.4844	–	Y	Toxicity Value[4]
Vanadium	0.02 – 0.02	22 / 32	0.021	3.4	0.2154	–	N	Toxicity Screening[2]
Zinc	0.01 – 0.01	31 / 32	0.01	22	1.5371	5#	Y	Standard[3]

TABLE 6–3
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
OVERBURDEN GROUNDWATER

OLIN ROCHESTER PHASE I RI/FS
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	Mean of all Samples	MCL	CPC?	Notes
OVERBURDEN GROUNDWATER: OFF–SITE[b] (mg/L)								
VOLATILE ORGANIC COMPOUNDS								
1,1–Dichloroethane	0.002 – 0.017	5 / 31	0.0006	0.002	0.0015	–	N	Toxicity Screening[2]
1,1–Dichloroethene	0.002 – 0.024	2 / 31	0.002	0.005	0.0017	0.007	N	Toxicity Screening[2]
1,2–Dichlorobenzene	0.001 – 0.001	10 / 31	0.0004	0.21	0.0146	0.6	N	Toxicity Screening[2]
1,2–Dichloroethane	0.001 – 0.014	2 / 31	0.014	0.17	0.0068	0.005	Y	
1,2–Dichloroethene (total)	0.002 – 0.002	10 / 31	0.0006	0.039	0.0051	–	N	Toxicity Screening[2]
1,2–Dichloropropane	0.001 – 0.013	2 / 31	0.001	0.002	0.0008	0.07	N	Toxicity Screening[2]
2–Butanone	0.004 – 0.04	1 / 31	0.036	0.041	0.0041	–	N	Frequency[1]
4–Methyl–2–pentanone	0.002 – 0.02	1 / 31	0.016	0.019	0.0020	–	N	Frequency[1]
Acetone	0.008 – 0.07	4 / 31	0.018	0.57	0.0304	–	N	Toxicity Screening[2]
Benzene	0.0008 – 0.0008	14 / 31	0.0007	0.21	0.0207	0.005	Y	Standard[3]
Carbon disulfide	0.004 – 0.04	2 / 31	0.002	0.008	0.0030	–	N	Toxicity Screening[2]
Carbon tetrachloride	0.002 – 0.02	1 / 31	0.0006	0.0006	0.0015	0.005	N	Frequency[1]
Chlorobenzene	0.001 – 0.001	11 / 31	0.001	0.62	0.0441	0.1	Y	Standard[3]
Chloroform	0.001 – 0.004	4 / 31	0.001	1.5	0.0845	0.1	Y	
Ethylbenzene	0.0008 – 0.008	9 / 31	0.0004	0.008	0.0013	0.7	N	Toxicity Screening[2]
Methylene chloride	0.001 – 0.008	2 / 31	0.2	2.5	0.0877	0.005	Y	
Tetrachloroethene	0.002 – 0.008	4 / 31	0.0007	0.34	0.0161	0.005	Y	
Toluene	0.001 – 0.001	18 / 31	0.0003	0.61	0.0483	1	N	Toxicity Screening[2]
Total Xylenes	0.002 – 0.002	13 / 31	0.002	0.063	0.0088	10	N	Toxicity Screening[2]
Trichloroethene	0.001 – 0.002	11 / 31	0.0006	0.3	0.0200	0.005	Y	Standard[3]
Vinyl chloride	0.001 – 0.012	4 / 31	0.009	0.018	0.0022	0.002	Y	
SEMIVOLATILE ORGANIC COMPOUNDS								
1,2,4–Trichlorobenzene	0.002 – 0.013	2 / 26	0.003	0.006	0.0021	0.07	N	Toxicity Screening[2]
2,6–Dichloropyridine	0.004 – 0.032	15 / 26	0.0005	6	0.5154	–	Y	
2–Chlorophenol	0.004 – 0.028	1 / 26	0.004	0.004	0.0036	–	N	Frequency[1]
2–Chloropyridine	0.004 – 0.032	18 / 26	0.0009	60	5.6132	–	Y	
2–Methylnaphthalene	0.002 – 0.01	3 / 26	0.0009	0.001	0.0014	–	N	Toxicity Screening[2]
3–Chloropyridine	0.004 – 0.032	8 / 26	0.002	4.5	0.2698	–	Y	
4–Chloroaniline	0.002 – 0.011	5 / 26	0.005	0.11	0.0085	–	N	Toxicity Screening[2]
4–Methylphenol	0.004 – 0.024	1 / 26	0.03	0.03	0.0041	–	N	Frequency[1]

TABLE 6-3
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
OVERBURDEN GROUNDWATER

OLIN ROCHESTER PHASE I RI/FS
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen-tration	Maximum Detected Concen-tration	Mean of all Samples	MCL	CPC?	Notes
Acenaphthene	0.001 – 0.008	4 / 26	0.0002	0.007	0.0017	–	N	Toxicity Screening[2]
Anthracene	0.001 – 0.008	1 / 26	0.002	0.002	0.0011	–	N	Toxicity Screening[2]
Benzo(b)fluoranthene	0.002 – 0.012	2 / 26	0.002	0.003	0.0017	0.002	N	Toxicity Screening[2]
Benzo(g,h,i)perylene	0.001 – 0.008	2 / 26	0.0007	0.001	0.0010	–	N	Toxicity Screening[2]
Benzo(k)fluoranthene	0.002 – 0.013	2 / 26	0.0008	0.001	0.0017	0.002	N	Toxicity Screening[2]
Benzoic acid	0.008 – 0.056	1 / 26	0.059	0.059	0.0095	–	N	Frequency[1]
Bis(2-Chloroethyl)ether	0.001 – 0.008	8 / 26	0.0007	0.13	0.0110	–	Y	
Bis(2-ethylhexyl)phthalate	0.001 – 0.008	11 / 26	0.001	0.026	0.0029	0.006	Y	Standard[3]
Di-n-octylphthalate	0.001 – 0.008	2 / 26	0.0004	0.0009	0.0012	–	N	Toxicity Screening[2]
Dibenzofuran	0.001 – 0.006	2 / 26	0.003	0.003	0.0010	–	Y	Toxicity Value[4]
Diethylphthalate	0.002 – 0.012	1 / 26	0.001	0.001	0.0016	–	N	Frequency[1]
Fluoranthene	0.001 – 0.008	3 / 26	0.002	0.004	0.0013	–	N	Toxicity Screening[2]
Fluorene	0.001 – 0.008	2 / 26	0.005	0.006	0.0016	–	N	Toxicity Screening[2]
Naphthalene	0.001 – 0.008	1 / 26	0.001	0.001	0.0012	–	N	Toxicity Screening[2]
Phenanthrene	0.001 – 0.008	2 / 26	0.002	0.011	0.0018	–	N	Toxicity Screening[2]
Pyrene	0.002 – 0.008	2 / 26	0.002	0.003	0.0015	–	N	Toxicity Screening[2]
Pyridine	0.004 – 0.032	12 / 26	0.0004	6.5	0.3001	–	Y	
p-Fluoroaniline	0.004 – 0.032	7 / 26	0.0008	2.1	0.1201	–	Y	Toxicity Value[4]
INORGANICS (æg/l)								
Aluminum		15 / 15	0.36	260	45.1707	0.2#	Y	Toxicity Value[4]
Antimony	0.003 – 0.004	3 / 15	0.003	0.003	0.0019	0.006	N	Toxicity Screening[2]
Arsenic	0.004 – 0.004	13 / 15	0.003	0.15	0.0413	0.05	Y	
Barium		15 / 15	0.033	3.1	0.6972	2	Y	Standard[3]
Beryllium	0.003 – 0.003	2 / 15	0.01	0.011	0.0027	0.004	Y	
Cadmium	0.0002 – 0.0002	14 / 15	0.0003	0.03	0.0044	0.005	Y	Standard[3]
Calcium		15 / 15	75	3500	637.6667	–	Y	Toxicity Value[4]
Chromium	0.01 – 0.01	11 / 15	0.011	0.52	0.0869	0.1	Y	Standard[3]
Cobalt	0.02 – 0.02	7 / 15	0.029	0.23	0.0458	–	Y	Toxicity Value[4]
Copper	0.01 – 0.01	11 / 15	0.012	0.67	0.1223	1.3*	N	Toxicity Screening[2]
Cyanide	0.01 – 0.01	7 / 15	0.012	0.18	0.026	0.2	N	Toxicity Screening[2]
Iron		14 / 14	2.1	780	124.8429	0.3#	Y	Toxicity Value[4]
Lead	0.002 – 0.002	13 / 14	0.002	0.64	0.1069	0.015*	Y	Toxicity Value[4]
Magnesium		15 / 15	20	740	142.6	–	Y	Toxicity Value[4]

TABLE 6–3
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
OVERBURDEN GROUNDWATER

OLIN ROCHESTER PHASE I RI/FS
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen–tration	Maximum Detected Concen–tration	Mean of all Samples	MCL	CPC?	Notes
Manganese		15 / 15	0.18	37	6.672	0.05#	Y	
Mercury	0.0004 – 0.0004	3 / 15	0.0004	0.013	0.0011	0.002	Y	Standard[3]
Nickel	0.03 – 0.03	10 / 15	0.034	0.61	0.1299	0.1	Y	Standard[3]
Potassium		15 / 15	1.3	42	11.72	–	Y	Toxicity Value[4]
Selenium	0.003 – 0.003	1 / 14	0.007	0.007	0.0019	0.05	N	Toxicity Screening[2]
Silver	0.0005 – 0.01	2 / 13	0.013	0.015	0.0060	0.1#	N	Toxicity Screening[2]
Sodium		15 / 15	9.5	2200	352.6933	–	Y	Toxicity Value[4]
Vanadium	0.02 – 0.02	10 / 15	0.027	0.69	0.0816	–	N	Toxicity Screening[2]
Zinc	0.01 – 0.01	13 / 14	0.018	2	0.5037	5#	N	Toxicity Screening[2]

NOTES:

Frequency[1] – Chemical was detected in fewer than 5 percent of the samples.

Toxicity Screening[2] – Chemicals with low ratios (i.e., less than 0.01) are not considered chemicals of potential concern (CPCs).

Standard[3] – Although chemical had a toxicity screening ratio less than 0.01, it exceeds a groundwater standard.

Toxicity Value[4] – Compound cannot be evaluated quantitatively because toxicity values are not available; will be qualitatively discussed.

Class[5] – Although the toxicity screening ratio was less than 0.01, this compound belongs to a class of compounds where at least one compound within this class has a risk ratio greater than 0.01.

MCL – Maximum Contaminant Level

– = No MCL listed for this compound

* – Action Level

– Secondary Standard

mg/L – milligrams per liter

SQL – Sample Quantitation Limit

CPC – Chemical of Potential Concern

Mean of all samples is arithmetic average of all detections plus one–half the SQL for non–detects.

Sample Locations:

[a] – Based on samples B–1 through B–11, B–17, C–1, C–2A, C–3 through C–5, E–1 through E–4, N–1 though N–3, S–1 though S–4, T–121, T–122, T–129, T–134, T–138, T–148, T–159, W–1 though W–5.

[b] – Based on samples B–14 though B–16, EC–1, MW–103, MW–104, MW–106 through MW–108, MW–2, MW–3, MW–G6, MW–G8, MW–G9, PZ–101, PZ–108, T–102, T–103, T–107, T–112, T–115, T–126, T–142 through T–145, T–147, T–150, T–154, T–155, T–157

TABLE 6–4
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
BEDROCK GROUNDWATER

OLIN ROCHESTER PHASE I RI/FS
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen–tration	Maximum Detected Concen–tration	Mean of all Samples	Federal MCL	NY State Groundwater Quality Class GA	Maximum Concentration Exceeds Standards?
BEDROCK GROUNDWATER: ON–SITE* (mg/L)								
VOLATILE ORGANIC COMPOUNDS								
1,2–Dichlorobenzene	0.001 – 0.4	10 / 15	0.0009	0.35	0.0758	0.6	0.0047	NYS[1]
1,2–Dichloroethane	0.001 – 0.56	1 / 15	0.58	0.58	0.0665	0.005	0.005	MCL[2] and NYS[1]
1,2–Dichloroethene (total)	0.002 – 0.8	8 / 15	0.001	0.097	0.0546	0.07/0.1	0.005	MCL[2] and NYS[1]
2–Butanone	0.004 – 1.6	1 / 15	0.007	0.007	0.0827	–	–	No Standard[3]
4–Methyl–2–pentanone	0.002 – 0.8	2 / 15	0.006	0.069	0.0447	–	–	No Standard[3]
Acetone	0.008 – 0.7	7 / 15	0.044	4.1	0.4887	–	–	No Standard[3]
Benzene	0.0008 – 0.32	11 / 15	0.002	0.21	0.0522	0.005	0.0007	MCL[2] and NYS[1]
Bromodichloromethane	0.001 – 0.56	2 / 15	0.016	0.38	0.0500	0.1	0.05	MCL[2] and NYS[1]
Bromoform	0.001 – 0.04	5 / 15	0.37	65	4.7769	0.1	0.05	MCL[2] and NYS[1]
Carbon disulfide	0.004 – 0.16	5 / 15	0.28	37	3.3523	–	–	No Standard[3]
Carbon tetrachloride	0.002 – 0.08	6 / 15	0.18	620	48.4038	0.005	0.005	MCL[2] and NYS[1]
Chlorobenzene	0.001 – 0.001	14 / 15	0.0008	3.6	0.3598	0.1	0.005	MCL[2] and NYS[1]
Chloroform	0.001 – 0.001	12 / 15	0.004	320	29.1168	0.1	0.007	MCL[2] and NYS[1]
Dibromochloromethane	0.001 – 0.48	4 / 15	0.027	7.2	0.5300	0.1	0.05	MCL[2] and NYS[1]
Ethylbenzene	0.0006 – 0.36	2 / 15	0.004	0.16	0.0299	0.7	0.005	NYS[1]
Methylene chloride	0.001 – 0.001	13 / 15	0.058	78	10.7849	0.005	0.005	MCL[2] and NYS[1]
Tetrachloroethene	0.002 – 0.04	9 / 15	0.0007	2.1	0.3328	0.005	0.005	MCL[2] and NYS[1]
Toluene	0.001 – 0.001	13 / 15	0.004	7.2	0.9930	1	0.005	MCL[2] and NYS[1]
Total Xylenes	0.002 – 0.92	5 / 15	0.001	0.96	0.1125	10	0.005	NYS[1]
Trichloroethene	0.002 – 0.2	7 / 15	0.002	0.75	0.0997	0.005	0.005	MCL[2] and NYS[1]
Vinyl chloride	0.001 – 0.48	4 / 15	0.005	0.085	0.0319	0.002	0.002	MCL[2] and NYS[1]
SEMIVOLATILE ORGANIC COMPOUNDS								
1,2,4–Trichlorobenzene	0.002 – 0.004	3 / 15	0.009	0.42	0.0303	0.07	0.005	MCL[2] and NYS[1]
1,3–Dichlorobenzene	0.002 – 0.003	1 / 15	0.06	0.062	0.0050	0.6	0.005	NYS[1]
1,4–Dichlorobenzene	0.001 – 0.002	2 / 15	0.004	0.035	0.0030	0.075	0.0047	NYS[1]
2,4–Dichlorophenol	0.004 – 0.004	1 / 15	0.004	0.004	0.0021	–	0.001 **	NYS[1]
2,6–Dichloropyridine	0.006 – 0.006	14 / 15	0.0006	22	4.7537	–	–	No Standard[3]
2–Chlorophenol	0.004 – 0.006	1 / 15	0.003	0.003	0.0023	–	0.001 **	NYS[1]
2–Chloropyridine	0.048 – 0.048	14 / 15	0.006	280	48.0127	–	–	No Standard[3]
2–Methylphenol	0.004 – 0.006	1 / 15	0.0008	0.0008	0.0021	–	0.001 **	No

TABLE 6-4
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
BEDROCK GROUNDWATER

OLIN ROCHESTER PHASE I RI/FS
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen-tration	Maximum Detected Concen-tration	Mean of all Samples	Federal MCL	NY State Groundwater Quality Class GA	Maximum Concentration Exceeds Standards?
3-Chloropyridine	0.006 – 0.006	13 / 15	0.003	19	2.6661	–	–	No Standard[3]
4-Chloroaniline	0.002 – 0.002	9 / 15	0.004	0.07	0.0212	–	–	No Standard[3]
4-Chloropyridine	0.004 – 0.006	2 / 15	0.001	0.04	0.0052	–	–	No Standard[3]
4-Methylphenol	0.004 – 0.004	1 / 15	0.001	0.001	0.0019	–	0.001 **	NYS[1]
4-Nitroaniline	0.001 – 0.001	1 / 15	0.0008	0.0008	0.0005	–	–	No Standard[3]
Benzoic acid	0.01 – 0.011	5 / 15	0.001	1.1	0.1043	–	–	No Standard[3]
Bis(2-Chloroethyl)ether	0.001 – 0.002	12 / 15	0.002	0.68	0.1678	–	0.001	NYS[1]
Bis(2-ethylhexyl)phthalate	0.001 – 0.002	11 / 15	0.001	0.03	0.0084	0.006	0.05	MCL[2]
Di-n-butylphthalate	0.001 – 0.004	1 / 15	0.006	0.006	0.0010	–	0.05	No
Hexachlorobutadiene	0.004 – 0.004	2 / 15	0.003	0.004	0.0022	–	–	No Standard[3]
Hexachloroethane	0.002 – 0.004	3 / 15	0.004	0.26	0.0229	–	–	No Standard[3]
Isophorone	0.001 – 0.001	1 / 15	0.0006	0.0006	0.0005	–	0.05	No
Pyridine	0.006 – 0.006	13 / 15	0.003	45	5.7335	–	–	No Standard[3]
p-Fluoroaniline	0.006 – 0.006	11 / 15	0.0003	0.88	0.2186	–	–	No Standard[3]
PESTICIDES/PCBs								
4,4'-DDE		1 / 2	0.0001	0.0001	0.0001	–	ND	NYS[1]
4,4'-DDT	0.0002 – 0.0002	1 / 2	0.0001	0.0002	0.0001	–	ND	NYS[1]
Endosulfan II		1 / 2	0.0001	0.0001	0.0001	–	–	No Standard[3]
Endosulfan Sulfate	0.0001 – 0.0001	1 / 2	0.0001	0.0001	0.0001	–	–	No Standard[3]
Endrin	0.0002 – 0.0002	1 / 2	0.0001	0.0001	0.0001	0.002	ND	NYS[1]
Heptachlor Epoxide	0.0001 – 0.0001	1 / 2	0.017	0.017	0.0085	0.0002	ND	NYS[1]
Methoxychlor		1 / 2	0.0001	0.0001	0.0001	0.04	0.035	No
gamma-BHC (Lindane)		2 / 2	0.0003	0.031	0.0157	0.0002	ND	NYS[1]
INORGANICS								
Aluminum	0.09 – 0.09	13 / 15	0.092	6.9	1.3715	0.2#	–	MCL[2]
Antimony	0.003 – 0.008	2 / 15	0.004	0.007	0.0023	0.006	0.003	MCL[2] and NYS[1]
Arsenic	0.003 – 0.004	13 / 15	0.003	0.13	0.0271	0.05	0.0025	MCL[2] and NYS[1]
Barium	0.03 – 0.03	14 / 15	0.045	1.1	0.2508	2	1	NYS[1]
Cadmium	0.0002 – 0.0002	10 / 15	0.0002	0.0026	0.0008	0.005	0.01	No
Calcium		14 / 14	4.1	820	179.9357	–	–	No Standard[3]
Chromium	0.01 – 0.01	6 / 15	0.011	0.099	0.0158	0.1	0.05	NYS[1]
Copper	0.01 – 0.01	11 / 15	0.01	0.15	0.0328	1.3*	0.2	No

TABLE 6–4
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
BEDROCK GROUNDWATER

OLIN ROCHESTER PHASE I RI/FS
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen–tration	Maximum Detected Concen–tration	Mean of all Samples	Federal MCL	NY State Groundwater Quality Class GA	Maximum Concentration Exceeds Standards?
Cyanide	0.01 – 0.01	7 / 15	0.014	0.07	0.0196	0.2	0.1	No
Iron		15 / 15	0.12	300	31.2547	0.3#	0.3	MCL[2] and NYS[1]
Lead	0.002 – 0.002	10 / 13	0.002	0.024	0.0064	0.015*	0.025	MCL[2]
Magnesium		14 / 14	1.3	150	38.1214	–	35	NYS[1]
Manganese		15 / 15	0.012	2.2	0.3847	0.05#	0.3	MCL[2] and NYS[1]
Mercury	0.0004 – 0.0004	6 / 15	0.0004	0.0016	0.0005	0.002	0.002	No
Nickel	0.03 – 0.03	3 / 15	0.034	0.11	0.024	0.1	–	No Standard[3]
Potassium		15 / 15	2.5	110	25.8933	–	–	No Standard[3]
Silver	0.0005 – 0.01	2 / 13	0.0009	0.001	0.0040	0.1#	0.05	No
Sodium		15 / 15	50	3700	1256	–	20	NYS[1]
Vanadium	0.02 – 0.02	6 / 15	0.021	6.6	0.4845	–	–	No Standard[3]
Zinc	0.01 – 0.01	13 / 15	0.018	1.6	0.1763	5#	0.3	NYS[1]
BEDROCK GROUNDWATER: OFF–SITE[b] (mg/L)								
VOLATILE ORGANIC COMPOUNDS								
1,1–Dichloroethane	0.002 – 0.17	6 / 10	0.002	0.025	0.0000	–	0.005	NYS[1]
1,2–Dichlorobenzene	0.001 – 0.001	7 / 10	0.001	5.8	0.6907	0.6	0.0047	MCL[2] and NYS[1]
1,2–Dichloroethane	0.001 – 0.14	1 / 10	0.08	0.08	0.0157	0.005	0.005	MCL[2] and NYS[1]
1,2–Dichloroethene (total)	0.002 – 0.2	7 / 10	0.002	0.58	0.0892	0.07/0.1	0.005	MCL[2] and NYS[1]
Acetone	0.008 – 0.7	1 / 10	0.76	0.76	0.1152	–	–	No Standard[3]
Benzene		10 / 10	0.001	0.18	0.0627	0.005	0.0007	MCL[2] and NYS[1]
Carbon disulfide	0.004 – 0.4	1 / 10	0.004	0.004	0.0264	–	–	No Standard[3]
Carbon tetrachloride	0.002 – 0.2	1 / 10	0.001	0.001	0.0131	0.005	0.005	No
Chlorobenzene	0.001 – 0.001	7 / 10	0.002	1.7	0.2855	0.1	0.005	MCL[2] and NYS[1]
Chloroform	0.001 – 0.13	3 / 10	0.003	0.092	0.0204	0.1	0.007	NYS[1]
Ethylbenzene	0.0008 – 0.088	3 / 10	0.002	0.004	0.0064	0.7	0.005	No
Methylene chloride	0.001 – 0.001	6 / 10	0.002	10	1.5043	0.005	0.005	MCL[2] and NYS[1]
Tetrachloroethene	0.002 – 0.2	3 / 10	0.001	0.016	0.0127	0.005	0.005	MCL[2] and NYS[1]
Toluene	0.001 – 0.001	8 / 10	0.002	2.2	0.3338	1	0.005	MCL[2] and NYS[1]
Total Xylenes	0.002 – 0.24	5 / 10	0.0008	0.038	0.0207	10	0.005	NYS[1]
Trichloroethene	0.002 – 0.2	6 / 10	0.001	0.069	0.0196	0.005	0.005	MCL[2] and NYS[1]
Vinyl chloride	0.001 – 0.12	7 / 10	0.002	0.23	0.0448	0.002	0.002	MCL[2] and NYS[1]

TABLE 6-4
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
BEDROCK GROUNDWATER

OLIN ROCHESTER PHASE I RI/FS
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen-tration	Maximum Detected Concen-tration	Mean of all Samples	Federal MCL	NY State Groundwater Quality Class GA	Maximum Concentration Exceeds Standards?
SEMIVOLATILE ORGANIC COMPOUNDS								
1,4-Dichlorobenzene	0.002 – 0.002	1 / 10	0.034	0.034	0.0040	0.075	0.0047	NYS[1]
2,6-Dichloropyridine	0.006 – 0.006	8 / 10	0.0007	8.4	1.6505	–	–	No Standard[3]
2-Chlorophenol	0.004 – 0.05	1 / 10	0.0004	0.0004	0.0043	–	0.001 **	No
2-Chloropyridine		10 / 10	0.004	50	10.6224	–	–	No Standard[3]
2-Methylnaphthalene	0.002 – 0.002	2 / 10	0.003	0.015	0.0026	–	–	No Standard[3]
2-Methylphenol	0.004 – 0.05	1 / 10	0.009	0.009	0.0052	–	0.001 **	NYS[1]
3-Chloropyridine	0.006 – 0.006	7 / 10	0.013	2.1	0.4394	–	–	No Standard[3]
4-Chloroaniline	0.002 – 0.002	5 / 10	0.007	0.31	0.0475	–	–	No Standard[3]
4-Chloropyridine	0.004 – 0.006	2 / 10	0.0003	0.01	0.0032	–	–	No Standard[3]
4-Methylphenol	0.004 – 0.042	2 / 10	0.002	0.017	0.0054	–	0.001 **	NYS[1]
Acenaphthene	0.001 – 0.002	1 / 10	0.001	0.001	0.0009	–	0.02	No
Benzoic acid	0.008 – 0.011	3 / 10	0.001	0.073	0.0132	–	–	No Standard[3]
Bis(2-Chloroethyl)ether	0.001 – 0.002	6 / 10	0.006	0.15	0.0269	–	0.001	NYS[1]
Bis(2-ethylhexyl)phthalate	0.002 – 0.008	6 / 10	0.001	0.05	0.0077	0.006	0.05	No
Butylbenzylphthalate	0.004 – 0.004	1 / 10	0.001	0.001	0.0020	–	0.05	No
Di-n-butylphthalate	0.001 – 0.001	1 / 10	0.026	0.027	0.0031	–	0.05	No
N-Nitrosodiphenylamine	0.001 – 0.001	1 / 10	0.001	0.001	0.0006	–	0.05	No
Naphthalene	0.001 – 0.002	1 / 10	0.002	0.003	0.0010	–	0.01	No
Phenanthrene	0.001 – 0.002	1 / 10	0.002	0.002	0.0010	–	0.05	No
Pyridine	0.006 – 0.006	7 / 10	0.006	1.8	0.279	–	–	No Standard[3]
p-Fluoroaniline	0.006 – 0.006	8 / 10	0.006	1.2	0.2385	–	–	No Standard[3]
INORGANICS								
Aluminum		10 / 10	0.16	1.4	0.518	0.2#	–	MCL[2]
Antimony	0.003 – 0.004	2 / 10	0.003	0.004	0.0018	0.006	0.003	NYS[1]
Arsenic	0.003 – 0.004	3 / 10	0.005	0.042	0.0071	0.05	0.0025	NYS[1]
Barium		10 / 10	0.066	0.6	0.2703	2	1	No
Cadmium	0.0002 – 0.0002	4 / 10	0.0002	0.0005	0.0002	0.005	0.01	No
Calcium		9 / 9	87	2200	370.7778	–	–	No Standard[3]
Chromium	0.01 – 0.01	2 / 10	0.01	0.011	0.0059	0.1	0.05	MCL[2]
Copper	0.01 – 0.01	2 / 10	0.012	0.31	0.0332	1.3*	0.2	NYS[1]
Cyanide	0.01 – 0.01	6 / 10	0.018	0.073	0.0222	0.2	0.1	No
Iron		9 / 9	0.18	6.4	2.2178	0.3#	0.3	MCL[2] and NYS[1]

TABLE 6-4
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT BEDROCK GROUNDWATER

OLIN ROCHESTER PHASE I RI/FS
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen-tration	Maximum Detected Concen-tration	Mean of all Samples	Federal MCL	NY State Groundwater Quality Class GA	Maximum Concentration Exceeds Standards?
Lead	0.002 – 0.002	5 / 6	0.002	0.003	0.0022	0.015*	0.025	No
Magnesium		9 / 9	25	400	86	–	35	NYS[1]
Manganese		10 / 10	0.03	0.62	0.2168	0.05#	0.3	MCL[2] and NYS[1]
Potassium		10 / 10	6.7	210	31.7	–	–	No Standard[3]
Sodium		10 / 10	31	15000	1903.75	–	20	NYS[1]
Zinc	0.01 – 0.01	5 / 10	0.011	0.043	0.0147	5#	0.3	No

NOTES:

* – Action Level

\# – Secondary Standard

** – Total phenols limit of 1.0 µg/L

mg/L – milligrams per liter

SQL – Sample Quantitation Limit

CPC – Chemical of Potential Concern

Mean of all samples is arithmetic average of all detections plus one-half the SQL for non-detects.

ND – Not detectable

NYS[1] – Maximum detected concentration exceeds New York State groundwater standards.

MCL[2] – Maximum detected concentration exceeds federal MCLs.

No Standard[3] – No federal or state standard is available for evaluation.

– = No standard available for this compound

Sample Locations:

[a] – Based on samples BR-1 through BR-8, BR-2D, BR-3D, PZ-105 through PZ-107.

[b] – Based on samples BR-103 through BR-108, BR-105D, PZ-102 through PZ-104.

TABLE 6-5
SUMMARY OF POTENTIAL EXPOSURE PATHWAYS

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM, AND POINT	SELECTED FOR EVALUATION?	REASON FOR SELECTION OR EXCLUSION
CURRENT AND FUTURE LAND USE			
Site Workers	Dermal contact and incidental ingestion of surface soil, inhalation of volatiles and particulates from surface soil.	Yes	Workers are currently on site on a daily basis.
Site Visitor	Dermal contact and incidental ingestion of surface soil, inhalation of volatiles and particulates from surface soil.	No	Will have fewer and less intense exposures than site worker.
FUTURE LAND USE			
Construction or Utility Worker	Dermal contact with and incidental ingestion of surface and subsurface soil; inhalation of volatiles and particulates from soil; dermal contact with and incidental ingestion of overburden groundwater; inhalation of volatiles released from groundwater.	Yes	Excavation activities are possible at the site. Overburden groundwater is shallow and could enter excavated areas.
Site Worker	Dermal contact and ingestion of ground-water as drinking water; inhalation of volatiles released from groundwater.	No	Water used on-site is from city water supply.
Off-Site Resident	Dermal contact and ingestion of ground-water as drinking water; inhalation of volatiles released from groundwater.	No	Groundwater from this area is not used as drinking water. Residents are connected to municipal water.

TABLE 6-6
QUANTITATIVE RISK SUMMARIES BY MEDIA

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

	MEAN		MAXIMUM	
	Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index
CURRENT AND FUTURE USE				
SURFACE SOIL (0 – 2 inches)				
Incidental Ingestion of Onsite Facility Surface Soil: Industrial/Commercial Worker	1E-05	0.08	5E-05	0.4
Dermal Contact with Onsite Facility Surface Soil: Industrial/Commercial Worker	ND	ND	ND	ND
Inhalation Exposure to Particulates and Volatiles from Onsite Facility Surface Soil: Industrial/Commercial Worker	4E-08	0.001	1E-07	0.004
TOTAL: Industrial/Commercial Worker	1E-05	0.08	5E-05	0.4
Incidental Ingestion of Onsite Non-facility Surface Soil: Industrial/Commercial Worker	3E-06	0.02	6E-06	0.04
Dermal Contact with Onsite Non-facility Surface Soil: Industrial/Commercial Worker	ND	0.0001	ND	0.0002
Inhalation Exposure to Particulates and Volatiles from Onsite Non-facility Surface Soil: Industrial/Commercial Worker	2E-08	0.001	1E-07	0.002
TOTAL: Industrial/Commercial Worker	3E-06	0.02	6E-06	0.04
FUTURE USE				
SOIL (0-10 feet)				
Incidental Ingestion of Soil (0-10 feet): Construction Worker (1 Month Exposure)	2E-07	0.5	2E-06	5
Dermal Contact with Soil (0-10 feet): Construction Worker (1 Month Exposure)	ND	ND	ND	ND
Inhalation Exposure to Particulates and Volatiles from Soil (0-10 feet): Construction Worker (1 Month Exposure)	3E-06	46	1E-05	129
TOTAL: Construction Worker	3E-06	47	1E-05	134
Incidental Ingestion of Soil (0-10 feet): Construction Worker (6 Month Exposure)	1E-06	0.5	1E-05	5
Dermal Contact with Soil (0-10 feet): Construction Worker (6 Month Exposure)	ND	ND	ND	ND
Inhalation Exposure to Particulates and Volatiles from Soil (0-10 feet): Construction Worker (6 Month Exposure)	2E-05	45	8E-05	126
TOTAL: Construction Worker	2E-05	46	9E-05	131
ONSITE OVERBURDEN GROUNDWATER				
Incidental Ingestion of Onsite Overburden Groundwater: Construction Worker (1 Month Exposure)	2E-06	23	3E-05	306
Dermal Contact with Onsite Overburden Groundwater: Construction Worker (1 Month Exposure)	1E-04	57	4E-03	792
Inhalation Exposure to Volatiles from Onsite Overburden Groundwater: Construction Worker (1 Month Exposure)	6E-09	0.00003	1E-07	0.001
TOTAL: Construction Worker	1E-04	81	4E-03	1098
Incidental Ingestion of Onsite Overburden Groundwater: Construction Worker (6 Month Exposure)	1E-05	23	2E-04	300
Dermal Contact with Onsite Overburden Groundwater: Construction Worker (6 Month Exposure)	8E-04	56	2E-02	776
Inhalation Exposure to Volatiles from Onsite Overburden Groundwater: Construction Worker (6 Month Exposure)	4E-08	0.00003	9E-07	0.001
TOTAL: Construction Worker	9E-04	79	2E-02	1076

TABLE 6–6
QUANTITATIVE RISK SUMMARIES BY MEDIA

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

	MEAN		MAXIMUM	
	Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index
OFFSITE OVERBURDEN GROUNDWATER				
Incidental Ingestion of Offsite Overburden Groundwater: Construction Worker (1 Month Exposure)	3E–07	6	2E–06	47
Dermal Contact with Offsite Overburden Groundwater: Construction Worker (1 Month Exposure)	2E–07	32	2E–06	234
Inhalation Exposure to Volatiles from Offsite Overburden Groundwater: Construction Worker (1 Month Exposure)	4E–10	0.000003	9E–09	0.00007
TOTAL: Construction Worker	3E–06	39	2E–06	281
Incidental Ingestion of Offsite Overburden Groundwater: Construction Worker (6 Month Exposure)	3E–06	6	1E–05	46
Dermal Contact with Offite Overburden Groundwater: Construction Worker (6 Month Exposure)	1E–06	32	1E–05	230
Inhalation Exposure to Volatiles from Offsite Overburden Groundwater: Construction Worker (6 Month Exposure)	3E–09	0.000003	5E–08	0.00008
TOTAL: Construction Worker	3E–06	38	2E–05	275
KODAK PROPERTY OVERBURDEN GROUNDWATER				
Incidental Ingestion of Kodak Overburden Groundwater: Construction Worker (1 Month Exposure)	Not Evaluated		1E–06	66
Dermal Contact with Kodak Overburden Groundwater: Construction Worker (1 Month Exposure)	Not Evaluated		2E–06	86
Inhalation Exposure to Volatiles from Kodak Overburden Groundwater: Construction Worker (1 Month Exposure)	Not Evaluated		9E–09	0.001
TOTAL: Construction Worker	Not Evaluated		4E–06	152
Incidental Ingestion of Kodak Overburden Groundwater: Construction Worker (6 Month Exposure)	Not Evaluated		8E–06	65
Dermal Contact with Kodak Overburden Groundwater: Construction Worker (6 Month Exposure)	Not Evaluated		1E–05	84
Inhalation Exposure to Volatiles from Kodak Overburden Groundwater: Construction Worker (6 Month Exposure)	Not Evaluated		5E–08	0.001
TOTAL: Construction Worker	Not Evaluated		2E–05	149

ND – Toxicity data not available for quantitative evalution

TABLE 6-7
QUANTITATIVE RISK SUMMARIES BY RECEPTOR

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

	MEAN		MAXIMUM	
	Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index
CURRENT AND FUTURE USE				
Industrial/Commercial Worker Contact with Onsite Facility Surface Soil: Incidental Ingestion, Dermal Contact, Inhalation of Particulates				
TOTAL: Facility Industrial/Commercial Worker	**1E-05**	**0.08**	**5E-05**	**0.4**
Industrial/Commercial Worker Contact with Onsite Non-facility Surface Soil: Incidental Ingestion, Dermal Contact, Inhalation of Particulates				
TOTAL: Non-facility Industrial/Commercial Worker	**3E-06**	**0.02**	**6E-06**	**0.04**
FUTURE USE				
Construction Worker One Month Contact with Soil (0-10 feet): Incidental Ingestion, Dermal Contact, Inhalation of Particulates	3E-06	47	1E-05	134
Construction Worker One Month Contact with Onsite Overburden Groundwater: Incidental Ingestion, Dermal Contact, Inhalation of Volatiles	1E-04	81	4E-03	1098
TOTAL: Onsite Construction Worker – One Month	**1E-04**	**128**	**4E-03**	**1232**
Construction Worker Six Month Contact with Onsite Soil (0-10 feet): Incidental Ingestion, Dermal Contact, Inhalation of Particulates	2E-05	46	9E-05	131
Construction Worker Six Month Contact with Onsite Overburden Groundwater: Incidental Ingestion, Dermal Contact, Inhalation of Volatiles	9E-04	79	2E-02	1076
TOTAL: Onsite Construction Worker – Six Months	**9E-04**	**125**	**2E-02**	**1207**
Construction Worker One Month Contact with Offsite Overburden Groundwater: Incidental Ingestion, Dermal Contact, Inhalation of Volatiles				
TOTAL: Offsite Construction Worker – One Month	**1E-06**	**39**	**6E-06**	**281**
Construction Worker Six Month Contact with Offsite Overburden Groundwater: Incidental Ingestion, Dermal Contact, Inhalation of Volatiles				
TOTAL: Offsite Construction Worker – Six Months	**6E-06**	**38**	**4E-05**	**275**
Construction Worker One Month Contact with Kodak Overburden Groundwater: Incidental Ingestion, Dermal Contact, Inhalation of Volatiles				
TOTAL: Kodak Construction Worker – One Month	**Not Evaluated**		**4E-06**	**152**
Construction Worker Six Month Contact with Kodak Overburden Groundwater: Incidental Ingestion, Dermal Contact, Inhalation of Volatiles				
TOTAL: Kodak Construction Worker – Six Months	**Not Evaluated**		**2E-05**	**149**

TABLE 6-8
POTENTIAL SOURCES OF UNCERTAINTY

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

UNCERTAINTY	EFFECT	JUSTIFICATION
Likelihood of exposure pathways	Overestimate	Future pathways may not actually occur.
Exposure assumptions (e.g., frequency, duration)	Overestimate	Parameters selected are conservative estimates of exposure.
Degradation of chemicals not considered	Overestimate	Risk estimates are based on recent chemical concentrations. Concentrations will tend to decrease over time as a result of degradation.
Absorption of contaminants on inhaled particulates	Overestimate	Assumption of 100% absorption of chemicals on particulates is conservative.
Extrapolation of animal toxicity data to humans.	Unknown, probably overestimate	Animals and humans differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical. Animal studies typically involve high-dose exposures, whereas humans are exposed to low doses in the environment.
Use of linearized, multistage model to derive cancer slope factors.	Overestimate	Model assumes a non-threshold, linear-at-low-dose relationship for carcinogens. Many compounds induce cancer by non-genotoxic mechanisms. Model results in a 95% upper confidence limit of the cancer risk. The true risk is unlikely to be higher and may be as low as zero.
Summation of effects (cancer risks and hazard indices) from multiple substances.	Unknown	The assumption that effects are additive ignores potential synergistic and/or antagonistic effects. Assumes similarity in mechanism of action, which is not the case for many substances. Compounds may induce tumors or other toxic effects in different organs or systems.
Use of uncertainty factors in the derivation of reference doses	Unknown	Ten-fold uncertainty factors are incorporated to account for various sources of uncertainty. Although some data seem to support the ten-fold factor, its selection is somewhat arbitrary.

continued

TABLE 6-8
POTENTIAL SOURCES OF UNCERTAINTY

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

UNCERTAINTY	EFFECT	JUSTIFICATION
Application of the RfD for pyrene to all PAHs without RfDs and assumption that their effects are additive.	Unknown	Noncarcinogenic effects of PAHs may vary from that of pyrene.
No toxicity values are available for lead and it is excluded from quantitative evaluation.	Underestimate	The UBK model is not appropriate for use in the evaluation of lead ingestion by adults. This evaluation was performed qualitatively using suggested USEPA lead concentrations for soils.
Some analytes excluded from quantitative evaluation because no toxicity information is available.	Underestimate	The exclusion of analytes without toxicity values from quantitative evaluation may bias estimates of risk low.

TABLE 6-9
RISK CHARACTERIZATION SUMMARY

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

LOCATION/MEDIA	EXPOSURE SCENARIO	RISK LEVEL EXCEEDING CRITERIA[1,2]	PREDOMINANT EXPOSURE PATHWAYS CONTRIBUTING TO RISK	PREDOMINANT CPC CONTRIBUTING TO RISK (% OF RISK)[3]
On-site Soil (0-10 feet)	Construction Worker/Excavation	Noncancer	Inhalation	Manganese (97%)
			Incidental ingestion	Mercury (3%)
On-site Overburden Groundwater	Construction Worker/Excavation	Noncancer	Incidental ingestion	Carbon tetrachloride (4%) 2-Chloropyridine (12%) Manganese (6%)
			Dermal contact	Carbon tetrachloride (30%) 2-Chloropyridine (5%) Manganese (33%)
On-site Overburden Groundwater	Construction Worker/Excavation	Cancer	Dermal contact	PAHs (87%)
Off-site Overburden Groundwater	Construction worker/Excavation	Noncancer	Incidental ingestion	2-Chloropyridine (4%) Manganese (10%)
			Dermal contact	2-Chloropyridine (20%) Manganese (58%)

Notes:

[1] Risk level for noncarcinogens is the summary Hazard Index.
Risk level for carcinogens is the summary cancer risk probability.

[2] Criteria based on U.S. Environmental Protection Agency guidance.

[3] Based on average exposure concentrations and total risk.

TABLE 6–10
ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL [a]

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

ANALYTE	CONCENTRATION		FREQUENCY OF DETECTION	CPC ?	NOTES
	AVERAGE [b]	MAXIMUM			
VOLATILE ORGANIC COMPOUNDS (mg/kg)					
Chloroform	0.0050 *	0.0005	1 / 6	Y	
SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)					
1,2,4–Trichlorobenzene	0.192 *	0.022	1 / 6	Y	
2,6–Dichloropyridine	0.065	0.17	6 / 6	Y	
2–Chloropyridine	0.224	0.57	6 / 6	Y	
2–Methylnaphthalene	0.107 *	0.087	4 / 6	Y	
3–Chloropyridine	0.164 *	0.063	2 / 6	Y	
Acenaphthene	0.103	0.27	5 / 6	Y	
Acenaphthylene	0.110	0.17	4 / 6	Y	
Anthracene	0.179	0.48	5 / 6	Y	
Benzo(a)anthracene	0.643	1.6	6 / 6	Y	
Benzo(a)pyrene	0.563	1.2	6 / 6	Y	
Benzo(b)fluoranthene	1.003	2	6 / 6	Y	
Benzo(g,h,i)perylene	0.147	0.22	6 / 6	Y	
Benzo(k)fluoranthene	0.703	1.3	6 / 6	Y	
Bis(2–ethylhexyl)phthalate	3.475	9.5	6 / 6	Y	
Carbazole	0.102	0.33	6 / 6	Y	
Chrysene	0.761	1.5	6 / 6	Y	
Di–n–butylphthalate	0.217	0.33	1 / 6	Y	
Di–n–octylphthalate	0.247	0.43	1 / 6	Y	
Dibenzo(a,h)anthracene	0.144 *	0.11	2 / 6	Y	
Dibenzofuran	0.116	0.15	4 / 6	Y	
Fluoranthene	1.226	2.8	6 / 6	Y	
Fluorene	0.175	0.27	3 / 6	Y	
Hexachlorobenzene	0.180 *	0.039	1 / 6	Y	
Indeno(1,2,3–c,d)pyrene	0.198	0.4	6 / 6	Y	
Naphthalene	0.134 *	0.061	3 / 6	Y	
Phenanthrene	0.672	1.9	6 / 6	Y	
Pyrene	1.178	3	6 / 6	Y	
Pyridine	0.179 *	0.074	1 / 6	Y	
INORGANICS (mg/kg)					
Aluminum	6,533	8,700	6 / 6	Y	
Arsenic	5.4	12	6 / 6	Y	
Barium	60	110	6 / 6	Y	
Cadmium	0.5	0.8	6 / 6	Y	
Calcium	42,983	95,000	6 / 6	N	[d]
Chromium	28	150	6 / 6	Y	
Cobalt	3.9	7.1	3 / 6	Y	
Copper	21	48	6 / 6	Y	
Iron	13,833	17,000	6 / 6	N	[c]
Lead	74	140	6 / 6	Y	
Magnesium	17,508	50,000	6 / 6	N	[c]
Manganese	428	760	6 / 6	Y	
Mercury	0.20	0.4	4 / 6	Y	
Nickel	24	62	6 / 6	Y	
Potassium	893	1,200	6 / 6	N	[c]
Selenium	0.4	0.8	1 / 6	Y	
Silver	0.4	0.7	6 / 6	Y	
Sodium	648	1,400	6 / 6	N	[c]
Vanadium	17	20	6 / 6	Y	
Zinc	150	240	6 / 6	Y	

NOTES:

[a] Based on samples SS–102, SS–105, SS–109, SS–112, SS–113, SS–115.

[b] Average concentration is the arithmetic mean of all sample results with 1/2 the SQL used for non–detects. Some averages may exceed maximum concer due to elevated SQLs.

[c] Analyte is an essential nutrient, and is considered to be hazardous via ingestion in the terrestrial food web only at very high concentrations.

*Average concentration exceeds maximum due to use of elevated SQLs in calculation (see note [b]).

TABLE 6-11
CONCENTRATIONS IN GROUNDWATER AND CANAL WATER COMPARED TO ECOLOGICAL TOXICITY BENCHMARK CONCENTRATIONS

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound	High Water Conditions Calculated Concentration In Canal (mg/L)	Low Water Conditions Calculated Concentration In Canal (mg/L)	Chronic Surface Water Benchmark (mg/L)	High Water HQ	Low Water HQ
Benzene	5.17E-08	5.59E-06	0.181	2.9E-07	3.1E-05
Bromodichloromethane	2.82E-09	3.05E-07	1.06	2.7E-09	2.9E-07
Dibromochloromethane	2.35E-09	2.54E-07	1.06	2.2E-09	2.4E-07
Bromoform	3.76E-09	4.07E-07	0.910	4.1E-09	4.5E-07
Carbon tetrachloride	3.76E-09	4.07E-07	0.860	4.4E-09	4.7E-07
Chlorobenzene	4.70E-08	5.08E-06	0.005	9.4E-06	1.0E-03
1,2-dichlorobenzene	9.86E-08	1.07E-05	0.005	2.0E-05	2.1E-03
1,3-dichlorobenzene	1.88E-09	2.03E-07	0.005	3.8E-07	4.1E-05
Ethylbenzene	1.88E-09	2.03E-07	1.0	1.9E-09	2.0E-07
1,1-dichloroethane	1.17E-08	1.27E-06	20	5.9E-10	6.4E-08
1,2-dichloroethane	2.82E-09	3.05E-07	20	1.4E-10	1.5E-08
1,1,1-trichloroethane	3.76E-09	4.07E-07	9.4	4.0E-10	4.3E-08
1,1-dichloroethylene	4.70E-09	5.08E-07	1.16	4.0E-09	4.4E-07
trans-1,2-dichloroethylene	2.72E-07	2.95E-05	1.16	2.3E-07	2.5E-05
trichloroethylene	6.58E-09	7.11E-07	21.9	3.0E-10	3.2E-08
tertachloroethylene	3.76E-09	4.07E-07	0.84	4.5E-09	4.8E-07
chloroform	2.82E-09	3.05E-07	1.24	2.3E-09	2.5E-07
p-Fluoraniline	9.86E-07	1.07E-04	0.545	1.8E-06	2.0E-04
methylene chloride	1.55E-07	1.68E-05	82.5	1.9E-09	2.0E-07
Xylenes (total)	7.52E-09	8.13E-07	0.014	5.5E-07	5.9E-05
Di-n-butylphthalate	1.27E-08	1.37E-06	0.003	4.2E-06	4.6E-04
bis(2-Ethylhexyl)phthalate	2.35E-08	2.54E-06	0.0006	3.9E-05	4.2E-03
1,2-dichloropropane	2.35E-09	2.54E-07	5.7	4.1E-10	4.5E-08
cis-1,3-dichloropropane	2.82E-09	3.05E-07	0.244	1.2E-08	1.2E-06
pyridine	3.01E-07	3.25E-05	0.35	8.6E-07	9.3E-05
2,6-dichloropyridine	1.97E-06	2.13E-04	1.32	1.5E-06	1.6E-04
3-chloropyridine	7.05E-07	7.62E-05	1.32	5.3E-07	5.8E-05
toluene	5.64E-08	6.10E-06	0.56	1.0E-07	1.1E-05
vinyl chloride	1.08E-07	1.17E-05	14.5	7.4E-09	8.0E-07
2-chloropyridine	2.82E-05	3.05E-03	1.32	2.1E-05	2.3E-03
4-chloroaniline	5.17E-08	5.59E-06	0.04	1.3E-06	1.4E-04
Benzoic Acid	2.77E-08	3.00E-06	55	5.0E-10	5.5E-08
bis(2-Chloroethyl)ether	1.17E-08	1.27E-06	6.78	1.7E-09	1.9E-07

TABLE 6–11
CONCENTRATIONS IN GROUNDWATER AND CANAL WATER COMPARED TO ECOLOGICAL TOXICITY BENCHMARK CONCENTRATIONS

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

Compound	High Water Conditions Calculated Concentration In Canal (mg/L)	Low Water Conditions Calculated Concentration In Canal (mg/L)	Chronic Surface Water Benchmark (mg/L)	High Water HQ	Low Water HQ
Aluminum	4.70E–07	5.08E–05	0.087	5.4E–06	5.8E–04
Antimony	1.88E–09	2.03E–07	0.03	6.3E–08	6.8E–06
Arsenic	1.88E–09	2.03E–07	0.19	9.9E–09	1.1E–06
Barium	2.58E–07	2.79E–05	NA	NA	NA
Berryllium	1.41E–09	1.52E–07	0.0053	2.7E–07	2.9E–05
Cadmium	9.40E–11	1.02E–08	0.0011	8.5E–08	9.2E–06
Chromium	4.70E–09	5.08E–07	0.011	4.3E–07	4.6E–05
Cobalt	9.40E–09	1.02E–06	0.005	1.9E–06	2.0E–04
Copper	4.70E–09	5.08E–07	0.012	3.9E–07	4.2E–05
Iron	3.01E–06	3.25E–04	0.3	1.0E–05	1.1E–03
Lead	1.41E–09	1.52E–07	0.0032	4.4E–07	4.8E–05
Manganese	1.69E–06	1.83E–04	NA	NA	NA
Mercury	1.88E–10	2.03E–08	0.000012	1.6E–05	1.7E–03
Nickel	1.41E–08	1.52E–06	0.096	1.5E–07	1.6E–05
Selenium	1.41E–09	1.52E–07	0.001	1.4E–06	1.5E–04
Silver	4.70E–09	5.08E–07	0.00012	3.9E–05	4.2E–03
Thallium	1.88E–09	2.03E–07	0.008	2.3E–07	2.5E–05
Vanadium	9.40E–09	1.02E–06	0.014	6.7E–07	7.3E–05
Zinc	1.08E–08	1.17E–06	0.03	3.6E–07	3.9E–05
Cyanide	9.40E–09	1.02E–06	0.0052	1.8E–06	2.0E–04

Notes:

HQ = Hazard quotient.
Maximum concentrations calculated based on groundwater at the wells located west of the Olin site (i.e., BR–105, BR–106, BR–107, & BR–108).
NA = Not available.

TABLE 6-12
ECOLOGICAL RISK SCREENING FOR PLANTS FROM SURFACE SOIL EXPOSURES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

	CONCENTRATION		SCREENING	HAZARD
ANALYTE	AVERAGE [a]	MAXIMUM	BENCHMARK [b]	QUOTIENT [c]
VOLATILE ORGANIC COMPOUNDS (mg/kg)				
Chloroform	0.0050	0.0005	NA	NA
SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)				
1,2,4-Trichlorobenzene	0.192	0.022	NA	NA
2,6-Dichloropyridine	0.065	0.17	NA	NA
2-Chloropyridine	0.224	0.57	NA	NA
2-Methylnaphthalene	0.107	0.087	NA	NA
3-Chloropyridine	0.164	0.063	NA	NA
Acenaphthene	0.103	0.27	NA	NA
Acenaphthylene	0.110	0.17	NA	NA
Anthracene	0.179	0.48	NA	NA
Benzo(a)anthracene	0.643	1.6	NA	NA
Benzo(a)pyrene	0.563	1.2	NA	NA
Benzo(b)fluoranthene	1.003	2	NA	NA
Benzo(g,h,i)perylene	0.147	0.22	NA	NA
Benzo(k)fluoranthene	0.703	1.3	NA	NA
Bis(2-ethylhexyl)phthalate	3.475	9.5	200	4.8E-02
Carbazole	0.102	0.33	NA	NA
Chrysene	0.761	1.5	NA	NA
Di-n-butylphthalate	0.217	0.33	200	1.6E-03
Di-n-octylphthalate	0.247	0.43	200	2.2E-03
Dibenzo(a,h)anthracene	0.144	0.11	NA	NA
Dibenzofuran	0.116	0.15	NA	NA
Fluoranthene	1.226	2.8	NA	NA
Fluorene	0.175	0.27	NA	NA
Hexachlorobenzene	0.180	0.039	NA	NA
Indeno(1,2,3-c,d)pyrene	0.198	0.4	NA	NA
Naphthalene	0.134	0.061	NA	NA
Phenanthrene	0.672	1.9	NA	NA
Pyrene	1.178	3	NA	NA
Pyridine	0.179	0.074	NA	NA
INORGANICS (mg/kg)				
Aluminum	6,533	8700	10	8.7E+02
Arsenic	5.4	12	10	1.2E+00
Barium	60	110	500	2.2E-01
Cadmium	0.5	0.8	2	4.0E-01
Chromium	28	150	2	7.5E+01
Cobalt	3.9	7.1	25	2.8E-01
Copper	21	48	40	1.2E+00
Lead	74	140	50	2.8E+00
Manganese	428	760	500	1.5E+00
Mercury	0.2	0.4	0.3	1.3E+00
Nickel	24	62	25	2.5E+00
Selenium	0.4	0.8	1	8.0E-01
Silver	0.4	0.7	2	3.5E-01
Vanadium	17	20	2.5	8.0E+00
Zinc	150	240	20	1.2E+01
			TOTAL HI:	**9.8E+02**

NOTES:

[a] Average concentration is the arithmetic mean of all sample results with 1/2 the SQL used for non-detects. Some average concentrations may exceed maximum concentrations due to elevated SQLs.

[b] Screening benchmarks are presented in Table @.11.

[c] The hazard quotient is calculated by dividing the maximum concentration by the screening benchmark.

NA = Not Available

TABLE 6-13
ECOLOGICAL RISK SCREENING FOR INVERTEBRATES FROM SURFACE SOIL EXPOSURES

OLIN CHEMICALS PHASE I RI REPORT
ROCHESTER, N.Y.

ANALYTE	CONCENTRATION AVERAGE [a]	MAXIMUM	SCREENING BENCHMARK [b]	HAZARD QUOTIENT [c]
VOLATILE ORGANIC COMPOUNDS (mg/kg)				
Chloroform	0.0050	0.0005	150	3.3E-06
SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)				
1,2,4-Trichlorobenzene	0.192	0.022	20	1.1E-03
2,6-Dichloropyridine	0.065	0.17	8	2.1E-02
2-Chloropyridine	0.224	0.57	8	7.1E-02
2-Methylnaphthalene	0.107	0.087	34	2.6E-03
3-Chloropyridine	0.164	0.063	8	7.9E-03
Acenaphthene	0.103	0.27	34	7.9E-03
Acenaphthylene	0.110	0.17	34	5.0E-03
Anthracene	0.179	0.48	34	1.4E-02
Benzo(a)anthracene	0.643	1.6	34	4.7E-02
Benzo(a)pyrene	0.563	1.2	34	3.5E-02
Benzo(b)fluoranthene	1.003	2	34	5.9E-02
Benzo(g,h,i)perylene	0.147	0.22	34	6.5E-03
Benzo(k)fluoranthene	0.703	1.3	34	3.8E-02
Bis(2-ethylhexyl)phthalate	3.475	9.5	630	1.5E-02
Carbazole	0.102	0.33	34	9.7E-03
Chrysene	0.761	1.5	34	4.4E-02
Di-n-butylphthalate	0.217	0.33	630	5.2E-04
Di-n-octylphthalate	0.247	0.43	630	6.8E-04
Dibenzo(a,h)anthracene	0.144	0.11	630	1.7E-04
Dibenzofuran	0.116	0.15	NA	NA
Fluoranthene	1.226	2.8	34	8.2E-02
Fluorene	0.175	0.27	34	7.9E-03
Hexachlorobenzene	0.180	0.039	20	1.9E-03
Indeno(1,2,3-c,d)pyrene	0.198	0.4	34	1.2E-02
Naphthalene	0.134	0.061	34	1.8E-03
Phenanthrene	0.672	1.9	34	5.6E-02
Pyrene	1.178	3	34	8.8E-02
Pyridine	0.179	0.074	8	9.2E-03
INORGANICS (mg/kg)				
Aluminum	6,533	8,700	NA	NA
Arsenic	5.4	12	100	1.2E-01
Barium	60	110	NA	NA
Cadmium	0.5	0.8	50	1.6E-02
Chromium	28	150	50	3.0E+00
Cobalt	3.9	7.1	NA	NA
Copper	21	48	30	1.6E+00
Lead	74	140	1190	1.2E-01
Manganese	428	760	NA	NA
Mercury	0.20	0.4	36	1.1E-02
Nickel	24	62	400	1.5E-01
Selenium	0.4	0.8	NA	NA
Silver	0.4	0.7	NA	NA
Vanadium	17	20	NA	NA
Zinc	150	240	130	1.8E+00
			TOTAL HI:	**7.5E+00**

NOTES:

[a] Average concentration is the arithmetic mean of all sample results with 1/2 the SQL used for non-detects. Some average concentrations may exceed maximum concentrations due to elevated SQLs.

[b] Screening benchmarks are presented in Table @.12.

[c] The hazard quotient is calculated by dividing the maximum concentration by the screening benchmark.

NA = Not Available