FEASIBILITY STUDY REPORT

DOVATRON INTERNATIONAL
ORDER ON CONSENT INDEX # B7-0516-97-05
SITE CODE #704024

Former Binghamton Plastics Site
498 Conklin Avenue
Binghamton, New York

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Project No. 796-0460

TABLE OF CONTENTS

Page

FIGURES

TABLES

PLATES

1.0 INTRODUCTION

This Feasibility Study has been prepared by Shield Engineering Associates, Inc., PC (Shield) to evaluate remedial options at the former Binghamton Plastics site in Binghamton, New York. The facility is located at 498 Conklin Avenue, Binghamton, Broome County, New York (Figure 1). The site, owned by the Dii Group and currently leased to McIntosh Laboratories, Inc., is on the New York State Department of Environmental Conservation (NYSDEC) *Registry of Inactive Hazardous Waste Disposal Sites* (Site Code 704024).

1.1 PURPOSE AND ORGANIZATION OF REPORT

The purpose of this feasibility study is to satisfy the requirements set forth in the NYSDEC Order on Consent (Index # B7-0516-97-05) that was signed into effect on June 23, 1998. The feasibility study (FS) was performed in accordance with the NYSDEC-approved *Remedial Investigation/Feasibility Study Work Plan* dated August 28, 1998. The Order on Consent states that the "Respondent shall prepare an FS Report that shall:

1. Evaluate on-site and off-site remedial actions to eliminate, to the maximum extent practicable, all health and environmental hazards and potential hazards at the site.

2. Perform and prepare the FS in accordance with the Department-approved RI/FS Work Plan and in a manner consistent with CERCLA, the NCP, and the guidance documents identified in Subparagraph II.B.2 of the Order on Consent."

This report is organized into the following sections:

1.0 – Introduction
2.0 – Project Goals and Objectives
3.0 – Development of Remedial Alternatives
4.0 – Preliminary Screening of Alternatives
5.0 – Detailed Analysis of Alternatives
6.0 – Recommended Remedial Alternative
7.0 – References

1.2 SITE DESCRIPTION

The facility, at 498 Conklin Avenue, Binghamton, Broome County, New York (Figure 1), is situated in an industrial/residential setting. The site is bounded by McIntosh Laboratories to the west, the Erie-Lakawanna Railroad, a public park and Susquehanna River to the north, and residential properties to the east and south (Figure 2).

The subject site consists of a large industrial building (44,800 square feet) with associated parking, landscape, and storage areas. A complete list of chemical substances used at the plant is not available; however, the use of TCE and 1,1,1-TCA has been substantiated.

1.2.1 Topography

The site is situated at an elevation ranging from approximately 870 to 880 feet above Mean Sea Level (MSL). The site topography is relatively level sloping gently to the north in the area of the building. The parking area on the southern side of the building is approximately 4 feet higher than the rest of the property. The area north of Conklin Avenue slopes steeply towards the Susquehanna River. Figure 1 shows the regional topography of the area.

1.2.2 Geology

Regional Geology

The site lies in the southeastern portion of the Allegheny Plateau province of the Appalachian Mountains in New York. The rocks of the Allegheny Plateau are sedimentary, several types of which are exposed in outcrops of the plateau. The rock types are limestone, dolostone, sandstone, siltstone, shale, and salt. Three surficial lithologic groups are in the Binghamton, New York area; the West Falls Group, the Sonyea Group and the Genesee Group. These groups are Upper Devonian in age.

The uppermost bedrock group below the subject site is the Sonyea Group. This group consists of siltstone and shale beds. The Sonyea Group ranges in thickness from 200 to 1,000 feet.

Overlying the Sonyea Group is the West Falls Group. This group has eroded directly under the site. The West Falls Group is the predominant bedrock underling the Susquehanna River Valley in central New York State. It consists of eight formations that contain sandstones, siltstones and shales. The West Falls Group ranges in thickness from 1,100 to 1,600 feet.

The Genesee Group is the sedimentary lithologic group underlying the Sonyea Group. It consists of shale and limestone formations and outcrops north of the Binghamton area. This group consists of four separate identified formations. These formations range in thickness from 200 to 1,000 feet.

Area Glaciation

The surface topography in the vicinity of the site consists of glacial and glaciofluvial features common in this portion of the Allegheny Plateau. Erosion and glacial deposition originally formed these features. A preglacial river originally carved the Susquehanna River Valley. The valley was then deepened and widened by continental glacial erosion.

During glacial advance, the ice deposited large volumes of unstratified sediments (glacial till) along the margins of the ice sheet.

The continental glacier began to retreat north approximately 21,000 years ago. As the ice receded northward, meltwater streams eroded the till deposits. These high-energy meltwater streams produced well-sorted fluvial deposits in the valley floor. In addition, preglacial lakes supplied sedimentary deposits. According to the U.S. Geological Survey's (USGS) Open File Report No. 91-457, a lacustrine deposit underlies the Susquehanna Valley floor from Binghamton to Great Bend, reaching thicknesses of 70 feet. The Susquehanna River subsequently deposited fluvial deposits consisting of sand, silts and clays.

Site Geology

Fourteen ground water monitoring wells and one recovery well (DMW1) have been installed on-site. Additionally, numerous soil borings have been drilled on the western side of the property. Three of the monitoring wells and the recovery well were installed by previous consultants. To date, Shield has installed eleven monitoring wells, advanced four soil borings with a drill rig and nine soil borings with a Geoprobe® direct-push soil sampler. The following site geology is based on site research and observations from drilling operations.

The surficial sediments at the site consist of brown, poorly sorted, weathered, glacial till and is found at depths ranging from 0 to 25 feet below the ground surface. The weathered till is unstratified and contains clays, silts, sands, gravels and cobbles. The upper weathered till is a brown clay that contains poorly sorted, sub-rounded gravel.

Below the weathered brown till lies the unweathered till. These sediments are similar to the weathered till and consist of poorly sorted clay, silt, sand, gravel, and cobbles. However, the color grades from light brown to olive-gray and contains fewer cobbles.

1.2.3 Soil Types

Based upon the U.S. Department of Agriculture, Soil Conservation Service (USDA SCS), *Soil Survey, Broome County, New York,* dated March 1971, the soil type at the site is the Mardin Channery silt loam (8 to 15 percent slopes). The Mardin Channery silt loam consists of deep, gently sloping to steep, well-drained and moderately well-drained soils that form in glacial till.

In addition, the local National Resource Conservation Service (NRCS) office was contacted for information related to hydric soils on site. According to NRCS personnel, hydric soils are not known to exist on the property.

1.2.4 Hydrogeology

Regional Hydrogeology

The main ground water aquifer in the area is the Five Mile Point aquifer. The sediments that make up this aquifer are glacial outwash deposits. According to the USGS's Open File Report No. 91-457, the aquifer consists of 30- to 70-foot-thick beds of sand and gravel underlain by sand and silt. The aquifer is bounded laterally and partially beneath by glacial till. The potentiometric surface of the ground water in the Five Mile Point aquifer is approximately 830 ft above mean sea level.

Ground water in the study area is hydraulically connected to the Susquehanna River. The ground water in the area generally flows along the valley walls toward the river and is recharged from upland runoff. Pumping from well fields in the towns of Kirkwood and Conklin has altered the natural flow pattern. In well field areas, ground water that previously discharged to the river is now captured by production wells (USGS Open File Report No. 91-457).

Site Hydrogeology

According to the USGS report, the Binghamton Plastics Site is located approximately two miles downgradient of the westernmost boundary of Five Mile Point aquifer. Based upon this information, the site should not present any threat to the aquifer.

The ground water underlying the site is separated into two water-bearing units. There is a shallow water zone on the southwestern side of the property in the vicinity of the contaminated source area. This shallow water zone was not encountered on the northern and eastern sides of the property.

Ground water on the southwest side of the property (MW1, MW4, MW5, MW8, MW9, MW10, and MW11) was encountered between approximately 3 and 5 feet below the ground surface. Due to the shallow depth of ground water in this area and the potential for cross-contamination into the deeper, regional aquifer, these wells were not installed below a depth of 20 feet. Based upon the first three gauging events, the direction of ground water flow in the shallow ground water zone is to the west-northwest towards Chambers Street. Ground water on the northern and eastern side of the property (MW3, MW6, MW7, and MW12) was encountered between approximately 23 and 32 feet below the ground surface. These wells range from 40 to 48 feet in depth. Ground water flow in this deeper aquifer has been established to be to the east-northeast at a gradient of 0.076 ft/ft. A tight weathered till separates the perched/shallow water bearing unit from the deeper, regional aquifer. Contamination has not been detected in the deeper, regional aquifer to date. Based upon three ground water gauging events, the wells in the deeper aquifer and the wells completed within the shallow aquifer do not appear to be hydraulically connected.

1.2.5 Surface Water

No surface water features (e.g., ponds, streams, springs) are on the subject site. The surface water runoff is collected through a series of catch basins, pipes, and open ditches. The catch basins consist of below ground concrete boxes with grates and curb inlets on the surface that allow water to enter the boxes. The water is transported from the catch basins below the ground to an outfall where the water is discharged to the surface. Catch basins and pipes are used to collect surface water runoff from paved areas. The roof drains discharge to the surface adjacent to the building.

1.2.6 Ambient Air Quality

The site is located in Broome County, New York, Air Quality Control Region 7, in an industrial area. The Region 7 air quality monitoring network consists of six locations where ambient air quality is measured for comparison to the National Ambient Air Quality Standards (NAAQS). The monitoring location in Broome County is in Binghamton. Particulate matter less than 10 microns in aerodynamic diameter (PM10) is measured. Other monitors located in Region 7 analyze for sulfur oxides, ozone, nitrous oxides and carbon monoxide. The location closest to the Binghamton site that measures for multiple parameters is Camp Georgetown, Chenago County, where sulfur oxides, ozone and acid deposition are measured.

The NAAQS are published in the Federal Register and in the 40 Series Code of Federal Regulations (CFR). New York also publishes standards in the state regulations. New York has not adopted the federal standard for PM10, but uses it currently to establish compliance. The primary and secondary NAAQS for PM10 are 50 ug/m^3 for a yearly arithmetic mean average, and 150 ug/m^3 for a maximum 24-hour concentration. According to information from the *New York State Air Quality Report Ambient Air Monitoring System, 1995 Annual Division of Air Resources Report*, the highest reported annual arithmetic mean for Binghamton was 26 ug/m^3 (1991). The 1995 data indicate an annual arithmetic mean of 19 ug/m^3, and a maximum 24- hour concentration of 49 ug/m^3 occurring on July 26, 1995. From a review of the Binghamton area data, no exceedances of PM10 were noted.

1.2.7 Meteorology

Data referenced in this subsection were obtained from the National Weather Service, Binghamton Airport office and the Soil Survey for Broome County. Broome County has a continental humid climate. The summers are warm, and the winters are long and cold with frequent periods of snowfall and stormy weather. The Great Lakes do not have a strong direct influence on the area. All climate data are obtained from the Binghamton airport, which is at an elevation of 1,590 feet above Mean Sea Level. Temperature ranges will vary according to location and are normally a function of diurnal valley breeze and local topographic influence.

The regional topography and location of the county favor a considerable amount of cloudiness, most often in late fall and winter. On average, there are 215 cloudy days per year. The prevailing cloudiness also decreases the percentage of possible sunshine from 60 to 70 percent in the summer to 30 percent in winter.

Mean annual precipitation in the area is 36.99 inches, with the greatest recorded 24-hour rainfall event being 3.88 inches (October 15-16, 1955). Showers and thunderstorms occur on 25 to 30 days a year, providing the greatest precipitation during the months of May through October. This is usually followed by a frontal passage bringing cold, dry, stable air behind the precipitation event. The area experiences snowfall for an extended season. Seasonal snowfall ranges from a record high of 134 inches to a low of 47.8 inches. The greatest 24-hour snowfall was 23 inches on February 3-4, 1961.

Prevailing winds in the area are generally westerly. However, regional topographic and man-made features such as ridges, water, buildings, and vehicles can alter local winds. The average wind speed is 9 mph in the late summer/early fall season and increases to 12 mph in the winter. The area experienced an all-time-record wind speed of 74 mph in July 1992. Dense fog will also occur about 50 days per year.

The annual average temperature is 45.5°F, with a yearly average maximum of 54°F and a yearly average minimum of 37°F. The summer months can be very hot, with a record high temperature of 98°F recorded on July 16, 1988. The average high temperature in the summer is 66.9°F, with an average low temperature in the winter of 23.5°F. Winter can be extremely cold, with a record low of -10°F recorded on January 19, 1994. The average relative humidity in the summer months ranges between 50 to 60 percent; with infrequent extended periods of high temperature and relative humidity.

The average annual atmospheric pressure is 28.26 inches of mercury, with high pressure predominating during the late summer/early fall and the lowest pressures occurring in the winter months.

1.2.8 Ecology

As indicated previously, the site is located in an industrial setting and has been developed and used for industrial purposes. A large portion of the site is covered with a structure and asphalt/concrete for parking and roadways. The western side of the property in the vicinity of the contaminated source area is covered with gravel.

Vegetation is limited to grassy areas directly around the building and parking areas. Some landscaped areas (shrubs and perennials) are also located at the site. No ponds, lagoons, or other surface water features are present at the site. No information is available indicating that a site-specific ecological survey has been conducted.

1.3 SITE HISTORY

According to previous reports, Binghamton Plastics constructed the subject facility in 1956. Additions to the property were reportedly constructed in 1963, 1978, and 1980. Binghamton Plastics operated the facility until the early 1980's when Universal Instruments Corporation purchased the property and converted the facility into a circuit board assembly plant. Universal Instruments operated the facility until they were taken over by Dover Electronics Corporation in the late 1980's. In 1993, Dover Electronics was separated from Dover as a stand-alone corporation named Dovatron, Inc. In 1996, Dovatron changed its name to the Dii Group. The building has been leased to and occupied by McIntosh Laboratories since the early 1990s. The facility is currently used as an electronics assembly and repair facility.

Shield reviewed a June 1990 letter to Hagopian Engineering Associates from the Broome County Health Department (Hagopian 1990). This letter indicated that there were three contaminated sites within a 1/2-mile radius of Conklin Avenue. One of those sites was identified as Binghamton Plastics Dump, which was listed as being located at 498 Conklin Avenue. Reportedly, waste plastics and oils were thought to have been disposed of there. However, this information has not been substantiated.

Starting in 1985, numerous environmental investigations have been conducted at the subject facility by several environmental consultants. These investigations were conducted by Hagopian Engineering Associates (Hagopian), Stetson-Harza, Harza Northeast and Shield Environmental Associates.

Tank Removal (1986)

A 1,000-gallon hydraulic oil tank was reportedly removed from the site in 1986. The name of the tank removal contractor is unknown, and a tank closure report was not available for review. However, the reports reviewed (*Environmental Site Investigation for Dover Electronics Company, DEM-East and Kirkwood North Locations* and *DEM-East, Phase III Investigation, Final Report*) indicated that the tank contained 650 gallons of hydraulic oil contaminated with 1,1,1-trichloroethane (1,1,1-TCA) and trichloroethene (TCE).

Hagopian Engineering Associates (July 1990)

In July 1990, Dover Electronics contracted Hagopian Engineering to conduct a site investigation at the facility for the purpose of establishing an environmental baseline. Concrete cores were collected from six locations inside the 1956 portion of the building to identify an oil-staining problem related to the floor tiles. Several soil samples were also collected in this area. Exact locations of the samples collected were not identified in the copy of the report reviewed (Hagopian, 1990). Samples were analyzed by Upstate Laboratories, Inc. for volatile organic compounds (VOCs) using SW-846 Methods 8010, 8020, and/or 8240. A petroleum scan (FID 310-13) was used to fingerprint selected samples for the presence of petroleum products (gasoline, kerosene, fuel oil and lubricating oil). Concrete core data indicated no chemical contamination, with the exception of hydraulic oil that was detected in the top surface of one concrete core (Core #3), was found. No contamination was found in the soil samples collected below the concrete cores.

Additional soil sampling outside the building indicated elevated chemical compounds in subsurface soils at two borings (B3C and B4C) in the vicinity of the removed UST. Boring B3C contained detectable concentrations of 1,1,1-TCA, TCE, carbon tetrachloride and lubricating oil. Boring B4C contained detectable concentrations of 1,1,1-TCA, TCE and lubricating oil.

Hagopian Engineering Associates (June 1991)

In May/June 1991, Hagopian conducted an expanded subsurface site investigation documented in a report entitled *Phase II Environmental Site Investigation for Dover Electronics*. During the investigation, ground water monitoring wells (MW1-MW4) were installed and soil gas, soil and ground water samples were collected. Stetson-Harza later renamed the monitoring wells DMW1-DMW4.

This investigation detected elevated VOCs in the soils and ground water. Elevated levels of 1,1,1-TCA and TCE were detected in a soil sample collected from 8-10 below the ground surface in DMW1. A soil sample collected from DMW2 also showed an elevated concentration of TCE. A ground water sample collected from DMW1 showed high concentrations of TCE and 1,1,1-TCA. Ground water in DMW2 also had an elevated level of TCE. Hagopian recommended removing the contaminated soil and treating the impacted ground water.

Stetson-Harza Investigation (July 1992)

In July 1992, four borings (D-1 through D-4) were drilled 4 to 6 feet below the ground surface. Two composite soil samples (D-1-2 and D-3-4) were analyzed for VOCs using EPA SW-846 Method 8240. One sample (D-1-2) was also analyzed for toxic characteristic leachate procedure (TCLP) metals, TCLP pesticides and herbicides and TCLP volatiles and base neutral acid compounds. Additionally, the ground water monitoring wells (DMW1-DMW4) were redeveloped, sampled and analyzed for VOCs. Ground water elevation data were also collected during this sampling event. The results of this investigation were documented in a report entitled *Dover Electronics Company DEM – East Phase III Investigation* dated December 1992.

Ground water samples collected indicated elevated concentrations of 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), trans- and cis-1,2-dichloroethene (1,2-DCE), 1,1,1-TCA, and TCE. Based upon these data, a pump and treat ground water treatment system was recommended.

Harza Northeast – Ground Water Treatment System (August 1993)

In August 1993, Stetson-Harza designed a pump and treat system using the existing well (DMW1) as the extraction well piped to a carbon treatment system (two carbon units placed in series). The proposed system was presented in a report entitled *On-Site Ground water Treatment System Engineering Report* dated August 1993. Chemical constituents detected in DMW1 included TCE, PCE, 1,1,1-TCA, 1,1,2-trichloroethane (TCA), cis- and trans-1,2-DCE, 1,1-DCA, 1,1-DCE, vinyl chloride, chloromethane, methylene chloride, chloroform, and cis-1,1-dichloropropane. TCE, 1,1,1-TCA, cis-1,2-DCE, and 1,1-DCA have been detected at the highest concentrations in the influent samples.

The system consists of a positive displacement pump with a pneumatic controller, tanks, pressure gauges, and sampling ports. The system was also fitted with a bag filter prior to carbon treatment. Upon treatment, the system discharges to the Binghamton-Johnson City Sanitary Sewer System. An operational report for the ground water treatment system indicated that approximately 50,030 gallons had been pumped and treated over a 450-day period; however, Dii personnel have reported periods of much lower flow from the treatment well. The system has been shutdown periodically for maintenance and repair and has not run continuously. The system has also undergone some changes to reduce compressor overheating.

Significant concentrations of TCE, 1,1,1-TCA, 1,2-DCE and 1,1-DCA have been removed from the ground water during the operation of the ground water treatment system. In March 1995, Harza Northeast prepared a report entitled *1993 and 1994 Operation Report for On-Site Ground water Recovery and Treatment System.*

Shield Environmental Associates (October 1996)

In October 1996, Shield Environmental personnel sampled the ground water monitoring wells that were installed by Hagopian in 1991, with the exception of DMW2 that was removed during the widening of Chambers Street. Each well was purged of at least three well volumes of water with a disposable bailer prior to sampling. The ground water samples were submitted to Quanterra Environmental Services (Quanterra) for VOC analysis using EPA SW-846 Method 8240 and semi-volatile organic compound (SVOC) analysis using EPA SW-846 Method 8270. Results of this sampling event are contained in the *Baseline Summary Report* dated May 8, 1998.

Shield Environmental Associates (October 1997)

During the period of October 7 to October 10, 1997, three soil borings that were converted into monitoring wells (MW5, MW6, and MW7) were advanced between 20 and 40 feet below the ground surface. The soil borings were drilled through glacial till using a drill rig equipped with 4.25-inch-inside-diameter (I.D.) hollow-stem augers. Continuous soil samples were collected from MW5 to a depth of 16 feet with a split-spoon sampler and field screened with a photoionization detector (PID). The field screening did not detect VOCs in any of the samples collected from MW5. One soil sample, collected from MW5 at a depth of 6 to 8 feet below the ground surface, was submitted to Quanterra Environmental Services for total VOC analysis. Due to their distances from the contamination source, soil samples were not collected from MW6 and MW7.

Water was encountered at approximately eight to ten feet below the ground surface during the drilling of MW5. MW5 was completed to a depth of 20 feet. Water was encountered approximately 30 feet below the surface during the drilling of MW6 and MW7. These wells were completed to a depth of 40 feet. The wells were constructed of 2-inch-diameter, Schedule 40 PVC pipe with 0.010-inch slotted well screen located at the bottom 10-foot interval of each well. A silica sand filter pack was placed to 2 feet above the screen in the annular space of each well. A 2-foot-thick bentonite seal was placed above the filter pack. The remaining annular space was filled with grout to approximately 1 foot below the ground surface. The wells were sealed in 8-inch manholes with locking, watertight caps inside 2-foot by 2-foot concrete well pads. Following installation, each well was developed until the discharge was free of sediment or until the well ran dry.

On October 15, 1997, all wells on site were purged of at least 3 well volumes of water with a disposable bailer prior to sampling. The samples were placed in an iced cooler and submitted to Quanterra for VOC analysis using EPA SW-846 Method 8260A. Results of this investigation are contained in the *Baseline Summary Report* dated May 8, 1998.

Shield Environmental Associates (January/February 1998)

During the period of January 27 to February 5, 1998, twelve soil borings (MW8 through MW13 and SB1 through SB6) were drilled through glacial till using a drill rig equipped with 4.25-inch I.D. hollow-stem augers. Soil samples were collected from each soil boring with a split-spoon sampler and field screened with a PID. VOCs were not detected in any of the samples that were field screened. At least one soil sample from each boring located in the vicinity of the source area was submitted to an EPA approved laboratory for analysis. MW8 through MW13 were converted into ground water monitoring wells and constructed in the same manner as MW5, MW6 and MW7 described above. Following installation, each well (with the exception of MW13, which was dry) was developed until the discharge was free of sediment or until the well ran dry.

On February 5, 1998, the water levels in all monitoring wells on site (DMW1 through MW13) were gauged with an electronic water level indicator accurate to 0.01 feet. DMW2 was removed during the widening of Chambers Street and could not be gauged; however, MW8 was placed in the general vicinity of the former location of DMW2. A perched aquifer appears to be present in the vicinity of the source area on the western side of the building. The water in this perched zone was encountered between approximately 2 to 3 feet below the ground surface. Based on this gauging event, movement within the perched aquifer appears to be to the west-northwest toward Chambers Street. The uppermost regional aquifer was encountered between approximately 22 to 28 feet below the ground surface in DMW3, MW6, MW7 and MW12. Ground water flow in the regional aquifer is to the northeast.

On February 5, 1998, all monitoring wells, with the exception of MW13 which was dry, were purged and sampled using a disposable bailer. Water samples from all wells were placed in an iced cooler and transported to an EPA approved laboratory for total VOC analysis using EPA SW-846 Method 8260A. Water samples collected from DMW1, MW5, and MW9 located within or in the vicinity of the source area were analyzed for the full Target Compound List/Target Analyte List (TCL/TAL). Results of this investigation are contained in the *Baseline Summary Report* dated May 8, 1998.

In June of 1998, an Order on Consent (Index #B7-0516-97-05) was signed into effect by the New York State Department of Environmental Conservation (NYSDEC). Shield Environmental prepared a Remedial Investigation/Feasibility Study (RI/FS) Work Plan and conducted the RI in accordance with the Consent Order. A draft copy of the RI Report was submitted to the NYSDEC in August 1999.

1.4 SUMMARY OF REMEDIAL INVESTIGATION

1.4.1 Contaminant Source Investigation

Three investigative techniques were used during the source area investigation. These techniques included exploratory trenching, passive soil gas sampling, split-spoon soil sampling, and surface water sampling. The surface water sampling was also a part of the Sitewide contaminant migration investigation and was discussed in Section 2.2 of the RI Report.

A subsurface trenching operation was conducted to collect data regarding the character, vertical and lateral extent, and nature of contamination in the expected source area at the facility. The trenches were excavated along the footer of the existing building and along utility lines to determine the pathways of contaminant migration at the facility.

Soil samples were also collected using split-spoon (drill rig) and direct-push (Geoprobe) samplers to define the vertical and lateral extent of vadose zone soil contamination in suspected primary and secondary source areas. The focus areas for the direct-push sampling was under the 1963 addition to the building.

1.4.2 Trenching

During the period of November 16-18, 1999 eleven test trenches were excavated in the locations shown on Plate 1. Two additional test trenches were excavated in the utility trenches located on Chambers Street on July 27, 1999. All soil and ground water samples collected from the test trenches were submitted to Quanterra for SSPL analyses. Selected samples were also submitted for TAL/TCL analyses.

Field observations and headspace analyses did not detect high levels of volatile organic compounds in the soil samples collected from the test trenches. Some black staining was noted along the footer of the building in Trench 1 and Trench 2; however, strong odors were not noted.

Laboratory analysis detected concentrations of TCE, cis-1,2-DCE, and vinyl chloride at levels exceeding the *Soil Cleanup Objectives to Protect Ground Water Quality (TAGM 4046)* in soil samples collected from Trench 7. PCE was detected at a concentration exceeding cleanup objectives in a soil sample collected from Trench 4. Laboratory analyses of soil samples collected from the remaining test trenches did not detect VOCs at concentrations exceeding the cleanup objectives.

Soil samples collected from Trench 1 and Trench 3 were also analyzed for the TAL/TCL. Semi-volatile organic compounds (SVOCs) were not reported above the established detection limits. Metals were detected at concentrations consistent with normal background concentrations.

Perched water was encountered along the building footer in Trenches 1, 2, and 9. Water was also encountered in the vicinity of the former UST pit in Trenches 4 and 10. One or more VOCs were detected above the levels specified in the *Ground water Standards/Criteria (TAGM 4046)* in water samples collected from all trenches except Trench 2.

Water samples from T1 and T2 were analyzed for the TAL/TCL. SVOCs were not reported above the established detection limits in either sample. Any elevated metals concentrations in water samples collected from T1 and T2 are most likely the result of sediment in the sample.

1.4.3 Soil Borings (Outside)

Four soil borings (SB7, SB8, MW14, and MW15) were advanced outside of the building at the locations shown on Plate 1. Soil samples collected from SB7, SB8 and MW14 did not show VOC concentrations above the established reporting limits. The soil sample from MW15 (MW15 SS (6'-8')) showed detections above the established reporting limits of TCE and cis-1,2-DCE, however, the concentrations were below the appropriate SCGs for soils.

1.4.4 Passive Soil Gas Survey

During the period of May 8-9, 1999, a passive soil gas survey was conducted. Nineteen soil gas detectors were placed under the concrete floor of the facility at the locations shown in Figure 3.

The soil gas samples were shipped overnight via Federal Express to Maryland Spectral Services, Inc. for SSPL analysis. 1,1,1-TCA was detected at concentrations exceeding 100 ng/L in SG10, SG11, and SG13. TCE was detected at concentrations exceeding 50 ng/L in SG02, SG03, SG07, and SG13. 1,1,2-Trichlorotrifluoroethane (Freon 113), which can be produced from the degradation of chlorinated organics, was detected in excess of 100 ng/L in SG01, SG05, SG10, SG13 and SG14. A contour map showing total soil gas concentrations of the SSPL and 1,1,2 trichlorotrifluoroethane is presented in Figure 5.

Due to the nature of the collection of passive soil gas samples, the soil gas concentrations do not directly correspond to expected soil concentrations of VOCs. The soil gas samples were evaluated on a qualitative basis and used as a screening tool to establish the locations for the collection of soil samples under the facility.

1.4.5 Geoprobe® Soil Borings (Inside)

On July 16, 1999, nine soil borings (GP1-GP9) were advanced inside the building. The locations of the soil borings were based on the results of the passive soil gas analysis and limited only by equipment access restrictions. Soil samples were not collected significantly below the ground water table. Ground water under the facility was encountered at a depth of approximately 6-7 feet below the floor of the facility. Figure 4 shows the locations of the soil borings. All soil samples were shipped overnight via Federal Express to Quanterra for SSPL analyses.

Although there were many detections of chlorinated organics in the soil samples collected below the building, only one sample (GP6 (0.5'-4')) exceeded the NYSDEC *Soil Cleanup Objectives to Protect Ground Water Quality (TAGM 4046)* for TCE.

1.4.6 Surface Water

On February 2, 1999, three surface water samples were collected. The samples were collected from manholes and catch basins shown on Plate 1. The samples were shipped overnight via Federal Express to Quanterra for SSPL analyses.

One sample (MH282-SW) was collected from the storm sewer system under Chambers Street. VOCs were not detected above the established detection limits. Samples were also collected from a catch basin (CB342-SW) and a catch basin outfall (CBO45-SW). 1,1,1-TCA and PCE were detected above New York State SCGs for surface water in a sample collected from CB342. Additionally, 1,1,1-TCA and TCE were detected above surface water SCGs in a sample collected from CBO45.

1.4.7 Geologic Investigation

Soil samples collected during the drilling phases of the RI showed interbedded grayish brown and yellowish brown silty clays, silt, and sand to a depth of approximately 30 feet below the ground surface. The soil contained poorly sorted, sub-rounded pebbles and cobbles typical of a glacial till deposit. Samples collected on the southwest side of the facility were less compact and saturated below a depth of approximately 6 feet. Monitoring wells and soil borings in this area were not drilled below a depth of 20 feet to avoid the cross-contamination of the deeper aquifer.

1.4.8 Ground Water Investigation

The location and elevation of each monitoring well on site has been determined by survey. The depth to ground water in each well has been measured with a water level indicator accurate to 0.01 feet. Some monitoring wells have been gauged numerous times during the past two years. All of the wells currently on site have been gauged at least once.

Based on previous and current ground water elevation data, there are two distinct ground water zones on site. A shallow aquifer was encountered on the southern and western sides of the facility at a depth ranging from approximately 1.4 to 5.7 feet below the ground surface. Ground water flows in a west-northwesterly direction in the shallow aquifer. Figure 6 is a potentiometric surface map for ground water in the shallow aquifer. This aquifer was not encountered during drilling on the northern and eastern sides of the facility.

A deeper regional aquifer was encountered across the site at a depth ranging from approximately 22.6 to 32.0 feet below the ground surface in DMW3, MW6, MW7 and MW12. This aquifer flows in a northeasterly direction toward the Susquehanna River. Figure 7 is a potentiometric surface map for ground water in the deeper aquifer.

During the period of December 7-10, 1998, all monitoring wells on site were sampled. Quanterra analyzed all ground water samples collected during the RI for the SSPL. Selected ground water samples were analyzed for the full TAL/TCL.

Ground water samples collected from the shallow aquifer on the southwestern side of the facility showed strong detections of chlorinated organics. TCE was detected at concentrations exceeding 1 mg/l in DMW1, MW5, MW11 and MW15. Chlorinated organics were detected at concentrations exceeding levels specified in *Appendix A, Table 1 (Ground water Standards/Criteria)* of the *Technical and Administrative Guidance Memorandum (TAGM) 4046* in DMW1, MW5, MW8, MW9, MW10, MW11 and MW15. Contaminants were not detected above the established reporting limits in ground water samples collected from one upgradient monitoring well (DMW4) and two downgradient monitoring wells (MW13 and MW14) that were installed within the shallow aquifer. Figure 8 is an isopach map showing the total concentrations of the SSPL compounds in ground water at the site.

A water sample from MW5 was analyzed for the full TAL/TCL. Semi-volatiles, metals, PCBs, herbicides and pesticides were not detected above allowable TAGM 4046 concentrations.

Selected ground water samples collected within the contaminant plume were also analyzed for total organic carbon (TOC), sulfates, nitrates and chlorides. These analyses results are used in conjunction with parameters measured during the low-flow sampling to evaluate natural biodegradation rates and contaminant persistence.

Contaminants were not detected above the established reporting limits in ground water samples collected from monitoring wells (DMW3, MW6, MW7, and MW12) that were installed within the deeper regional aquifer.

1.4.9 Pump Test

Two limited pump tests were conducted using DMW1 and MW5 during the period of February 1-8, 1999. The purpose of these tests was to establish the approximate hydraulic conductivity, transmissivity, and storativity of the shallow aquifer in the area of the highest ground water contamination. These tests also established the approximate cone of depression.

Data from the pumping and observation wells were recorded using pressure transducers and data loggers. This information, along with the physical characteristics of the pumping well and observation wells, was imported into AQTESOLV® for Windows®. AQTESOLV® is a computer program that features a suite of analytical solutions for determining aquifer properties from pumping tests. The program features an automatic curve-matching feature that provides greater objectivity and a detailed statistical evaluation of the results.

Pump Test #1 was conducted using MW5 as the pumping well and MW15 as the observation well located approximately 16 feet from MW5. The transmissivity at MW5 was calculated at 0.617 ft^2/min; the storativity was 0.001679; and the hydraulic conductivity was 3.09 x 10^{-2} ft/min. The radius of influence was at least 16 feet.

Pump Test #2 was conducted using DMW1 as the pumping well and MW15 as the observation well located approximately 40 feet from MW5. The transmissivity at DMW1 was calculated at 1.0 ft^2/min; the storativity was 0.001039; and the hydraulic conductivity was 5.00 x 10^{-2} ft/min. The radius of influence was at least 40 feet.

The aquifer properties calculated from these pump tests are much higher than what is normally expected in a tight till. However, as discussed earlier, the soils in the vicinity of DMW1 and MW5 were not as dense as in the surrounding area. Additionally, soils in this area were saturated below a depth of approximately 6 feet. During the low-flow sampling discussed in Section 2.4.2, many of the wells completed in the shallow aquifer produced less than 0.05 gallons per minute. DMW1 and MW5 produced as much as 0.5 gallons per minute during the pump test.

1.4.10 Indoor Air Quality Monitoring

In August 1999, Shield conducted indoor air quality monitoring at the former Binghamton Plastics facility. Tests were conducted during business hours and on the weekend. Five Summa canisters were placed inside the facility at the locations shown on Figure 9 for each test. Summa canisters are stainless steel collection devices that are used to obtain qualitative and quantitative analysis of ambient air. Air enters the canisters through a regulator that controls the air flow. Air samples were collected continuously over an 8-hour period.

Volatile organic compounds (VOCs) detected in the building were magnitudes lower than the 8-hour time weighted average exposure limits established by OSHA for industry workers (29 CFR 1910.1000). Additionally, according to the New York State Department of Health (NYSDOH) database, VOC concentrations in the building are generally consistent with average VOC concentrations found in residential settings. Based on the results of the indoor air monitoring, the NYSDOH has concluded that indoor air VOC concentrations do not currently pose a health threat to workers at the facility.

1.5 NATURE AND EXTENT OF CONTAMINATION

1.5.1 Applicable Standards, Criteria and Guidance (SCGs)

Table 1 summarizes the New York State Applicable Standards, Criteria and Guidance documents in effect for this site.

1.5.2 Summary of Nature and Extent of Contaminated Media

Soil (Vadose Zone)

Soil samples were collected across the site using an excavator (test trenches), a drill rig (outdoor soil borings) and a Geoprobe® (indoor soil borings). Soil samples collected outside of the building have not shown contaminant concentrations exceeding State cleanup objectives (TAGM 4046) within the vadose zone. TCE was detected above cleanup standards in only one soil sample collected under the building; however, a passive soil gas survey suggests that a significant source may exist under the southwest section of the building.

Ground Water

Concentrations of TCE and 1,1,1-TCA exceeding regulatory cleanup standards (TAGM 4046) have been detected in a shallow ground water zone located on the southwestern side of the property. Associated degradation products (1,1-DCE, 1,2-DCE, 1,1-DCA, vinyl chloride and chloroform) have also been detected at levels exceeding regulatory standards. The formal analytical results suggest that the shallow ground water contamination is isolated to an area measuring approximately 10,000 square feet. However, analytical results of soil and water samples collected from excavations within Chambers Street indicate that contamination may be migrating off-site through utility conduits.

A deeper aquifer flowing northeast at a depth of approximately 25-30 feet below the ground surface has not shown contamination above regulatory standards.

Surface Water

Surface water drains from the site into catch basins located on the property and in Chambers Street and Conklin Avenue. A storm water sample collected from a manhole located on Chambers Street did not detect contaminants above regulatory standards. Water samples collected from a catch basin on the north side of the building and the associated catch basin outfall located on the north side of Conklin Avenue had detections of TCE and 1,1,1-TCA slightly above regulatory standards. A drain line that runs through the center of the building feeds the catch basin on the north side of the facility. The outfall on the north side of Conklin Avenue flows on the surface to the north for approximately 15 feet before flowing into another catch basin that is piped to an intermittent stream located approximately 300 feet down gradient of the facility. The intermittent stream has not been sampled.

2.0 PROJECT GOALS AND OBJECTIVES

The project goals and objectives are media-specific for achieving protection of human health and the environment. The goals and objectives are developed on the basis of chemicals of concern, media currently impacted, exposure pathways and allowable exposure levels. A list of the contaminants of concern by affected media is contained in Table 2. The exposure levels are based upon applicable standards, criteria, and guidance (SCGs) and acceptable risks.

The baseline risk assessment evaluated the potential impacts of site contaminants on human health and the environment through air, soil, surface water, sediments and ground water at and near the Binghamton Plastics Site. The chemicals of concern are based upon contaminants found in the waste source areas, the frequency and concentrations found in the environmental media, their physical and chemical characteristics and potential associated human health risks.

2.1 SOURCE AREA

Data collected during the RI suggests that a source for the ground water contamination at the site exists under the 1963 addition to the building. Although only one soil sample collected under the facility showed TCE concentrations above allowable levels in soil (TAGM 4046), passive soil gas and ground water data indicate a significant source of TCE and 1,1,1-TCA contamination under the facility.

Detailed information concerning former processes at the facility and plant design (i.e. utility lines, sumps, discharge points, septic tanks, etc.) has not been found. Based on the low concentrations of TCE and 1,1,1-TCA in the soil with respect to the ground water, it is possible that a point source such as a sump or underground tank may still exist under the building.

A sub-floor drain line inside of the building was investigated during the RI. The line has been disconnected and is no longer utilized by the facility. Due to either corrosion or collapse of the pipe, a trace of the line was not successful. It is not known if the pipe discharged to the suspected source area under the 1963 addition to the building. A water sample collected from inside of the pipe did not contain VOCs above the established detection limit.

2.2 GROUND WATER

The ground water plume at the site covers an area of approximately 10,000 square feet and is mostly contained within a shallow, perched water-bearing zone on the western side of the property. Water samples collected off-site from trenches excavated adjacent to the utility lines under Chambers Street showed elevated concentrations of VOCs downgradient of the plume.

The objectives for remediation of the on-site ground water contamination will be two-fold. The first objective is to discontinue the off-site migration of VOCs in ground water. The second objective is to attack the on-site TCE and 1,1,1-TCA contamination to reduce the concentrations in ground water to below the 1.1.1 Technical and Operational Guidance Series (TOGS) standards or to a standard designed to protect human health and the environment.

3.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The following section will present remedial alternatives that are meant to address the remedial goals presented in the previous section.

3.1 PRESUMPTIVE REMEDIES DIRECTIVE

The EPA has developed policy and procedures for presumptive remedies at sites where commonly encountered characteristics are present. Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The EPA has: evaluated technologies that have been consistently selected at sites using the remedy selection criteria set out in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); reviewed currently available performance data on the application of these technologies, and; has determined that a particular set of remedies is presumptively the most appropriate for addressing specific types of sites. The objective of the presumptive remedies is to use past experience to speed up the evaluation a selection of remedial options, to ensure the consistency in remedy selection and to reduce the time and cost required to clean up similar types of sites. The presumptive remedies directive eliminates the need for the initial step of identifying and screening a variety of alternatives during the Feasibility Study. The NCP states, "the lead agency shall include an alternatives screening step, *when needed*, to select a reasonable number of alternatives for detailed analysis." EPA has analyzed feasibility studies for sites with commonly encountered contamination (i.e., sites with VOC-contaminated soil) and found that certain technologies are routinely screened out based on effectiveness, implementability, or excessive costs, consistent with the procedures set forth in the NCP. Accordingly, EPA has determined that for sites that meet the requirements of the presumptive remedies directives, site-specific identification and screening of alternatives is not necessary.

The FS will use the following presumptive remedy guidance directives: *Presumptive Remedies: Policy and Procedures,* USEPA Directive 9355.0-47FS, September 1993; *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils,* USEPA Directive 9355.0-48FS, September 1993; *Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites-Final Guidance,* USEPA Directive 9283.1-12; and *Presumptive Remedy: Supplemental Bulletin Multi-Phase Extraction (MPE) Technology for VOCs in Soil and Ground water,* USEPA Directive 9355.0-68FS, April 1997.

3.2 IDENTIFICATION OF REMEDIAL ALTERNATIVES FOR SOIL

As discussed in the previous section, the EPA has determined that, for sites that meet the requirements of the presumptive remedies directives, site-specific identification and screening of alternatives is not necessary. This section identifies remedial alternatives for the contaminated soil at the Binghamton Plastics site. These alternatives have been generated based on the guidance included in the EPA's document entitled *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils.* In addition to the presumptive remedies, a "no further action" alternative has been included.

3.2.1 No Further Action

The "no further action" alternative is included as a baseline to evaluate the other alternatives. Under this alternative, no action would be taken to address the contaminated soils present at the site.

3.2.2 Soil Vapor Extraction (SVE)

Soil vapor extraction (SVE) is an in situ soil remediation technology used for vadose zone (unsaturated zone) VOC contamination. An SVE system works by applying a vacuum to the contaminated soil to induce the controlled flow of air, thereby removing VOCs by volatilization. The vacuum is generated using a vacuum pump/compressor and VOCs are typically recovered through a series of horizontal or vertical wells, or recovery trenches. Discharged off-gases and recovered condensate may require treatment depending on the concentrations of the contaminants in the discharge stream and local standards and guidelines.

As stated above, SVE is applicable for sites were VOCs exist in unsaturated soils. Its strengths include; effectiveness to remove significant concentrations of VOC contaminants from soils in a relatively short period of time, minimized site disturbance compared to excavation, and relatively low operations and maintenance cost. SVE is limited by contaminant volatility, by soil types; in general SVE is less effective in tighter soils. Also, SVE is limited by soil moisture content, contaminant solubility, and variable soil conditions.

At the former Binghamton Plastics Site, horizontal wells will be considered for vapor extraction to attack the VOCs in source area soils under the rear of the on-site facility. Horizontal wells versus vertical wells are used when the target area is relatively shallow.

The EPA directive entitled *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils* contains the average performance, advantages, limitations and general costs for SVE systems for comparison of approved presumptive remedy technologies.

3.2.3 Thermal Desorption

Thermal desorption is an ex situ process that uses direct or indirect heat exchange to vaporize organic contaminants from soil, sediment, sludge or other solid and semisolid matrices. The vapors are then condensed or otherwise collected for further treatment. This process can be performed either on the site or off the site. All the VOC compounds detected at the site can be readily treated by thermal desorption.

Thermal desorption is applicable for aromatics, gasoline and diesel range organic compounds and chlorinated solvents. Strengths include short duration remediation effort and relatively cost effective. Limitations depend on whether it is performed on-site or off-site. On-site limitations include volume of material for it to be cost effective to acquire permits and mobilize equipment, soil conditions and available space onsite for material management and equipment. Off-site limitations include availability of a thermal treatment system local to the site to make it cost effective, regulatory/permit limitations for handling chlorinated solvents, and other soil conditions such as debris being present.

Table 3 of the EPA directive entitled *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils* contains the average performance, advantages, limitations and general costs for thermal desorption.

3.2.4 Incineration

Incineration is an ex-situ process that employs thermal decomposition via oxidation at temperatures usually greater than 900 degrees Celsius. The incineration process is designed to destroy the organic constituents in the waste. Incineration oxidizes organic compounds, thereby destroying the VOCs. Applicability, strengths and limitations are similar to those described for thermal treatment, except that incineration can provide complete destruction.

Table 3 of the EPA directive entitled *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils* contains the average performance, advantages, limitations and general costs for incineration.

3.3 IDENTIFICATION OF REMEDIAL ALTERNATIVES FOR GROUND WATER

This section identifies remedial alternatives for remediating the contaminated ground water at the site. These alternatives have been generated using EPA guidance documents.

3.3.1 No Further Action

This alternative is listed as no <u>further</u> action to acknowledge the interim remedial measures (IRMs) and remedial measures taken prior to the June 1998 Consent Order. The no further action alternative is included as a procedural requirement and as a baseline to evaluate the other alternatives. Under this alternative, no additional remedial action would be taken to address the contaminated ground water present at the site. As part of this action, ground water samples would be collected from a limited number of wells and analyzed for specific contaminants, which have exceeded New York State guidance levels (TOGS).

3.3.2 Air Sparging

Air sparging involves the introduction of compressed air into the contaminated ground water zone. It is used to mobilize dissolved VOC contaminants in ground water to the gaseous phase, which then migrates to the vadose zone. The gaseous VOCs are typically removed from the vadose zone by an SVE system. Additionally, low flow air sparging is used in conjunction with aerobic biodegradation.

Well spacing and air injection rates for air sparging are typically established during pilot testing. High flow rates (>5 cfm) are typical when air sparging is used to volatilize compounds in combination with SVE. Lower air flow rates (<5 cfm) are characteristic of biological processes.

Air Sparging is applicable for volatile and/or biodegradable contaminants where soil conditions allow. Sparging effectiveness is dependent on several parameters including; soil heterogeneity and permeability, the contaminant solubility, and contaminant concentration.

3.3.3 Natural Attenuation

Monitored natural attenuation uses natural biodegradation, sorption and volatilization of the affected media to reduce the VOC concentrations in the contaminated ground water zone. The term "monitored natural attenuation" as used in EPA's directive entitled *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water* (September 1998) refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored clean-up approach) to achieve site-specific remedial objectives within a time frame that is reasonable compared to other methods. The natural attenuation processes that are at work in such a remedial approach include a variety of physical, chemical, or biological processes. These processes, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume or concentrations of contaminants in ground water.

Natural biodegradation of chlorinated solvents can be in the form of chemical reactions, microbiological reactions or a combination of both. Chemical reactions of chlorinated solvents undergo either or both substitution or dehydrohalogenation reactions in water. Substitution reactions of chlorinated or halogenated solvents in water involve the replacement of a halogen substituent with a hydroxy (-OH) group. Dehydrohalogenation reactions of halogenated solvents in water usually involve the elimination of hydrogen halide from an alkane and the formation of an alkene.

Microbiological reactions are similar to the substitution and elimination reactions above, except that they are mediated by microorganisms. These can be either aerobic or anaerobic. The more highly chlorinated solvents such as tetrachloroethylene (PCE) do not appear to readily undergo aerobic degradation.

Factors affecting the natural attenuation processes include; 1) the presence of heavy metals and high sulfide concentrations; 2) lack of appropriate nutrients; 3) geologic or hydrogeological conditions such as fractured rock.

3.3.4 In-Well Air Stripping

In-well air stripping involves mobilizing the dissolved VOC contamination in ground water to the gas phase inside treatment wells. This action is performed by pumpingcontaminated ground water into contact with forced air through a media. The metal or plastic media is designed to increase the surface area of the bubbling water, thereby increasing the volatilization process. The water is forced vertically up through the media, which is packed or stacked in the well. The water is then discharged into a shallower zone in the same water-bearing unit through a screened interval in the same well. The ground water is continually pumped from the total depth of the well and discharged into a shallower zone.

This continuous pumping of ground water from the bottom of the well and re-injection at a shallower depth creates a water current loop. Contaminants are not destroyed by air stripping, rather they are physically separated from the ground water and transferred to the air. Depending on the contaminant level in the air discharge, the contaminated air stream may require treatment.

This technology is typically applicable for sites where traditional pump and treat technologies for VOCs are used. Its strengths compared to other treatments include limited use of space at the site, and no treated water discharge streams to permit or monitor. Weaknesses include a hydrogeological setting that produces lower volumes of water limiting the radius of influence and requiring wells to be closely spaced. Furthermore, capital costs for equipment is higher than traditional wells and ex-situ air strippers.

3.3.5 Ground Water Extraction and Treatment

The following remedial alternatives involve ex-situ ground water treatment. Ground water would be pumped from recovery wells (or via Multi-Phase Extraction) and treated prior to discharge. Following treatment, with the appropriate permits, the water would be discharged to the surface or the local sanitary sewer system.

Air Stripping

Air stripping uses volatilization to transfer contaminants from ground water to the air. Contaminants are removed or stripped from the water using a forced air stream. Specific chemicals are stripped depending on the equilibrium vapor pressure of that chemical as expressed by its Henry's law constant.

Air stripping is typically applicable for contaminants in ground water that have relatively low solubility and good volatility. Examples include aromatic hydrocarbons, and certain chlorinated solvents such as PCE, TCE...etc. This technology is limited by site characteristics including the ability of the site to yield enough ground water to make it economical to recover and air strip and water quality that would require pretreatment to remove other contaminants such as heavy metals that may foul or impact stripper performance. Depending on the off-gas concentrations and the efficiency of the stripper, effluent treatment for the off-gases and the water may be required.

Granular Activated Carbon

Activated carbon removes contaminants from ground water by adsorption. The adsorption process takes place in three steps: (1) contaminant migration to the external sorbent surface; (2) diffusion into the sorbent pore structure; and (3) adsorption onto the sorbent surface. The principal form of activated carbon used for ground water treatment is granular activated carbon (GAC). GAC acts as an excellent sorbent due to its large surface area.

GAC treatment is typically provided through the use of drums or some larger vessel, depending on the ground-water flow rate. GAC treatment has shown demonstrated effectiveness for a wide range of contaminates including; petroleum hydrocarbons, chlorinated solvents, metals, semi-volatile organics, and organo-sulfur compounds...etc. Factors affecting GAC cost effective treatment include: the concentration of contaminants present, whether free product is present, the need for pretreatment due to ground water quality parameters such as solids/metals, ongoing transportation/disposal of spent carbon. Carbon may need to be disposed of as a hazardous waste due to its characteristics.

Chemical/Ultraviolet (UV) Oxidation

Chemical oxidation uses oxidizing agents to destroy toxic organic chemicals in ground water. Commonly used oxidizing agents include ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide. Ozone and hydrogen peroxide are generally preferred for removing organics. Chlorine based oxidants can produce toxic byproducts such as HCL chlorinated organics. Ultraviolet (UV) light is often used in conjunction with ozone and/or hydrogen peroxide to promote a faster and more complete destruction of the organic compounds.

Chemical/Ultraviolet oxidation is typically applicable for the destruction of both halogenated and non-halogenated organic compounds. The compounds may be volatile or semi-volatile. Chemical/UV is typically used in conjunction with other technologies due to the high cost of capital equipment and electrical consumption as part of operations. An example of this is a site where both semi-volatiles and volatiles exist. An air stripper used to address the VOCs prior to treatment via chemical or UV oxidation would mostly likely be more cost effective than oxidation alone. Also, water quality parameters such as solids or metals concentrations may require pretreatment.

Oil/Water Separation

Oil/Water Separation uses the differences in the physical properties of oil and water for separation of oils from water. Oil droplets greater than 20 microns have the ability to float to the surface due to the oils lighter density. However, oil droplets smaller than 20 microns, will typically stay in suspension (the oil is emulsified). Oil/Water separation may be as simple as providing a vessel for retention to allow the oil droplets to float to the surface and be removed. Instances where oils are emulsified, coalescing media or chemical addition may need to be added to enhance the oil separation. Coalescing media provides surface area for the smaller oil droplets to contact one another to form a larger droplet allowing them to float to the surface. Also, pH adjustment and/or polymer addition may be necessary to adequately break the emulsion.

Oil/water separation is appropriate for sites where free phase or emulsified oils are present in the ground water. Its strengths include the ability to remove the oil efficiently at a relatively low cost. Specifically, relative to this site, the oil removal would most likely improve subsequent removal/treatment of chlorinated compounds from the ground water. Oils may foul carbon units and/or the air stripper and significantly reduce the efficiency of a UV oxidation system. An oil/water separator can be limited by the ability to recover oils from the ground water and the degree of emulsification.

3.3.6 Passive/Reactive Treatment Walls

The passive/reactive treatment wall involves installing a permeable reactive wall downgradient across the ground water flow path, allowing contaminated water to passively flow through the wall. The medium that is used to construct the treatment wall is designed to degrade the VOCs by chemical or biological processes. The wall can be constructed of activated iron filings, hydrogen releasing compounds, iron perchloride and/or other technologies. During a treatability study or remedial design, the most effective treatment media would be identified and selected.

This technology is applicable to chlorinated and non-chlorinated organic compounds. The primary strength of this technology is the limited effort required for operations, monitoring and maintenance. The factors impacting the effectiveness include available space on-site to install the subsurface wall, permeability of existing soils (high flow zones can get very expensive), very small hydraulic gradients which may not sufficiently move water through the wall, and water quality.

3.3.7 Dual or Multi-Phase Extraction

Dual or Multi-phase extraction (MPE) is a generic term for technologies that extract VOCs from both the unsaturated and saturated soils. MPE couples SVE and ground water pump-and treat by applying a vacuum on a sealed recovery well. The potential treatment technologies for the recovered ground water are addressed above in Section 3.3.5. In MPE, ground water extraction can be achieved by several methods or techniques. These include:

- The use of a drop tube within a well and a single vacuum pump that recovers both vapor and ground water,
- The use of two pumps; a submersible pump and vacuum pump used in combination at either high (18 to 26 inHg) or low (2 to 12 inHg) vacuum conditions, and
- Bioslurping, which is similar to the single vacuum pump combined with the drop tube; except the tube is set at the ground water interface.

MPE is typically applicable for VOCs and free floating light non-aqueous phase liquids (LNAPL) in ground water conditions where hydraulic conductivities (K) range from $K=10^{-3}$ to 10^{-5}. Also, low transmissivity formations of less than 500 gpd/ft are normally considered to be applicable. MPE allows for the treatment of unsaturated/dewatered soils and can create a greater influence around the well; when compared to traditional pumping techniques. Factors that limit the effectiveness of MPE include whether the aquifer may be confined or unconfined, geologic settings (sands/clays), vadose zone soil permeability to air, depth to ground water, and contaminant parameters that limit the use of SVE such as contaminant vapor pressure and volatility.

Based on the site characteristics relative to ground water and the presence of LNAPL and VOCs in the shallow ground water, MPE may be applicable. This extraction method would need to be coupled with other ex-situ treatment alternatives as mentioned in the previous sections.

3.4 SUPPLEMENTAL PROACTIVE GROUND WATER TREATMENT

A supplemental ground water treatment may be considered in addition to the presumptive remedy selected. The supplemental treatment would expedite the presumptive remedy by biodegradation, chemical degradation, or volatilization of the VOCs. The supplemental treatment would be initiated as an enhancement to the selected presumptive remedy as deemed appropriate. This will be determined as part of the Remedial Design (RD).

4.0 PRELIMINARY SCREENING OF ALTERNATIVES

As discussed in the presumptive remedy guidance for soils entitled *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soil*, the EPA has determined that, for sites which meet the requirements of the presumptive remedies directives, site-specific identification and screening of the alternatives is not necessary.

Some alternatives identified can be eliminated by using screening criteria. Therefore, to reduce the detailed analysis of alternatives, the following partial screening of alternatives is presented.

4.1 SCREENING CRITERIA

The criteria used to evaluate alternatives during the screening process include short- and long-term effectiveness and implementability, all of which are discussed below.

Short-term effectiveness assesses the impacts of the alternative during the construction and implementation phase. Alternatives are evaluated with respect to their effects on human health and the environment during implementation of the remedial actions. The aspects evaluated include protection of the community during the remedial action, environmental impacts as a result of the remedial action, time until the remedial response objectives are achieved, and protection of workers during the remedial action.

Long-term effectiveness addresses the results of the remedial action in terms of its permanence and quantity/nature of waste or residual waste remaining at the site after response objectives have been met. The factors being evaluated include the permanence of the remedial alternative, magnitude of the remaining risk, and the adequacy and reliability of controls used to manage residual waste.

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. The evaluation includes feasibility of construction and operation; the reliability of the technology; the ease of undertaking additional remedial action; monitoring considerations; activities needed to coordinate with other offices or agencies; availability of adequate off-site treatment, storage and disposal services; availability of equipment; and the availability of services and materials.

4.2 SCREENING OF ALTERNATIVES FOR SOIL

The alternatives presented in Section 3.2 to address soil contamination at the site have been generated based on the presumptive remedy guidance entitled *Presumptive Remedy: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils.* The elimination of the following alternatives is based on the criteria for preliminary screening outlined in Section 4.1.

4.2.1 No Further Action

No further action does not achieve either long term or short-term effectiveness and therefore is not acceptable. However, No Further Action is retained for the detailed analysis as a baseline for evaluating the other alternatives.

4.2.2 Thermal Desorption and Incineration

Data collected during the remedial investigation suggested that the source of ground water contamination at the site exists under the existing structure. Although thermal desorption and incineration would provide both short-term and long-term effectiveness, neither technology could be implemented without the demolition of the building. Therefore, ex-situ soil remediation methods will be eliminated as alternatives.

4.3 SCREENING OF ALTERNATIVES FOR GROUND WATER

The alternatives presented in Section 3.3 to address ground water contamination at the site have been generated based on EPA guidance documents. The elimination of the following alternatives is based on the criteria for preliminary screening outlined in Section 4.1.

4.3.1 Air Sparging

The remedial investigation has shown that the contaminated ground water at the site is relatively confined to a small-perched zone underneath and adjacent to the facility. However, contaminated water was detected in a utility trench located under a road adjacent to the property. One goal of the ground water remediation system will be to lower the perched ground water zone below the depth of the adjacent utility conduits. This should prevent additional contaminants from migrating off-site.

An air sparging system may be effective in removing contaminants from the perched ground water; however, this type of system will not lower the ground water table and will not prevent migration of contamination into the adjacent utility conduits. In fact, air sparging could cause an artificial mounding of the ground water that might facilitate the movement of contaminants off-site. Based on these reasons, air sparging is eliminated using the short- and long- term effectiveness criteria.

4.3.2 Natural Attenuation

Based on data collected during the RI activities, natural attenuation does not currently have a substantial impact on contaminant reduction at the site. Degradation products such as 1,1-DCA, 1,1-DCE and 1,2-DCE (cis and trans) have consistently been detected in ground water samples collected from within the contaminant plume. However, TCE and 1,1,1-TCA concentrations have not significantly changed over the past five to ten years. Furthermore, total organic carbon (TOC), sulfate and dissolved oxygen concentrations detected in ground water samples are not conducive to chlorinated organics degradation.

According to the USEPA document entitled *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground water,* TOC concentrations greater than 20 mg/L provide a good carbon and energy source that drives dechlorination. The average TOC concentration in ground water samples at the site is approximately 6.25 mg/L. Additionally, sulfate concentrations in ground water that are greater than 20 mg/L may compete with the reductive pathway. The average sulfate concentration at the site is approximately 40 mg/L. Natural attenuation is therefore eliminated as a treatment alternative based on the screening criteria of long- and short-term effectiveness.

4.3.3 In-Well Air Stripping

The sediments in the water plume consist of inner-bedded glacial till and thinly bedded clastic deposits (silt- and sand-size grains). Drilling activities and pumping test results performed during the RI field activities showed that the individual more hydraulic conductive sand layers are interbedded with the nonconductive till layers. The more impermeable till layers would prevent the existence of the ground water current loop. The pump at the bottom of the treatment well would extract the water and the discharged water at a shallower zone would be difficult to discharge. The pumping zone and recharge zone would not be in direct contact.

Additionally, as with the air sparging alternative above, in-well air stripping will not lower the ground water table. Therefore, contaminated ground water within the perched zone will continue to migrate off-site within the adjacent utility trenches. For these reasons, the long-term and short-term effectiveness of the in-well air stripping alternative prohibits it from being a feasible option.

4.3.4 Passive/Reactive Treatment Wall

As shown in Figure 6, the shallow aquifer (the aquifer of concern for TCE and 1,1,1-TCA contamination) is flowing in a west to northwest direction toward Chambers Street. Also, according to the RI the buried utility trenches are acting as a conduit allowing the off-site migration of VOCs. Based on the flow path, the depth to ground water and hydrogeologic conditions at the site, a passive/reactive treatment wall may be effective for the in-situ treatment of chlorinated compounds in the shallow aquifer.

A significant limitation of this alternative would be its inability to impact a draw down of the shallow aquifer under the building. A draw down of the shallow aquifer would support the use of remedies to proactively address the source of contamination that is expected to be in the soils beneath the building. The mild hydraulic gradient in the shallow aquifer would limit effectiveness and allow contaminants to remain on-site longer. The longer the contaminants remain, the greater the risk to site workers for exposure should site conditions change.

One short-term impact includes the potential for worker exposure during installation of the treatment wall. Also, the area to be excavated is bordered by Chambers Street. Care would have to be taken as part of this effort to not impact integrity of this public street. These exposures could be managed through the implementation of engineering controls, monitoring and personal protection equipment.

Another short-term impact that could seriously affect the performance of the wall would be the mobilization of LNAPL present at the site. To date, free has not been found in MW5, MW8 or MW10, but is present closer to the building. This would be the approximate location of the treatment wall. The excavation and installation of a high permeability zone to a depth of approximately 15 feet below grade could potentially allow migration of free product that is present in the shallow soils and ground water just west of the building. Migration of free product would have a tendency to foul the wall or cover the iron filings and limit the effectiveness of degrading the chlorinated compounds. Fouling would affect the long-term performance of this alternative.

Given this information, a passive/reactive treatment wall is eliminated as a treatment alternative based on the lack of contaminant removal over time increasing the risks to site workers.

4.3.5 Dual/Multi-Phase Extraction

In accordance with EPA's *Multi-Phase Extraction: State-of-the-Practice* dated June 1999, MPE is typically applicable for VOCs' and free floating LNAPL in ground water conditions where hydraulic conductivities range from $K = 10^{-3}$ to 10^{-5} and where transmissivity is less than 500 gpd/ft.

Results from the pump tests in DMW1 and MW5, conducted during the RI, indicate that the hydraulic conductivity and transmissivity for the site were $K = 10^{-2}$ and >500 gpd/ft, respectively. The pump tests also indicated the rate of recovery was relatively low (<0.5 gpm). Therefore MPE would not be effective as a primary treatment alternative. However, the low rate of recovery could possibly be enhanced through the use of MPE inlieu of traditional recovery with submersible pumps.

MPE would be an alternative to address the presence of LNAPL.is issue. A technique called Bioslurping; where a well is screened in both the vadose zone and saturated zone. A drop tube is set just above the ground water interface to recover LNAPL present while pulling contaminated VOCs from the vadose zone.

At this time, there is not enough information to establish if MPE can meet the long- and short-term screening criteria. It would be necessary to perform a field test to determine if MPE would provide enhanced ground water recovery and address the LNAPL issue.

MPE would be considered as a supplemental method of ground water recovery that will primarily address LNAPL and secondarily VOC contamination in the vadose zone. It would most likely be used, if deemed appropriate, along with other ground water recovery and treatment alternatives. At this time, MPE is set-aside and will not be evaluated in the detailed analysis, until additional field data can be gathered and evaluated for its short-term and long-term effectiveness. A pilot test will be performed during the RD to further address this issue.

4.4 ALTERNATIVES TO BE EVALUATED DURING THE DETAILED ANALYSIS

The following alternatives have been retained for the detailed analysis of alternatives:

Remedial Alternatives Identified for Soil

- No Further Action
- Soil Vapor Extraction

Remedial Alternatives Identified for Ground Water

- No Further Action
- Ground Water Extraction and Treatment

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 DESCRIPTION OF EVALUATION CRITERIA

Shield has conducted a detailed analysis of the alternatives in which each alternative is analyzed against a set of evaluation criteria. There will also be a comparative analysis of all the options against the evaluation criteria with respect to one another.

The evaluation criteria are defined as follows:

Overall Protection of Human Health and the Environment addresses whether a remedy provides adequate protection from impacted media and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls or institutional controls.

Compliance with SCGs addresses whether a remedy will meet all of the applicable standards, criteria or guidance including federal, state and local environmental statutes and/or provide grounds for evoking a waiver.

Short-Term Effectiveness addresses the period of time needed during remediation to achieve protection from any adverse impacts on human health and the environment.

Long-Term Effectiveness and Permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met.

Reduction of Toxicity, Mobility or Volume Through Treatment addresses the statutory preference to permanently and significantly reduce the toxicity, mobility and volume of the hazardous substances.

Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

Cost includes estimated capital, operation, maintenance, and net present worth costs.

The following is a modifying criterion:

Agency and Community Acceptance will be addressed based upon comments on the RI/FS report and the recommended remedial alternative(s).

5.2 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES FOR SOIL

Section 4 of this report outlined the preliminary screening of alternatives, which eliminated various remedial techniques based on the screening criteria. Since the site meets the requirements for the presumptive remedies strategy for sites with VOC contaminated soil, the remedial options identified in the presumptive remedy directive are not required to go through the screening process. Two remedial options for source area soil contamination remains that were either a presumptive remedy or passed the three screening criteria.

5.2.1 No Further Action

Under this alternative, no additional remedial action would be taken to address the contaminated soils present at the site. The no further action alternative is included as a procedural requirement and as a baseline to evaluate the other alternatives. No Further Action would include the implementation of legal restrictions regarding land usage.

Extensive trenching within the area of the ground water plume and soil borings advanced under the existing structure did not locate an obvious source of the ground water contamination. Soil samples collected from one Geoprobe sampling point inside the building and one trench outside of the building showed slightly elevated concentrations of TCE and vinyl chloride. These concentrations, however, were not high enough to account for the high concentrations of TCE and 1,1,1-TCA found in the ground water.

At this time, the source of the ground water contamination has not been located. During the RD for ground water, additional soil samples will be collected to attempt to locate the source.

Results of the RI indicate the presence of soil above NYSDEC TAGM standards in areas around the on-site building. Although the current risk to human health and the environment is not an "unacceptable risk" (as stated in the Baseline Risk Assessment) a source area for contamination impacting ground water may still be present.

Overall Protection of Human Health and the Environment: Although this alternative does not result in any increase short-term risk, it does not comply with the project specific SCGs, and is not effective in the long-term. Therefore, this alternative would not be protective of human health and the environment within an acceptable time frame.

Compliance with SCGs: The remedial investigation demonstrated that significant concentrations of TCE and other chlorinated compounds are present around the existing building. The No Further Action alternative would not address this contamination and subsequently the SCGs that have been identified herein.

Short-Term Effectiveness: Legal restrictions would not significantly decrease risk at the site for the short-term.

Long-Term Effectiveness and Permanence: Risks associated with the contamination on the site would be somewhat reduced due to the legal restrictions. However, this alternative fails to provide long-term effectiveness to clean up the site to meet the SCGs.

Reduction of Toxicity, Mobility or Volume Through Treatment: No Further Action may prove to reduce the toxicity, mobility or volume. However this will be at a very slow rate and possibly through natural attenuation. The time frame required for this to take place would not be acceptable.

Implementability: This alternative can be easily implemented.

Cost: The estimated cost to implement this alternative would be approximately $10,000 for legal restrictions. No O&M costs would be associated with this effort.

5.2.2 Soil Vapor Extraction (SVE)

As outlined in Section 3.3.3, SVE is an in-situ soil remedial technology, to be used to remediate vadose zone (unsaturated zone) VOC contamination. An SVE system works by applying a vacuum to the contaminated soil to induce the controlled flow of air, thereby removing VOCs by volatilization. The discharged off-gas from the system may require treatment depending on the concentrations of the contaminant in the treated soil and local air standards and guidelines.

At the Site, approximately ten (10) horizontal extraction wells would be installed to address the VOCs in the source area soils under the building. The horizontal wells are necessary because no access is available inside the building for vertical well installation.

The SVE unit would be housed in a small temporary building near the southwest corner of the facility. It is expected that off-gas treatment using carbon or catalytic oxidation will be necessary. For this evaluation it is assumed that vapor phase carbon is used.

Overall Protection of Human Health and the Environment: SVE would be effective in providing protection of human health and the environment by reducing the amount of contamination present and its mobility. Although there may be short-term risks associated with construction, these could be easily mitigated with proper controls. The time to implement the alternative is estimated to be 2 to 3 months, and the length of operation of the system is estimated at approximately 3 to 4 years.

Compliance with SCGs: SVE would significantly reduce the concentrations of the chlorinated solvents in shallow soils at this site. Additionally, this reduction could meet SCGs for the contaminants in the soil under and around the building. Action-specific SCGs for this alternative apply to the excavation and handling of site soils during well installation, monitoring requirements, and OSHA health and safety requirements (e.g., 29 CFR 1910). Compliance with these SCGs would be achieved by following a site-specific health and safety plan. This alternative would incorporate an air emission source that is subject to New York regulations 6 NYCRR 200, 201, and 212, and the *New York Air*

Guide 1, Guidelines for the Control of Toxic Ambient Air Contaminants. The air emissions would be treated, as necessary, to meet these regulatory requirements.

Short-Term Impacts and Effectiveness: There is the potential for worker exposure during installation of the vapor extraction wells. This exposure would be significantly reduced through the implementation of engineering controls, monitoring and personal protection equipment. An additional concern would be the impact that the noise of the operating treatment system would have on adjacent residents. There are no residences directly adjacent to the site, but there are commercial properties in the immediate vicinity. Noise levels could be easily reduced in a sound controlled building.

Long-Term Effectiveness and Permanence: Soil vapor extraction is very successful at addressing VOC contamination. This alternative would be a permanent remedy, relative to the VOCs in the shallow soils, since the contaminants would be removed.

Reduction of Toxicity, Mobility, and Volume: Removal and treatment of the contaminants from the soil will reduce the toxicity, mobility and volume of the contaminants in the shallow site soils.

Implementability: Implementing SVE under the facility building would be difficult. The horizontal wells must be installed close to active subsurface utility lines and will be installed under an occupied facility. Also, the radius of influence in the glacial till is expected to be relatively low. While the radius of influence of the horizontal SVE wells is expected to be low, during design activities, a pilot test will be performed to see if there is adequate vacuum coverage under the building during the remedial action. The SVE equipment and materials are commercially available from several vendors. Controls will be implemented during field installation to minimize the exposure of workers and other on-site personnel to airborne VOCs.

Cost: The estimated capital cost for this alternative is $215,000. The annual O&M cost is estimated to be $41,000. It is estimated that a four year operational period will be necessary. The present worth value of this alternative would be $ 360,400 using a 5% discount rate over four years.

5.3 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES FOR GROUND WATER

Two remedial options for ground water remediation will be considered during the detailed analysis of alternatives for the Site. The VOC ground water plume has migrated off-site through utility conduits located under Chambers Street.

5.3.1 No Further Action

As described in Section 3.1.1, the alternative listed as no further action is designed to acknowledge that a small ground water extraction and treatment system has been in operation at the site since 1993. Under this alternative, no additional remedial action would be taken to address the contaminated ground water present at the site, with the exception of implementation of legal restrictions and annual ground water monitoring and reporting. Fourteen samples would be taken and analyzed for VOCs on an annual basis.

Overall Protection of Human Health and the Environment: As the property is currently used, this alternative does not result in any increase short-term risk, it does not comply with the project specific SCGs, and is not effective in the long term. Therefore, this alternative would not be protective of human health and the environment within an acceptable time frame.

Compliance with SCGs: Results of the RI indicate the presence of ground water contamination above the NYSDEC TOGS standards on- and off-site. The No Further Action alternative would not address this contamination and subsequently the SCGs that have been identified herein.

Short-Term Effectiveness: Legal restrictions and ground water monitoring would not increase the short-term risk at the site.

Long-Term Effectiveness and Permanence: Over a long period of time the chemical concentrations in the ground water may decline due to natural processes. An accurate time frame for ground water concentrations to decline below TOGs is unknown. Therefore, this alternative fails to provide long-term effectiveness or permanence to clean up the site to meet the SCGs.

Reduction of Toxicity, Mobility or Volume Through Treatment: No Further Action may reduce the toxicity, mobility or volume through natural attenuation mechanisms. Results of the RI indicate the presence of ground water contamination above the NYSDEC TOGS standards. Although the current risk to human health and the environment is not an "unacceptable risk", VOC ground water contamination is still migrating off-site.

Implementability: This alternative can be easily implemented.

Cost: The estimated cost to implement this alternative would be approximately $10,000 for legal restrictions. The annual O&M cost is estimated to be $10,000. Operational period for cleanup to take place is unknown. Therefore, 30 years is used to determine cost for remediation. The present worth value of this alternative would be $101,300 using a 5% discount rate over thirty (30) years.

5.3.2 Ground Water Extraction and Treatment

The ground water extraction and ex-situ treatment option is an attractive alternative for treating the ground water at this site. This treatment option would enhance the overall protection of human health and the environment by containing the contaminant plume and preventing additional contaminant migration into the adjacent utility conduits. This is the only alternative that will lower the ground water table to prevent contaminant migration off site. It would also reduce the VOC volume in ground water, thereby making the ground water less toxic. The short-term criteria would be met and the implementability is feasible.

Limited pump tests conducted during the remedial investigation indicated the presence of conductive soils within the contaminant plume. A five-hour pump test from a two-inch diameter well showed a 40-foot radius of influence and produced approximately 0.3 to 0.4 gallons per minute. These tests conclude that the ground water extraction and treatment option would be an effective alternative at this site. Furthermore, due to the small size of the contaminant plume, this system should be cost effective.

The ground water extraction and treatment system is expected to include approximately six ground water extraction wells screened from approximately 5 to 15 feet below grade. Recovered ground water would be treated using an oil/water separator and an air stripper. Additionally, treatment prior to the air stripper using a bag filter may be necessary to improve system performance and reduce solids fouling. The air stripper will be sized to treat from 1 to 25 gpm of VOC contaminated water. Off-gas treatment may be required depending upon VOC concentrations and regulatory guidelines. Special consideration will be given due to the presence of vinyl chloride in the site ground water. Specialized off-gas control may be necessary (such as catalytic oxidation). Weekly monitoring and monthly reporting would be provided. Quarterly sampling and analysis for VOCs would be performed from selected wells.

As stated in Section 4.3.5, MPE will be further considered during the RD. This will be considered to enhance ground water and LNAPL recovery.

Overall Protection of Human Health and the Environment: The ground water pump and treatment has demonstrated to be an effective approached to mitigate VOC contaminated ground water. A pump test demonstrated that the aquifer could be pumped sufficiently to remove contaminated ground water. Based on this the data, it is expected to provide protection of human health and the environment by reducing the amount of contamination present. Although there may be short-term risks associated with construction, these could be easily mitigated with proper controls.

Compliance with SCGs: Ground water extraction and treatment should significantly reduce the concentrations of the chlorinated solvents in saturated soils, thus meeting the SCGs. This alternative would incorporate an air emission source that is subject to New York regulations 6 NYCRR 200, 201, and 212, and the *New York Air Guide 1, Guidelines for the Control of Toxic Ambient Air Contaminants.* The air emissions would be treated, as necessary, to meet these regulatory requirements.

Short-Term Impacts and Effectiveness: There is the potential for worker exposure during installation of the extraction wells. This exposure would be significantly reduced through the implementation of engineering controls, monitoring and personal protection equipment. An additional concern would be the impact that the noise of the operating treatment system would have on adjacent residents. There are no residences directly adjacent to the site, but there are commercial properties in the immediate vicinity. Noise levels could easily be reduced by housing the unit in a sound controlled building.

Long-Term Effectiveness and Permanence: Removal and treatment of contaminated ground water has been successful at addressing VOC contamination in ground water and can be a permanent solution. Achieving an appropriate draw down would reduce and or eliminate off-site migration and thus provide a permanent solution.

Reduction of Toxicity, Mobility, and Volume: Removal and treatment of the contaminants from the ground water will reduce the toxicity, mobility and volume of the contaminants.

Implementability: Based on the soils conditions established during the RI, Ground water extraction and treatment is implementable for the off-site ground water. Extraction and treatment equipment and materials are commercially available from several vendors.

Cost: The estimated capital cost to implement this alternative would be approximately $135,000. The annual O&M cost is estimated to be $33,000. The operational period for cleanup to take place is unknown until the source area is addressed. Therefore, 30 years is used to determine cost for remediation. The present worth value of this alternative would be $642,276 using a 5% discount rate over thirty (30) years.

5.4 COMPARATIVE ANALYSIS OF ALTERNATIVES

The following two sections will compare the treatment alternatives for the source area soil and ground water contamination.

5.4.1 Comparative Analysis for Soils

Overall Protection of Human Health and the Environment: The no further action alternative would not be protective of human health or the environment within an acceptable time frame. SVE would actively address the source contamination and would be protective of human health and environment.

Compliance with SCGs: The no further action alternative would not meet SCGs since it would leave elevated contaminant concentrations in on-site soils. SVE would meet the SCGs for soil.

Short-Term Impacts and Effectiveness: The no further action alternative would cause no increased short-term impacts since no intrusive work would take place. SVE would result in air emissions that would require treatment, posing a short-term risk should the air emissions control device be breached. This risk would be reduced through the proper use of air treatment devices.

SVE would have limited potential for worker exposure, since the only intrusive activity would be the installation of horizontal wells. Controls would include air monitoring, personal protective equipment, and as necessary vapor suppression measures.

Long-Term Effectiveness and Permanence: The no further action alternative would allow the continued migration of contaminants from the soil to the ground water. SVE would provided permanent remedies for specific areas in the site soils.

Reduction of Toxicity, Mobility, and Volume: With the no further action alternative, reduction in the toxicity, mobility, or volume of waste would occur very slowly, if at all, through natural attenuation. This would not be an acceptable time frame. With no further action alternative, there is a potential that VOCs may become mobile and potentially threaten the environment and health of on-site personnel. The SVE alternative would remove/treat site related contamination from under the building. SVE would most likely result in a decrease in the movement of soil contaminants to the ground water.

Implementability: The no further action alternative would be the easiest to implement, since no construction would be necessary. SVE would be the most difficult to implement due to the location of contaminants, on-site appurtenances such as the building, and potential utilities beneath the building.

Cost: A summary of the costs is presented in Table 3. The costs are the present worth based on a 5% discount rate over the estimated life of the project. As shown in Table 3, the no further action alternative is the least expensive.

5.4.2 Comparative Analysis for Ground Water

Overall Protection of Human Health and the Environment: The no further action alternative would not be protective of human health or the environment within an acceptable time frame. Ground water and ex-situ treatment would actively address the ground water contamination and would be protective of human health and the environment.

Compliance with SCGs: The no further action alternative would not meet SCGs, since it would leave elevated contaminant concentrations in ground water. Ground water extraction and ex-situ treatment would meet the SCGs for ground water. The question that remains is the time frame for remediation to be complete. Until the source is addressed it is difficult to estimate a time. Estimates will be provided as part of the remedial design.

Short-Term Impacts and Effectiveness: The no further action alternative would cause no increased short-term impacts since no intrusive work would not take place. An ex-situ ground water treatment alternative poses a greater risk for work exposure to VOCs. Ex-situ ground water treatment would result in air emissions that may require treatment, posing a short-term risk should the air emissions control device be breached. This risk would be reduced through the proper use of air treatment devices.

Long-Term Effectiveness and Permanence: The no further action alternative would allow the continued migration of contaminants through the ground water to possible off-site receptors. Ground water and ex-situ treatment would provide permanent remedies for contaminated ground water. The air stripper would provide an emissions source that could be a possible long-term risk, unless properly controlled and monitored.

Reduction of Toxicity, Mobility, and Volume: With the no further action alternative, reduction in the toxicity, mobility, or volume of waste would occur very slowly, if at all, through natural attenuation. This would not be an acceptable time frame. With the no further action alternative there is a potential that VOCs could further mobilize and exhibit a greater threat to off-site receptors. Ex-situ ground water treatment would remove/treat ground water contamination. This alternative would reduce the toxicity, mobility and volume of contaminants.

Implementability: The no further action alternative would be the easiest to implement, since no construction would be necessary. Ex-situ ground water treatment would be easily implementable and several equipment sources are available.

Cost: A summary of the costs is presented in Table 3. The costs are the present worth based on a 5% discount rate over the estimated life of the project. As shown in Table 3, the no further action alternative is the least expensive.

6.0 RECOMMENDED REMEDIAL ALTERNATIVES

6.1 BASIS OF RECOMMENDATION

The recommendations to address the contamination at the Former Binghamton Plastics Site are a multi-pronged approach. The following provides the basis for recommendations on the treatment alternatives.

6.1.1 Subsurface Soils

The No Further Action alternative was rejected because this alternative is not protective of human health or the environment, does not meet/satisfy SCGs, and the evaluations criteria. It would leave a potential source under the building, which would continue to pose a threat to the environment and human health. Whereas, SVE has successfully been used at other sites to remediate soil contaminated with volatile organic compounds. SVE would be effective in achieving the remedial goals and meet the requirements of the seven evaluation criteria. A pilot SVE test will be performed under the 1963 addition to the building as a part of the Remedial Design. A full-scale SVE system will subsequently be designed and installed if warranted.

6.1.2 Ground Water Treatment

The no further action alternative was rejected because this alternative is not protective of human health or the environment, does not meet/satisfy SCGs, and the evaluations criteria. It would leave contamination within the aquifer that could threaten the environment and human health.

Ground water extraction and ex-situ treatment have been successfully used at other sites to remediate VOC contaminated ground water. This alternative would be effective in achieving the remedial goals and would meet the requirements of the seven evaluation criteria.

The VOC impacted ground water at the site will be treated using a ground water extraction and ex-situ treatment system. As discussed in Section 5.3, the conductivity of the soils in the area of the contaminant plume is conducive to a ground water extraction system.

The most important advantage of a ground water extraction system is the draw down that will be created within the contaminated perched ground water zone. This draw down will prevent the migration of contaminated ground water off-site through the adjacent utility conduits. In addition to the containment of the contamination on-site, ground water within the perched zone will be aggressively removed and treated. An oil/water separator combined with an air stripper is currently proposed as the ex-situ treatment system. As stated earlier, MPE will be considered during the RD as an enhancement to traditional ground water extraction.

6.2 SUPPLEMENTAL TREATMENT

Supplemental ground water treatment may be considered in addition to the above remedies selected for ground water. The supplemental treatment will be a proactive approach to attack "hot spots" in the ground water plume. The treatment will expedite the ground water remediation efforts by the implementation of any or a combination of biodegradation, chemical degradation, or volatilization of the VOCs. The supplemental treatment would be initiated only after the presumptive treatment remedies are actively treating the on-site and off-site ground water.

If used, the NYSDEC-approved supplemental treatment approach would be formulated during the design phase of the project and would be implemented during the treatment phase. The ROD will outline the possible use of a supplemental treatment approach for ground water remediation after NYSDEC approval.

6.3 CONCEPTUAL DESIGN OF THE PREFERRED REMEDIES

The following discusses the implementation of the preferred remedial alternative in general terms. The remedial design (RD) will address the specific components of the remedy in detail. During the RD it may become necessary to modify components of this conceptual design. These modifications would be based on additional findings from field-testing to be conducted during the RD. Figure 10 provides location and layout of both of the remedies.

The recommended remedies to address soil and ground water contamination are as follows:

- ➢ Contaminated soils will be addressed using SVE. A pilot SVE test will be performed under the 1963 addition to the building as a part of the Remedial Design. A full-scale SVE system will subsequently be designed and installed if warranted.

- ➢ VOC contaminated ground water will be addressed using extraction wells combined with ex-situ treatment (oil/water separation & air stripping). As part of the RD, supplemental treatment alternatives will be considered. The supplemental treatment would be a proactive approach to enhance treatment of the ground water plume. The treatment would expedite the ground water extraction and ex-situ treatment process by biodegradation, chemical degradation, or volatilization of the VOCs. The supplemental treatment would be initiated only after the presumptive treatment remedies are actively treating ground water. If utilized, the NYSDEC approved supplemental treatment would be formulated during the design phase of the project and will be implemented during the treatment phase of the project.

The total present worth for the remedial program is estimated to be $1,002,662 ($350,000 in capital costs & $652,662 total present worth of O&M).

Following mobilization to the site, the work zones would be established and the areas identified on Figure 10 would be field located and marked for construction activities. Following utility clearances, up to 10 horizontal wells (number to be verified during pilot RD) would be installed under the building as part of SVE system installation. The SVE unit is expected to be installed somewhere in the southwest corner of the property. This unit will be housed in a small portable building. Cuttings would be stockpiled for disposal with other contaminated soils.

On the western portion of the property, along Chambers Street, (as shown on Figure 10) the ground water collection wells will be installed using traditional drilling techniques. Approximately six 4-inch diameter extraction wells will be installed and developed. The contaminated development water will be pumped to the existing air stripper for subsequent treatment.

The ex-situ treatment system will be installed in the same building as the SVE unit. Once operational, off-gas treatment will be implemented, as necessary, to address emissions control. It is expected that the ground water extraction system will recover ground water at a rate ranging from 2 to 10 gpm for the six wells.

Any free oil (LNAPL) product recovered, will be packaged, characterized and disposed of appropriately. Operations and maintenance will be performed on a weekly basis. Reporting and monitoring will be according to regulatory requirements. It is expected that monthly reporting will be required.

Operation and maintenance of the remediation system will be performed on a weekly basis. Long term monitoring of ground water levels and contaminant concentrations will be conducted on a quarterly basis until the system has achieved the remediation goals established by the NYSDEC. Deed restrictions that define future land use of the property may also be required.

7.0 CERTIFICATION

This document has been prepared under the direct supervision of a Professional Engineer registered by the State of New York. Based upon site observations and available data, it is the opinion of the undersigned that the attached Feasibility Study is in substantial accordance with the Order on Consent Index #B7-0516-97-05.

Maurice Lloyd, P.E.
Shield Engineering Associates, Inc., PC

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073230

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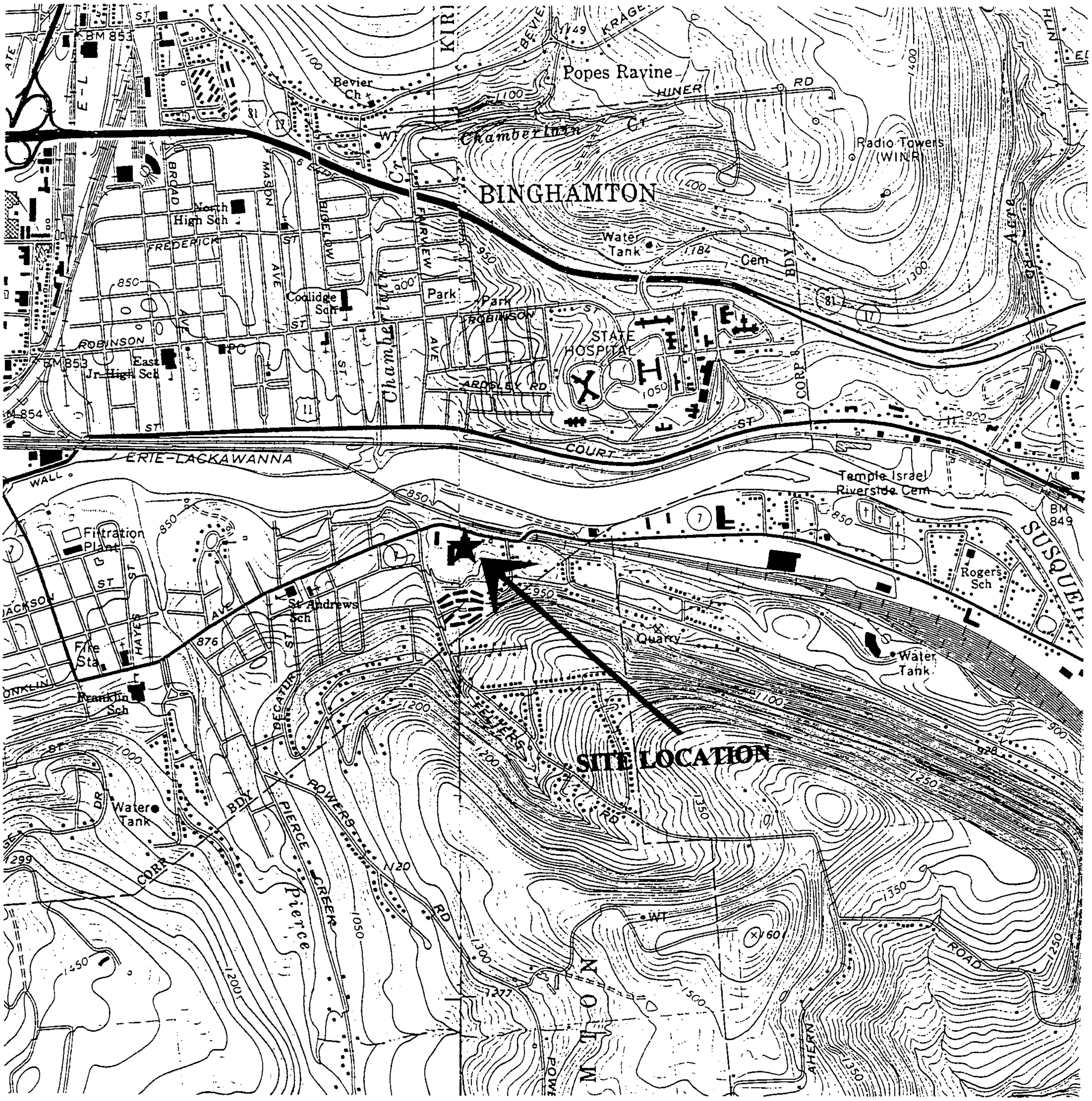

SOURCE: USGS Topographic Quadrangle Maps
Binghamton East, New York
1968 – Photoinspected 1976
Binghamton West, New York
1968 – Photoinspected 1976

-N-

0 1,000' 2,000'
SCALE

DATE: 02/03/00	FIGURE 1	SHIELD
DRAWN BY: P.D.H.	SITE LOCATION MAP	ENGINEERING ASSOCIATES, INC., P.C.
APPROVED BY: M.A.L.	DII – BINGHAMTON PLASTICS	CHARLOTTE, NORTH CAROLINA
CLIENT NO.: 796–0460	BINGHAMTON, NEW YORK	

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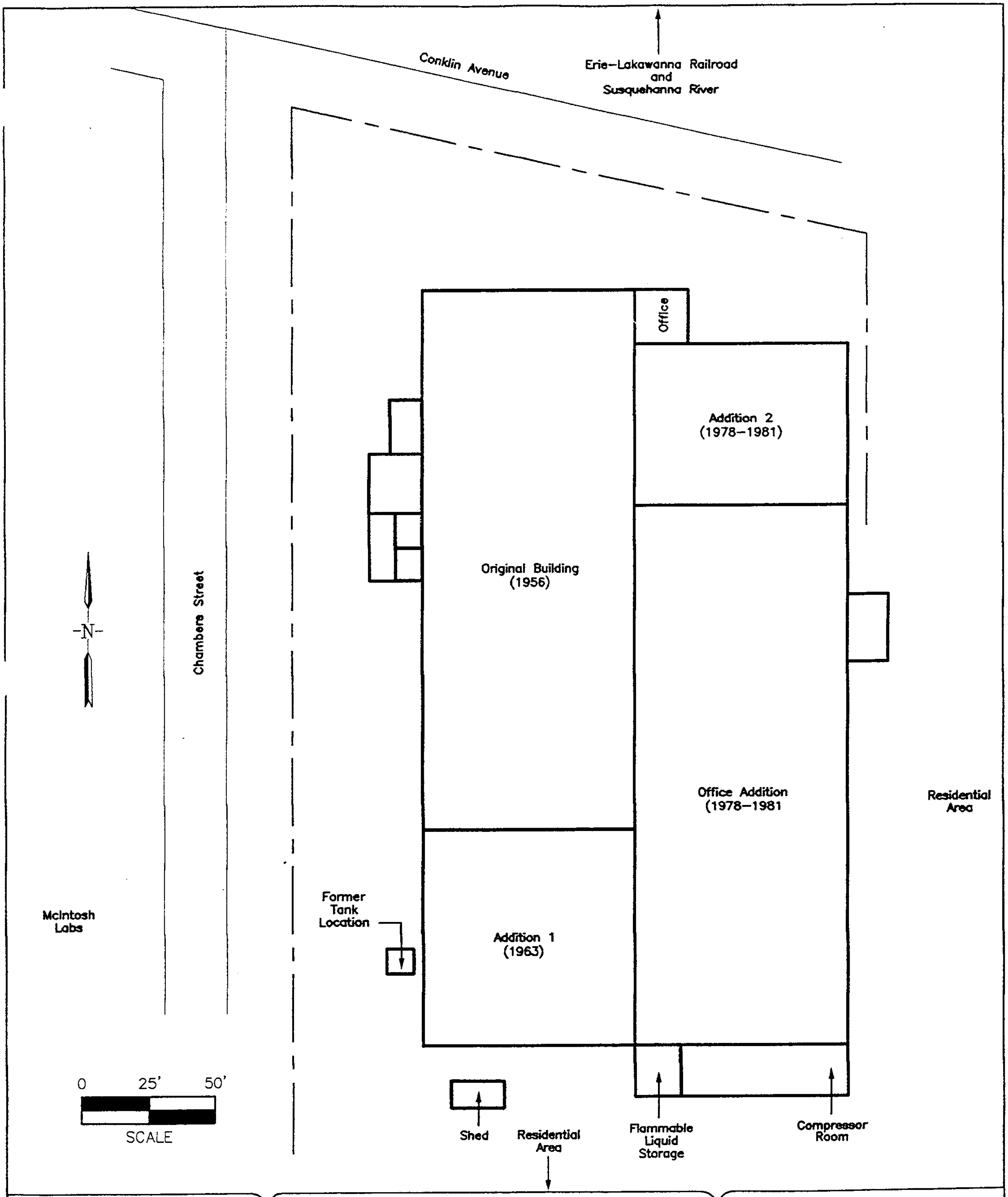

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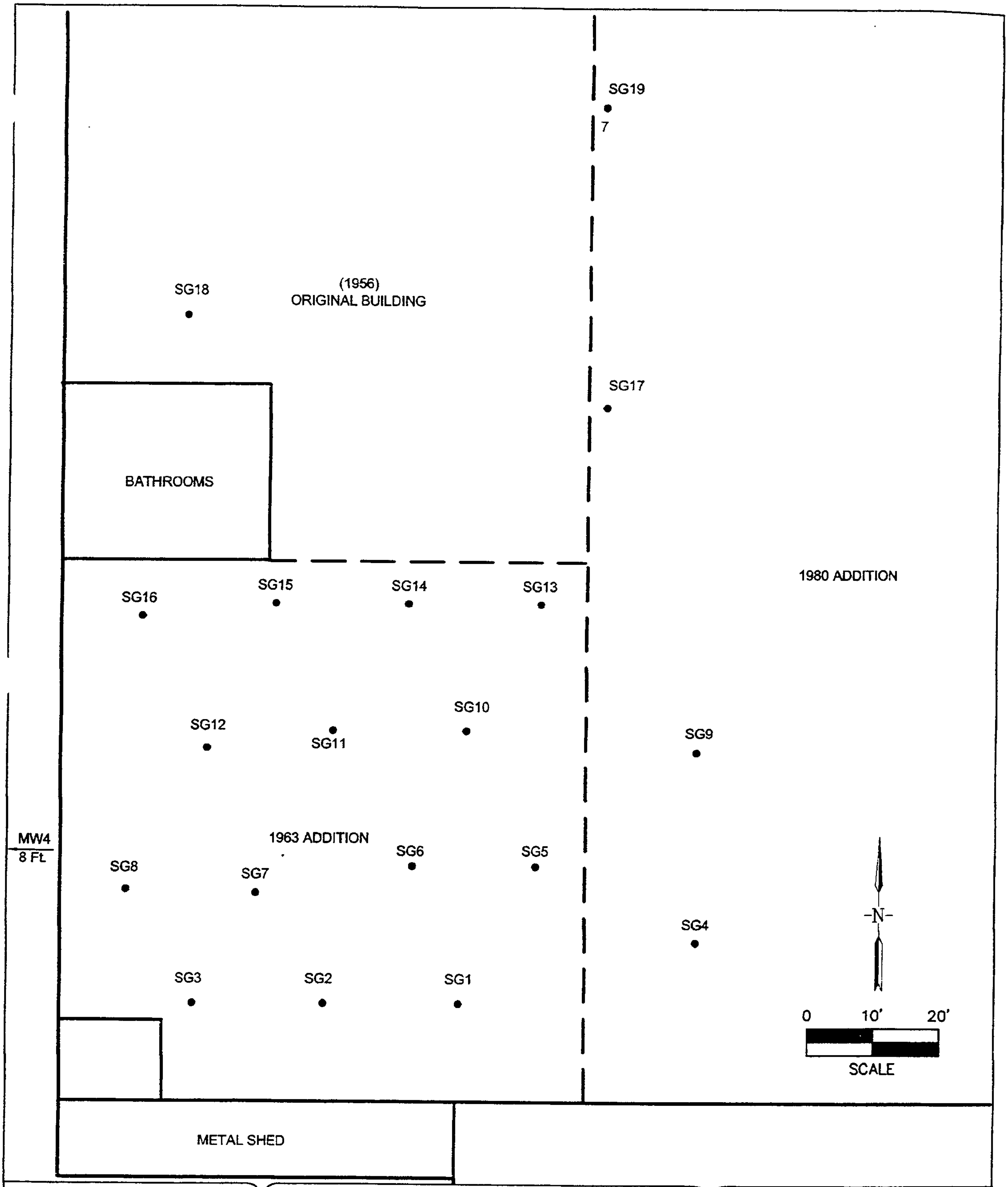
DRAWN BY: P.D.H.
APPROVED BY: M.A.L.
CLIENT NO.: 796-0460

FIGURE 2

MAP SHOWING HISTORICAL SITE FEATURES
AND SURROUNDING PROPERTIES
DII - BINGHAMTON PLASTICS
BINGHAMTON, NEW YORK

SHIELD
ENGINEERING ASSOCIATES, INC., P.C.
CHARLOTTE, NORTH CAROLINA

60460



DATE: 02/03/00

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APPROVED BY: M.A.L.

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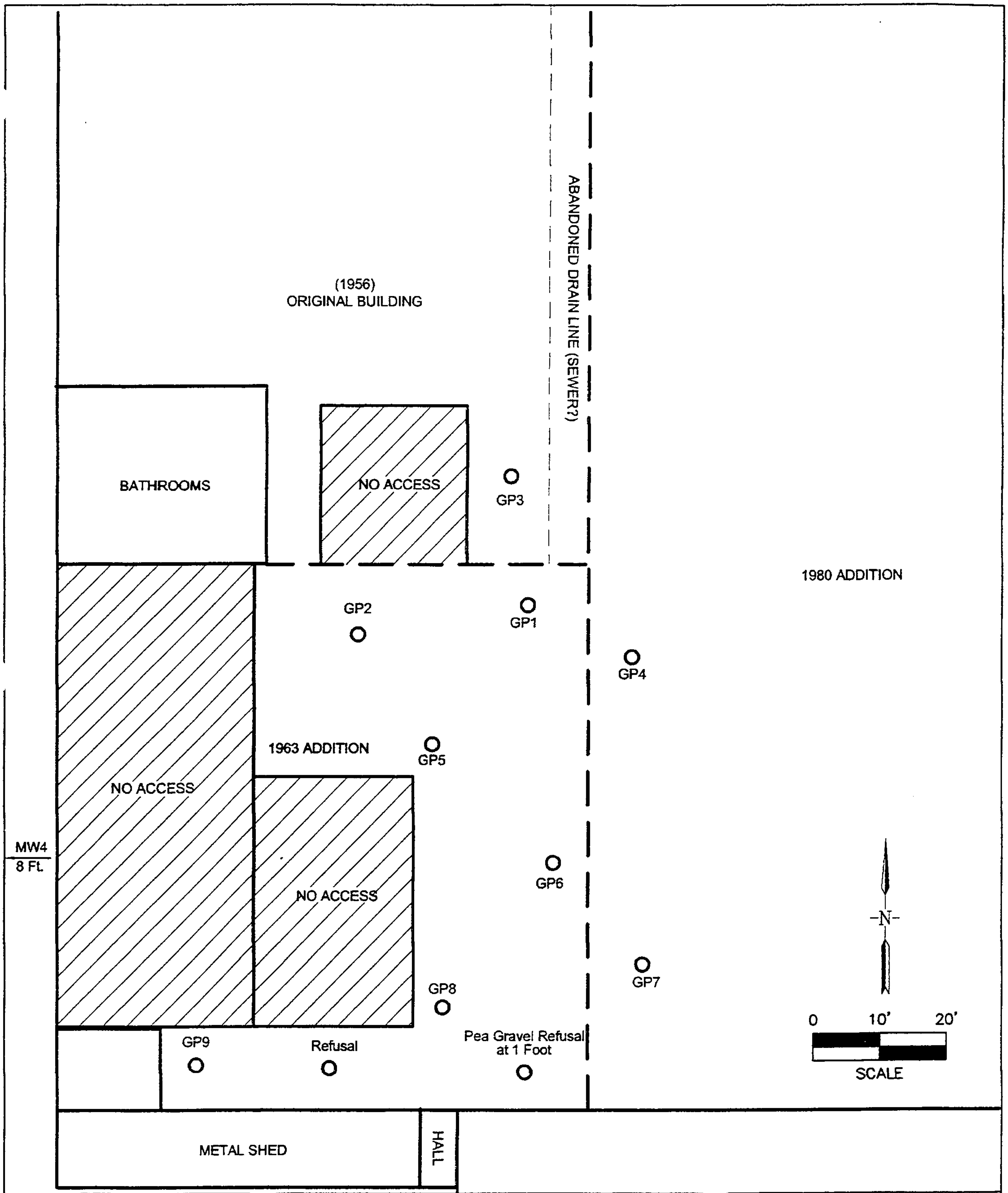
FIGURE 3

PASSIVE SOIL GAS POINTS
DII – BINGHAMTON PLASTICS
BINGHAMTON, NEW YORK

SHIELD
ENGINEERING ASSOCIATES, INC., P.C.
CHARLOTTE, NORTH CAROLINA



DATE: 02/03/00

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APPROVED BY: M.A.L.

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FIGURE 4

GEOPROBE BORING POINTS
DII – BINGHAMTON PLASTICS
BINGHAMTON, NEW YORK

SHIELD
ENGINEERING ASSOCIATES, INC., P.C.
CHARLOTTE, NORTH CAROLINA

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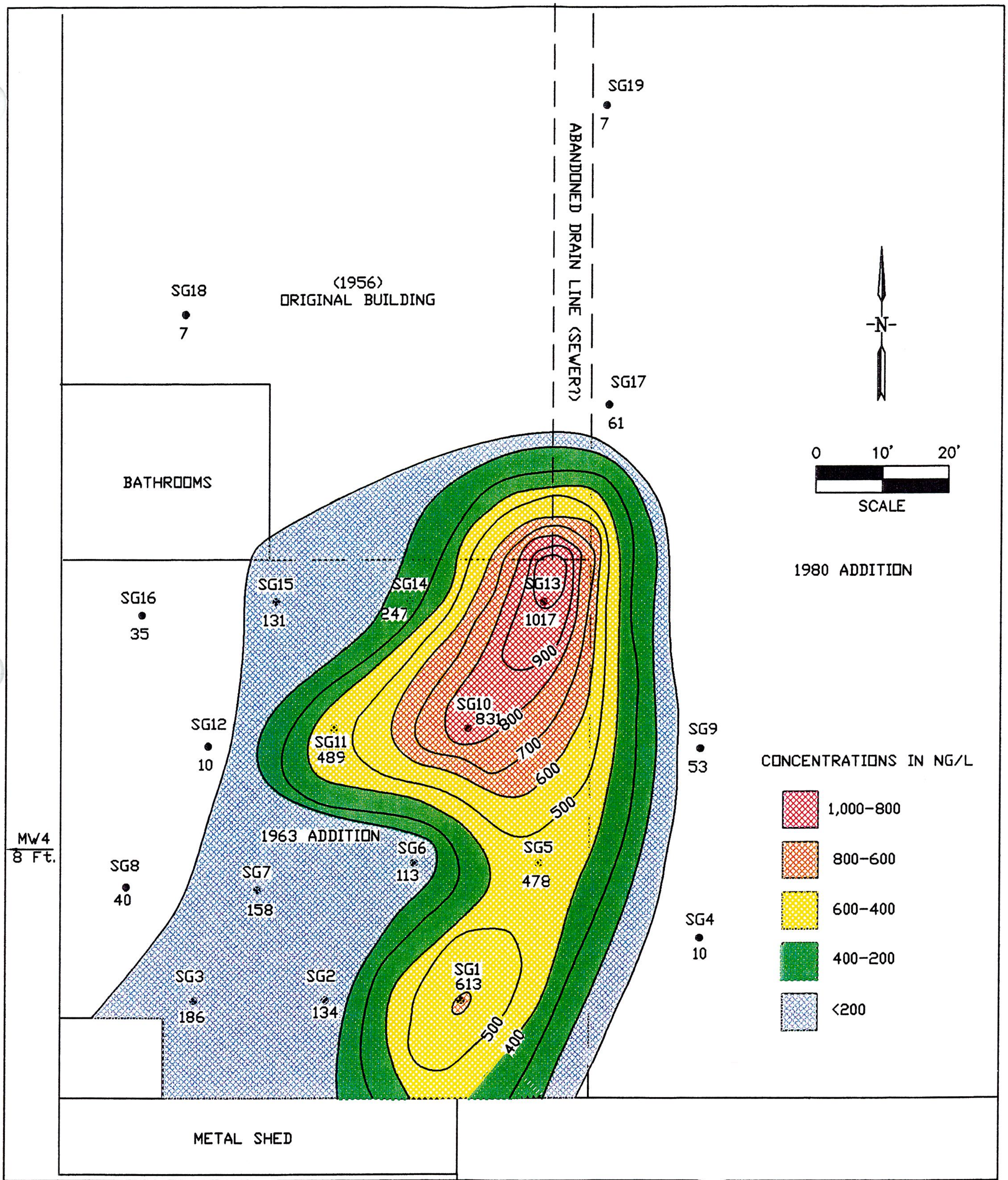

DATE: 02/03/00

DRAWN BY: P.D.H.

APPROVED BY: M.A.L.

CLIENT NO.: 796-0460

FIGURE 5

SOIL GAS CONCENTRATION MAP
DII – BINGHAMTON PLASTICS
BINGHAMTON, NEW YORK

SHIELD
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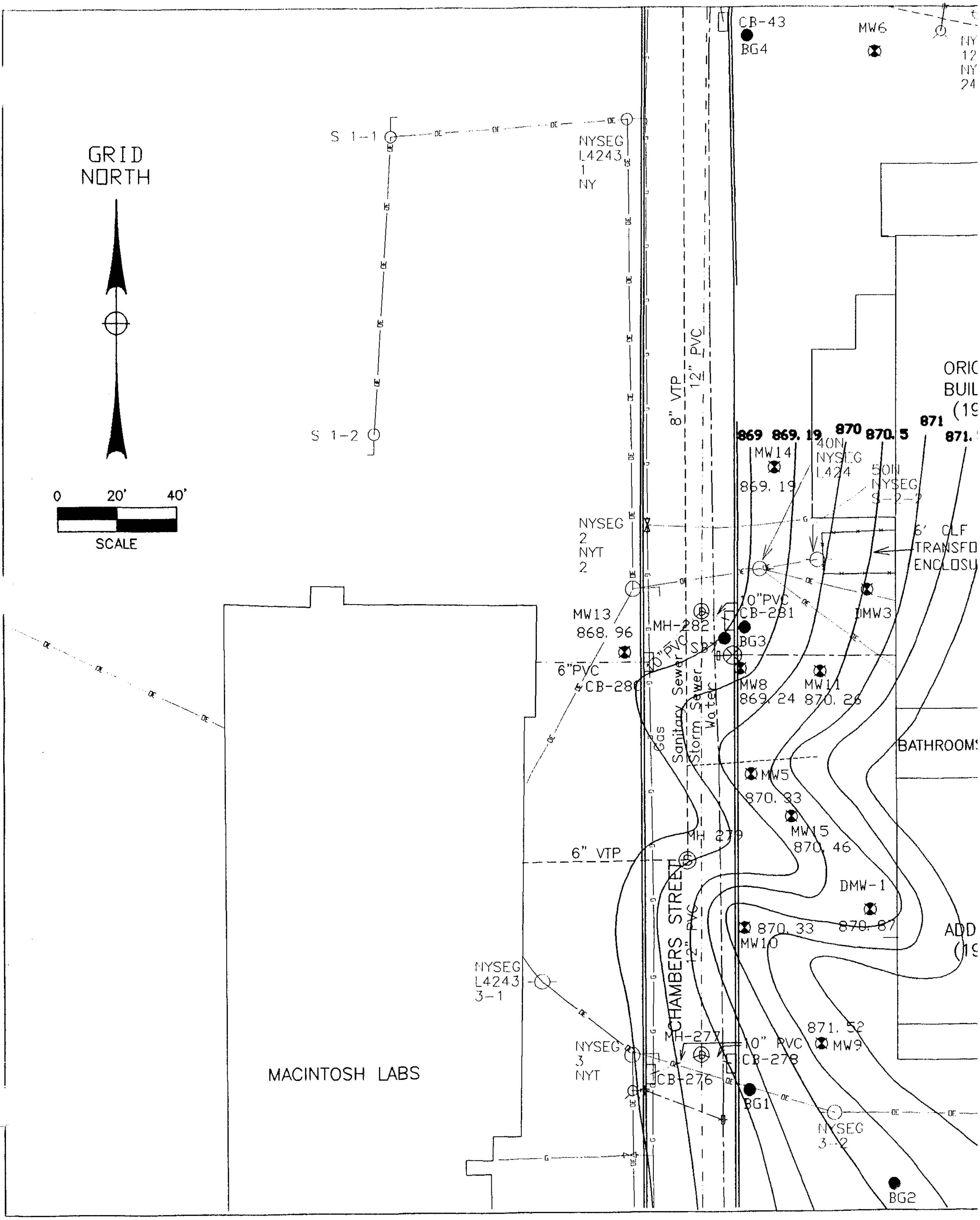
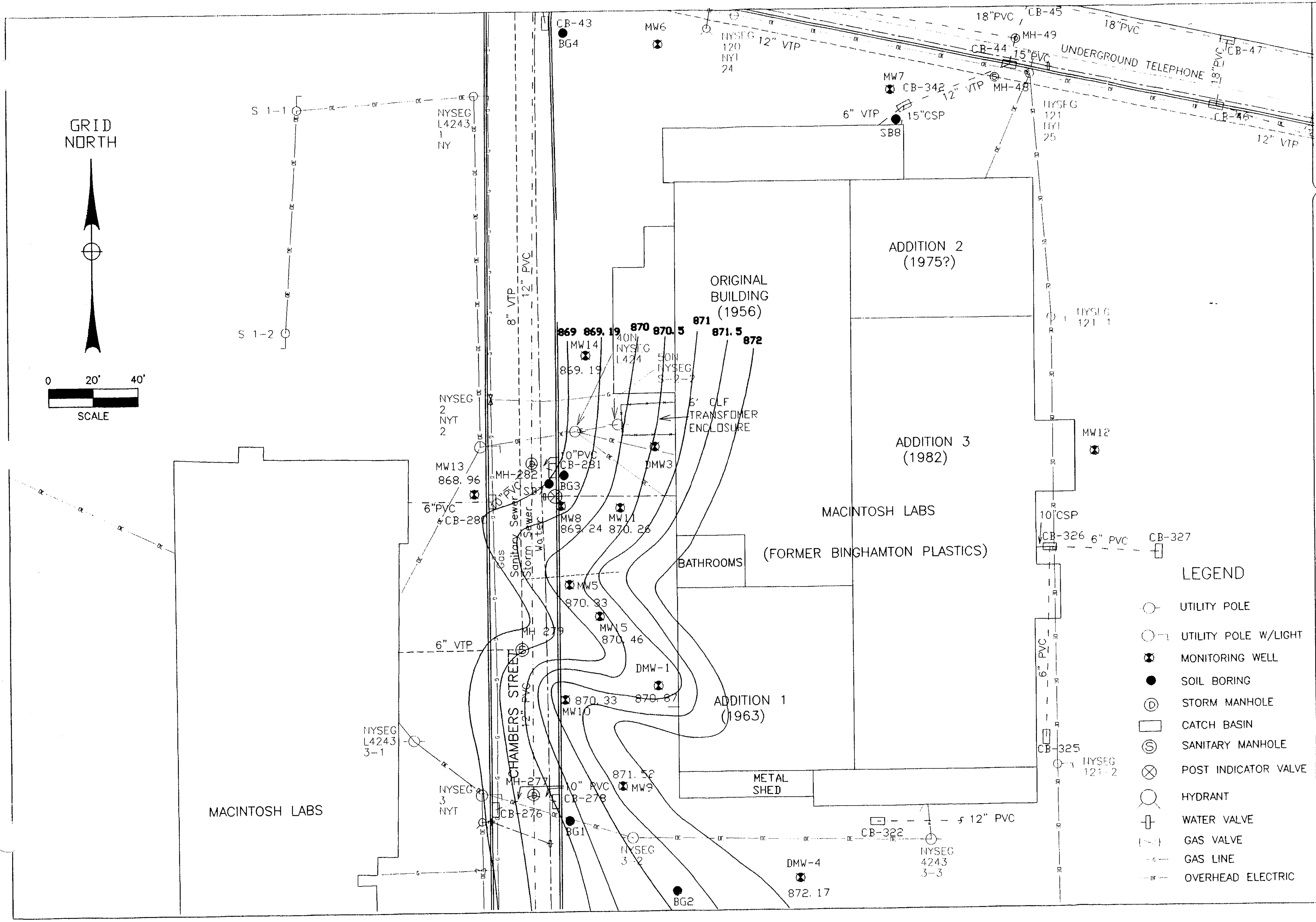
CHARLOTTE, NORTH CAROLINA

GRID
NORTH
0
20'
40'
SCALE
CB-43
BG4
MW6
NY
12
NY
24
S 1-1
S 1-2
NYSEG
L4243
1
NY
8" VTP
12" PVC
ORIG
BUIL
(19
869
869.19
870
870.5
871
871.
MW14
869.19
40N
NYSEG
L424
50N
NYSEG
S-2-2
NYSEG
2
NYT
2
6' CLF
TRANSFO
ENCLOSU
MW13
868.96
MH-282
10"PVC
CB-281
BG3
DMW3
SB
6"PVC
CB-280
10"PVC
MW8
869.24
MW11
870.26
Gas
Sanitary Sewer
Storm Sewer
Water
BATHROOMS
MW5
870.33
MW15
870.46
MH 279
6" VTP
CHAMBERS STREET
12" PVC
DMW-1
870.33
MW10
870.87
ADD
(19
NYSEG
L4243
3-1
MACINTOSH LABS
NYSEG
3
NYT
MH-277
10" PVC
CB-278
CB-276
871.52
MW9
BG1
NYSEG
3-2
BG2



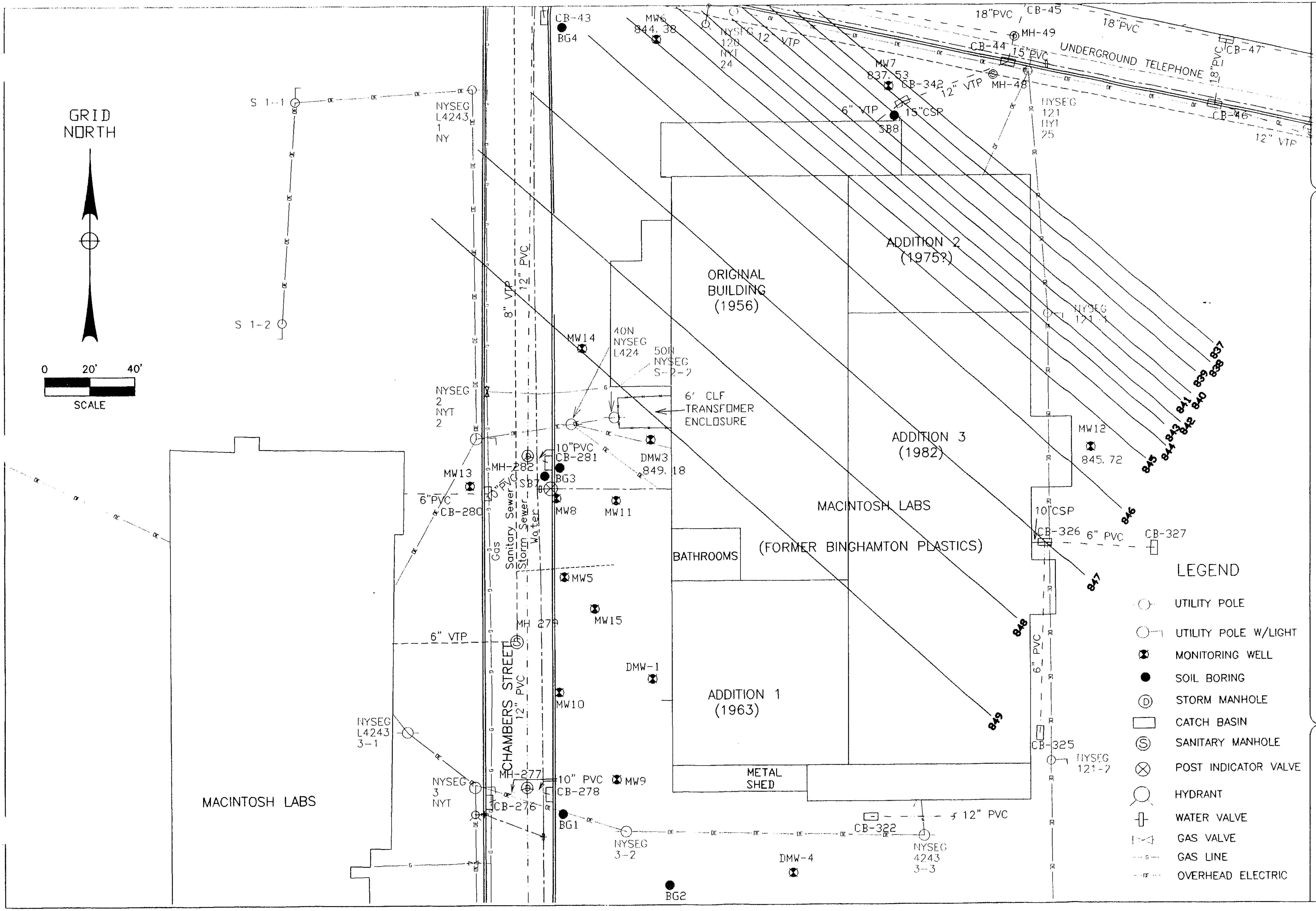
SHIELD
ENGINEERING ASSOCIATES, INC., P.C.
CHARLOTTE, NORTH CAROLINA

FIGURE 6

POTENTIOMETRIC MAP (SHALLOW AQUIFER)
DII - BINGHAMTON
BINGHAMTON, NEW YORK

DATE: 02/03/00
DRAWN BY: P.D.H.
APPROVED BY: M.A.L.
CLIENT NO.: 796-0460

60460-17



SHIELD
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CHARLOTTE, NORTH CAROLINA

FIGURE 7

POTENTIOMETRIC MAP (DEEP AQUIFER)

DII - BINGHAMTON

BINGHAMTON, NEW YORK

DATE: 02/03/00

DRAWN BY: P.D.H.

APPROVED BY: M.A.L.

CLIENT NO.: 796-0460

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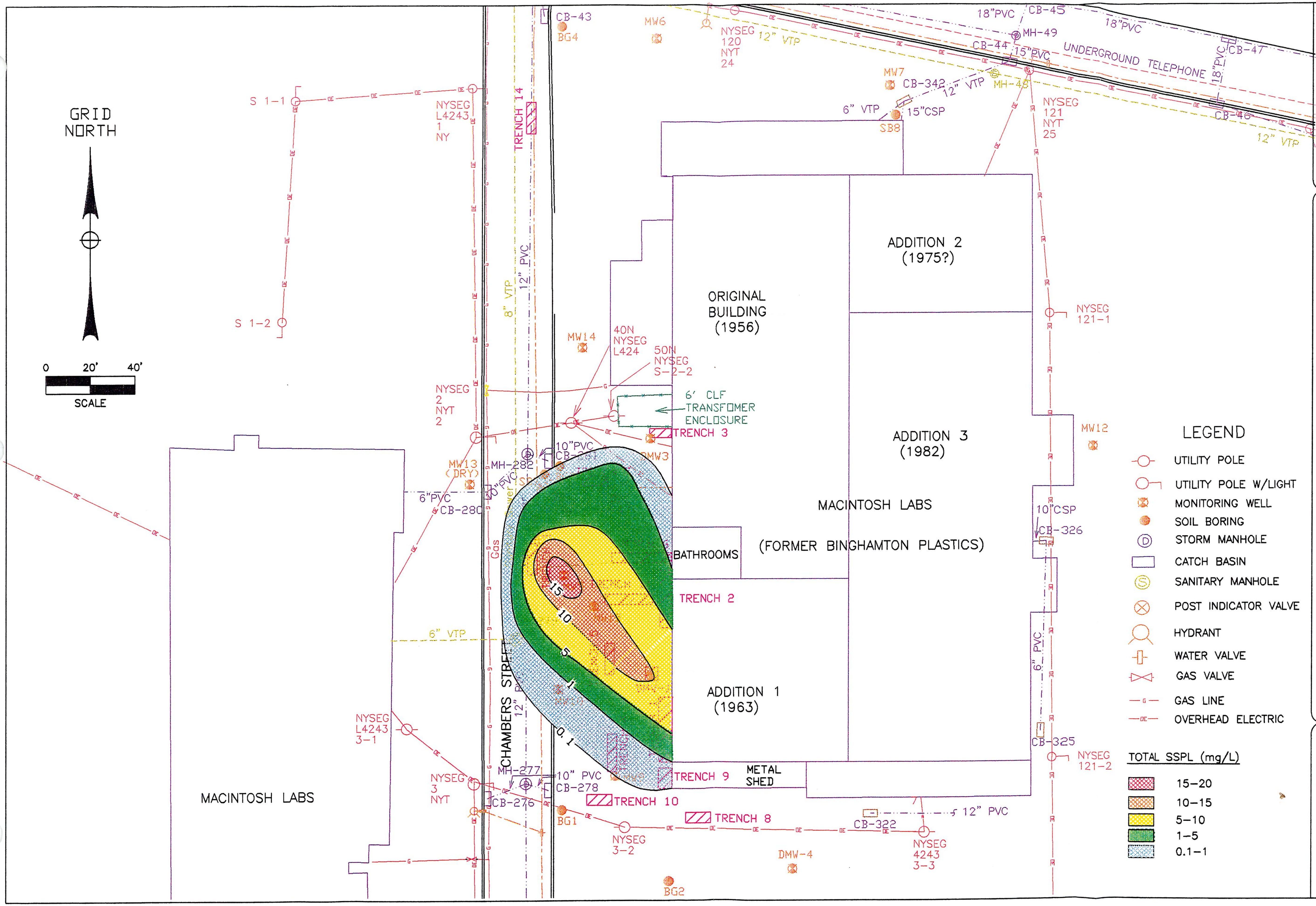

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FIGURE 8
TOTAL SITE-SPECIFIC PARAMETER LIST (SSPL)
COMPOUNDS IN GROUNDWATER

DII – BINGHAMTON PLASTICS
BINGHAMTON, NEW YORK

DATE: 02/03/00
DRAWN BY: P.D.H.
APPROVED BY: M.A.L.
CLIENT NO.: 796-0460

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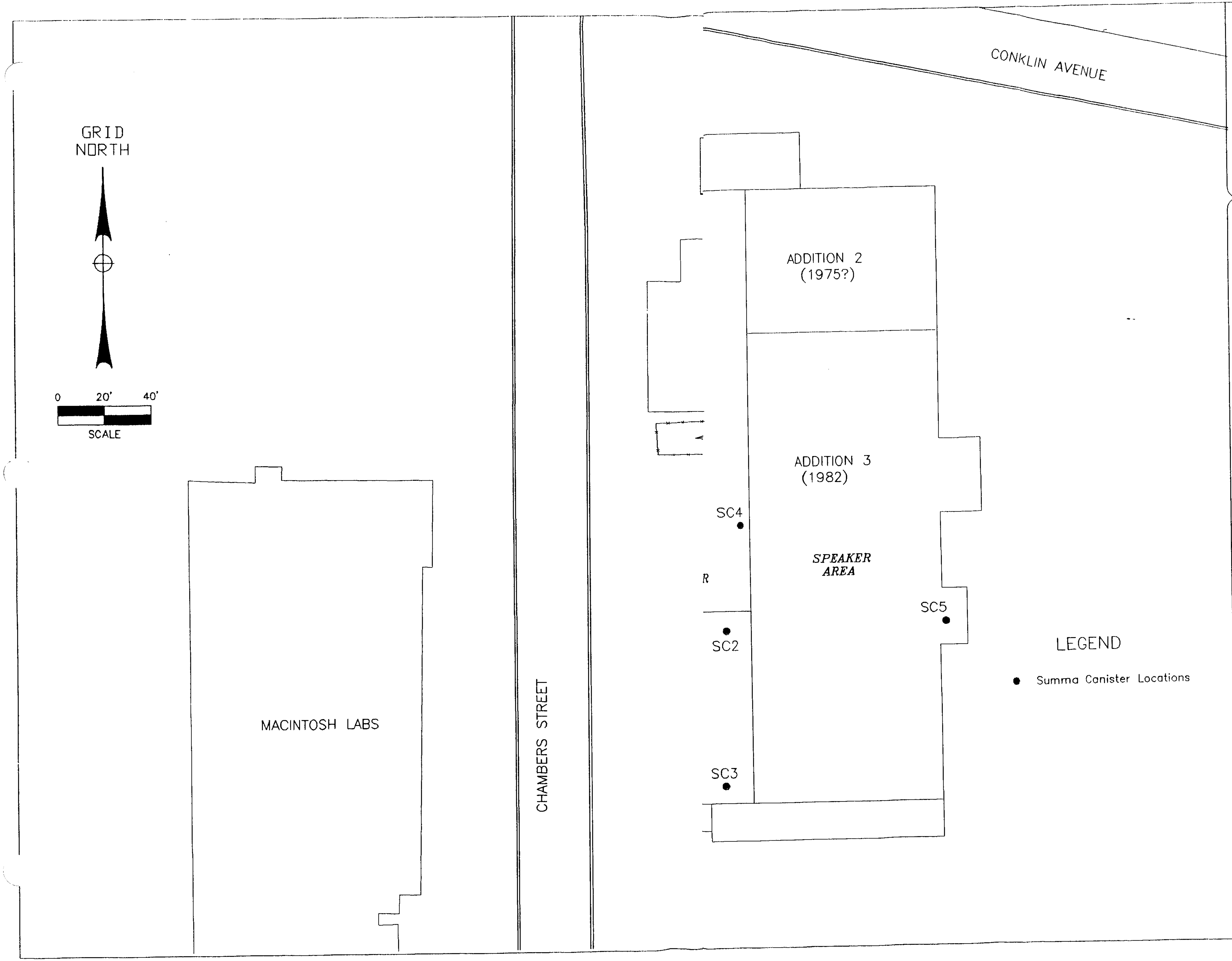

SHIELD
ENGINEERING ASSOCIATES, INC., P.C.
CHARLOTTE, NORTH CAROLINA

FIGURE 9

SUMMA CANISTER LOCATIONS
DII – BINGHAMTON PLASTICS
BINGHAMTON, NEW YORK

DATE: 02/03/00
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APPROVED BY: M.A.L.
CLIENT NO.: 796-0460

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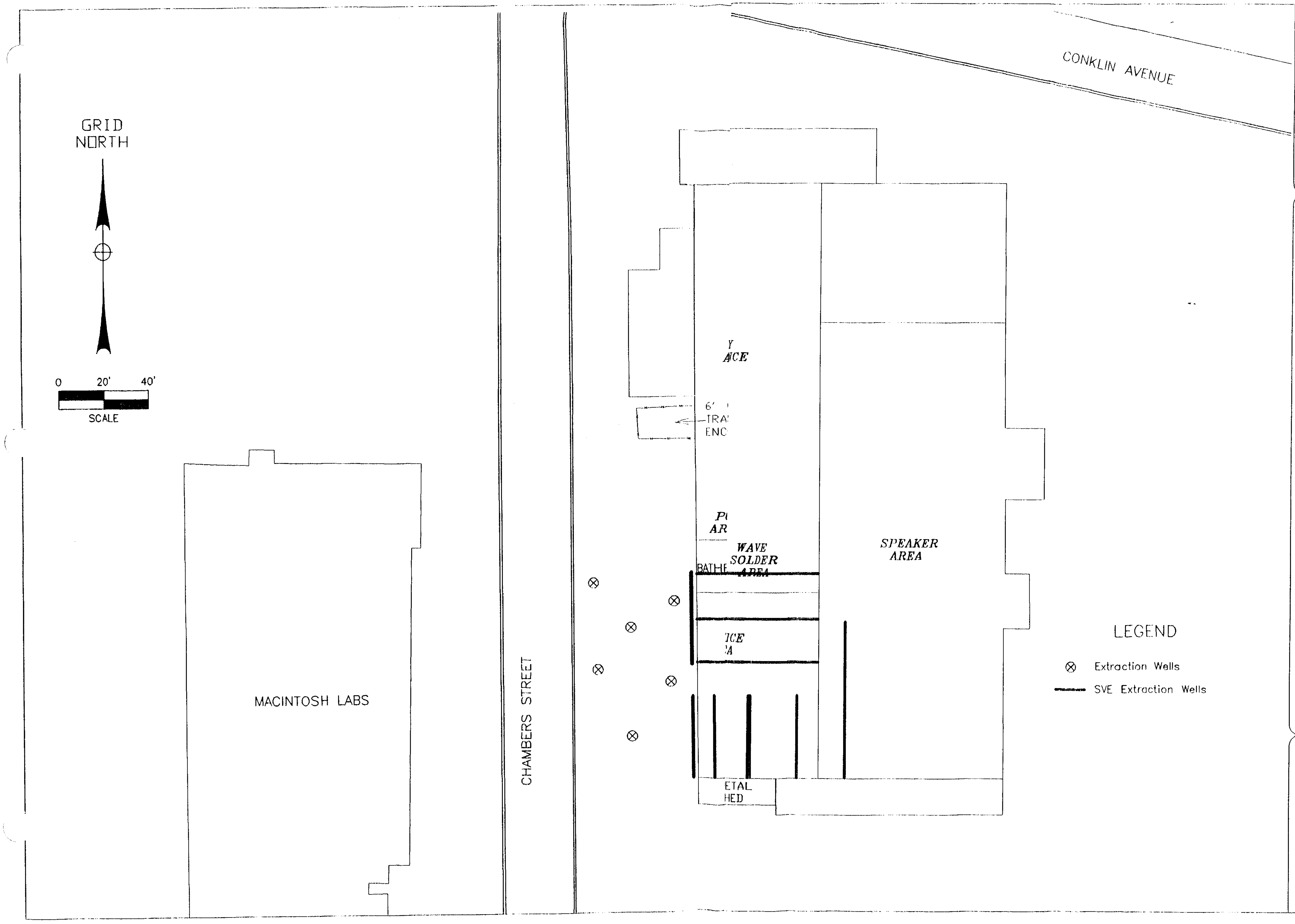

SHIELD
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CHARLOTTE, NORTH CAROLINA

FIGURE 10

PROPOSED CONCEPTUAL LAYOUT
DII - BINGHAMTON PLASTICS
BINGHAMTON, NEW YORK

DATE: 02/03/00
DRAWN BY: P.D.H.
APPROVED BY: M.A.L.
CLIENT NO.: 796-0460

Tables

TABLE 1
NEW YORK STATE STANDARDS, CRITERIA AND GUIDELINES (SCGs)

1. Division of Water Technical and Operational Guidance Services (1.1.1.) Ambient Water Quality Standards and Guidance Values (originator: Jon Zambruno)

2. Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Clean Levels (TAGM 4046) 1994

3. New York State Inactive Hazardous Waste Site, Citizen Participation Plan, August 30, 1988

4. Fresh Water Wetlands Mapping and Classification Regulations 6 NY CRR Part 664

5. NYSDEC Division of Environmental Remediation Guidance for the Development of Data Usability Summary Reports

6. NYSDEC – Division of Environmental Remediation, Spill Technology and Remediation Series (STARS) Memo #1: Petroleum-Contaminated Soil Guidance Policy.

7. NYSDEC – Division of Air Resources, Guidelines for the Control of Toxic Ambient Air Contaminants (Air Guide 1), November 12, 1997.

TABLE 2
CONTAMINANTS OF CONCERN BY AFFECTED MEDIA
FORMER BINGHAMTON PLASTICS, BINGHAMTON, NEW YORK

Groundwater
- 1,1-dichloroethane
- 1,1-dichloroethene
- 1,2-dichloroethene (cis)
- 1,2-dichloroethene (trans)
- 1,1,1-trichloroethane
- trichloroethene
- tetrachloroethene
- vinyl chloride

Subsurface Soil
- 1,2-dichloroethene (cis)
- trichloroethene
- vinyl chloride

Surface Water
- 1,1,1-trichloroethane
- trichloroethene
- tetrachloroethene

TABLE 3
COST COMPARISONS OF THE REMEDIAL ALTERNATIVES
Dii - Binghamton Plastics Site

Remedial Alternative	Capital Costs	Annual O&M Costs	Present Worth Costs (1)	Notes
Soil				
No Futher Action	$ 10,000		$ 10,000	No O&M
Soil Vapor Extraction (2)	$ 215,000	$ 41,000	$ 360,386	Four (4) years O&M
Ground Water				
No Further Action	$ 10,000	$ 10,000	$ 101,285	30 years of O&M
Ground Water Extraction Using Submersible Pumps & Treatment w/ Oil/Water Seperator & Air Stripper	$ 135,000	$ 33,000	$ 642,276	30 years of O&M

(1) 5% discount rate is the basis for determining Present Worth Costs