EG&G MOUND-22-03-10-02-03-9505310013

Environmental Restoration Program

# SOIL VAPOR RECONNAISSANCE OPERABLE UNIT 2, MAIN HILL OU-2 PHASE I TECHNICAL MEMORANDUM

## MOUND PLANT
## MIAMISBURG, OHIO

February 1995

## FINAL

(Revision 0)

**Department of Energy**
**Ohio Field Office**

Environmental Restoration Program
EG&G Mound Applied Technologies

CONTENTS

EXECUTIVE SUMMARY ..... ES-1

1. INTRODUCTION ..... 1-1
   1.1. SITE BACKGROUND ..... 1-1
   1.2. OBJECTIVE ..... 1-3
   1.3. PREVIOUS INVESTIGATIONS ..... 1-5
   1.4. FACTORS INFLUENCING SAMPLE LOCATIONS ..... 1-6
      1.4.1. Historical and Current Use of Buildings in Areas Investigated ..... 1-6
         1.4.1.1. G Building - Garage ..... 1-6
         1.4.1.2. Paint Shop ..... 1-8
         1.4.1.3. Building M - Plating Shop ..... 1-8
         1.4.1.4. Building 23 ..... 1-9
         1.4.1.5. WD Building ..... 1-9
         1.4.1.6. B Building Solvent Storage Shed ..... 1-9
         1.4.1.7. DS Building ..... 1-10
      1.4.2 Documented Spills in Areas Investigated ..... 1-10
      1.4.3. Environmental Conditions ..... 1-12
         1.4.3.1. Geology ..... 1-12
         1.4.3.2. Soils ..... 1-12
         1.4.3.3. Utilities ..... 1-13
      1.4.4. Physical and Chemical Factors ..... 1-13
         1.4.4.1. Vapor Pressure ..... 1-14
         1.4.4.2. Water Solubility ..... 1-14
         1.4.4.3. Henry's Law Constant ..... 1-14
         1.4.4.4. Influence of Chemical and Physical Factors on Selecting Sample Locations ..... 1-14

2. SUMMARY OF ACTIVITIES ..... 2-1
   2.1. SOIL VAPOR METHODOLOGY OVERVIEW ..... 2-1
   2.2. SAMPLING PROCEDURES ..... 2-1
   2.3. ANALYTICAL PROCEDURES ..... 2-2
   2.4. QUALITY ASSURANCE/QUALITY CONTROL ..... 2-2

3. PRESENTATION OF RESULTS ..... 3-1
   3.1. GENERAL OVERVIEW ..... 3-1
   3.2 WD AREA ..... 3-1
   3.3. PAINT SHOP AREA ..... 3-2
   3.4. M BUILDING ..... 3-2
   3.5. G AND GW BUILDINGS ..... 3-3
   3.6. DS BUILDING AREA ..... 3-4

4. DATA ANALYSIS ..... 4-1
   4.1. DATA VALIDATION ..... 4-1
   4.2. ANALYSIS BASED ON ENVIRONMENTAL FACTORS ..... 4-1
      4.2.1. Geological Factors ..... 4-2
      4.2.2. Climatic Factors ..... 4-3
      4.2.3. Underground Utilities ..... 4-3
      4.2.4. Physical Features ..... 4-4
   4.3. ANALYSIS BASED ON INTEGRATION WITH PREVIOUS INVESTIGATIONS ..... 4-4
   4.4. ANALYSIS BASED ON CHEMICAL AND PHYSICAL FACTORS ..... 4-4
   4.5. DATA ANALYSIS SUMMARY ..... 4-5

5. CONCLUSIONS AND RECOMMENDATIONS ..... 5-1

6. REFERENCES . . . . . 6-1

APPENDIX A SOIL VAPOR ANALYTICAL RESULTS
APPENDIX B SITE MAPS WITH ANALYTICAL RESULTS

FIGURES

1.1. Site Location . . . . . 1-2
1.2. Mound Plant Areas and Main Buildings . . . . . 1-4
1.3. Sample Locations . . . . . 1-7

4.1. Areas of Contamination, Main Hill East . . . . . 4-6
4.2. Areas of Contamination, Main Hill West . . . . . 4-7

5.1. Areas Requiring Additional Sampling, Main Hill West . . . . . 5-2
5.2. Areas Requiring Additional Sampling, Main Hill East . . . . . 5-3

TABLES

I.1. Documented Spills or Organic Fluids in Areas Investigated . . . . . 1-11
I.2. Physical and Chemical Parameters of Concern . . . . . 1-15

II.1. Sample Numbering System . . . . . 2-4

V.1. Summary of Recommendations . . . . . 5-5

## LIST OF ACRONYMS
## MOUND PLANT, ER PROGRAM

| | |
|---|---|
| AEC | Atomic Energy Commission |
| $CaCO_3$ | Calcium Carbonate |
| CERCLA | Comprehensive Environmental Response, Conservation, and Liability Act |
| DCA | Dichloroethane |
| DCE | Dichloroethene |
| DOE | U.S. Department of Energy |
| DS | Development Standards |
| EG&G | EG&G Mound Applied Technologies |
| EPA | U.S. Environmental Protection Agency |
| ER | Environmental Restoration (Program) |
| FFA | Federal Facility Agreement |
| FID | Flame Ionization Detector |
| FS | Feasibility Study |
| GC | Gas Chromatograph |
| ICF KE | ICF Kaiser Engineers, Inc. |
| mL | milliliter |
| MRC | Monsanto Research Corporation |
| NPL | National Priority List |
| OU | Operable Unit |
| PCE | Perchloroethene (Tetrachloroethene) |
| PPB | parts per billion |
| RI | Remedial Investigation |
| RI/FS | Remedial Investigation/Feasibility Study |
| SCS | Soil Conservation Service |
| SD | Sewage Disposal Plant |
| TCA | Trichloroethane |
| TCE | Trichloroethene |
| TVOC | Total Volatile Organic Compounds |
| VOC | Volatile Organic Compound |
| WD | Waste Disposal |

## EXECUTIVE SUMMARY

Mound Plant is a research and manufacturing facility for the production of radioactive power sources and military detonators. It is located in Miamisburg, Ohio and is operated by EG&G Mound Applied Technologies (EG&G) for the Department of Energy (DOE). Mound Plant was placed on the Comprehensive Environmental Response, Conservation and Liability Act (CERCLA) National Priority List (NPL) in November of 1989 and a Federal Facility Agreement (FFA) was signed between the Department of Energy and the Environmental Protection Agency (EPA) in October of 1990. In response to being placed on the NPL, Mound was divided into Operable Units (OU) to simplify program management. The Main Hill of Mound Plant is Operable Unit 2.

A remedial investigation (RI) of Operable Unit 2 (OU-2) was started in April, 1994. The first part of the investigation, Phase I, was conducted to collect data to help in scoping the remaining phases of the RI. As part of the Phase I reconnaissance, a soil vapor investigation was performed.

The soil vapor investigation of Operable Unit 2, Main Hill was performed during April of 1994. The objective of the soil vapor investigation was to identify areas of the Main Hill that would require additional sampling during Phase II of the remedial investigation. A hydraulically driven sample probe was used to collect soil vapor from soil pore spaces. Samples were analyzed for the contaminants of concern which include several chlorinated compounds. Samples were analyzed using gas chromatography utilizing a wide-bore DB-624 column with a flame ionization detector.

Samples were obtained from areas surrounding or near several buildings: Paint Shop, M, WD, DS, G and GW. Locations were based on the historical and current use of the buildings, the environmental conditions on the Main Hill, physical and chemical characteristics of the contaminants, and data gaps from previous investigations. A previous investigation had detected soil vapor contamination in several areas including B Building, Building 28, H Building and Building 17. Contamination found at the B Building is currently being remediated under an interim remedial action by soil vapor extraction. A review of the results of the previous investigation and building use indicated samples should be collected from near G Building, the Paint Shop, M Building, WD Building, Building 23, and the DS Building. Environmental factors such as geology, soils, climate and underground utilities had little affect on the sample locations for several reasons. The nature of the geology, the unknown distribution of site soils, the wide coverage of the site limiting the affect of climate, and the numerous utilities limited the use of these factors in considering sample locations. Building use and chemical parameters of contaminants had the greatest influent on sample locations in addition to areas that had not been previously investigated. Samples were obtained at 2.5 foot intervals until bedrock was encountered.

Detectable levels of contamination were found in all areas investigated. Freon 11 was detected most often while toluene and cis-1,2-DCE were detected almost as frequently. Trichloroethene, chloroform, bromoform, and bromodichloromethane were not detected at any location.

Their was no indication that environmental factors such as soil, geology, climate or underground utilities influenced the pattern of contamination. The results indicate that the soil vapor contamination corresponds to the historical use of the buildings. Based on the results, additional soil sampling is warranted during the Phase II investigation to augment the sampling already planned.

Section 1

# 1. INTRODUCTION

## 1.1. SITE BACKGROUND

Mound Plant originated as part of the Manhattan Engineer District in 1943; its purpose was to determine the chemical and metallurgical properties of polonium (DOE 1986). The work was performed for the U.S. Army at several locations in Dayton, Ohio, by Monsanto Research Corporation (MRC 1985). In 1946, 182 acres were purchased for the permanent Mound Plant Site on the outskirts of the city of Miamisburg, in Montgomery County, Ohio (Figure 1.1). The Site is approximately 10 miles south-southwest of Dayton and 45 miles north of Cincinnati. In 1948, work being performed at the Dayton units was moved to this Site, and in January 1949, operations involving radionuclides began.

Early Mound Plant programs investigated the chemical and metallurgical properties of polonium-210 and its applications, particularly the fabrication of neutron and alpha sources for weapon and nonweapon use. Investigations involving uranium, protactinium-231, and plutonium-239 were performed from 1950 to 1963 as part of the national civilian power reactor program. In 1954, separation of the stable isotopes of noble gases began. Development of plutonium-238 heat sources started at Mound Plant in 1961 because of its high specific activity and relatively short half-life (87.74 years). Since that time, heat sources fueled with plutonium-238 have been developed and fabricated.

In 1957, a new mission assigned to Mound Plant was the development, production, and surveillance of detonators for military applications. Development of explosives timers in 1959 led to their manufacture starting in 1963. The development and manufacture of ferroelectric transducers and firing sets (components that control initiation of detonators) began in 1962. All these programs are continuing.

The first of several programs requiring tritium-handling technology was initiated in 1958. Today, Mound Plant has an extensive capability for handling and studying tritium and tritium compounds for weapons or nonweapons applications. A facility also exists for the recovery and purification of tritium from all types of wastes generated at DOE sites which handle tritium. Facilities also exist for the development of tritium-containing materials and processes for weapons applications and possible manufacture (MRC 1985).

On the Main Hill, several buildings had a history of practices that included the use of chemicals. Organic solvents were used or stored in the GW Building, Paint Shop, DS Building Solvent Storage Shed, M Building, E Building Solvent Storage Shed, B Building Solvent Storage Shed and Building 28. Waste oils, fuel oils, gasoline, and diesel fuel were used in the G Building, B Building, and Building 28. The WD

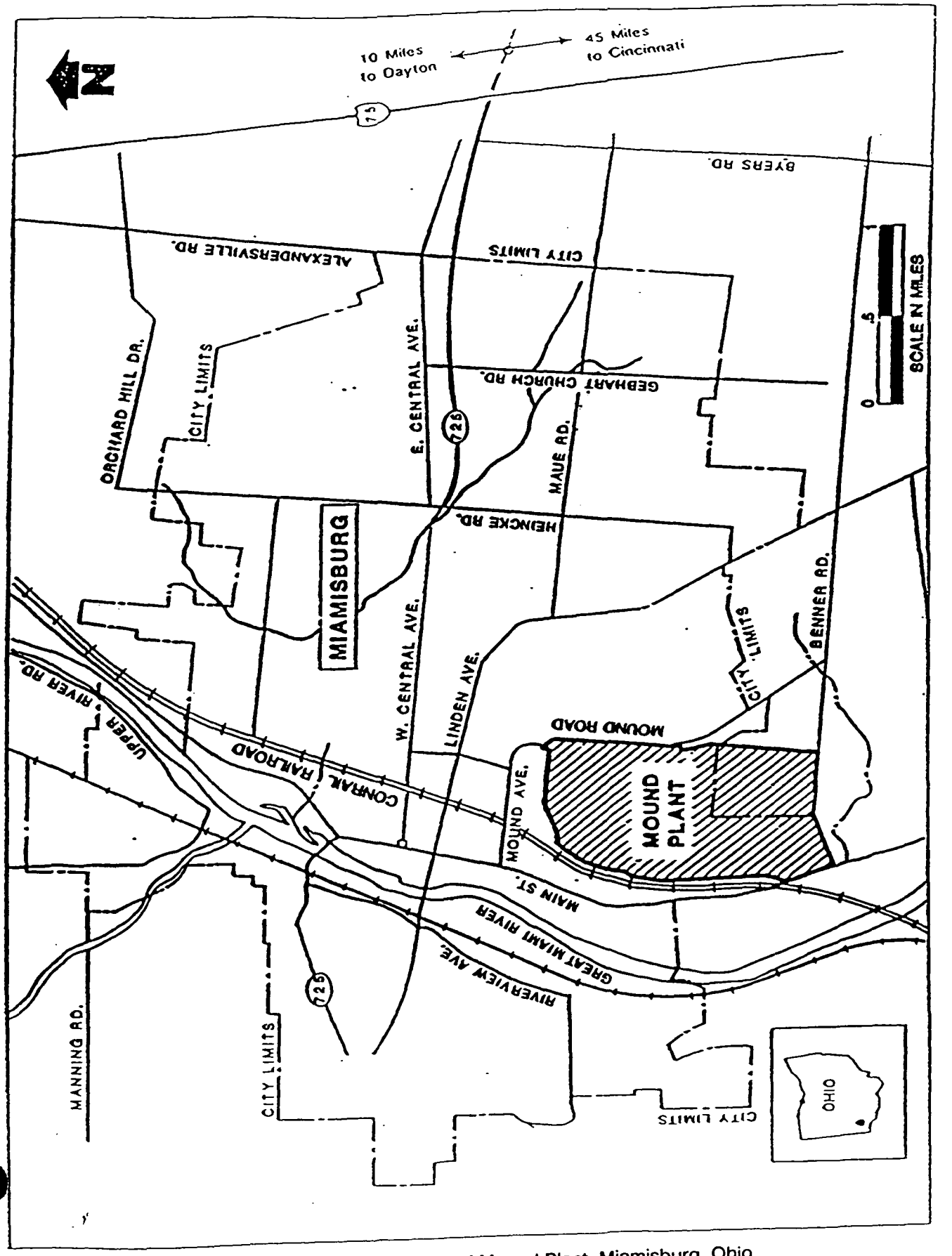



Figure 1.1. Location of Mound Plant, Miamisburg, Ohio

Building also treated wastes from these buildings (DOE 1994c). Solvents were used as cleaning agents during manufacturing processes while waste oils were often the by-product of metal cutting during manufacturing.

In the early 1970s, as national concerns about the environment and the conservation of resources grew, Mound Plant expanded its comprehensive programs in environmental control, waste management, and energy conservation. In January 1975, Mound Plant formally came under the jurisdiction of the Energy Research and Development Administration upon dissolution of the Atomic Energy Commission (AEC). In October 1977, Mound Plant was incorporated into the DOE complex.

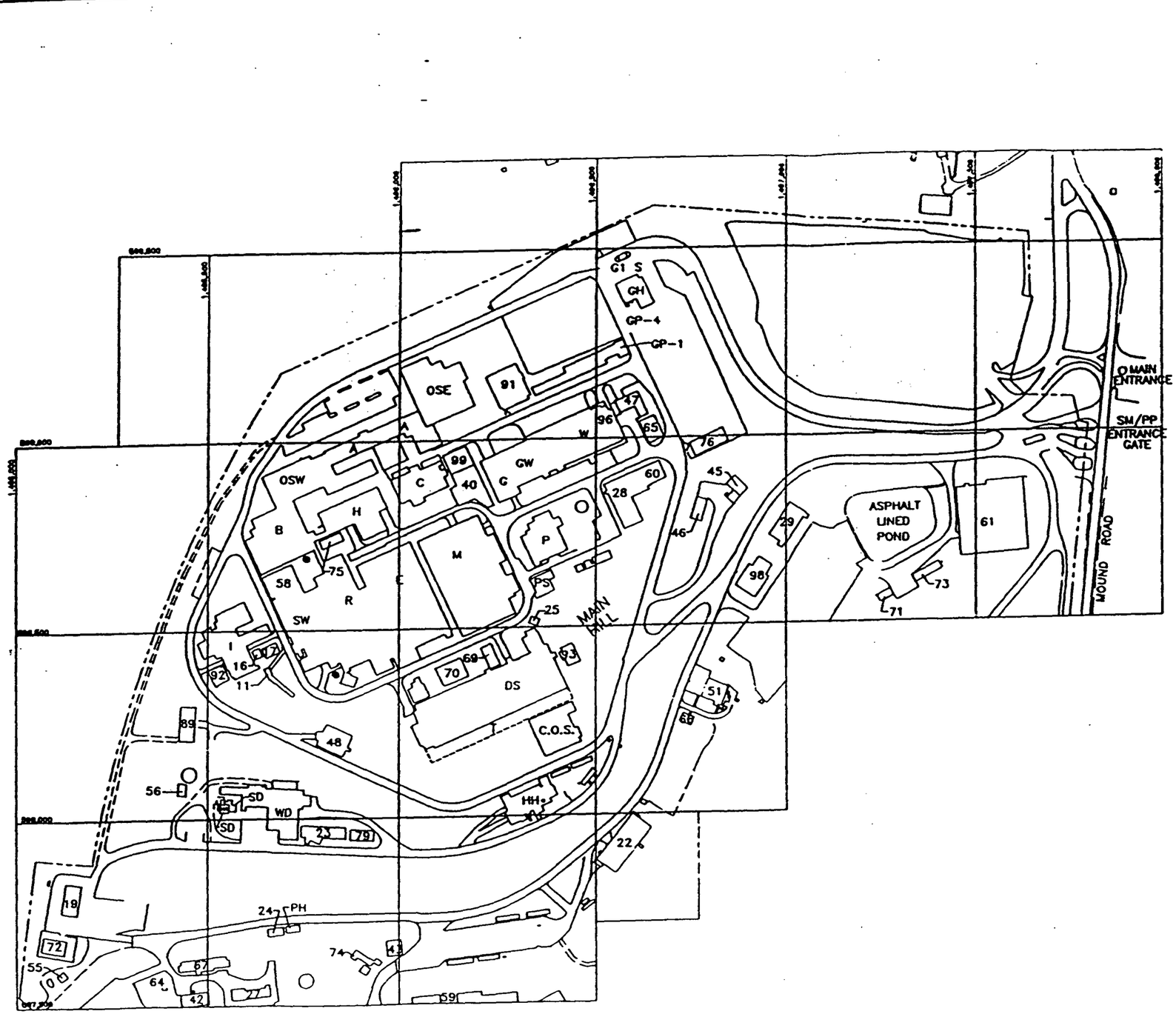
Mound Plant was placed on the CERCLA (Superfund) National Priority List (NPL) in November, 1989. Pursuant to that status, a CERCLA Section 120 Federal Facility Agreement (FFA) was signed between DOE and EPA ( Administrative Docket Number V-W-90-C-075), and became effective October 12, 1990. A Remedial Investigation/Feasibility Study (RI/FS) was initiated at Mound to characterize the nature and extent of risks faced by uncontrolled hazardous waste and for evaluating potential remedial options.

In response to being placed on the NPL, an Environmental Restoration (ER) Program was initiated by DOE at Mound to fulfill its obligations under the FFA. The site was divided into Operable Units to simplify the investigation and program management (DOE 1992b). The Main Hill of Mound Plant (Figure 1.2) is OU-2. Operable Unit 2 comprises the portion of the site where the majority of the research and manufacturing took place.

## 1.2. OBJECTIVE

The objectives of the OU-2 RI/FS is to define the nature and extent of contamination on the Main Hill, characterize the risks to human health and the environment posed by exposure to affected medium, to evaluate potential remedies and to determine the affect of potential releases of contaminants to groundwater. The objectives for Phase I of this investigation, was to obtain information to help establish the scope for the subsequent phases of the investigation. As part of Phase I, a soil vapor survey was performed.

The soil vapor survey performed during this investigation was a reconnaissance sampling effort. This data will be used during the scoping of the Phase II sampling effort to determine which areas need further investigation. Specifically, the soil vapor survey was performed to identify areas of the site containing volatile organic compound (VOC) contamination within the subsurface soils that had not been identified during previous soil vapor investigations.




# NOTES:

1. THE ELECTRONIC BASE MAP DATA FILE WAS OBTAINED BY ICF KAISER ENGINEERS, CINCINNATI, OHIO, FROM ROY F. WESTON, INC., ALBUQUERQUE, NEW MEXICO, WHO OBTAINED IT FROM WOOLPERT CONSULTANTS, INC., DAYTON, OHIO. THE DATA WERE PHOTOGRAMMETRICALLY COMPILED FROM AERIAL PHOTOGRAPHY DATED 12/08/85.

2. WESTON CONVERTED MOUND PLANT COORDINATES TO OHIO STATE PLANE COORDINATES USING AN ALGORITHM PROVIDED BY OAK RIDGE NATIONAL LABORATORY, GRAND JUNCTION PROJECT OFFICE.

# LEGEND:

- 53 STRUCTURES
- PAVED ROADWAY
- UNPAVED ROADWAY
- MOUND PLANT BOUNDARY

Figure 1.2. Mound Plant Areas and Main Building

## 1.3. PREVIOUS INVESTIGATIONS

There have been two previous soil vapor investigations. One was performed in 1987 to help define the locations of new monitoring wells (DOE 1989). In this investigation samples were collected from 58 locations southwest of the Main Hill. Target compounds for this investigation were chosen based on previous sampling of existing monitoring wells. The target compounds consisted of trichloroethene, trans-1,2-dichloroethene, vinyl chloride, benzene, ethylbenzene, and toluene. Each of these compounds were detected during the 1987 soil vapor survey. However, most of the detections were at low concentrations (2 to 50 ppb) compared with high (greater than 1,000 ppb) concentrations. The only area with elevated concentrations were near the landfill which is not in Operable Unit 2.

The other investigation was performed in 1992 (DOE 1992c). These samples were collected from four primary areas: the Main Hill, Area 7, Building 51, and Area J (Figure 1.3). As part of this soil vapor survey, more than 200 investigative samples were collected and analyzed. The soil vapor samples collected from the Main Hill, Area 7, Building 51, and Area J at Mound Plant were initially collected for the analysis of six target compounds, including trichloroethene, trans- and cis-1,2-dichloroethene, 1,1,1-trichloroethane, toluene, and trichlorofluoromethane (Freon 11). These compounds were targeted based on the results of previous contaminant characterization efforts, including the analysis of groundwater seeps and the study of underground storage tanks at the site. All soil vapor and groundwater samples were analyzed in an on-site mobile laboratory for VOCs using U.S. EPA Method 8021. Peaks on the gas chromatograph curves showed the presence of additional solvent-type VOCs. Following the completion of the first 10-day field shift, the target compound list was expanded to include 1,1,1-trichloro-1,2,2-trifluoroethane (Freon 113) and tetrachloroethene (PCE) which were the most prevalent of the additional VOCs detected based on interpretations made by the field laboratory chemist.

The results of this investigation indicated that contamination was present in several locations on the Main Hill (Appendix B). Freon 11 was detected at low levels (2-4 ppb) near the GW and W Buildings and at 240 ppb near Building 28. Freon 113 was detected at concentrations ranging from four to 131,000 ppb. The majority of Freon 113 detections were found in the B Building Solvent Storage Shed area. Detected levels of 1,2-trans-dichloroethene and 1,2-cis-dichloroethene ranged from 13 to 247 ppb and 81 to 40,800 ppb, respectively, all within the B Building Solvent Storage Shed area. Concentrations of 1,1,1-trichloroethane ranged from two to 315 ppb. Detectable levels of this compound were found randomly on the Main Hill. Tetrachloroethene was detected near Building 17 at 1,191 ppb and Building 28 at 34 ppb. Trichloroethene was detected at concentrations ranging from four to 34,780 ppb. The majority of the detections were in the B Building Solvent Storage Shed area. Other detections were observed at random locations around the Main Hill. Toluene was also detected at concentrations ranging

from three to 23,142 ppb. Most of the detections were in the B Building Solvent Storage Shed area, HH Building and Building 17.

Based on the results of this investigation, "hot spots" of contamination were centered at the B Building Solvent Storage Shed, Building 17, and the west side of the B Building.

The contamination at the B Building Solvent Storage Shed lead to an interim remedial action to remediate the soils in the area (DOE 1993). Soil vapor extraction (SVE) was the selected method of remediation and remedial efforts began in May of 1994. Initial soil vapor results indicated that concentrations of TCE ranged from less than 50 ppb to 2,650 ppb and 1,2-DCE (cis and trans) ranged from 100 ppb to 277.9 ppm (DOE 1994b). Since remediation began, concentrations of TCE have dropped to a maximum of 1,560 ppb and 1,2-DCE to 1,410 ppb.

## 1.4. FACTORS INFLUENCING SAMPLE LOCATIONS

### 1.4.1. Historical and Current Use of Buildings

Historical and current use of buildings, along with the data gaps from previous investigations, had the greatest influence on sample locations. Contaminants of concern had been or had potentially been used in all of the buildings investigated. The exceptions are the degradation products of tetrachloroethene and trichloroethene which are 1,2-dichloroethene (cis and trans) and 1,1-dichloroethane. Toluene may not have been used in a building but is a chemical found in gasoline and oil. The following sections describe the historical and current use of buildings to provide a rationale for their use in selecting sample locations. Specific sample locations are shown in Figure 1.3.

#### 1.4.1.1. G Building - Garage

The garage is used to maintain the automobiles, trucks, buses, and heavy duty equipment used at Mound. The building is approximately 122 ft by 62 ft and is made of structural steel and brick with concrete floors. The building contains a new parts storage area, offices, restrooms, and a custodial operations storage area. Maintenance operations include oil changes, antifreeze replacement, vehicle repair, and tire and battery replacement. Building G is also used to store janitorial supplies such as floor strippers, floor finishes, cleansers, deodorizers, hand soaps, sponges, and mops that are used throughout Mound. These materials are stored in locked cabinets and caged areas. The historical and current use of this building indicated that the underlying soils may be contaminated with either motor oil, antifreeze, or organic based cleaning material. For that reason, samples were collected from locations that were

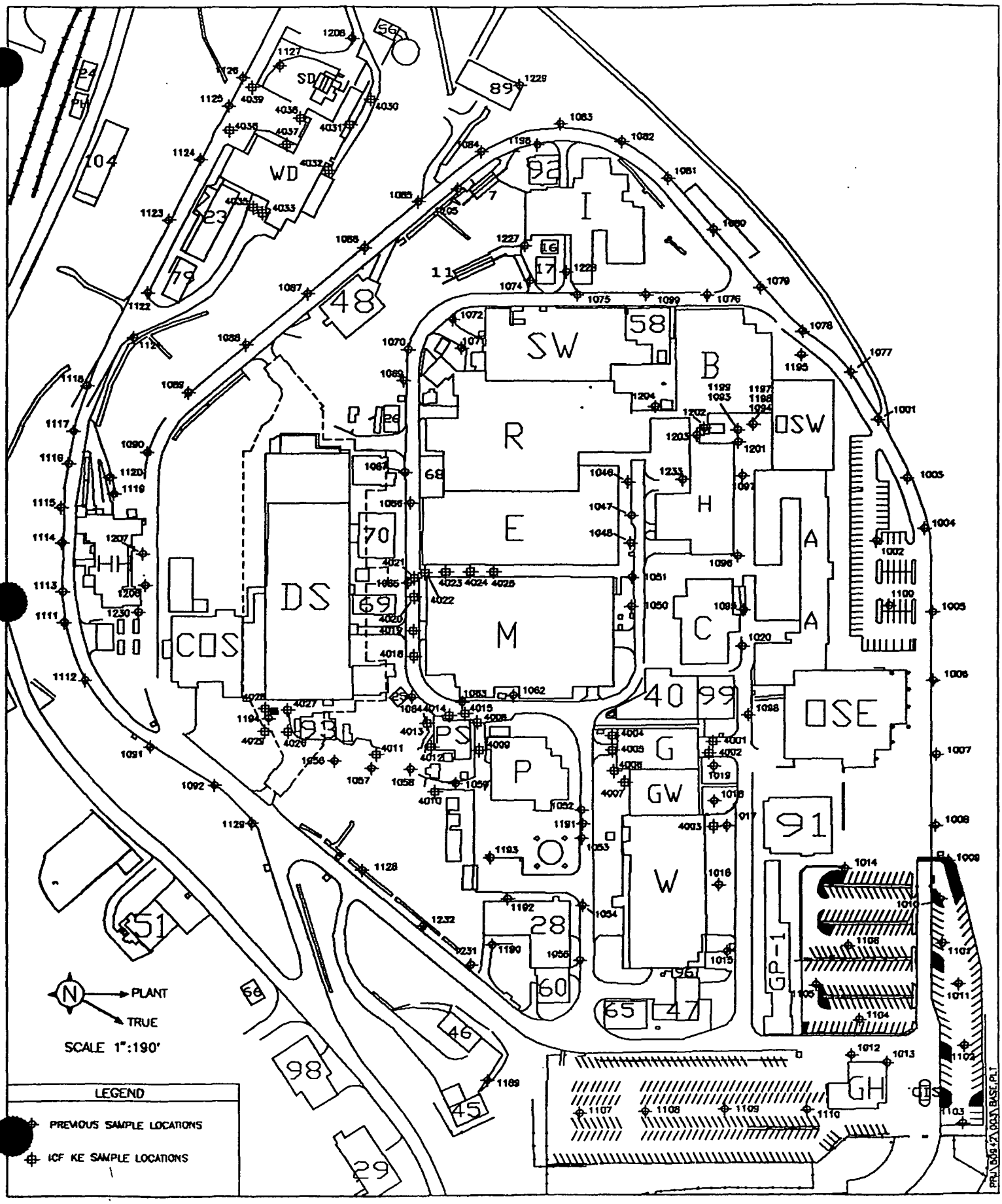



Figure 1.3. Sample Locations

judged to be areas where spills could collect or enter the soil. Specific locations were selected based on surface drainage patterns and obvious cracks in the overlying concrete.

#### 1.4.1.2. Paint Shop

The paint shop began operating in 1963. The shop is used for both maintenance and production parts painting. Maintenance work includes the painting of such items as racks and furniture. Production work includes the painting of metal shipping containers, styrofoam shipping trays, and test panels. All painting is done inside spray booths. Based on the high use of solvents in this building, it was determined that samples should be collected around the building. Specific locations were based on the drainage patterns from the building to the surrounding areas, the surface drainage patterns of the surrounding areas and obvious cracks in the concrete. Some locations were also influenced by underground utilities.

#### 1.4.1.3. Building M - Plating Shop

The Mound plating shop started in the M Building in the late 1940s (Figure 1.2). Plating processes and metal purification experiments were performed there. The shop itself consisted of eight to ten 150-gallon plating solution tanks that were handmade from boiler plate steel (Shawhan 1991). Sulfuric acid anodizing solution wastes and sodium hydroxide cleaning wastes were regenerated on an infrequent basis. The plating solutions were reused and generally recycled; but, when necessary, they were dumped into a large underground tank. The tank consisted of a concrete vault structure west of the original M Building that connected to the plant sanitary sewer. The cascade rinse systems also drained to the underground tank. The condition of this tank will be discussed in the OU-2 subsurface utility investigation. Soil sampling will be conducted as part of Phase II activities.

In 1962, a production plating shop and a general plating shop were installed in the M Building, and the old plating shop was dismantled. During the dismantling process, the plating solutions were removed from the equipment and neutralized. All of the old tanks and equipment were removed. The underground tank was retained and reconnected to the new equipment.

In 1981, a new production plating shop was built on the south end of the M Building. In 1985 or 1986, a new general plating shop was built next to it. The new shops were built to upgrade the old equipment and use modern technology. The old equipment still exists in the M Building, but has been cleaned out. The waste products were drummed and disposed of off-plant through the waste management system.

Based on the historical use of the building, it was decided that samples should be obtained from the areas adjacent to the building. Specific locations were selected based on areas not previously investigated, surface drainage patterns, and breaks in the concrete.

#### 1.4.1.4. Building 23

Building 23 serves as a mixed waste storage building in which drums are staged for off-plant disposal. Spenting organic solvents are packaged in 30-gallon drums with Floro adsorbent and then overpacked into 55-gallon drums. The drum staging area has a concrete floor, with a floor drain in the middle of the floor. The floor drain is connected to a sump. Non radioactive or clean material is released to the sanitary sewer system. The contaminated material is pumped to the WD Building alpha wastewater influent tanks. Based on the historical use of the building, and previous nondetect soil gas sampling results in this area, a confirmatory sample was collected adjacent to the building in an area not previously investigated.

#### 1.4.1.5. WD Building

The central facility for the treatment of liquid radioactive wastes at Mound is the WD Building (Figure 1.2), which houses the alpha and beta wastewater treatment systems. The WD Building was constructed as part of the original plant design in 1948 and became operational in February 1949. It was originally designed to accept all liquid wastes generated from process operations and research activities; but, in practice, most wastewater was pretreated to remove the highest percent of solids possible or was treated independently of WD Building. Since its beginnings, alpha wastewater treatment has been the core of WD Building operations, supporting the polonium operations until 1971 and plutonium operations since. Alpha wastewater sources include the process operations in the SW and R Buildings and Building 38 and the wastewater sumps in the WD Building. Historical alpha wastewater sources included the B, HH, H, and SM Buildings. The beta wastewater facility was installed in the mid-1960s. Beta wastewater sources included the SW, R, T and HH Buildings. Because this building once processed all wastes generated from the site, samples were obtained from the area immediately adjacent to the building. Specific locations were selected by using the procedures discussed for other buildings.

#### 1.4.1.6. B Building Solvent Storage Shed

Although the B Building Solvent Storage Shed area had high levels of volatile organic contamination, the building and associated shed were not factors in the selection of sample locations. The previous investigations and the planned remedial efforts eliminated the area from consideration. In addition, future

phases of the RI/FS will include soil sampling in the area. Confirmational sampling following remediation will also be conducted.

#### 1.4.1.7. DS Building

The DS Building solvent storage shed is on the east side of DS Building on the Main Hill, in the north-central portion of Mound (Figure 1.2). The shed was built in the early 1970s and is still in operation. The shed is a completely enclosed structure of approximately 10 ft by 10 ft, with a 12-ft ceiling equipped with a fan for ventilation. It has a concrete floor and a sealed drain with an unknown point of discharge, although a storm drain is near the shed. The concrete floor is curbed and covered with a metal grate. The curbing was not installed until 1987, at which time the drain was sealed. Historically, solvents were stored in 5-gallon cans within the building and picked up and delivered by laborers. The shed now receives waste solvent from the DS Building and also contains product-grade solvent to be used in the building. Waste solvents are pumped from DS Building into sealed 55-gallon drums in the storage shed through automatic discharge hoses which are equipped with automatic shutoff devices. During a 1990 site visit, two drums of waste solvents composed of 1,1,1-trichloroethane, trichlorofluoromethane, and trichloroethene; and product-grade solvents including one drum of 1,1,1-trichloroethane, two drums of trichlorofluoromethane, and one drum of ethyl alcohol, were found (DOE 1992b). Drummed waste solvent is transferred as required to the hazardous waste storage area in Building 72 near the western edge of the Mound boundary (MRC 1983). The use of this shed prompted the collection of samples at several locations near the shed. Specific locations were based on accessibility and topography.

### 1.4.2. Documented Spills In Areas Investigated

Documented spills of organic fluids in the areas investigated are presented on Table I.1. Volatile organic compounds of concern from these spills would be benzene and toluene from oil, fuel oils, and waste oils, and Freon 11. The spills in the M Building and the Power House (P Building) led to the collection of samples adjacent to these buildings. The specific locations for M Building were selected based on areas not previously investigated. Sample locations at the Power House were placed between it and the Paint Shop (PS Building). Surface topography indicated that spills within the Power House would flow toward the Paint Shop.

**Table I.1. Documented Spills of Organic Fluids in Areas Investigated**

| Building | Date | Contaminant | Quantity |
|---|---|---|---|
| M | 9/17/87 | Oil | Unknown |
| | | Waste Oil (Cimperial 1011) Freon | 55 gallons |
| Power House | 6/6/73 | Fuel Oil | 50 - 100 gallons |
| | 7/20/89 | Fuel Oil | 10 - 15 gallons |
| | 8/18/83 | No. 2 Fuel | 10 gallons |
| | 1/6/88 | No. 2 Fuel | 200 gallons |

### 1.4.3. Environmental Conditions

#### 1.4.3.1. Geology

The bedrock at Mound Plant is comprised of marine shales and limestones of the Ordovician System. Rocks are grouped within the Cincinnatian Series and include rocks from the Richmondian and Mayvillian Stages. These units comprise the time-stratigraphic framework within the areas of southwestern Ohio and eastern Indiana. Formations encountered include, from the lowest to the highest, the Corryville Formation, the Mount Auburn Formation, the Oregonia Formation, the Waynesville Formation, the Liberity Formation, and the Whitewater Formation. Historically, the formations within the Cincinnatian Series were defined on the basis of fossils and faunal zones, i.e., they were biostratigraphic units. In the strict sense of stratigraphic nomenclature, formations must be defined on the basis of lithologic characteristics (DOE 1994a).

Two broad types of fractures are observed in Mound Plant bedrock, natural and induced. Natural fractures comprise the fracture carapace and are distinguished from induced fractures by their geometry and morphology. Natural fractures are defined as those fractures that existed in the rock prior to drilling. They exhibit diagnostic characteristics, including irregular, open apertures that typically exhibit evidence of solution dissolution and precipitation of minerals, slickensides, and multiple breakage (DOE 1994a). These fractures would capture any releases of liquid VOC contamination that had migrated through the soil column. The bedrock fractures would then spread the contamination along the fracture system. Due to the limited information on the location of the fractures, the location of soil vapor samples was not influenced by the geology of the Main Hill.

#### 1.4.3.2. Soils

Nine soil series, as classified by the Soil Conservation Service (SCS) have been identified at Mound Plant (DOE 1994a). Two of the nine soil series at Mound Plant, as identified by the SCS, are within the OU-2 boundaries; they are described as follows:

- Urban Land, Loamy Material- This soil is found on uplands and is underlain by glacial till or limestone bedrock. The glacial till is loamy, but compact, surface runoff is mostly medium or rapid. This land has been developed for residential, business, or industrial use to the extent that most of the acreage is under roof and pavement. New construction sites on this land are a potential source of silt pollution in nearby drainage ways.

- Fairmount Series Silty Clay Loam, 12 to 25% Slopes, Moderately Eroded - The Fairmount series consists of well-drained, dark-colored soils that formed in residuum weathered from thin-bedded limestone and clay shale bedrock. These soils form on slopes that are moderately steep to very steep. The primary use of these soils is for pastures and trees. The

soils are in narrow bands around the sides of the hills and are underlain by limestone bedrock. The surface layer is typically a three- to four- inch-thick, very dark grayish brown-and-olive silty clay. The surface layer typically overlies interbedded limestone and calcareous clay shale bedrock. Fairmount soils have a low available-moisture content and moderately low permeability. Surface runoff is rapid, resulting from the sloped topography. Fairmount soils have a shallow rooting depth and are neutral-to-moderately alkaline.

The Urban Land series caps the top of Main Hill, and the Fairmount silty clay loam is found along Main Hill Outslopes. Previous to the occupation of the site by the DOE, the Main Hill was primarily used for farming. Considerable portions of the area occupied by the Urban Land series have since been disturbed over the years by cut-and-fill operations that leveled Main Hill and by other construction activities. The Fairmount series is probably less disturbed, but may be covered in areas by soils and bedrock that were cut from Main Hill and redistributed. Recent remedial work at the Main Hill indicated the presence of three soil types: silts and very fine sands (ML), silty sands (SM), and silty granules with moderately low air conductivities (DOE 1994b). Soil air pneumatic conductivities in the range of $10^{-4}$cm/sec to $10^{-5}$cm/sec were observed during this remedial effort (DOE 1994b). Due to the unknown extent and location of the cut-and-fill operations and the effect of other construction activities at the Main Hill, soil vapor sampling locations were not influenced by the soil types.

#### 1.4.3.3. Utilities

The extent of underground utilities and physical factors on the Main Hill limited the selection of sample locations. Underground utilities are so numerous and widespread, soil vapor sampling would have to be conducted over the entire site. However, the presence of underground utilities on the Main Hill prompted the moving of several locations. It was also the reason for omitting two sample locations, 16 and 17, between M Building and the Paint Shop. These samples were omitted when utility clearance for hand augering could not be obtained in this area due to the shallow utilities.

Underground utilities caused a change in sampling methodology at several locations. Between M and E Buildings there were various utility trenches which would not allow the use of the hydraulic rig due to a Mound required 5-foot clearance from the underground lines. Therefore, sample locations 22, 23, 24, and 25 had to be collected by hand augering to between 2 ft and 3 ft, placing a rod in the hole, backfilling the hole with bentonite, letting it equilibrate for a minimum of 20 minutes and then collecting the sample.

### 1.4.4. Physical and Chemical Factors

Because of the heterogeneous nature of soil, the location of volatile organic compounds in both the liquid and vapor phase are often difficult to predict with any degree of certainty. However, if the variability of the site specific factors is properly recognized, a degree of interpretation on location can be made. This

section discusses the significance of the physical and chemical parameters to the detection of soil contamination using soil vapor sampling.

#### 1.4.4.1. Vapor Pressure

Vapor pressure is the pressure of vapor confined above the liquid from which it originated. Organic compounds with high vapor pressures would be expected to be present in the vapor phase of soil pores and are a good candidate for soil vapor sampling.

Vapor pressure and the other chemical or physical parameters of the contaminants of concern are presented in Table 1.2.

#### 1.4.4.2. Water Solubility

The extent to which an organic compound (solute) dissolves in water is the water solubility of the compound. Organic compounds with a high water solubility would expect to exist mostly in the liquid water phase and not vapor phase. The rate these compounds are transported from the source of the contamination would be highly dependent on their solubilities. These compounds would not be good candidates for soil vapor sampling. Water solubility of the contaminants of concern are presented in Table I.2.

#### 1.4.4.3. Henry's Law Constant

Henry's Law constant is conventionally expressed as the ratio of partial pressure in the vapor to the concentration in the liquid. This coefficient reflects the air-water partitioning which is helpful in understanding in which phase an organic compound may be found. Organic compounds with a high vapor pressure and low solubility would be good candidates for detection through soil vapor monitoring. Henry's Law constants for the contaminants of concern are shown in Table I.2.

#### 1.4.4.4. Influence of Chemical and Physical Factors on Selecting Sample Locations

Sample locations were also selected by considering the historical and current use of buildings on the Main Hill as compared to the chemical and physical parameters of the contaminants. Table I.2 presents these parameters for the contaminants of concern.

Fuel oil, motor oil, lubricating oil and gasoline would be expected to contain toluene. The high vapor pressure and low solubility of toluene indicated that sampling in areas where oils or gasoline were used

**Table I.2. Physical and Chemical Parameters of Concern**

| Compound | Vapor Pressure (kPa) | Solubility | Henry's Law Constant (atm $m^3$/mol) |
|---|---|---|---|
| Chloroform | 25.6 | 0.82% | 3.39E-08 |
| Bromoform | 0.747 | 0.10% | 5.84E-04 |
| TCE | 9.87 | 0.11% | 9.10E-08 |
| Toluene | 3.8 | slightly soluble | 6.68E-08 |
| PCE | 2.48 | 150 mg/l | 2.90E-02 |
| Freon 11 | 5,000 | soluble | 4.01E-01 |
| Freon 113 | 300 | insoluble | 4.36E-01 |
| Bromodichloromethane | 59.15 | 200 mg/l | 2.05E-01 |
| 1,1,1-TCA | 16.53 | 720 g/$m^3$ | 1.72E-02 |
| 1,1-DCA | 30.10 | 5,100 g/$m^3$ | 5.54E-08 |
| cis-1,2-DCE | 27.46 | 3,500 g/$m^3$ | 3.19E-02 |
| trans-1,2-DCE | 43.47 | 6,300 g/$m^3$ | 3.19E-02 |

Source: Soil Gas Sensing for Detection and Mapping of Organic Solvents, Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, CR 812189-01, 1989.

Air/Superfund National Technical Guidance Study Series, Volume II - Estimation of baseline Air Emissions at Superfund Sites, Office of Air Quality, U.S. Environmental Protection Agency, EPA-450/1-89-002A, 1990.

or spilled would be useful. The same argument can be made for Freon 11 and Freon 113. Where these products were used or spilled, soil vapor sampling should detect evidence of contamination if it exists. The same can also be said of bromodichloromethane, TCE, 1,1,1-TCA, 1,2-DCE (cis and trans), 1,1-DCA, PCE and chloroform. Only bromoform with its low vapor pressure could be difficult to detect by soil vapor sampling.

Based on the known or suspected use of these chemicals in buildings on the Main Hill and their suitability to detection by soil vapor sampling, sampling locations were selected next to the buildings. Samples were collected at locations as close as practicable to each building to reduce the affect of volatilization on spills.

Section 2

# 2. FIELD IMPLEMENTATION

## 2.1. SOIL VAPOR METHODOLOGY OVERVIEW

Soil vapor sampling is an indirect method to evaluate soil or groundwater contamination. It has a benefit of being relatively inexpensive and can be completed quickly. Its primary limitations are that the data does not usually meet the data quality objective required for risk assessments or feasibility studies. It also does not provide a quantitative direct measurement of the soil or groundwater contamination. Its chief purpose is as a screening tool to help determine soil sampling or monitoring well locations. For this investigation, it was used to help determine future soil sampling locations.

Soil vapor sampling is based on the partitioning of volatile and semi-volatile compounds between the liquid and the vapor phase. The vapor, which fills the pore space of the soil, is sampled using either passive or active sampling methods. In most cases, samples are actively obtained by withdrawing the vapor using a vacuum pump. Samples are collected from the sample train by several methods such as syringes, sample bulbs, or absorbent tubes. Once the sample is collected, it is analyzed by gas chromatography for the contaminants of concern.

## 2.2. SAMPLING PROCEDURES

Soil vapor sampling was conducted in accordance with the approved Field Sampling Plan (DOE 1994c). Vapor sampling for this investigation was performed by driving 3-foot sections of 1-inch drill rods with stainless steel drive points into the subsurface and drawing soil vapor to a gas collection system mounted on a soil vapor collection rig. A vacuum pump was used to draw soil vapors through the sampling apparatus. After at least three purge volumes had been evacuated, and the soil vapor pressures had returned to normal, the sample was collected in a 250-mL gas sampling bulb. The sampling bulb consisted of glass with teflon stopcocks at either end. The bulb also had a gas tight septum that was used as the sample port for the extraction of an aliquot of the sample. The aliquot of the sample was extracted from the sample bulb using a gas tight syringe and injected into a gas chromatograph.

During this investigation, most of the soil vapor probes were installed using a truck-mounted hydraulic hammer. Some of the locations required manual hammering due to rig access difficulty. The manually hammered samples were collected using a portable vacuum pump. Samples were collected at intervals of 2.5 feet. The total sampling depths varied depending on probe refusal which was caused by shallow bedrock or buried rock/debris. After the sample was collected, the rods were pulled from the hole and the holes were backfilled with bentonite pellets and hydrated.

All sampling equipment was decontaminated between locations according to the procedures described in the Field Sampling Plan (DOE 1994c).

## 2.3. ANALYTICAL PROCEDURES

Analytical procedures were performed in accordance with the approved Field Sampling Plan (DOE 1994c). All soil vapor samples were analyzed in an on-site mobile laboratory for VOCs using a Hewlett Packard Model 5890A Series II gas chromatograph (GC). Compound separation and detection were performed using a 30-meter wide-bore DB-624 column and a flame-ionization detector (FID). During this field effort the samples were analyzed for the 13 chemicals listed in the Field Sampling Plan (DOE 1994c). These included Freon 11, Freon 113, toluene, bromoform, bromodichloromethane, chloroform, 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), trichloroethene (TCE), tetrachloroethane (PCE), and total VOCs (TVOCs).

Each soil vapor sample was injected into the GC with a gas-tight syringe at a volume of 500 µl (microliters). The analysis was performed with an initial oven temperature of 50°C that was increased to 100°C after two minutes. Analysis time was 10 minutes, but was shortened the second week to 9 minutes.

## 2.4. QUALITY ASSURANCE/QUALITY CONTROL

Quality control samples were collected and analyzed throughout the field effort to monitor VOC contamination, check data accuracy and precision, and analytical instrument operation. The procedures were in accordance with the approved Quality Assurance Project Plan (DOE 1994d).

Prior to each days soil vapor sampling, field blanks of the entire sampling apparatus were taken and analyzed to check contamination in the sampling system. Duplicate soil vapor samples were collected at a frequency of one per 20 soil vapor samples to measure precision. Instrument check samples were analyzed daily to monitor instrument response, accuracy, and retention times.

In addition to quality control samples, other quality assurance procedures were implemented to enhance data quality. Prior to sampling, probes were purged of three probe volumes to remove ambient air. After purging, soil pressures were allowed to return to their original pressure. This was done to monitor the equilibration of the soil/solute/vapor partitioning of the volatile organics. Sampling immediately after the purging results in samples that are biased low because little of the volatile organics are left in the vapor phase. This is caused by the purging of three probe volumes which removes approximately two probe volumes of vapor from the area surrounding the probe tip. This disrupts the equilibrium which takes

several minutes to reestablish. If samples are obtained immediately after sampling, little vapor is left to obtain.

Another assurance procedure was the use of bentonite grout to surround the probe annular space at the surface. This was done to prevent drawing ambient air into the probe during sampling. Finally, as outlined in the Field Sampling Plan, field logs were maintained and a sample identification system was used. Table II.1 demonstrates the sample identification system.

**Table II.1. Sample Numbering System**

| Sample Matrix | Identification System |
|---|---|
| Investigative Samples | |
| Soil Vapor | M204-WXXX-YZZ.Z |
| Quality Control Samples | |
| Duplicate | M204-WXXX-1ZZZ.Z |
| Equipment Blank | M204-WXXX-3ZZZ.Z |
| Sample Blank | M204-WXXX-4ZZZ.Z |

Explanations:

M2 - Mound Plant Operable Unit 2
04 - Soil Vapor Investigation
W - Sample Matrix Type
  4 - Soil Vapor
XXX - Sample Location
Y - Sample Type
  0 - Standard Sample
  1 - Duplicate
  2 - Trip Blank
  3 - Equipment Blank
  4 - Sample Blank
ZZZ.Z - Sample Depth

Section 3

# 3. PRESENTATION OF RESULTS

## 3.1. GENERAL OVERVIEW

The data was reviewed and validated prior to its use. Detectable levels of contamination were found in all areas investigated. Freon 11 was detected most often (22 times) while toluene and cis-1,2-DCE were detected 13 and 12 times, respectively. Trichloroethene, chloroform, bromoform, and bromodichloromethane were not detected at any location. All analytical results are presented in tables in Appendix A and figures in Appendix B.

Concentrations of Freon 11 ranged from less than 536 ppb to 22,500 ppb. Toluene concentrations ranged from 526 ppb to 20,526 ppb while cis-1,2-DCE ranged from a concentration of less than 1,515 to 5,808 ppb. Total volatile organic concentrations ranged from 526 ppb to 42,028 ppb.

## 3.2. WD AREA

In the WD Area some of the target compounds were detected in several samples. Freon 11 was detected at four locations at concentrations ranging from 1,429 to 8,571 ppb. Trans-1,2-DCE was detected at one location at a concentration less than 1,768 ppb. 1,1-DCA was detected at two locations at concentrations of less than 1,482 and 1,975 ppb. Cis-1,2-DCE was detected at three locations at concentrations of less than or equal to 1,515 ppb. 1,1,1-TCA was detected at one location with a concentration of less than 1,403 ppb. Toluene was detected at four locations at concentrations ranging from 526 to 20,526 ppb. Toluene was also detected in the probe rod blank at a concentration of 1,316 ppb. Therefore, the two samples with concentrations that were less than 1,316 ppb are considered to be estimated values. Total volatile organics were detected at concentrations ranging from 526 to 22,502 ppb. Analytical results for the WD area are presented in the following table as well as in Appendices A and B.

**Soil Vapor Analytical Results, WD Building**

| Location | Depth (ft) | Toluene (ppb) | 1,1-DCA (ppb) | 1,1,1-TCA (ppb) | trans-1,2-DCE (ppb) | cis-1,2-DCE (ppb) | Freon 11 (ppb) | TVOC (ppb) |
|---|---|---|---|---|---|---|---|---|
| 4030 | 2.5 | 20,526.3 | 1,975.3 | ND | ND | ND | ND | 22,501.6 |
| 4030 | 5.0 | 3,157.9 | ND | ND | ND | ND | ND | 3,157.9J |
| 4030 | 10.0 | 1,052.6J | ND | ND | ND | ND | ND | 1,052.6J |
| 4030 | 11.2 | 526.3J | ND | ND | ND | ND | ND | 526.3J |
| 4033 | 2.5 | ND | ND | <1,403.5 | <1,768 | 1,515.2 | 8,571.4 | 13,257. |
| 4033 | 5.0 | ND | ND | ND | ND | <1,515.2 | 6,428.6 | 7,943.8 |
| 4033 | 12.0 | ND | ND | ND | ND | ND | <2,500 | <2,500 |
| 4036 | 7.5 | ND | <1,481.5 | NA | ND | <1,515.2 | 1,428.6 | <4,425.3 |

ND - Nondetect ppb - parts per billion J - qualified as estimated

## 3.3. PAINT SHOP AREA

Six of the target compounds were detected in the paint shop area. The two locations containing contamination were Boring #4014 and #4015. Freon 11 was detected at five locations at concentrations ranging from less than 3,571 to 15,893 ppb. Trans-1,2-DCE was detected at two locations at concentration of less than 2,273 and 6,818 ppb. 1,1-DCA was detected at five locations at concentrations ranging from less than 1,975 to 12,099 ppb. Cis-1,2-DCE was detected at three locations at concentrations ranging from less than 2,020 to 5,808 ppb. 1,1,1-TCA was detected at two locations at concentrations of 2,281 and 5,263 ppb. Toluene was detected at three locations at concentrations ranging from less than 526 to 789 ppb. Total volatile organics were detected at ranges from less than 1975 to 42,028 ppb. Analytical results for the Paint Shop area are presented in the following table. The results are also presented in the Appendix A.

| Soil Vapor Analytical Results, Paint Shop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Location | Depth (ft) | 1,1,1-TCA (ppb) | Toluene (ppb) | Freon 11 (ppb) | Trans-1,2-DCE (ppb) | 1,1-DCA (ppb) | cis-1,2-DCE (ppb) | Total VOC (ppb) |
| 4014 | 2.5 | 5,263.2 | 789.2 | 11,250.0 | 6,818.2 | 12,098.8 | 5,808.1 | 42,027.7 |
| 4014 | 5.0 | ND | <526.3 | 5,892.9 | ND | <1,975.3 | ND | <8,394.5 |
| 4014 | 11.1 | ND | ND | ND | ND | <1,975.3 | ND | <1,975.3 |
| 4015 | 5.0 | ND | ND | 3,571.4 | <2,273 | ND | ND | <5,844.4 |
| 4015 | 7.5 | 2,280.7 | <526.3 | 15,892.9 | ND | 3,456.8 | 2,020.2 | 26,449.6 |
| 4015 | 9.2 | ND | ND | 8,571.4 | ND | 1,975.3 | <2,020.2 | <12,566.9 |

ND - Nondetect ppb - parts per billion J - qualified as estimated

## 3.4. M BUILDING

Six compounds were detected in the M and E Building area. Freon 11 was detected at 10 locations at concentrations ranging from less than 2,857 to 22,500 ppb. Trans-1,2-DCE was detected at four locations at concentrations ranging from less than 2,020 to 4,293 ppb. 1,1,1-TCA was detected at four locations at concentrations ranging from less than 1,403 to 3,333 ppb. Cis-1,2-DCE was detected at five locations at concentrations ranging from less than 1,768 to 3,788 ppb. The compound PCE was found in one location at a concentration of 3,235 ppb. Toluene was detected at five locations at concentrations ranging from less than 526 to 1,053 ppb. Total volatile organics detected ranged from less than 2,857 to 34,967 ppb. All of the samples with detectable levels of contamination were from locations in the roadway on the south side of M Building. A summary of the analytical results for the M Building is presented in the following table as well as Appendices A and B.

| Soil Vapor Analytical Results, M Building | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Location | Depth (ft) | 1,1,1-TCA (ppb) | Toluene (ppb) | PCE (ppb) | Freon 11 (ppb) | Trans-1,2-DCE (ppb) | Cis-1,2-DCE (ppb) | Total VOC (ppb) |
| 4019 | 5.0 | ND | ND | ND | <3,035.7 | ND | ND | <3,035.7 |
| 4019 | 7.5 | ND | ND | ND | <3,035.7 | ND | ND | <3,035.7 |
| 4018 | 2.5 | ND | 526.3 | ND | 4,285.7 | ND | ND | 4,812 |
| 4018 | 5.0 | ND | <526.3 | 3,235.3 | ND | ND | ND | <3,761.6 |
| 4020 | 2.5 | 3,333.3 | 1,052.6 | ND | 22,500 | 4,297.9 | 3,787.9 | 34,966.8 |
| 4020 | 5.0 | <1,403.5 | 789.5 | ND | 3,750 | <2,020 | <1,767.7 | <9,730.9 |
| 4020 | 7.5 | ND | 789.5 | ND | 9,107.1 | <2,020 | 1,767.7 | <13,684.5 |
| 4020 | 12.5 | 1,403.5 | ND | ND | 6,428.6 | ND | ND | 7,832.1 |
| 4020 | 15.0 | <1,430.5 | ND | ND | 5,714.3 | ND. | <1,767.7 | <8,885.5 |
| 4020 | 17.5 | ND | ND | ND | 5,535.7 | <2,020 | 2,777.8 | <10,333.7 |
| 4020 | 19.7 | ND | ND | ND | <2,857.1 | ND | ND | <2,857.1 |

ND - Nondetect ppb - parts per billion J - qualified as estimated

### 3.5. G AND GW BUILDINGS

Six compounds were detected around G and GW Buildings. Freon 11 was detected at three locations at concentrations ranging from less than 536 to 2,321 ppb. Cis and trans-1,2-DCE were each detected at one location at a concentration of 1,768 ppb. 1,1,1-TCA was detected at two locations at concentrations of 1,404 and 2,983 ppb. Toluene was detected at one location at a concentration of less than 526 ppb. 1,1-DCA was detected at one location with a concentration of less than 1,482 ppb. The total volatile organics detected ranged from less than 536 to 7,787 ppb. The analytical results for these buildings are presented in the appendices and are summarized in the following table.

| Soil Vapor Analytical Results, G and GW Building | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Location | Depth (ft) | 1,1,1-TCA (ppb) | Toluene (ppb) | trans-1,2-DCE (ppb) | cis-1,2-DCE (ppb) | Freon 11 (ppb) | 1,1-DCA (ppb) | TVOC (ppb) |
| 4002 | 2.0 | ND | ND | ND | ND | <535.7 | ND | <535.7 |
| 4003 | 1.5 | 1,403.5 | <526.3 | 1,767.7 | 1,767.7 | 2,321.4 | ND | <7,786.6 |
| 4004 | 2.0 | 2,982.5 | ND | ND | ND | ND | ND | 2,982.5 |
| 4005 | 2.0 | ND | ND | ND | ND | ND | <1,481.5 | <1,481.5 |
| 4006 | 2.5 | ND | ND | ND | ND | <535.7 | ND | <535.7 |

ND - Nondetect ppb - parts per billion J - qualified as estimated

## 3.6. DS BUILDING AREA

Two of the target compounds were detected at the solvent shed adjacent to the DS Building. Freon 11 was detected at one location at a concentration of less than 1,607 ppb. Freon 113 was detected at two locations at concentrations of 25,874 and 49,481 ppb. Total volatile organics were detected at ranges from less than 1,607 to 49,481 ppb.

| Soil Vapor Analytical Results, DS Building Area | | | | |
|---|---|---|---|---|
| Location | Depth (ft) | Freon 113 (ppb) | Freon 11 (ppb) | Total VOC (ppb) |
| 4028 | 5.0 | 25,974.0 | ND | 25,974.0 |
| 4028 | 7.5 | 49,480.5 | ND | 49,480.5 |
| 4027 | 5.0 | ND | <1.607 | <1,607 |

ND - Nondetect ppb - parts per billion J - qualified as estimated

Section 4

# 4. DATA ANALYSIS

## 4.1. DATA VALIDATION

The data analyzed by the mobile laboratory was reviewed by a chemist other than the one operating the mobile lab. It was reviewed to check for errors due to manual calculations, incorrect calibration parameters, or computing integrator mistakes. The reviewing chemist also noted any chromatographic abnormalities.

The data was also reviewed to evaluate the QA/QC sample results. Results from the field blanks were checked and the data qualified as (J) or estimated if that day's data was associated with field blank contamination greater than five times the sample result.

Duplicate samples were reviewed to monitor sampling and analytical precision versus the data quality objectives. Instrument check samples were also checked to assess the accuracy of the data and overall performance of the analytical system.

The only data qualified due to the validation were toluene and TVOCs in samples M204-4030-000.5.0, M204-4030-0010.0, M204-4030-0011.2 and M204-4030-1011.2. These samples were qualified as estimated due to field blank contamination.

Once the data was validated, it was reduced and entered into a database. The data was then converted from the reporting units of micrograms per liter (µg/l) to parts per billion (ppb). This step was performed to produce units consistent with past investigations to allow integration and analysis of all soil vapor data generated at the Main Hill.

## 4.2. ANALYSIS BASED ON ENVIRONMENTAL FACTORS

The data was analyzed to estimate the effect of environmental factors. This was performed in an attempt to predict the possible sources, sinks, and transport routes of the contamination. By estimating the sources, sinks and transport routes, future sampling locations can be more accurately determined.

Environmental factors evaluated were geology, climate, topography, underground utility lines, and physical features such as buildings, roadways, and parking lots.

### 4.2.1. Geological Factors

The site geology that has the most effect on the fate and transport of contamination detectable by soil vapor sampling is probably the fractured limestone and shale bedrock and the overlying soils (DOE 1992c). The bedrock is generally found at depths of two to 20 feet below ground (BG) and is highly fractured (DOE 1994a). The overlying soil is generally composed of silty gravels, silty sands, or silts (DOE 1994b). The soil is generally compacted, probably from historical construction activities and has an estimated soil air pneumatic conductivity ranging from $10^{-5}$cm/sec to $10^{-4}$cm/sec (DOE 1994b).

The fairly low conductivities of the soil is probably more of a hinderance to vertical diffusion than horizontal diffusion (API 1972). Because of the contaminants of concern are heavier than air, downward flow would be expected. Vertical transport by diffusion predicts a linear increase in volatile organics with depth (EST 1988). However, an analysis of concentrations versus depth generally show a sharp decrease from the concentrations found at the 2.5 foot level and the deeper depths. This indicates there is relatively little downward diffusion of the soil vapor. It also indicates the source of the soil vapor contamination probably is near the surface.

The low permeabilities would hinder vertical migration more than horizontal migration of soil vapor and this low permeability would also reduce the downward transport of contamination in the liquid phase as well (Schwille 1984). Spills of solvents would tend to spread horizontally, at a rate approaching that of the vertical migration. The rapidly decreasing concentrations with depth supports this conclusion.

Surface topography could influence the transport of liquid phase contamination caused by spills. However, this environmental factor would have little affect on most of the Main Hill which is relatively flat. In addition, the dip of the bedrock, which is virtually non-existent at approximately 5 feet per mile would have little affect on gravity flow of liquid phase contamination. An analysis of the data indicates no patterns that would indicate topographical or stratigraphic influences on the transport of contamination.

Another geologic condition that would influence the transport of contamination in either the liquid or vapor phase would be fractures in the bedrock. Because of the limited permeabilities of the soil, these fractures would have a limited influence unless the bedrock is close to the surface and the source of the contamination. In addition, these fractures would speed the transport of liquid phase contamination away from the soils. Therefore, predicting the transport of contamination based on fractures to the bedrock and the soil vapor concentrations would be very difficult.

Groundwater contaminated with solvents can be detected by soil vapor sampling in the vadose zone. Soil vapor concentrations in the vadose zone that originates from groundwater contamination generally

decrease as the distance from the groundwater increases. An analysis of the data indicates that the concentration generally decrease with depth. Because of this and the approximate 50 foot depth to groundwater (DOE 1992a), soil vapor contamination found on the Main Hill probably originates from surface or near surface sources.

### 4.2.2. Climatic Factors

Climatic conditions affecting the migration of contamination include rainfall, atmospheric pressure changes, and temperature. Due to the wide coverage of the Main Hill with buildings, roads, sidewalks, and parking lots, rainfall, infiltration, and the resulting leaching of the soil column would be limited. The data, which indicates the surface boundary contains the highest levels of contamination, supports this assumption. If these factors had an affect on the migration of contamination, concentrations would decrease with depth and the surface would not be the area of maximum contamination (USDA 1904).

The wide coverage of the site with the physical features previously described would also limit the dispersion of the contamination due to volatilization and atmospheric pressure changes. These environmental factors would cause a decrease in concentrations near the surface. The data does not indicate that this has occurred, however, due to the coverage of the Main Hill with roads, sidewalks, and buildings, which would limit volatilization and atmospheric pressure effects, no conclusions can be drawn from the data.

### 4.2.3. Underground Utilities

An analysis of the contamination patterns detected by the soil vapor investigation compared to the underground utility lines provides little correlation. The large numbers of underground utilities on the Main Hill makes it very difficult to assess the effect of the underground utilities as to the source or the transport of the contamination. However, an analysis of the concentration versus depth does indicate that underground utilities may be a source of contamination at one location. At the Paint Shop, Freon 11, 1,1-DCA and cis-1,2-DCE were detected at their highest concentrations at a depth of 7.5 feet. A sanitary sewer is located within 10 feet of this sample location at an approximate depth of 5 feet. The DS Building solvent storage shed is another area potentially impacted by underground utilities (sealed drain beneath shed). While the overall patterns of contamination at the site could be attributable to the underground utilities, there is not enough evidence to support an assumption that they are a major source or transport route.

### 4.2.4. Physical Features

The lack of correlation of the other environmental factors to the observed levels of contamination leaves the physical features such as buildings and their historical usage as the major features that would affect the pattern of contamination. The spill history and usage of the Buildings corresponds to the detectable contamination patterns. Spills at the M Building, the historical use of the DS, M and WD Buildings, and the Paint Shop would indicate that contamination would be found in these areas. The data supports this assumption. The results suggest that little contamination from these sources was transported laterally, either by gravity flow or diffusion through the soil or along underground utility corridors.

In conclusion the data does not indicate that such environmental factors as geology, topography, climate, or underground utilities had an affect on the transport of contamination. However, building use does appear to control the pattern of contamination found at the Main Hill. The one exception is the Paint Shop where underground utilities may be a source of contamination. This conclusion was also reached by previous investigations (DOE 1992c).

## 4.3. ANALYSIS BASED ON INTEGRATION WITH PREVIOUS INVESTIGATIONS

The data was also analyzed to determine if the results were consistent with the investigation performed in 1992. Data was analyzed visually but not statistically. The visual analysis indicated that an attempt at a geostatistical analysis of spatial, concentration and compound correlation would not provide meaningful results.

There was no correlation of results, either by concentration, compound or space. This is not surprising because the sampling locations were partially chosen to fill data gaps from the previous investigation. Appendix B shows the results of past soil gas investigations on the Main Hill.

## 4.4. ANALYSIS BASED ON CHEMICAL AND PHYSICAL FACTORS

The detection of contamination by soil vapor sampling corresponded well with the chemical and physical parameters of concern and historical and current building use. The high vapor pressures and low solubilities of the contaminants of concern indicated that if contamination existed in the subsurface, it should be detectable. The only exceptions, were TCE, chloroform, bromoform, and bromodichloromethane. This could be expected with bromoform, however, if TCE or chloroform were present in the subsurface, detection by soil vapor sampling would be expected. Based on the lack of detections for TCE, bromodichloromethane, and chloroform, it can be speculated that contamination of

these compounds in the subsurface is not present at the locations sampled. No such assumption should be made for bromoform.

## 4.5. DATA ANALYSIS SUMMARY

The previous sections present an analysis of the results of the soil vapor sampling. The results indicate that historical building use was the primary factor in the pattern of contamination. Environmental factors and the results of the previous investigations did not appear to be related to the pattern of contamination. In addition, there did not appear to be any evidence of migration of soil vapor or the liquid from which it would originate.

The pattern of results did not justify the contouring of the data. The limited scope of this and past investigation, as well as the limit number of detections of contamination prevented valid data contouring. However, "hot spots" or areas of contamination are apparent and are shown in Figure 4.1 and Figure 4.2.

Figure 4.1. Areas of Contamination, Main Hill East

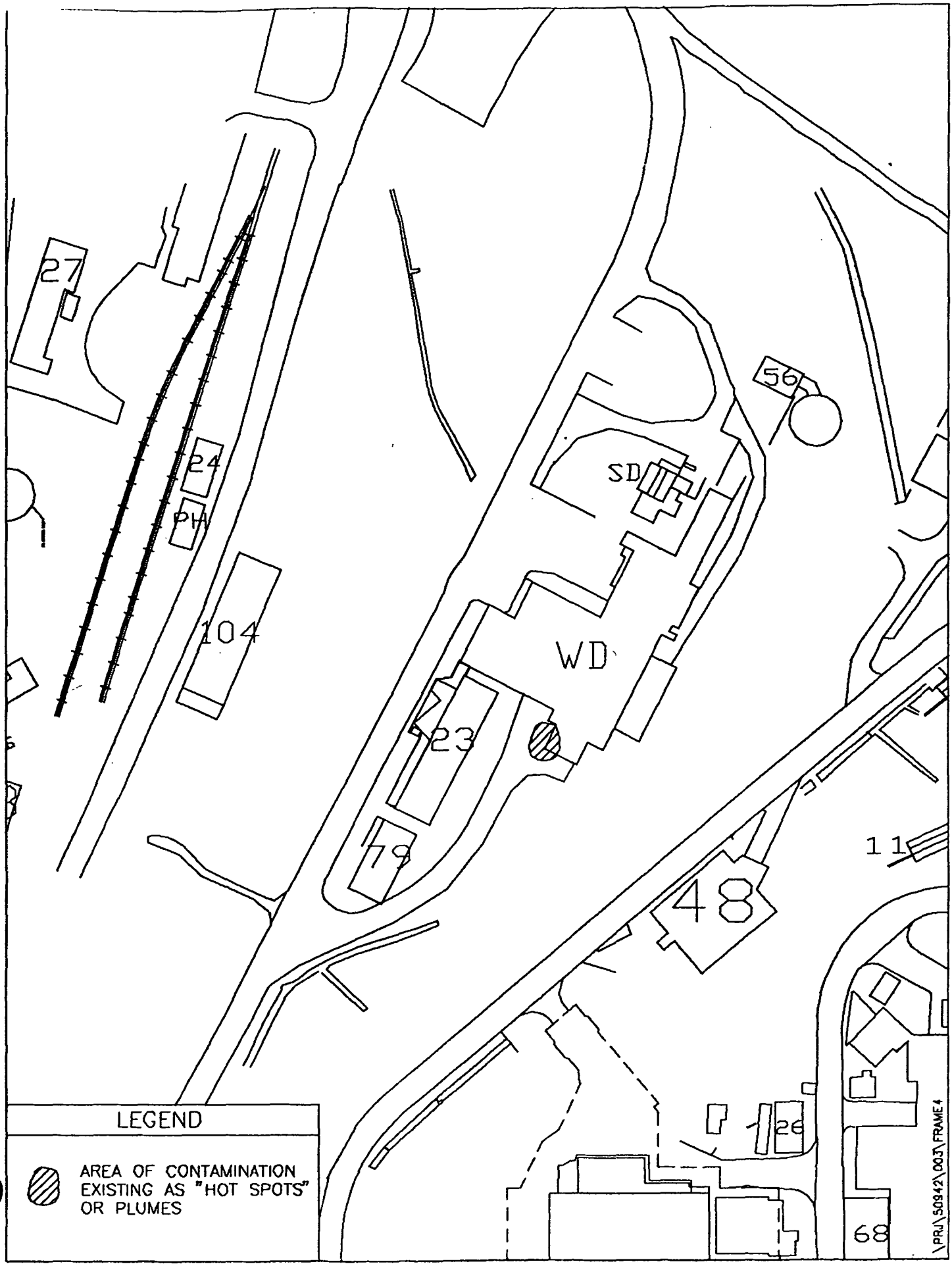



Figure 4.2. Areas of Contamination, Main Hill West

Section 5

## 5. CONCLUSIONS AND RECOMMENDATIONS

The data indicates that limited areas of contamination exist in several locations (Figures 4.1 and 4.2). These areas should be investigated further during future phases of the remediation investigation. Some of these areas are already included in the Phase II soil sampling, but other areas are not included at this time. Directed soil sampling in these new areas can provide additional information on the nature and extent of contamination detected during the soil vapor survey. Specific changes to future sampling will be addressed in OU-2 Work Plan and Field Sampling Plan modifications.

Most of the detected concentrations of contamination were found near the Paint Shop and M Building. This was expected based on the historical use of the buildings. The data indicates that a contaminated area of soil vapor, and thus an area of soil contamination may exist between and under these two buildings. Freon 11 was the chief contaminant of concern found in these locations although trans and cis-1,2-dichloroethene were frequently detected. Toluene and 1,1,1-trichloroethane were detected in the area but less frequently. Based on the results of the soil vapor survey the planned Phase II soil sampling should be modified to add sampling locations between the Paint Shop and M Building (Figure 5.1).

The sampling limitations at the M and E Buildings due to underground utilities may have caused the analytical results to be biased. The lack of detectable concentrations of contaminated soil vapor does not correspond to the historical use of the M Building and the results from locations south of the building. For these reasons, we recommend that additional Phase II soil samples be obtained between the M and E Buildings (Figure 5.1). No additional soil sampling beyond the planned Phase II sampling is recommended along the roadway between M and DS Buildings

Samples obtained near a solvent storage shed located next to the DS Building also displayed elevated levels of contaminated soil vapor that is probably associated with historical building use. Freon 113 and Freon 11 were detected at elevated levels adjacent to the building. Based on the analytical results and the historical use of the building additional Phase II soil sampling should be performed around the DS solvent storage shed (Figure 5.1).

Elevated levels of several compounds were also detected near the loading dock of the WD Building. Small spills while unloading solvents at this location may be the source of this contamination. Due to the historical use of this building and the results of the soil vapor survey, additional soil sampling is warranted around the loading dock (Figure 5.2) in addition to the planned Phase II sampling.

Figure 5.1. Areas Requiring Additional Sampling, Main Hill West

Figure 5.2. Areas of Requiring Additional Sampling, Main Hill East

The G and GW Buildings did not display elevated levels of compounds associated with their historical use at a frequency expected. Elevated levels of toluene, which is found in gasoline and motor oil, were only seen in one location. Detections of other compounds were also limited in frequency and concentration. Since some samples will be obtained from the area immediately adjacent to the buildings during Phase II, no additional sampling other than the planned Phase II sampling is recommended near the G and GW Buildings.

Based on results of nondetect in several areas with historical usage of VOCs, it is recommended that one confirmatory soil sample be collected in each of these areas (G, GW, WD, PS and M Buildings) during Phase II activities.

A summary of recommendations is provided in Table V.1. Specific sample locations, the number of samples and analytical parameters will be discussed in the modification to the Work Plan and Field Sampling Plan.

**Table V.1. Summary of Recommendations**

| Area/Building | Recommendation | Rationale |
|---|---|---|
| Paint Shop | Obtain additional soil samples during Phase II from locations between the Paint Shop and M Building. | Historical use of both buildings and the results of the soil vapor investigation indicate soil sin this are area extensively contaminated. |
| M Building | Obtain samples during Phase II from between M and E Buildings. | Sampling method imposed by underground utilities may have lead to biased samples. |
| DS Building | Obtain samples during Phase II from around solvent storage shed. | Historical use of building and analytical results indicate building is or was a source of soil contamination. |
| WD Building | Obtain additional samples during Phase II around the loading dock. | Historical use of building and analytical results indicates that spills occurred at the dock. |
| G, GW, WD, Paint Shop and M Buildings | Obtain one soil sample from each area of nondetect results from soil vapor survey. | Confirmatory samples based on historical use of buildings. |

Section 6

# 6. REFERENCES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Appendix A

# APPENDIX A

# SOIL VAPOR ANALYTICAL RESULTS

| SAMPLE I.D. | Hole | DATE | DEPTH | Chloroform ppb | 1,1,1-TCA ppb | TCE ppb | BDCM ppb | Toluene ppb | PCE ppb | Bromoform ppb | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BUILDING WD | | | | | | | | | | | |
| M204-4000-4024 | NA | 5-2-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4033-3000 | PH-33 | 5-2-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4033-0002.5 | PH-33 | 5-2-94 | 2.5' | ND | < 1403.5 | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4033-0005.0 | PH-33 | 5-2-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4033-0007.5 | PH-33 | 5-2-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4033-0010.0 | PH-33 | 5-2-94 | 10.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4033-0012.5 | PH-33 | 5-2-94 | 12.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4033-0013.3 | PH-33 | 5-2-94 | 13.3' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4035-0002.5 | PH-35 | 5-2-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4035-0003.9 | PH-35 | 5-2-94 | 3.9' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4025 | NA | 5-2-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4028 | NA | 5-4-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4029 | NA | 5-4-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4038-0002.5 | PH-38 | 5-4-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4038-0005.0 | PH-38 | 5-4-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4038-0007.5 | PH-38 | 5-4-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4038-0009.3 | PH-38 | 5-4-94 | 9.3' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4037-3000 | PH-37 | 5-4-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4037-0002.5 | PH-37 | 5-4-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4037-0005.0 | PH-37 | 5-4-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4037-0007.5 | PH-37 | 5-4-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4037-0008.9 | PH-37 | 5-4-94 | 8.9' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4030 | NA | 5-4-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4039-0002.5 | PH-39 | 4-14-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4039-0005.0 | PH-39 | 4-14-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4039-0007.5 | PH-39 | 4-14-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4039-0010.0 | PH-39 | 4-14-94 | 10.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4039-0012.5 | PH-39 | 4-14-94 | 12.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4039-0013.0 | PH-39 | 4-14-94 | 13.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4005 | NA | 4-14-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |

ND Non Detect

NA Not Applicable

QC Quality Control

J Qualitied as Estimated

ppb Parts Per Billion

< Less Than

Table A.1. Soil Vapor Analytical Results

| SAMPLE I.D. | Hole | DATE | DEPTH | Freon-11 ppb | Freon-113 ppb | trans-1,2-DCE ppb | 1,1-DCA ppb | cis-1,2-DCE ppb | Total VOC ppb | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| BUILDING WD | | | | | | | | | | |
| M204-4000-4024 | NA | 5-2-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4033-3000 | PH-33 | 5-2-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4033-0002.5 | PH-33 | 5-2-94 | 2.5' | 8571.4 | ND | <1768 | ND | 1515.2 | 13257.8 | SOIL-GAS SAMPLE |
| M204-4033-0005.0 | PH-33 | 5-2-94 | 5.0' | 6428.6 | ND | ND | ND | < 1515.2 | 7943.8 | SOIL-GAS SAMPLE |
| M204-4033-0007.5 | PH-33 | 5-2-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4033-0010.0 | PH-33 | 5-2-94 | 10.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4033-0012.5 | PH-33 | 5-2-94 | 12.5' | < 2500 | ND | ND | ND | ND | 2500 | SOIL-GAS SAMPLE |
| M204-4033-0013.3 | PH-33 | 5-2-94 | 13.3' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4035-0002.5 | PH-35 | 5-2-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4035-0003.9 | PH-35 | 5-2-94 | 3.9' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4025 | NA | 5-2-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4028 | NA | 5-4-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4029 | NA | 5-4-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4038-0002.5 | PH-38 | 5-4-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4038-0005.0 | PH-38 | 5-4-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4038-0007.5 | PH-38 | 5-4-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4038-0009.3 | PH-38 | 5-4-94 | 9.3' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4037-3000 | PH-37 | 5-4-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4037-0002.5 | PH-37 | 5-4-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4037-0005.0 | PH-37 | 5-4-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4037-0007.5 | PH-37 | 5-4-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4037-0008.9 | PH-37 | 5-4-94 | 8.9' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4030 | NA | 5-4-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4039-0002.5 | PH-39 | 4-14-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4039-0005.0 | PH-39 | 4-14-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4039-0007.5 | PH-39 | 4-14-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4039-0010.0 | PH-39 | 4-14-94 | 10.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4039-0012.5 | PH-39 | 4-14-94 | 12.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4039-0013.0 | PH-39 | 4-14-94 | 13.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4005 | NA | 4-14-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |

ND Non Detect

NA Not Applicable

QC Quality Control

J Qualitied as Estimated

ppb Parts Per Billion

< Less Than

Table A.1. Soil Vapor Analytical Results

| SAMPLE I.D. | HOLE | DATE | DEPTH | Chloroform ppb | 1,1,1-TCA ppb | TCE ppb | BDCM ppb | Toluene ppb | PCE ppb | Bromoform ppb | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BUILDING WD | | | | | | | | | | | |
| M204-4000-4001 | NA | 4-13-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4032-3000 | PH-32 | 4-13-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4032-0002.5 | PH-32 | 4-13-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0005.0 | PH-32 | 4-13-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0007.5 | PH-32 | 4-13-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0010.0 | PH-32 | 4-13-94 | 10.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0012.5 | PH-32 | 4-13-94 | 12.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0015.0 | PH-32 | 4-13-94 | 15.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0017.5 | PH-32 | 4-13-94 | 17.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0020.0 | PH-32 | 4-13-94 | 20.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-1020.0 | PH-32 | 4-13-94 | 20.0' | ND | ND | ND | ND | ND | ND | ND | QC-DUPLICATE SAMPLE |
| M204-4000-4002 | NA | 4-13-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4031-0002.5 | PH-31 | 4-13-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-0005.0 | PH-31 | 4-13-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-0007.5 | PH-31 | 4-13-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-0010.0 | PH-31 | 4-13-94 | 10.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-0012.5 | PH-31 | 4-13-94 | 12.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-0014.0 | PH-31 | 4-13-94 | 14.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-1014.0 | PH-31 | 4-13-94 | 14.0' | ND | ND | ND | ND | ND | ND | ND | QC-DUPLICATE SAMPLE |
| M204-4000-4003 | NA | 4-13-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4004 | NA | 4-14-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4030-3000 | PH-30 | 4-14-94 | NA | ND | ND | ND | ND | 1315.8 | ND | ND | QC-PROBE ROD BLANK |
| M204-4030-0002.5 | PH-30 | 4-14-94 | 2.5' | ND | ND | ND | ND | 20526.3 | ND | ND | SOIL-GAS SAMPLE |
| M204-4030-0005.0 | PH-30 | 4-14-94 | 5.0' | ND | ND | ND | ND | 3157.9J | ND | ND | SOIL-GAS SAMPLE |
| M204-4030-0007.5 | PH-30 | 4-14-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4030-0010.0 | PH-30 | 4-14-94 | 10.0' | ND | ND | ND | ND | 1052.6J | ND | ND | SOIL-GAS SAMPLE |
| M204-4030-0011.2 | PH-30 | 4-14-94 | 11.2' | ND | ND | ND | ND | 526.3J | ND | ND | SOIL-GAS SAMPLE |
| M204-4030-1011.2 | PH-30 | 4-14-94 | 11.2' | ND | ND | ND | ND | 526.3J | ND | ND | QC-DUPLICATE SAMPLE |
| M204-4000-4006 | NA | 4-18-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4036-3000 | PH-36 | 4-18-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4036-0002.5 | PH-36 | 4-18-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4036-0005.0 | PH-36 | 4-18-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4036-0007.5 | PH-36 | 4-18-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4036-0010.0 | PH-36 | 4-18-94 | 10.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4036-0012.5 | PH-36 | 4-18-94 | 12.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4036-0015.0 | PH-36 | 4-18-94 | 15.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |

ND Non Detect

NA Not Applicable

QC Quality Control

J Qualitied as Estimated

ppb Parts Per Billion

< Less Than

Table A.1. Soil Vapor Analytical Results

| SAMPLE I.D. | Hole | DATE | DEPTH | Freon-11 ppb | Freon-113 ppb | trans-1,2-DCE ppb | 1,1-DCA ppb | cis-1,2-DCE ppb | Total VOC ppb | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| BUILDING WD | | | | | | | | | | |
| M204-4000-4001 | NA | 4-13-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4032-3000 | PH-32 | 4-13-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4032-0002.5 | PH-32 | 4-13-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0005.0 | PH-32 | 4-13-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0007.5 | PH-32 | 4-13-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0010.0 | PH-32 | 4-13-94 | 10.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0012.5 | PH-32 | 4-13-94 | 12.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0015.0 | PH-32 | 4-13-94 | 15.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0017.5 | PH-32 | 4-13-94 | 17.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-0020.0 | PH-32 | 4-13-94 | 20.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4032-1020.0 | PH-32 | 4-13-94 | 20.0' | ND | ND | ND | ND | ND | ND | QC-DUPLICATE SAMPLE |
| M204-4000-4002 | NA | 4-13-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4031-0002.5 | PH-31 | 4-13-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-0005.0 | PH-31 | 4-13-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-0007.5 | PH-31 | 4-13-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-0010.0 | PH-31 | 4-13-94 | 10.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-0012.5 | PH-31 | 4-13-94 | 12.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-0014.0 | PH-31 | 4-13-94 | 14.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4031-1014.0 | PH-31 | 4-13-94 | 14.0' | ND | ND | ND | ND | ND | ND | QC-DUPLICATE SAMPLE |
| M204-4000-4003 | NA | 4-13-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4004 | NA | 4-14-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4030-3000 | PH-30 | 4-14-94 | NA | ND | ND | ND | ND | ND | 1315.8 | QC-PROBE ROD BLANK |
| M204-4030-0002.5 | PH-30 | 4-14-94 | 2.5' | ND | ND | ND | 1975.3 | ND | 22501.6 | SOIL-GAS SAMPLE |
| M204-4030-0005.0 | PH-30 | 4-14-94 | 5.0' | ND | ND | ND | ND | ND | 3157.9J | SOIL-GAS SAMPLE |
| M204-4030-0007.5 | PH-30 | 4-14-94 | 7.5' | ND | ND | ND | ND | ND | 0 | SOIL-GAS SAMPLE |
| M204-4030-0010.0 | PH-30 | 4-14-94 | 10.0' | ND | ND | ND | ND | ND | 1052.6J | SOIL-GAS SAMPLE |
| M204-4030-0011.2 | PH-30 | 4-14-94 | 11.2' | ND | ND | ND | ND | ND | 526.3J | SOIL-GAS SAMPLE |
| M204-4030-1011.2 | PH-30 | 4-14-94 | 11.2' | ND | ND | ND | ND | ND | 526.3J | QC-DUPLICATE SAMPLE |
| M204-4000-4006 | NA | 4-18-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4036-3000 | PH-36 | 4-18-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4036-0002.5 | PH-36 | 4-18-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4036-0005.0 | PH-36 | 4-18-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4036-0007.5 | PH-36 | 4-18-94 | 7.5' | 1428.6 | ND | ND | < 1481.5 | < 1515.2 | 4425.3 | SOIL-GAS SAMPLE |
| M204-4036-0010.0 | PH-36 | 4-18-94 | 10.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4036-0012.5 | PH-36 | 4-18-94 | 12.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4036-0015.0 | PH-36 | 4-18-94 | 15.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |

ND Non Detect

NA Not Applicable

QC Quality Control

J Qualitied as Estimated

ppb Parts Per Billion

< Less Than

Table A.1. Soil Vapor Analytical Results

| SAMPLE I.D. | Hole | DATE | DEPTH | Chloroform ppb | 1,1,1-TCA ppb | TCE ppb | BDCM ppb | Toluene ppb | PCE ppb | Bromoform ppb | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BUILDING PS | | | | | | | | | | | |
| M204-4000-4010 | NA | 4-20-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4009-3000 | PH-09 | 4-20-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4009-0002.5 | PH-09 | 4-20-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4009-0003.9 | PH-09 | 4-20-94 | 3.9' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4012-0002.5 | PH-12 | 4-20-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4012-0005.0 | PH-12 | 4-20-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4012-0007.5 | PH-12 | 4-20-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4012-0008.8 | PH-12 | 4-20-94 | 8.8' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4011 | NA | 4-20-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4013-0002.5 | PH-13 | 4-20-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4013-0005.0 | PH-13 | 4-20-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4013-0007.5 | PH-13 | 4-20-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4013-1007.5 | PH-13 | 4-20-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | QC-DUPLICATE SAMPLE |
| M204-4013-0009.2 | PH-13 | 4-20-94 | 9.2' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4008-0002.5 | PH-08 | 4-20-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4008-0004.9 | PH-08 | 4-20-94 | 4.9' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4013 | NA | 4-21-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4014-0002.5 | PH-14 | 4-21-94 | 2.5' | ND | 5263.2 | ND | ND | 789.5 | ND | ND | SOIL-GAS SAMPLE |
| M204-4014-0005.0 | PH-14 | 4-21-94 | 5.0' | ND | ND | ND | ND | < 526.3 | ND | ND | SOIL-GAS SAMPLE |
| M204-4014-0007.5 | PH-14 | 4-21-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4014-0010.0 | PH-14 | 4-21-94 | 10.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4014-0011.1 | PH-14 | 4-21-94 | 11.1' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4014 | NA | 4-25-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4015 | NA | 4-25-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4015-3000 | PH-15 | 4-25-94 | NA | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4015-0002.5 | PH-15 | 4-25-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4015-0005.0 | PH-15 | 4-25-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4015-0007.5 | PH-15 | 4-25-94 | 7.5' | ND | 2280.7 | ND | ND | < 526.3 | ND | ND | SOIL-GAS SAMPLE |
| M204-4015-0009.2 | PH-15 | 4-25-94 | 9.2' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4016 | NA | 4-25-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4017 | NA | 4-26-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4017-3000 | PH-17 | 4-26-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4000-4018 | PH-10 | 4-26-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4010-0002.5 | PH-10 | 4-26-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4010-0005.0 | PH-10 | 4-26-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4010-0007.5 | PH-10 | 4-26-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4010-0010.0 | PH-10 | 4-26-94 | 10.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4010-0012.3 | PH-10 | 4-26-94 | 12.3' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4019 | NA | 4-26-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4020 | NA | 4-27-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4011-3000 | PH-11 | 4-27-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4011-0002.5 | PH-11 | 4-27-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4011-0005.0 | PH-11 | 4-27-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4011-0007.5 | PH-11 | 4-27-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4011-0010.0 | PH-11 | 4-27-94 | 10.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4011-0012.1 | PH-11 | 4-27-94 | 12.1' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| BUILDING DS | | | | | | | | | | | |
| M204-4000-4012 | NA | 4-21-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4028-3000 | PH-28 | 4-21-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4028-0002.5 | PH-28 | 4-21-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4028-0005.0 | PH-28 | 4-21-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4028-0007.5 | PH-28 | 4-21-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4027-0002.5 | PH-27 | 4-21-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4027-0005.0 | PH-27 | 4-21-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4029-0002.5 | PH-29 | 4-21-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4029-0005.0 | PH-29 | 4-21-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4029-0007.5 | PH-29 | 4-21-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4026-0002.5 | PH-26 | 4-21-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4026-0005.0 | PH-26 | 4-21-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4026-0007.5 | PH-26 | 4-21-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4026-0010.0 | PH-26 | 4-21-94 | 10.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |

ND Non Detect

NA Not Applicable

QC Quality Control

J Qualitied as Estimated

ppb Parts Per Billion

< Less Than

Table A.1. Soil Vapor Analytical Results

| SAMPLE I.D. | Hole | DATE | DEPTH | Freon-11 ppb | Freon-113 ppb | trans-1,2-DCE ppb | 1,1-DCA ppb | cis-1,2-DCE ppb | Total VOC ppb | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| BUILDING PS | | | | | | | | | | |
| M204-4000-4010 | NA | 4-20-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4009-3000 | PH-09 | 4-20-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4009-0002.5 | PH-09 | 4-20-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4009-0003.9 | PH-09 | 4-20-94 | 3.9' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4012-0002.5 | PH-12 | 4-20-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4012-0005.0 | PH-12 | 4-20-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4012-0007.5 | PH-12 | 4-20-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4012-0008.8 | PH-12 | 4-20-94 | 8.8' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4011 | NA | 4-20-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4013-0002.5 | PH-13 | 4-20-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4013-0005.0 | PH-13 | 4-20-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4013-0007.5 | PH-13 | 4-20-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4013-1007.5 | PH-13 | 4-20-94 | 7.5' | ND | ND | ND | ND | ND | ND | QC-DUPLICATE SAMPLE |
| M204-4013-0009.2 | PH-13 | 4-20-94 | 9.2' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4008-0002.5 | PH-08 | 4-20-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4008-0004.9 | PH-08 | 4-20-94 | 4.9' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4013 | NA | 4-21-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4014-0002.5 | PH-14 | 4-21-94 | 2.5' | 11250.0 | ND | 6818.2 | 12098.8 | 5808.1 | 42027.7 | SOIL-GAS SAMPLE |
| M204-4014-0005.0 | PH-14 | 4-21-94 | 5.0' | 5892.9 | ND | ND | < 1975.3 | ND | 8394.5 | SOIL-GAS SAMPLE |
| M204-4014-0007.5 | PH-14 | 4-21-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4014-0010.0 | PH-14 | 4-21-94 | 10.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4014-0011.1 | PH-14 | 4-21-94 | 11.1' | ND | ND | ND | < 1975.3 | ND | 1975.3 | SOIL-GAS SAMPLE |
| M204-4000-4014 | NA | 4-25-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4015 | NA | 4-25-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4015-3000 | PH-15 | 4-25-94 | NA | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4015-0002.5 | PH-15 | 4-25-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4015-0005.0 | PH-15 | 4-25-94 | 5.0' | 3571.4 | ND | <2273 | ND | ND | 5844.4 | SOIL-GAS SAMPLE |
| M204-4015-0007.5 | PH-15 | 4-25-94 | 7.5' | 15892.9 | ND | ND | 3456.8 | 2020.2 | 26449.6 | SOIL-GAS SAMPLE |
| M204-4015-0009.2 | PH-15 | 4-25-94 | 9.2' | 8571.4 | ND | ND | 1975.3 | < 2020.2 | 12566.9 | SOIL-GAS SAMPLE |
| M204-4000-4016 | NA | 4-25-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4017 | NA | 4-26-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4017-3000 | PH-17 | 4-26-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4000-4018 | PH-10 | 4-26-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4010-0002.5 | PH-10 | 4-26-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4010-0005.0 | PH-10 | 4-26-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4010-0007.5 | PH-10 | 4-26-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4010-0010.0 | PH-10 | 4-26-94 | 10.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4010-0012.3 | PH-10 | 4-26-94 | 12.3' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4019 | NA | 4-26-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4020 | NA | 4-27-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4011-3000 | PH-11 | 4-27-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4011-0002.5 | PH-11 | 4-27-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4011-0005.0 | PH-11 | 4-27-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4011-0007.5 | PH-11 | 4-27-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4011-0010.0 | PH-11 | 4-27-94 | 10.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4011-0012.1 | PH-11 | 4-27-94 | 12.1' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| BUILDING DS | | | | | | | | | | |
| M204-4000-4012 | NA | 4-21-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4028-3000 | PH-28 | 4-21-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4028-0002.5 | PH-28 | 4-21-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4028-0005.0 | PH-28 | 4-21-94 | 5.0' | ND | 25974.0 | ND | ND | ND | 25974 | SOIL-GAS SAMPLE |
| M204-4028-0007.5 | PH-28 | 4-21-94 | 7.5' | ND | 49480.5 | ND | ND | ND | 49480.5 | SOIL-GAS SAMPLE |
| M204-4027-0002.5 | PH-27 | 4-21-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4027-0005.0 | PH-27 | 4-21-94 | 5.0' | <1607 | ND | ND | ND | ND | 1607 | SOIL-GAS SAMPLE |
| M204-4029-0002.5 | PH-29 | 4-21-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4029-0005.0 | PH-29 | 4-21-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4029-0007.5 | PH-29 | 4-21-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4026-0002.5 | PH-26 | 4-21-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4026-0005.0 | PH-26 | 4-21-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4026-0007.5 | PH-26 | 4-21-94 | 7.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4026-0010.0 | PH-26 | 4-21-94 | 10.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |

ND Non Detect

NA Not Applicable

QC Quality Control

J Qualitied as Estimated

ppb Parts Per Billion

< Less Than

Table A.1. Soil Vapor Analytical Results

| SAMPLE I.D. | Hole | DATE | DEPTH | Chloroform ppb | 1,1,1-TCA ppb | TCE ppb | BDCM ppb | Toluene ppb | PCE ppb | Bromoform ppb | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BUILDING G | | | | | | | | | | | |
| M204-4004-0002.0 | PH-04 | 4-18-94 | 2.0' | ND | 2982.5 | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4005-0002.0 | PH-05 | 4-18-94 | 2.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4007 | NA | 4-18-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4006-0002.5 | PH-06 | 4-19-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4002-0002.0 | PH-02 | 4-19-94 | 2.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4001-0002.5 | PH-01 | 4-19-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4009 | NA | 4-19-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| BUILDING GW | | | | | | | | | | | |
| M204-4000-4008 | NA | 4-19-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4007-3000 | PH-07 | 4-19-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4007-0002.5 | PH-07 | 4-19-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4007-0005.0 | PH-07 | 4-19-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4007-1005.0 | PH-07 | 4-19-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | QC-DUPLICATE SAMPLE |
| M204-4003-0001.5 | PH-03 | 4-19-94 | 1.5' | ND | 1403.5 | ND | ND | < 526.3 | ND | ND | SOIL-GAS SAMPLE |
| BUILDING M | | | | | | | | | | | |
| M204-4019-0002.5 | PH-19 | 4-27-94 | 2.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4019-0005.0 | PH-19 | 4-27-94 | 5.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4019-0007.5 | PH-19 | 4-27-94 | 7.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4019-0010.0 | PH-19 | 4-27-94 | 10.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4019-0012.5 | PH-19 | 4-27-94 | 12.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4019-1012.5 | PH-19 | 4-27-94 | 12.5' | ND | ND | ND | ND | ND | ND | ND | QC-DUPLICATE SAMPLE |
| M204-4019-0015.0 | PH-19 | 4-27-94 | 15.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4019-0016.0 | PH-19 | 4-27-94 | 16.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4021 | NA | 4-27-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4022 | NA | 4-28-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4018-3000 | PH-18 | 4-28-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4018-0002.5 | PH-18 | 4-28-94 | 2.5' | ND | ND | ND | ND | 526.3 | ND | ND | SOIL-GAS SAMPLE |
| M204-4018-0005.0 | PH-18 | 4-28-94 | 5.0' | ND | ND | ND | ND | < 526.3 | 3235.3 | ND | SOIL-GAS SAMPLE |
| M204-4018-0006.0 | PH-18 | 4-28-94 | 6.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4020-0002.5 | PH-20 | 4-28-94 | 2.5' | ND | 3333.3 | ND | ND | 1052.6 | ND | ND | SOIL-GAS SAMPLE |
| M204-4020-0005.0 | PH-20 | 4-28-94 | 5.0' | ND | < 1403.5 | ND | ND | 789.5 | ND | ND | SOIL-GAS SAMPLE |
| M204-4020-0007.5 | PH-20 | 4-28-94 | 7.5' | ND | ND | ND | ND | 789.5 | ND | ND | SOIL-GAS SAMPLE |
| M204-4020-0010.0 | PH-20 | 4-28-94 | 10.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4020-0012.5 | PH-20 | 4-28-94 | 12.5' | ND | 1403.5 | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4020-0015.0 | PH-20 | 4-28-94 | 15.0' | ND | < 1403.5 | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4020-0017.5 | PH-20 | 4-28-94 | 17.5' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4020-0019.7 | PH-20 | 4-28-94 | 19.7' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4023 | NA | 4-28-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4026 | NA | 5-3-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4021-3000 | PH-21 | 5-3-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4021-0001.0 | PH-21 | 5-3-94 | 1.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4022-0003.0 | PH-22 | 5-3-94 | 3.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4023-0002.0 | PH-23 | 5-3-94 | 2.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4024-0002.0 | PH-24 | 5-3-94 | 2.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4025-0003.0 | PH-25 | 5-3-94 | 3.0' | ND | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4027 | NA | 5-3-94 | NA | ND | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |

ND Non Detect

NA Not Applicable

QC Quality Control

J Qualitied as Estimated

ppb Parts Per Billion

< Less Than

Table A.1. Soil Vapor Analytical Results

| SAMPLE I.D. | Hole | DATE | DEPTH | Freon-11 ppb | Freon-113 ppb | trans-1,2-DCE ppb | 1,1-DCA ppb | cis-1,2-DCE ppb | Total VOC ppb | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| BUILDING G | | | | | | | | | | |
| M204-4004-0002.0 | PH-04 | 4-18-94 | 2.0' | ND | ND | ND | ND | ND | 2982.5 | SOIL-GAS SAMPLE |
| M204-4005-0002.0 | PH-05 | 4-18-94 | 2.0' | ND | ND | ND | < 1481.5 | ND | 1481.5 | SOIL-GAS SAMPLE |
| M204-4000-4007 | NA | 4-18-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4006-0002.5 | PH-06 | 4-19-94 | 2.5' | < 535.7 | ND | ND | ND | ND | 535.7 | SOIL-GAS SAMPLE |
| M204-4002-0002.0 | PH-02 | 4-19-94 | 2.0' | < 535.7 | ND | ND | ND | ND | 535.7 | SOIL-GAS SAMPLE |
| M204-4001-0002.5 | PH-01 | 4-19-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4009 | NA | 4-19-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| BUILDING GW | | | | | | | | | | |
| M204-4000-4008 | NA | 4-19-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4007-3000 | PH-07 | 4-19-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4007-0002.5 | PH-07 | 4-19-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4007-0005.0 | PH-07 | 4-19-94 | 5.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4007-1005.0 | PH-07 | 4-19-94 | 5.0' | ND | ND | ND | ND | ND | ND | QC-DUPLICATE SAMPLE |
| M204-4003-0001.5 | PH-03 | 4-19-94 | 1.5' | 2321.4 | ND | 1767.7 | ND | 1767.7 | 7786.6 | SOIL-GAS SAMPLE |
| BUILDING M | | | | | | | | | | |
| M204-4019-0002.5 | PH-19 | 4-27-94 | 2.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4019-0005.0 | PH-19 | 4-27-94 | 5.0' | < 3035.7 | ND | ND | ND | ND | 3035.7 | SOIL-GAS SAMPLE |
| M204-4019-0007.5 | PH-19 | 4-27-94 | 7.5' | < 3035.7 | ND | ND | ND | ND | 3035.7 | SOIL-GAS SAMPLE |
| M204-4019-0010.0 | PH-19 | 4-27-94 | 10.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4019-0012.5 | PH-19 | 4-27-94 | 12.5' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4019-1012.5 | PH-19 | 4-27-94 | 12.5' | ND | ND | ND | ND | ND | ND | QC-DUPLICATE SAMPLE |
| M204-4019-0015.0 | PH-19 | 4-27-94 | 15.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4019-0016.0 | PH-19 | 4-27-94 | 16.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4021 | NA | 4-27-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4022 | NA | 4-28-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4018-3000 | PH-18 | 4-28-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4018-0002.5 | PH-18 | 4-28-94 | 2.5' | 4285.7 | ND | ND | ND | ND | 4812 | SOIL-GAS SAMPLE |
| M204-4018-0005.0 | PH-18 | 4-28-94 | 5.0' | ND | ND | ND | ND | ND | 3761.6 | SOIL-GAS SAMPLE |
| M204-4018-0006.0 | PH-18 | 4-28-94 | 6.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4020-0002.5 | PH-20 | 4-28-94 | 2.5' | 22500.0 | ND | 4292.9 | ND | 3787.9 | 34966.8 | SOIL-GAS SAMPLE |
| M204-4020-0005.0 | PH-20 | 4-28-94 | 5.0' | 3750.0 | ND | <2020 | ND | < 1767.7 | 9730.9 | SOIL-GAS SAMPLE |
| M204-4020-0007.5 | PH-20 | 4-28-94 | 7.5' | 9107.1 | ND | <2020 | ND | 1767.7 | 13684.5 | SOIL-GAS SAMPLE |
| M204-4020-0010.0 | PH-20 | 4-28-94 | 10.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4020-0012.5 | PH-20 | 4-28-94 | 12.5' | 6428.6 | ND | ND | ND | ND | 7832.1 | SOIL-GAS SAMPLE |
| M204-4020-0015.0 | PH-20 | 4-28-94 | 15.0' | 5714.3 | ND | ND | ND | < 1767.7 | 8885.5 | SOIL-GAS SAMPLE |
| M204-4020-0017.5 | PH-20 | 4-28-94 | 17.5' | 5535.7 | ND | <2020 | ND | 2777.8 | 10333.7 | SOIL-GAS SAMPLE |
| M204-4020-0019.7 | PH-20 | 4-28-94 | 19.7' | < 2857.1 | ND | ND | ND | ND | 2857.1 | SOIL-GAS SAMPLE |
| M204-4000-4023 | NA | 4-28-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4000-4026 | NA | 5-3-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |
| M204-4021-3000 | PH-21 | 5-3-94 | NA | ND | ND | ND | ND | ND | ND | QC-PROBE ROD BLANK |
| M204-4021-0001.0 | PH-21 | 5-3-94 | 1.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4022-0003.0 | PH-22 | 5-3-94 | 3.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4023-0002.0 | PH-23 | 5-3-94 | 2.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4024-0002.0 | PH-24 | 5-3-94 | 2.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4025-0003.0 | PH-25 | 5-3-94 | 3.0' | ND | ND | ND | ND | ND | ND | SOIL-GAS SAMPLE |
| M204-4000-4027 | NA | 5-3-94 | NA | ND | ND | ND | ND | ND | ND | QC-SYSTEM BLANK |

ND Non Detect

NA Not Applicable

QC Quality Control

J Qualitied as Estimated

ppb Parts Per Billion

< Less Than

# APPENDIX B

# SITE MAPS WITH ANALYTICAL RESULTS

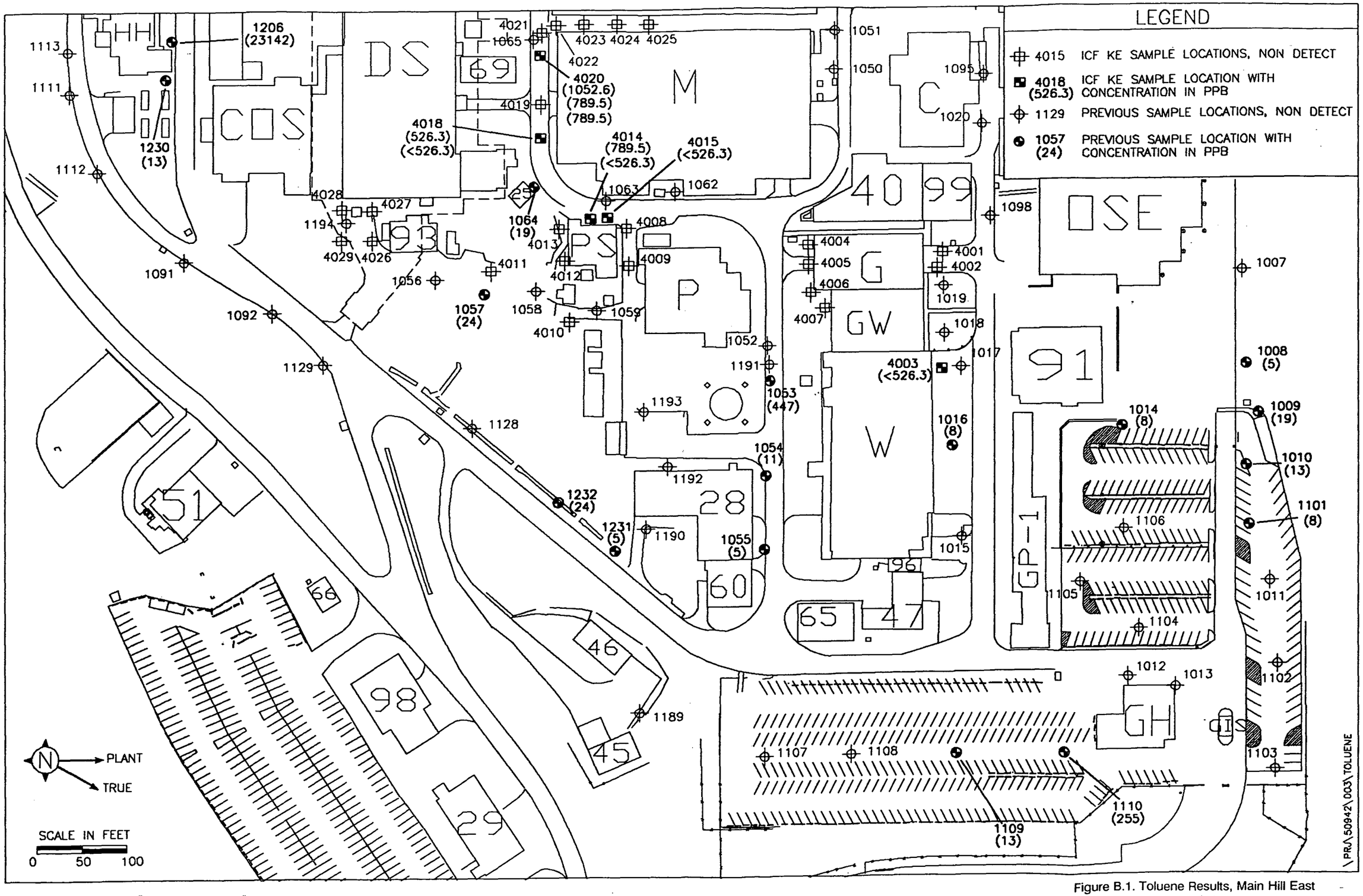


Figure B.1. Toluene Results, Main Hill East

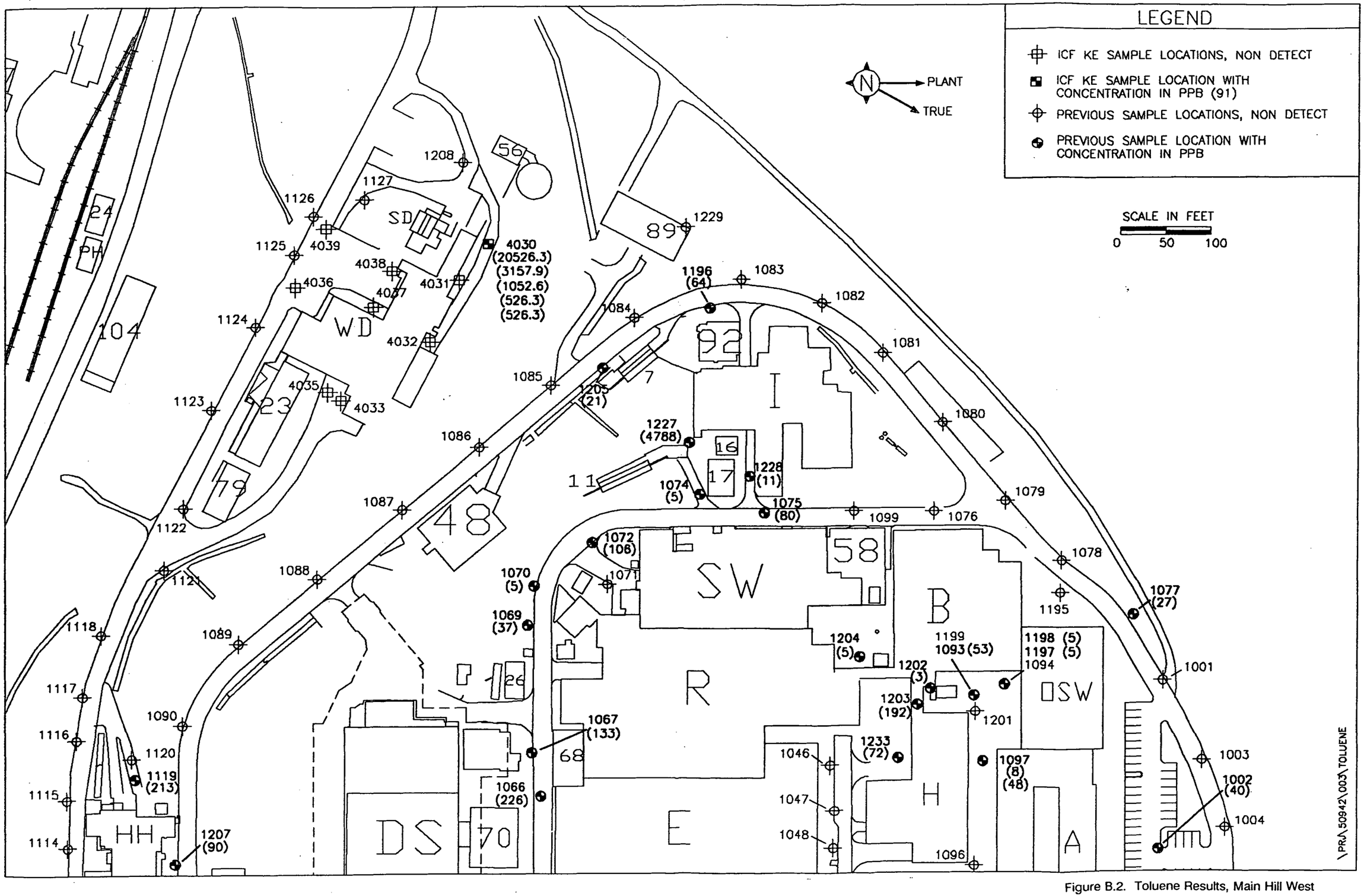


Figure B.2. Toluene Results, Main Hill West

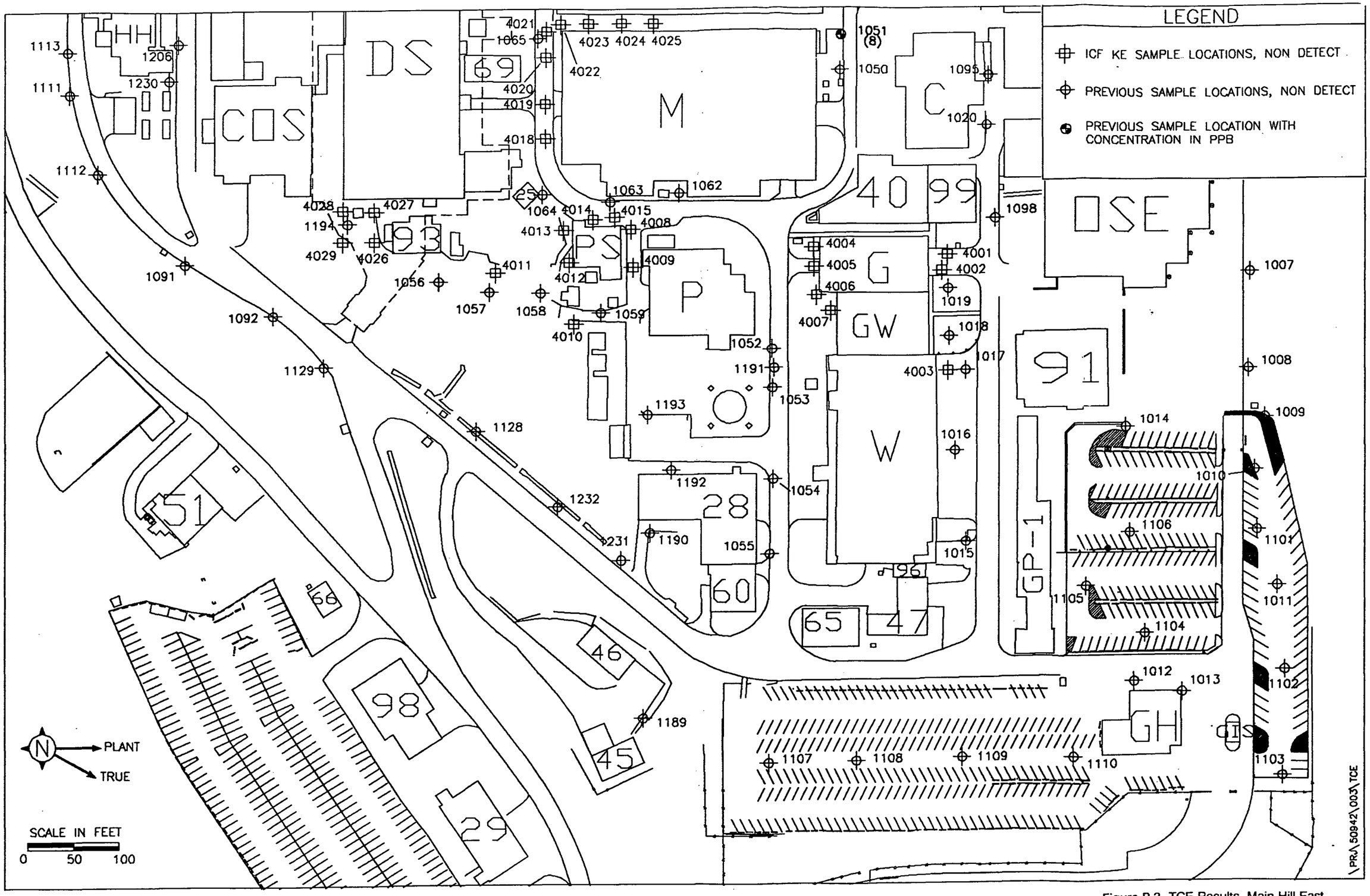


Figure B.3 TCE Results, Main Hill East

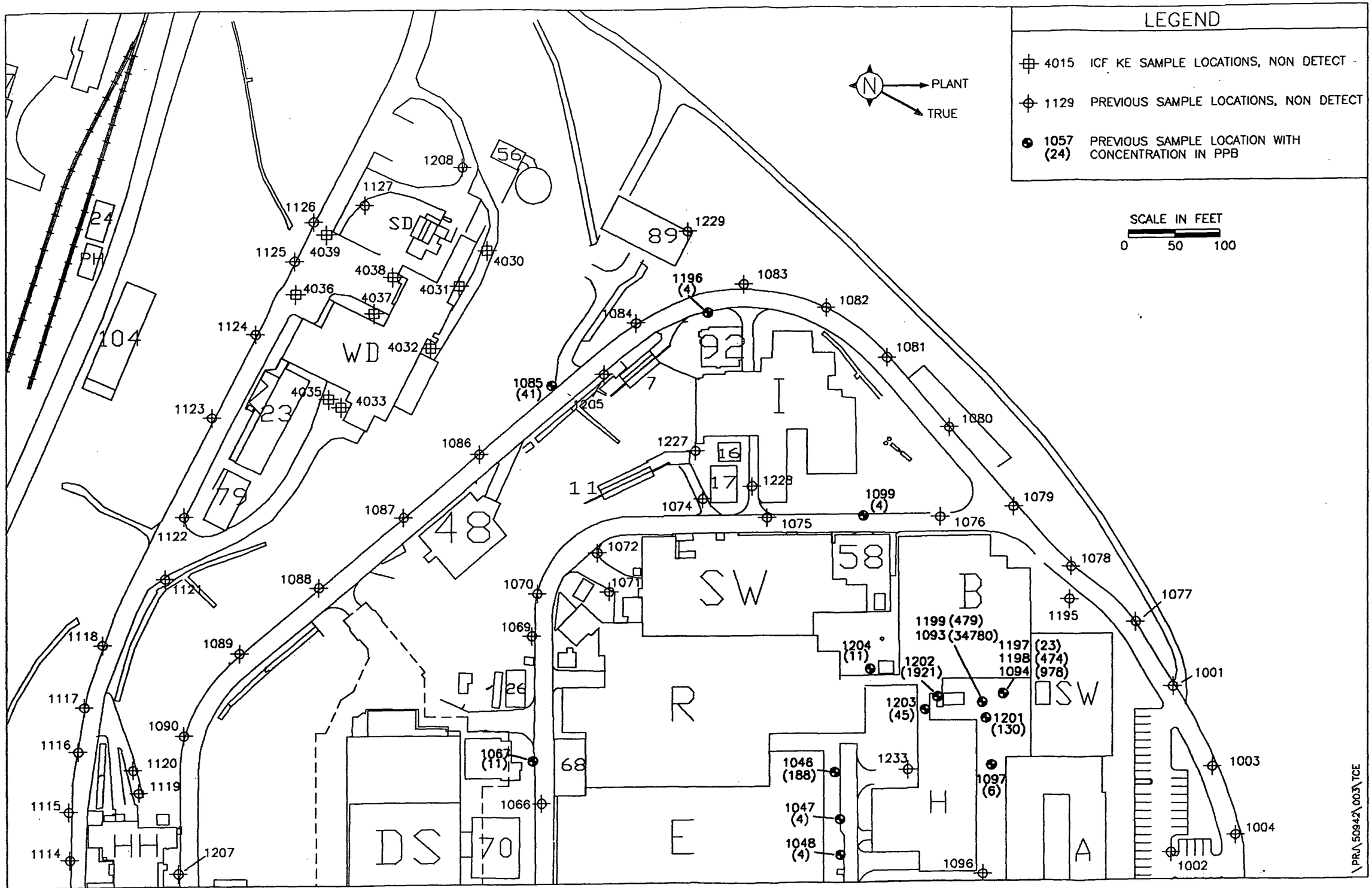


Figure B.4. TCE Results, Main Hill West

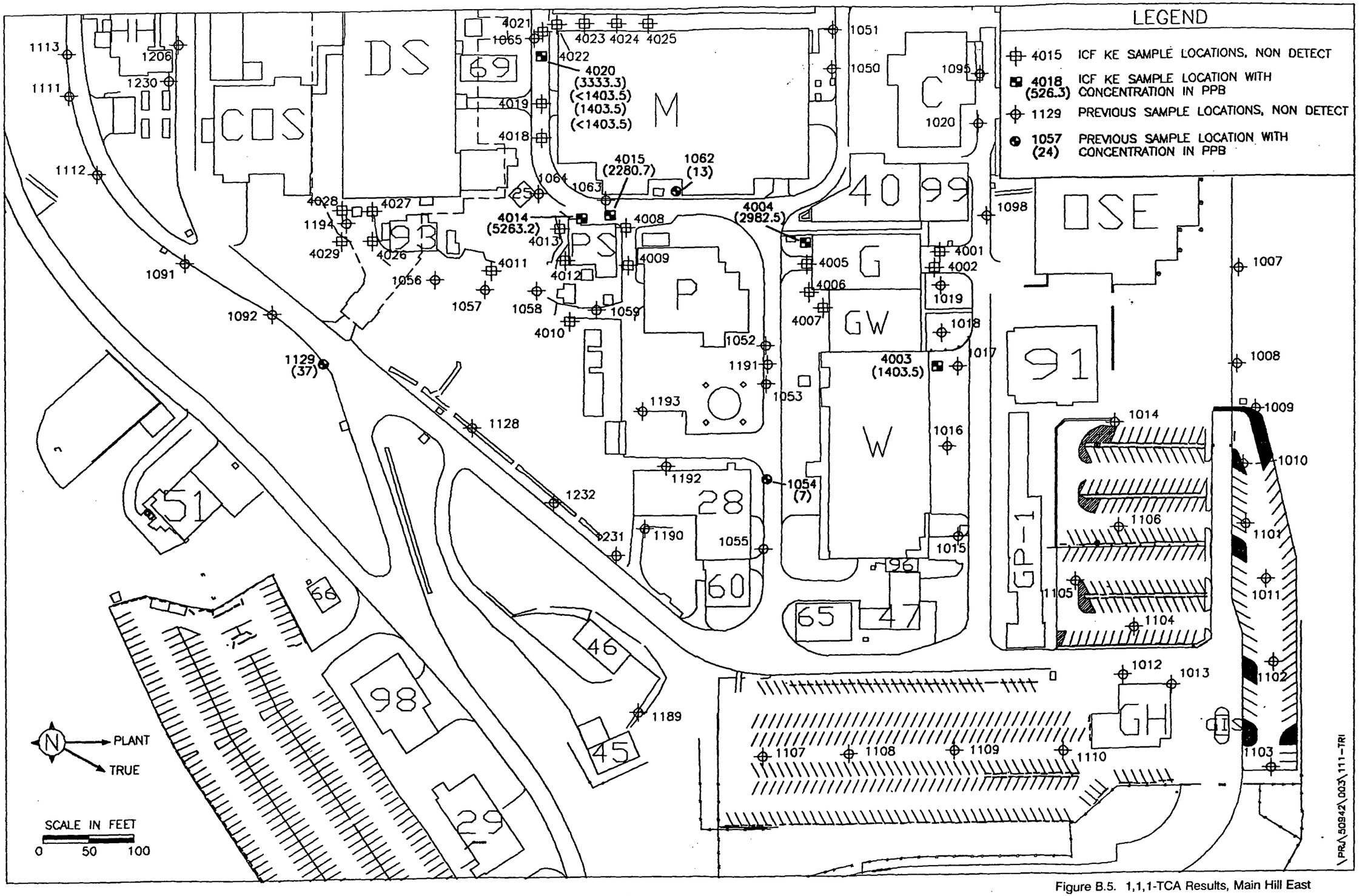


Figure B.5. 1,1,1-TCA Results, Main Hill East

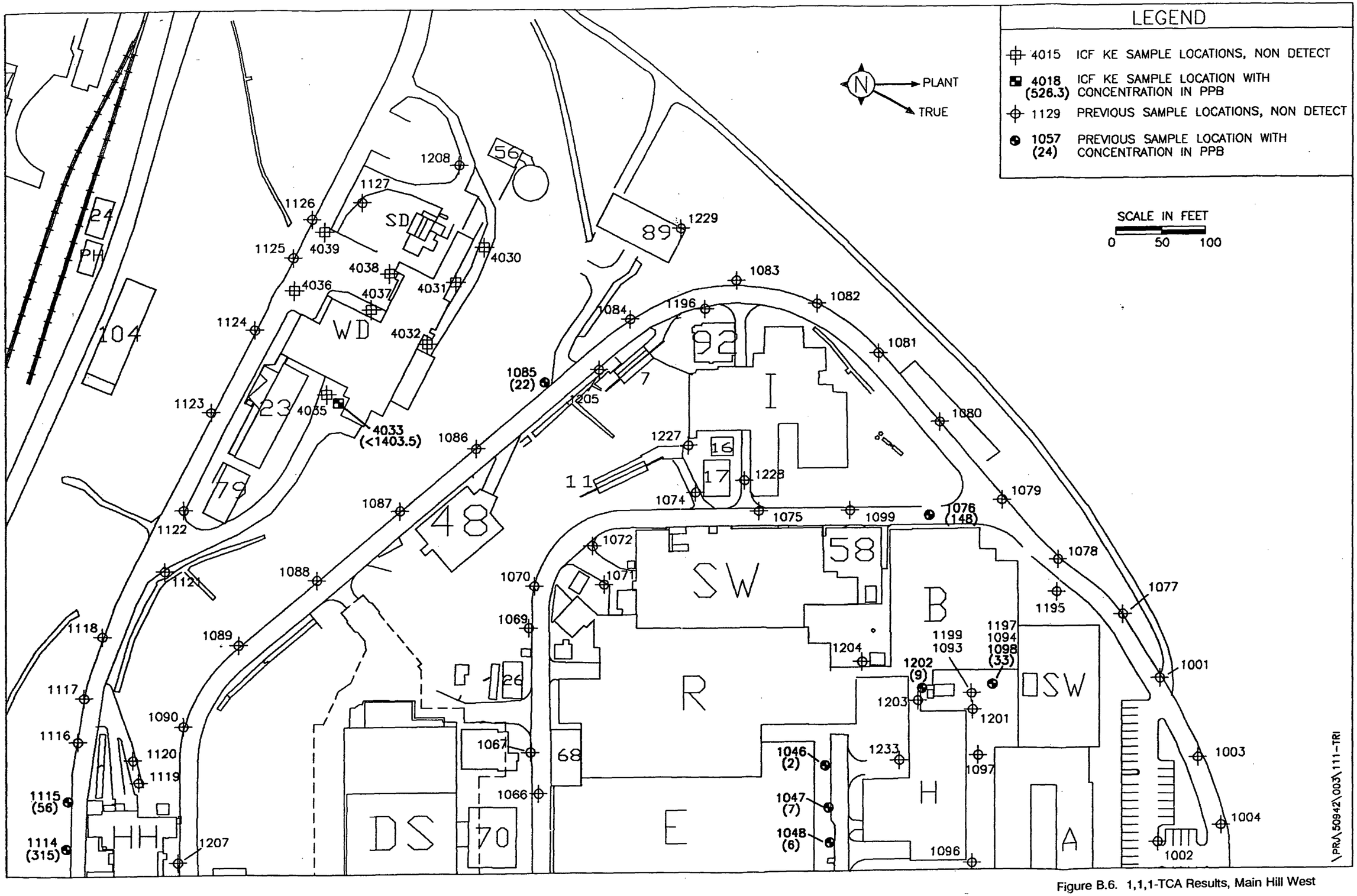


Figure B.6. 1,1,1-TCA Results, Main Hill West

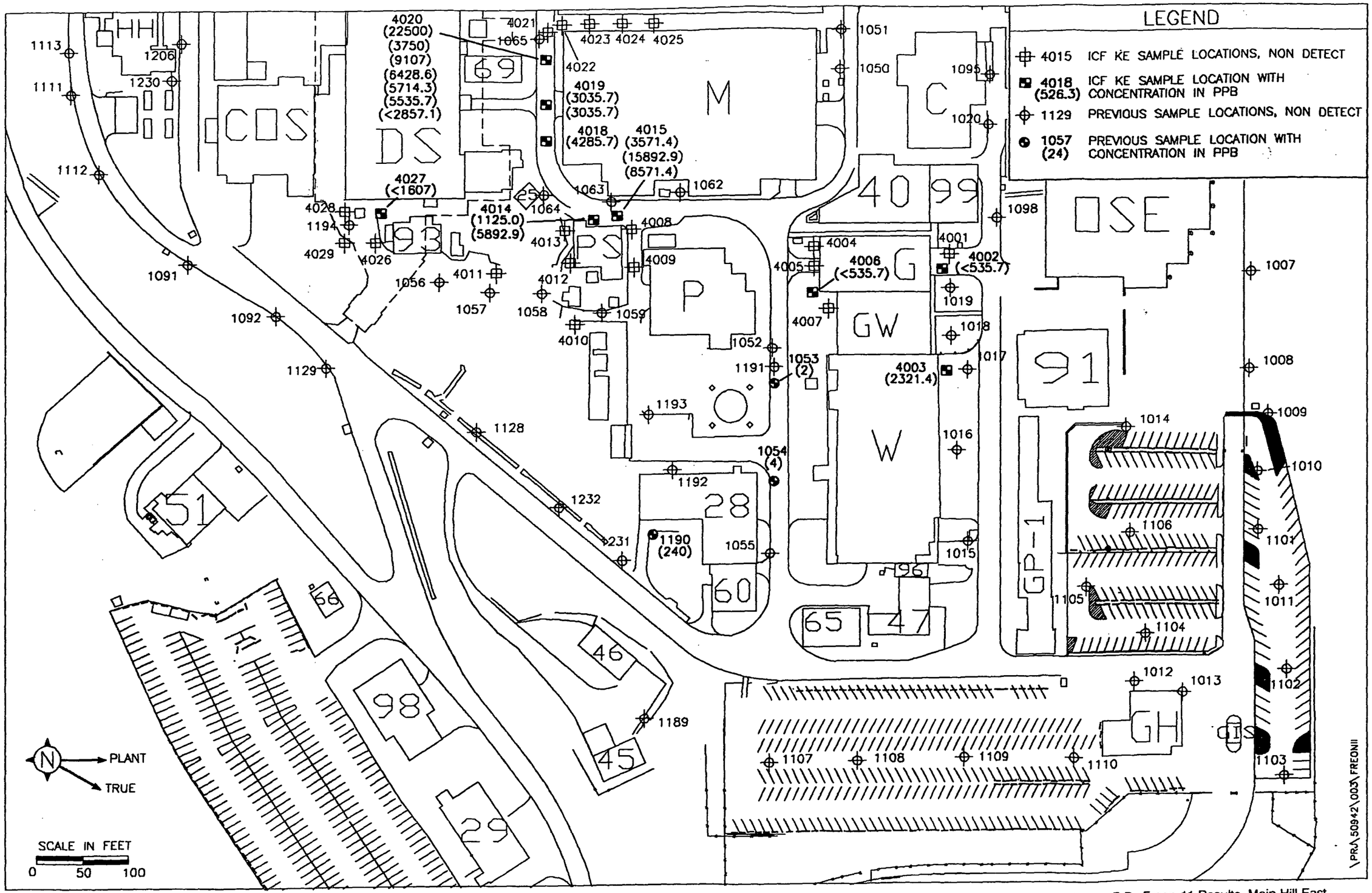


Figure B.7. Freon 11 Results, Main Hill East

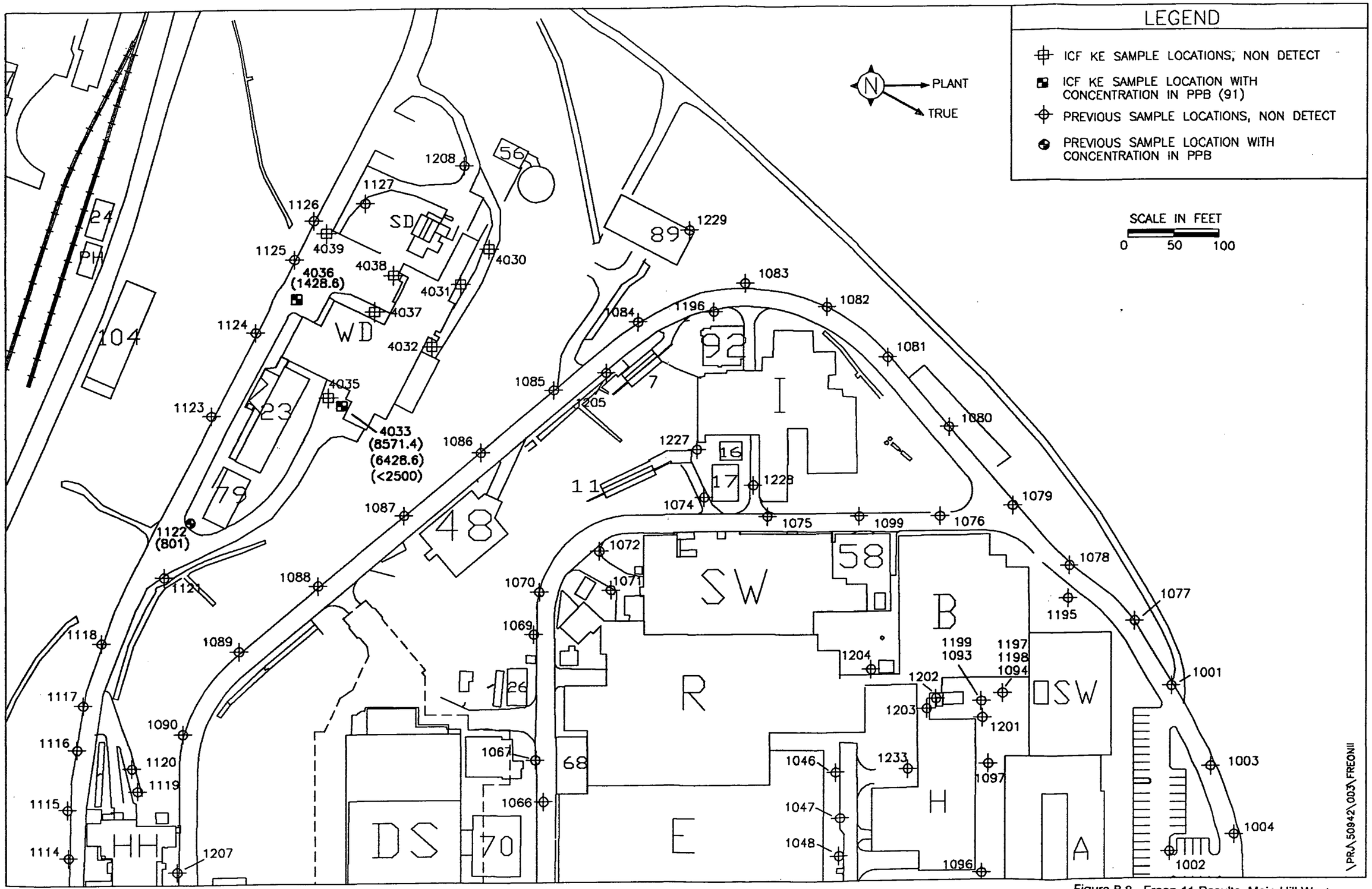


Figure B.8. Freon 11 Results, Main Hill West

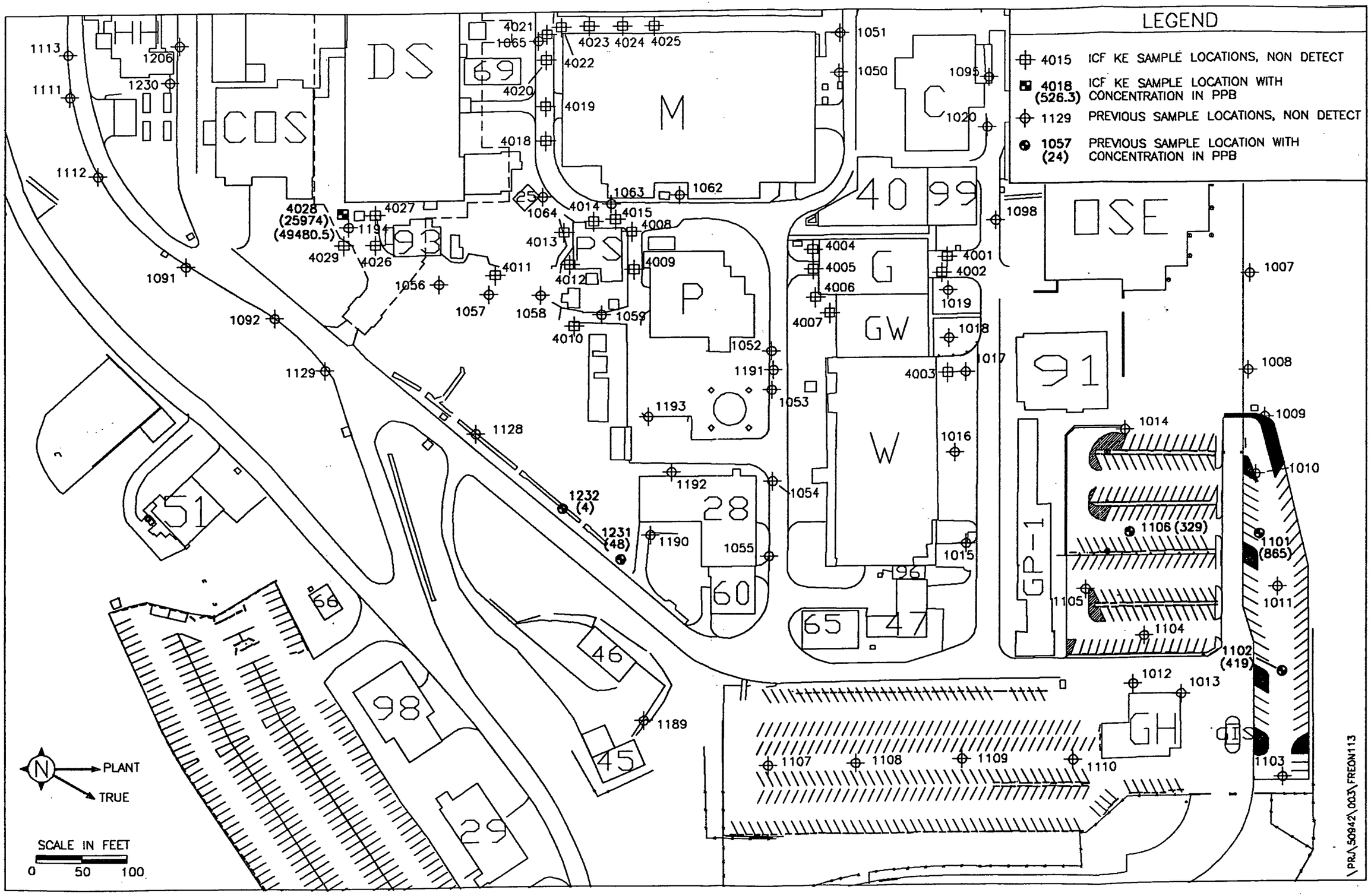


Figure B.9. Freon 113 Results, Main Hill East

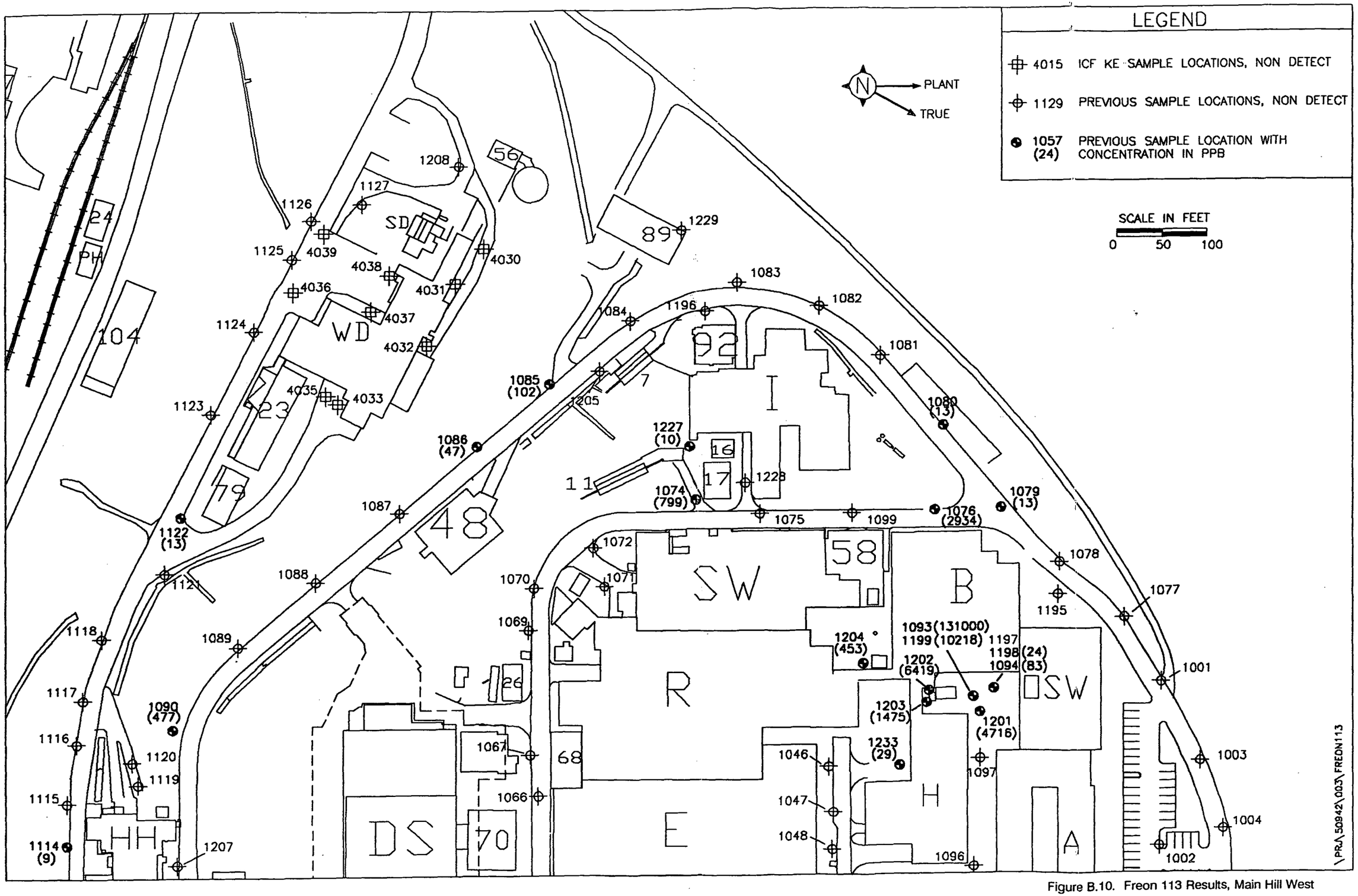


Figure B.10. Freon 113 Results, Main Hill West

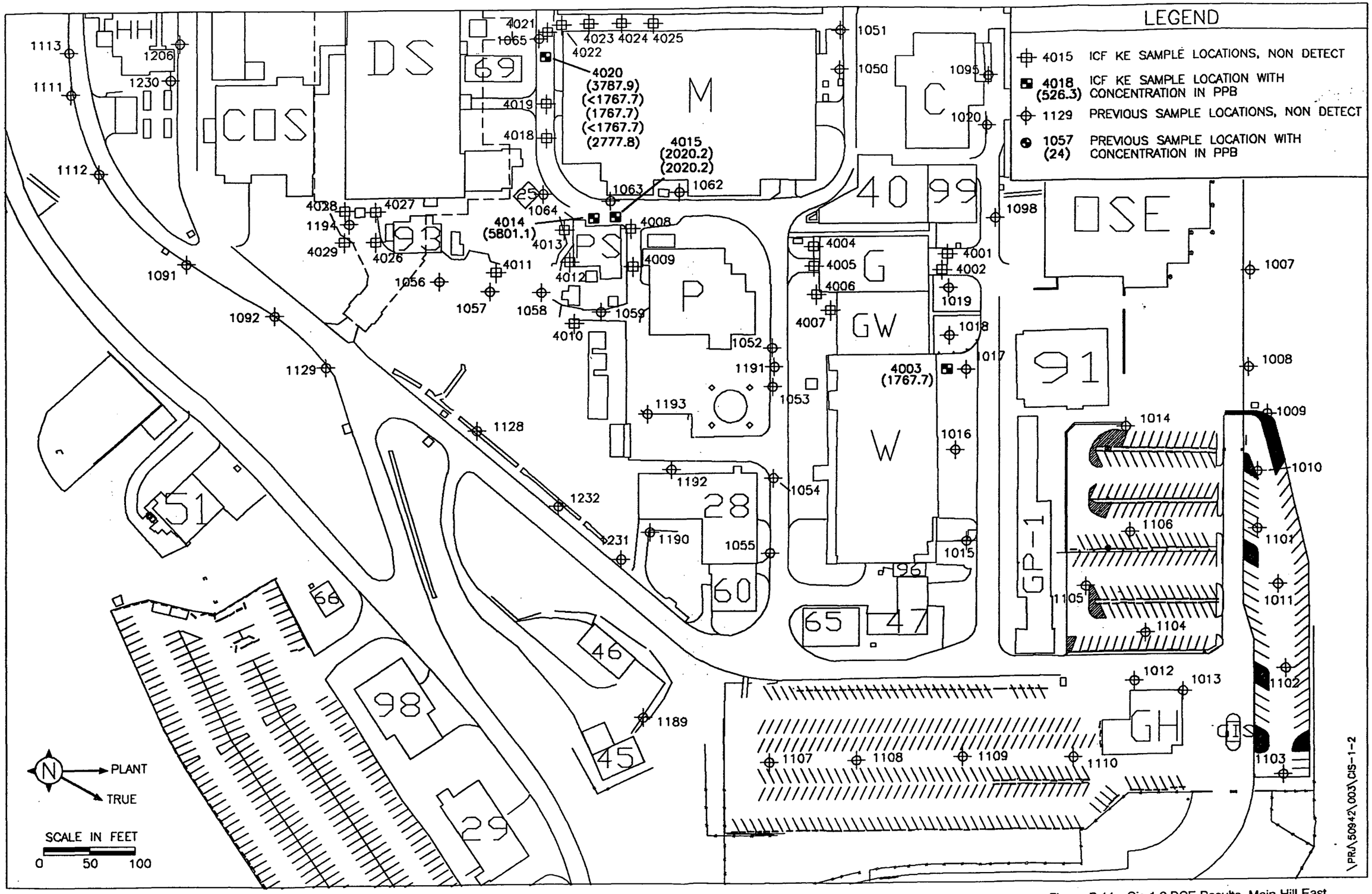


Figure B.11. Cis-1,2-DCE Results, Main Hill East

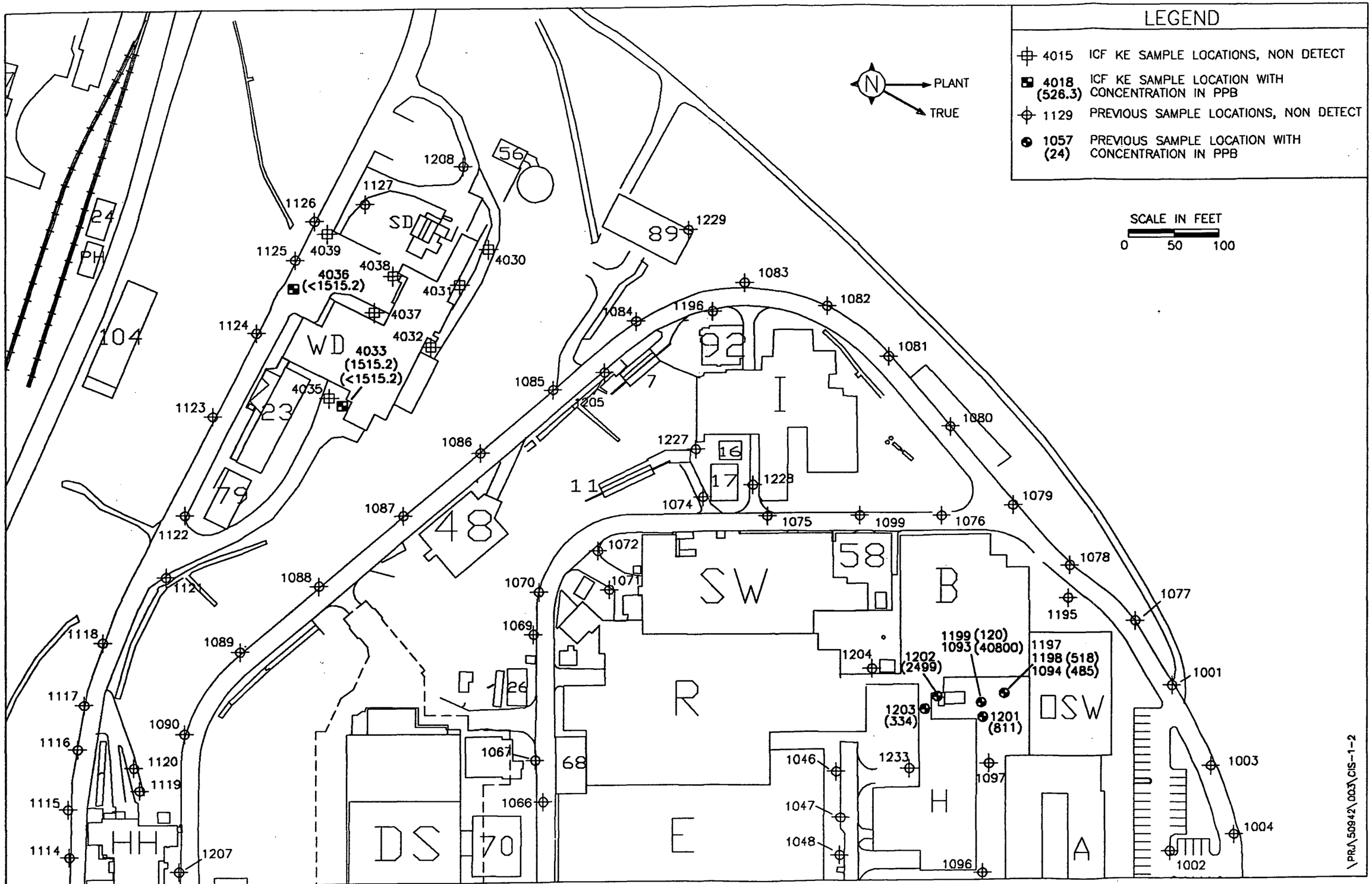


Figure B.12. Cis,1-2-DCE Results, Main Hill West

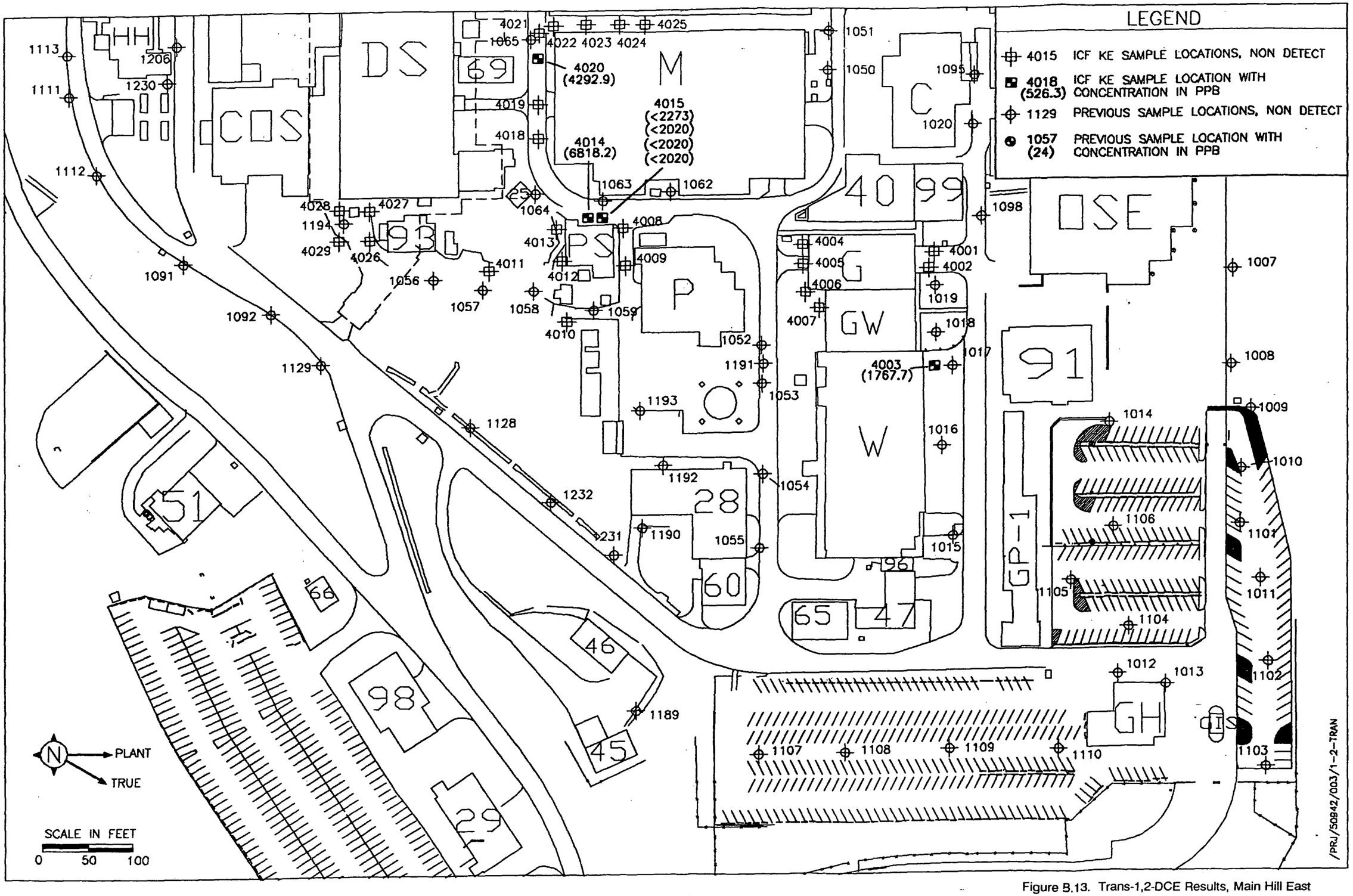


Figure B.13. Trans-1,2-DCE Results, Main Hill East

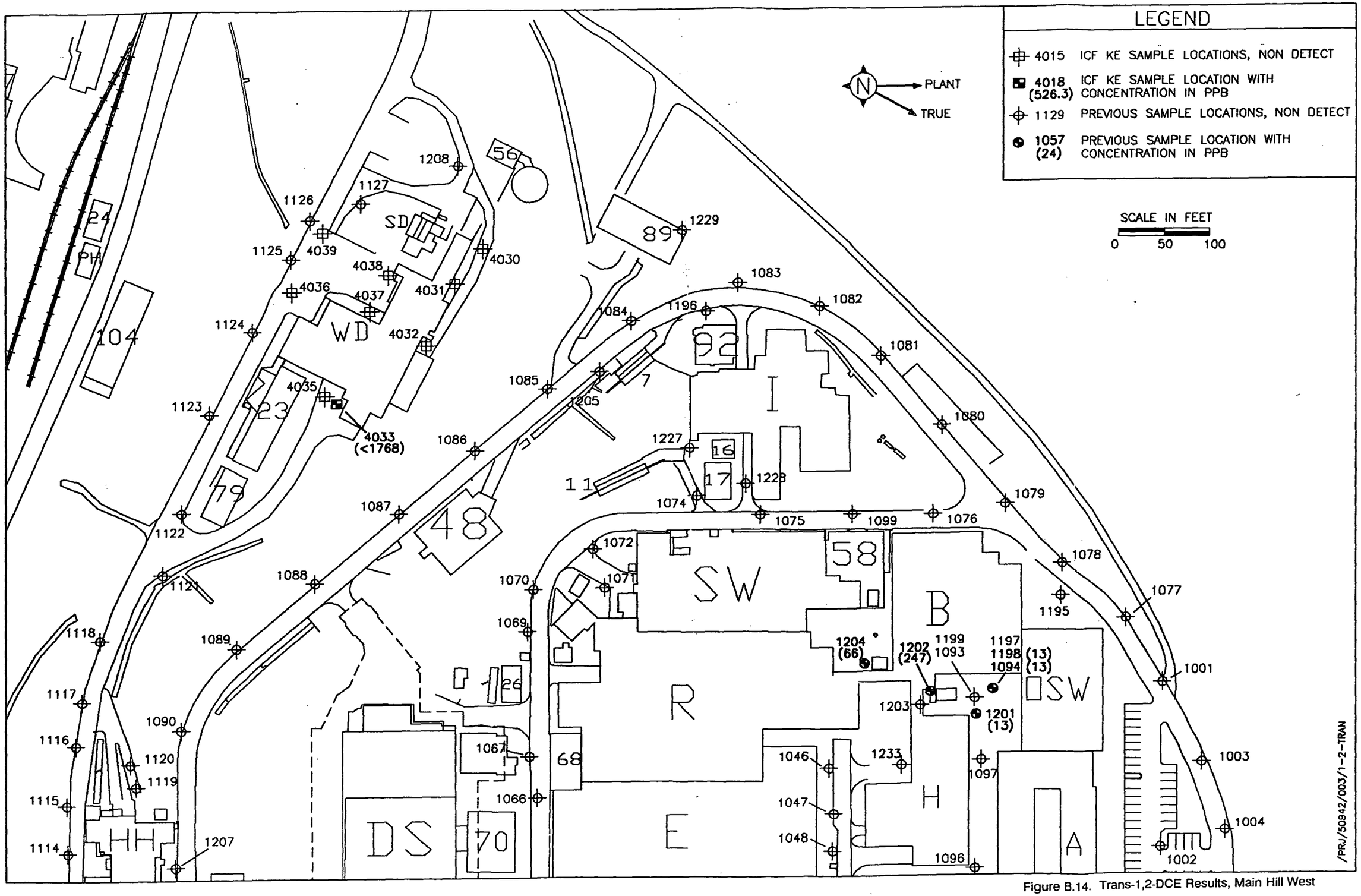


Figure B.14. Trans-1,2-DCE Results, Main Hill West

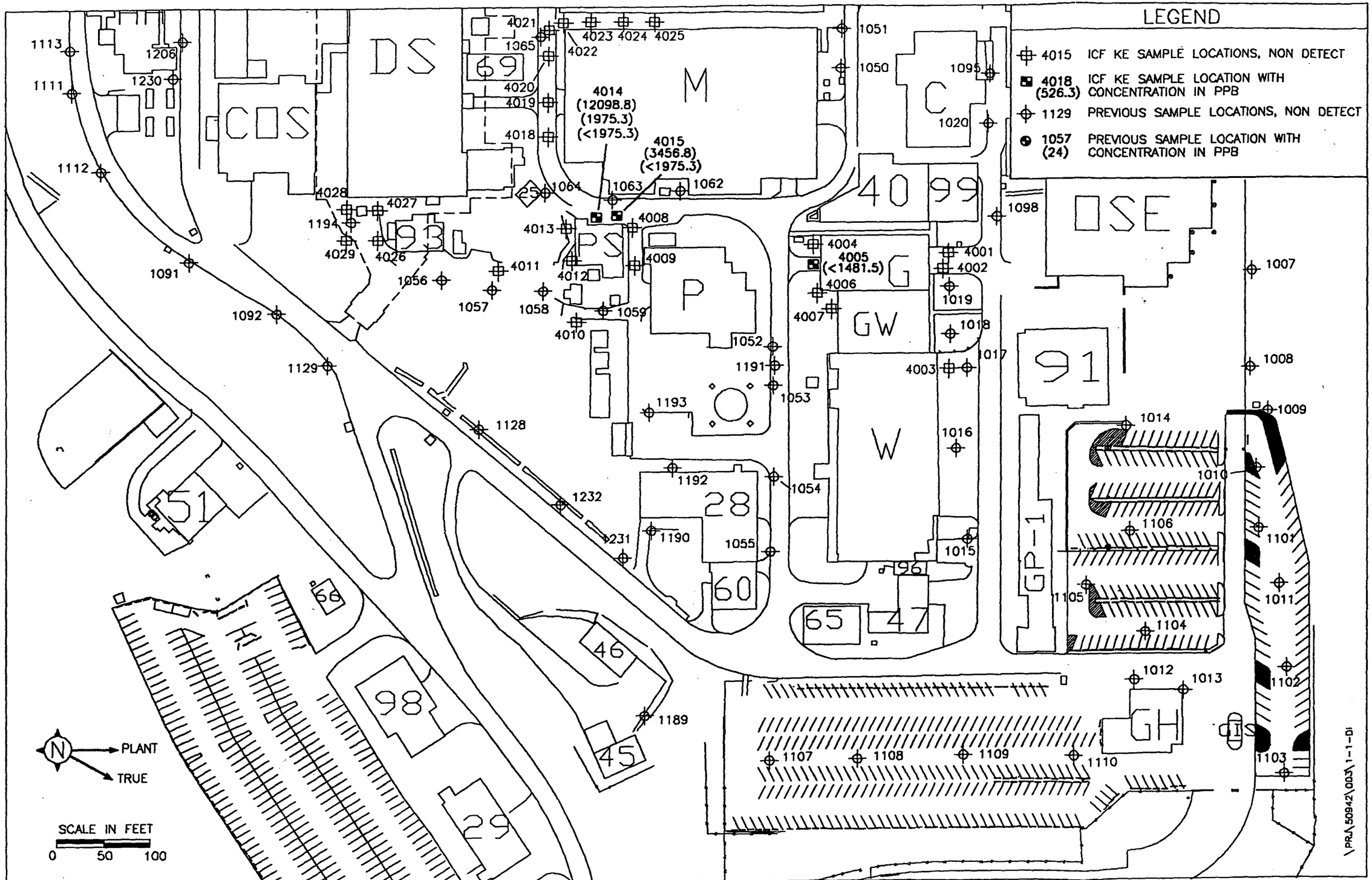


Figure B.15. 1,1-DCA Results, Main Hill East

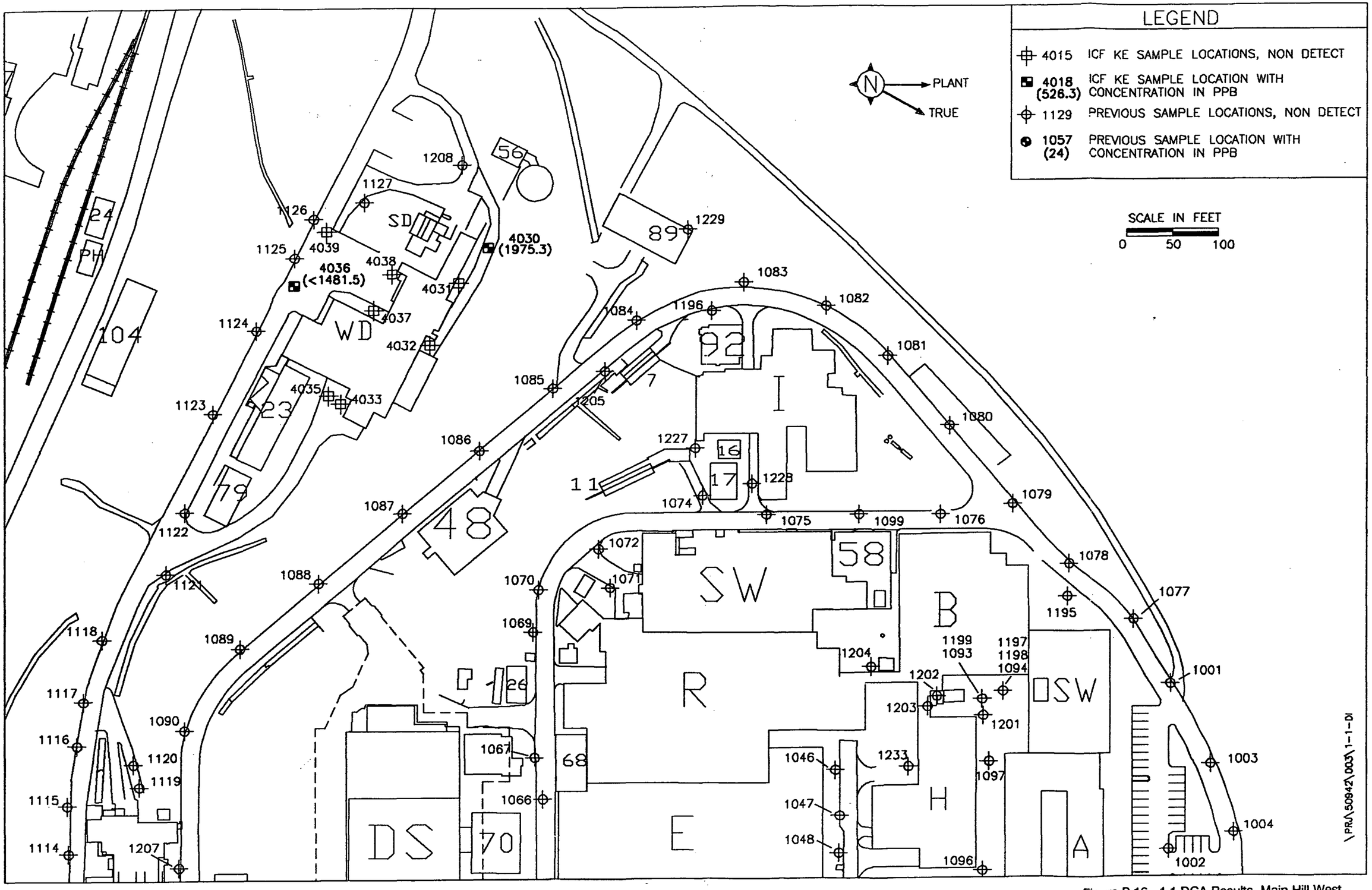


Figure B.16. 1,1-DCA Results, Main Hill West

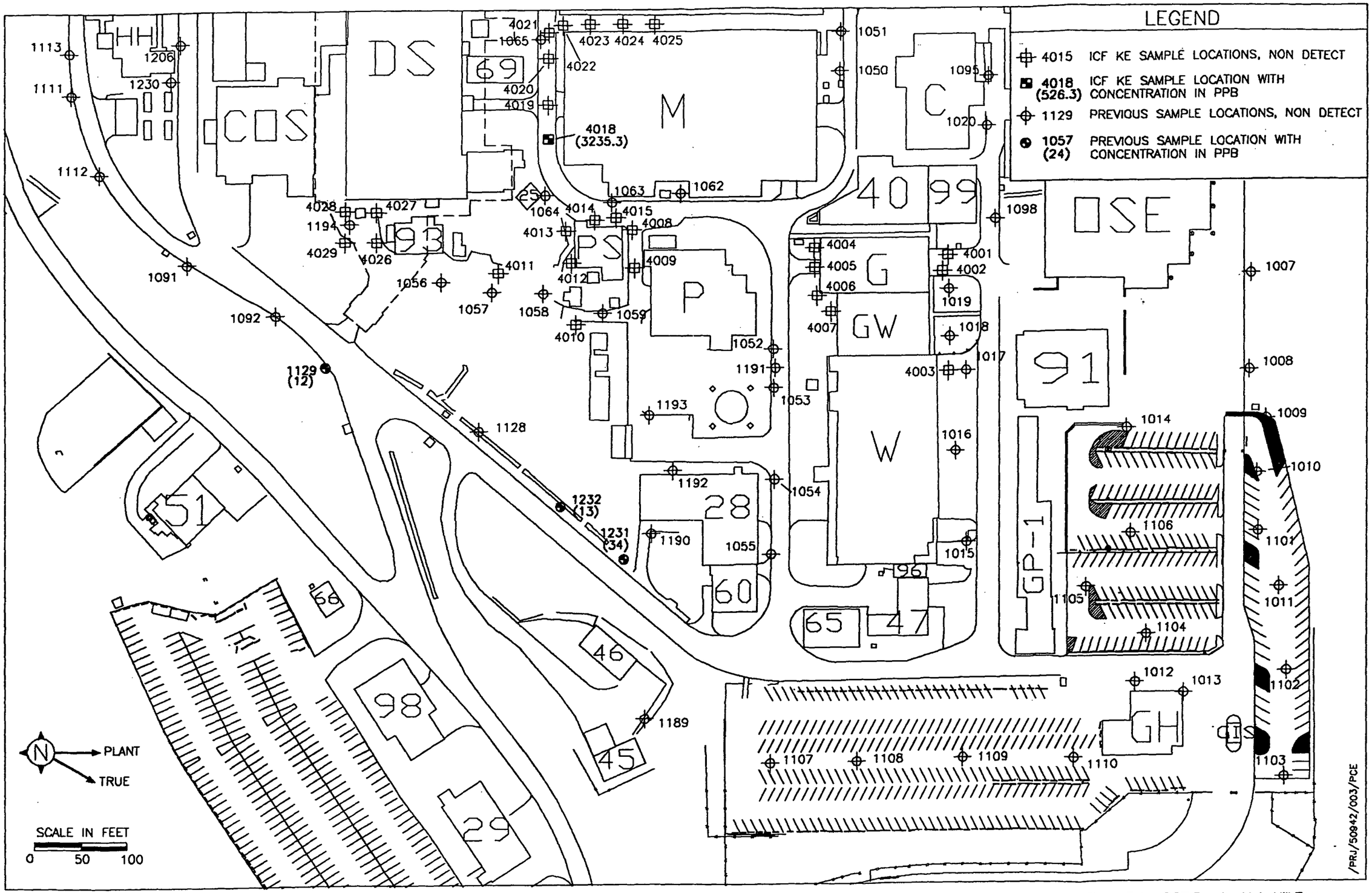


Figure B.17. PCE Results, Main Hill East

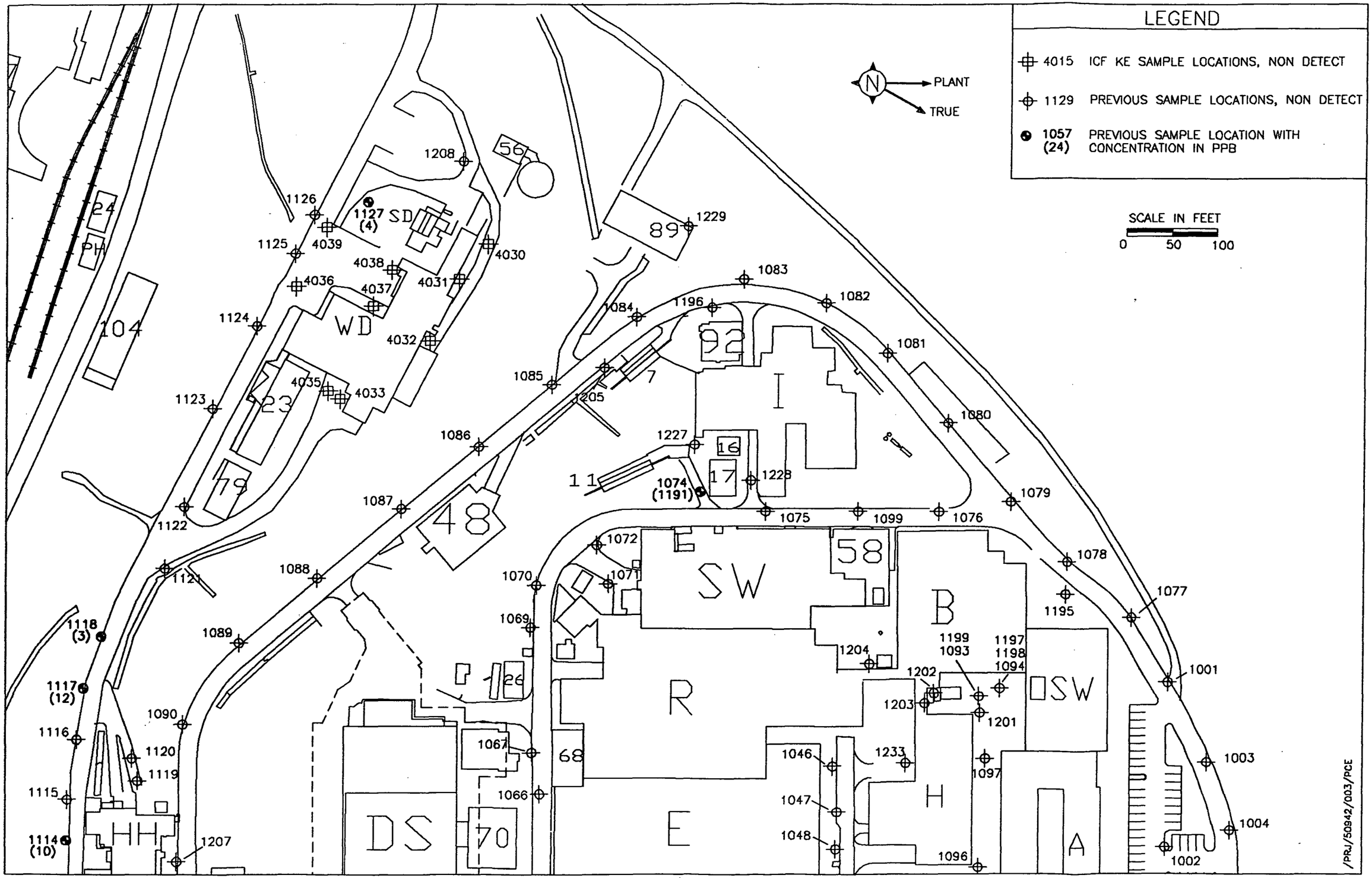


Figure B.18. PCE Results, Main Hill West

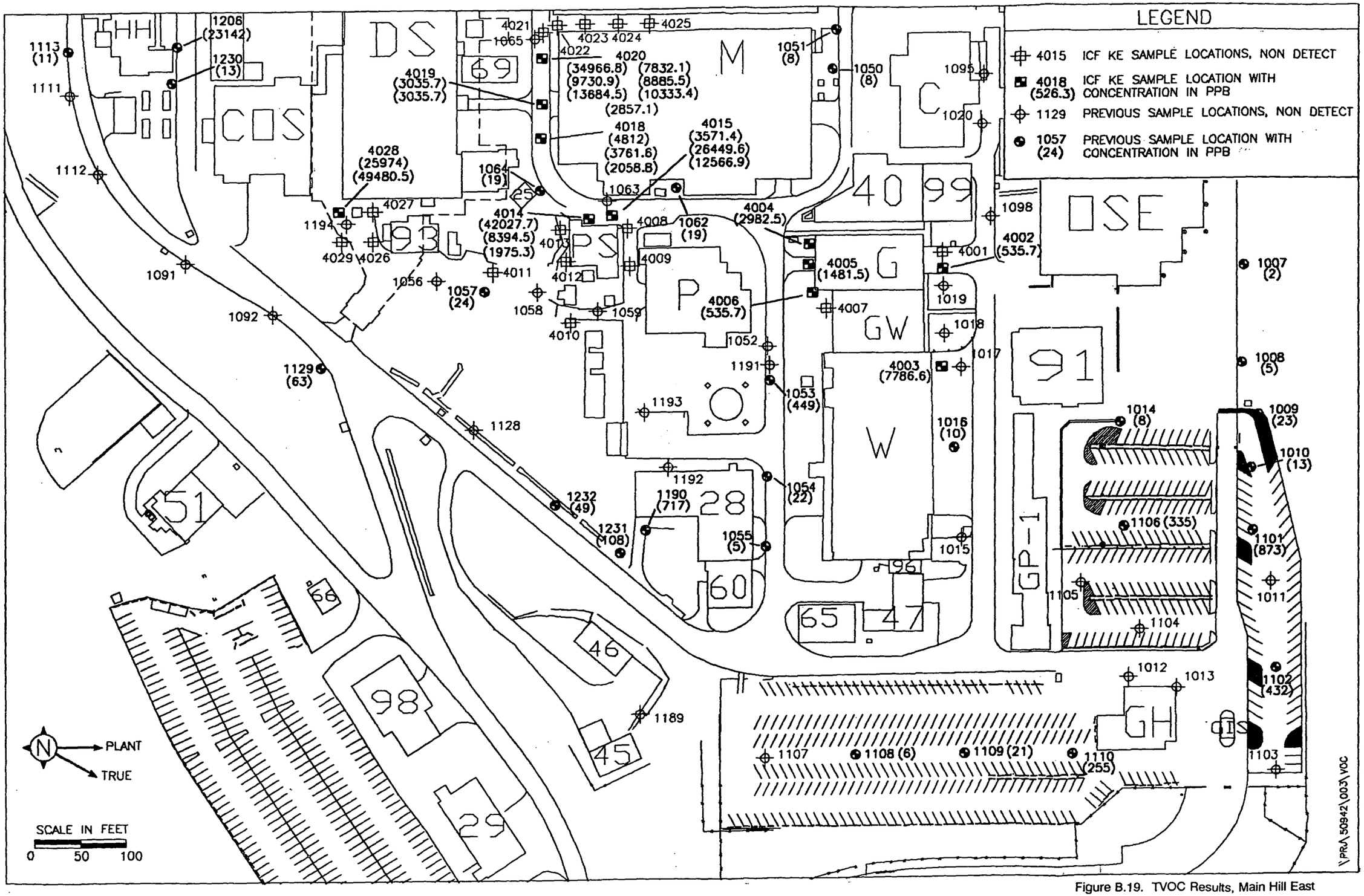


Figure B.19. TVOC Results, Main Hill East

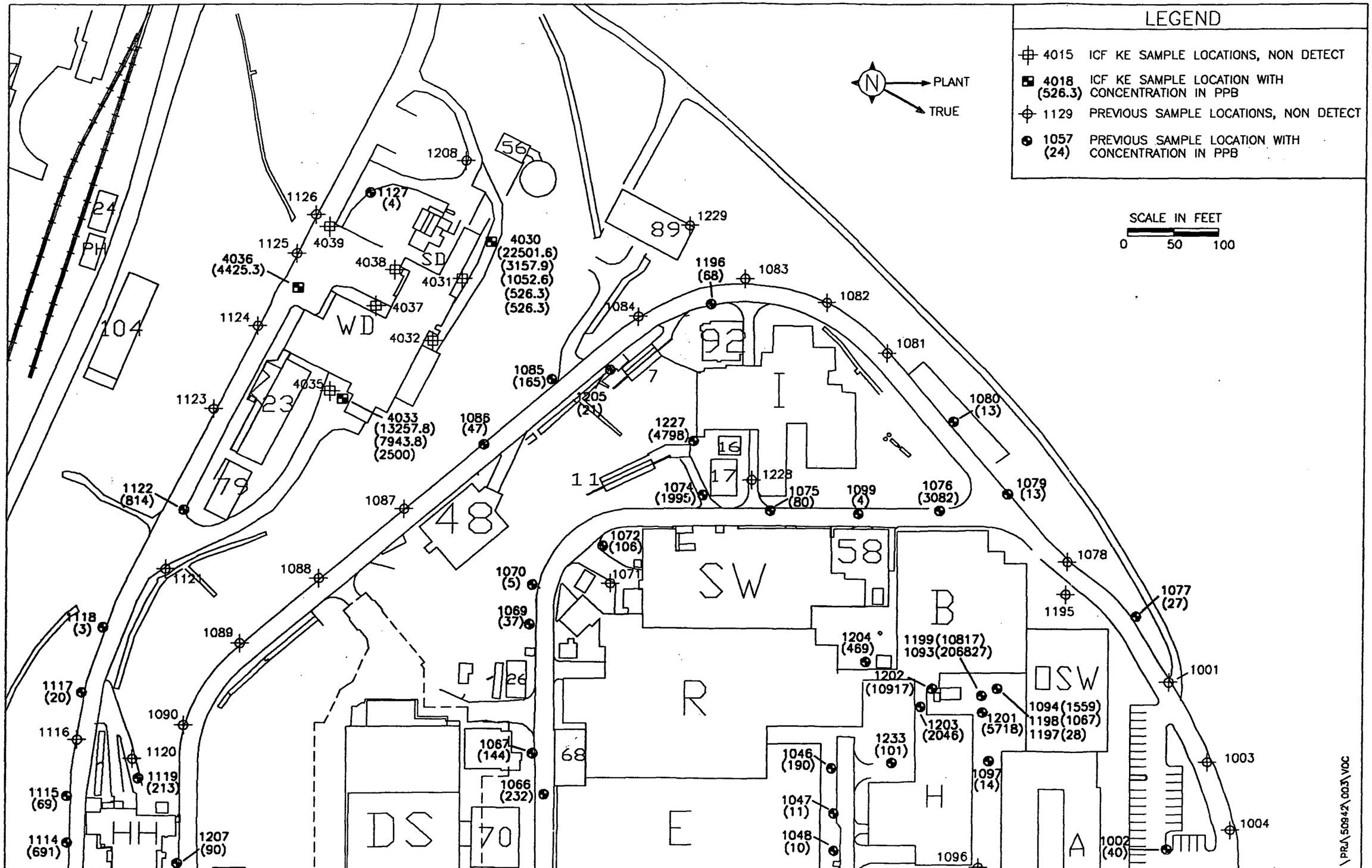


Figure B.20. TVOC Results, Main Hill West